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Report of the Working Group for the Celtic Seas Ecoregion (WGCSE)

4–13 May 2016

Copenhagen, Denmark

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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1 Executive Summary

The ICES Working Group for the Celtic Seas Ecoregion (WGCSE) met from 4th–13th May 2016 at ICES Headquarters in Copenhagen. The participants were from five countries; Belgium, France, Ireland, the Russian Federation and the UK. Of the 27 participants, 14 attended all of the meeting, eight attended part-time, three contributed by correspondence. The WG supported throughout by two professionals from ICES secretariat who assisted the WG with their advice drafting tasks. The meeting was chaired by Colm Lordan (Ireland).

In total the WG is responsible for the provision of updated fisheries data, assessments and draft advice for 39 demersal fish and *Nephrops* stocks across ICES Subareas 6 and 7 (with the distribution of megrim extending into Division 4.a and anglerfish into Subarea 4 and Division 3.a). This includes twelve *Nephrops* stocks, five sole and plaice stocks, four cod and whiting stocks, two megrim, haddock and sea bass stocks stocks, one anglerfish and one putative Pollock stock. Advice for *Nephrops*, anglerfish and Rockall megrim is delayed until autumn to make use of the most up to date survey information. Advice from the remaining stocks was scheduled for release on the 30th June.

Since the last Working Group meeting three stocks have gone through an Inter-Benchmark procedure; nep-17, nep-14 and bss-47 the results of which were presented to the group. WKMSYREF4 also revised reference points based on new methods and ICES guidelines for the majority of WGCSE category 1 stocks in the autumn of 2016 and these new reference points were published in February 2016 and were used as the basis for the advice this year. For category 3–5 stocks in western waters WKPROXY also carried out evaluation of MSY proxies and ICES released advice on those in February 2016. The WG was advised by the secretariat not to update these proxy evaluations with new data. The WG also did spend time review or commenting on the WKPROXY analysis since that was not on the ToRs of the group. Reconciling the proxy reference points, which were based on different methodology, with the WG assessments in the summary sheet did cause some issues and discussions at the WG and the ADG.

Update assessments were generally carried out according to the stock annexes (any deviations were detailed in the stock sections). The type of final assessments presented at the WG are summarised as follows:

- Category 1 age-based assessments and forecasts were conducted for cod-scow, whi-scow, had-rock, cod-7.e–k, had-7.b–k, whi-7.b–k, sol-iris, sol-celt and sol-echw.
- Category 1 length and age-based assessments and forecasts was conducted for bss-47
- Category 1 age-based assessment without forecasts was conducted for cod-iris
- Category 1 Bayesian surplus production model for meg-46a;
- Category 1: UWTV survey based assessments and advice were used for nep-11, nep-12, nep-13, nep-14, nep-15, nep-16, nep-17, nep-19, nep-2021 and nep-22. Fisheries data were updated at the May meeting and survey data were updated in the autumn.

- Category 3: Catch-at-age based assessments with caveats i.e. used for trends only and without forecasts for ple-iris, ple-echw, ple-7.h–k and sol-7.h–k.
- Category 3: Assessments based on survey data (Surba model or survey index) are used as the assessment and advice basis for ang-46, meg-rock, had-iris, ple-celt and whi-iris.
- Category 5 & 6: No assessments were carried out in 2016 for bss-wosi, ple-7.bc, sol-7.bc, cod-rock, cod 7.bc, pol-celt, whi-rock, nep-oth-6.a and nep-oth-7 only landings statistics were updated.

Overall the stock status across the ecoregion shows a slight improvement relative to that presented last year. Of the 39 stocks assessed 19 were fished below F_{MSY} and 15 were above $B_{trigger}$, ten stocks were fished above F_{MSY} and eleven were below $B_{trigger,}$ ten stocks had unknown status relative to F_{MSY} and 13 relative to $B_{trigger}$ (see table below).

Number of stocks relative to reference points by WG year:

	2011	2012	2013	2014	2016
F Below F_{MSY}	17	11	14	16	19
F Above F_{MSY}	9	14	13	11	10
Unknown	10	11	12	12	10
	2011	2012	2013	2014	2016
SSB Above $B_{trigger}$	13	13	11	13	15
SSB Below $B_{trigger}$	5	4	5	7	11
Unknown	18	19	23	19	13

West of Scotland Cod remains severely depleted but whiting is showing signs of recovery and the *Nephrops* stocks and megrim in Divisions 6.a and 4.a are exploited below F_{MSY} and have biomass or abundance above $B_{trigger}$. The assessment of Northern Shelf anglerfish stock also shows and increase in stock size although the stock remains in Category 3.

In the Irish Sea Cod and sole remain below B_{lim} but both stocks are starting to show signs of biomass increases in the most recent assessments. Whiting in 7.a remains at a very low level relative to the past and remains severely depleted. The two *Nephrops* stocks FU15 and FU14 are above $B_{trigger.}$ FU14 is exploited below F_{MSY} and FU15 is exploited above F_{MSY}. Plaice in the Irish Sea are estimated to be fished below proxy reference points and have a biomass above possible reference points (no quantitative estimates). Haddock in 7.a biomass is estimate to be the highest in the survey time series in 2016 and fishing mortality is estimated to be below the F_{MSY} proxy.

Further south in the Celtic Sea and West of Ireland areas, the biomass of haddock and whiting stocks have been at a high level well above MSY $B_{trigger}$ in recent years following some high or moderate recruitment. The cod stock is declining and is below well MSY $B_{trigger}$ and fishing mortality is increasing and is now estimated well above F_{MSY}. The quality of the assessment has also deteriorated with large retrospective revisions from year to year which was not previously a problem in this assessment. All the *Nephrops* stocks in this area are estimated to be exploited below F_{MSY}. There stocks are below MSY $B_{trigger}$: nep-17, nep-19 and nep-22. New MSY $B_{triggers}$ were established this year for two of the stocks FU22 and FU19. It was possibly to estimate F_{MSY} and promote FU20–21 *Nephrops* from category 4 to category 1 for the first time this year due to improved sampling data.

Celtic Sea sole is now assessed as being fished above F_{MSY} although the SSB remains above MSY $B_{trigger}$. Sole 7.hjk is assessed as being fished below the F_{MSY} proxy but no MSY $B_{trigger}$ has been defined. Western English Channel sole is well above MSY $B_{trigger}$ and is exploited below F_{MSY}. The assessments of plaice stocks in the Celtic Sea are typically more uncertain that those for sole due the lack of precise discard data which represents a substantial component of the catch. A trends based assessment is carried out for the western Channel plaice which shows a declining F and increasing SSB. Survey trends are used for Celtic Sea plaice (7.fg). This also shows an increasing stock size. In contrast the trends based assessment for 7.hjk plaice (which is based on 7.j data only) indicated a high F and recent decline in stock size.

Sea bass in 4.bc, 7.a and 7.d–h is assessed to be exploited above possible reference points. Fishing mortality shows a significant increasing trend over the last ten years while stock biomass has decline since 2005 following some weak year classes. The stock is estimated to have declined below B_{lim} in 2016.

Overall the WG managed to address most of the ToRs adequately. The quality and quantity of the stock reviews was better than last year. There were a few stocks where the report sections were produced very late or not at all. In these cases it is not always possible to ensure that the material is reviewed properly. This is a persistent problem in WGCSE and is something that needs to be rectified in the future since it impacts negatively on quality and also the workload of the chair.

1.1 Terms of reference

2015/2/ACOM05 The following ToRs apply to: AFWG, HAWG, NWWG, NIPAG, WGWIDE, WGBAST, WGBFAS, WGNSSK, WGCSE, WGDEEP, WGBIE, WGEEL, WGEF, WGHANSA and WGNAS.

The working group should focus on

a) Consider and comment on ecosystem overviews where available;

b) For the fisheries relevant to the working group consider and comment on:

  i) descriptions of ecosystem impacts of fisheries where available

  ii) descriptions of developments and recent changes to the fisheries

  iii) mixed fisheries overview, and

  iv) emerging issues of relevance for the management of the fisheries;

c) Conduct an assessment to update advice on the stock(s) using the method (analytical, forecast or trends indicators) as described in the stock annex and produce a brief report of the work carried out regarding the stock, summarising where the item is relevant:

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

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

iii) For relevant stocks estimate the percentage of the total catch that has been taken in the NEAFC Regulatory Area by year in the recent three years.

iv) The developments in spawning–stock biomass, total stock biomass, fishing mortality, catches (wanted and unwanted landings and discards) using the method described in the stock annex;

v) The state of the stocks against relevant reference points;

vi) Catch options for next year;

vii) Historical performance of the assessment and catch options and brief description of quality issues with these;

d) Produce a first draft of the advice on the fish stocks and fisheries under consideration according to ACOM guidelines.

e) With reference to the Frequency of Assessment criteria agreed by ACOM (see Section5.1 of WGCHAIRS document 03): (1) Complete the calculation of the first set of criteria, by calculating Mohn's rho index for the final assessment year F; (2) Comment on the list of stocks initially identified as candidates for less frequent assessment from the first set of criteria (adding stocks to the list or removing them would require a sufficient rationale to be provided).

f) Estimate precautionary reference points for all the category 1 stocks with undefined PA reference points, following the Technical Guidelines document on reference points developed by ACOM and the WKMSYREF4 report.

The working group is furthermore requested to

a) Consider and propose stocks to be benchmarked;

b) Review progress on benchmark processes of relevance to the expert group;

c) Propose specific actions to be taken to improve the quality and transmission of the data (including improvements in data collection);

d) Prepare the data calls for the next year update assessment and for the planned data evaluation workshops;

e) Update, quality check and report relevant data for the stock:

i) Load fisheries data on effort and catches into the InterCatch database by fisheries/fleets;

ii) Abundance survey results;

iii) Environmental drivers.

f) Produce an overview of the sampling activities on a national basis based on the InterCatch database or, where relevant, the regional database.

g) Identify research needs of relevance for the expert group.

Information of the stocks to be considered by each Expert Group is available here.

2015/2/ACOM13 The **Working Group for the Celtic Seas Ecoregion** (WGCSE), chaired by Colm Lordan, Ireland will meet at ICES Headquarters, Copenhagen, Denmark, 4–13 May 2016 and by correspondence September / October 2016 to:

a) Address generic ToRs for Regional and Species Working Groups.

b) Check the relevance of the reopening procedure and report on reopened advice if appropriate.

c) Prepare a working document to report back on the progress - via specific milestones, deliverables, and identification of responsible parties - of data evaluation and stock assessment models for cod in Division 7.a (Irish Sea), haddock in Division 7.a (Irish Sea), plaice in Division 7.a (Irish Sea) and whiting in Division 7.a (Irish Sea).

The assessments will be carried out on the basis of the stock annex. The assessments must be available for audit on the first day of the meeting.

Material and data relevant for the meeting must be available to the group no later than 12 April 2016 according to the Data Call 2016.

WGCSE will report by 19 May 2016 for the attention of ACOM and WKIrish, and by 7 October 2016 for *Nephrops* stocks, anglerfish and Rockall megrim. Concerning ToR b) the group will report on the ACOM guidelines on reopening procedure of the advice before 12 October and will report on reopened advice before 28 October.

1.2 General considerations

Participation in WGCSE has generally declined in recent years and the number of part-time participants has also increased (Figure 1.2.1 and Figure 1.2.2). The number of participants in the meeting by day is typically only around 20 (Figure 1.2.2). WGCSE assesses 39 stocks annually. This requires a substantial time commitment from the various institutes before during and after the meeting. Increasingly review work takes place in the one to two weeks after the WGCSE meeting. Some participants are not available during this period which hampers the completion of the various report and stock audit sections.

This year there were a number of new participants to the group which is an encouraging sign. Institutes should send new staff or staff involved in data collection to get exposure to the WG environment. WGCSE has lost some of the most experienced participants in the last few years. The declining numbers of participants present at the meeting and their levels of experience reduces the scope for good plenary discussions, subgroups on strategic issues, critical review, etc. Increasingly during the meeting many of the participants are focused on their own stock sections and group interaction is suffering.

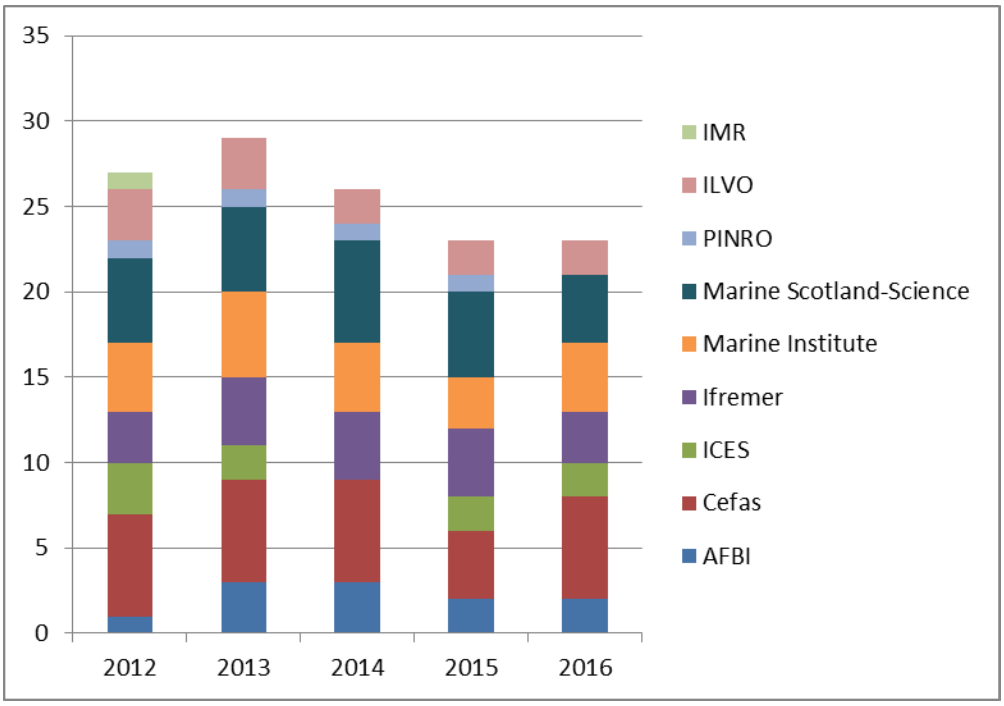


Figure 1.2.1. Numbers of WGCSE full-time participants by institute over time.

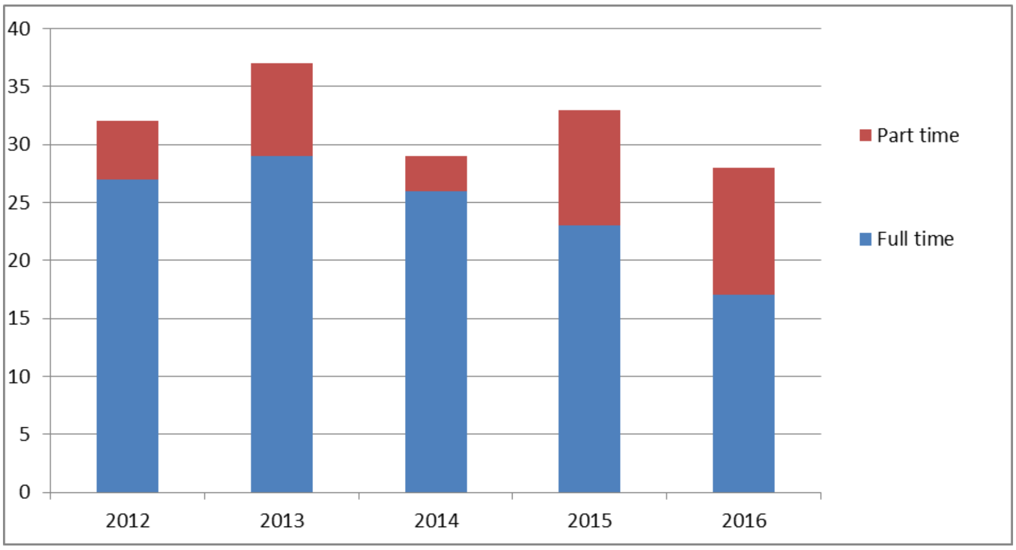


Figure 1.2.2. Numbers of WGCSE participants over time and whether they were full-time or part-time.

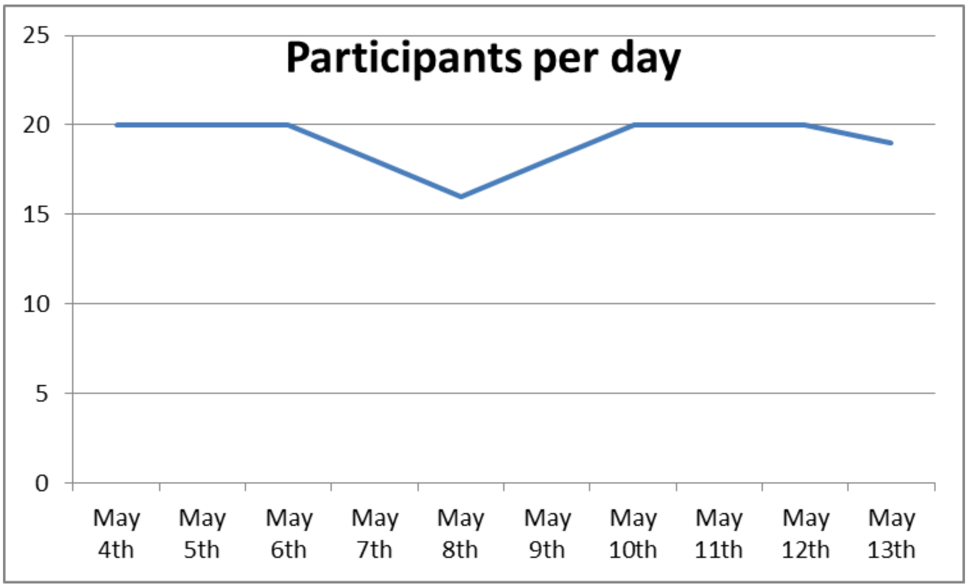


Figure 1.2.3. Number of participants in WGCSE 2016 by day.

1.3 InterCatch

Métier-based data call for WGCSE and WGMIXFISH

The format of the data call the procedure for data submission was practically the same as in 2015. An official data call was issued by ICES, with a deadline for data delivery by 12th April 2016. No major issues occurred this year, and only few data were delayed compared to this date and some errors needed to be corrected before the working group without having a major impact on the work.

A number of issues were highlighted during the meeting in relation to data and InterCatch. The first relates to the RDB. ToR l) asks the WG to "*Produce an overview of the sampling activities on a national basis based on the InterCatch database or, where relevant, the regional database*". In the past WGCSE, and prior to that WGNSDS and WGSSDS, provided details of annual sampling levels by country in a table. The objective of including this table was to provide some sort of quality metric on the underlying sampling data. WGCSE 2016 did not carry out this type of data compilation because in principle these data should already be available through the RDB where a time-series should be extractable by various stratification levels. However, the RDB was not available to WGCSE members and sampling levels reported to IC were not easily accessible from InterCatch. **WGCSE recommend that those developing the RDB and IC to provide data summary products for EGs** since the information would be useful to support and verify these types of quality comments that are often included about sampling levels in the summary sheets.

Some stocks in WGCSE continue to suffer from over-stratification of input. InterCatch works well for stock with low numbers of strata, however as the number of strata increases the time and complexity involved for the stock co-ordinator to raise and check data in InterCatch increases significantly. **WGCSE recommend that benchmark WGs, such as WKIRISH, provide clear guidance on the aggregation levels for input data to InterCatch across a number of stocks**. WGCSE further recommend that data submitters ensure consistency across time in the stratification and codification at a stock level. The current list of metiers available to WGCSE is far too broad and a short list agreed with the stock co-ordinator should be used.

1.4 Internal auditing and external reviews

ICES removed in general the external review process that had been in place for some years, and replaced it by an internal audit process within the Working Group itself. The WG audit process essentially takes two forms.

1) The stock coordinator presents the input data, the assessment settings, diagnostics and results as well as the forecast inputs and outputs in plenary at the meeting.
2) The draft report section is reviewed in detail by an independent WG member. After which the audit and stock sections are checked, edited and finalized by the WG chair.

Data compilation at national level and international level in InterCatch is not checked during the audit which is potential weakness in the process. **WGCSE recommends that improved access to, and transparency of, data through the RDB and InterCatch is need to improve this step in the audit process.**

WGCSE has developed "r markdown" code over the last couple of years to independently audit XSA assessments and forecasts. This year the code was applied to the XSA assessment for cod 7.e–k, sole 7.a, sole 7.fg, sole 7.e, whiting 7.b–k. In addition the haddock 7.b–k assessment, which is carried out in ASAP, is fully documented using a series of well laid out "r markdown" scripts. This approach greatly improves transparency and quality assurance for those stocks. **WGCSE recommends that as part of the benchmark process that standard scripts are developed for each stock.**

Audits were also carried out by WG members using the standard template for cod 6.a, had6.b, had7.a, ple 7.e, ple7.fg, whg6.b, whg6.a and meg6.a4.a. The capacity of the group to properly audit TSA assessments and the surplus production assessment is limited due to lack of expertise in those methods and the fact that the assessments are not easily run by independent experts. Audits were not carried out this year for cod 7.a and bass47 due to the late or non-availability of the report sections on the WG SharePoint site before the ADG. In the case of bass, the inter-benchmark process was also not finalized at the time of the WG meeting.

Audits on all the *Nephrops* stocks were carried out by correspondence. The improved standardization of report sections and tables greatly improved the capacity to check the various calculations. All catch options tables were independently checked at the ADG. WGCSE recommends further standardization with the North Sea and the development of simple r markdown scripts to produce WG plots, tables, etc. and to run forecast.

In general, the number and quality of audits was greatly improved in 2016 no significant errors were detected.

1.5 Frequency of assessments

ACOM provided for the first time criteria to test whether a category 1 stock could be a candidate for biennial assessments. The criteria are summarized in Table 1.5.1.

Table 1.5.1. Criteria to be applied to identify candidate stocks for less frequent assessment.

Stock Category	Criteria to be used to identify candidate stocks for less frequent assessment.
Cat. 1 and 2	Stocks are considered candidates for biennial assessment if: The advice for the stock has been 0-catch or equivalent for the latest three advice years. Stocks are considered candidates for biennial assessment if the following criteria are fulfilled simultaneously: Life span (i.e. maximum normal age) of the species is larger than five years. The stock status in relation to the reference points is according to the MSY criteria F(latest assessment year) <= 1.1 x F_{MSY} OR if F_{MSY} range has been defined: F(latest assessment year) is <= F_{upper} (upper bound in F range) AND SSB(start of intermediate year) >= MSY $B_{trigger}$ The average contribution to the catch in numbers of the recruiting year class in latest five years is less than 25% of the total catch in numbers. Should be calculated as the average over the latest five years of the catch in numbers of first age divided by the total catch in number by year. The retrospective pattern, based on a seven years peel of Mohn's Rho index, shows that F is consistently underestimated by less than 20% The formula to be used in the calculations is: $\rho = \frac{1}{7}\sum_{u=Y-7}^{Y-1}\left(1 - \frac{F_{u,u}}{F_{u,Y}}\right)$. The result should be <0.20, where $F_{u,u}$ is F in year u estimated from an assessment that ends in year u, and $F_{u,Y}$ is the F in year u estimated from the most recent assessment (which ends in year Y)
Cat. 3	By default all stocks in this category are considered candidates for biennial or triennial assessment.
Cat 4-5-6	By default all stocks in this category are considered candidates for triennial assessment.

Results of the criteria check for category 1 stocks can be found in the Table 1.5.2 below. In conclusion, only sole7.e is the only WGCSE category 1 stock which is a candidate for biennial assessments based on the current ACOM criteria alone (Table 1.5.2). However, this stock is under an EC multi-annual management plan that requires annual advice. In general, only if the criteria based on the status of the stock are met, the other criteria need to be tested. There are quite a few *Nephrops* stocks that are potential candidates for biennial advice, however, the Mohn's Rho and percentage of recruiting year-class criteria are not applicable to UWTV based assessment. **WGCSE recommends that alternative criteria could be considered for *Nephrops* stocks**.

Table 1.5.2. Summary of criteria for WGCSE category 1 stocks which may be candidates for biennial advice.

2016 Stock code	Life span	Stock status relative to F_{MSY}	Stock status relative to $MSY B_{trigger}$	Percentage of recruiting year classes in catch	Mohn's rho
bss-47	medium			0	0.01
cod-7e–k	medium			19%	0.13
cod-scow	medium			51%	NA
had-7b–k	medium			41%	-0.43
had-rock	medium			14%	-0.23
meg-4a6a	medium			Not relevant	Not relevant
nep-11	medium			Not relevant	Not relevant
nep-12	medium			Not relevant	Not relevant
nep-13	medium			Not relevant	Not relevant
nep-14	medium			Not relevant	Not relevant
nep-15	medium			Not relevant	Not relevant
nep-16	medium			Not relevant	Not relevant
nep-17	medium			Not relevant	Not relevant
nep-19	medium			Not relevant	Not relevant
nep-20–21	medium			Not relevant	Not relevant
nep-22	medium			Not relevant	Not relevant
sol-celt	medium			6%	-0.04
sol-echw	medium			4%	-0.03
sol-iris	medium			2%	0.11
whg-7e–k	medium			60%	-0.28
whg-scow	medium			83%	NA

NA - not available.

1.6 ToR g WGCSE recommendations for stocks to be benchmarked

WGCSE recommend that cod, haddock and whiting in the Celtic Sea should be benchmarked together in 2018. The focus of the benchmark would be on streamlining data compilation procedures for fishery-dependent and survey data. This will give improved transparency and diagnostics surrounding commercial tuning fleets and surveys. The benchmark should also relook at the assessment methods and diagnostics given the potential for changes in selectivity in the commercial fishery. The benchmark should also investigate mixed fisheries and multispecies interactions as well as environmental drivers that may be impacting on growth and recruitment of all three species. Further detail is given in the stock sections.

3 West of Scotland

3.1 Area overview

There is no area overview.

3.2 Cod in Division 6.a

Cod in Division 6.a is included in the EU long-term management plan for cod stocks and the fisheries exploiting those stocks (Council Regulation (EC) 1342/2008). A benchmark assessment was conducted in February 2012 (ICES, 2012) and an inter-benchmark in February 2015 (ICES, 2015). In general the assessment carried out at the WG follows the procedure outlined in the stock annex developed at the benchmark and updated at the inter-benchmark. There are minor deviations in terms of weighting of individual datapoints which are described in Section 3.2.3.

ICES Advice applicable for 2016 and 2017

ICES advises that when the MSY approach is applied, there should be no directed fisheries and all catches should be minimized in 2016 and 2017.

ICES Advice applicable for 2015

No new data are available that change the perception of the stock from the advice given in 2013. Therefore, the same catch advice is still applicable for 2015: ICES advises on the basis of the MSY and precautionary approach that there should be no directed fisheries and that bycatch and discards should be minimized.

3.2.1 General

Stock definition and the management unit

General information about the stock can be found in the stock annex. The assessment unit is Division 6.a and the management unit is ICES Divisions 6.a plus EU and international waters of Division 5.b to the east of 12°00′W. Prior to 2009, the TAC was set for ICES Subareas 6, 12 and 14 plus Subdivision 5.b.1.

Management applicable to 2012–2016

The minimum landing size of cod for human consumption in this area is 35 cm.

Since 2012 the TAC for cod in Division 6.a has been set to zero with allowance for a bycatch of cod to be landed provided that it does not comprise more than 1.5% of the live weight of the total catch retained on board per fishing trip.

TAC for 2012–2014

Species:	Cod *Gadus morhua*	Zone:	VIa; Union and international waters of Vb east of 12° 00′ W (COD/5BE6A)
Belgium	0		
Germany	0		
France	0		
Ireland	0		
United Kingdom	0		
Union	0		
TAC	0 (1)		Analytical TAC

(1) By-catch of cod in the area covered by this TAC may be landed provided that it does not comprise more than 1,5 % of the live weight of the total catch retained on board per fishing trip.

TAC for 2015–16

Species:	Cod *Gadus morhua*	Zone:	VIa; Union and international waters of Vb east of 12° 00′ W (COD/5BE6A)
Belgium	0		
Germany	0		
France	0		
Ireland	0		
United Kingdom	0		
Union	0		
TAC	0 (1)		Analytical TAC

(1) By-catch of cod in the area covered by this TAC may be landed provided that it does not comprise more than 1,5 % of the live weight of the total catch retained on board per fishing trip. This provision shall not apply for catches subject to the landing obligation.

Technical measures applicable to the West of Scotland, including those associated with the cod recovery plan in force up to 2008 (Council Regulation No. 423/2004), the cod long-term management plan in force from 2009 (Council Regulation No. 1342/2008) and amended by Council Regulation No. 1243/2012.

The fishery in 2015

The table of official landings statistics is given in Table 3.2.1. Official landings in 2015 were 244 tonnes, an increase of over 50% on the 2014 value which was the lowest of the time-series. Minor updates (5 tonnes from France) were made to 2014 landings. Approximately 70% of the official landings are reported by UK vessels with the remainder from Norway and Ireland. The majority of reported cod landings in Division 6.a are now taken in the far north of the area (Figure 3.2.1 shows Scottish reported landings by statistical rectangle).

Due to restrictive TACs, seasonal/spatial closures of the fishery, and effort restrictions based on bycatch composition, the likelihood of misreporting and underreporting of cod in the past is considered to have been high. Underreporting is considered to have been reduced to low levels following the introduction of legislation in Ireland and the UK in 2006. However, area misreporting of cod landings from Division 6.a into Division 4.a (i.e. caught in Division 6.a., but declared in Division 4.a) and to a lesser extent Division 5.b, by the Scottish fleet is now believed to occur. The UK legislation introduced in 2006 is also believed to be responsible for a significant increase in discards starting in 2006.

Area-misreported landings by the Scottish fleet are considered to represent a considerable proportion of the total landings. Estimates of misreporting based on surveillance and consideration of VMS data by Marine Scotland Compliance, have been made available to the WG. Figure 3.2.2 shows the time-series of misreporting estimates which are assumed to come from the TR1 fleet. Total misreporting of Division 6.a cod landings in 2015 was 461 t (largely reported into Division 4.a), more than double the estimate for 2014 and representing over 60% of the total landings in 2015.

3.2.2 Data

Catch data

The landings uploaded into InterCatch are shown in Figure 3.2.3 by métier and country and discard weights and proportions are shown in Figures 3.2.4 and 3.2.5 respectively. The Norwegian longline métier is the largest unsampled métier (~ 7.5% of the total landings in 2015).

There are no age composition samples from the misreported landings and the WG followed the procedure described in the Stock Annex in which Scottish TR1 landings numbers-at-age were raised to the total reported plus area-misreported landings prior to uploading to InterCatch. However, this fleet could potentially have a different landings age composition (they are assumed not to discard) and hence the WG considers that a more appropriate approach would be to upload the misreported landings into InterCatch as a separate unsampled fleet.

It can be seen that landings by Scottish trawl ≥100 mm dominate, and discards are also highest from this fleet. However the discard rate is higher from the Scottish trawl 70–100 mm fleet Figure 3.2.4. The discard rate observed in the Irish fleet is considerably lower than both Scottish fleets. The proportion of the catch discarded (by weight) for the sampled fleets is given below.

Fleet	Scottish TR1^	Scottish TR2	Irish TR1	N Irish TR2
Discard %	55%	97%	6%	0

^ The calculation of this discard proportion includes some landings misreported into the North Sea which have no associated discards. The discard proportion of the sampled (non-misreporting) component of the fleet is approximately 80%.

Discard proportions and landings and discard age distributions were assigned within InterCatch to unsampled fleets on the same basis (and as described in the Stock Annex). The discard percentages assigned to fleets without discard estimates are shown in Figure 3.2.6. The final mix of numbers-at-age from sampled and unsampled landings and sampled and raised (unsampled) discards is given in Figure 3.2.7. Given the limited landings by fleets other than the Scottish TR1, the choice of allocation scheme makes little difference to the overall catch-at-age composition. Note that in Figure 3.2.7, the misreported landings appear as 'Sampled landings' (although they are not), due to the way they are uploaded to InterCatch (as described in the previous paragraph).

Sampling levels (number of trips) by country are given below. Observer sampling coverage is slightly better than in previous years (See stock annex). Sampling of the Scottish TR1 landings is still relatively poor. The small sample sizes (which include a few very large fish with high raising factors) result in an SOP of 1.07 times the landings in this fleet in 2015.

	SCOTLAND			IRELAND	NORTHEN IRELAND
Year	TR1	*TR2*	Total	Total	Total
Landings	15	1	16	99	
Observer	12	29	41	18	4

The WG estimates of total landings and discards are given in Table 3.2.2 and shown in Figure 3.2.8. These values are for fish aged 1 to 7+ which is the age range used in the assessment. An additional 4 tonnes of age 0 fish were also discarded.

The total discard proportion by weight is shown in Figure 3.2.9. The estimate of total discards as a proportion of total catch by weight has declined in 2015 compared to 2014 although these estimates are uncertain (CV of over 70% for the Scottish TR1 discard weight estimate in 2015). Given the 1.5% bycatch regulation, the landings are potentially limited more by catch-rates of other species in the fishery. So, for example, an increase in the catch rate of anglerfish and/or haddock could have allowed for a greater proportion of cod catches to be landed by the Scottish TR1 fleet.

Discarding occurs across most of the age classes in the catch including age 5 and 6 in recent years. The discard rate (proportion by number caught) declined across all age classes (with the exception of age 3) in 2015 (Figure 3.2.10).

Age-compositions

Raised landings numbers-at-age and discard numbers-at-age are given in Tables 3.2.4 and 3.2.6 respectively and total catch numbers-at-age in Table 3.2.8. The age composition in the catch is very truncated with few individuals over age 3 apparent in the catch in recent years (Figure 3.2.11).

Weight-at-age

Annual mean weights-at-age in landings, discards and catch are given in Tables 3.2.5, 3.2.7 and 3.2.9. Figure 3.2.12 shows the mean weights-at-age in the landings and discards. The mean weight- of age 2 and 3 fish in the landings has increased since the mid-2000s. Other age classes show fluctuations with a long-term downward trend particularly for ages 5 and above. Values at older age are noisy, particularly in recent years. Mean weight-at-age in the discards shows no real trend, although there are higher values for ages three and four when they first began to be discarded around ten years ago.

Survey data

All available survey data are given in Table 3.2.3, with the data used in the assessment highlighted in bold. Survey descriptions are given in the stock annex.

The cpue by survey haul for the IRGFS-WIBTS-Q4 survey are shown in Figure 3.2.13 and in Figure 3.2.14 for the two Scottish surveys (UKSGFS-WIBTS-Q1 and UKSGFS-

WIBTS-Q4). All surveys show mostly zero returns over latitudes between 56 degrees N and 58.5 degrees N (although the IRGFS-WIBTS-Q4 survey only extends to 56.5 degrees N). This pattern has been consistent in surveys since 2007. The Scottish surveys have highest catch rates to the north of 58.5 degrees N, in and around the 'windsock' closed area. The Q1 surveys catch cod in the Clyde region and the Q4 surveys show moderate catch rates off the Northern Irish coast. From the IRGFS-WIBTS-Q4 survey there is also evidence of higher abundance in this area as well as along the shelf edge in the southern part of Division 6.a, although in 2015 there are few positive catches.

A series of inshore and offshore Scottish industry–science surveys, known as the West Coast Demersal Fish (WCDF) project were conducted between December 2013 and November 2014. The initiative, funded by the Scottish Government and the European Fisheries Fund, was a joint venture between Marine Scotland Science and the Scottish Fishermen's Federation with the aim of improving the understanding of the current state of demersal stocks to the West of Scotland. The surveys show a broadly similar distribution to the UKSGFS-WIBTS-Q1 and UKSGFS-WIBTS-Q4 with bigger fish and increased abundance inside the Windsock compared to outside.

Biological data

Natural mortality-at-age (M) is assumed to be weight-dependent after Lorenzen (1996) but time invariant. M is calculated by finding the time-series means for stock weights-at-age before applying the Lorenzen parameters and the values are shown below.

Natural mortality (M) at-age:

Age	1	2	3	4	5	6	7+
	0.537	0.386	0.306	0.262	0.237	0.223	0.211

Figure 3.2.15 shows the resulting M-at-age values used in the assessment and the values calculated in each year individually for comparison. Proportion of fish mature-at-age are unchanged from the last meeting and is as detailed in the stock annex.

A study by the sea mammal research unit (SMRU) on seal predation has indicated that seal predation on cod probably constitutes significant natural mortality. A version of the TSA assessment model incorporating a seal predation model element was developed for WKROUND 2012. The specification of the seal feeding model is provided in the stock annex. Because only two years of seal consumption data were available at the time, WKROUND considered estimation of the seal feeding parameters likely to be highly uncertain and inclusion of seal predation in the model to be potentially adding little other than noise to the assessment. WKROUND 2012 concluded the final assessment of 6.a cod should not include seal predation estimation but that a supplementary run including the seal feeding model should be run to test the sensitivity of the assessment to model specification. The latest estimates of grey seal population were taken from Thomas, 2011.

3.2.3 Stock assessment

This assessment uses a TSA run as outlined in the stock annex. Exploratory analysis of the input catch and survey data are also carried out.

Data screening

Catch curves from commercial catch-at-age data (landings plus discards) are shown in Figure 3.2.16. Although the data are noisy, there is some evidence for a flattening off of the catch curves in recent years compared to those of the cohorts spawned in the late 1990s. A plot of log catch curve gradients derived from commercial catch data (landings plus discards) over different age ranges is shown in Figure 3.2.17. There is some evidence of a decreasing mortality in recent years here too, particularly over age ranges including age 2.

Figure 3.2.18 shows the mean standardised catch-at-age by proportion (number). It shows good tracking of the strong cohorts as recently as the 2005 year class which shows well even at age 7+. More recently the data become rather noisy and in 2015, the proportion of the catch-at-age six is the highest of the time-series and the proportion-at-age five is also above average. Neither of these observations are supported by above average values at younger ages of the same cohort. Potentially the age 6 value could be an overspill of fish from the North Sea as this coincides with the strong 2009 year class in that area.

Figures 3.2.19 and 3.2.20 show the log mean standardised indices from the ScoGFS-WIBTS-Q1 survey by year and by cohort respectively. The early part of the time-series appears to track the cohorts relatively well with no obvious year effects. However in later years the indices become more noisy and there is some evidence of year effects in the survey.

Figure 3.2.21 shows log catch curves for the ScoGFS-WIBTS-Q1 survey. It shows a strong "hook" at the younger ages, with abundance-at-age two often higher than at-age one. In later years survey abundance also shows increases from age 2 to age 3 in the same year class and the survey's ability to track recent cohorts seems poor relative to the 1990s and early 2000s. The survey scatterplots (Figure 3.2.22) show some consistency in the estimates of year-class strength across age classes, although less so at older ages. There is no trend in the log catch curve gradients derived from this survey (Figure 3.2.23) for any of the age ranges considered.

Figures 3.2.24 and 3.2.25 show the log mean standardised indices by cohort and year from the IRGFS-WIBTS-Q4. The log mean standardised indices plot shows consistent signals at ages 1 and 2 with no real year effects. The scatterplots (Figure 3.2.27) also show reasonable consistency between ages one and two, but the tracking at older ages is less strong. The data cover too few age classes sufficiently well to give an indication in trend in mortality through catch curve gradients (Figure 3.2.26).

Figures 3.2.28 and 3.2.29 shows log mean standardised indiced by year and cohort from the UKSGFS-WIBTS-Q1. There is little evidence of successful tracking of cohorts and some evidence of survey year effects. The log catch curves from the UKSGFS-WIBTS-Q1 are also very noisy (Figure 3.2.30). Even the catch rates of successive age classes (within the same cohort) are only weakly related (Figure 3.2.31).

Overall, information on mortality trends from all survey-series (including the ScoGFS-WIBTS-Q1) appears weak.

Final assessment

Model settings and input parameter settings for the final run are given in Table 3.2.10 and final parameter estimates from the TSA run are given in Table 3.2.11. There is a minor deviation from the stock annex in that landings-at-age five and age six are allowed to have higher variance in order to be able to address the inconsistencies in the age composition of the 2015 landings data observed in Figure 3.2.18 (and described above). These two datapoints are unexpectedly high, not consistent with other data and could potentially be due to migration of fish from the adjacent North Sea stock. A run of TSA (not shown), with these points unweighted, gives very high prediction errors. Standardised prediction errors at-age from the update assessment run for landings and discards are shown in Figure 3.2.32 and for the two surveys in Figure 3.2.33. These are the main diagnostic tools for time-series Kalman filter models like TSA, and indicate the discrepancy between the model prediction and observation as the model steps through the data from the start to the end. They are a useful guide to suggest observations which might need to be downweighted. Errors within ±2 are considered reasonable.

Figures 3.2.34 and 3.2.35 show the residuals by age class for landings and discards and the two surveys respectively. The calculation of residuals has not previously been available and these plots were scrutinised by the WG for the first time this year. The landings residuals show tendency for positive residuals at younger ages and an increase in the variance of the residuals in more recent years. This latter effect may be associated with the assumption of constant cv in the landings data which may be violated in recent years (the very low level of landings in recent years would imply very precise landings which is unlikely to be the case). A fuller and more systematic evaluation of the weightings and uncertainty associated with the input data is currently underway which can be guided by the cv estimates which are now available as part of the catch estimation procedure which takes place in national labs. There are also some minor trends in the residuals at younger ages in the ScoGFS-WIBTS-Q1 survey which are associated with the mis-match between commercial catch and survey data combined with the assumption that the survey has no trend in catchability. The time-series of observed and fitted discard proportions-at-age is shown in Figure 3.2.36. The predictions follow the general trend in the data which are quite noisy.

Table 3.2.12 gives the TSA population numbers-at-age and Table 3.2.13 gives their associated standard errors. Estimated F at-age is given in Table 3.2.14 and standard errors on the log of this mortality are given in Table 3.2.15. Full summary output is given in Table 3.2.16. A summary plot for this run is shown in Figure 3.2.37.

Retrospectives for the final assessment run are shown in Figure 3.2.38. This figure also shows lines at ±2 se (approximate 95% confidence limits) around the run using all years of data. Retrospective bias is small. The confidence interval for mean F is very wide, reflecting uncertainty in estimation of mean F when that estimation is based to a large extent on survey data (1991–2005) or the age structure of discards data (2006 onwards).

Stock status

Historical stock trends are shown in Figure 3.2.37 and the stock–recruitment relationship is shown in Figure 3.2.39. The estimated SSB shows a steady downward trend until 2006 and has fluctuated at a slightly higher level since then. The 2012 year class (recruitment in 2013) is estimated to be the highest since 2006, but given that mean F is still estimated to be high, this results in only minor increases in SSB in recent years.

Estimated SSB in the final year is well below B_{lim} (= 14 000 tonnes) and mean F remains above F_{lim} (= 0.82) and well above F_{MSY} (=0.17) in 2015. Estimates of mean F in the assessment, however, are very uncertain and there are indications from the commercial catch data that there has been a reduction in F across some age groups at least although this is not apparent in the survey data and the age structure remains very truncated. Partial mean F for landings and discards separately is shown in Figure 3.2.42 and shows that 50% of mean F is due to discarding in 2015.

The TSA estimated stock–recruit relationship is shown in Figure 3.2.39. It includes the datapoint of the 1986 year class which appears as an outlier. The relatively high strength of the 2005 year class (considering the size of SSB) can also be seen.

The precautionary approach plot for this stock is given in Figure 3.2.40. It shows clearly how the stock has moved and remained in the zone indicating reduced reproductive capacity and unsustainable removals.

Comparison with supplementary (seal predation) assessment

New data on seal consumption have recently become available to update the model, but not in time for this year's WG. A comparison was included in last year's report.

3.2.4 Short-term stock projections

In 2015, advice was issued by ICES for two year and therefore no short-term stock projections were required in 2016.

3.2.5 Reference points

Both MSY and precautionary reference points were updated at WKMSYREF4 in November 2015 are shown below (weights in tonnes). There are small differences to those used in the advice for 2015.

	ADVICE 2015	WKMSYREF4	RATIONALE (WKMSYREF4)
B_{lim}	14 000	14 000	B_{loss} from which the stock has increased (SSB in 1992 as estimat

			ed in 2015)
B_{pa}	22 000	20 000	1.4 x B_{lim}
F_{lim}	0.8	0.82	Based on simulation with segmented regression recruitment with B_{lim} as the breakpoint
F_{pa}	0.6	0.59	F_{lim}/1.4
F_{MSY}	0.19	0.17	
MSY $B_{trigger}$	22 000	20 000	B_{pa}
F_{MSY} upper		0.25	
F_{MSY} lower		0.11	

3.2.6 Management plans

Cod in 6.a is included in Council Regulation No. 1342/2008 establishing a long-term plan for cod stocks and fisheries exploiting those stocks. The plan and its evaluation by ICES are discussed in Section 9.

3.2.7 Uncertainties and bias in assessment and forecast

Figure 3.2.41 shows a comparison between this year's and last year's assessments. Compared to the 2015 assessment, SSB in 2014 has been revised down from 2905 t to 2407 t while the estimate of mean F in that year remains 0.89. The estimate of recruitment in 2014 is revised up from 3.359 million to 3.013 million. The estimate of SSB in 2015 from this year's assessment is 2849 t with a s.e. of 444 t. Short-term forecasts of SSB conducted at previous WGs have not shown particularly good consistency with estimates of SSB in assessments conducted in successive years. (WGCSE 2015).

Landings

Since the early 1990s the most significant problem with assessment of this stock is with commercial data. Incorrect reporting of landings, species, quantity and management area, is known to have occurred. Scottish landings (from 2006) are adjusted by estimates of misreporting (in an attempt to reduce bias in the assessment) and in 2015, misreported landings account for over 60% of the total landings. The misreporting estimates are provided by Marine Scotland Compliance based on intelligence and consideration of VMS data. Estimates based on provisional analysis of VMS data linked to landings at a trip level (conducted at the 2015 inter-benchmark (ICES, 2015)) gave somewhat higher estimates. In addition these misreported landings are unsampled and potentially have different age compositions to the rest of the Scottish TR1 fleet due to likely differences in discarding behaviour.

Discards

On average (over the last five years), discarding accounts for over 70% of the total catch. Although sampling levels have improved in recent years, discard estimates are still very uncertain (approximate CV = 70% for Scottish TR1) contributing to uncertainty in the estimates of mean F.

Biological factors

Assumptions on mean weight-at-length and mean maturity-at-age have remained unchanged for a long period. However, biological responses of cod in 6.a as a localised species to high exploitation and low population numbers are so far unknown to the working group.

The contribution of seal predation to total cod mortality is likely to be significant and this may impair the ability of the cod stock to recover but data is limited. New weight dependent natural mortalities-at-age have been adopted to better take account of higher natural mortality at younger ages but it is not certain these values fully accommodate the possible large source of natural mortality from seals. Regular surveys giving estimates of consumption by seals would give greater confidence in natural mortality estimates. An assessment conducted by Cook *et al.* (2015) suggests declining fishing mortality and that seal predation may be impairing the recovery of this stock.

Stock structure

Stock structure is complex and at least two subpopulations are known to occur within this area. The survey distribution plots show that there is an almost complete absence of cod on the shelf in Division 6.a with the majority of the landings and stock concentrated in an area in the north of the region (around the 'windsock' closed area) bordering Division 4.a. It may be more appropriate to consider this component of the stock as part of the North Sea stock (or at least the northern component of this stock).

Assessment method

Down-weighting of various input datapoints to allow for inconsistencies in the data has been conducted on a rather *ad hoc* basis in the past and could potentially have introduced bias. A more systematic approach which uses estimates of CVs derived as part of the catch estimation process conducted in national laboratories may improve the assessment model diagnostics.

3.2.8 Recommendation for next Benchmark

PROBLEM	SOLUTION	EXPERTISE NECESSARY[1]	SUGGESTED TIME
Stock identity	Evaluate a possible merge between North Sea and 6.a cod stocks. In alternative split area 6.a in two areas North and South.	Scientists from MSS and MI	Next benchmark although would need collaboration with WGNSSK.
Inpacts from the Land all obligation	The impact are currently unown	Scientists from MSS	Close to next benchmark to allow the land all obligation to set in.

	but need to be adressed once identified		
Misreporting of landings; does not take account of fleet components.	Further analysis of misreporting data supplied by Scotland.	Scientists from MSS	One year before the benchmark as it is a proceess that is time consuming.
Assessment method	Consideration of variance structures used in the TSA model to improve diagnostics	Scientists from MSS	Intersessionally

[1] MSS = Marine Scotland Science; MI = Marine Institute Ireland.

3.2.9 Management considerations

The fishery is managed by a combination of landings limits, area closures, technical measures and effort restrictions. These do not seem to have been effective in controlling catches. Despite considerable reductions in fishing effort over the past decade, the stock structure is still truncated with few older fish present.

The fishing opportunities regulation has explicitly made the stock a bycatch species from 2012. Allowing landings up to 1.5% of the live weight of the total catch can cause a perverse incentive for vessels to increase catches of other species and does not inhibit the catch of cod.

Although the UK 'Buyers and Sellers' and Irish 'Sales Notes' legislation is considered to have reduced underreporting from 2006, discard data show increased discards at-ages one and two and a change in discard practices such that fish are discarded at older ages. In 2008, Scotland introduced a voluntary programme known as "Conservation Credits", which involved seasonal closures, real-time closures (RTCs) and various selective gear options. This was designed to reduce mortality and discarding of cod. RTCs are determined by lpue, based on fine scale VMS data and daily logbook records and also by on-board inspections. There have been no RTCs to the west of Scotland in the years since 2012 due to the lack of occurrence of high lpue in the area. Estimates of continuing high discard rates in Division 6.a indicate the scheme has not been as effective as in the North Sea. Figure 3.2.42 highlights the problem from discards. In recent years mortality from landings is estimated to have decreased rapidly but over the same period mortality from discards has increased just as rapidly. It also needs to be remembered that mortality estimates arising from an assessment heavily based on survey and/or discard data are poorly estimated. In contrast, historical trends in spawning biomass and recruitment appear to be robust measures of stock dynamics.

Estimates of misreporting from Marine Scotland Compliance imply ICES landings estimates which are in excess of TACs during the mid-2000s. Misreported landings make a significant contribution to the fishing mortality on this stock.

Cod is taken in mixed demersal fisheries, and in Division 6.a is now regarded as a bycatch species. To greatly reduce cod catch would likely result in having to greatly reduce harvesting of other stocks such as haddock, whiting and anglerfish. It is also important the bycatch from the *Nephrops* fleet is closely monitored (including discard observations). In 2015, trawl gear vessels targeting finfish (TR1) are responsible for around 85% of cod catches in Division 6.a, the *Nephrops* fleet (TR2) take approximately 12% and the remainder are taken by other gears, mainly longliners.

The EU cod long-term management plan, (Council Regulation No. 1342/2008) is complemented by a system of fishing effort limitation and in waters west of Scotland landings composition restrictions.

A report by the Sea Mammal Research unit (Hammond and Harris, 2006) gives estimates of cod consumed by grey seals to the west of Scotland. Although highly uncertain the estimates suggest predation mortality on cod is significant and this may impair the ability of the cod stock to recover, but data are limited (Cook *et al.*, 2015).

3.2.10 Frequency of assessment

This stock has had zero catch advice for over ten years and therefore meets the first of the criteria for consideration for biennial assessment.

Sources

Cook, R. M., Holmes, S. J. and Fryer, R. J. 2015. Grey seal predation impairs recovery of an over-exploited fish stock. J. Applied Ecol., 52(4), 969–979.

Hammond, P. S., and Harris, R. N. 2006. Grey seal diet composition and prey consumption off western Scotland and Shetland. Final report to Scottish Executive Environment and Rural Affairs Department and Scottish Natural Heritage.

ICES. 2012. Report of the Benchmark Workshop on Western Waters Roundfish (WKROUND), 22–29 February 2012, Aberdeen, UK. ICES CM 2012/ACOM:49. 283 pp.

Lorenzen K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural ecosystems and aquaculture. Journal of Fish Biology 49, 627–647.

STECF. 2011. Scientific, Technical and Economic Committee for Fisheries. Evaluation of Fishing Effort Regimes Regarding Annexes IIA, IIB and IIC of TAC & Quota Regulations, Celtic Sea and Bay of Biscay (STECF-11–13).

STECF. 2011. Scientific, Technical and Economic Committee for Fisheries. Evaluation of Fishing Effort Regimes (STECF-13–13).

Thomas, L. 2011. Estimating the size of the UK grey seal population between 1984 and 2010. SCOS Briefing Paper 11/02.

Scientific, Technical and Economic Committee for Fisheries (STECF) – Evaluation of Fishing Effort Regimes in European Waters - Part 2 (STECF-14-20). 2014. Publications Office of the European Union, Luxembourg, EUR 27027 EN, JRC 93183, 844 pp.

Table 3.2.1. Cod in Division 6.a. ICES official catch statistics.

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium	48	88	33	44	28	-	6	-	22	1	2	+	11	1	+
Denmark	-	-	4	1	3	2	2	3	2	+	4	2	-	-	+
Faroe Islands	-	-	-	11	26	-	-	-	-	-	-	-	-	-	-
France	7,411	5,096	5,044	7,669	3,640	2,220	2,503	1,957	3,047	2,488	2,533	2,253	956	714	842
Germany	66	53	12	25	281	586	60	5	94	100	18	63	5	6	8
Ireland	2,564	1,704	2,442	2,551	1,642	1,200	761	761	645	825	1,054	1,286	708	478	223
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-
Norway	204	174	77	186	207	150	40	171	72	51	61	137	36	36	79
Spain	28	-	-	-	85	-	-	-	-	-	16	+	6	42	45
UK (E. W. N.I.)	260	160	444	230	278	230	511	577	524	419	450	457	779	474	381
UK (Scotland)	8,032	4,251	11,143	8,465	9,236	7,389	6,751	5,543	6,069	5,247	5,522	5,382	4,489	3,919	2,711
UK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total landings	18,613	11,526	19,199	19,182	15,426	11,777	10,634	9,017	10,475	9,131	9,660	9,580	6,992	5,671	4,289

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015*
Belgium	+	2	+	-	-	-	-	-	-	-	0	0	0	0	-	-
Denmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Faroe Islands	-	-	-	-	2	0	0.8	12	1		0.2	0	-	-	-	-
France	236	391	208	172	91	107	100.7	92	82	74	60.3	46	4.21	3.36	5	-
Germany	6	4	+	+			2	2	1	0	0	0	0.04	0	-	-
Ireland	357	319	210	120	34	27.9	18	70	58.2	24.4	48.7	41.3	17.8	13.7	11.68	17.47
Netherlands	-	-	-	-	-	-	-	-	-	0		0	0	0	-	-
Norway	114	40	88	45	10	17	30	30	65	18	20.7	8.3	56.2	24.017	13.848	59.12
Spain	14	3	11	3	-	-	-	-	-	-	-	-	-	-	-	-
UK (E. W. N.I.)	280	138	195	79	46	25	-	21	6	14	-	-	-	-	-	-
UK (Scotland)	2,057	1,544	1,519	879	413	243	-	260	232	-	-	-	-	-	-	-
UK	-	-	-	-	-	-	332.1	-	-	104	118.6	110	137.2	131.266	129.995	167.89
Total landings	2,767	2,439	2,231	1,298	596	419.9	483.6	487	445.2	234.4	248.5	205.6	215.5	172.343	160.523	244.48

*** Preliminary.**

Table 3.2.2. Cod in Division 6.a. Landings, discards and catch (tonnes) estimates, as used by the WG. Values are totals for fish aged 1 to 7+. Values in brackets were used in 2012 assessment.

YEAR	LANDINGS		DISCARDS		CATCH	
	Unadjusted	Adjusted for misreporting	Unadjusted	Adjusted for misreporting	Unadjusted	Adjusted for misreporting
1978	13521		161		13682	
1979	16087		39		16126	
1980	17879		423		18302	
1981	23866		303		24169	
1982	21510		571		22081	
1983	21305		197		21502	
1984	21271		329		21600	
1985	18608		963		19571	
1986	11820		263		12083	
1987	18975		2388		21363	
1988	20413		368		20781	
1989	17171		2076		19247	
1990	12176		571		12747	
1991	10926		622		11548	
1992	9086		1779		10865	
1993	10315		139		10454	
1994	8929		661		9590	
1995	9438		141		9579	
1996	9425		63		9488	
1997	7033		499		7532	
1998	5714		538		6252	
1999	4201		69		4270	
2000	2977		821		3798	
2001	2347		92		2439	
2002	2242		480		2722	
2003	1241		34		1275	
2004	540		72		612	
2005	479		41		520	
2006	463	488	464	-504	927	952(992)
2007	525	595	1879	-2363	2404	2474(2958)
2008	451	682	695	-1363	1146	1377(2045)
2009	222	408	945	-2538	1167	1353(2946)
2010	239	559	785	-2881	1024	1344(3440)
2011	206	454	1671	-5840	1877	2124(6363)
2012	160	466	1166		1326	1632
2013	172	295	1202		1374	1497
2014	156	361	1311		1467	1672
2015	256	717	983		1239	1700

Table 3.2.3. Cod in Division 6.a. Survey data made available to the WG. Data used in update assessment are highlighted in bold. For the Scottish surveys, numbers are standardised to catch rate per ten hours. For the Irish surveys, effort is given as minutes towed and numbers are in units.

ScoGFS- WIBTS- Q1: **Scottish west coast groundfish survey**

1985	2010							
1	1	0	0.25					
1	7							
10	**1.5**	**23.7**	**8.6**	**13.6**	**3.9**	**2.5**	**1.2**	1985
10	**1.5**	**6.9**	**26.8**	**5.6**	**7.3**	**2.5**	**1.9**	1986
10	**57.4**	**16.2**	**15.3**	**22.8**	**3.0**	**2.8**	**0.0**	1987
10	**0.0**	**64.9**	**14.2**	**3.4**	**2.1**	**0.7**	**0.2**	1988
10	**4.5**	**7.2**	**45.1**	**8.6**	**1.9**	**0.5**	**0.8**	1989
10	**2.0**	**24.6**	**4.1**	**14.7**	**4.2**	**1.6**	**0.8**	1990
10	**4.8**	**5.4**	**17.4**	**5.2**	**13.4**	**2.8**	**0.5**	1991
10	**7.3**	**11.5**	**5.4**	**7.6**	**3.4**	**2.3**	**0.5**	1992
10	**1.7**	**38.2**	**12.7**	**1.7**	**1.4**	**1.1**	**0.0**	1993
10	**13.6**	**14.7**	**25.1**	**5.8**	**1.0**	**0.0**	**0.0**	1994
10	**6.4**	**23.8**	**14.0**	**16.5**	**1.2**	**1.9**	**0.7**	1995
10	**2.8**	**20.9**	**24.1**	**4.1**	**2.8**	**1.3**	**0.0**	1996
10	**11.1**	**7.7**	**11.6**	**7.9**	**4.2**	**4.7**	**1.0**	1997
10	**2.8**	**30.9**	**5.3**	**8.7**	**3.7**	**0.6**	**2.0**	1998
10	**1.5**	**8.2**	**8.2**	**1.4**	**3.2**	**0.5**	**0.5**	1999
10	**13.3**	**5.4**	**6.9**	**1.3**	**0.0**	**0.4**	**0.0**	2000
10	**2.7**	**18.4**	**5.7**	**13.2**	**19.5**	**1.1**	**1.6**	2001
10	**5.3**	**4.3**	**10.6**	**2.6**	**0.5**	**3.0**	**0.0**	2002
10	**2.7**	**16.7**	**2.0**	**4.7**	**1.8**	**0.7**	**0.4**	2003
10	**5.7**	**3.0**	**5.6**	**2.3**	**1.7**	**0.0**	**0.0**	2004
10	**1.3**	**1.5**	**1.2**	**0**	**0**	**0.4**	**0**	2005
10	**2.2**	**1.9**	**1.1**	**0.3**	**0**	**0**	**0.3**	2006
10	**2.1**	**18.8**	**3.4**	**1.2**	**0**	**0.6**	**0**	2007
10	**0.8**	**2.1**	**44.2**	**6.3**	**0.8**	**0**	**0**	2008
10	**1.8**	**2.6**	**2.3**	**0.4**	**0**	**0**	**0**	2009
10	**4.6**	**16.2**	**3.7**	**1.0**	**0.7**	**0**	**0**	2010

Table 3.2.3. Continued. Cod in Division 6.a. Survey data made available to the WG. For the Scottish surveys, numbers are standardised to catch rate per ten hours. For the Irish surveys, effort is given as minutes towed and numbers are in units.

UKSGFS-WIBTS-Q1 (index)

2011	2016							
1	1	0	0.25					
1	7							
10	**0.52**	**32.95**	**21.07**	**0.93**	**0.98**	**0.74**	**0.00**	2011
10	**13.99**	**27.30**	**22.72**	**4.58**	**3.50**	**2.20**	**4.20**	2012
10	**20.03**	**40.26**	**26.38**	**36.95**	**7.76**	**0.30**	**0.00**	2013
10	**11.40**	**41.73**	**13.44**	**5.12**	**4.31**	**0.75**	**0.00**	2014
10	**8.16**	**36.40**	**70.70**	**37.74**	**23.25**	**13.00**	**2.47**	2015
10	**4.73**	**56.07**	**65.41**	**44.56**	**5.67**	**2.36**	**2.29**	2016

UKSGFS-WIBTS-Q1 (variance)

2011	2016							
1	1	0	0.25					
1	7							
10	**0.09**	**78.37**	**24.06**	**0.22**	**0.49**	**0.30**	**0.00**	2011
10	**44.18**	**120.08**	**33.73**	**2.31**	**8.34**	**4.83**	**13.02**	2012
10	**118.35**	**151.04**	**136.89**	**240.05**	**6.47**	**0.09**	**0.00**	2013
10	**20.17**	**383.27**	**12.23**	**3.04**	**5.47**	**0.28**	**0.00**	2014
10	**14.35**	**112.82**	**1264.73**	**602.27**	**289.82**	**98.91**	**5.48**	2015
10	**1.81**	**214.42**	**607.48**	**319.21**	**5.02**	**1.60**	**1.85**	2016

Table 3.2.3. Continued. Cod in Division 6.a. Survey data made available to the WG. For the Scottish surveys, numbers are standardised to catch rate per ten hours. For the Irish surveys, effort is given as minutes towed and numbers are in units.

IreGFS	Irish groundfish survey			
1993	2002			
1	1	0.75	0.79	
0	3			
1849	0.0	312.0	49.0	13.0
1610	20.0	999.0	56.0	13.0
1826	78.0	169.0	142.0	69.0
1765	0.0	214.0	89.0	18.0
1581	6.0	565.0	31.0	10.0
1639	0.0	83.0	53.0	6.0
1564	0.0	24.0	14.0	3.0
1556	0.0	124.0	4.0	1.0
755	3.0	82.0	28.0	2.0
798	0.0	50.6	2.2	1.2

ScoGFS-WIBTS-Q4: **Quarter 4 Scottish ground fish survey**

1996	2010									
1	1	0.75	1.00							
0	8									
10	0	0.7	14.4	5	3	1.1	0.5	0	0	1996
10	1	10.9	2.4	1.4	1.4	1.4	0.2	0	0	1997
10	+	14.8	9.7	1.1	0	0	0	0	0	1998
10	2	4	6	9.2	0.5	0	0	0	0	1999
10	0	15.8	2.6	0.4	0.4	0	0	0	0	2000
10	1	1.7	7.3	1.7	0.3	0	0	0	0	2001
10	1	10.4	2.8	6.8	0.6	0	0	0	0	2002
10	1	1.5	11.3	2.9	0.6	0	0	0	0	2003
10	0	5.1	3.8	1.4	0	0.7	0	0	0	2004
10	+	2.1	3	0	0.6	0.3	0	0	0	2005
10	0	16.9	5.9	1.4	0.7	0	0	0	0	2006
10	0	12	20	1.3	0.5	0	0.3	0	0	2007
10	2	7.7	5	7	1	0	0	0	0	2008
10	2	14.2	3.8	1.2	1.2	0.3	0	0	0	2009
10	na	na	na	na	na	na	na	na	na	2010

Table 3.2.3. Cont. Cod in Division 6.a. Survey data made available to the WG. For the Scottish surveys, numbers are standardised to catch rate per ten hours. For the Irish surveys, effort is given as minutes towed and numbers are in units.

UKSGFS-WIBTS-Q4 (index)

2011	2015									
1	1	0.75	1.0							
0	8									
10	0.60	9.71	31.54	10.88	0.93	1.70	2.38	0.00	0.00	2011
10	0.75	19.78	7.12	15.43	13.60	1.02	0.68	0.34	0.00	2012
Survey not completed due to mechanical issues										2013
10	1.67	23.65	28.06	15.63	5.57	6.63	1.37	0.00	0.00	2014
10	3.64	28.17	52.53	34.22	10.58	4.24	5.27	1.18	0.59	2015

UKSGFS-WIBTS-Q4 (variance)

2011	2015									
1	1	0.75	1.0							
0	8									
10	0.21	31.08	38.07	5.78	0.19	1.56	4.79	0.00	0.00	2011
10	0.14	41.72	2.79	11.37	48.79	1.05	0.46	0.12	0.00	2012
Survey not completed due to mechanical issues										2013
10	0.68	132.97	56.62	44.17	3.87	4.79	0.39	0.00	0.00	2014
10	5.55	98.78	316.23	51.22	8.60	4.43	4.61	0.34	0.12	2015

Table 3.2.3. Continued. Cod in Division 6.a. Survey data made available to the WG. For the Scottish surveys, numbers are standardised to catch rate per ten hours. For the Irish surveys, effort is given as minutes towed and numbers are in units.

IRGFS-WIBTS-Q4 Irish West Coast groundfish.

2003	2015					
1	1	0.79	0.92			
0	4					
1127	0	10	11	0	0	2003
1200	0	24	10	1	0	2004
960	63	13	7	0	2	2005
1510	0	95	12	0	0	2006
1173	0	161	12	0	1	2007
1135	0	23	24	4	0	2008
1378	1	75	4	5	0	2009
1291	0	70	31	4	3	2010
1287	1	26	26	4	0	2011
1230	0	74	7	3	0	2012
1295	0	92	11	0	0	2013
1200	0	113	20	2	0	2014
1213	0	15	11	3	0	2015

Table 3.2.4. Cod in Division 6.a. Landings-at-age (thousands).

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1966	384	2883	629	999	825	78	52
1967	261	2571	3705	670	442	264	67
1968	333	1364	3289	1838	215	171	151
1969	64	1974	1332	1943	759	149	170
1970	256	1176	1638	571	476	153	74
1971	254	1903	550	841	240	201	95
1972	735	2891	1591	409	501	108	110
1973	1015	1524	1442	583	161	193	104
1974	843	2318	778	1068	288	72	102
1975	1207	1898	1187	533	325	90	35
1976	970	3682	1467	638	256	215	56
1977	1265	1314	1639	624	269	87	79
1978	723	1761	999	695	286	97	75
1979	929	1612	2125	682	342	134	69
1980	1195	3294	2001	796	191	77	37
1981	461	7016	3220	904	182	29	20
1982	1827	1673	3206	1189	367	111	33
1983	2335	4515	1118	1400	468	148	60
1984	2143	2360	2564	448	555	185	59
1985	1355	5069	1269	1091	140	167	79
1986	792	1486	2055	411	191	40	30
1987	7873	4837	988	905	137	56	26
1988	1008	8336	2193	278	210	39	20
1989	2017	1082	3858	709	113	69	33
1990	513	4024	432	924	170	23	11
1991	1518	1728	1805	188	266	70	23
1992	1407	1868	575	720	69	58	24
1993	328	3596	1050	131	183	24	36
1994	942	1207	1545	280	56	51	20
1995	753	2750	700	630	70	15	11
1996	341	2331	1210	247	204	31	13
1997	1414	1067	989	281	66	62	7
1998	310	3318	293	174	57	16	9
1999	132	884	1047	64	48	24	9
2000	765	532	211	231	15	12	13
2001	96	1241	155	63	52	3	4
2002	337	340	522	41	13	14	4
2003	62	516	85	107	6	2	1
2004	44	92	85	11	26	2	1
2005	31	121	43	37	7	6	0.5
2006[1]	18	96	76	22	13	2	1

	AGE						
YEAR	1	2	3	4	5	6	7+
2007[1]	6	187	70	37	3	4	3
2008[1]	0.1	34	130	25	16	1	3
2009[1]	2	12	11	59	8	2	0.3
2010[1]	0	43	61	38	32	1	0.4
2011[1]	0	11	40	34	12	13	2
2012[1]	3	1	41	51	5	4	5
2013[1]	0.1	8	9	43	10	2	1
2014[1]	0	3	66	31	23	2	0
2015[1]	0	53	55	41	29	27	1

[1] **Values include adjustment for misreporting.**

Table 3.2.5. Cod in Division 6.a. Mean weight-at-age in landings (kg).

	AGE						
YEAR	1	2	3	4	5	6	7+
1966	0.730	1.466	3.474	5.240	4.868	8.711	9.250
1967	0.681	1.470	2.906	4.560	6.116	7.394	8.058
1968	0.745	1.776	2.766	4.721	6.304	7.510	8.278
1969	0.860	1.284	2.821	4.259	6.169	6.374	7.928
1970	0.595	0.955	2.533	4.678	6.016	7.120	8.190
1971	0.674	1.046	2.536	4.167	6.023	6.835	8.100
1972	0.609	1.192	2.586	4.417	6.226	7.585	8.538
1973	0.597	1.181	2.784	4.601	5.625	7.049	8.611
1974	0.611	1.103	2.834	4.750	6.144	7.729	9.339
1975	0.603	1.369	3.078	5.302	6.846	8.572	10.328
1976	0.616	1.397	3.161	5.005	6.290	8.017	9.001
1977	0.629	1.160	2.605	4.715	6.269	7.525	9.511
1978	0.630	1.373	3.389	5.262	7.096	8.686	9.857
1979	0.693	1.373	2.828	4.853	6.433	7.784	9.636
1980	0.624	1.375	3.002	5.277	7.422	8.251	9.331
1981	0.550	1.166	2.839	4.923	7.518	9.314	10.328
1982	0.692	1.468	2.737	4.749	6.113	7.227	9.856
1983	0.583	1.265	2.995	4.398	6.305	8.084	9.744
1984	0.735	1.402	3.168	5.375	6.601	8.606	10.350
1985	0.628	1.183	2.597	4.892	6.872	8.344	9.766
1986	0.710	1.211	2.785	4.655	6.336	8.283	9.441
1987	0.531	1.312	2.783	4.574	6.161	7.989	10.062
1988	0.806	1.182	2.886	5.145	6.993	8.204	9.803
1989	0.704	1.298	2.425	4.737	7.027	7.520	9.594
1990	0.613	1.275	2.815	4.314	7.021	9.027	11.671
1991	0.640	1.095	2.618	4.346	6.475	8.134	10.076
1992	0.686	1.293	2.607	4.268	6.190	7.844	10.598
1993	0.775	1.316	2.940	4.646	6.244	7.802	8.409
1994	0.644	1.292	2.899	4.710	6.389	8.423	8.409
1995	0.606	1.148	2.857	4.956	6.771	8.539	9.505
1996	0.667	1.221	2.738	5.056	6.892	8.088	10.759
1997	0.595	1.210	2.571	4.805	6.952	7.821	9.630
1998	0.605	1.061	2.264	4.506	6.104	8.017	9.612
1999	0.691	1.039	2.194	4.688	6.486	8.252	9.439
2000	0.689	1.261	2.457	4.126	6.666	7.917	8.392
2001	0.654	0.988	2.679	4.568	5.860	7.741	9.386
2002	0.668	1.140	2.330	4.841	6.175	7.192	9.548
2003	0.671	1.016	2.312	3.854	6.220	8.075	8.839
2004	0.609	1.027	2.194	4.396	6.003	8.258	9.678
2005	0.776	1.172	2.624	4.118	4.908	6.753	10.240
2006[1]	0.656	1.169	2.236	3.822	6.172	7.796	11.1

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
2007[1]	0.476	0.976	2.512	4.285	6.491	7.733	8.81
2008[1]	0.557	1.183	2.992	4.826	6.33	7.957	8.471
2009[1]	0.988	1.961	3.132	4.759	5.904	8.171	8.646
2010[1]	n/a	1.521	2.671	3.977	5.269	6.144	7.974
2011[1]	n/a	1.434	3.2	4.057	5.832	6.525	9.891
2012[1]	0.66	1.737	2.797	4.833	6.876	7.296	7.52
2013[1]	0.993	1.372	2.966	4.073	6.141	7.158	9.849
2014[1]	0.969	1.422	2.094	3.046	4.697	5.505	7.206
2015[1]	0.834	2.623	2.947	3.84	5.456	5.561	8.819

[1] **Values calculated after landings numbers-at-age adjusted for misreporting.**

Table 3.2.6. Cod in Division 6.a. Discard numbers at age (thousands). Data from 1978–2001 raised from Scottish sampling only; later data use samples from other nations when available. Values for 2006–2011 differ to those used in the 2012 assessment when both landings and discards were adjusted for misreporting.

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1978	412	26	0	0	0	0	0
1979	16	81	0	0	0	0	0
1980	1171	0	0	0	0	0	0
1981[1]	54	907	0	0	0	0	0
1982[1]	1808	8	0	0	0	0	0
1983[1]	843	25	0	0	0	0	0
1984[1]	1088	11	0	0	0	0	0
1985[1]	5188	114	0	0	0	0	0
1986[1]	970	14	0	0	0	0	0
1987[1]	14358	12	0	0	0	0	0
1988[1]	231	1059	2	0	0	0	0
1989[1]	6243	6	0	0	0	0	0
1990[1]	4181	41	0	0	0	0	0
1991[1]	2518	14	2	0	0	0	0
1992[1]	7385	143	3	0	0	0	0
1993[1]	279	84	1	0	0	0	0
1994[1]	2743	6	0	0	0	0	0
1995[1]	625	56	0	0	0	0	0
1996[1]	191	50	0	0	0	0	0
1997[1]	1521	34	0	0	0	0	0
1998[1]	790	972	0	0	0	0	0
1999[1]	230	5	0	0	0	0	0
2000[1]	2882	33	0	0	0	0	0
2001[1]	176	115	0	0	0	0	0
2002[1]	1051	199	0	0	0	0	0
2003[1]	69	26	1	0	0	0	0
2004	232	21	0	0	0	0	0
2005	108	20	0	0	0	0	0
2006	1210	47	24	2	3	1	1
2007	566	1489	50	38	3	3	0
2008	68	101	281	1	0.2	0	0
2009	605	150	109	94	0	5	0
2010	352	392	65	7	3	0	0
2011	316	281	535	42	0.3	2	0
2012	374	93	383	50	0.1	0	0
2013	2030	321	131	103	15	0	2
2014	705	316	255	51	19	1	0
2015	161	307	217	25	6	1	0

[1] **Values revised after 2012 benchmark because of new method for raising discards.**

Table 3.2.7. Cod in Division 6.a. Mean weight-at-age in discards (kg). Data from 1978–2001 raised from Scottish sampling only; later data use samples from other nations when available.

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1978	0.37	0.321	0	0	0	0	0
1979	0.276	0.43	0	0	0	0	0
1980	0.361	0	0	0	0	0	0
1981	0.135	0.326	0	0	0	0	0
1982	0.314	0.392	0	0	0	0	0
1983	0.223	0.374	0	0	0	0	0
1984	0.298	0.435	0	0	0	0	0
1985	0.178	0.346	0	0	0	0	0
1986	0.267	0.305	0	0	0	0	0
1987	0.166	0.37	0	0	0	0	0
1988	0.296	0.283	0	0	0	0	0
1989	0.332	0.59	0	0	0	0	0
1990	0.132	0.454	0	0	0	0	0
1991	0.245	0.351	0	0	0	0	0
1992	0.22	1.03	2.382	0	0	0	0
1993	0.239	0.812	3.723	0	0	0	0
1994	0.24	0.365	0	0	0	0	0
1995	0.203	0.256	0	0	0	0	0
1996	0.226	0.389	0	0	0	0	0
1997	0.321	0.328	0	0	0	0	0
1998	0.23	0.367	0.59	0	0	0	0
1999	0.294	0.299	0	0	0	0	0
2000	0.28	0.421	0	0	0	0	0
2001	0.248	0.417	0	0	0	0	0
2002	0.263	1.021	0	0	0	0	0
2003	0.272	0.57	0.39	0	0	0	0
2004	0.258	0.581	0	0	0	0	0
2005	0.285	0.501	0	0	0	0	0
2006	0.259	1.291	2.649	3.499	6.24	5.581	11.122
2007	0.198	0.94	3.016	4.453	5.018	10.627	0
2008	0.22	0.976	2.046	4.047	7.937	0	0
2009	0.261	1.312	2.248	3.324	0	6.448	0
2010	0.253	1.312	2.268	3.218	3.245	0	0
2011	0.212	1.023	2.207	2.993	4.891	4.168	0
2012	0.151	1.197	2.18	3.222	8.537	0	0
2013	0.111	0.945	2.119	3.05	5.029	0	6.27
2014	0.145	1.124	2.415	3.066	4.007	4.731	0
2015	0.344	0.994	2.32	3.409	4.414	6.103	0

Table 3.2.8. Cod in Division 6.a. Total catch-at-age (thousands). Values for 2006–2011 differ to those used in the 2012 assessment when both landings and discards were adjusted for misreporting.

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1978	1135	1787	999	695	286	97	75
1979	945	1693	2125	682	342	134	69
1980	2366	3294	2001	796	191	77	37
1981[1]	515	7923	3220	904	182	29	20
1982[1]	3635	1681	3206	1189	367	111	33
1983[1]	3178	4540	1118	1400	468	148	60
1984[1]	3231	2371	2564	448	555	185	59
1985[1]	6543	5183	1269	1091	140	167	79
1986[1]	1762	1500	2055	411	191	40	30
1987[1]	22231	4849	988	905	137	56	26
1988[1]	1239	9395	2195	278	210	39	20
1989[1]	8260	1088	3858	709	113	69	33
1990[1]	4694	4065	432	924	170	23	11
1991[1]	4036	1742	1807	188	266	70	23
1992[1]	8792	2011	578	720	69	58	24
1993[1]	607	3680	1051	131	183	24	36
1994[1]	3685	1213	1545	280	56	51	20
1995[1]	1378	2806	700	630	70	15	11
1996[1]	532	2381	1210	247	204	31	13
1997[1]	2935	1101	989	281	66	62	7
1998[1]	1100	4290	293	174	57	16	9
1999[1]	362	889	1047	64	48	24	9
2000[1]	3647	565	211	231	15	12	13
2001[1]	272	1356	155	63	52	3	4
2002[1]	1388	539	522	41	13	14	4
2003[1]	131	542	86	107	6	2	1
2004	267	113	85	11	26	2	1
2005	139	141	43	37	7	6	0.5
2006[2]	1228	143	100	24	16	3	2
2007[2]	572	1676	120	75	6	7	3
2008[2]	68.1	135	411	26	16.2	1	3
2009[2]	607	162	120	153	8	7	0.3
2010[2]	352	435	126	45	35	1	0.4
2011[2]	316	292	575	76	12.3	15	2
2012[2]	377	94	424	101	5.1	4	5
2013[2]	2030	329	139	146	25	2	3
2014[2]	705	320	322	81	42	3	0
2015[2]	161	360	272	66	35	27	1

[1] Values revised after 2012 benchmark because of new method for raising discards.

[2] Values include adjustment for misreporting of landings.

Table 3.2.9. Cod in Division 6.a. Mean weight-at-age (kg) in total catch. Values for 2006–2011 differ to those used in the 2012 assessment when both landings and discards were adjusted for misreporting.

	Age						
Year	1	2	3	4	5	6	7+
1978	0.389	0.946	3.389	5.262	7.096	8.686	9.857
1979	0.688	1.308	2.828	4.853	6.433	7.784	9.636
1980	0.440	1.375	3.002	5.277	7.422	8.251	9.331
1981[1]	0.50	1.070	2.839	4.923	7.518	9.314	10.328
1982[1]	0.504	1.463	2.737	4.749	6.113	7.227	9.856
1983[1]	0.488	1.260	2.995	4.398	6.305	8.084	9.744
1984[1]	0.588	1.398	3.168	5.375	6.601	8.606	10.350
1985[1]	0.271	1.165	2.597	4.892	6.872	8.344	9.766
1986[1]	0.466	1.203	2.785	4.655	6.336	8.283	9.441
1987[1]	0.295	1.310	2.783	4.574	6.161	7.989	10.062
1988[1]	0.711	1.081	2.883	5.145	6.993	8.204	9.803
1989[1]	0.423	1.294	2.425	4.737	7.027	7.520	9.594
1990[1]	0.185	1.267	2.815	4.314	7.021	9.027	11.671
1991[1]	0.394	1.089	2.615	4.346	6.475	8.134	10.076
1992[1]	0.295	1.274	2.606	4.268	6.190	7.844	10.598
1993[1]	0.529	1.304	2.941	4.646	6.244	7.802	8.409
1994[1]	0.343	1.287	2.899	4.710	6.389	8.423	8.409
1995[1]	0.423	1.130	2.857	4.956	6.771	8.539	9.505
1996[1]	0.509	1.204	2.738	5.056	6.892	8.088	10.759
1997[1]	0.453	1.183	2.571	4.805	6.952	7.821	9.630
1998[1]	0.336	0.904	2.264	4.506	6.104	8.017	9.612
1999[1]	0.439	1.035	2.194	4.688	6.486	8.252	9.439
2000[1]	0.366	1.212	2.457	4.126	6.666	7.917	8.392
2001[1]	0.391	0.940	2.679	4.568	5.860	7.741	9.386
2002[1]	0.361	1.096	2.330	4.841	6.175	7.192	9.548
2003[1]	0.461	0.995	2.290	3.854	6.220	8.075	8.839
2004	0.314	0.945	2.194	4.396	6.003	8.258	9.678
2005	0.395	1.078	2.624	4.118	4.908	6.753	10.240
2006[2]	0.265	1.209	2.335	3.799	6.183	7.071	11.103
2007[2]	0.201	0.944	2.723	4.37	5.813	9.001	8.81
2008[2]	0.22	1.028	2.345	4.801	6.351	7.957	8.471
2009[2]	0.264	1.362	2.329	3.876	5.904	6.951	8.646
2010[2]	0.253	1.332	2.462	3.856	5.095	6.144	7.974
2011[2]	0.212	1.038	2.276	3.469	5.812	6.248	9.891
2012[2]	0.154	1.205	2.239	4.036	6.913	7.296	7.52
2013[2]	0.111	0.955	2.171	3.352	5.488	7.158	7.608
2014[2]	0.145	1.127	2.349	3.058	4.379	5.358	7.206
2015[2]	0.345	1.232	2.447	3.674	5.266	5.575	8.819

[1] **Values revised from 2012 benchmark because of new method for raising discards.**

[2] **Values calculated after landings numbers-at-age adjusted for misreporting.**

Table 3.2.10. Cod in Division 6.a. TSA parameter settings for the assessment run.

PARAMETER	SETTING	JUSTIFICATION
Age of full selection.	$a_m = 4$	Carried over from previous TSA. Based on inspection of XSA runs.
Multipliers on variance matrices of measurements.	$B_{landings}(a) = 2$ for ages 6, 7+ $B_{survey}(a) = 2$ for age 1, 5, 6	Allows extra measurement variability for poorly-sampled ages.
Multipliers on variances for fishing mortality estimates.	H(1) = 2	Allows for more variable fishing mortalities for age 1 fish.
Downweighting of particular datapoints.	Landings: Age 2 in 1987 age 6 in 1982 and 2009, age 7 in 1982,1983,1989. Age 5 & 6 in 2015 Discards: age 1 in 1988 and 1992, age 2 in 1988, 1992,1998,2002. Survey: age 2 in 2007 and 2010, age 3 in 2008 (large haul near 4W line), age 4 in 2001 and 2008, age 5 in 2001.	Large values indicated by exploratory prediction error plots. Downweighting in 2001 resulted from a single large haul, 24 fish >75 cm in 30 minutes.
Discards	Discards are allowed to evolve over time constrained by a trend. Ages 1 to 4 are modelled independently. A step function is specified with the step occurring in 2006.	
Recruitment.	Modelled by a Ricker model, with numbers-at-age 1 assumed to be independent and normally distributed with mean η1 S exp(−η2 S), where S is the spawning–stock biomass at the start of the previous year. To allow recruitment variability to increase with mean recruitment, a constant coefficient of variation is assumed.	
Large year classes.	The 1986 year class was large, and recruitment at-age 1 in 1987 is not well modelled by the Ricker recruitment model. Instead, N(1, 1987) is taken to be normally distributed with mean 5η1 S exp(−η2 S). The factor of 5 was chosen by comparing maximum recruitment to median recruitment from 1966–1996 for 6.a cod, haddock, and whiting in turn using previous XSA runs. The coefficient of variation is again assumed to be constant.	

Table 3.2.11. Cod in Division 6.a. Comparison of TSA parameter estimates from recent assessments.

Parameter	Notation	Description	2014 WG	2015 WG	2016 WG
Initial fishing mortality	*F* (1, 1981)	Fishing mortality-at-age *a* in year *y*	0.3024	0.3063	0.3307
	F (2, 1981)		0.6232	0.603	0.6863
	F (4, 1981)		0.9901	0.9469	1.0448
Fishing mortality standard deviations	σ_F	Transitory changes in overall fishing mortality	0.086	0.113	0.153
	σ_U	Persistent changes in selection (age effect in F)	0.0167	0.0304	0.0145
	σ_V	Transitory changes in the year effect in fishing mortality	0.0925	0.0822	0.1463
	σ_Y	Persistent changes in the year effect in fishing mortality	0.0109	0.0971	0
Measurement CVs	$CV_{landings}$	CV of landings-at-age data	0.1257	0.1245	0.1174
	$CV_{discards}$	CV of discards-at-age data	0.578	0.5079	0.446
Recruitment	η_1	Ricker parameter (slope at the origin)	1.1243	1.3184	1.2655
	η_2	Ricker parameter (curve dome occurs at $1/\eta_2$)	0.0168	0.0234	0.0239
	cv_{rec}	Coefficient of variation of recruitment data	0.4066	0.3922	0.3934
Discards	$\sigma_{logit\ p}$	Transitory trends in discarding	0.8468	0.7504	0.7607
	$\sigma_{persistent}$	Persistent trends in discarding	0.3176	0.5145	0.3383
	Step fn age 1	Amount by which discards increase in 2006	4.2166	3.6191	3.9398
	Step fn age 2		6.0607	5.8156	5.75
	Step fn age 3		1.0313	0.8856	0.9198
	Step fn age 4		0.0255	-0.4122	-0.4842
Survey selectivities SCOWIBTS.Q1	$\Phi(1)$	Survey selectivity-at-age *a*	0.6026	0.536	0.5602
	$\Phi(2)$		3.0289	2.8965	2.8965
	$\Phi(3)$		7.2463	6.6972	6.9061
	$\Phi(4)$		10.7017	10.0868	10.6042
	$\Phi(5)$		15.1325	14.0764	15.2594
	$\Phi(6)$		20.9711	19.2501	20.5213

Parameter	*Notation*	Description	2014 WG	2015 WG	2016 WG
Survey CVs	σ_{survey}	CV parameter controlling gamma type dispersion	0.2957	0.0891	0.2657
	η_{survey}	CV parameter controlling poisson type dispersion	1.1022	1.3844	1.1524
Survey catchability standard deviations	σ_{Ω}	Transitory changes in survey catchability	NA	NA	NA
	σ_{β}	Persistent changes in survey catchability	NA	NA	NA
Survey selectivities UKGFSWIBTS.Q1	Φ(1)	Survey selectivity-at-age *a*	NA	1.6459	0.6683
	Φ(2)		NA	20.7721	20.8016
	Φ(3)		NA	28.6685	44.3821
	Φ(4)		NA	40.9166	49.9699
	Φ(5)		NA	37.9549	93.113
	Φ(6)		NA	35.556	68.1332
Survey catchability standard deviations	σ_{Ω}	Transitory changes in survey catchability	NA	0.3729	0.5386
	σ_{β}	Persistent changes in survey catchability	NA	0	0
Misreporting		Transitory changes in misreporting	NA	0	0
		Persistent changes in misreporting	0.1724	0.1716	0.2279

Table 3.2.12. Cod in Division 6.a. TSA population numbers-at-age (millions).

	Age						
Year	1	2	3	4	5	6	7+
1981	10997	19572	6920	1879	348	54	38
1982	25822	5303	7277	2456	672	118	31
1983	14778	12387	2261	2727	869	238	54
1984	25521	6409	4954	788	888	289	94
1985	14148	11967	2394	1609	235	231	112
1986	21475	4741	4099	716	341	64	77
1987	61668	10065	1904	1450	227	108	48
1988	6831	19921	3803	577	353	62	44
1989	24793	2752	6465	1150	184	100	32
1990	8430	9690	977	1653	314	51	34
1991	13219	3290	3524	355	490	106	30
1992	23000	5354	1089	1152	121	152	40
1993	9129	10385	2050	339	326	40	66
1994	19160	4194	4008	606	114	93	34
1995	15283	8317	1698	1410	176	36	37
1996	6782	7011	2908	560	444	58	25
1997	24221	2987	2273	797	160	127	21
1998	7131	10746	829	551	220	45	38
1999	5055	2920	3030	200	148	72	25
2000	19516	2164	809	731	51	40	28
2001	4274	7231	678	239	201	15	19
2002	9555	1832	2337	179	54	53	11
2003	2446	3417	534	616	43	12	13
2004	3164	842	812	127	149	11	6
2005	1629	1067	201	196	39	29	3
2006	6006	607	320	29	31	6	5
2007	1784	2622	223	105	7	10	4
2008	1515	695	817	53	23	2	3
2009	3718	672	240	239	14	5	1
2010	3871	1659	250	77	69	4	2
2011	2209	1860	663	76	21	23	2
2012	2573	949	673	144	10	5	6
2013	4514	1112	365	224	35	3	3
2014	3013	1576	392	118	65	7	1
2015	2682	1330	600	116	36	18	2
2016	3781	1263	501	201	33	10	6
GM(81-15)	7599	3415	1261	391	113	33	15

***2016 values are TSA-derived projections of population numbers.**

Table 3.2.13. Cod in Division 6.a. Standard errors on TSA population numbers-at-age (thousands).

	Age						
Year	1	2	3	4	5	6	7+
1981	865	1253	453	121	36	9	6
1982	1337	285	491	173	47	21	5
1983	1120	623	119	184	63	25	8
1984	1286	431	270	48	65	32	11
1985	1214	555	151	107	18	34	15
1986	1640	357	232	48	33	9	13
1987	6229	730	120	100	20	17	7
1988	964	2000	208	46	38	11	8
1989	2086	223	641	73	14	15	6
1990	1328	673	74	181	25	7	6
1991	1644	451	357	34	64	13	4
1992	2104	591	144	131	13	26	7
1993	881	829	215	42	41	6	10
1994	1967	365	383	75	13	16	5
1995	1553	860	162	143	24	6	7
1996	948	663	338	62	51	10	4
1997	2274	373	277	110	20	20	4
1998	1088	1005	131	83	32	9	8
1999	769	412	401	35	24	11	5
2000	2042	294	128	108	9	9	5
2001	694	898	97	36	30	3	4
2002	1392	282	322	30	12	12	2
2003	670	527	87	93	9	4	5
2004	726	236	175	24	28	3	2
2005	442	234	59	44	7	9	2
2006	799	140	50	8	6	2	3
2007	280	342	40	11	2	2	1
2008	262	108	101	8	3	1	1
2009	472	109	33	25	2	2	0
2010	427	205	35	9	6	1	1
2011	303	207	72	9	2	3	0
2012	470	130	72	17	2	1	1
2013	756	206	47	20	4	1	1
2014	666	362	69	14	7	2	0
2015	904	328	149	23	6	4	1
2016*	1302	442	141	61	10	3	2

***2016 values are standard errors on TSA-derived projections of population numbers.**

Table 3.2.14. Cod in Division 6.a. TSA estimates for mortality-at-age.

	AGE						
Year	1	2	3	4	5	6	7
1981	0.208	0.614	0.739	0.750	0.855	0.873	0.878
1982	0.180	0.436	0.681	0.767	0.780	0.790	0.806
1983	0.320	0.509	0.738	0.857	0.854	0.907	0.911
1984	0.190	0.603	0.819	0.951	1.133	1.032	1.022
1985	0.568	0.676	0.904	1.315	1.075	1.330	1.260
1986	0.178	0.538	0.740	0.905	0.941	0.923	0.860
1987	0.514	0.562	0.894	1.152	1.071	1.075	1.062
1988	0.379	0.717	0.884	0.879	1.061	1.033	0.985
1989	0.403	0.665	1.035	1.037	1.066	1.177	1.126
1990	0.407	0.634	0.699	0.983	0.832	0.789	0.783
1991	0.376	0.729	0.821	0.803	0.951	1.002	1.069
1992	0.238	0.576	0.873	1.012	0.867	0.836	0.914
1993	0.242	0.564	0.925	0.817	1.033	0.943	0.910
1994	0.302	0.512	0.736	0.987	0.939	1.032	1.011
1995	0.242	0.670	0.809	0.898	0.886	0.896	0.854
1996	0.300	0.749	0.988	1.001	1.034	1.169	1.131
1997	0.273	0.867	1.099	1.034	1.045	1.155	1.067
1998	0.361	0.879	1.073	1.057	0.888	1.022	0.974
1999	0.332	0.877	1.120	1.117	1.099	1.014	1.097
2000	0.462	0.788	0.931	1.048	1.036	1.051	1.163
2001	0.310	0.745	1.016	1.184	1.106	0.967	0.955
2002	0.486	0.841	1.032	1.144	1.197	1.250	1.348
2003	0.392	0.929	1.089	1.142	1.107	1.173	1.160
2004	0.403	0.840	1.003	0.933	1.258	1.274	1.207
2005	0.383	0.783	1.189	1.317	1.426	1.293	1.226
2006	0.292	0.642	0.842	1.073	0.960	0.957	0.950
2007	0.397	0.788	1.078	1.241	1.247	1.237	1.255
2008	0.293	0.687	0.942	1.097	1.217	1.190	1.242
2009	0.276	0.618	0.848	1.013	1.021	1.080	0.994
2010	0.195	0.525	0.885	1.048	0.852	0.828	0.849
2011	0.315	0.634	1.209	1.701	1.150	1.165	1.323
2012	0.307	0.573	0.782	1.180	1.092	1.087	1.133
2013	0.523	0.674	0.808	0.976	1.377	1.324	1.377
2014	0.291	0.592	0.929	0.939	1.093	1.043	0.951
2015	0.225	0.601	0.806	1.021	1.076	1.039	0.986

Table 3.2.15. Cod in Division 6.a. Standard errors of TSA estimates for log mortality-at-age.

	Age						
Year	1	2	3	4	5	6	7+
1981	0.028	0.055	0.065	0.068	0.129	0.144	0.145
1982	0.023	0.041	0.061	0.070	0.089	0.134	0.138
1983	0.043	0.044	0.059	0.074	0.097	0.125	0.154
1984	0.026	0.055	0.065	0.078	0.122	0.144	0.164
1985	0.067	0.052	0.071	0.097	0.121	0.179	0.195
1986	0.040	0.057	0.065	0.084	0.113	0.149	0.135
1987	0.090	0.071	0.073	0.093	0.131	0.158	0.171
1988	0.100	0.069	0.066	0.080	0.115	0.168	0.162
1989	0.072	0.064	0.091	0.083	0.118	0.161	0.190
1990	0.086	0.069	0.076	0.103	0.105	0.125	0.129
1991	0.086	0.095	0.098	0.097	0.127	0.159	0.189
1992	0.065	0.078	0.111	0.117	0.125	0.135	0.163
1993	0.060	0.072	0.109	0.111	0.142	0.164	0.152
1994	0.069	0.068	0.091	0.122	0.134	0.164	0.178
1995	0.059	0.085	0.096	0.105	0.126	0.154	0.146
1996	0.075	0.092	0.119	0.120	0.138	0.190	0.198
1997	0.064	0.107	0.126	0.130	0.147	0.179	0.189
1998	0.085	0.101	0.134	0.135	0.127	0.174	0.168
1999	0.082	0.110	0.131	0.149	0.154	0.164	0.194
2000	0.096	0.104	0.129	0.137	0.153	0.175	0.203
2001	0.078	0.097	0.126	0.146	0.152	0.169	0.165
2002	0.111	0.112	0.126	0.149	0.176	0.198	0.243
2003	0.098	0.116	0.135	0.139	0.163	0.204	0.200
2004	0.099	0.117	0.132	0.126	0.161	0.215	0.212
2005	0.103	0.126	0.176	0.177	0.199	0.209	0.228
2006	0.079	0.112	0.136	0.144	0.113	0.154	0.153
2007	0.100	0.116	0.150	0.127	0.148	0.175	0.207
2008	0.080	0.114	0.133	0.135	0.154	0.195	0.190
2009	0.075	0.105	0.127	0.111	0.115	0.178	0.168
2010	0.054	0.086	0.122	0.114	0.095	0.127	0.141
2011	0.083	0.098	0.132	0.150	0.134	0.152	0.225
2012	0.084	0.096	0.109	0.132	0.130	0.170	0.174
2013	0.139	0.115	0.125	0.108	0.141	0.209	0.215
2014	0.084	0.109	0.152	0.150	0.187	0.162	0.172
2015	0.068	0.124	0.165	0.201	0.220	0.216	0.203

Table 3.2.16. Cod in Division 6.a. TSA summary table. "Obs." denotes sum-of-products of numbers and mean weights-at-age, not reported caught, landed and discarded weight.

Year	Landings (tonnes)			Discards (tonnes)			Total catches (tonnes)			Mean F(2–6)		SSB (tonnes)		Recruitment (000s at age 1)	
	Obs.	Pred.	SE	Obs.	Pred.	SE	Obs.	Pred.	SE	Estimate	SE	Estimate	SE	Estimate	SE
1981	23865	24168	1460	303	202	107	24168	24370	1464	0.739	0.047	40542	1558	10997	865
1982	21511	20023	1235	571	602	174	22082	20625	1230	0.666	0.038	38096	1557	25822	1337
1983	21305	19931	944	197	227	98	21503	20158	951	0.739	0.039	33852	1125	14778	1120
1984	21272	20567	956	329	425	163	21601	20992	956	0.877	0.046	31713	1058	25521	1286
1985	18607	17631	805	963	779	146	19570	18410	815	0.993	0.049	25098	843	14148	1214
1986	11820	11503	705	263	492	162	12083	11995	742	0.781	0.049	19532	736	21475	1640
1987	18971	17014	1167	2388	2100	736	21358	19114	1338	0.920	0.053	20793	806	61668	6229
1988	20413	19853	1637	368	342	172	20781	20195	1659	0.885	0.047	27006	1336	6831	964
1989	17169	16126	1304	2076	1621	475	19246	17747	1375	0.951	0.053	23132	1447	24793	2086
1990	12175	11897	779	571	246	84	12746	12143	791	0.787	0.063	18935	1125	8430	1328
1991	10927	10116	1315	622	494	193	11549	10610	1376	0.826	0.082	15669	1445	13219	1644
1992	9086	8665	1197	1779	674	257	10865	9339	1263	0.832	0.084	13274	1304	23000	2104
1993	10314	10784	1314	139	361	117	10453	11145	1350	0.835	0.086	16698	1389	9129	881
1994	8928	10380	1327	661	709	227	9588	11089	1403	0.793	0.081	17457	1528	19160	1967
1995	9439	11414	1427	141	375	129	9580	11789	1466	0.816	0.082	17900	1557	15283	1553
1996	9427	12249	1550	63	256	89	9489	12505	1580	0.943	0.092	17859	1637	6782	948
1997	7034	9866	1382	499	891	322	7533	10757	1486	1.011	0.100	13005	1396	24221	2274
1998	5714	9494	1284	538	337	125	6252	9831	1321	0.974	0.099	11224	1161	7131	1088
1999	4201	7303	1162	69	250	93	4270	7553	1199	1.053	0.108	10020	1212	5055	769
2000	2977	5274	853	821	1321	357	3798	6596	991	0.951	0.105	6982	898	19516	2042
2001	2347	5757	917	92	235	80	2439	5992	950	1.013	0.103	7657	904	4274	694

Year	Landings (tonnes)			Discards (tonnes)			Total catches (tonnes)			Mean F(2-6)		SSB (tonnes)		Recruitment (000s at age 1)	
	Obs.	**Pred.**	**SE**	**Obs.**	**Pred.**	**SE**	**Obs.**	**Pred.**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**
2002	2243	5641	950	480	607	205	2722	6248	1032	1.054	0.112	7409	974	9555	1392
2003	1241	4305	763	34	169	72	1275	4474	798	1.067	0.110	5673	786	2446	670
2004	540	2470	569	72	196	82	612	2666	610	1.008	0.107	3543	648	3164	726
2005	511	1754	453	41	115	52	552	1869	478	1.179	0.141	2273	444	1629	442
2006	488	385	54	465	873	175	954	1259	203	0.879	0.080	1428	161	6006	799
2007	595	533	67	1880	1474	265	2474	2007	280	1.088	0.080	2432	215	1784	280
2008	682	580	72	695	1048	204	1377	1629	216	0.986	0.082	2461	230	1515	262
2009	408	452	57	945	989	164	1353	1442	165	0.875	0.070	2004	158	3718	472
2010	559	545	49	785	1037	183	1344	1582	200	0.827	0.063	2363	183	3871	427
2011	454	435	42	1670	1755	231	2124	2190	232	1.173	0.075	2854	205	2209	303
2012	466	450	49	1166	1240	185	1632	1689	194	0.906	0.071	2622	199	2573	470
2013	299	343	40	1202	1220	172	1501	1563	170	0.959	0.074	2220	169	4514	756
2014	357	435	51	1311	1192	231	1668	1627	243	0.888	0.102	2407	287	3013	666
2015	770	617	112	983	1251	246	1752	1867	292	0.876	0.134	2849	444	2682	904
2016*		575	190		1333	353		1909	431	0.956	0.161	2677	543	3781	1302
Min	299	343	40	34	115	52	552	1259	165	1	0	1428	158	1515	262
GM	3351	4146	455	436	571	165	4900	6190	688	1	0	8582	690	7599	966
AM	7918	8542	801	719	746	193	8637	9288	880	1	0	13400	889	11712	1217
Max	23865	24168	1637	2388	2100	736	24168	24370	1659	1	0	40542	1637	61668	6229

***Estimates for 2016 are TSA projections.**

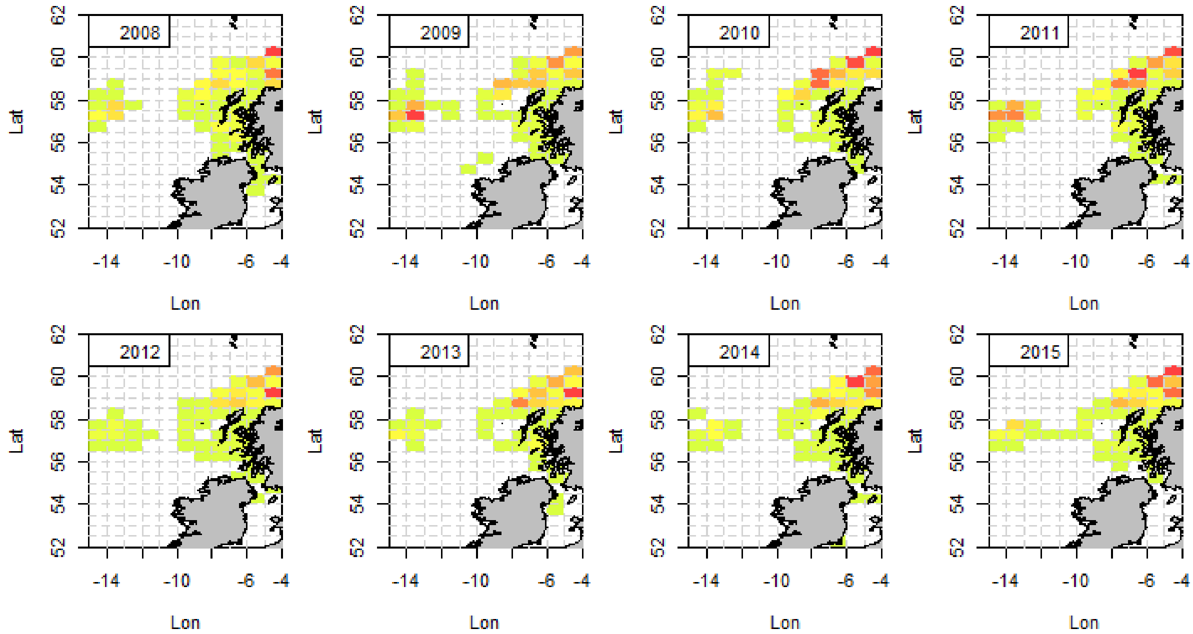


Figure 3.2.1. Distribution of Scottish reported landings by statistical rectangle by year.

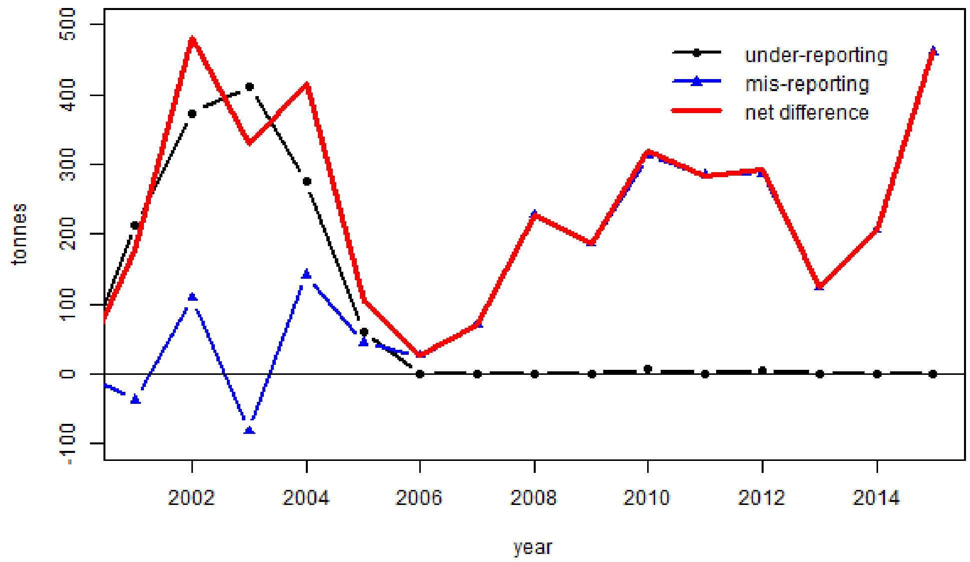


Figure 3.2.2. Cod in Division 6.a. Estimates of underreporting and area misreporting of cod caught in ICES Division 6.a by Scottish vessels. Negative values of area misreporting indicate a net balance of misreporting into Division 6.a from other areas.

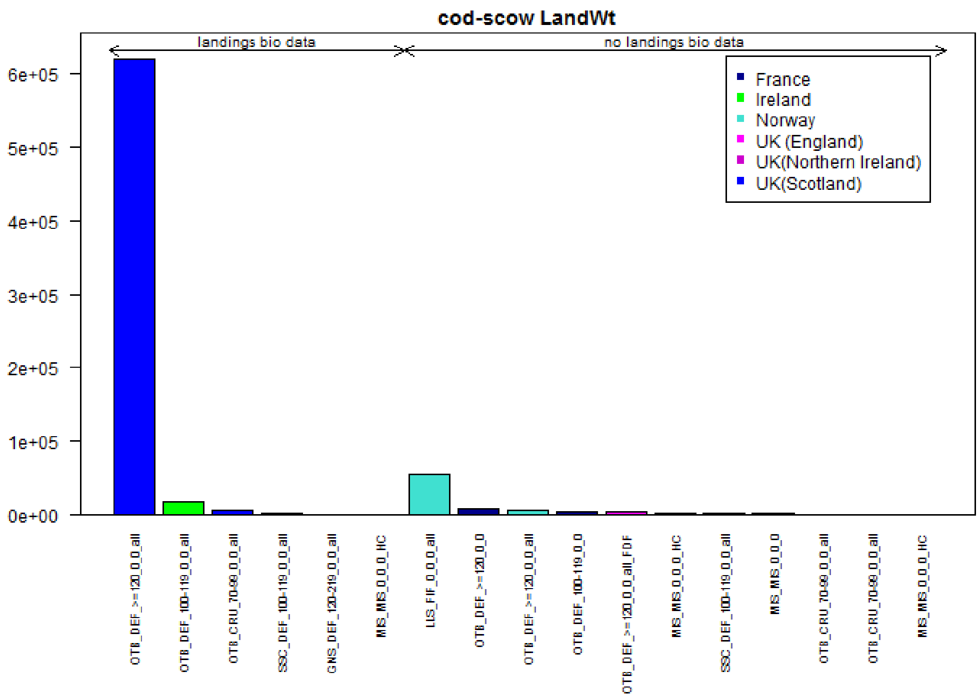


Figure 3.2.3. Cod in Division 6.a. Amounts landed by métier (kg) in 2015 as entered into InterCatch.

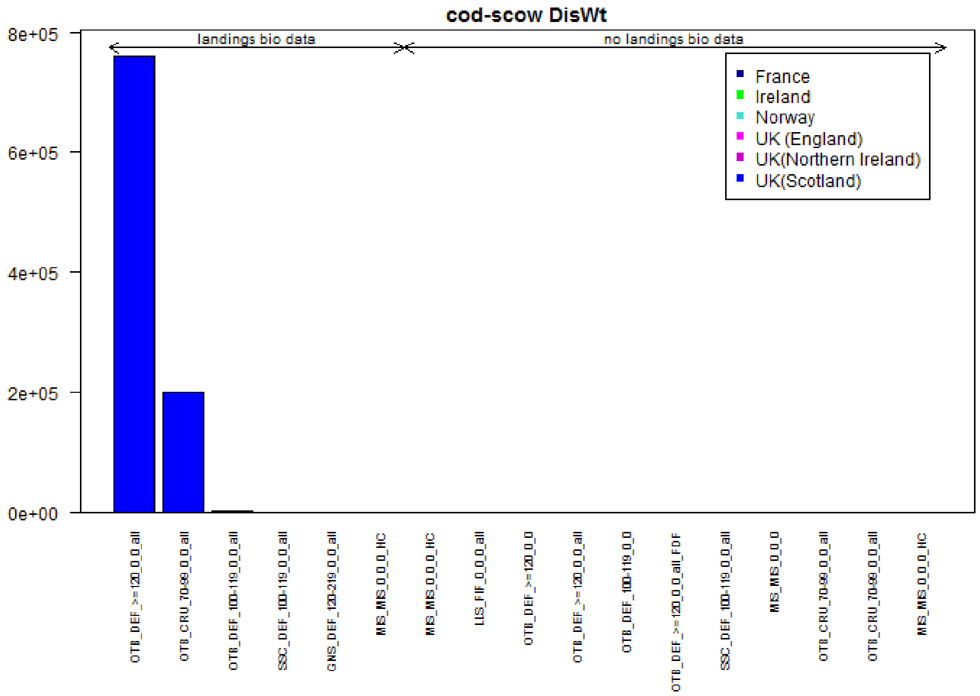


Figure 3.2.4. Cod in Division 6.a. Amounts discarded by métier (kg) in 2015 as entered into InterCatch.

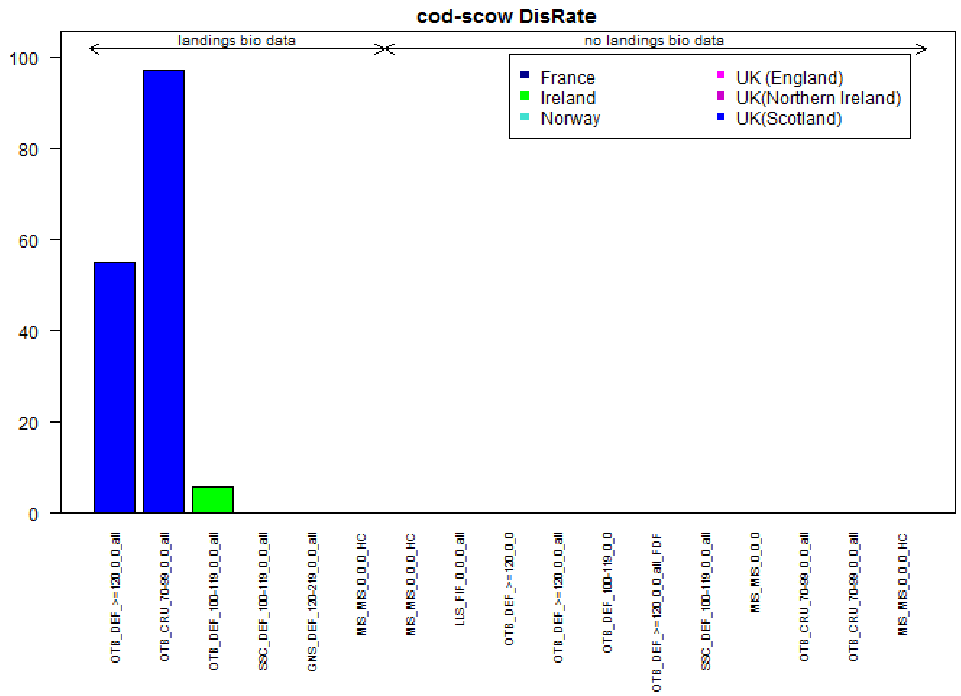


Figure 3.2.5. Cod in Division 6.a. Discard rates before allocations within InterCatch.

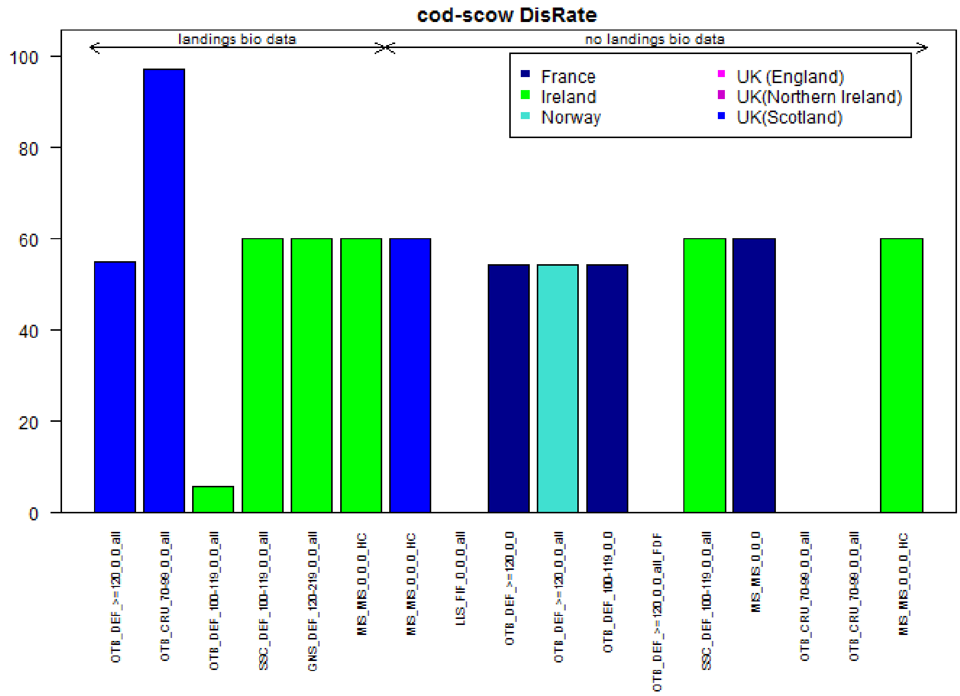


Figure 3.2.6. Cod in Division 6.a. Discard rates for all fleets after allocations within InterCatch.

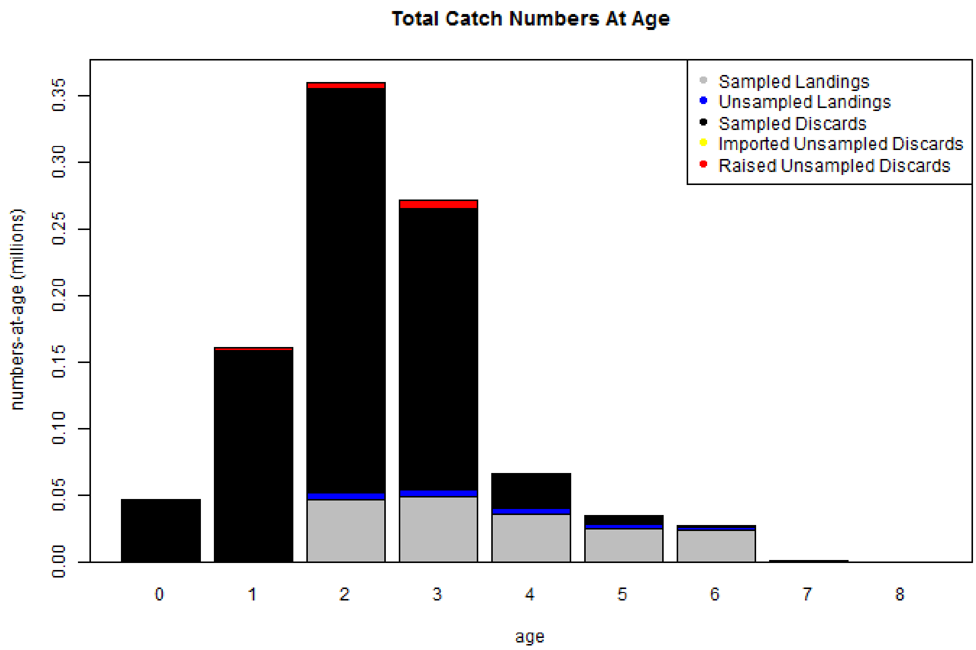


Figure 3.2.7. Cod in Division 6.a. Number-at-age constituted by sampled and unsampled landings and sampled and raised (unsampled) discards after allocations within InterCatch.

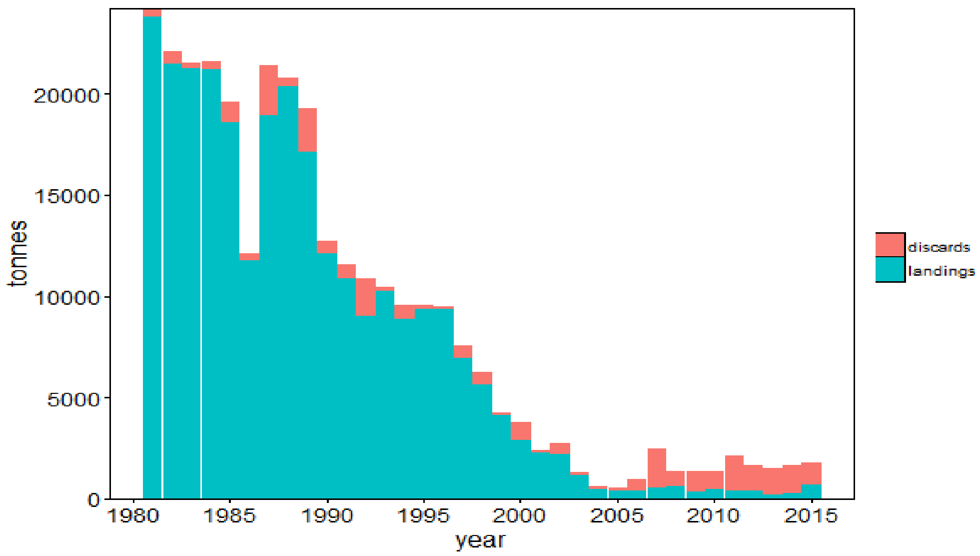


Figure 3.2.8. Cod in Division 6.a. Landings and discards estimates by weight, as used by the WG. Values are totals for fish aged 1 to 7+.

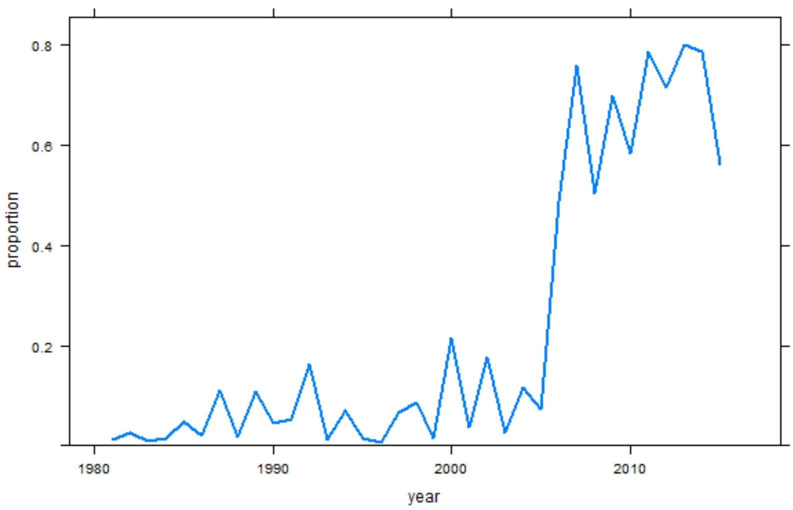


Figure 3.2.9. Cod in Division 6.a. Discard proportion (of total catch) by weight. Includes fish aged 1 to 7+.

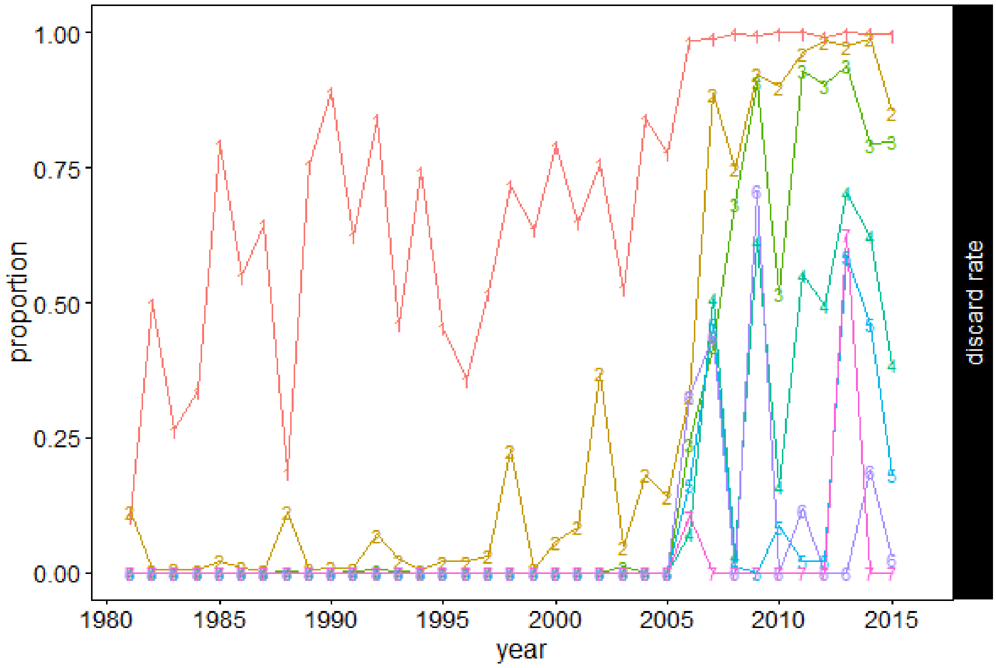


Figure 3.2.10. Cod in Division 6.a. Discard proportion by number.

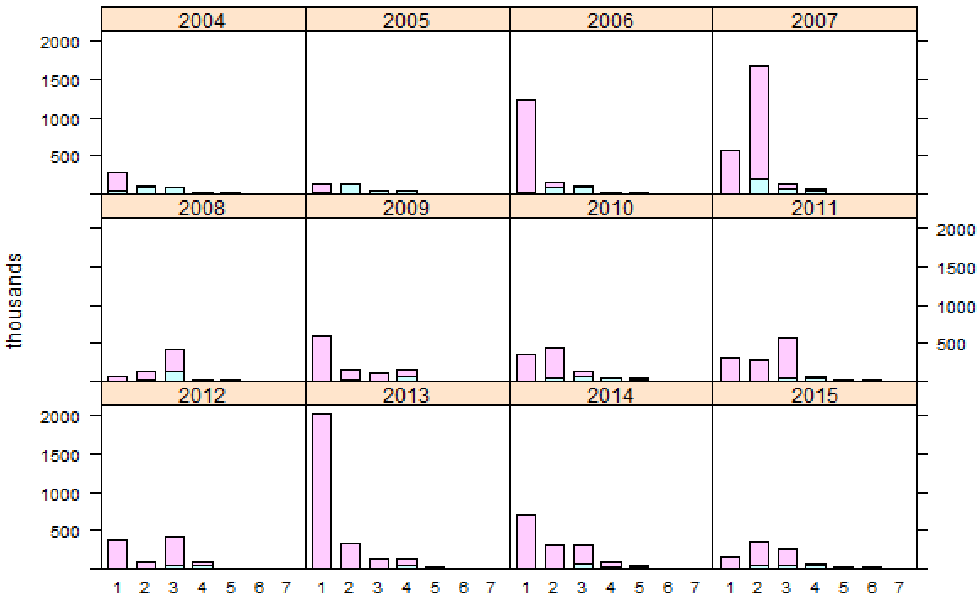


Figure 3.2.11. Cod in Division 6.a. Catch-at-age in numbers by year. Pink: discards, blue: landings.

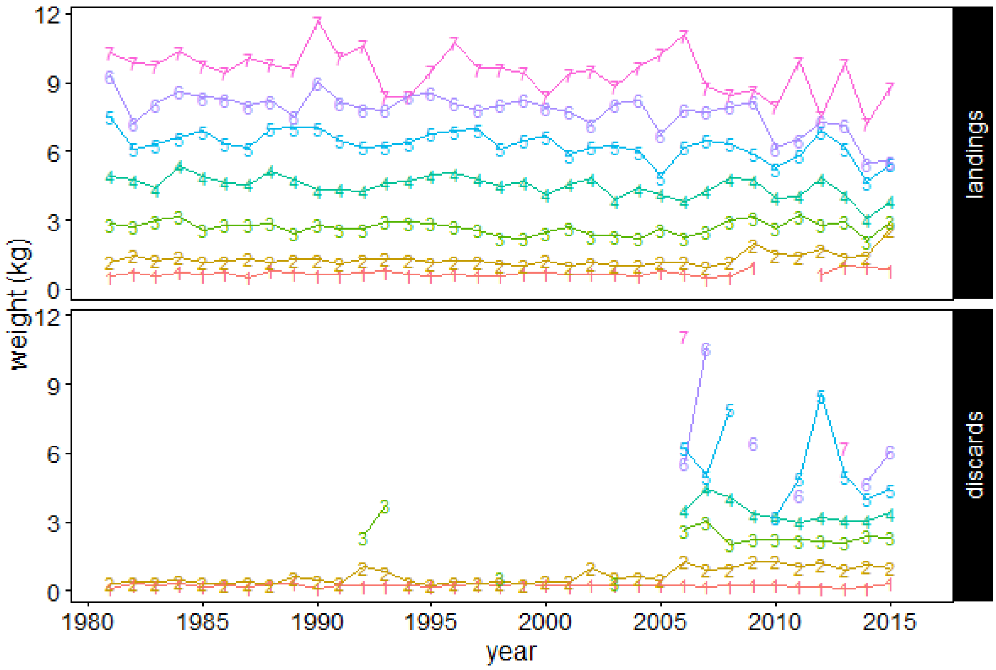


Figure 3.2.12. Cod in Division 6.a. Mean weights-at-age in landings and discards.

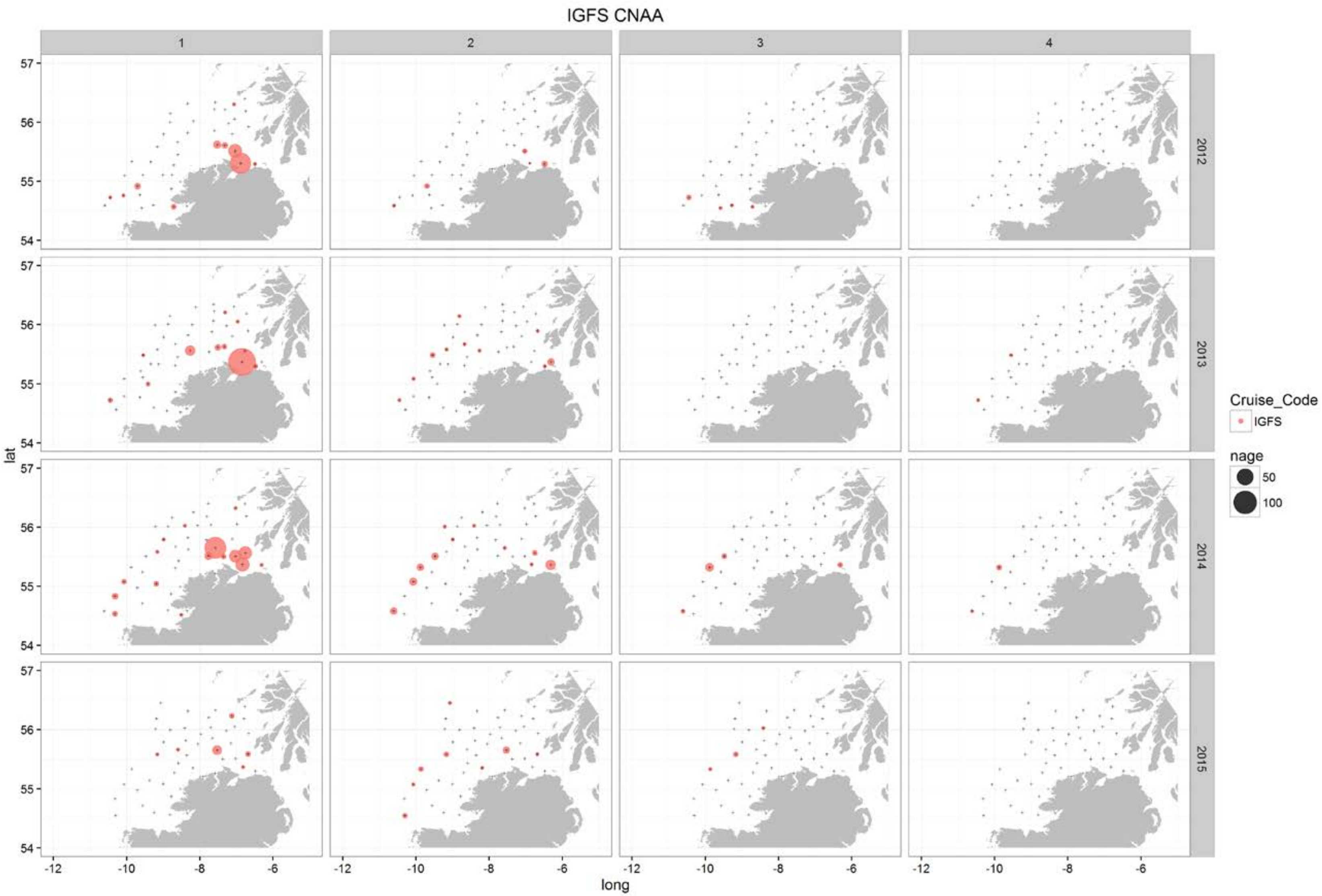


Figure 3.2.13. Cod in Division 6.a. Catch numbers for fish aged at 1+ per haul resulting from quarter four Irish ground fish survey (IRGFS-WIBTS-Q4). Values are standardised to 60 minutes towing. Zero shown as a black + symbol.

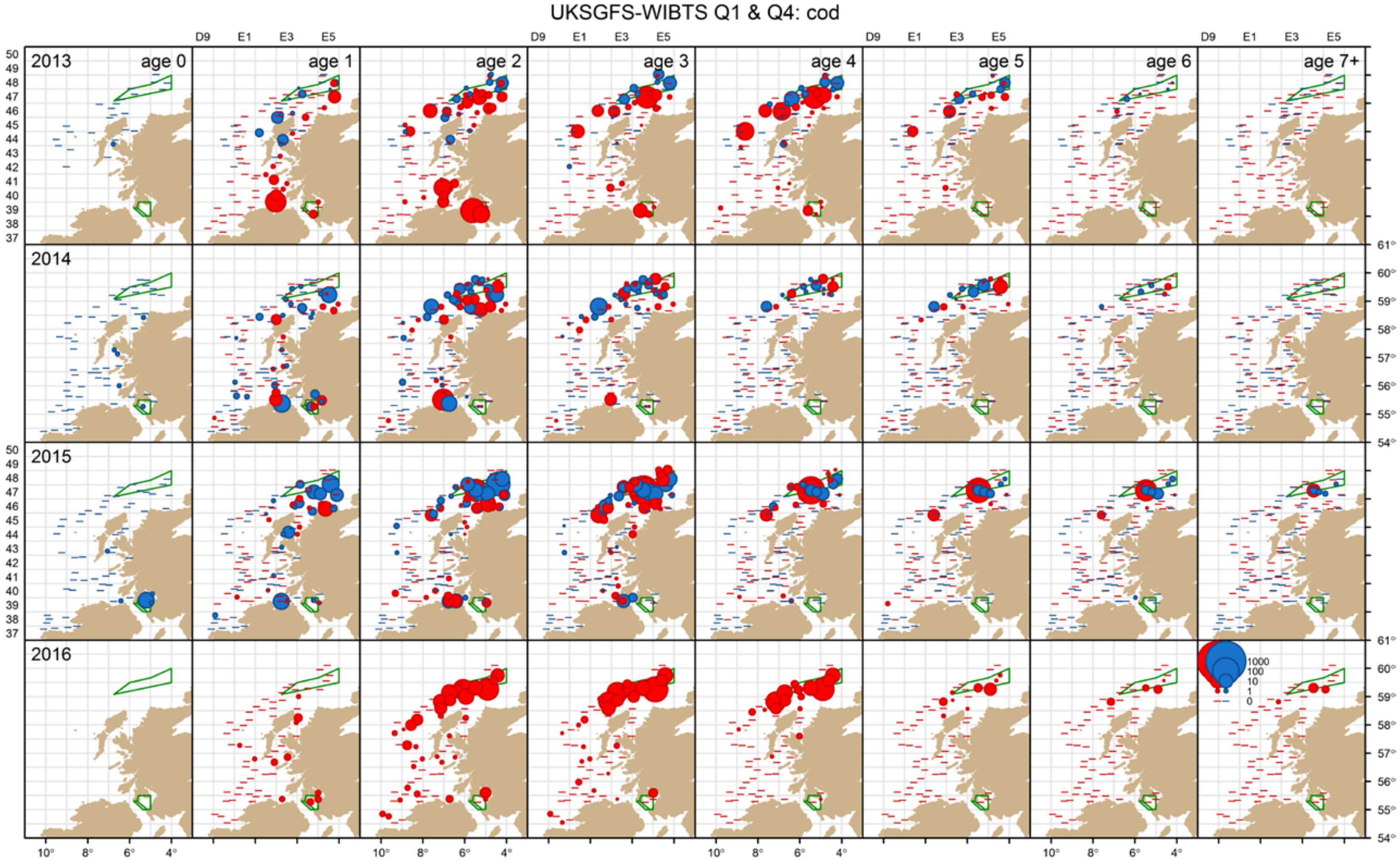


Figure 3.2.14. Cod in Division 6.a. Cpue numbers for fish aged at 1+ per tow resulting from Scottish quarter one survey (UKSGFS-WIBTS-Q1) in red and (UKSGFS-WIBTS-Q4) in blue. Numbers are standardised to 30 minutes towing. Green polygons are areas closed to fishing.

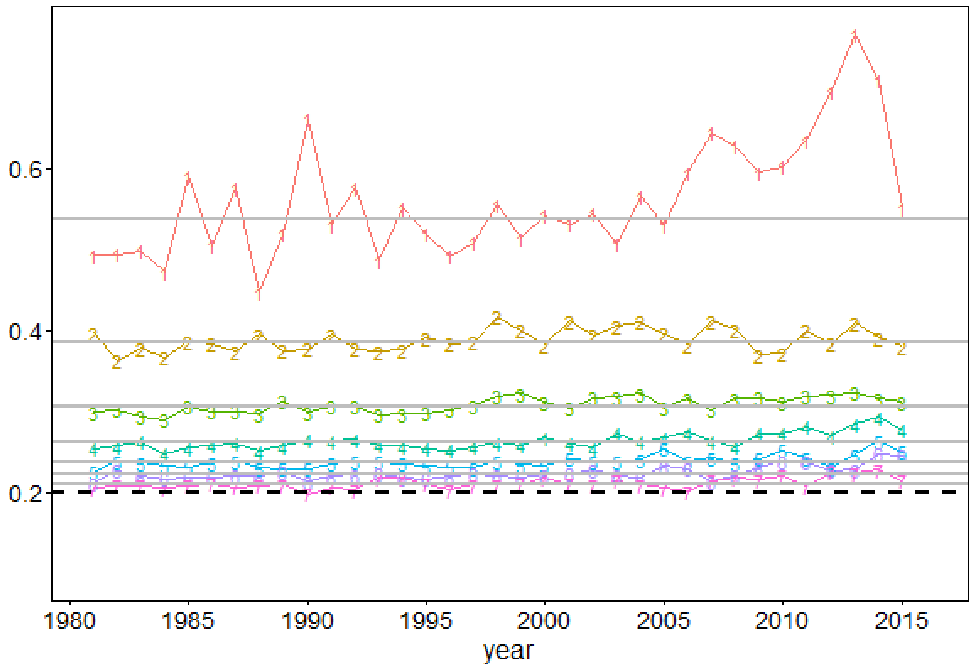


Figure 3.2.15. Cod in Division 6.a. Natural mortality-at-age based on mean weight-at-age and mortality–weight relationship. Solid horizontal lines show the time averaged values at each age used in the assessment. Dotted horizontal line shows value of 0.2 previously used at all ages in all years.

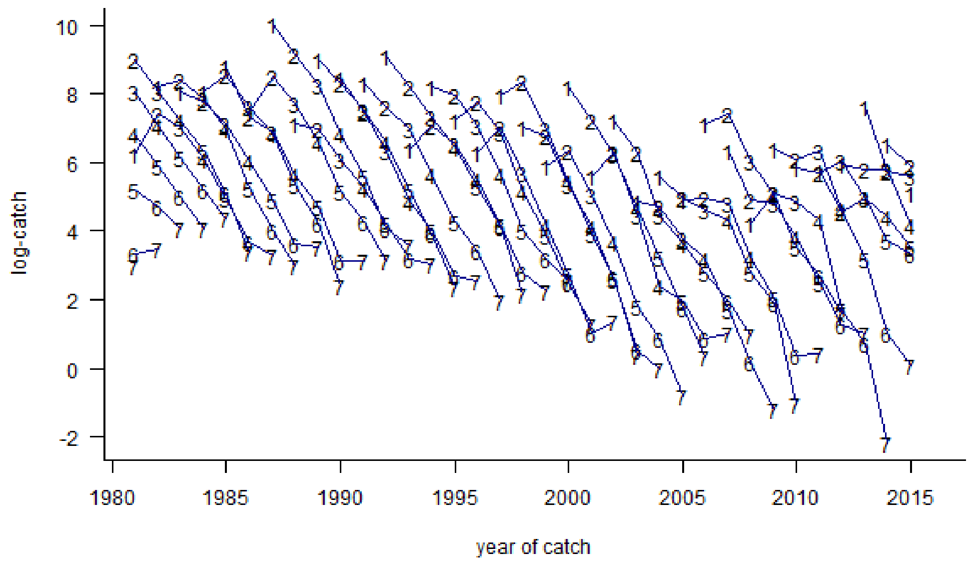


Figure 3.2.16. Cod in Division 6.a. Catch curves from commercial catch-at-age data.

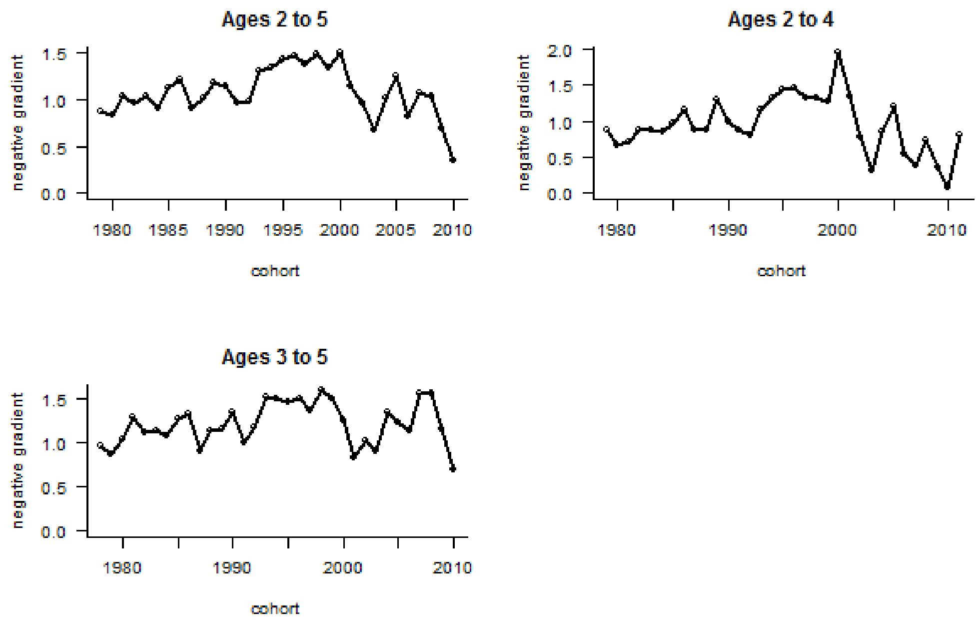


Figure 3.2.17. Cod in Division 6.a. Log catch (landings + discards) curve gradient plot using WG commercial catch-at-age data over different age ranges.

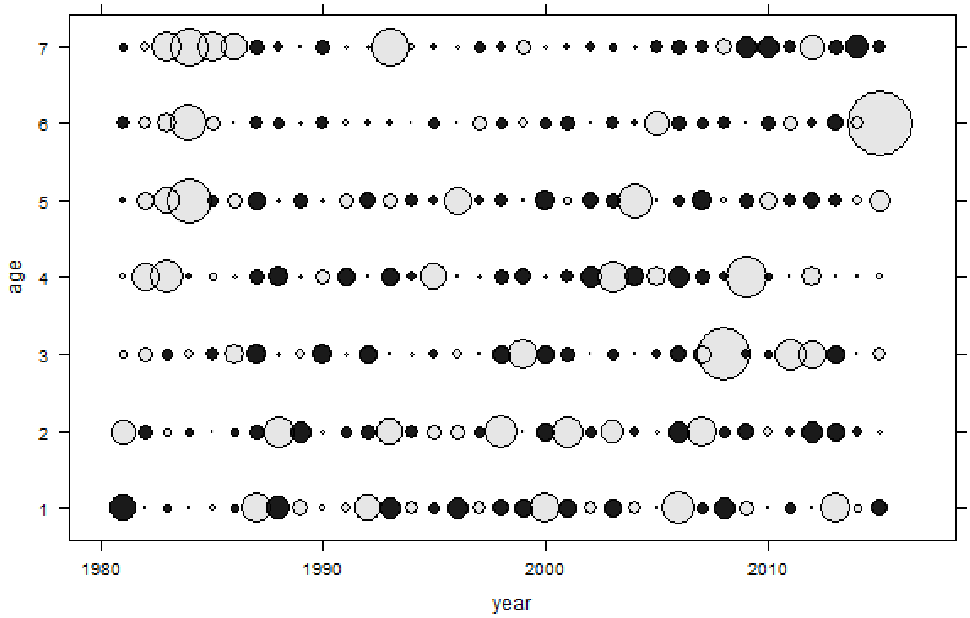


Figure 3.2.18. Cod in Division 6.a. Mean standardised catch-at-age proportions by number.

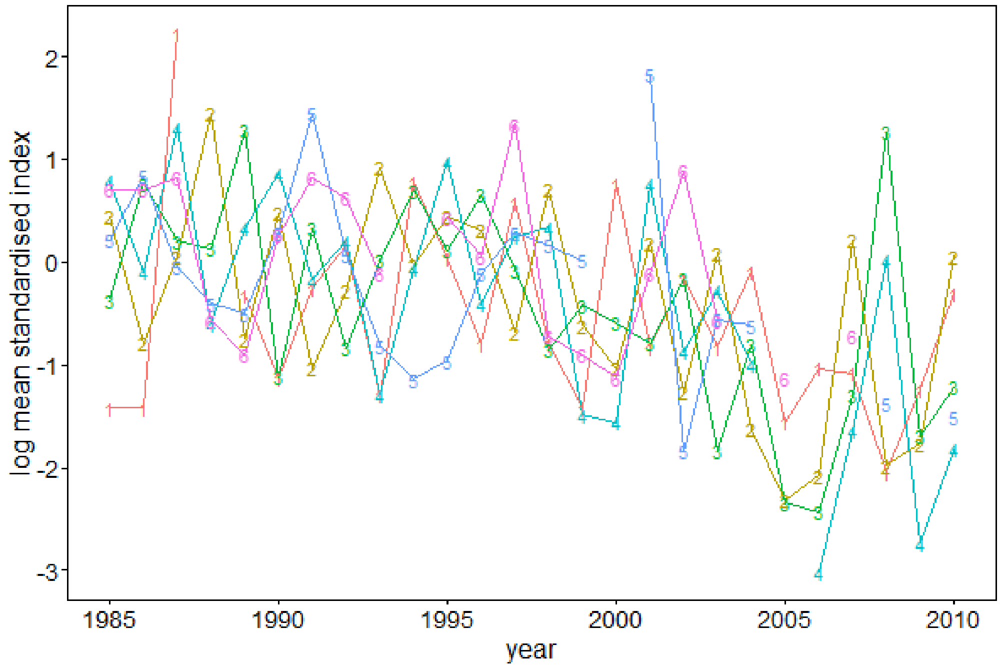


Figure 3.2.19. Cod in Division 6.a. Log mean standardised index values -by year- from Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1); ages 1–6. Survey finished in 2010.

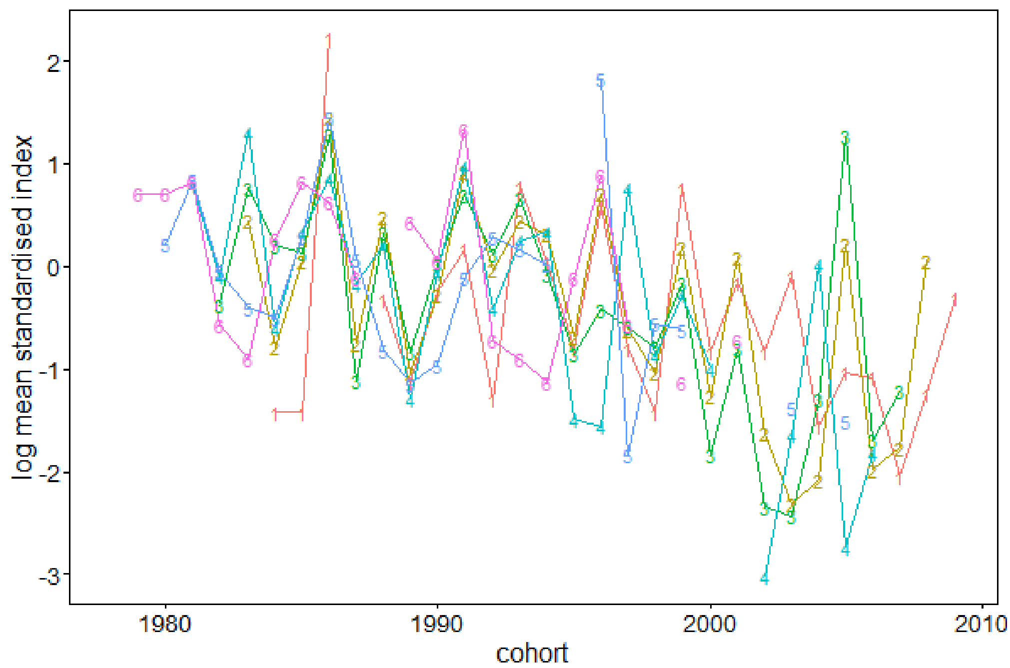


Figure 3.2.20. Cod in Division 6.a. Log mean standardised index values -by cohort- from Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1); ages 1–6. Survey finished in 2010.

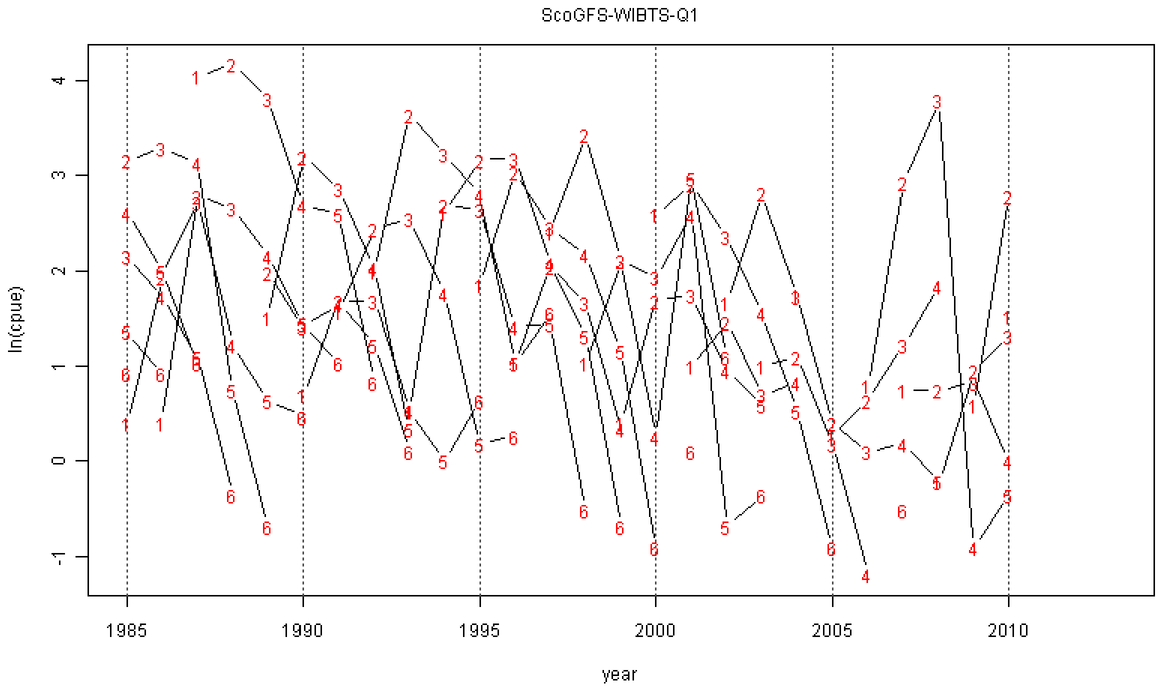


Figure 3.2.21. Cod in Division 6.a. Log catch curves from Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1); ages 1–6. Survey finished in 2010.

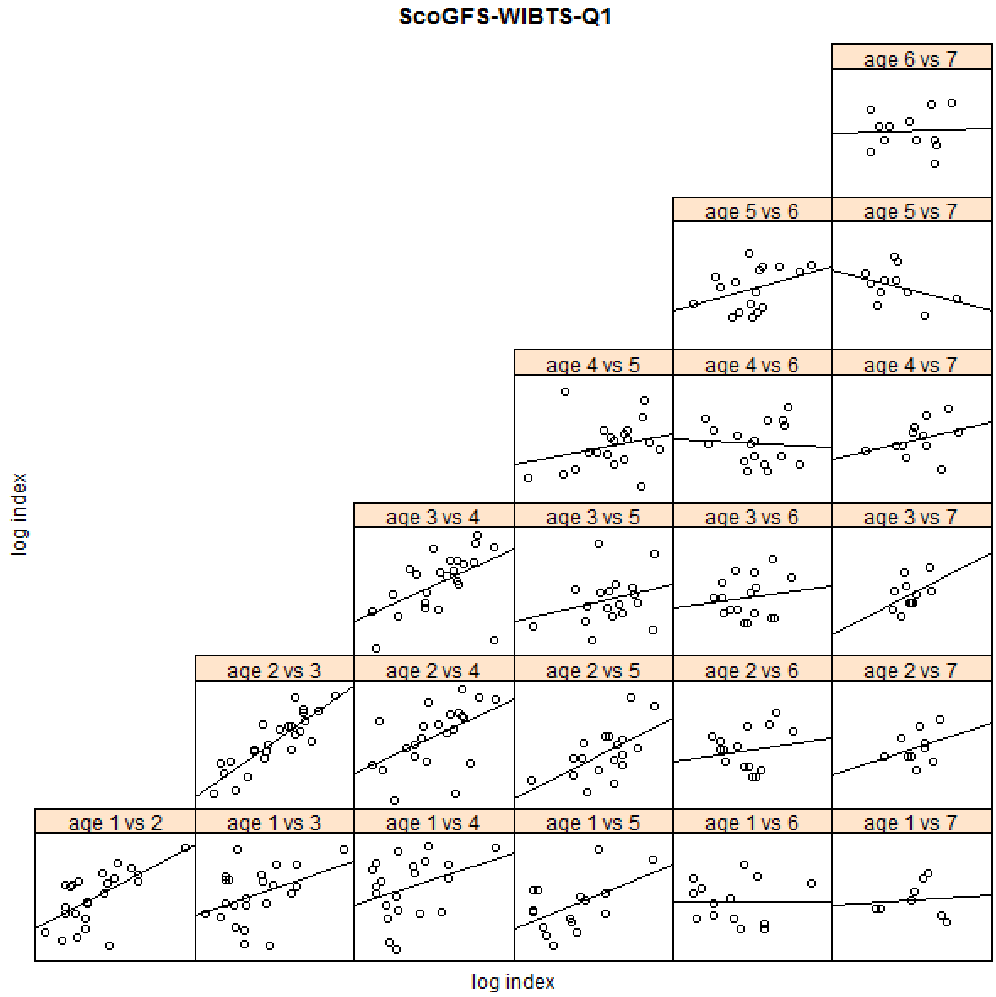


Figure 3.2.22. Cod in Division 6.a. Within-survey correlations for the Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1), comparing index values at different ages for the same cohorts. The straight line in a linear regression. Survey finished in 2010.

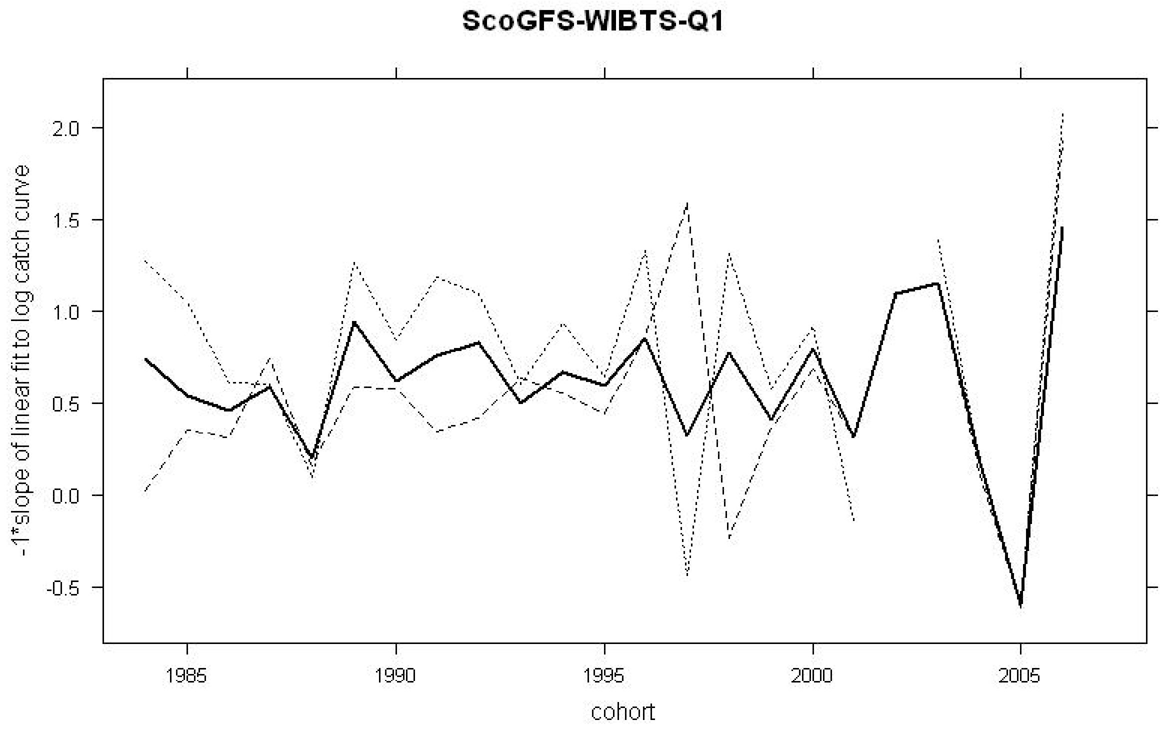


Figure 3.2.23. Cod in Division 6.a. Log catch curve gradient plot using ScoGFS-WIBTS-Q1 index data. Solid line shows time-series of gradient of linear fit to curve over the age range 2–5, dashed line over the ages 2–4 and dotted line over the ages 3–5. Last cohort shown was at-age 5 in 2010, the last year of the ScoGFS-WIBTS-Q1 survey.

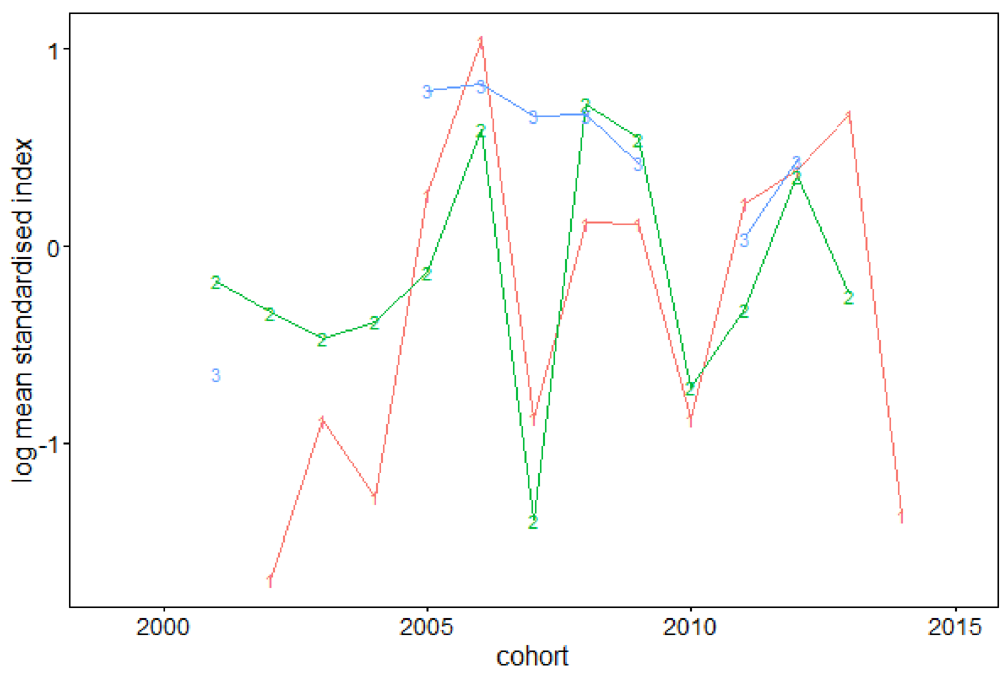


Figure 3.2.24. Cod in Division 6.a. Log mean standardised index values -by cohort- from Irish quarter four ground fish survey (IRGFS-WIBTS-Q4); ages 1–3. Survey started in 2003.

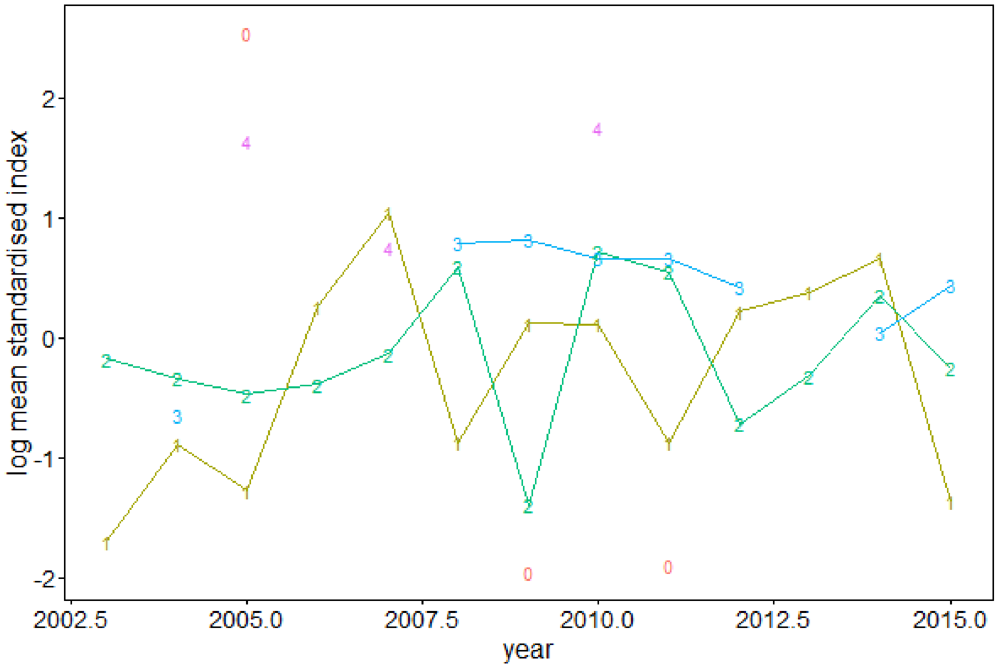


Figure 3.2.25. Cod in Division 6.a. Log mean standardised index values -by year- from Irish quarter four ground fish survey (IRGFS-WIBTS-Q4); ages 0–4. Survey started in 2003.

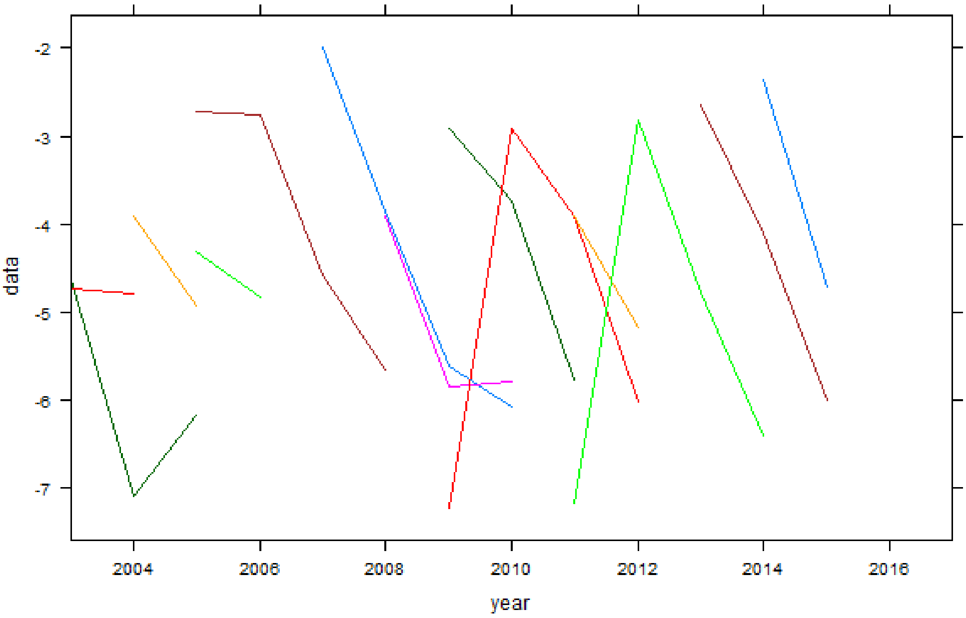


Figure 3.2.26. Cod in Division 6.a. Log catch curves from Irish quarter four ground fish survey (IRGFS-WIBTS-Q4); ages 1–4. Survey started in 2003.

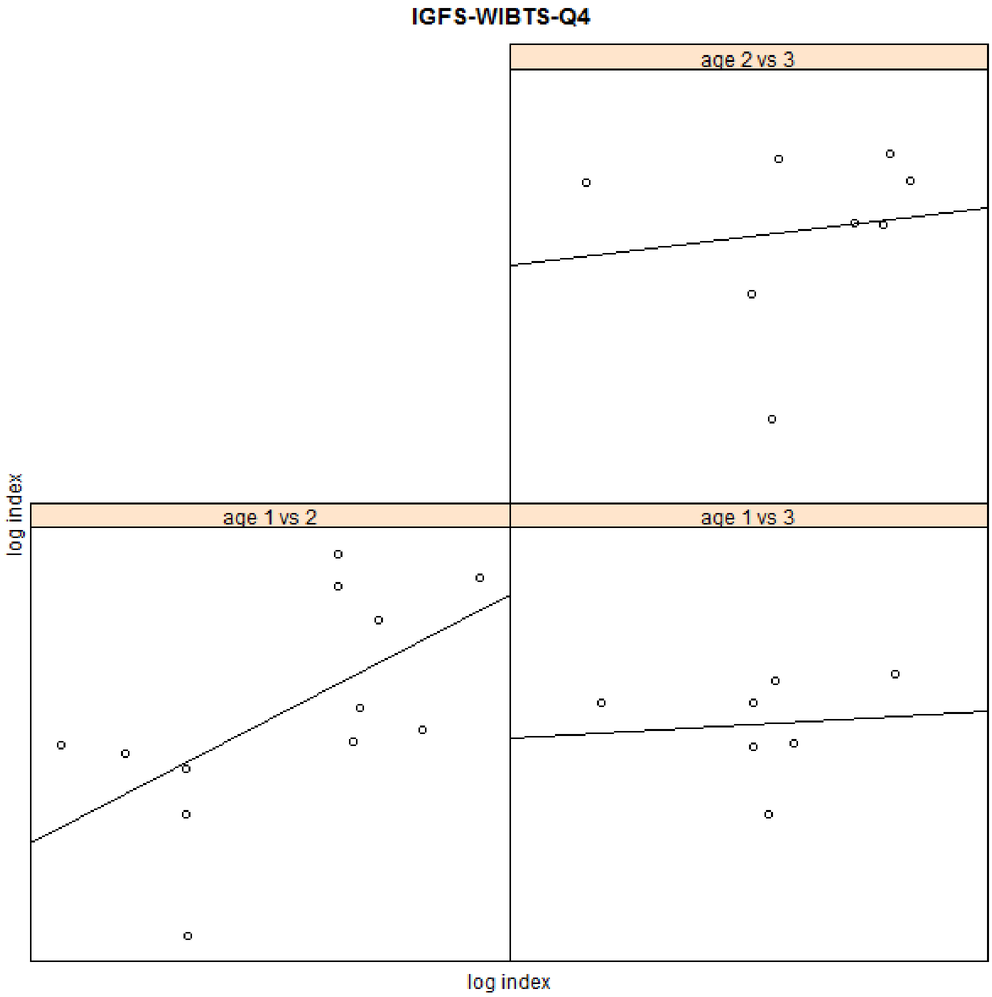


Figure 3.2.27. Cod in Division 6.a. Within-survey correlations for the Irish quarter four ground fish survey (IRGFS-WIBTS-Q4), comparing index values at different ages for the same cohorts. The straight line is a linear regression.

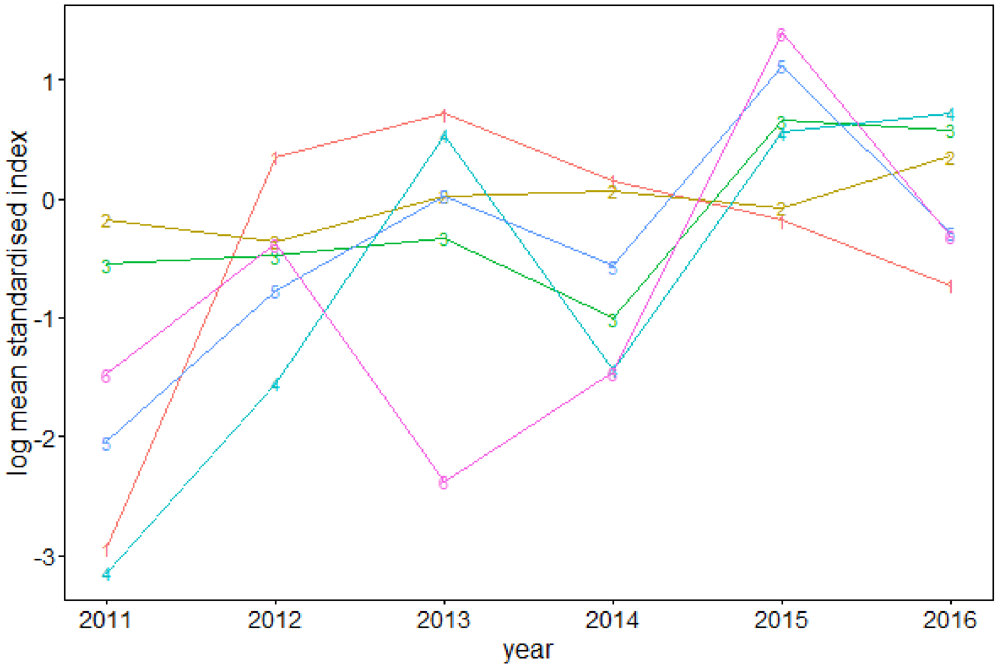


Figure 3.2.28. Cod in Division 6.a. Log mean standardised index values -by year- from Scottish quarter one ground fish survey UKS-IBTS-Q1); ages 1–6.

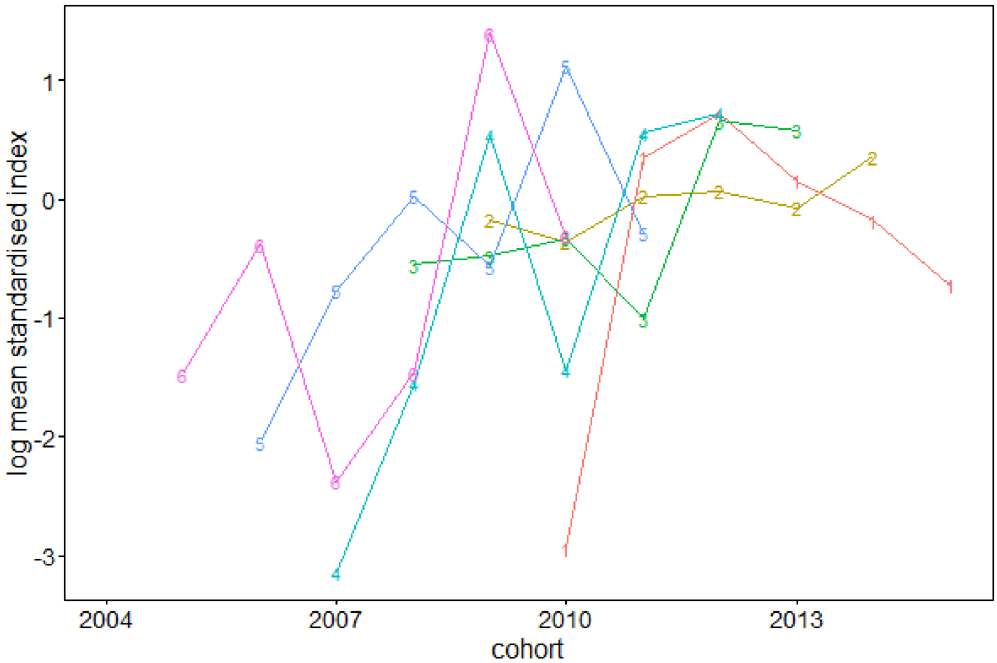


Figure 3.2.29. Cod in Division 6.a. Log mean standardised index values -by cohort- from Scottish quarter one ground fish survey UKS-IBTS-Q1); ages 1–6.

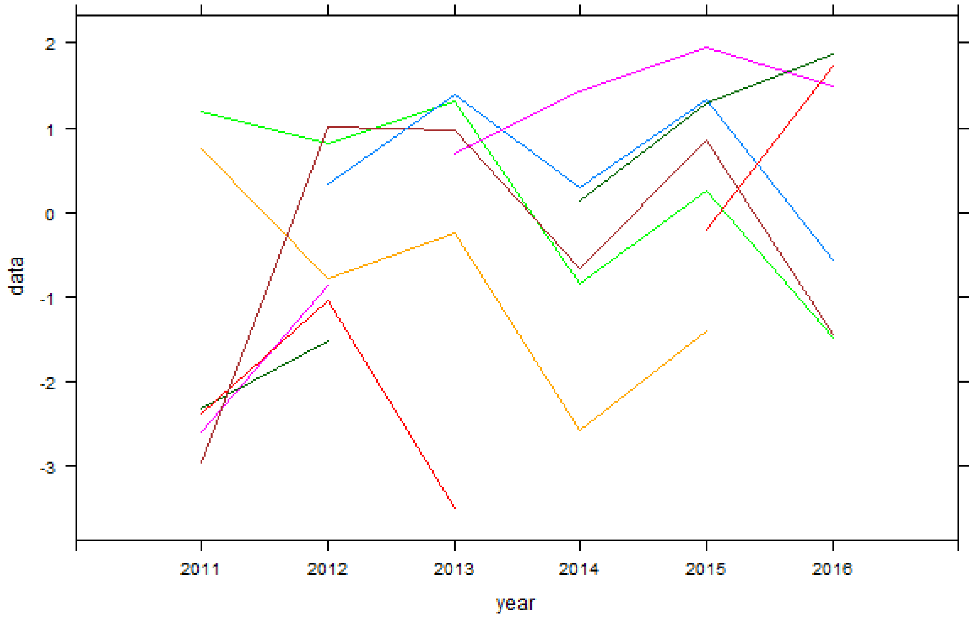


Figure 3.2.30. Cod in Division 6.a. Log catch curves from new Scottish quarter one ground fish survey (UKS-IBTS_Q1); ages 1–7. Survey started in 2011.

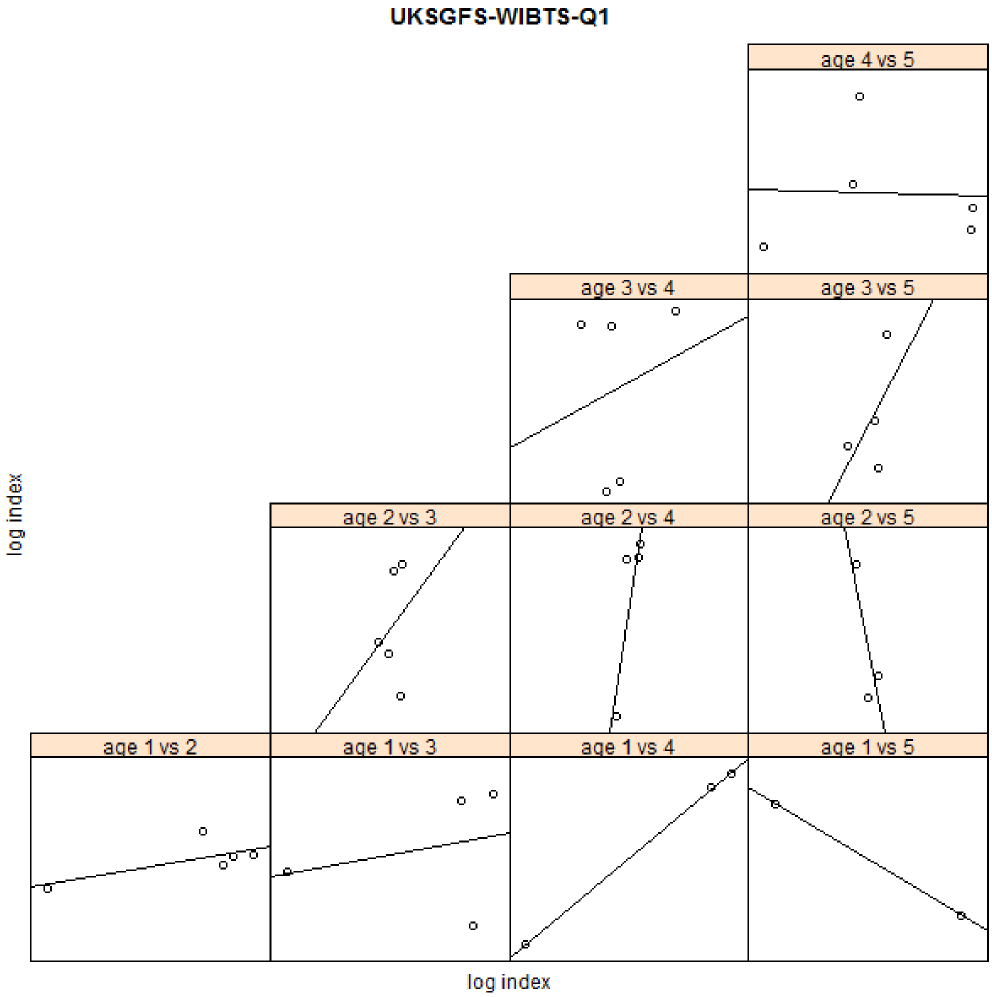


Figure 3.2.31. Cod in Division 6.a. Within survey scatterplots from new Scottish quarter one ground fish survey (UKS-IBTS_Q1), comparing index values at different ages for the same cohorts. The straight line in a linear regression.

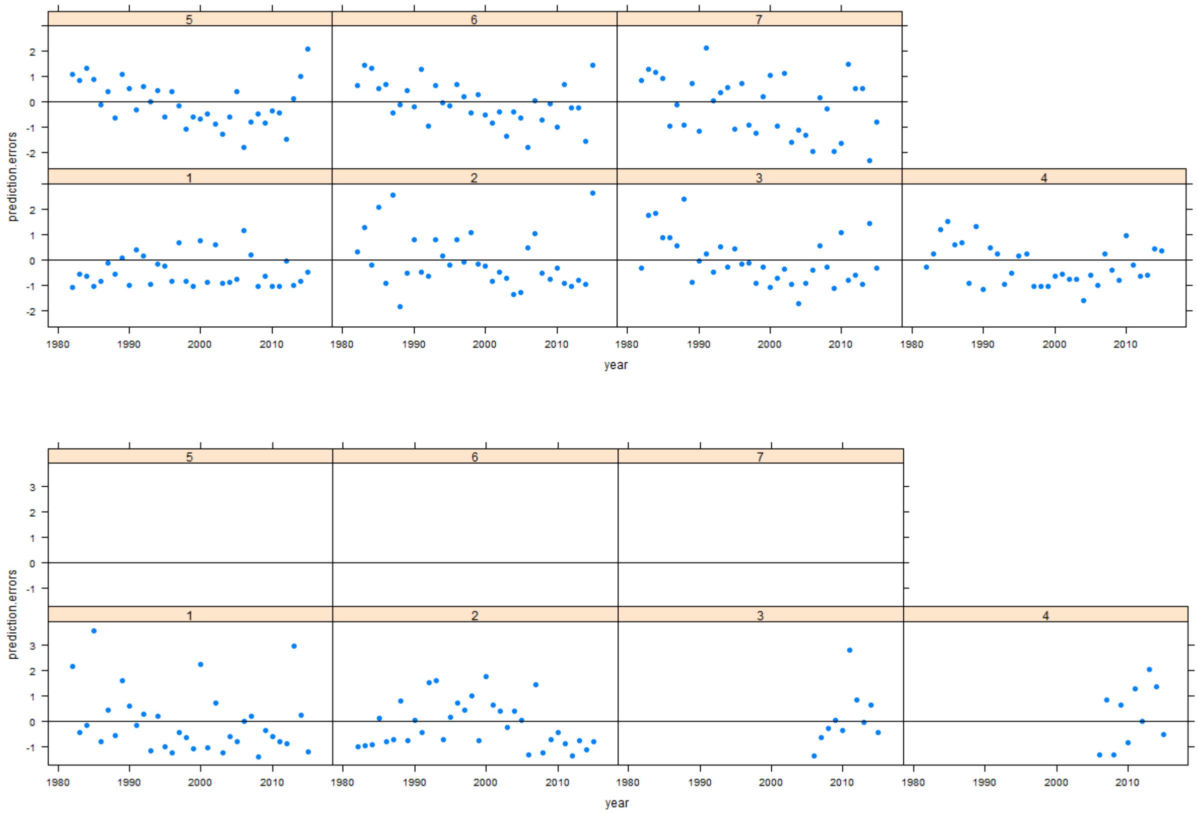


Figure 3.2.32. Cod in Division 6.a. TSA final run. Standardised prediction errors at-age plots for landings (upper) and discards (lower).

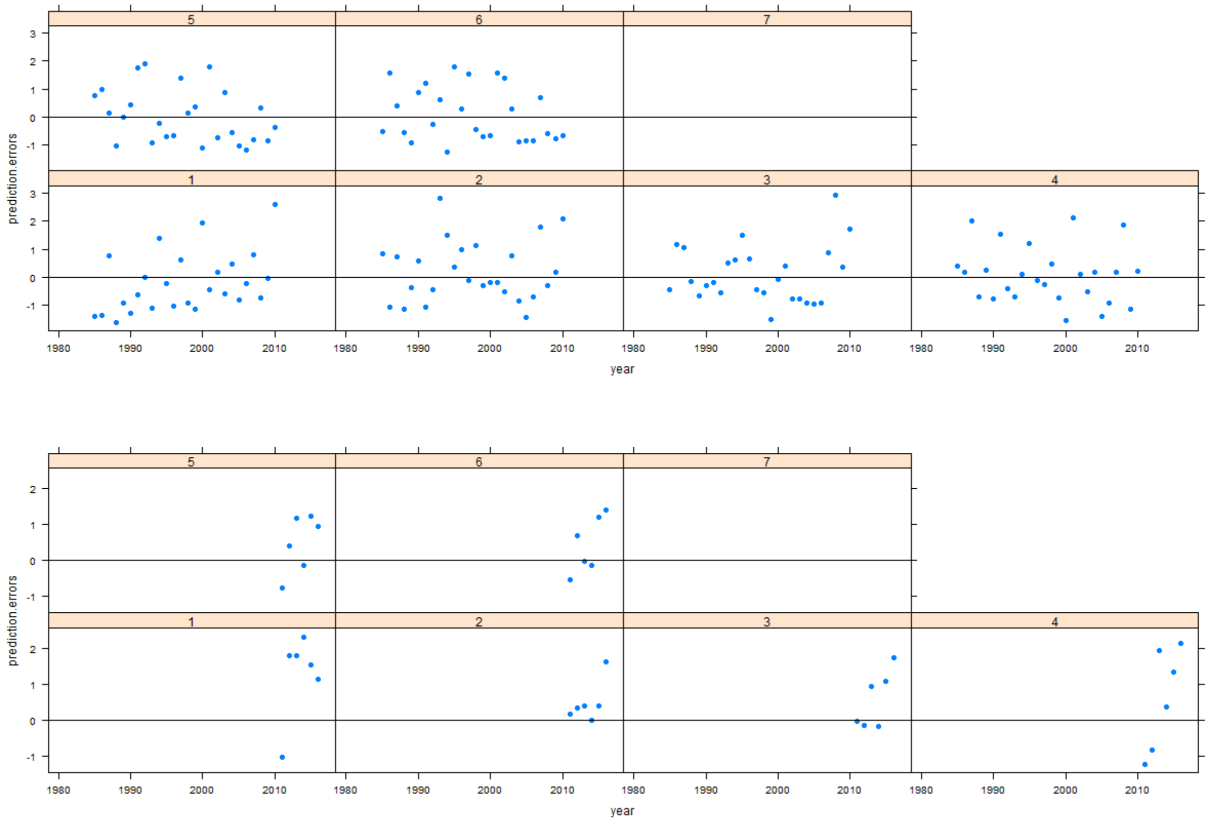
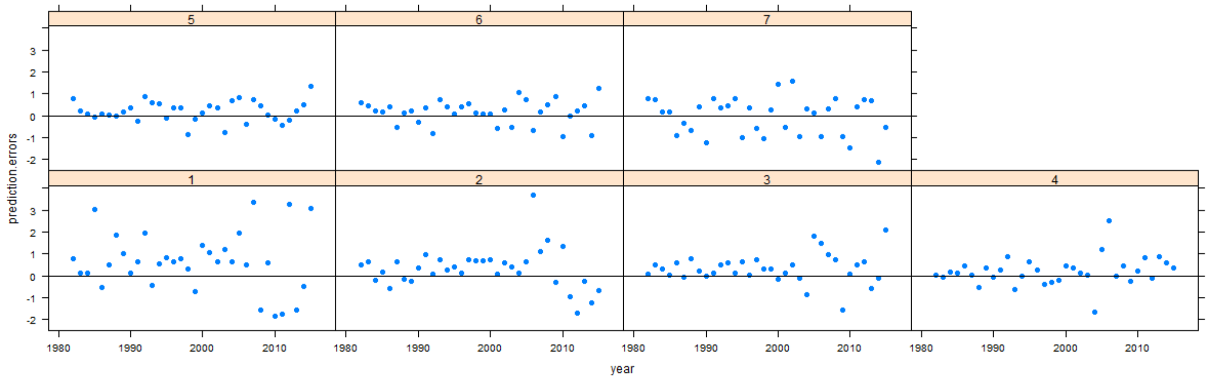


Figure 3.2.33. Cod in Division 6.a. TSA run. Standardised prediction errors at-age plots for ScoGFS-WIBTS-Q1 (upper) and UKSGFS-WIBTS-Q1 (lower).



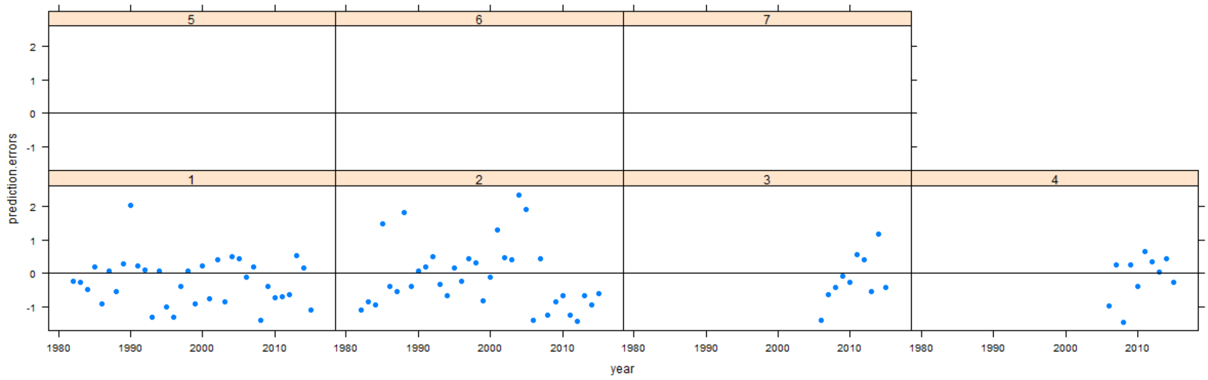


Figure 3.2.34. Cod in Division 6.a. TSA final run. Residuals at-age plots for landings (upper) and discards (lower).

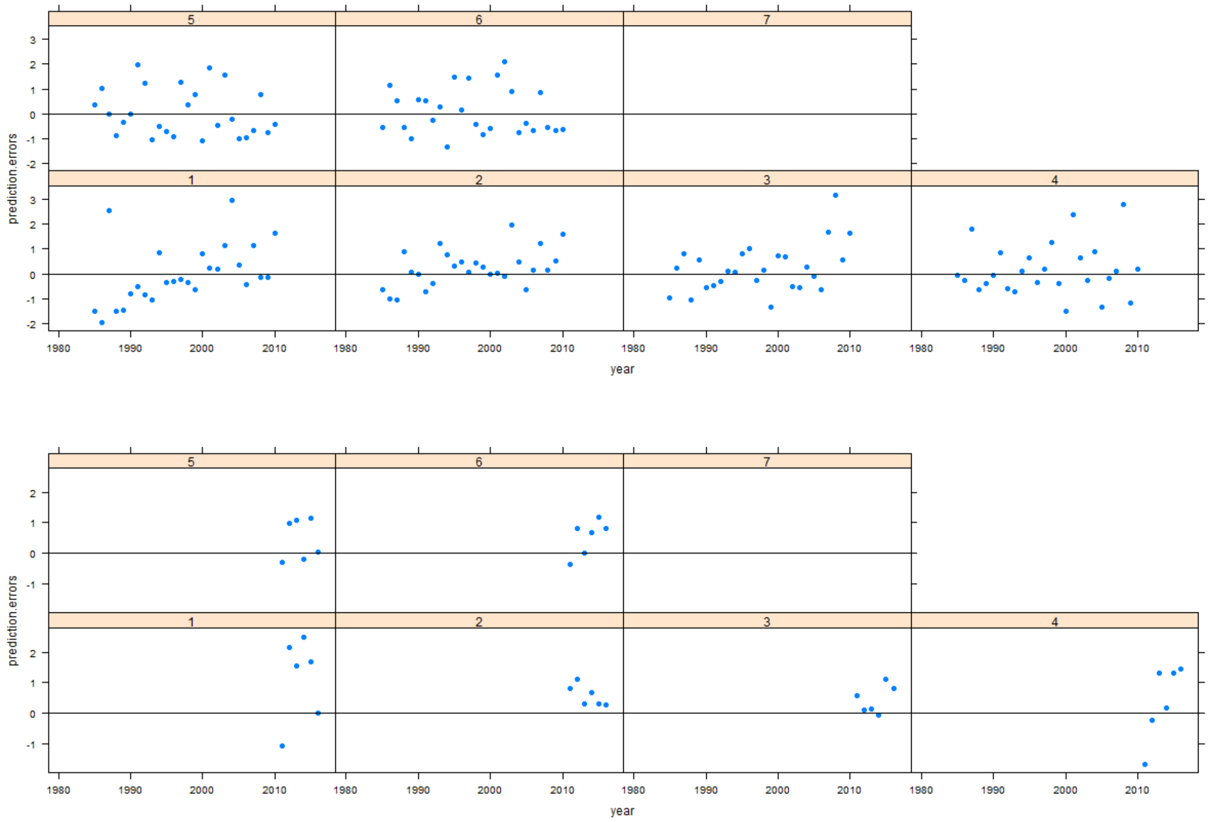


Figure 3.2.35. Cod in Division 6.a. TSA final run. Residuals at-age plots for ScoGFS-WIBTS-Q1 (upper) and UKSGFS-WIBTS-Q1 (lower).

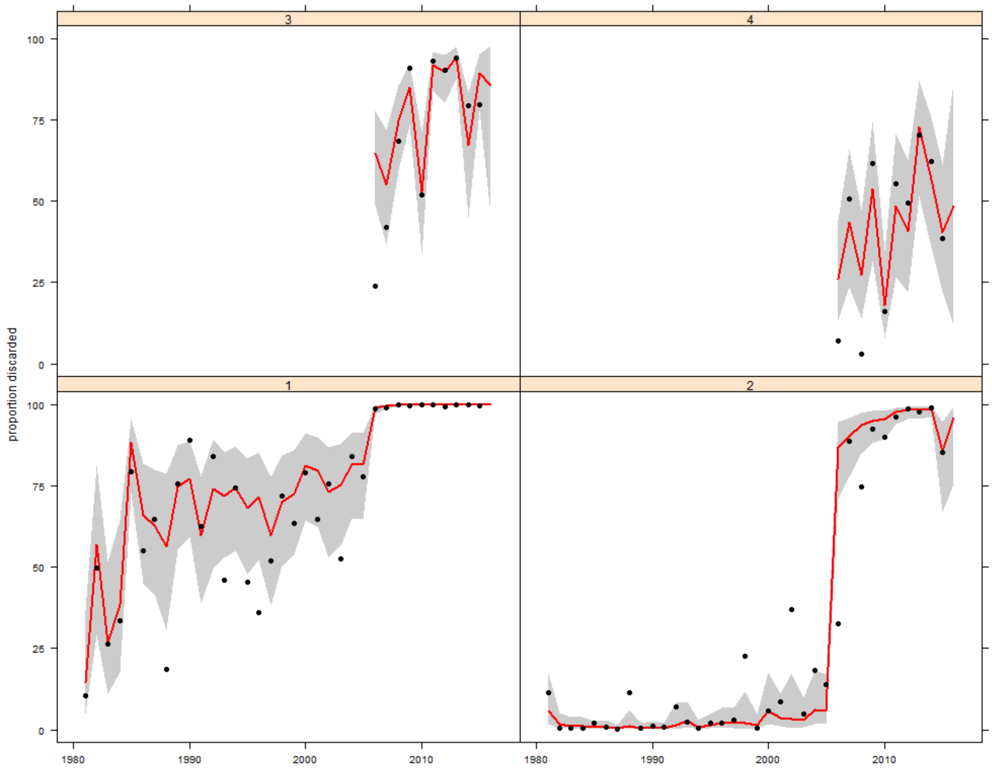


Figure 3.2.36. Cod in Division 6.a. Observed (points) and fitted (red lines with 95% CI indicated by grey bands) for the proportion discarded by age.

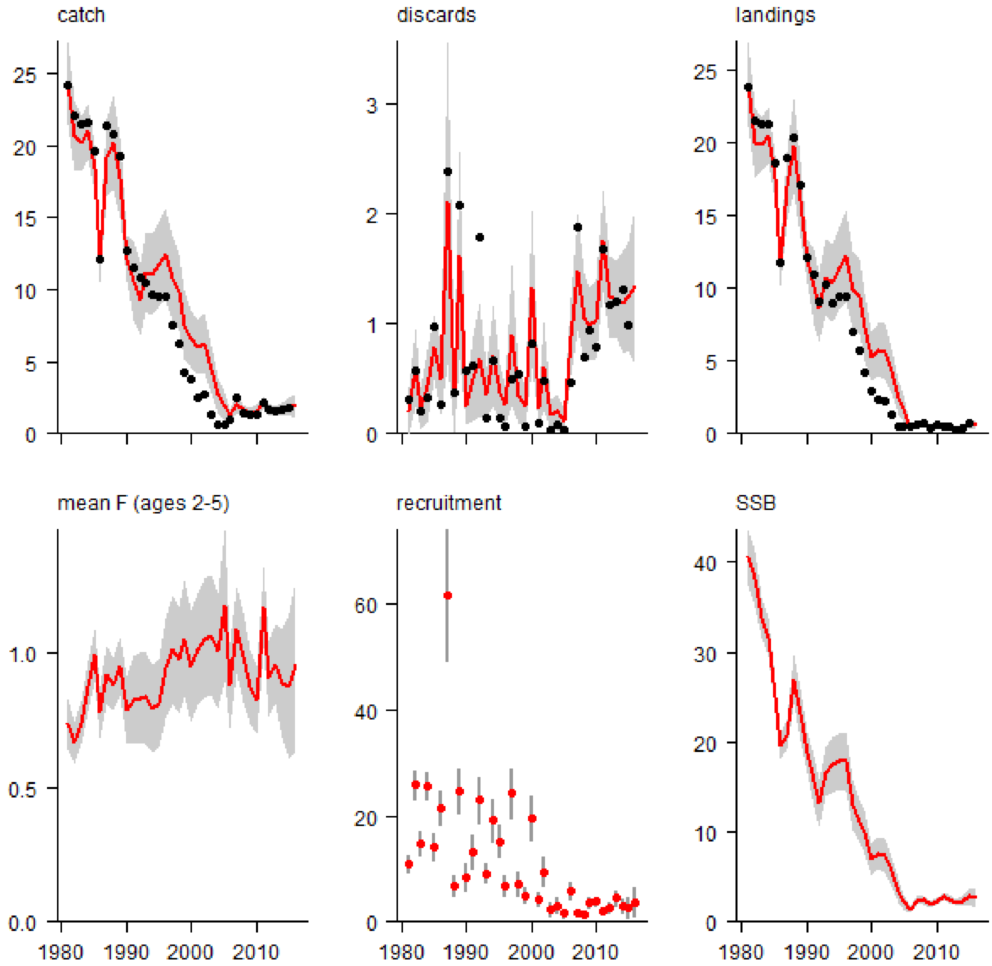


Figure 3.2.37. Cod in Division 6.a. Summary plot of final TSA run. Stock summary from final TSA assessment. Red lines (or points) give best estimates, grey bands (or lines) give approximate pointwise 95% confidence intervals, and black points give observed values.

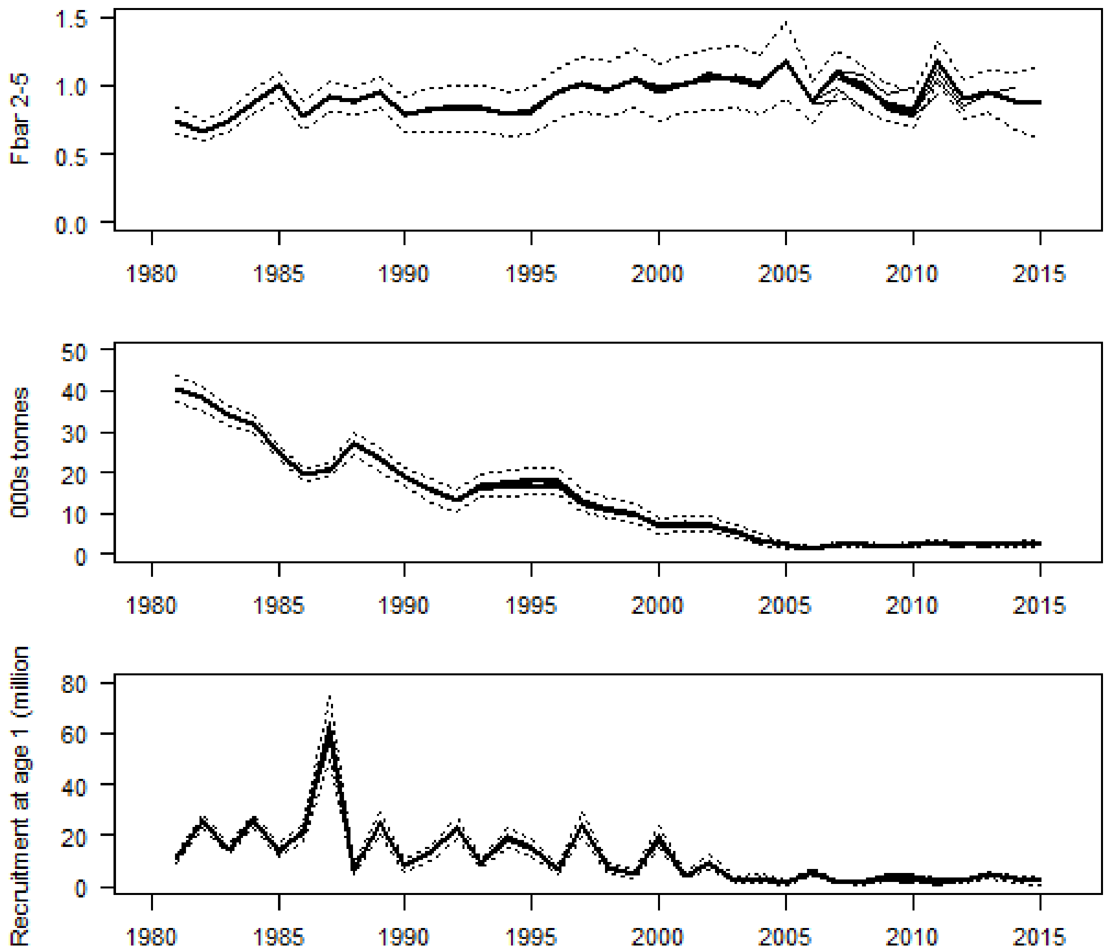


Figure 3.2.38. Cod in Division 6.a. Retrospective plots of TSA run. Biological reference points are given by horizontal dashed lines. Confidence intervals for the run using all years of data are shown by dotted lines.

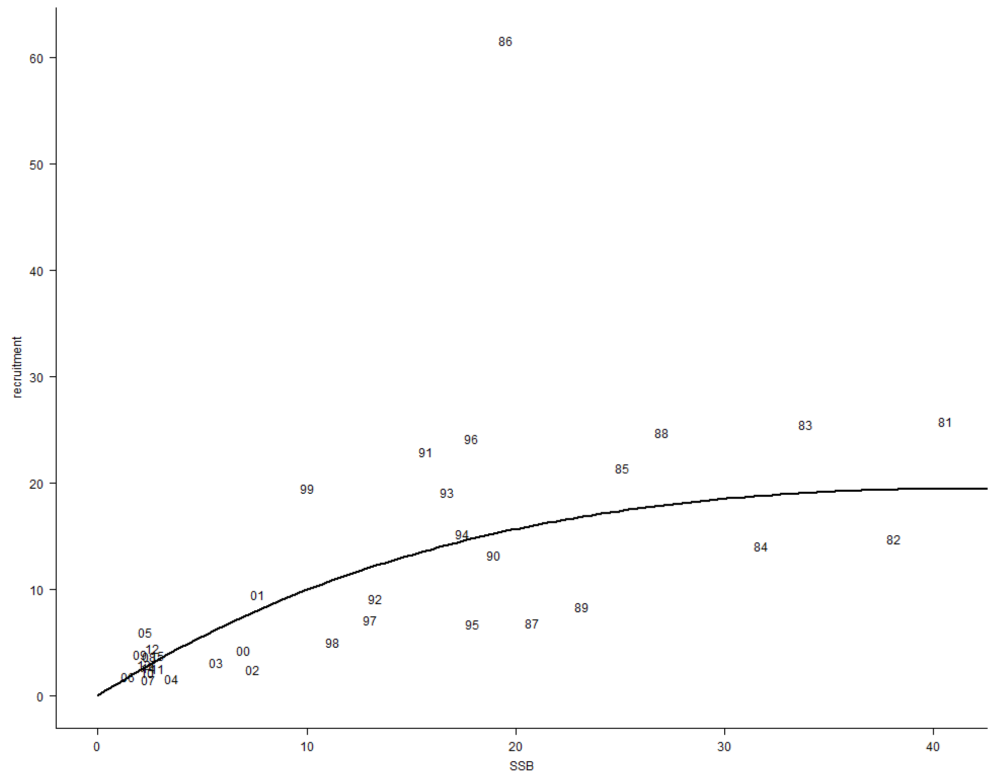


Figure 3.2.39. Cod in Division 6.a. TSA final run. Stock–recruit relationship. Numbers indicate year class.

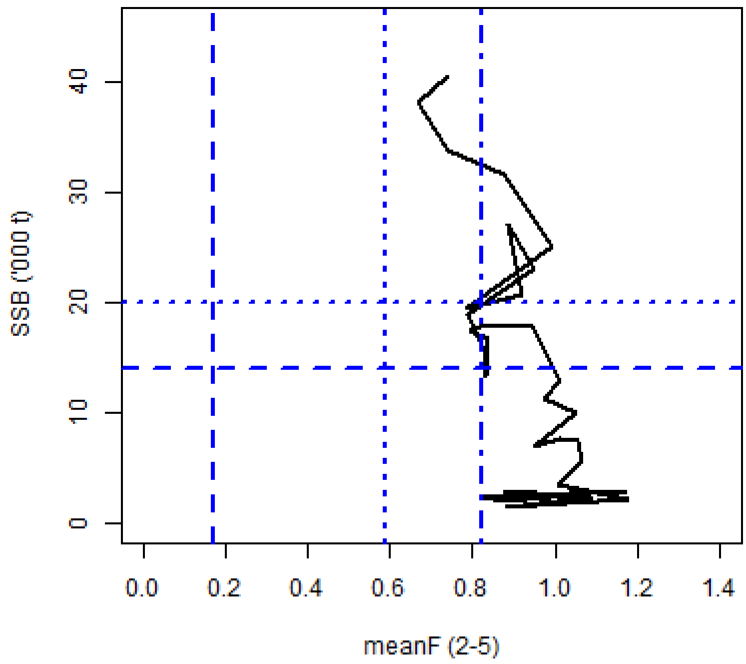


Figure 3.2.40. Cod in Division 6.a. Trajectory of SSB against mean F. Horizontal lines are B_{lim} (dashed) and B_{pa}/MSY $B_{trigger}$ (dotted). Vertical lines are F_{MSY} (dashed), F_{pa} (dotted) and F_{lim} (dash-dotted).

Figure 3.2.41. Cod in Division 6.a. Comparison of SSB, mean F (2–5) estimates and recruitment-at-age one produced by final run assessments between this year's assessment and previous four assessments.

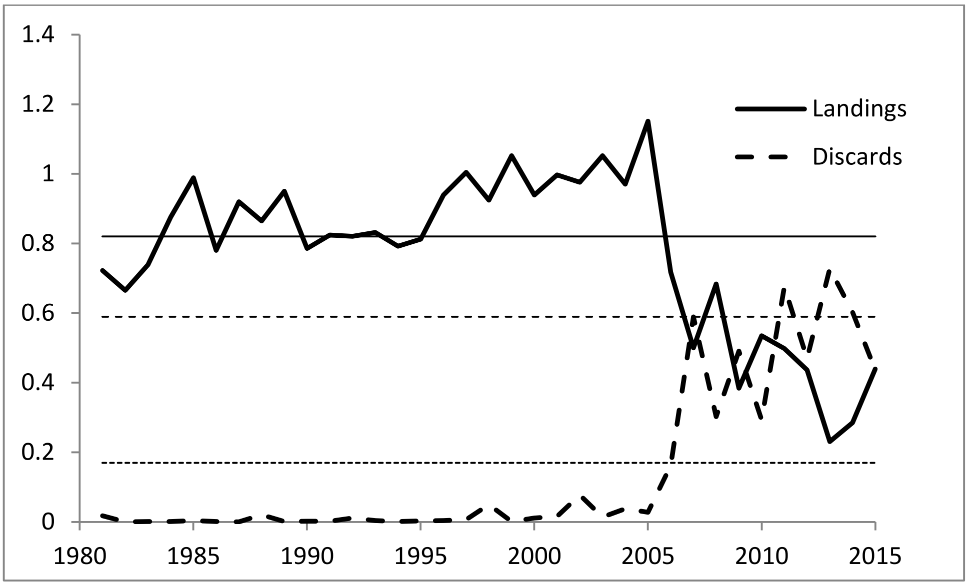


Figure 3.2.42. Cod in Division 6.a. Partial mean F attributed to landings and discards. Horizontal lines represent F_{lim} (solid), F_{pa} (dashed) and F_{MSY} (dotted) values for the stock.

3.2.11 Audit of Cod-Scow

Date: 18/05/16

Auditor: Stephen Shaw

General

For single stock summary sheet advice:

1) Assessment type: update/SALY TSA assessment used
2) Assessment: TSA
3) Forecast:presented
4) Assessment model: Time-series analysis (TSA) using commercial catches and indices of abundance from two fishery-independent surveys (ScoGFS-WIBTS-Q1 and UKSGFS-WIBTS-Q1)
5)
6) Data issues: None
7) Consistency Similar to last year
8) Stock status: SSB has been below B_{lim} since 1997 and is forecast to remain at a relatively low level under the catch options considered. F is high and has remained above F_{lim} for most of the time-series. Although ICES has recommended no directed fisheries and a bycatch limit of 1.5% of catch weight since 2012, F has continued to remain above F_{lim}. Management measures have not been effective in controlling catches and maintaining SSB above the reference point for long-term sustainability. This stock has been harvested unsustainably in the past and is currently suffering from reduced reproductive capacity.
9) Management Plan:
10) Agreed in 2008: EU long-term management plan for cod (EC 1342/2008), which outlines the procedures for setting the TAC and measures for calcu-

lating fishing effort. An SSB limit of 14 000 tonnes (B_{lim}) and a precautionary SSB level of 22 000 tonnes (B_{pa}) within five to ten years and fishing mortality reduced to 0.40 (F_{MGT}). The main elements in the plan are a 10% annual reduction in F and a 15% constrain on TAC change between years. The management plan has not been evaluated by ICES.

11) General comments

Technical comments

None.

Conclusions

The assessment has been performed correctly

Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? Yes
- Is the assessment according to the stock annex description? Yes
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? yes
- Have the data been used as specified in the stock annex? yes
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex?
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes

3.4. Whiting in Division 6.a

Type of assessment in 2016

An update/SPALY TSA was carried out. However, the improved optimisation of the assessment model this year resulted in a downward revision of the stock biomass compared to last year's assessment. Reference points have been re-estimated based on this new assessment model.

ICES advice applicable to 2015

ICES advises on the basis of the precautionary approach that there should be no directed fishery and bycatch should be minimized.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/whg-scow.pdf

ICES advice applicable to 2016

ICES advises that when the precautionary approach is applied, there should be no directed fisheries and all catches should be minimized in 2016.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/whg-scow.pdf

3.4.1 General

Stock description

General information is now located in the Stock Annex.

Management applicable to 2015 and 2016

The TAC for whiting (in tonnes) is set for ICES Subareas 6, 12 and 14 and EU and international waters of ICES Division 5.b, for 2016 is shown below (a 50-tonnes reduction of TAC compared to 2015):

Species:	Whiting *Merlangius merlangus*	**Zone:**	VI; Union and international waters of Vb; international waters of XII and XIV (WHG/56-14)
Germany	1		
France	26		
Ireland	64		
United Kingdom	122		
Union	213		
TAC	213		Analytical TAC

(Council Regulation (EU) 2016/72).

The minimum landing size for whiting in Division 6.a is 27 cm.

Fishery in 2015

A description of the fisheries in the West of Scotland is given in the Stock Annex.

Anecdotal information from the fishing industry suggests that the number of vessels targeting whiting continues to be very low. However, the recent low TACs combined with increased interest in bigger whiting (driven by good prices) has resulted in an increasing uptake of the whiting quota.

Total landings (nominal landings, ICES statistics) in 2015 were 221 t, up by 22% from 2014 (Table 3.4.1). These are the third lowest recorded landings in the time-series. The majority were landed by Scottish and Irish vessels, and a smaller amount by Dutch vessels (with <1 t reported by France). The UK landings in Division 6.a in 2015 constituted 81% of the UK quota, while Ireland exceeded its quota by 11%. Total landings in 2015 amounted to 84% of TAC for that year.

The total estimated international catch of ages 1 and older in 2015 was 1060 t of which 833 t were discards (Table 3.4.2). An additional 629 t were discarded as the 0-group. Of the discards, 12% were discarded by the TR1 fleet and 77% were discarded by the TR2 (*Nephrops*) fleet.

Mandatory introduction of larger square mesh panels for the TR2 fleet in 2008 does not seem to have had much of an effect on the discards of whiting in Division 6.a in 2015. In terms of quantity, the discards in 2015 (ages 1 and older) were higher than those in 2014, and also above the average in the last decade. In terms of discard rate (discards as a proportion of catch), they were still high (the third highest in the time-series).

3.4.2 Data

Landings

Total landings, as officially reported to ICES in 1965–2015, are shown in Figure 3.4.1 and Table 3.4.2. In the past, there had been concerns that the quality of landings data was deteriorating, giving a possible reason for the different stock dynamics implied by the commercial fleet and the annual survey (ScoGFS-WIBTS-Q1) being in operation at that time (see Section 5.1.6.1.3 in the 2005 WG Report; ICES, 2005) and as a result the total landings data from 1995 to 2005 are not used in the assessment. Improved compliance measures and the introduction of UK and Irish legislation requiring registration of all fish buyers and sellers may mean that the reported total landings from 2006 onwards are more representative of actual landings.

Landings uploaded to InterCatch by métier and country are shown in Figure 3.4.2. Age distributions were estimated from market samples. Annual numbers-at-age in the landings are given in Table 3.4.3. Annual mean weights-at-age in the landings are given in Table 3.4.6 and shown in Figure 3.4.3. These have been variable in recent years due to the variability associated with low sample sizes. Efforts to increase sampling in these fisheries are being pursued.

Discards

This year, WG estimates of discards are based on data collected in the Irish and Scottish discard programme (raised by weighted average to the level of the total international discards). Discard age compositions from Scottish and Irish samples have been applied to unsampled fleets. Discards uploaded to InterCatch by métier and country are shown in Figure 3.4.2.

Annual numbers-at-age in the discards are given in Table 3.4.4. Annual mean weights-at-age in the discards are given in Table 3.4.7 and shown in Figure 3.4.3.

Biological

Annual numbers-at-age in the total catch are given in Table 3.4.5. Annual mean weights-at-age in the total catch are given in Table 3.4.8. As in previous meetings, the catch mean weights-at-age were also used as stock mean weights-at-age (see the Stock Annex).

Natural mortality (*M*) is assumed to vary and be dependent on fish weight (Lorenzen, 1996). *M* values are time-invariant and are calculated as:

$$M_a = 3.0\overline{W}_a^{-0.29}$$

where M_a is natural mortality-at-age a, $\overline{W}_a$ is the time-averaged stock weight-at-age *a* (in g) and the numbers are the Lorenzen's parameters for fish in natural ecosystems.

Maturity-at-age was assumed to be knife-edge, with the value 0 at age 1 and full maturity-at-age 2+ according to the Stock Annex.

Surveys

Five research vessel survey series for whiting in 6.a were available to the WG. In all surveys listed, the highest age represents a true age not a plus group.

- Scottish first quarter west coast groundfish survey (ScoGFS-WIBTS-Q1): ages 1–7, years 1985–2010.
- Scottish fourth quarter west coast groundfish survey (ScoGFS-WIBTS-Q4): ages 0–7, years 1996–2009.

The Q1 Scottish Groundfish survey was running in the period 1981–2010, and this was performed using a repeat station format with the GOV survey trawl together with the west coast groundgear rig, 'C'. Similarly the Q4 Scottish Groundfish survey was running in 1996–2009, once again using the GOV survey trawl with groundgear 'C' and the fixed station format. The Q4 survey was not carried out in 2010 due to an engine break down of the research vessel.

In 2011, the Q1 and Q4 Scottish Groundfish surveys were re-designed. The previous repeat station survey format consisting of the same series of survey trawl positions being sampled at approximately the same temporal period every year is considered a rather imprecise method for surveying both these subareas and as such a move towards some sort of random stratified survey design was judged necessary (see further details of the modified survey design in the Stock Annex). The introduction of the new design initiated two time-series:

- Scottish first quarter west coast groundfish survey (UKSGFS-WIBTS-Q1): ages 1–7, years 2011–2016.
- Scottish fourth quarter west coast groundfish survey (UKSGFS-WIBTS-Q4): ages 0–7, year 2011–2015.

(see the distribution of whiting cpue at-age in the Q1 and Q4 surveys in 2013–2016, Figure 3.4.4). The Q4 survey in 2013 was not complete due to adverse weather conditions, and it covered only the northern half of Division 6.a and is therefore not used in the assessment. The Q1 survey for 2016 has recently been completed and processed. As a result, six years of data are currently available in the time-series for the Q1 survey and four years of data for the Q4 survey (as valid indices). These data were made available this year's assessment.

The Irish groundfish survey:

- Irish fourth quarter west coast groundfish survey (IGFS-WIBTS-Q4): ages 0–6, years 2003–2015.

(see the distribution of whiting at-age in the two Q4 surveys, UKSGFS-WIBTS-Q4 and IGFS-WIBTS-Q4, in 2012–2015, Figure 3.4.5). The previous Irish survey (IreGFS), being in operation in 1993–2002 (see the Stock Annex), is not used in the assessment. The current Irish survey uses the RV Celtic Explorer and is part of the IBTS coordinated western waters surveys. The vessel uses a GOV trawl, and the design is a depth stratified survey with randomised stations. Effort is recorded in terms of minutes towed. This survey was considered long enough to be used in the assessment of whiting in Division 6.a, giving useful additional indications of year-class strength.

Further descriptions of the above five surveys can be found in the last IBTSWG report (ICES, 2015a).

IBPWSRound decided to include the new Scottish survey time-series in the assessment (ICES, 2015b). An attempt was made to use one index to represent the stock abundance combining the two Q4 surveys currently in operation, IGFS-WIBTS-Q4 and UKSGFS-WIBTS-Q4. However, considerable differences were found between the two surveys with cpue being overall higher in the Irish survey. As a consequence of these differences, the IBPWSRound agreed to continue using the Irish Q4 survey as an independent time-series although did not rule out revisiting this issue when a longer time-series of Scottish data became available. Ultimately, five survey time-series were used in the last year and present assessment.

The survey indices for the five surveys are shown in Table 3.4.9 with data used in the final assessment highlighted in bold.

A comparison of scaled (standardised to z-scores) survey indices (from the five time-series) at-age show roughly similar trends, mainly for the Scottish surveys, for most ages (up to age 5, Figure 3.4.6). The two new Scottish surveys seem to show greater consistency (on a year basis) compared to the previous surveys.

Log mean-standardised survey indices by year class and by year in the new Scottish time-series are shown in Figure 3.4.7. Given the short length of the survey time-series, the year-class plots demonstrate, in most cases, the ability of the surveys to reliably track year classes and to identify the stronger/weaker than average year classes.

The log-catch curves for the commercial catch and for the surveys are shown in Figure 3.4.8. The curves for both ScoGFS-WIBTS-Q1 and ScoGFS-WIBTS-Q4 (unchanged since 2011) are relatively linear and not very noisy. They also show a fairly steep and consistent drop in abundance. Patterns are less clear with the Irish survey. Little can be said in this respect about the new survey time-series (UKSGFS-WIBTS-Q1 and UKSGFS-WIBTS-Q4) as they are relatively short.

Commercial cpue

Four commercial catch effort time-series were previously available to the WG, but they have not been used for a number of years. They are only presented in the Stock Annex.

3.4.3 Historical stock development

The final assessment of whiting in 6.a was conducted using a TSA model. The method was first developed by Gudmundsson (1994), and it was modified by Rob Fryer for the purpose of assessing time-series containing several years with survey data but no reliable catch data (Fryer, 2002). Subsequent enhancements to the method are detailed in Needle and Fryer (2002). The TSA model allows for years with missing catch or survey data.

Alternative exploratory assessments conducted using SURBA (Needle, 2003) and a Bayesian approach (Cook, 2012) were presented at the WKROUND benchmark in 2012 (ICES, 2012a), but were not further explored in this assessment.

Data screening and exploratory runs

Model used: TSA

Software used: NAG library (FORTRAN DLL) and functions in R.

Input data types and characteristics:

- Landings, ages 1–7+, years 1981–2015 (1995–2005 age structure only used);
- Discards, ages 1–7+, years 1981–2015 (1995–2005 age structure only used);
- ScoGFS-WIBTS-Q1, ages 1-6, years 1985–2010;
- ScoGFS-WIBTS-Q4, ages 1-6, years 1996–2009;
- IGFS-WIBTS-Q4, ages 1-4, years 2003–2006 and 2008–2015;
- UKSGFS-WIBTS-Q1: ages 1–6, years 2011–2016;
- UKSGFS-WIBTS-Q4: ages 1–6, years 2011–2012 and 2014–2015.

The assessment of whiting in 6.a was conducted using a TSA model with updated survey data (five time-series). The details of the method are presented in the Stock Annex. No modification to the landings was made to account for area misreporting although total landings are excluded from the assessment for the years 1995–2005 as the reported landings data are considered to be unreliable during this period. (ICES, 2012a). A "hockey-stick" model was employed to describe the stock–recruitment relationship. Some extra variability in landings and discards was allowed for some ages. Also some points in the time-series that were identified as outliers were downweighted to improve the fit. One point in the IGFS-WIBTS-Q4 time-series (for 2007) was treated as an outlier and was excluded from the analysis. Similarly, one point in UKSGFS-WIBTS-Q4 (for 2013) was excluded as the survey was not complete in that year. Table 3.4.10 shows the TSA parameter settings for the assessment run.

The main diagnostics of the quality of the model fit was the value of the objective function (-2*log likelihood), prediction errors and a consideration of how well the model has replicated discard ratios in the input data.

The WG assessment in 2015 was not properly optimised. The introduction of the new survey time-series at IBPWSRound had a considerable effect (not anticipated at that time) on some of the model parameters. In this year's assessment, greater care was taken to ensure that the model parameters were accurately chosen, which consequently improved the model's performance. This alteration resulted in a downward revision of the stock biomass compared to last year's assessment.

IBPWSRound attempted TSA runs with and without a survey catchability trend compared (ICES, 2015b). In the latter, the parameters for persistent and transitory trends in survey catchability were both set to 0. Given the overestimation of catch and uncertainty in the assessment with fixed survey catchability, this option was not further explored and the assessment including estimation of survey catchability trend was retained, which also applies to the present assessment.

Final assessment

The TSA run using the five surveys is presented as the final assessment run. Table 3.4.11 shows the TSA parameter estimates for the assessment.

Figure 3.4.9 shows the proportion discarded at-age from the final TSA run. Discards continue to account for a large proportion of the total catch, with no obvious tendency to decrease or to level off.

Table 3.4.12 gives the TSA population numbers-at-age and Table 3.4.13 gives their associated standard errors. Estimated F at-age is given in Table 3.4.14 and standard errors on the log of this mortality are given in Table 3.4.15. Full summary output is given in Table 3.4.16.

Standardised prediction errors for landings and discards are given in Figure 3.4.10, and those for the five surveys in Figure 3.4.11. None of these are large enough to invalidate the model fit and there are no obvious time-trends in recent years.

TSA also estimated a change in catchability (this is plotted as the percentage change compared to the catchability at the start of each of the five surveys, Figure 3.4.12). There was a large increase in catchability in the two previous Scottish surveys and in the Irish current survey. No such increase could be seen in the new Scottish surveys.

The TSA stock–recruit plot is presented in Figure 3.4.13 and shows a rather good relationship, partly because the stock was driven to very low levels of SSB in 2006–2010. The summary plots for the final assessment are shown in Figure 3.4.14.

The final estimates for the stock are:

$F_{(2\text{–}4)}$ in 2015 = 0.057
SSB in 2016 = 16 247 t

Retrospectives for the final assessment run are shown in Figure 3.4.15. This figure also shows lines at ±2 se (approximate 95% confidence limits) around the run in the last year. Retrospective bias is small with respect to SSB. With respect to mean F and recruitment, the results are roughly within the confidence limits of this year's run. The confidence interval for mean F reflects uncertainty in estimation of mean F when that estimation is based to a large extent on survey data (1995–2005) or the age structure of discards data (2006 onwards).

Comparison with last year's assessment

The above estimates show considerable inconsistency (especially with regard to SSB) with the last year's assessment:

$F_{(2\text{–}4)}$ in 2014 = 0.029 (the present assessment: in 2014, 0.061)
SSB in 2015 = 23 058 t (the present assessment: in 2015, 10 020 t)

The origin of this inconsistency is discussed in "Data screening and exploratory runs" above.

State of the stock

The spawning–stock biomass (SSB) has been increasing since 2006 but remains very low compared to the historical estimates and is below B_{lim}. Fishing mortality (F) has declined continuously since around 2000 and is now very low. Recruitment is estimated to have been very low since 2002 but estimated to have increased in recent years.

3.4.4 Short-term projections

A short-term projection was made using WGFRANSW following the procedure outlined in the Stock Annex.

The recruitment value (in thousand fish) derived from TSA and used in the forecast for 2016 was 87 905. The value for 2017 and 2018 was taken as the geometric mean for 2006–2015 and was 33 415.

A three-year mean exploitation pattern was taken to represent *status quo* mortality.

Input data to the short-term projection is shown in Table 3.4.17. Management options from the forecast and detailed tables of catch numbers-at-age are shown in Table 3.4.18.

A plot of the short-term forecast is shown in Figure 3.4.16. Results from sensitivity analysis from this forecast are shown in Figure 3.4.17 and probability profiles in Figure 3.4.18.

3.4.5 MSY explorations

MSY reference points and ranges were calculated for this stock by WKMSYREF4 (ICES, 2016). However, these were based on the results of last year's stock assessment which has now been shown not to have been fully optimised. The reference points have therefore been updated based on the results from the final assessment presented at this year's WG. The approach again uses EqSim and follows the same procedure as that agreed at WKMSYREF4. The detail of the analysis and the results are presented in Working Document 7 (Dobby, 2016).

In this WG's assessment, B_{lim} was estimated to be 31 880 t (breakpoint of the TSA stock–recruit relationship). The corresponding value for B_{pa} was assessed at 44 632 t (equal to 1.4 × B_{lim}). The estimated values for F_{lim} and F_{pa} were 0.27 and 0.19.

The new analysis resulted in F_{MSY} being 0.23 (with confidence interval of (0.16, 0.34)). However, at this level of fishing mortality the analysis suggested a significant risk of SSB falling below B_{lim} and therefore the F_{MSY} value is capped at 0.18 (upper precautionary F_{MSY}, $F_{P.05}$ = the F with 5 % risk of falling below B_{lim}). MSY $B_{trigger}$ was established to be 44 600 t ($B_{trigger}$(=B_{pa})).

3.4.6 MSY and Biological reference points

The reference points (after rounding) estimated recently are summarised in the table below:

REFERENCE POINT	IBPWS-Round	WGCSE 2015	WKMSY-REF4	WGCSE 2016	Rationale (WKSYREF4)
B_{lim}	28 500 t	28 500 t	28 500 t	31 900 t	SSB value at the change point in the segmented regression stock–recruit function.
B_{pa}	39 900 t	39 900 t	39 900 t	44 600 t	B_{lim} × 1.4

REFERENCE POINT	IBPWS-Round	WGCSE 2015	WKMSY-REF4	WGCSE 2016	Rationale (WKSYREF4)
F_{lim}	Not defined	Not defined	0.25	0.27	Based on segmented regression simulation of recruitment with B_{lim} as the breakpoint
F_{pa}	Not defined	Not defined	0.18	0.19	F_{lim}/1.4
F_{MSY}	0.22	Not defined	0.22	0.23	with $B_{trigger}$(=B_{pa})
$F_{P.05}$ (5% risk to B_{lim} with $B_{trigger}$ (= B_{pa})		Not defined	0.16	0.18	upper precautionary with $B_{trigger}$(=B_{pa})
F_{MSY} upper		Not defined	0.32	0.34	with $B_{trigger}$(=B_{pa})
F_{MSY} lower		Not defined	0.15	0.16	with $B_{trigger}$(=B_{pa})
MSY $B_{trigger}$	39 900 t	Not defined	39 900 t	44 600 t	B_{pa}
Median SSB at F_{MSY}	45 600 t	Not defined	36 600	39 000	

3.4.7 Management plans

There are no specific management objectives or a management plan for this stock, but a plan is under development.

3.4.8 Uncertainties and bias in the assessment and forecast

The most significant problem with assessment of this stock is with commercial data. Incorrect reporting of landings (species and quantity) is known to have occurred in the past and directly affecting the perception of the stock. TSA is explicitly designed to allow for omission in the catch data during this period (1995–2005 uses only age-structure data from the catch), which is why it was used here as the final assessment.

The survey data and commercial catch data contain different signals concerning the stock. A similar problem has been present in the North Sea whiting stock (as reported by ICES, 2010). Three potential sources of this discrepancy were identified for the North Sea stock, and they may apply to whiting in 6.a as well: bias in catch estimates, changes in survey catchability or changes in natural mortality due to predation or regime shift (ICES, 2010). Allowing the TSA assessment to interpret this difference as a persistent trend (increase) in survey catchability may lead to an underestimation of stock size, but the magnitude of underestimation is unknown.

After being explored extensively, new reliable reference points were eventually delivered by this WG for the stock that will be used in future assessments.

Long-term information on the historical yield and catch composition indicates that the present stock size is low. The current assessment also indicates that the stock is at a low level. Total mortality has been declining over the past few years. The sum of the Scottish west coast groundfish survey indices (both in quarter one and quarter four) is also low, but shows a moderate increase from 2008 onwards.

3.4.9 Recommendation for next benchmark

A landings and discards disaggregated assessment appeared to be a reliable basis for determining the status of the whiting stock in Division 6.a.

The emergence of a trend in survey catchability needs to be addressed. The cause of this is very uncertain. Trends in catchability have been a feature of this assessment in the past and point to some issues with the model structure or assumptions. There have been significant changes in the commercial fishing practices in recent years that are not explicitly taken into account by this assessment model (e.g. emergency measures since 2010 and decline in the TR1 gadoid fishery prior to that). This will require detail explorations in the next benchmark.

The discrepancy in the abundance index between the two Q4 surveys, IGFS-WIBTS-Q4 and UKSGFS-WIBTS-Q4, should further be explored. With more years of data available (an additional 2–3 years), the analysis of catchability in the two surveys could be revisited with the ultimate goal of creating one common index.

With regard to the assessment method, changes to the variance structures used in the model should be allowed if they improve model diagnostics (e.g. likelihood ratio tests, prediction error plots).

3.4.10 Management considerations

Recruitment during the 1990s appears to have been high while after the year 2000, it has been below average. A number of relatively strong (compared to the recent past) year classes have been recorded recently (2009, 2011, 2013 and 2014).

Whiting are caught in mixed fisheries with cod and haddock in Division 6.a. Management of whiting will be strongly linked to that for cod for which there is an ongoing recovery plan (EC, 2008). There have also been several technical conservation measures introduced in the 6.a gadoid fishery in recent years including the mandatory increases in mesh size to 120 mm.

Whiting are caught and heavily discarded in small meshed fisheries for *Nephrops*. When this stock falls under the landing obligation, it can (in the presence of high discards and low quota) become a "choke species" for the *Nephrops* fishery.

3.4.11 References

Cook, R. M. 2012. Assessment of West of Scotland cod (ICES Division VIa) using a Bayesian approach. Working paper to WKROUND 2012, February 2012: 1–31.

EC. 2008. Council Regulation (EC) No 1342/2008 of 18 December 2008 establishing a long-term plan for cod stocks and the fisheries exploiting those stocks and repealing, Regulation (EC) No 423/2004, OJ L 348, 24.12.2008: 20–33.

Fryer, R. J. 2002. TSA: is it the way? Appendix D in report of Working Group on Methods on Fish Stock Assessment. ICES CM 2002/D:01.

Gudmundsson, G. 1994. Time series analysis of catch-at-age observations. Applied Statistics 43: 117–126.

ICES. 2005. Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks (WGNSDS), 10–19 May 2005, Murmansk, Russia, ICES CM 2005/ACFM:13, pp. 644.

ICES. 2010. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), 5–11 May 2010, ICES Headquarters, Copenhagen, ICES CM 2010/ACOM:13, pp. 1072.

ICES. 2011. Report of the Working Group for Celtic Seas Ecoregion (WGCSE), 11–19 May 2011, Copenhagen, Denmark, ICES CM 2011/ACOM:12, pp. 1572.

ICES. 2012a. Report of the Benchmark Workshop on Western Waters Roundfish (WKROUND), 22–29 February 2012, Aberdeen, UK. ICES CM 2012/ACOM:49, pp. 283.

ICES. 2012b. Report of the Working Group on the Celtic Seas Ecoregion (WGCSE), 9–18 May 2012, Copenhagen, Denmark. ICES CM 2012/ACOM:12.

ICES. 2014. Report of the Joint ICES-MYFISH Workshop to consider the basis for F_{MSY} ranges for all stocks (WKMSYREF3), 17–21 November 2014, Charlottenlund, Denmark. ICES CM 2014/ACOM:64. 147 pp.

ICES. 2015a. Report of the International Bottom Trawl Survey Working Group (IBTSWG), 23–27 March 2015, Bergen, Norway. ICES CM 2015/SSGIEOM:24. 278 pp.

ICES. 2015b. Report of the Inter-Benchmark Protocol of West of Scotland Roundfish (IBPWS-Round), February–April 2015. By correspondence. ICES CM 2015/ACOM:37. 72 pp.

ICES. 2016. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 183 pp.

Lorenzen, K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural ecosystems and aquaculture. Journal of Fish Biology, 49: 627–647.

Needle, C. L. 2003. Survey-based assessments with SURBA. Working Document to the ICES Working Group on Methods of Fish Stock Assessment, Copenhagen, 29 January–5 February 2003.

Needle, C. L. and Fryer, R. J. 2002. A modified TSA for cod in Division VIa: separate landings and discards. Working document to the ICES Advisory Committee on Fisheries Management. October 2002.

3.4.12 Audit of whg-scow

Date: 24/05/2016

Auditor: Sofie Nimmegeers

General

ICES provides annual catch advice for this stock on the basis of the MSY approach. A full analytical assessment and forecast were performed in 2016 in accordance with the procedures outlined in the stock annex. Since 2007, catches should be reduced to the lowest possible level.

Assessment type: Update/SALY. This stock was benchmarked at WKROUND in 2012 and inter-benchmarked at IBPWSRound in 2015.

Assessment: Age-based analytical assessment (TSA) with catches included in the model and forecast.

Forecast: Presented and consistent with the procedures used last year.

Assessment model: TSA using commercial catches and five survey indices of abundance (ScoGFS-WIBTS-Q1, ScoGFS-WIBTS-Q4, IGFS-WIBTS-Q4, UKS-WIBTS-Q1 and UKS-WIBTS-Q4). TSA also estimates a change in catchability. There is a large increase in catchability in the ScoGFS-WIBTS-Q1, ScoGFS-WIBTS-Q4 and IGFS-WIBTS-Q4 surveys that is not seen in the new UKS-WIBTS-Q1 and UKS-WIBTS-Q4 surveys.

Data issues: Data were available as described. Incorrect reporting of landings (species and quantity) is known to have occurred in the past and directly affecting the perception of the stock. TSA is explicitly designed to allow for omission in the catch data during this period (1995–2005 uses only age-structure data from the catch), which is why it was used here as the final assessment. The potential for improvement in the quality of survey data needs to be investigated. The issue of changes in survey catchability needs to be addressed. The discrepancy in the abundance index between the two Q4 surveys, IGFS-WIBTS-Q4 and UKSGFS-WIBTS-Q4, should be further explored. With more years of data available (an additional 2–3 years), the analysis of catchability in the two surveys could be revisited with the ultimate goal of creating one common index.

Consistency: The stock assessment settings are consistent with those used last year. A comparison of the estimates of this year's assessment with last year's is not given. This year's assessment significantly downscales estimates of SSB and R compared to last year, with SSB_{2014} and R_{2014} revised downwards by 50% and 56% respectively. The estimated F in 2014 (0.029) was significantly up scaled by 110% in this year's assessment (0.061). The only association that is mentioned in the report is F_{2014} and SSB_{2015} (last year's assessment) compared to F_{2015} and SSB_{2016} (this year's assessment). However, this does not reflect the consistency of the assessment.

Stock status: The paragraph on the stock status (in 3.4.3 Historical stock development-Final assessment) has not been updated. Mean F_{2-4} is compared to the old F_{pa} value (0.6) instead of the revised F_{pa} value of 0.19. The period 2002–2009 is mentioned as a sequence of low recruitments and 2010, 2012, 2014 and 2015 as strong recruitments. However, the 2009, 2011 and 2013 year classes are of the same level as the 2001–2003 year classes. This is the result of the significant downscaling of the recent recruitments in this year's assessment. Consequently, the 2014 year class is the strongest since the year 2002 instead of 2000. In 2011–2015 SSB increases slightly instead of considerable.

Management Plan: No management plan for this stock.

General comments

The document was generally well written and easy to follow.

Technical comments

No major errors were identified in the report, tables or figures. Editorial changes (using track changes and comments) have been made to the report and tables.

Conclusions

The assessment has been performed correctly and provides an appropriate basis for providing catch advice.

Table 3.4.1. Whiting in Division 6.a. Nominal landings (in tonnes) as officially reported to ICES.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	1	-	+	-	+	+	+	-	1	1	+	-	-	-	-	+	-	-	-	-	-	-
Denmark	1	+	3	1	1	+	+	+	+	-	-	-	-	-	+	+	-	-	-	-	-	-
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	+
France	199	180	352	105	149	191	362	202	108	82	300	48	52	21	11	6	9	7	6	1	1	3
Germany	+	+	+	1	1	+	-	+	-	-	+	-	-	-	-	-	-	+	1	-	-	-
Ireland	1,315	977	1,200	1,377	1,192	1,213	1,448	1,182	977	952	1,121	793	764	577	568	356	172	196	56	69	125	99
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
Spain	-	-	-	-	-	-	1	-	1	2	+	-	2	-	-	-	-	-	-	-	-	-
UK(E, W & NI)	44	50	218	196	184	233	204	237	453	251	210	104	71	73	35	13	5	2	1	-	-	-
UK (Scot.)	6,109	4,819	5,135	4,330	5,224	4,149	4,263	5,021	4,638	3,369	3,046	2,258	1,654	1,064	751	444	103	178	424	-	-	-
UK (total)																				370	354	247
Total landings	7,669	6,026	6,908	6,010	6,751	5,786	6,278	6,642	6,178	4,657	4,677	3,203	2,543	1,735	1,365	819	289	383	488	441	482	349

Table 3.4.1. (Continued).

Country	2011	2012	2013	2014	2015*
Belgium	-	-	-	-	-
Denmark	-	-	-	-	-
Faroe Islands	1	1	-	-	-
France	+	+	1	1	+
Germany	-	-	-	-	-
Ireland	149	96	97	97	88
Netherlands	-	-	-	-	11
Norway	-	-	-	-	-
Spain	-	-	-	-	-
UK(E, W & NI)	-	-	-	-	-
UK(Scot.)	-	-	-	-	-
UK(total)	80	204	116	83	122
Total landings	230	301	214	181	221

*** Preliminary.**

Table 3.4.2. Whiting in Division 6.a. Landings, discards and catch estimates 1978–2014, as used by the WG. Values are totals for fish over the ages 1 to 7+. Discard and catch values are revised 1978–2003 compared to previous assessments because of a revised method for raising discards.

Year	Weight (tonnes)			Numbers (thousands)		
	Total	Human consumption	Discards	Total	Human consumption	Discards
1978	19346	14677	4669	85502	54369	31133
1979	20100	17081	3019	77484	61393	16091
1980	14598	12816	1782	54643	44562	10081
1981	14335	12203	2132	59247	46067	13180
1982	19356	13871	5485	84886	47883	37003
1983	22264	15970	6294	86244	49359	36885
1984	20475	16458	4017	89113	50218	38895
1985	17733	12893	4840	75192	43166	32026
1986	11123	8454	2669	49413	31273	18140
1987	23462	11544	11918	158176	41221	116955
1988	19484	11352	8132	109474	40681	68793
1989	13407	7531	5876	72364	26876	45488
1990	10173	5643	4530	51426	19201	32225
1991	11543	6660	4883	63767	25103	38664
1992	15253	6004	9249	93424	22266	71158
1993	11631	6872	4759	52365	23246	29119
1994	9356	5901	3455	44986	20060	24926
1995	11847	6076	5771	66432	18763	47669
1996	15096	7156	7940	81230	22329	58901
1997	11536	6285	5251	55724	19250	36474
1998	13847	4631	9216	88803	14387	74416
1999	8588	4613	3975	43219	15970	27249
2000	16295	3010	13285	176734	10118	166616
2001	6701	2438	4263	38114	8477	29637
2002	4560	1709	2851	28381	5765	22616
2003	2075	1356	719	10063	4124	5939
2004	3437	811	2626	21749	2571	19178
2005	1239	341	898	6154	1051	5103
2006	1326	380	946	12988	1049	11939
2007	849	484	365	4879	1145	3734
2008	617	443	174	3085	1232	1853
2009	905	488	417	18038	1115	16923
2010	1193	307	886	18391	601	17790
2011	569	230	339	4877	583	4294
2012	1041	313	729	9679	702	8977
2013	1175	222	953	15444	522	14922
2014	770	184	586	11226	408	10818
2015	1060	227	833	9336	479	8857
Min	569	184	174	3085	408	1853
GM	5758	2718	2490	35353	8348	21919
AM	9957	5990	3967	53480	20463	33018
Max	23462	17081	13285	176734	61393	166616

Table 3.4.3. Whiting in Division 6.a. Landings-at-age (thousands).

	Age						
Year	1	2	3	4	5	6	7+
1965	6938	6085	43530	4803	388	103	22
1966	1685	10544	2229	28185	1861	186	52
1967	5169	26023	10619	697	14574	789	143
1968	7265	16484	9239	3656	324	5036	368
1969	873	25174	8644	2566	1206	118	2333
1970	730	6423	28065	3241	670	214	550
1971	2387	8617	4122	34784	1338	240	223
1972	16777	12028	4013	1363	14796	793	148
1973	14078	36142	5592	1461	357	4292	310
1974	9083	51036	10049	1166	180	52	849
1975	14917	16778	36318	2819	281	57	245
1976	8500	46421	15757	17423	1508	66	57
1977	16120	13376	25144	3127	4719	292	24
1978	17670	18175	6682	9400	941	1433	68
1979	6334	34221	13282	3407	3488	276	384
1980	11650	11378	14860	4155	1244	1085	190
1981	3593	24395	11297	4611	1518	452	201
1982	2991	5783	29094	6821	2043	803	348
1983	3418	7094	8040	22757	6070	1439	540
1984	7209	12765	8221	4387	14825	1953	858
1985	4139	19520	8574	3351	1997	4764	822
1986	2674	14824	9770	2653	532	291	529
1987	6430	13935	13988	5442	837	330	259
1988	1842	20587	9638	6168	1949	290	207
1989	2529	5887	11889	4767	1266	468	71
1990	3203	8028	2393	4009	1326	204	37
1991	3294	8826	10046	1208	1391	286	51
1992	2695	9440	4473	4782	396	373	106
1993	1051	10179	6293	2673	2738	163	147
1994	909	4889	9158	3607	712	715	69
1995	215	4322	6516	5654	1397	376	282
1996	990	5410	7675	5052	2461	583	157
1997	877	3658	8514	4316	1441	338	106
1998	840	3504	4277	3698	1442	338	288
1999	1013	6131	4546	2040	1774	355	112
2000	484	2952	4211	1570	485	328	89
2001	461	3271	2630	1567	401	131	16
2002	62	1624	3018	799	227	23	13
2003	170	710	1111	1673	347	111	2
2004	54	724	543	521	622	78	29
2005	28	276	455	140	99	45	7
2006	82	139	369	260	61	113	24

	Age						
Year	1	2	3	4	5	6	7+
2007	187	168	255	326	132	27	50
2008	6	265	394	336	152	55	24
2009	59	216	254	430	100	44	13
2010	53	94	153	119	126	24	31
2011	0	310	133	82	28	17	12
2012	9	25	375	210	57	15	11
2013	21	49	83	277	67	18	7
2014	12	30	131	102	99	23	11
2015	11	83	61	164	69	67	25

Table 3.4.4. Whiting in Division 6.a. Discards-at-age (thousands). Previous discard estimates (ICES, WGCSE 2011) for the years 1978–2003 were replaced by those estimated by Millar and Fryer (2005).

	Age						
Year	1	2	3	4	5	6	7+
1965	17205	4968	11437	531	14	2	0
1966	4322	8946	515	3317	79	3	0
1967	12237	20791	2674	84	629	12	1
1968	16394	12612	2137	377	13	82	3
1969	1983	20494	2093	292	51	2	26
1970	1776	6704	7494	382	33	4	0
1971	5505	6719	969	3906	57	4	1
1972	39192	8930	850	152	610	14	1
1973	30521	26995	1225	147	14	77	2
1974	23101	40590	2362	123	7	1	7
1975	37295	13541	8485	310	12	1	0
1976	24891	35812	3360	1940	63	1	0
1977	48148	8675	5432	301	212	5	0
1978	17886	12512	501	194	0	40	0
1979	2581	12099	1113	264	34	0	0
1980	2725	4889	2003	366	86	12	0
1981	1128	10415	1397	201	27	12	0
1982	19511	3421	12683	1197	187	4	0
1983	21690	6748	2909	5372	158	8	0
1984	34330	2400	909	371	811	73	1
1985	17615	9858	3273	672	205	363	40
1986	6159	9823	1962	185	1	0	10
1987	97611	17427	1763	154	0	0	0
1988	28057	38019	2239	467	11	0	0
1989	31079	5598	8570	223	13	5	0
1990	20952	11176	71	23	3	0	0
1991	23211	7540	7355	266	236	56	0
1992	50665	16729	2810	954	0	0	0
1993	14057	11139	2903	588	431	0	1
1994	12700	6859	3872	1152	189	150	4
1995	21974	21786	3416	484	7	1	1
1996	33621	18625	5086	1535	13	1	20
1997	22422	9632	3806	540	71	2	1
1998	53742	16058	3553	847	177	31	8
1999	7928	17097	1402	503	275	44	0
2000	158913	5254	2238	154	16	41	0
2001	5666	23084	715	172	0	0	0
2002	11055	8531	2428	415	175	9	3
2003	3770	1416	334	374	32	9	4
2004	14667	3557	536	305	107	4	2
2005	2923	1578	534	37	19	7	4
2006	9784	852	1000	256	36	11	2

	Age						
Year	1	2	3	4	5	6	7+
2007	995	1077	308	64	4	3	0
2008	806	638	142	162	51	41	0
2009	6926	112	72	49	16	3	0
2010	16005	1427	245	42	61	6	1
2011	2697	1410	172	12	3	0	0
2012	7837	434	576	106	21	2	0
2013	13156	1338	159	252	12	3	2
2014	10618	44	71	35	36	10	3
2015	7550	866	284	119	20	17	0

Table 3.4.5. Whiting in Division 6.a. Total catch-at-age (thousands).

	Age						
Year	1	2	3	4	5	6	7+
1965	24143	11054	54967	5334	402	105	22
1966	6007	19490	2744	31502	1940	189	53
1967	17406	46814	13293	781	15204	801	144
1968	23659	29096	11376	4034	337	5118	372
1969	2856	45668	10737	2858	1257	120	2358
1970	2506	13128	35559	3623	703	218	550
1971	7891	15336	5090	38690	1395	245	224
1972	55969	20958	4863	1514	15406	807	149
1973	44599	63137	6817	1608	371	4369	313
1974	32185	91625	12412	1289	188	53	856
1975	52213	30319	44804	3129	293	58	245
1976	33392	82233	19117	19363	1571	67	57
1977	64268	22051	30576	3428	4931	297	24
1978	35556	30687	7183	9594	941	1473	68
1979	8915	46320	14395	3671	3522	276	384
1980	14375	16267	16863	4521	1330	1097	190
1981	4721	34810	12694	4812	1545	464	201
1982	22502	9204	41777	8018	2230	807	348
1983	25108	13842	10949	28129	6228	1447	540
1984	41539	15165	9130	4758	15636	2026	859
1985	21754	29378	11847	4023	2202	5127	862
1986	8833	24647	11732	2838	533	291	539
1987	104041	31362	15751	5596	837	330	259
1988	29899	58606	11877	6635	1960	290	207
1989	33608	11485	20459	4990	1279	473	71
1990	24155	19204	2464	4032	1329	204	37
1991	26505	16366	17401	1474	1627	342	51
1992	53360	26169	7283	5736	396	373	106
1993	15108	21318	9196	3261	3169	163	148
1994	13609	11748	13030	4759	901	865	73
1995	22189	26108	9932	6138	1404	377	283
1996	34611	24035	12761	6587	2474	584	177
1997	23299	13290	12320	4856	1512	340	107
1998	54582	19562	7830	4545	1619	369	296
1999	8941	23228	5948	2543	2049	399	112
2000	159397	8206	6449	1724	501	369	89
2001	6127	26355	3345	1739	401	131	16
2002	11117	10155	5446	1214	402	32	16
2003	3940	2126	1445	2047	379	120	6
2004	14721	4281	1079	826	729	82	31
2005	2951	1854	989	177	118	52	11
2006	9866	991	1369	516	97	124	26

Year	Age 1	2	3	4	5	6	7+
2007	1182	1245	563	390	136	29	50
2008	812	903	536	498	203	96	24
2009	6985	328	325	478	116	47	13
2010	16058	1521	399	161	187	30	32
2011	2697	1720	305	93	32	17	12
2012	7846	460	952	316	78	16	11
2013	13177	1388	243	529	79	21	8
2014	10630	75	202	137	136	33	14
2015	7561	949	345	283	88	84	25

Table 3.4.6. Whiting in Division 6.a. Landings weight-at-age (kg).

	Age						
Year	1	2	3	4	5	6	7+
1965	0.218	0.249	0.308	0.452	1.208	0.72	0.778
1966	0.238	0.243	0.325	0.374	0.61	0.72	0.828
1967	0.204	0.24	0.319	0.424	0.412	0.639	0.821
1968	0.206	0.263	0.366	0.444	0.554	0.538	0.735
1969	0.178	0.223	0.335	0.5	0.57	0.649	0.63
1970	0.205	0.203	0.274	0.382	0.519	0.619	0.683
1971	0.209	0.247	0.276	0.316	0.426	0.551	0.712
1972	0.211	0.258	0.345	0.368	0.426	0.494	0.638
1973	0.196	0.235	0.362	0.479	0.485	0.532	0.666
1974	0.193	0.215	0.317	0.444	0.591	0.641	0.584
1975	0.209	0.245	0.305	0.471	0.651	0.615	0.717
1976	0.201	0.242	0.309	0.361	0.497	0.687	0.856
1977	0.2	0.244	0.296	0.392	0.431	0.629	0.819
1978	0.199	0.235	0.286	0.389	0.516	0.549	0.612
1979	0.218	0.232	0.306	0.404	0.536	0.678	0.693
1980	0.172	0.242	0.33	0.42	0.492	0.595	0.817
1981	0.192	0.228	0.289	0.382	0.409	0.409	0.547
1982	0.184	0.22	0.276	0.352	0.505	0.513	0.526
1983	0.216	0.249	0.28	0.34	0.409	0.494	0.51
1984	0.216	0.259	0.313	0.371	0.412	0.458	0.458
1985	0.185	0.238	0.306	0.402	0.43	0.461	0.538
1986	0.174	0.236	0.294	0.365	0.468	0.482	0.499
1987	0.188	0.237	0.304	0.373	0.511	0.52	0.576
1988	0.176	0.215	0.301	0.4	0.483	0.567	0.6
1989	0.171	0.22	0.279	0.348	0.459	0.425	0.555
1990	0.225	0.251	0.324	0.359	0.417	0.582	0.543
1991	0.199	0.22	0.291	0.354	0.391	0.442	0.761
1992	0.193	0.23	0.288	0.349	0.388	0.397	0.51
1993	0.186	0.242	0.314	0.361	0.412	0.452	0.474
1994	0.161	0.217	0.29	0.371	0.451	0.482	0.483
1995	0.19	0.225	0.296	0.381	0.469	0.473	0.528
1996	0.195	0.245	0.288	0.365	0.483	0.526	0.569
1997	0.198	0.245	0.297	0.384	0.522	0.629	0.661
1998	0.215	0.236	0.301	0.364	0.438	0.5	0.646
1999	0.181	0.225	0.28	0.365	0.44	0.524	0.594
2000	0.205	0.241	0.298	0.336	0.419	0.488	0.617
2001	0.173	0.234	0.303	0.37	0.395	0.376	0.595
2002	0.213	0.257	0.304	0.363	0.464	0.65	0.707
2003	0.228	0.264	0.309	0.362	0.374	0.436	0.717
2004	0.193	0.251	0.295	0.345	0.382	0.403	0.342
2005	0.189	0.261	0.313	0.378	0.44	0.482	0.356
2006	0.221	0.292	0.319	0.394	0.455	0.528	0.567

	Age						
Year	1	2	3	4	5	6	7+
2007	0.215	0.280	0.349	0.418	0.498	0.598	0.660
2008	0.274	0.245	0.322	0.384	0.514	0.530	0.653
2009	0.328	0.347	0.437	0.479	0.470	0.519	0.595
2010	0.288	0.402	0.456	0.567	0.652	0.619	0.613
2011	0.210	0.327	0.405	0.523	0.613	0.570	0.393
2012	0.295	0.304	0.387	0.508	0.615	0.705	0.493
2013	0.191	0.277	0.354	0.442	0.541	0.631	0.729
2014	0.243	0.271	0.374	0.463	0.544	0.659	0.699
2015	0.290	0.356	0.444	0.467	0.513	0.601	0.624

Table 3.4.7. Whiting in Division 6.a. Discard weight-at-age (kg).

	Age						
Year	1	2	3	4	5	6	7+
1965	0.122	0.177	0.213	0.249	0.287	0.303	0.287
1966	0.122	0.178	0.212	0.248	0.29	0.297	0.286
1967	0.122	0.178	0.213	0.248	0.29	0.295	0.289
1968	0.128	0.179	0.213	0.249	0.291	0.298	0.287
1969	0.121	0.178	0.214	0.249	0.29	0.295	0.285
1970	0.121	0.175	0.213	0.249	0.29	0.299	0.284
1971	0.12	0.177	0.211	0.248	0.29	0.299	0.284
1972	0.121	0.177	0.213	0.248	0.289	0.301	0.281
1973	0.123	0.176	0.215	0.252	0.288	0.301	0.285
1974	0.119	0.177	0.214	0.25	0.285	0.299	0.288
1975	0.119	0.176	0.213	0.25	0.286	0.301	0.278
1976	0.116	0.177	0.213	0.249	0.288	0.3	0.28
1977	0.118	0.177	0.214	0.249	0.289	0.299	0.282
1978	0.135	0.167	0.199	0.288	0.32	0.238	0
1979	0.173	0.188	0.208	0.215	0.281	0	0
1980	0.14	0.179	0.208	0.22	0.271	0.386	0
1981	0.108	0.16	0.195	0.298	0.286	0.295	0
1982	0.096	0.18	0.209	0.243	0.283	0.44	0
1983	0.141	0.186	0.228	0.237	0.267	0.267	0
1984	0.087	0.199	0.246	0.26	0.259	0.303	0.227
1985	0.102	0.191	0.237	0.286	0.326	0.312	0.316
1986	0.092	0.17	0.196	0.245	0.258	0.33	0.263
1987	0.085	0.182	0.233	0.249	0.225	0	0
1988	0.076	0.143	0.203	0.227	0.262	0	0
1989	0.099	0.177	0.205	0.209	0.294	0.305	0
1990	0.124	0.171	0.214	0.219	0.237	0.264	0
1991	0.085	0.169	0.205	0.223	0.226	0.281	0
1992	0.109	0.173	0.219	0.227	0	0	0
1993	0.118	0.197	0.225	0.242	0.256	0	0.436
1994	0.087	0.157	0.22	0.283	0.297	0.253	0.299
1995	0.075	0.154	0.189	0.246	0.278	0.597	0.493
1996	0.095	0.18	0.203	0.229	0.302	0.421	0.26
1997	0.112	0.182	0.221	0.235	0.243	0.422	0.819
1998	0.098	0.179	0.225	0.254	0.282	0.264	0.245
1999	0.077	0.168	0.217	0.205	0.266	0.268	0
2000	0.075	0.164	0.203	0.233	0.282	0.25	0
2001	0.094	0.154	0.196	0.203	0.381	0	0
2002	0.073	0.162	0.212	0.245	0.24	0.295	0.276
2003	0.077	0.177	0.231	0.242	0.213	0.3	0.278
2004	0.086	0.186	0.236	0.246	0.304	0.349	0.314
2005	0.088	0.149	0.223	0.214	0.315	0.292	0.373
2006	0.046	0.197	0.235	0.295	0.322	0.518	0.362

	Age						
Year	1	2	3	4	5	6	7+
2007	0.059	0.159	0.225	0.226	0.334	0.794	0.266
2008	0.075	0.211	0.286	0.301	0.397	0.222	0.304
2009	0.051	0.288	0.227	0.262	0.248	0.253	0
2010	0.038	0.124	0.269	0.375	0.376	0.401	0.964
2011	0.030	0.141	0.321	0.266	0.221	0	0
2012	0.057	0.151	0.292	0.355	0.349	0.414	0.907
2013	0.041	0.208	0.238	0.355	0.377	0.297	0.371
2014	0.049	0.168	0.279	0.364	0.442	0.441	0.791
2015	0.074	0.181	0.226	0.349	0.322	0.440	0

Table 3.4.8. Whiting in Division 6.a. Total catch weight-at-age (kg).

	Age						
Year	1	2	3	4	5	6	7+
1965	0.150	0.217	0.288	0.432	1.176	0.712	0.778
1966	0.155	0.213	0.304	0.361	0.597	0.713	0.812
1967	0.146	0.212	0.298	0.405	0.407	0.634	0.817
1968	0.152	0.227	0.337	0.426	0.544	0.534	0.729
1969	0.138	0.203	0.311	0.474	0.559	0.643	0.626
1970	0.145	0.189	0.261	0.368	0.508	0.613	0.683
1971	0.147	0.216	0.264	0.309	0.420	0.545	0.710
1972	0.148	0.223	0.322	0.356	0.421	0.491	0.636
1973	0.146	0.210	0.336	0.458	0.478	0.528	0.661
1974	0.140	0.198	0.297	0.425	0.576	0.635	0.582
1975	0.145	0.214	0.288	0.449	0.636	0.610	0.717
1976	0.138	0.214	0.292	0.350	0.489	0.681	0.856
1977	0.139	0.218	0.281	0.379	0.425	0.623	0.819
1978	0.160	0.210	0.276	0.387	0.516	0.545	0.612
1979	0.202	0.222	0.295	0.378	0.530	0.678	0.693
1980	0.167	0.220	0.308	0.393	0.467	0.594	0.817
1981	0.173	0.196	0.271	0.379	0.402	0.408	0.547
1982	0.109	0.202	0.252	0.336	0.499	0.513	0.526
1983	0.155	0.215	0.270	0.324	0.405	0.479	0.510
1984	0.099	0.245	0.305	0.358	0.397	0.454	0.456
1985	0.107	0.216	0.288	0.383	0.427	0.448	0.537
1986	0.109	0.198	0.274	0.360	0.465	0.481	0.474
1987	0.097	0.210	0.297	0.369	0.510	0.520	0.576
1988	0.080	0.164	0.281	0.392	0.477	0.567	0.600
1989	0.108	0.204	0.255	0.337	0.446	0.422	0.555
1990	0.140	0.217	0.295	0.342	0.405	0.575	0.543
1991	0.096	0.207	0.265	0.338	0.376	0.424	0.761
1992	0.114	0.195	0.265	0.329	0.388	0.397	0.510
1993	0.123	0.211	0.271	0.331	0.361	0.452	0.473
1994	0.089	0.170	0.258	0.344	0.419	0.448	0.473
1995	0.076	0.166	0.235	0.361	0.440	0.472	0.526
1996	0.098	0.198	0.257	0.336	0.482	0.526	0.537
1997	0.116	0.200	0.275	0.369	0.505	0.629	0.661
1998	0.101	0.197	0.274	0.341	0.420	0.469	0.573
1999	0.084	0.194	0.269	0.341	0.433	0.505	0.594
2000	0.076	0.199	0.277	0.329	0.415	0.477	0.617
2001	0.100	0.183	0.280	0.350	0.395	0.376	0.560
2002	0.074	0.194	0.270	0.346	0.385	0.541	0.728
2003	0.080	0.211	0.287	0.340	0.360	0.424	0.498
2004	0.086	0.197	0.266	0.308	0.371	0.400	0.340
2005	0.089	0.166	0.264	0.344	0.420	0.456	0.362
2006	0.047	0.210	0.258	0.345	0.406	0.527	0.551

	Age						
Year	1	2	3	4	5	6	7+
2007	0.084	0.175	0.281	0.387	0.494	0.616	0.659
2008	0.076	0.221	0.312	0.357	0.484	0.397	0.649
2009	0.053	0.327	0.391	0.457	0.440	0.500	0.595
2010	0.038	0.141	0.341	0.517	0.562	0.573	0.622
2011	0.030	0.174	0.358	0.491	0.571	0.570	0.393
2012	0.058	0.160	0.329	0.456	0.543	0.673	0.497
2013	0.041	0.211	0.278	0.401	0.516	0.583	0.658
2014	0.050	0.210	0.341	0.438	0.517	0.593	0.720
2015	0.074	0.196	0.264	0.417	0.470	0.567	0.624

Table 3.4.9. Whiting in Division 6.a. Survey data made available to the WG. Data used in the TSA run are highlighted in bold. For the Scottish surveys, numbers are standardised to catch rate per ten hours. The Scottish surveys from 2011 have been conducted according to new design and groundgear.

ScoGFS-WIBTS-Q1: Scottish Groundfish Survey - Effort in hours - Numbers-at-age.

Year	Effort	Age						
	(hours)	1	2	3	4	5	6	7
1985	10	3140	1792	380	85	23	156	18
1986	10	1456	1525	403	68	10	9	10
1987	10	6938	1054	584	142	36	2	1
1988	10	567	3469	654	189	42	5	1
1989	10	910	505	586	237	48	3	0
1990	10	1818	571	122	216	61	4	1
1991	10	3203	276	299	22	39	9	1
1992	10	4777	1597	410	517	56	18	0
1993	10	5532	6829	644	91	30	11	2
1994	10	6614	2443	1487	174	56	15	6
1995	10	5598	2831	1160	370	70	17	32
1996	10	9385	2237	635	341	135	30	4
1997	10	5663	2444	1531	355	102	17	4
1998	10	9851	1352	294	195	50	14	1
1999	10	6125	4952	489	103	16	1	0
2000	10	12862	471	152	34	10	11	0
2001	10	4653	1955	242	41	8	1	1
2002	10	5542	1028	964	89	15	1	1
2003	10	6934	746	436	300	32	2	4
2004	10	5887	1566	189	131	44	9	1
2005	10	1308	723	183	35	8	11	2
2006	10	1441	466	282	77	0	3	1
2007	10	614	522	127	75	16	3	2
2008	10	593	127	77	26	8	3	0
2009	10	906	387	103	105	20	9	7
2010	10	3523	340	108	52	40	4	3

ScoGFS-WIBTS-Q4: Scottish Groundfish Survey - Effort in hours - Numbers-at-age.

ear	Effort	Age							
	(hours)	0	1	2	3	4	5	6	7
1996	10	5154	1908	1116	570	188	51	6	1
1997	10	8001	2869	951	323	160	46	12	1
1998	10	1852	2713	1125	150	100	20	1	0
1999	10	8203	2338	582	141	33	24	1	1
2000	10	4434	4056	789	160	9	7	1	0
2001	10	9615	1957	1420	155	40	12	2	0
2002	10	14658	1591	621	479	30	9	5	0
2003	10	9932	3446	567	338	83	27	4	0
2004	10	5923	1758	940	83	57	62	1	0
2005	10	2297	308	318	76	9	4	1	1
2006	10	415	296	140	101	35	8	3	0
2007	10	1894	434	326	99	83	48	1	0
2008	10	2297	208	78	110	28	24	4	0
2009	10	4833	236	178	50	58	12	6	6

IGFS-WIBTS-Q4: Irish groundfish survey - Effort in minutes - Numbers-at-age.

Year	Effort	Age						
	(min)	0	1	2	3	4	5	6
2003	1127	1101	12886	2894	512	290	102	1
2004	1200	6924	3114	1312	104	35	16	1
2005	960	910	2228	1126	91	5	4	0
2006	1510	99	1055	921	214	27	3	0
2007	1173	138	1989	2380	722	169	251	122
2008	1135	24	4342	1328	573	243	123	36
2009	1378	16906	1430	989	325	68	21	41
2010	1291	108	9822	1510	382	121	64	15
2011	1287	453	4449	6042	683	290	68	71
2012	1230	264	6938	741	2014	501	47	22
2013	1295	24274	1066	4026	1074	1197	140	12
2014	1200	29869	15860	2599	5237	599	711	60
2015	1213	3765	30864	6545	1605	809	163	109

UKSGFS-WIBTS-Q1: Scottish Groundfish Survey - Effort in hours - Numbers-at-age.

Year	Effort	Age						
	(hours)	1	2	3	4	5	6	7
2011	10	222	1884	397	64	37	45	12
2012	10	3441	293	738	72	14	5	7
2013	10	552	1031	302	463	61	7	3
2014	10	5805	125	246	110	74	7	1
2015	10	2545	760	285	259	65	58	8
2016	10	3226	3485	576	148	84	42	25

UKSGFS-WIBTS-Q4: Scottish Groundfish Survey - Effort in hours - Numbers-at-age.

Year	Effort	Age							
	(hours)	0	1	2	3	4	5	6	7
2011	10	3644	119	2096	109	30	14	10	1
2012	10	748	964	426	658	110	19	2	11
2013	10	1732	125	309	110	159	27	2	0
2014	10	11569	1518	346	168	82	55	31	0
2015	10	4263	2794	727	115	91	20	27	1

Table 3.4.10. Whiting in Division 6.a. TSA parameter settings for the assessment run.

Parameter	Setting	Justification
Age of full selection	am = 4	Based on inspection of previous XSA and TSA runs.
Multipliers on variance matrices of measurements	Blandings(a) = 2 for ages 1, 7+ Bdiscards(a) = 2 for age 5 BScoGFS-WIBTS-Q4(a) = 2 for age 6	Allows extra measurement variability for poorly-sampled ages.
Multipliers on variances for fishing mortality estimates	H(1) = 2	Allows for more variable fishing mortalities for age 1 fish.
Downweighting of particular datapoints	Discards: cvmult = 3 for age 1 in 1981, age 1 in 1987, age 3 in 1991, age 1 in 2000, age 1 in 2013 Surveys: ScoGFS-WIBTS-Q1 cvmult = 3 for age 5 in 1992, age 2 in 1993, age 1 in 2000, age 2 in 2000 cvmult = 5 for age 4 in 1992 ScoGFS-WIBTS-Q4 cvmult = 3 for age 4 in 2007, age 5 in 2007	Large values indicated by exploratory prediction error plots.
Discards	Discards are allowed to evolve over time constrained by a trend. Ages 1 to 5 are modelled independently.	
Recruitments	Modelled by a hockey-stick model, with numbers-at-age 1 assumed to be independent and normally distributed. To allow recruitment variability to increase with mean recruitment, a constant coefficient of variation is assumed.	

Table 3.4.11. Whiting in Division 6.a. TSA parameter estimates for final assessment presented this year.

Parameter	Notation	Description	2015 IBPWSRound	2015 WG	2016 WG
Initial fishing mortality	F (1, 1981)	Fishing mortality-at-age a in year y	0.10	0.10	0.09
	F (2, 1981)		0.11	0.12	0.11
	F (4, 1981)		0.34	0.37	0.32
Fishing mortality standard deviations	σF	Transitory changes in overall fishing mortality	0.10	0.10	0.00
	σU	Persistent changes in selection (age effect in F)	0.10	0.11	0.09
	σV	Transitory changes in the year effect in fishing mortality	0.08	0.09	0.00
	σY	Persistent changes in the year effect in fishing mortality	0.27	0.30	0.27
Measurement CVs	CVlandings	CV of landings-at-age data	0.15	0.16	0.17
	CVdiscards	CV of discards-at-age data	0.53	0.54	0.53
Recruitment		Hockey-stick parameter Recruitment value at change point	27.6	28.4	29.6
		Hockey-stick parameter SSB at change point	2.85	2.86	3.19
	CVrec	Coefficient of variation of recruitment data	0.32	0.28	0.32
Discards	σlogit p	Transitory trends in discarding	0.35	0.30	0.30
	σpersistent	Persistent trends in discarding	0.20	0.20	0.22
Survey selectivities (ScoGFS-WIBTS-Q1)	Φ(1)	Survey selectivity at-age a	1.29	1.71	1.09
	Φ(2)		1.32	1.80	1.12
	Φ(3)		1.13	1.57	0.96
	Φ(4)		0.95	1.40	0.81
	Φ(5)		0.79	1.19	0.66
	Φ(6)		0.68	0.91	0.58
	σsurvey	Standard error of survey data	0.45	0.41	0.44
	ση		0.10	0.10	0.10
Survey catchability standard deviations	σΩ	Transitory changes in survey catchability	0.15	0.06	0.18
	σβ	Persistent changes in survey catchability	0.10	0.21	0.11
Survey selectivities (ScoGFS-WIBTS-Q4)	Φ(1)	Survey selectivity at-age a	3.67	3.63	3.23
	Φ(2)		3.28	3.28	2.97
	Φ(3)		2.67	2.57	2.33
	Φ(4)		2.18	2.22	2.02
	Φ(5)		3.03	3.15	2.70
	Φ(6)		0.65	0.64	0.47
	σsurvey	Standard error of survey data	0.20	0.19	0.21
	ση		0.18	0.17	0.19
Survey catchability standard deviations	σΩ	Transitory changes in survey catchability	0.00	0.00	0.00
	σβ	Persistent changes in survey catchability	0.15	0.16	0.15

Table 3.4.11. (Continued).

Parameter	Notation	Description	2015 IBPWSRound	2015 WG	2016 WG
Survey selectivities (IRGFS-WIBTS-Q4)	Φ(1)		8.56	8.70	12.93
	Φ(2)		7.90	8.31	10.99
	Φ(3)		8.51	9.19	14.59
	Φ(4)		7.08	7.63	10.48
	σsurvey	Standard error of survey data	0.31	0.27	0.28
	ση		0.34	0.40	0.51
Survey catchability standard deviations	σΩ	Transitory changes in survey catchability	0.17	0.16	0.10
	σβ	Persistent changes in survey catchability	0.08	0.09	0.16
Survey selectivities (UKSGFS-WIBTS-Q1)	Φ(1)		2.15	2.63	5.35
	Φ(2)		1.99	2.34	6.00
	Φ(3)		2.51	3.51	6.92
	Φ(4)		2.01	2.50	6.07
	Φ(5)		1.93	2.35	5.39
	Φ(6)		2.28	2.49	6.64
	σsurvey	Standard error of survey data	0.62	0.43	0.43
	ση		0.21	0.23	0.11
Survey catchability standard deviations	σΩ	Transitory changes in survey catchability	0.44	0.31	0.02
	σβ	Persistent changes in survey catchability	0.07	0.00	0.13
Survey selectivities (UKSGFS-WIBTS-Q4)	Φ(1)		2.25	1.83	6.91
	Φ(2)		6.43	6.88	11.10
	Φ(3)		3.38	3.73	6.84
	Φ(4)		3.72	4.38	8.24
	Φ(5)		2.42	2.70	5.45
	Φ(6)		2.98	3.61	7.95
	σsurvey	Standard error of survey data	0.36	0.33	0.28
	ση		0.07	0.05	0.06
Survey catchability standard deviations	σΩ	Transitory changes in survey catchability	0.07	0.00	0.01
	σβ	Persistent changes in survey catchability	0.06	0.00	0.20
Misreporting		Transitory changes in misreporting	0.01	0.01	0.00
		Persistent changes in misreporting	0.18	0.19	0.18

Table 3.4.12. Whiting in Division 6.a. TSA population numbers-at-age (thousands).

	Age						
Year	1	2	3	4	5	6	7+
1981	199412	472795	85943	22339	7089	2092	901
1982	165965	79763	219359	38602	9377	3063	1320
1983	197470	64742	35689	94988	15914	3992	1900
1984	327360	72423	24716	12391	31671	5392	2059
1985	311455	116455	24654	7362	3401	9310	2209
1986	292148	112139	38223	6072	1422	667	2530
1987	405448	110604	41120	12404	1530	368	831
1988	107793	143963	37676	12572	3332	356	253
1989	327864	35087	43306	10953	2582	637	55
1990	175330	120612	10925	12017	2645	487	78
1991	246749	64326	47167	3977	3592	799	124
1992	338629	92053	24192	17165	1334	1192	307
1993	269148	127642	35536	9054	5904	478	553
1994	284536	102409	49763	13035	2821	1906	337
1995	303509	110193	42123	18965	4264	949	767
1996	191840	117669	43301	15615	5558	1248	498
1997	177171	67620	44053	14478	4013	1401	438
1998	233525	59172	22586	13904	3475	962	445
1999	168645	73137	17172	6376	3243	770	310
2000	261927	47713	19236	4095	1188	628	208
2001	109882	75623	13656	5285	777	235	169
2002	42134	31227	22649	3973	1037	146	80
2003	64743	9471	10630	7574	1082	294	65
2004	40492	16503	2861	3516	1807	271	92
2005	23850	10102	4905	840	858	415	88
2006	27953	7292	3913	1786	263	259	164
2007	14785	9167	2897	1523	591	90	147
2008	16907	4552	3846	1220	537	221	90
2009	25932	5368	1756	1598	402	177	107
2010	64382	9002	2234	717	592	150	107
2011	20197	22520	4081	1013	285	250	108
2012	44057	7783	10742	2031	491	140	180
2013	23949	16942	3785	5403	1008	251	167
2014	65998	9501	8397	1964	2808	540	229
2015	105780	26813	4779	4429	1054	1551	434
2016*	87905	43421	13519	2528	2391	585	1124
2017*	158379	35993	21855	7136	1361	1325	972
GM(81–15)	108382	39696	15707	6027	1907	607	280

*** 2016 and 2017 values are TSA-derived projections of population numbers.**

Table 3.4.13. Whiting in Division 6.a. Standard errors on TSA population numbers-at-age (thousands).

	Age						
Year	1	2	3	4	5	6	7+
1981	19833	33944	7413	1957	722	258	223
1982	17331	8049	16387	3645	919	351	169
1983	19031	6951	3914	7961	1715	462	224
1984	26231	7153	3150	1671	3269	785	292
1985	23672	9445	3021	1158	624	1416	443
1986	21284	8864	3989	1075	423	266	783
1987	33264	8329	3932	1601	430	185	436
1988	11260	12249	3212	1417	591	168	215
1989	21814	3910	4408	1220	536	239	124
1990	18530	8291	1310	1674	481	231	135
1991	23420	7009	3341	511	693	222	147
1992	29039	8864	2669	1319	199	289	137
1993	24158	11119	3536	1058	560	82	153
1994	26677	9693	4857	1589	452	279	93
1995	25124	11179	4586	2406	738	217	176
1996	20562	10378	4954	1995	950	319	166
1997	23553	8010	4171	1881	633	333	166
1998	33294	9301	3329	1647	637	239	171
1999	28334	12219	3562	1118	514	209	123
2000	41694	9765	3913	1011	248	134	77
2001	17096	13811	2772	958	180	50	45
2002	9116	5710	4352	803	222	48	26
2003	11848	2651	1751	1485	211	65	22
2004	7470	3746	648	558	355	61	25
2005	3382	2158	877	180	118	98	26
2006	2511	798	468	201	31	27	33
2007	1734	797	274	174	70	12	22
2008	1590	578	343	130	86	36	16
2009	2050	551	234	164	63	43	25
2010	5957	749	244	113	81	33	32
2011	1852	2323	357	125	58	45	33
2012	5992	751	1157	187	67	32	39
2013	3609	2490	380	633	105	37	35
2014	12180	1527	1280	210	361	62	38
2015	14101	5210	783	706	120	213	56
2016*	29413	6170	2691	434	400	71	155
2017*	56283	12313	3214	1472	245	235	133
GM(81–15)	12080	4650	1883	786	300	128	86

*** 2016 and 2017 values are standard errors on TSA-derived projections of population numbers.**

Table 3.4.14. Whiting in Division 6.a. TSA estimates for mortality-at-age.

	Age						
Year	1	2	3	4	5	6	7+
1981	0.1023	0.1237	0.2169	0.3300	0.3300	0.3300	0.3300
1982	0.1146	0.1523	0.2567	0.3466	0.3466	0.3466	0.3466
1983	0.1786	0.2653	0.4296	0.5571	0.5571	0.5571	0.5571
1984	0.2209	0.3732	0.5437	0.6887	0.6887	0.6887	0.6887
1985	0.2365	0.4418	0.6234	0.7959	0.7959	0.7959	0.7959
1986	0.1841	0.3610	0.4910	0.5985	0.5985	0.5985	0.5985
1987	0.2260	0.4413	0.5917	0.7151	0.7151	0.7151	0.7151
1988	0.2610	0.5174	0.6475	0.8773	0.8773	0.8773	0.8773
1989	0.2319	0.4482	0.5967	0.7737	0.7737	0.7737	0.7737
1990	0.1753	0.3111	0.4287	0.5703	0.5703	0.5703	0.5703
1991	0.1767	0.3295	0.4333	0.5671	0.5671	0.5671	0.5671
1992	0.1678	0.3135	0.4216	0.5481	0.5481	0.5481	0.5481
1993	0.1697	0.3045	0.4268	0.6254	0.6254	0.6254	0.6254
1994	0.1534	0.2609	0.3797	0.5679	0.5679	0.5679	0.5679
1995	0.1788	0.2960	0.4150	0.6434	0.6434	0.6434	0.6434
1996	0.2424	0.3754	0.5178	0.7954	0.7954	0.7954	0.7954
1997	0.2865	0.4403	0.5856	0.8438	0.8438	0.8438	0.8438
1998	0.3379	0.5135	0.6607	0.9218	0.9218	0.9218	0.9218
1999	0.4129	0.6269	0.7818	1.1263	1.1263	1.1263	1.1263
2000	0.4117	0.5842	0.7314	1.1390	1.1390	1.1390	1.1390
2001	0.3902	0.5210	0.6389	1.0442	1.0442	1.0442	1.0442
2002	0.3055	0.3848	0.4680	0.7503	0.7503	0.7503	0.7503
2003	0.3439	0.3962	0.4722	0.8255	0.8255	0.8255	0.8255
2004	0.4021	0.4182	0.5259	0.8466	0.8466	0.8466	0.8466
2005	0.3705	0.3475	0.4534	0.6770	0.6770	0.6770	0.6770
2006	0.3490	0.2821	0.3735	0.5793	0.5793	0.5793	0.5793
2007	0.3101	0.2205	0.2798	0.4698	0.4698	0.4698	0.4698
2008	0.3489	0.2472	0.2947	0.5239	0.5239	0.5239	0.5239
2009	0.3246	0.2104	0.2627	0.4278	0.4278	0.4278	0.4278
2010	0.2525	0.1500	0.1933	0.3110	0.3110	0.3110	0.3110
2011	0.1639	0.0923	0.1187	0.1845	0.1845	0.1845	0.1845
2012	0.1475	0.0754	0.1040	0.1620	0.1620	0.1620	0.1620
2013	0.1127	0.0554	0.0760	0.1144	0.1144	0.1144	0.1144
2014	0.0865	0.0415	0.0585	0.0834	0.0834	0.0834	0.0834
2015	0.0786	0.0387	0.0560	0.0777	0.0777	0.0777	0.0777
2016*	0.0817	0.0402	0.0583	0.0808	0.0808	0.0808	0.0808
2017*	0.0848	0.0417	0.0605	0.0840	0.0840	0.0840	0.0840
GM(81–15)	0.2198	0.2578	0.3478	0.5080	0.5080	0.5080	0.5080

*** Estimates for 2016 and 2017 are TSA projections.**

Table 3.4.15. Whiting in Division 6.a. Standard errors of TSA estimates for log mortality-at-age.

	Age						
Year	1	2	3	4	5	6	7+
1981	0.0130	0.0140	0.0237	0.0332	0.0332	0.0332	0.0332
1982	0.0168	0.0187	0.0295	0.0362	0.0362	0.0362	0.0362
1983	0.0287	0.0327	0.0493	0.0533	0.0533	0.0533	0.0533
1984	0.0373	0.0464	0.0622	0.0632	0.0632	0.0632	0.0632
1985	0.0410	0.0521	0.0688	0.0708	0.0708	0.0708	0.0708
1986	0.0335	0.0436	0.0557	0.0567	0.0567	0.0567	0.0567
1987	0.0416	0.0518	0.0640	0.0661	0.0661	0.0661	0.0661
1988	0.0479	0.0632	0.0696	0.0797	0.0797	0.0797	0.0797
1989	0.0433	0.0597	0.0655	0.0729	0.0729	0.0729	0.0729
1990	0.0333	0.0436	0.0516	0.0568	0.0568	0.0568	0.0568
1991	0.0336	0.0464	0.0515	0.0580	0.0580	0.0580	0.0580
1992	0.0323	0.0451	0.0513	0.0586	0.0586	0.0586	0.0586
1993	0.0335	0.0462	0.0541	0.0704	0.0704	0.0704	0.0704
1994	0.0309	0.0417	0.0502	0.0656	0.0656	0.0656	0.0656
1995	0.0375	0.0499	0.0593	0.0819	0.0819	0.0819	0.0819
1996	0.0518	0.0665	0.0770	0.1043	0.1043	0.1043	0.1043
1997	0.0613	0.0785	0.0855	0.1102	0.1102	0.1102	0.1102
1998	0.0701	0.0871	0.0900	0.1084	0.1084	0.1084	0.1084
1999	0.0839	0.1000	0.1014	0.1188	0.1188	0.1188	0.1188
2000	0.0843	0.0927	0.0945	0.1238	0.1238	0.1238	0.1238
2001	0.0802	0.0846	0.0870	0.1193	0.1193	0.1193	0.1193
2002	0.0651	0.0673	0.0673	0.0929	0.0929	0.0929	0.0929
2003	0.0749	0.0731	0.0712	0.0999	0.0999	0.0999	0.0999
2004	0.0926	0.0827	0.0884	0.1165	0.1165	0.1165	0.1165
2005	0.0906	0.0743	0.0838	0.1112	0.1112	0.1112	0.1112
2006	0.0718	0.0495	0.0489	0.0640	0.0640	0.0640	0.0640
2007	0.0644	0.0397	0.0389	0.0577	0.0577	0.0577	0.0577
2008	0.0732	0.0452	0.0411	0.0584	0.0584	0.0584	0.0584
2009	0.0697	0.0395	0.0374	0.0490	0.0490	0.0490	0.0490
2010	0.0557	0.0293	0.0285	0.0365	0.0365	0.0365	0.0365
2011	0.0383	0.0191	0.0188	0.0222	0.0222	0.0222	0.0222
2012	0.0373	0.0170	0.0183	0.0221	0.0221	0.0221	0.0221
2013	0.0305	0.0135	0.0148	0.0167	0.0167	0.0167	0.0167
2014	0.0250	0.0108	0.0124	0.0125	0.0125	0.0125	0.0125
2015	0.0245	0.0111	0.0135	0.0126	0.0126	0.0126	0.0126
2016*	0.0349	0.0164	0.0220	0.0271	0.0271	0.0271	0.0271
2017*	0.0421	0.0202	0.0281	0.0367	0.0367	0.0367	0.0367
GM(81–15)	0.0449	0.0424	0.0479	0.0582	0.0582	0.0582	0.0582

*** Estimates for 2016 and 2017 are standard errors of TSA projections of log F.**

Table 3.4.16. Whiting in Division 6.a. TSA summary table. "Obs." denotes sum-of-products of numbers and mean weights-at-age, not reported caught, landed and discarded weight.

Year	Landings (tonnes)			Discards (tonnes)			Total catches (tonnes)			Mean F(2-4)		SSB (tonnes)		TSB (tonnes)		Recruitment (000s at-age 1)	
	Obs.	Pred.	SE	Obs.	Pred.	SE	Obs.	Pred.	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
1981	12194	11395	1280	2132	4584	950	14325	15979	1466	0.224	0.020	134808	7490	169093	8436	199412	19833
1982	13880	12958	1421	5485	4391	924	19366	17349	1634	0.252	0.023	92228	4937	110102	5426	165965	17331
1983	15962	16715	1555	6294	5362	939	22257	22077	2025	0.417	0.035	63447	3537	93307	4860	197470	19031
1984	16459	14407	1311	4017	5132	949	20476	19539	1876	0.535	0.043	46310	2856	82120	4367	327360	26231
1985	12879	11417	1114	4840	7332	1257	17719	18749	1820	0.620	0.047	42559	2664	79246	4104	311455	23672
1986	8458	7897	844	2669	5432	918	11127	13329	1328	0.484	0.039	38534	2431	72663	3701	292148	21284
1987	11542	9976	996	11918	8182	1377	23460	18158	1789	0.583	0.045	41043	2390	78087	4097	405448	33264
1988	11349	10627	1011	8132	5581	1067	19481	16208	1509	0.681	0.052	41707	2498	50563	2884	107793	11260
1989	7523	6674	699	5876	6246	1065	13399	12920	1413	0.606	0.049	22949	1651	57183	3025	327864	21814
1990	5642	5241	560	4530	5018	912	10172	10259	1125	0.437	0.039	33896	2053	57985	3537	175330	18530
1991	6658	5717	552	4883	4040	739	11541	9756	1025	0.443	0.040	27710	1848	52180	3254	246749	23420
1992	6005	5622	524	9249	6143	1061	15253	11765	1281	0.428	0.040	30931	2137	69278	4353	338629	29039
1993	6872	6684	633	4759	7122	1181	11631	13807	1415	0.452	0.045	43908	3060	76940	5117	269148	24158
1994	5901	5931	564	3455	5250	816	9356	11180	1072	0.403	0.043	38773	3077	64934	4905	284536	26677
1995	6078	6873	1056	5771	5947	1052	11849	12821	1841	0.451	0.054	39057	3621	62158	5013	303509	25124
1996	7158	7903	1332	7940	7736	1450	15098	15639	2468	0.563	0.071	42712	3777	61486	5264	191840	20562
1997	6290	8047	1228	5251	7081	1366	11542	15128	2293	0.623	0.078	34061	3252	54478	5402	177171	23553
1998	4627	5932	961	9216	7978	1629	13843	13910	2317	0.699	0.080	24199	3081	47505	5849	233525	33294
1999	4613	5186	991	3975	6918	1530	8588	12103	2277	0.845	0.088	21983	3424	36956	5441	168645	28334
2000	3011	3732	833	13285	7302	1710	16296	11035	2324	0.818	0.085	16493	3008	36241	5642	261927	41694
2001	2439	3261	695	4263	5650	1325	6702	8911	1853	0.735	0.080	18586	3132	29568	4523	109882	17096
2002	1767	2534	595	2851	2077	563	4618	4611	1069	0.534	0.063	13282	2240	16390	2751	42134	9116
2003	1355	1992	467	719	1808	518	2074	3800	910	0.565	0.068	8163	1437	13571	2266	64743	11848
2004	811	1177	286	2159	1671	520	2970	2848	759	0.597	0.083	5905	1081	9403	1607	40492	7470
2005	341	721	179	629	876	257	970	1597	409	0.493	0.080	3841	589	5962	791	23850	3382

Table 3.4.16. (Continued).

Year	Landings (tonnes)			Discards (tonnes)			Total catches (tonnes)			Mean F(2-4)		SSB (tonnes)		TSB (tonnes)		Recruitment (000s at-age 1)	
	Obs.	Pred.	SE	Obs.	Pred.	SE	Obs.	Pred.	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
2006	380	551	55	946	629	112	1327	1180	142	0.412	0.041	3491	246	4818	303	27953	2511
2007	427	442	39	317	429	78	745	870	98	0.323	0.035	3454	206	4691	282	14785	1734
2008	445	424	40	314	516	94	759	940	114	0.355	0.037	3050	217	4342	285	16907	1590
2009	488	407	40	419	481	87	908	887	109	0.300	0.032	3499	273	4882	336	25932	2050
2010	307	301	32	893	537	101	1200	838	116	0.218	0.024	2889	223	5389	392	64382	5957
2011	230	251	27	339	302	56	569	553	70	0.132	0.016	6235	538	6842	573	20197	1852
2012	313	291	32	727	450	86	1039	741	98	0.114	0.016	6158	550	8680	809	44057	5992
2013	222	252	27	951	277	51	1173	529	64	0.082	0.012	7558	838	8546	936	23949	3609
2014	184	220	22	583	304	67	767	524	77	0.061	0.010	7649	922	10898	1388	65998	12180
2015	227	231	24	835	581	136	1063	812	145	0.057	0.010	10020	1504	17881	2271	105780	14101
2016*	NA	304	89	NA	571	206	NA	876	278	0.060	0.020	16247	2176	21076	3175	87905	29413
2017*	NA	442	175	NA	848	391	NA	1290	538	0.062	0.027	18915	3549	27614	5296	158379	56283
Min	184	220		314	277		569	524		0.057		2889	206	4342	282	14785	1590
GM	2345	2529		2449	2423		5182	5091		0.372		17311	1542	27514	2265	108382	12080
AM	5230	5200		4018	3982		9248	9181		0.444		28031	2194	44696	3263	162199	16817
Max	16459	16715		13285	8182		23460	22077		0.845		134808	7490	169093	8436	405448	41694

*** Estimates for 2016 and 2017 are TSA projections.**

Table 3.4.17. Whiting in Division 6.a. Inputs to short-term predictions from TSA run. Mean weights assumed from final three years.

```
Whiting 6.a
input data for catch forecast and linear sensitivity analysis

Label     Value     CV     Label     Value     CV

Number at age              Weight in the stock
N1        87905   0.33     WS1        0.05   0.31
N2        43421   0.14     WS2        0.21   0.04
N3        13519   0.20     WS3        0.29   0.14
N4         2528   0.17     WS4        0.42   0.04
N5         2391   0.17     WS5        0.50   0.05
N6          585   0.12     WS6        0.58   0.02
N7         1124   0.14     WS7        0.67   0.07

H.cons selectivity         Weight in the HC catch
sH1        0.00   0.19     WH1        0.24   0.21
sH2        0.01   1.14     WH2        0.30   0.16
sH3        0.02   0.62     WH3        0.39   0.12
sH4        0.06   0.22     WH4        0.46   0.03
sH5        0.07   0.22     WH5        0.53   0.03
sH6        0.07   0.22     WH6        0.63   0.05
sH7        0.08   0.22     WH7        0.68   0.08

Discard selectivity        Weight in the discards
sD1        0.09   0.19     WD1        0.05   0.31
sD2        0.04   1.14     WD2        0.19   0.11
sD3        0.04   0.62     WD3        0.25   0.11
sD4        0.04   0.22     WD4        0.36   0.02
sD5        0.02   0.22     WD5        0.38   0.16
sD6        0.02   0.22     WD6        0.39   0.21
sD7        0.01   0.22     WD7        0.39   1.02

Natural mortality          Proportion mature
M1         0.81   0.10     MT1        0.00   0.10
M2         0.65   0.10     MT2        1.00   0.10
M3         0.58   0.10     MT3        1.00   0.00
M4         0.54   0.10     MT4        1.00   0.00
M5         0.51   0.10     MT5        1.00   0.00
M6         0.50   0.10     MT6        1.00   0.00
M7         0.48   0.10     MT7        1.00   0.00

Relative effort            Year effect for natural mortality
in HC fishery
HF16       1.00   0.05     K16        1.00   0.10
HF17       1.00   0.05     K17        1.00   0.10
HF18       1.00   0.05     K18        1.00   0.10

Recruitment in 2017 and 2018
R17       33415   0.73
R18       33415   0.73

Proportion of F before spawning = .00
Proportion of M before spawning = .00

Stock numbers in 2016 are TSA survivors.,,,
```

Table 3.4.18. Whiting in Division 6.a. Results of short-term forecasts from TSA run. Management options and detailed tables.

Whiting 6.a

Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2016	2017						
Mean F Ages 2 to 4								
H.cons	0.07	0.00	0.01	0.03	0.04	0.05	0.07	0.08
Effort relative to 2015								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Biomass								
Total 1 January	21.1	20.6	20.6	20.6	20.6	20.6	20.6	20.6
SSB at spawning time	16.2	18.7	18.7	18.7	18.7	18.7	18.7	18.7
Catch weight (,000t)								
H.cons	0.357	0.000	0.098	0.194	0.289	0.383	0.476	0.567
Discards	0.649	0.000	0.108	0.215	0.320	0.424	0.527	0.629
Total Catch	1.006	0.000	0.206	0.409	0.609	0.807	1.003	1.196
Biomass in year.... 2018								
Total 1 January		18.9	18.7	18.4	18.2	18.0	17.8	17.6
SSB at spawning time		17.1	16.8	16.6	16.4	16.2	15.9	15.7

	Year 2016	2017						
Effort relative to 2015								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.13	0.17	0.17	0.17	0.17	0.17	0.17	0.17
SSB at spawning time	0.12	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Catch weight								
H.cons	0.31	0.00	0.36	0.30	0.29	0.29	0.28	0.28
Discards	0.45	0.00	0.52	0.48	0.47	0.47	0.47	0.47
Biomass in year.... 2018								
Total 1 January		0.21	0.21	0.21	0.21	0.21	0.21	0.21
SSB at spawning time		0.21	0.21	0.21	0.21	0.21	0.21	0.21

Detailed forecast tables.

Forecast for year 2016
F multiplier H.cons=1.00

Populations		Catch number		
Age	Stock No.	H.Cons	Discards	Total
1	87905	8	5347	5355
2	43421	249	1167	1416
3	13519	247	386	632
4	2528	106	66	172
5	2391	130	35	165
6	585	32	9	41
7	1124	67	11	79
Wt	21	0	1	1

Forecast for year 2017
F multiplier H.cons=1.00

Populations		Catch number		
Age	Stock No.	H.Cons	Discards	Total
1	33415	3	2033	2035
2	35532	204	955	1159
3	21731	397	620	1016
4	7089	296	186	483
5	1344	73	20	93
6	1308	71	20	91
7	960	58	10	67
Wt	21	0	1	1

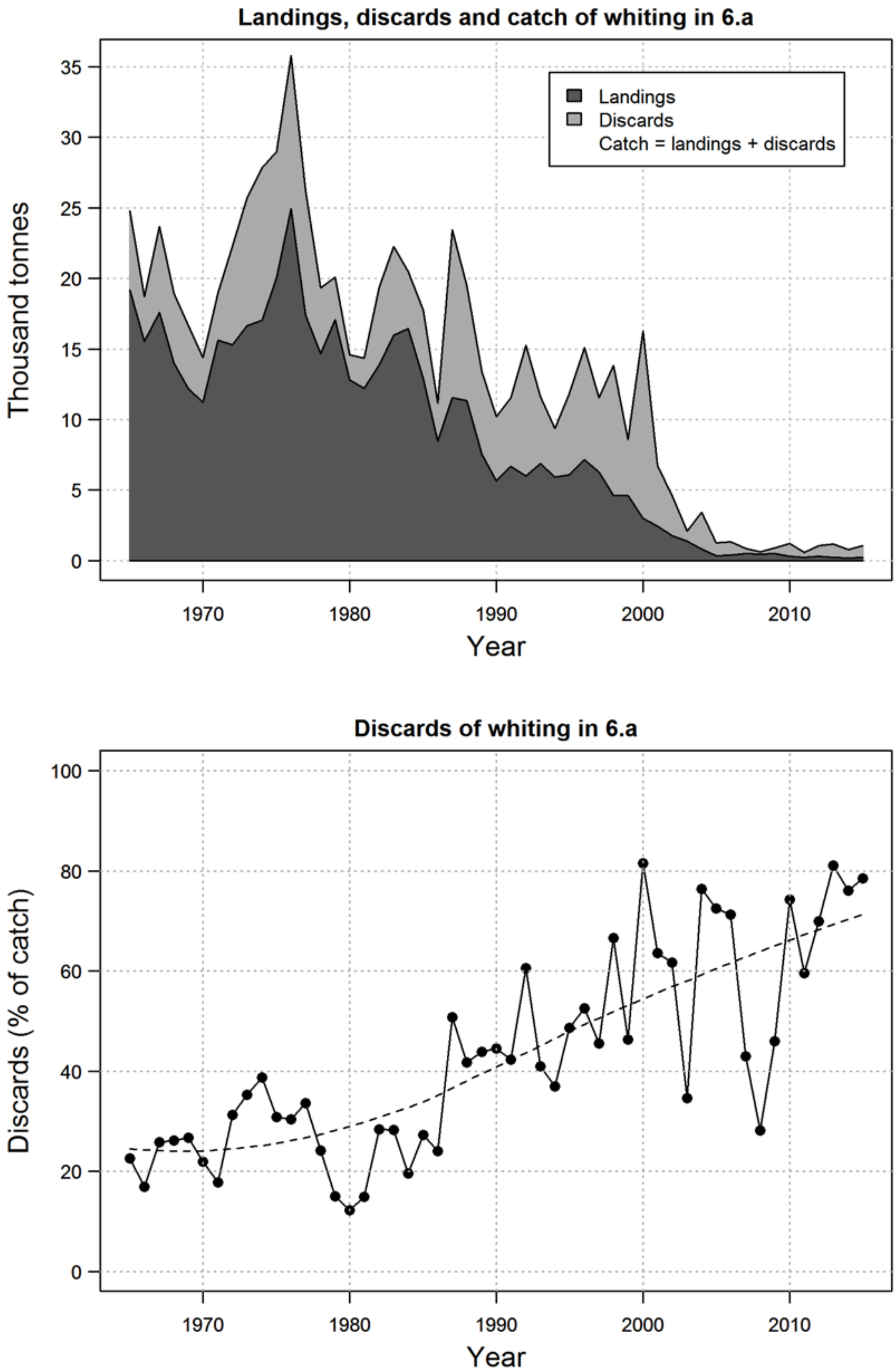


Figure 3.4.1. Whiting in Division 6.a. Landings, discards and catch (in tonnes, whiting at-age 1 and older) as officially reported to ICES (upper panel) and discards (as % of catch, lower panel).

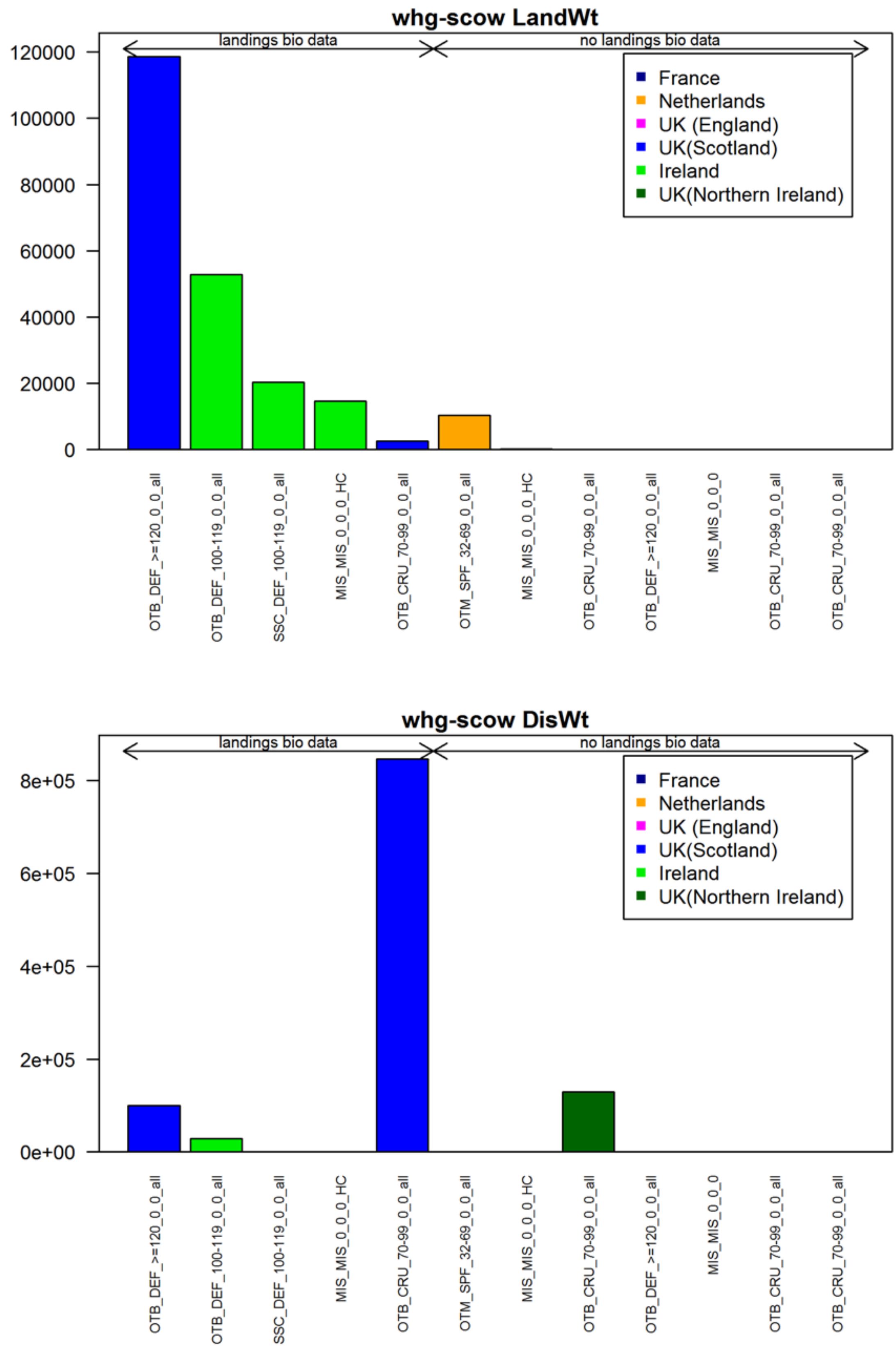


Figure 3.4.2. Whiting in Division 6.a. Landings (upper panel) and discards (all ages, lower panel) by métier (kg) in 2015 as entered into InterCatch.

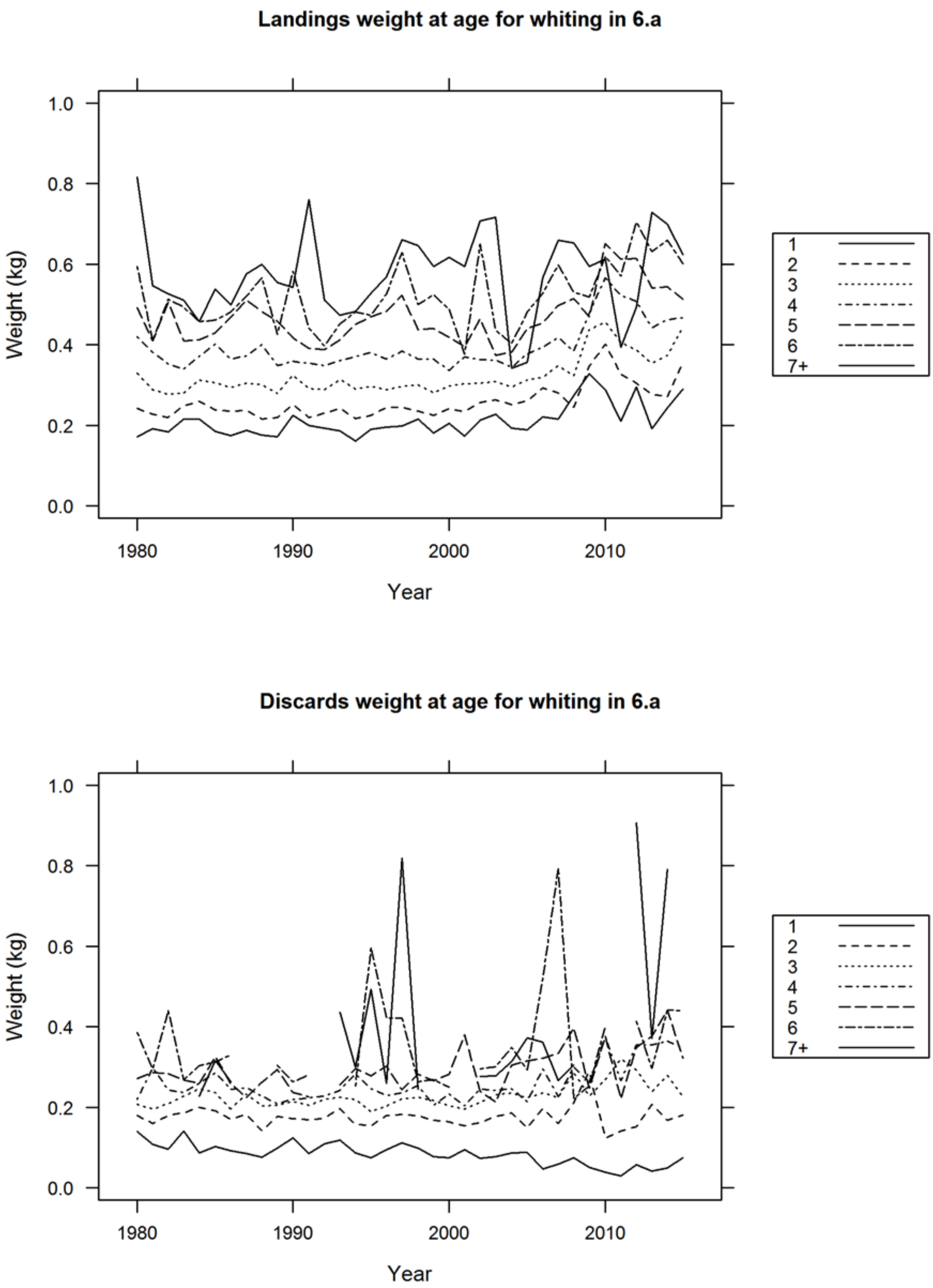


Figure 3.4.3. Whiting in Division 6.a. Mean weight-at-age in the landings (upper panel) and discards (lower panel).

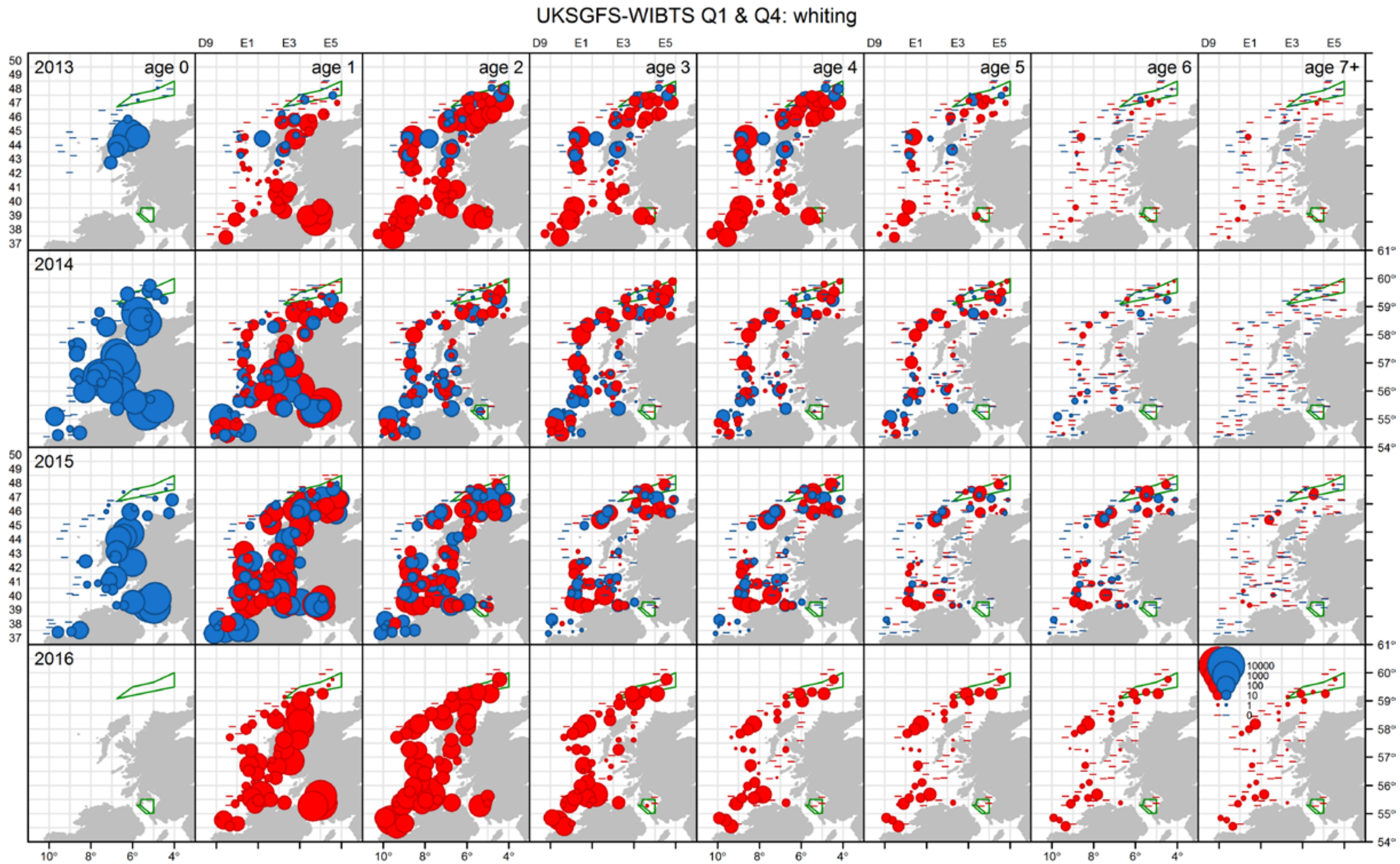


Figure 3.4.4. Whiting in Division 6.a. The catch of whiting per unit of effort during the Scottish first quarter west coast groundfish survey (UKSGFS-WIBTS-Q1, in red) and the Scottish fourth quarter groundfish survey (UKSGFS-WIBTS-Q4, in blue) in 2013–2016. Each circle is centred on the sample location and the size of the circle is proportional to the log number density (n/30 min fished), according to the legend. Two closed areas (the Windsock in the north and the Clyde in the south) are shown as green polygons.

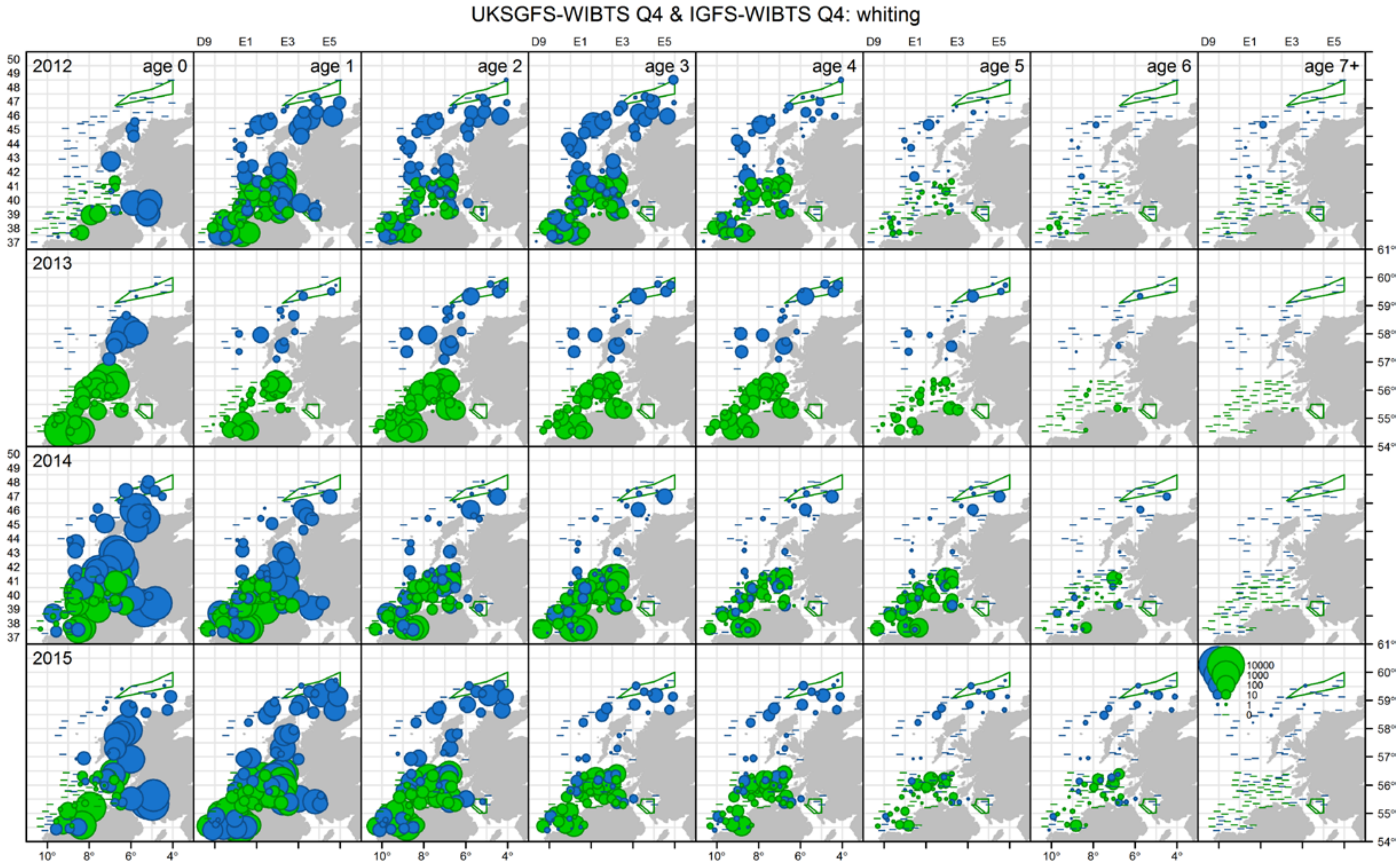


Figure 3.4.5. Whiting in Division 6.a. The catch of whiting per unit of effort during the Scottish fourth quarter west coast groundfish survey (UKSGFS-WIBTS-Q4, in blue) and the Irish fourth quarter groundfish survey (IGFS-WIBTS-Q4, in green) in 2012–2015. Each circle is centred on the sample location and the size of the circle is proportional to the log number density (n/30 min fished), according to the legend. Two closed areas (the Windsock in the north and the Clyde in the south) are shown as green polygons.

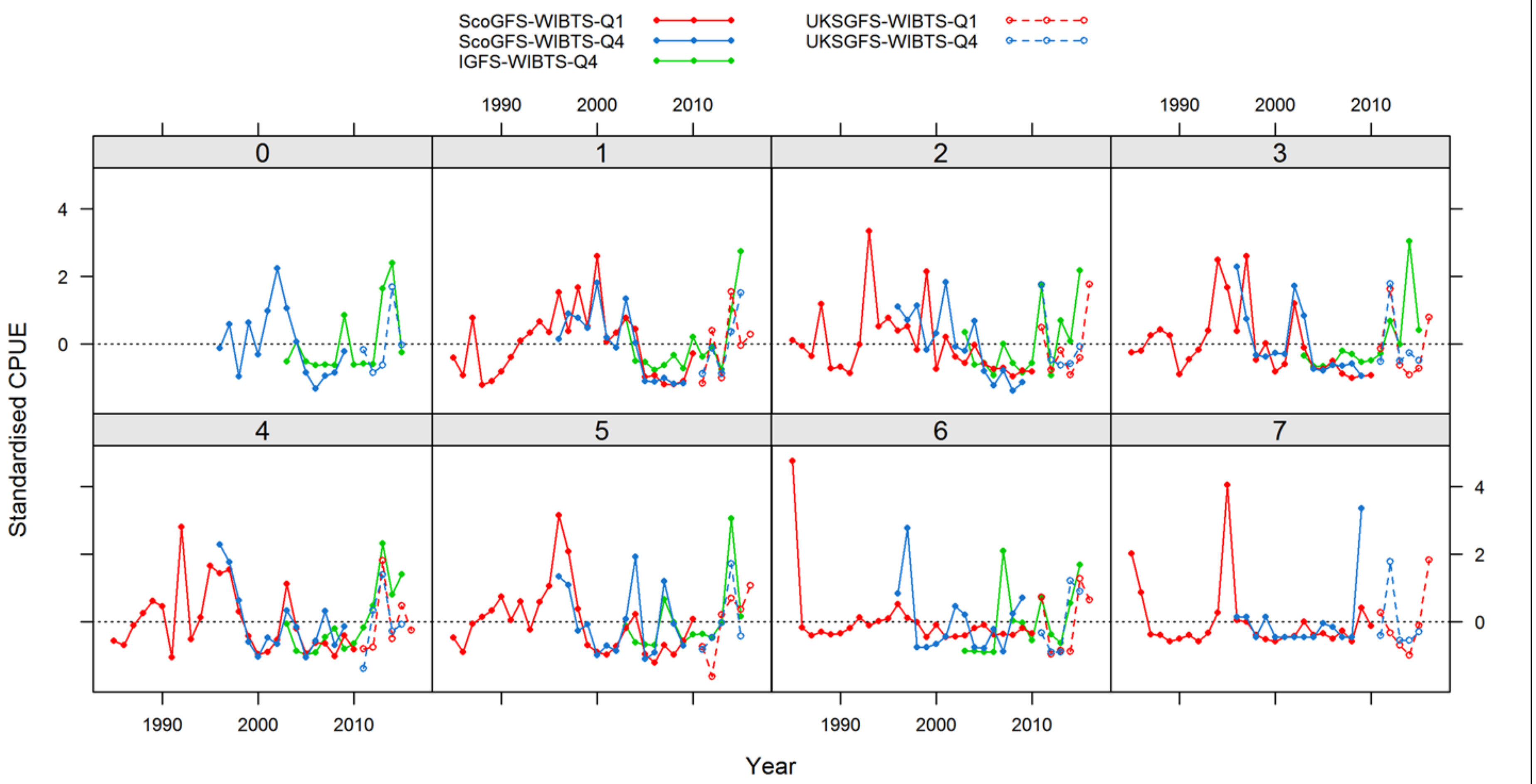


Figure 3.4.6. Whiting in Division 6.a. Scaled survey indices from ScoGFS-WIBTS-Q1, ScoGFS-WIBTS-Q4, IGFS-WIBTS-Q4, UKSGFS-WIBTS-Q1 and UKSGFS-WIBTS-Q4. The abundance index for IGFS-WIBTS-Q4 is shown only for ages 0–6.

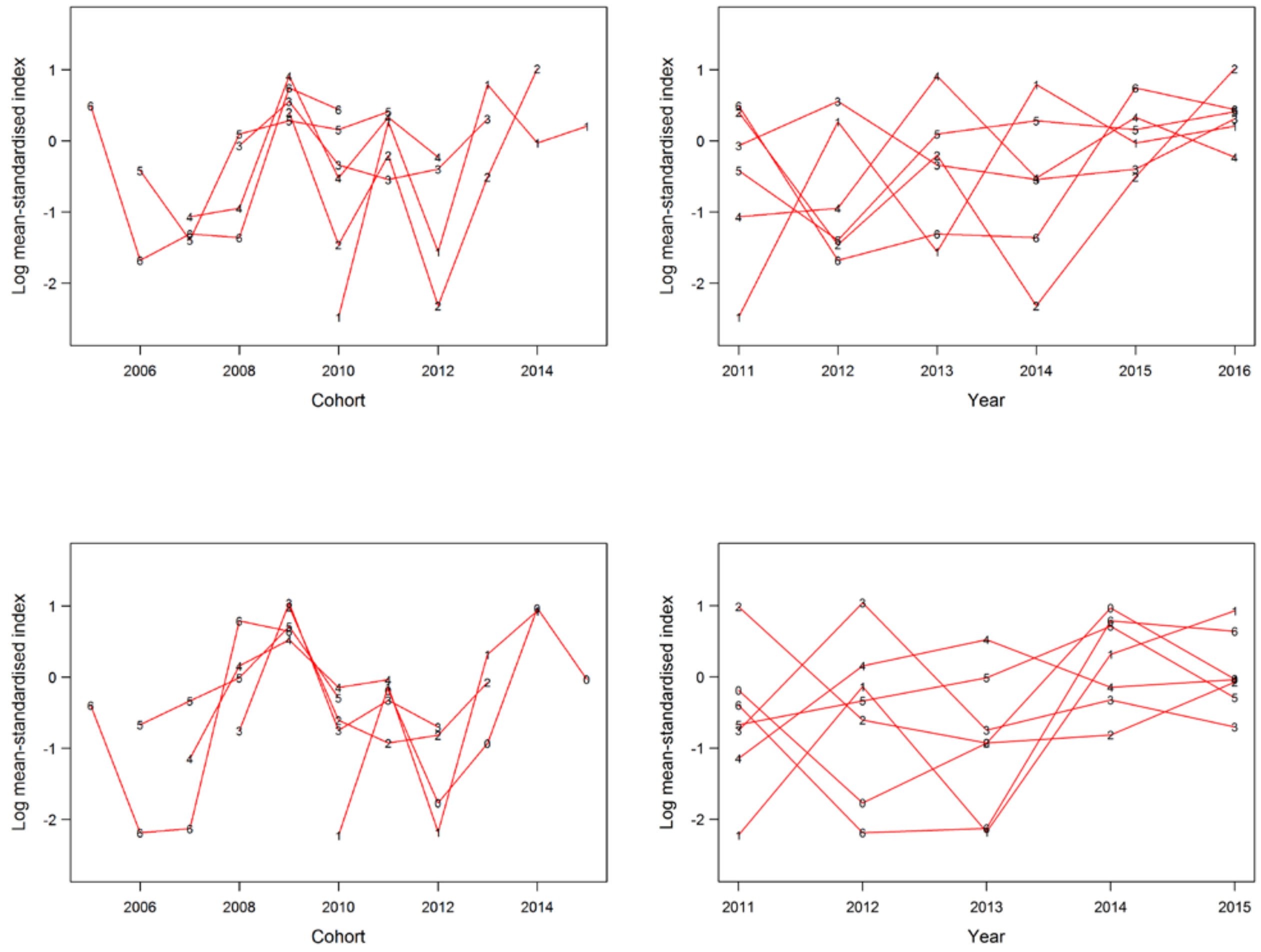


Figure 3.4.7. Whiting in Division 6.a. Log mean standardised survey index for each age by cohort (two left panels) and year (two right panels) in UKSGFS-WIBTS-Q1 and UKSGFS-WIBTS-Q4, respectively.

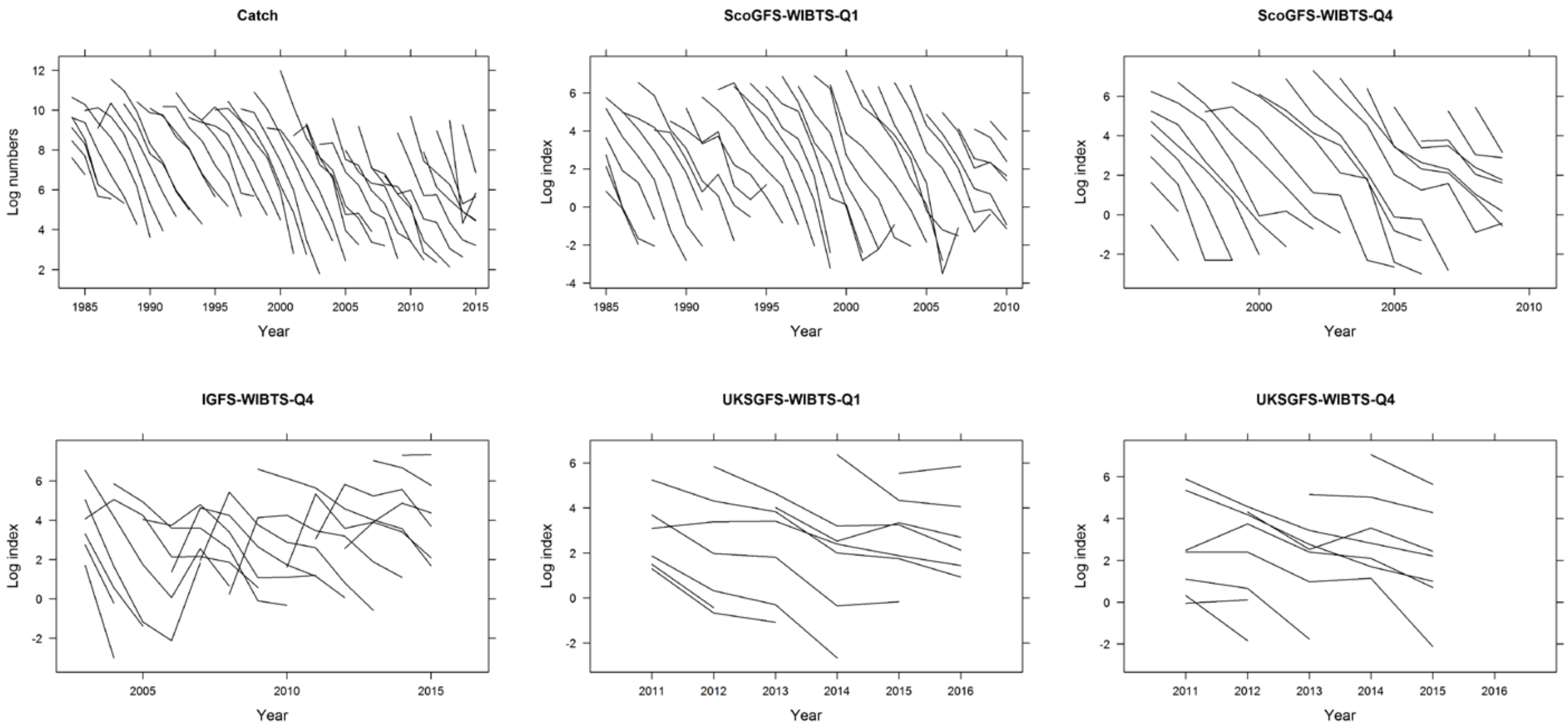


Figure 3.4.8. Whiting in Division 6.a. Log catch curves from the catch (ages 1–7) and from the five survey series (ages as specified in Table 3.4.9).

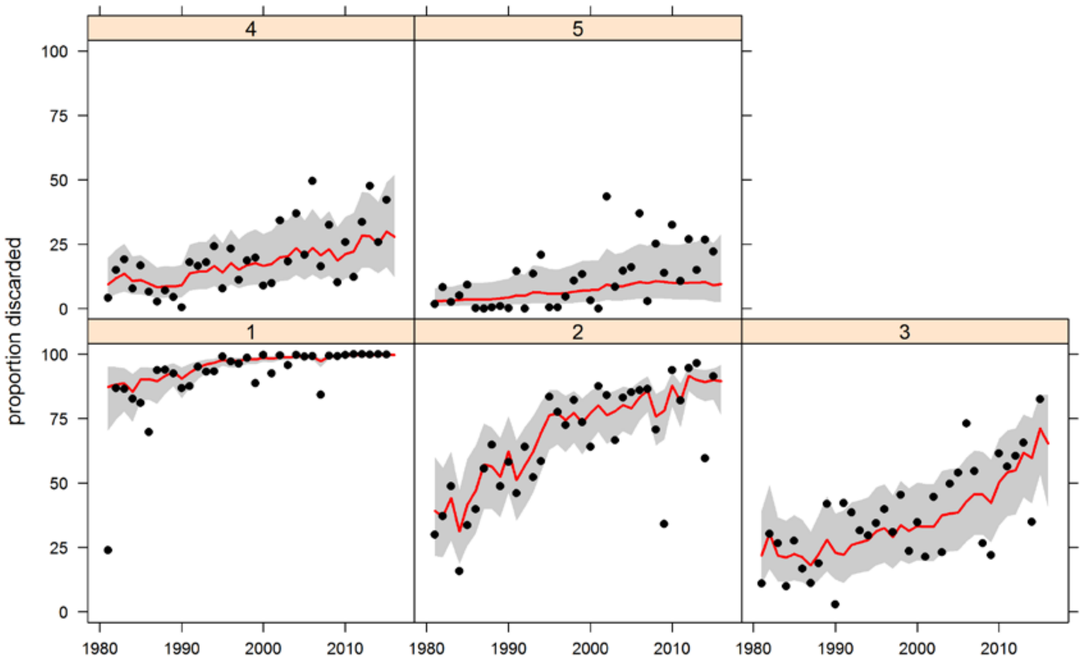


Figure 3.4.9. Whiting in Division 6.a. Proportion discarded at-age from the final TSA run.

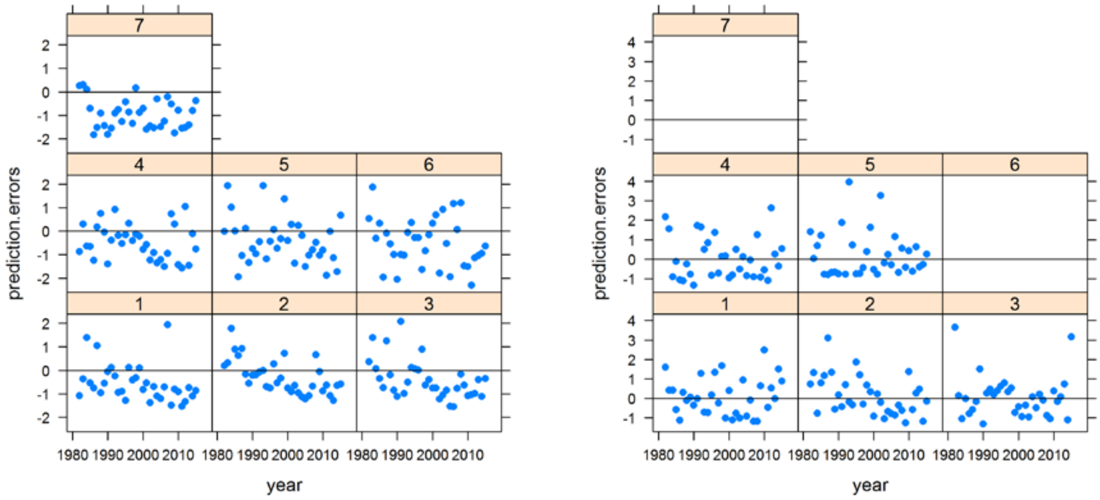


Figure 3.4.10. Whiting in Division 6.a. Standardised landings (left panel) and discards (right panel) prediction errors from the final TSA run.

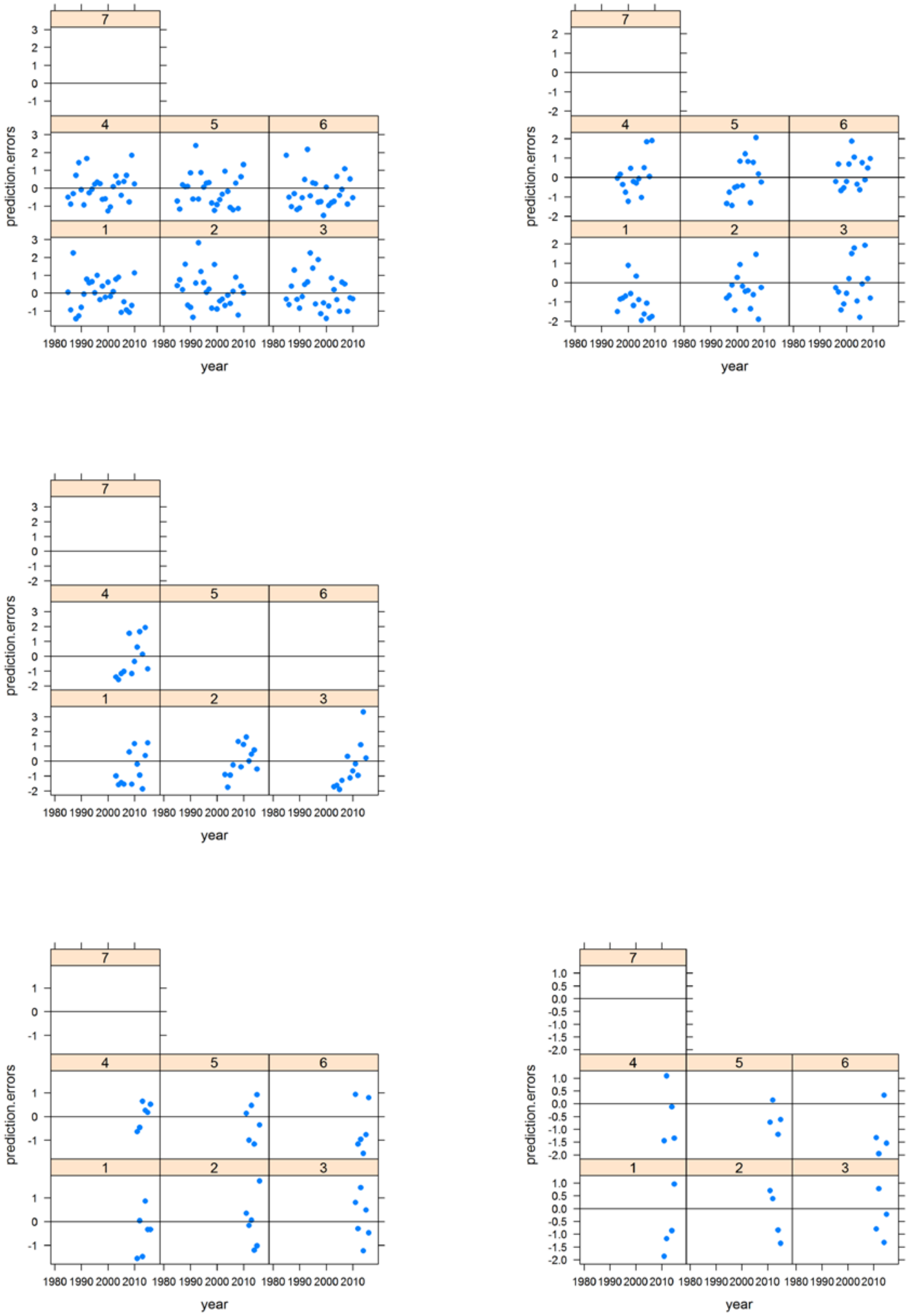


Figure 3.4.11. Whiting in Division 6.a. Standardised survey errors from TSA in ScoGFS-WIBTS-Q1 (top left panel), ScoGFS-WIBTS-Q4 (top left panel), IGFS-WIBTS-Q4 (middle panel), UKSGFS-WIBTS-Q1 (bottom left panel) and UKSGFS-WIBTS-Q4 (bottom right panel), from the final TSA run.

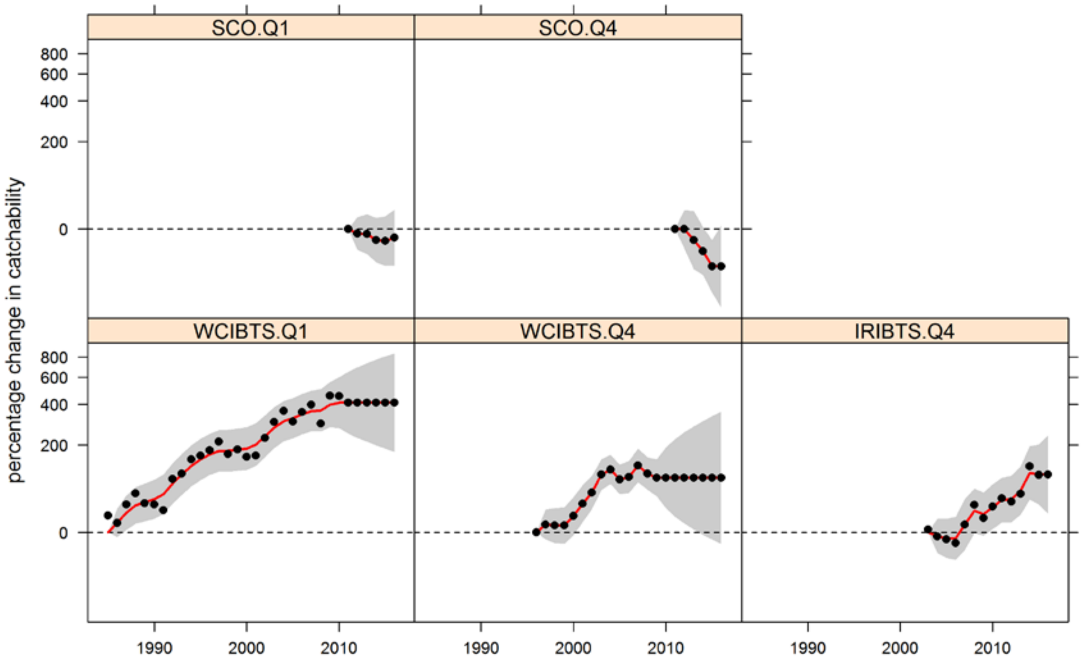


Figure 3.4.12. Whiting in Division 6.a. Percentage change in catchability from the final TSA run. Transient changes (points) and the persistent change (solid line) with uncertainty bounds.

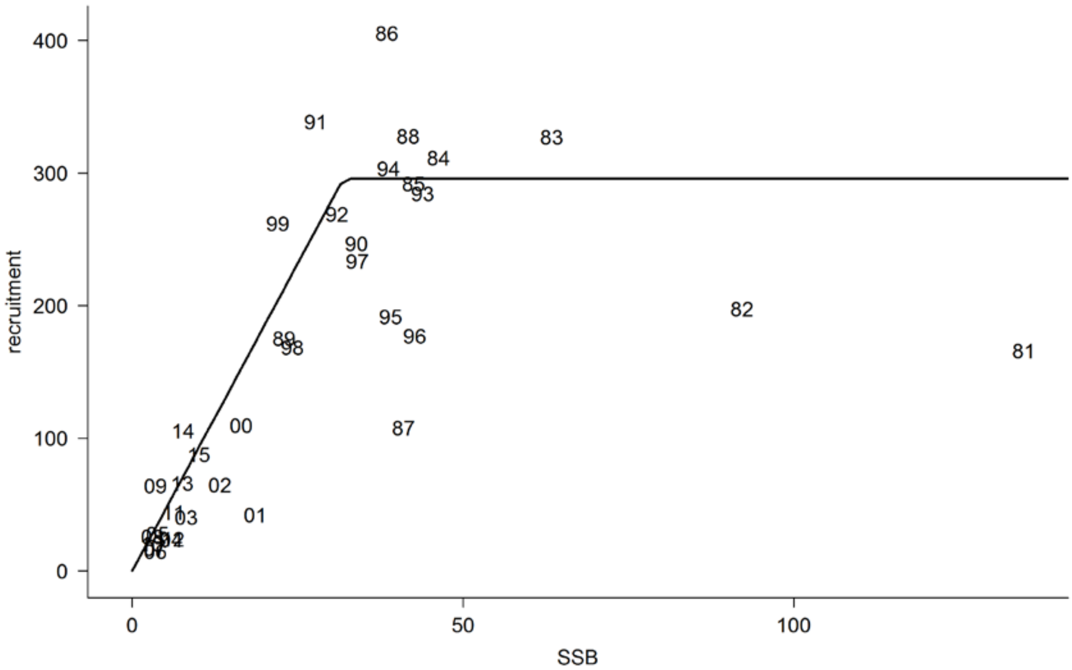


Figure 3.4.13. Whiting in Division 6.a. Stock–recruitment relationship (recruitment in millions, SSB in thousand tonnes) from the final TSA run, with points labelled as year classes, and fitted with a segmented-regression model ("hockey-stick", solid line).

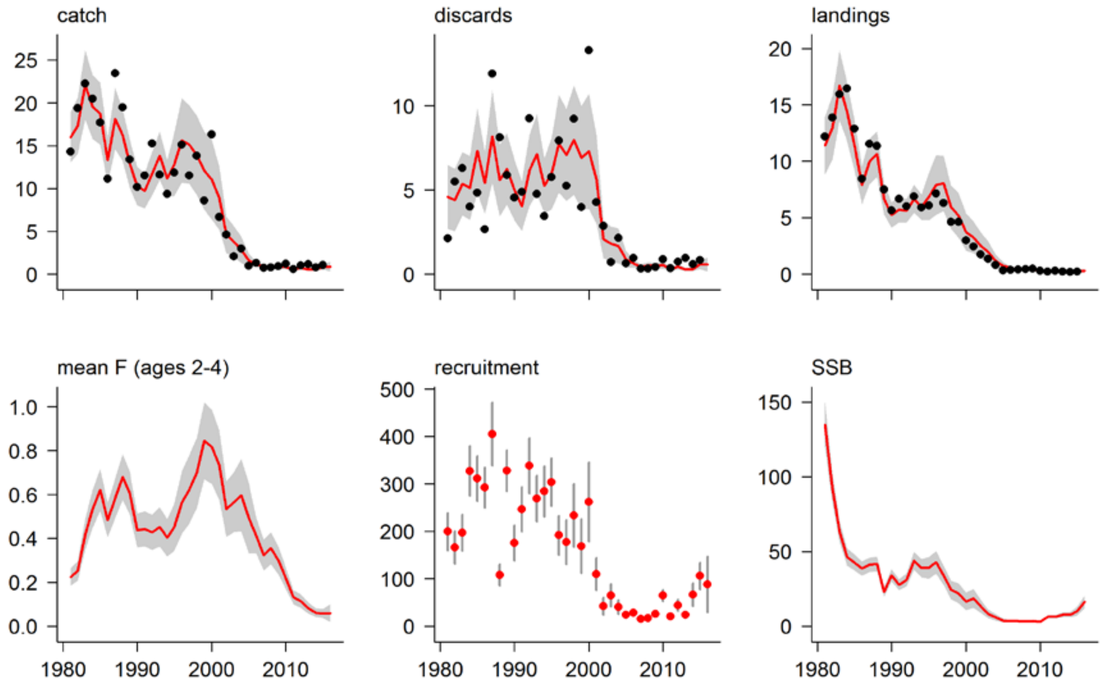


Figure 3.4.14. Whiting in Division 6.a. TSA stock summaries from the final TSA run. Catch, landings, discards and SSB in tonnes, recruitment in thousands. Estimates are plotted with approximate pointwise 95% confidence bounds. Dots indicate observed values for catch, landings and discards.

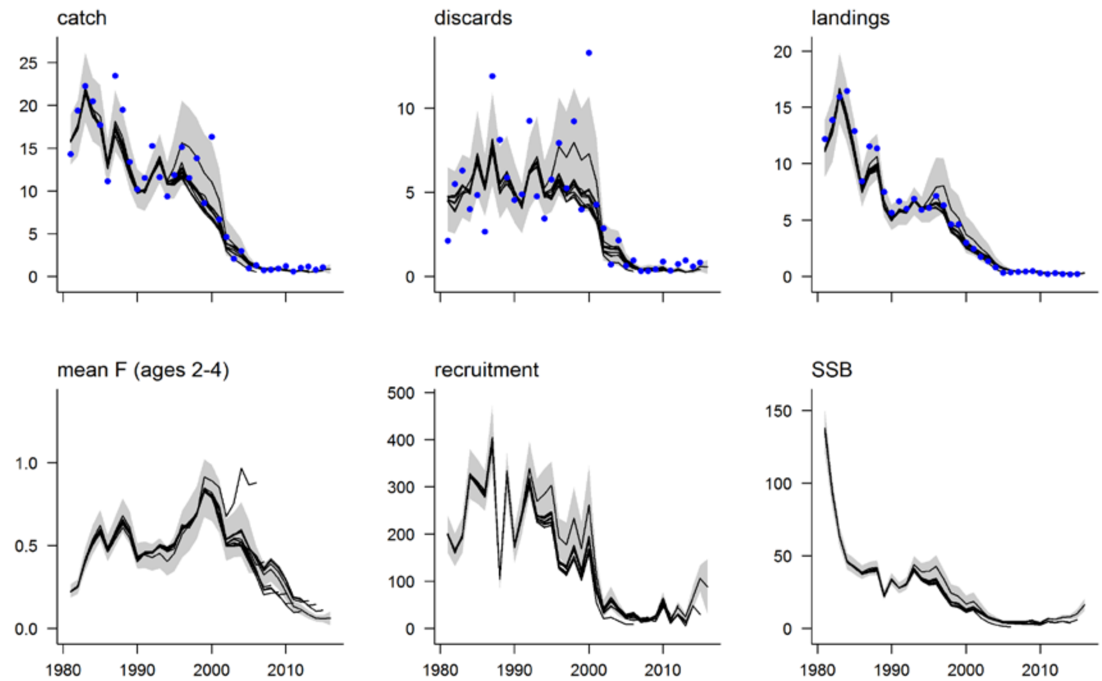


Figure 3.4.15. Whiting in Division 6.a. Retrospective plots of TSA run. Catch, landings, discards and SSB in tonnes, recruitment in thousands. Blue points show observed values, black lines show estimates in the respective years, grey bands show confidence intervals for the last estimate.

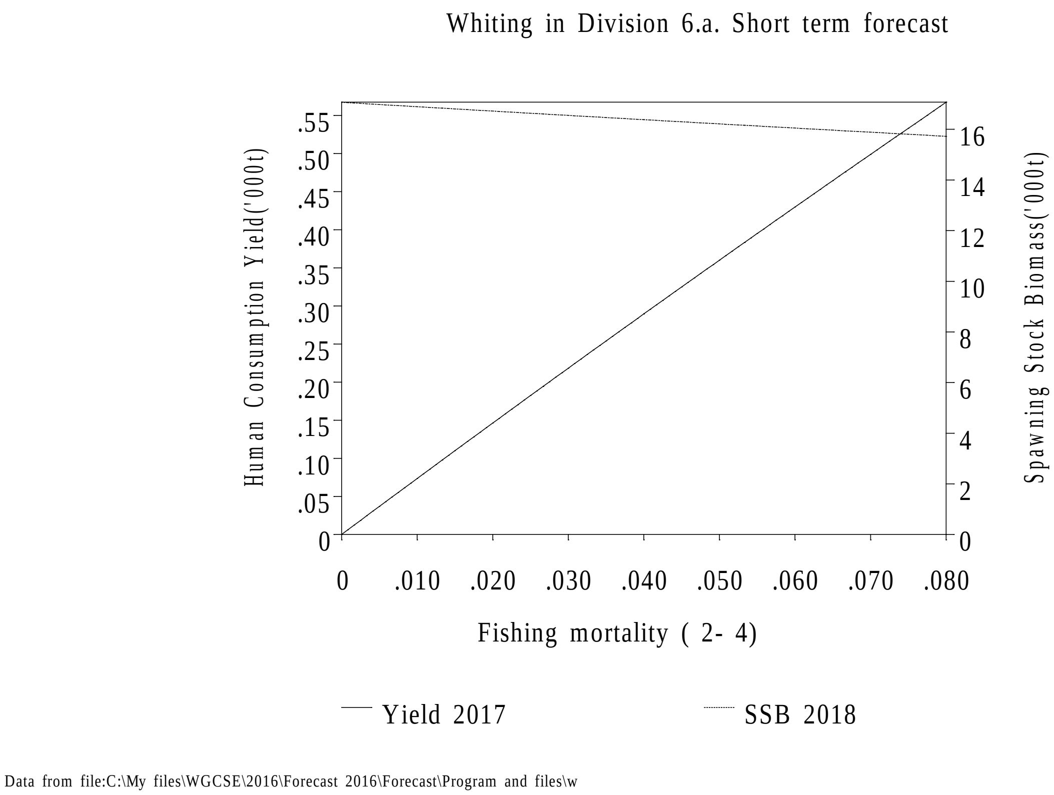


Figure 3.4.16. Whiting in Division 6.a. Short-term forecast.

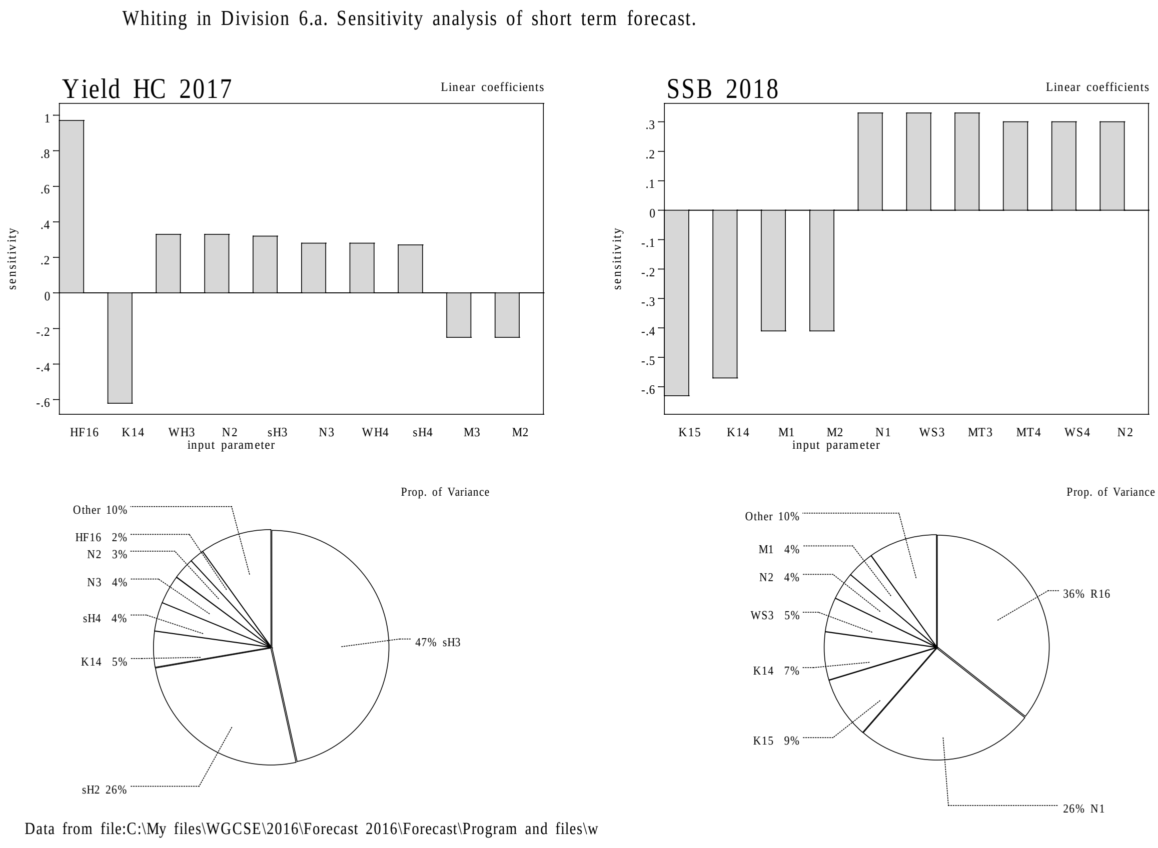


Figure 3.4.17. Whiting in Division 6.a. Sensitivity analysis of short-term forecast.

3.5 North Minch, FU11

Nephrops stocks have previously been identified by WGNEPH on the basis of population distribution, and defined as separate Functional Units. The Functional Units (FU) in ICES Division 6.a (of which there are three) are defined by the groupings of ICES statistical rectangles given in Table 3.5.1 and illustrated in Figure 3.5.1. The functional unit is the level at which the WG collates fishery data (quantities landed and discarded, fishing effort and length distributions) and at which it performs assessments.

Type of assessment in 2016

The assessment of North Minch *Nephrops* in 2016 is based on a combination of examining trends in fishery indicators and abundance estimated by underwater TV survey, both of which comprise an extensive dataseries for this FU. The assessment follows the process defined by the benchmark WG (WKNEPH 2009 and WKNEPH 2013). Further details on the assessment and catch options are provided in the stock annex.

ICES advice applicable to 2015

'ICES advises, on the basis of the MSY approach and considering that no discards ban is in place in 2015, that landings should be no more than 3092 t. Assuming that discard rates do not change from the average of the last three years (2011–2013) the resulting catch would be no more than 3312 t.'

ICES advice applicable to 2016

'ICES advises that when the MSY approach is applied, catches in 2016 (assuming zero discards) should be no more than 3770 tonnes. If instead discard rates continue at recent values (average of 2012–2014) and there is no change in assumed discard survival rate, this implies landings of no more than 3677 tonnes.'

To ensure that the stock in functional unit (FU) 11 is exploited sustainably, management should be implemented at the functional unit level.

3.5.1 General

Nominal landings as reported to ICES for Divisions 6.a and 6.b are presented in Table 3.5.2. Total official landings from Division 6.a were 11 728 tonnes, mostly reported by the UK with only 75 tonnes reported from Ireland. Table 3.5.3 shows WG estimates of landings in Division 6.a broken down by FU. *Nephrops* landings are also made from outside the functional units, from statistical rectangles where small pockets of suitable sediment exist, although these are generally small amounts. Over the time-series, average landings have been just over 250 t have been reported and landings were slightly higher in 2015 at 308 t (Table 3.5.3). The main areas of activity outside FUs are the Stanton Bank (to the west of the South Minch) and areas of suitable sediment along the shelf edge and slope to the west of the Hebrides. There are no functional units in Division 6.b and only very small quantities of *Nephrops* are landed. In 2015, no *Nephrops* were landed from this division.

Stock description and management units

The North Minch (FU11) is located at the northern end of the west coast of Scotland (Figure 3.5.1). Owing to its burrowing behaviour, the distribution of *Nephrops* is restricted to areas of mud, sandy mud and muddy sand. Within the North Minch functional unit these substrates are distributed according to prevailing hydrographic and bathymetric conditions. The area is characterised by numerous islands of varying size and sea lochs occur along the mainland coast. These topographical features create a diverse habitat with complex hydrography and a patchy distribution of soft sediments. Results from recent work on mapping the spatial extent of *Nephrops* habitat in the North Minch sea lochs indicate that the muddy habitat is only a very small proportion of the total *Nephrops* grounds (WKNEPH 2013).

Management applicable to 2015 and 2016

The management unit is Subarea 6 and EU and international waters of 5.b. The TAC for this area is 16 524 tonnes (increased from 14 190 tonnes in 2015) in 2016.

From 2016, fisheries catching *Nephrops* in Division 6.a are covered by the EU landings obligation (EU, 2015). Creel fisheries are exempted from the landings obligation, with a *de minimis* exemption consisting of a 7% discard rate by weight for the trawl fishery in 2016 and 2017.

Ecosystem aspects

Details of the ecosystem aspects for this functional unit are provided in the stock annex if available.

Fishery description

Information on developments in the fishery was provided by Marine Scotland staff, including fishery officers and scientists sampling in the ports and on-board vessels.

The fishery in 2015 was described as similar to 2014, with poor fishing during the winter months and vessels forced to tie up. A number of the larger vessels targeted whitefish throughout the year and did not fish for *Nephrops*. Prices for *Nephrops* were higher than 2014 and the lower cost of fuel meant improved profit margins for the fleet. The influx of the east coast vessels into the North Minch during the second quarter continued and locals express concerns regarding the large quantities of *Nephrops* and fish that these vessels catch.

The largest part of the North Minch fleet is based at Stornoway and made up of mostly 15 m length vessels. The Barra vessels are generally bigger than the Stornoway fleet, and are all over 15 m in length. The Barra fleet is more nomadic as the fishing grounds are exposed, which forces the fleet to find shelter on the east side of the North Minch. The majority of vessels are now twin rigging, using 80 mm mesh. In Barra, most trawlers land daily or every second day. Local fleets, mainly formed by smaller trawlers, also operate from ports of Lochinver, Ullapool and Gairloch and typically work 1–4 day trips.

Since 2009, vessels have been required to fit 120 mm square meshed panels, in accordance with the west coast emergency measures (Council Reg. (EU) 43/2009). Large SMPs (200 mm) are also widely used in the North Minch and are mandatory for all TR2 vessels with power >112 kW fishing under the Scottish Conservation Credits scheme. Little if any marketable fish bycatch was landed by the boats fishing in the North Minch, however estimates of discard rates of haddock and whiting remain high.

Further general information on the fishery can be found in the stock annex.

3.5.2 Data available

InterCatch

Data for 2015 were successfully uploaded into InterCatch prior to the 2016 WG meeting according with the deadline proposed. Uploaded data were worked up in InterCatch to generate 2015 raised international length–frequency distributions. Allocation schemes for any unsampled fleets are described in the stock annex. Data exploration in InterCatch has previously shown that outputs of raised data were very close to those generated by the previous method applied internally with differences being <0.1%. As such, InterCatch length–frequency outputs have been used in the stock assessment since 2012.

Commercial catch

Official catch statistics (landings) reported to ICES are shown in Tables 3.5.2(a) and 3.5.2(b); these relate to the whole of 6.a of which the North Minch is a part. Landings by gear category for FU11 provided by country are presented in Table 3.5.5. Landings from this fishery are usually only reported from Scotland but in 2012–2014, 2 tonnes of *Nephrops* were reported by Ireland. Total reported Scottish landings in 2015 were 2995 tonnes, consisting of 2578 tonnes landed by trawlers (86%) and 417 tonnes landed by creel vessels (14%). There was a revision to the provisional 2014 landings of 20 tonnes.

Effort data

In 2015 WGCSE agreed that effort should be reported in Kw days as this is likely to be more informative about changes in the actual fleet effort. Reported effort by all Scottish trawlers has shown a decreasing trend since 2000 (Figure 3.5.3) but in 2012 the effort increased by 20% due to the influx of vessels from the North Sea during the first quarter of the year. Effort was lower in 2013 and remained at a similar level in 2014 but fell in 2015. Note that the effort time-series (2000–2015) does not match with the more extensive year range available for landings, due to a lack of reliable effort data in the MSS in-house database.

Sampling levels

Length compositions of landings and discards are obtained during market and on-board observer sampling respectively. These sampling levels are shown in Table 3.5.4. Length compositions for the creel fishery are available for landings only as the small numbers of discards survive well and are not considered to be removed from the population. Sampling for this FU is considered to be adequate.

Length compositions

Figure 3.5.5 shows a series of annual length–frequency distributions for the period 2000 to 2015. Catch (removals) length compositions are shown for each sex along with the mean length for both. In both sexes the mean sizes fluctuate over time with evidence of a gradual increase in the mean lengths for both males and females. This parameter might be expected to reduce in size if overexploitation were taking place.

Sex ratio

Males consistently make the largest contribution to the landings, although the proportion of males does seem to vary between years (Figure 3.5.4(a)). 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.* This occurs because males are available throughout the year and the fishery is prosecuted in all quarters (although effort is reduced during the winter months when the weather is poor). Females on the other hand are mainly taken in the summer when they emerge after egg hatching. The seasonal change in proportion of males to females is evident in Figure 3.5.4(b) where males dominate in quarters one and four but the ratio is more even (or often female dominated) in quarters two and three.

Mean weights

The mean weight in the landings (trawls and creels combined) shows substantial interannual variation (Figure 3.5.6 and Table 3.5.8) increasing between 2008–2010 followed by a decrease between 2010–2012 and increasing 2013–2015. Given the relatively larger size of creel caught *Nephrops* (compared to trawl) the proportion of creel landings has a substantial effect on overall size composition and the increases to 2010 in particular are due to a higher proportion of creel landings. Figure 3.5.7 shows the mean weight by sample over the period 2009–2015. There has been a gradual increase in mean weight in the landings for North Minch trawl caught *Nephrops* over this period, and a slight decrease in mean weight for creel caught males. The mean weight in the landings has a significant impact on the catch forecast. Due to the high interannual variability in mean weights it was considered more appropriate to use a full-time series average, from 1999 (first year with creel and trawl length distributions combined) until 2015 for producing the catch options.

Discarding

Discarding of undersized and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discard rates fluctuate in this FU and averaged 12% by number in the last five years (Table 3.5.9). In 2015 the discard rate increased to 13.1% (from 6.3% in 2014).

It is likely that some *Nephrops* survive the discarding process. An estimate of 25% (Charuau *et al*., 1982; Sangster *et al*., 1997; Wileman *et al*., 1999) survival is assumed for this FU in order to calculate removals (landings + dead discards) from the population. The discard survival rate for creel caught *Nephrops* has been shown to be high (WKNEPH, 2013) and a value of 100% is used. The discard rate (adjusted for survival) which is used in the provision of landings options for 2017 was 9.2% based on a three year average of 2013–2015.

Abundance indices from UWTV surveys

Underwater TV surveys are available for this stock since 1994 (missing surveys in 1995 and 1997). The stock area for this FU was updated in 2013 to 2908 km^2 (see stock annex for further details). In 2015, 41 valid stations were used in the survey final analysis (Table 3.5.7).

Table 3.5.6 shows the basic analysis for the most recent TV survey conducted in FU11. At the 2012 SGNEPS meeting (ICES, 2012) it was decided that a CV (relative standard error) of <20% was an acceptable precision level for UWTV survey estimates of abundance. The CV for the most recent TV survey was 13% and lower than the precision level agreed (Table 3.5.6).

Figure 3.5.8 shows the distribution of stations in recent TV surveys (2010–2015), with the size of the symbols reflecting the *Nephrops* burrow density. Table 3.5.7 and Figure

3.5.9 show the time-series 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; ICES, 2013). A number of potential biases were highlighted including those due to edge effects, species burrow misidentification and burrow occupancy. The cumulative relative to absolute conversion factor estimated for FU11 was 1.33 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 33%.

3.5.3 Assessment

Comparison with previous assessments

The assessment is the same as last year and is based on a combination of examining trends in fishery indicators and underwater TV abundance estimates. Landings predictions are derived by applying a harvest rate to the UWTV survey estimate of abundance and assuming a length composition derived from recent fishery data (including data from both trawl and creel fisheries).

No major issues were highlighted by the audit conducted last year.

State of the stock

The underwater TV survey is presented as the best available information on the North Minch *Nephrops* stock. The surveys provide 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 therefore it only provides information on abundance over the area of the survey.

TV survey estimated stock abundance in 2015 was 1445 million individuals, a 15% increase from the 2014 estimate and well above the MSY $B_{trigger}$ value of 541 million (Table 3.5.7).

The calculated harvest ratio in 2015 (dead removals/TV abundance = 7.6%) was below the MSY proxy for this stock (the value associated with high long-term yield and low risk depletion) of 10.8%.

		Fishing pressure					Stock size			
		2012	2013	2014			2013	2014	2015	
Maximum sustainable yield	F_{MSY}	✗	✓	✓	Appropriate	MSY $B_{trigger}$	✓	✓	✓	Above trigger
Precautionary approach	F_{pa}, F_{lim}	?	✓	✓	Below possible reference points	B_{pa}, B_{lim}	✓	✓	✓	Above possible reference points
Management plan	F_{MGT}	-	-	-	Not applicable	SSB_{MGT}	-	-	-	Not applicable

3.5.4 Catch option table

Landings predictions at various harvest ratios (based on principles established at WKNEPH (ICES,2009)), including a selection of those equivalent to the per-recruit reference points, will be made on the basis of the 2016 UWTV survey conducted in June and presented in October 2016 for the provision of advice.

The table below shows the agreed inputs to the catch options table.

Input	Data	2016 assessment
Survey abundance (millions)	UWTV 2016	Not yet known
Mean weight in landings	1999–2015	25.89
Mean weight in discards	1999–2015	10.81
Dead discard rate	average 2013–2015	9.23%

Due to the high interannual variability in mean weights it was considered more appropriate to use a full time-series average, from 1999 (first year with creel and trawl length distributions combined) until 2015 for producing the catch options.

3.5.5 Reference points

New reference point F_{MSY} were derived for this stock at WKMSYRef4 (ICES, 2016). This was updated on the basis of an average of estimated F_{MSY} proxy harvest rates over a period of years, this corresponds more closely to the methodology for finfish. In cases where there is a clear trend in the values a five year average was chosen. Similarly, the five year average of the F at 95% of the YPR obtained at the F_{MSY} proxy reference point was proposed as the F_{MSY} lower bound and the five year average of the F above F_{max} that leads to YPR of 95% of the maximum as the upper bound. Using an average value also has the advantage of reducing the effect of any unusually high or low estimates of the F_{MSY} proxy which occasionally appear. For this stock the F_{MSY} proxy has been revised from 10.9% to 10.8%.

WKFMSYRef4 did not update the MSY $B_{trigger}$ except for rounding to tens of millions. MSY $B_{trigger}$ has been defined as the lowest stock size from which the abundance has increased (ICES, 2013) and is calculated as 541 million individuals and rounded to 540 million for use as MSY $B_{trigger}$ in the advice. Full details are contained in the stock annex.

These reference points should remain under review by WGCSE and may be revised should improved data become available.

Table 3.5.9 and Figure 3.5.10 show the harvest ratios for FU11. From 2006–2009 there was a sustained period of high, above F_{MSY} proxy, harvest rates followed by two years of low harvest rates of around 6–7%. There was a sudden increase in 2012. Since 2012, the harvest ratio has declined and has been below the F_{MSY} proxy for the last three years. It is likely that prior to 2006, the estimated harvest ratios may not be representative due to underreporting of landings.

3.5.6 Management strategies

Scotland has recently established a network of regional Inshore Fisheries Groups (rIFGs), non-statutory bodies that aim to improve the management of Scotland's inshore fisheries out to six nautical miles, and to give commercial inshore fishermen a strong voice in wider marine management developments. The rIFGs will contribute to regional policies and initiatives relating to management and conservation of inshore fisheries, including impacts on the marine environment and the maintenance of sustainable fishing communities and measures designed to better conserve and sustainably exploit stocks of shellfish and sea fish (including salmon) in their local waters. Although no IFG proposals specific to the management of *Nephrops* fisheries have yet been adopted, some of the IFG management plans for the Scottish West Coast include spatial management of *Nephrops* fisheries and the introduction of creel limits.

3.5.7 Quality of assessment and forecast

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. The length compositions from 1999 onwards are derived from both creel and trawl samples. The creel fishery which accounts for around 20% of the landings, increasingly operates over similar areas to trawling, and exhibits a length composition composed of larger animals.

There were concerns over the accuracy of historical landings and effort data prior to 2006 when Buyers and Sellers legislation was introduced and the reliability began to improve. Because of this the final assessment adopted is independent of official statistics. Harvest ratios since 2006 are also considered more reliable due to more accurate landings data reported under new legislation. Incorporation of creel length compositions (since the 2010 WG) has also improved estimates of harvest ratios. Underwater TV surveys have been conducted for this stock since 1994, with a continual annual series available since 1998. The number of valid stations in the survey has remained relatively stable throughout the time period. Confidence intervals around the abundance estimates are relatively small for this functional unit. In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. A three year average (2013–2015) of discard rates (adjusted to account for some survival of discarded animals) has been used in the calculation of catch options.

The cumulative absolute conversion factor estimates for FU11 are largely based on expert opinion (see stock annex). The precision of these bias corrections cannot yet be characterised. The method to derive landings for the catch options is sensitive to the input dead discard rate and mean weight in landings and this introduces uncertainties in the catch forecasts. Precision estimates are needed for these forecast inputs.

The stock area was revised in 2013 (ICES, 2013) using integrated VMS-logbook data to more accurately estimate the spatial extent of *Nephrops* catches. Two other factors however, have the potential to increase the fished area further. Firstly, the inclusion of vessels smaller than 15 m would likely increase the fished area in some of the inshore locations and secondly, it is known that most of the sea lochs have areas of mud substrate and are typically fished by creel boats. In recent years, a number of TV surveys have taken place in the major North Minch sea lochs in an attempt to improve estimates of the ground area and *Nephrops* abundance. Work presented at the WKNEPH 2013 (ICES, 2013) showed that the total area of the sea lochs is 105 km^2, which is considerably smaller than the offshore VMS area estimated to be 2908 km^2. Therefore, it is unlikely that the exclusion of these inshore areas from the survey have an impact in the mean densities and overall abundance of *Nephrops* in the North Minch.

3.5.8 Recommendation for next benchmark

This stock was last benchmarked in 2013 (ICES, 2013). WGCSE will keep the stock under close review and recommend future benchmark as required.

3.5.9 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.

Creel fishing takes place in this area but overall effort by this fleet in terms of creel numbers is not known and measures to control numbers are not in place. There is a need to ensure that the combined effort from all forms of fishing is taken into account when managing this stock.

There is a bycatch of other species in the area of the North Minch and STECF estimates that discards of whiting and haddock are high in 6.a generally. It is important that efforts are made to ensure that unwanted bycatch is kept to a minimum in this fishery. Current efforts to reduce discards and unwanted bycatches of cod include the implementation of large square meshed panels (SMPs) of 120 mm under the west coast emergency measures, and SMPs of 200 mm under Scottish Conservation Credits scheme.

3.5.10 References

Council Reg. (EU) 43/2009.

Charuau A., Morizur Y., Rivoalen J.J. 1982. Survival of discarded *Nephrops norvegicus* in the Bay of Biscay and in the Celtic Sea, ICES-CM-1982/B:13.

Dobby H. 2009. F_{MSY} proxies for *Nephrops* stocks. Working document for WGNSSK, 5–11 May 2010 and WGCSE, 12–20 May, 2010.

EU. 2015. COMMISSION DELEGATED REGULATION (EU) 2015/2438 of 12 October 2015 establishing a discard plan for certain demersal fisheries in north-western waters. Official Journal of the European Union, L 336/29.

http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R2438&from=EN.

ICES. 2010. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 9–11 November 2010, Lisbon, Portugal. ICES CM 2010/SSGESST:22. 95 pp.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 6–8 March 2012, Acona, Italy. ICES CM 2012/SSGESST:19. 36 pp.

ICES. 2013 Report of the Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM 2013/45. 230 pp.

ICES. 2015. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4). ICES CM 2015/ACOM:58. 185 pp.

ICES. 2016. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.4.1.

Sangster, G.I., Breen, M., Bova, D.J., Kynoch, R., O'Neill, F.G., Lowry. N., Moth-Poulsen, T. Hansen, U.J., Ulmestrand, M., Valentinsson, D., Hallback, H., Soldal, A.V., and Hoddevik, B. 1997. *Nephrops* survival after escape and discard from commercial fishing gear. Presented at ICES FTFB Working Group, Hamburg, Germany 14–17 April, 1997, ICES CM 1997 CM/B.

Wileman, D.A., Sangster, G.I., Breen, M., Ulmestrand, M., Soldal, A.V. and Harris, R.R. 1999. Roundfish and *Nephrops* survival after escape from commercial fishing gear. EU Contract Final Report. EC Contract No: FAIR-CT95-0753.

Table 3.5.1. ***Nephrops*** **functional units and descriptions by statistical rectangle.**

Functional Unit	Stock	Division	ICES Rectangles
11	North Minch	6.a	44–46 E3–E4
12	South Minch	6.a	41–43 E2–E4
13	Clyde	6.a	39–40 E4–E5

Table 3.5.2. (a). Nominal landings (tonnes) of *Nephrops* in Division 6.a, 1980–2015, as officially reported to ICES.

	FRANCE	IRELAND	SPAIN	UK–(ENGL+WALES+N.IRL)	UK–SCOTLAND	UK	TOTAL
1980	5	1	- -	-	7422	-	7428
1981	5	26	-	-	9519	-	9550
1982	1	1	-	1	9000	-	9003
1983	1	1	-	11	10 706	-	10 719
1984	3	6	-	12	11 778	-	11 799
1985	1	1	28	9	12 449	-	12 488
1986	8	20	5	13	11 283	-	11 329
1987	6	128	11	15	11 203	-	11 363
1988	1	11	7	62	12 649	-	12 730
1989	-	9	2	25	10 949	-	10 985
1990	-	10	4	35	10 042	-	10 091
1991	-	1	-	37	10 458	-	10 496
1992	-	10	-	56	10 783	-	10 849
1993	-	7	-	191	11 178	-	11 376
1994	3	6	-	290	11 047	-	11 346
1995	4	9	3	346	12 527	-	12 889
1996	-	8	1	176	10 929	-	11 114
1997	-	5	15	133	11 104	-	11 257
1998	-	25	18	202	10 949	-	11 194
1999	-	136	40	256	11 078	-	11 510
2000	1	130	69	137	10 667	-	11 004
2001	9	115	30	139	10 568	-	10 861
2002	-	117	18	152	10 225	-	10 512
2003	-	145	12	81	10 450	-	10 688
2004	-	150	6	267	9941	-	10 364
2005	-	153	17	153	7616	-	7939
2006	-	133	1	255	13 419	-	13 808
2007	-	155	-	2088	14 120	-	16 363
2008	-	56	1	419	14 795	-	15 271
2009	-	53	-	1226	11 462	-	12 741
2010	-	45	1	1962	10 250	-	12 258
2011	-	38	-	2517	10 419	-	12 974
2012	-	28	-	2502	11 807	-	14 337
2013	-	24	-	495	12 247	-	12 766
2014*	-	50	-	-	-	12 675	12 725
2015*	-	75	-	-	-	11 653	11 728

*** Note combined UK landings.**

Table 3.5.2. (b) Nominal landings (tonnes) of *Nephrops* in Division 6.b, 1980–2015, as officially reported to ICES. There are no Functional Units in ICES Division 6.b but occasional small landings are made.

	FRANCE	GERMANY	IRELAND	SPAIN	UK–(ENGL+WALES+N.IRL)	UK–SCOTLAND	TOTAL
1980	-	-	-	-	-	-	0
1981	-	-	-	-	-	-	0
1982	-	-	-	-	-	-	0
1983	-	-	-	-	-	-	0
1984	-	-	-	-	-	-	0
1985	-	-	-	-	-	-	0
1986	-	-	-	8	-	-	8
1987	-	-	-	18	11	-	29
1988	-	-	-	27	4	-	31
1989	-	-	-	14	-	-	14
1990	-	-	-	10	1	-	11
1991	-	-	-	30	-	-	30
1992	-	-	-	2	4	1	7
1993	-	-	-	2	6	9	17
1994	-	-	-	5	16	5	26
1995	1	-	-	2	26	1	30
1996	-	6	-	5	65	5	81
1997	-	-	1	3	88	23	115
1998	-	-	1	6	46	7	60
1999	-	-	-	5	2	5	12
2000	2	-	8	3	4	4	21
2001	1	-	1	14	2	7	25
2002	1	-	-	7	3	7	18
2003	-	-	1	5	6	18	30
2004	-	-	-	2	7	13	22
2005	3	-	1	1	5	7	17
2006	-	-	-	-	1	3	4
2007	-	-	-	2	3	-	5
2008	-	-	-	-	-	-	0
2009	-	-	-	-	-	-	0
2010	-	-	-	-	-	-	0
2011	-	-	-	-	-	-	0
2012	-	-	-	-	-	-	0
2013	-	-	-	-	-	-	0
2014	-	-	-	-	-	-	0
2015	-	-	-	-	-	-	0

Table 3.5.3. *Nephrops*, Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1981–2015.

Year	FU11	FU12	FU13	Other	Total
1981	2861	3652	2968	39	9520
1982	2799	3552	2620	27	8998
1983	3197	3413	4076	34	10720
1984	4143	4300	3310	36	11789
1985	4060	4008	4286	104	12458
1986	3381	3484	4341	89	11295
1987	4084	3892	3009	257	11242
1988	4035	4473	3664	529	12701
1989	3205	4745	2812	212	10974
1990	2546	4430	2909	182	10067
1991	2793	4442	3038	255	10528
1992	3559	4237	2803	248	10847
1993	3193	4458	3343	344	11338
1994	3614	4414	2630	441	11099
1995	3655	4682	3987	460	12784
1996	2872	3995	4057	239	11163
1997	3046	4344	3621	243	11254
1998	2441	3730	4841	157	11169
1999	3257	4052	3752	438	11499
2000	3247	3953	3417	421	11038
2001	3259	3991	3182	420	10852
2002	3440	3305	3384	397	10526
2003	3269	3879	3173	433	10754
2004	3082	3869	2973	403	10327
2005	2949	3848	3395	254	10446
2006	4166	4633	4780	241	13820
2007	3978	5471	6660	420	16529
2008	3799	5356	5923	128	15206
2009	3496	4285	4779	185	12745
2010	2413	3846	5843	569	12671
2011	2697	3702	6432	219	13050
2012	3542	3989	6687	435	14653
2013	3413	3776	5435	234	12858
2014	3255	3175	6206	245	12635
2015*	2995	3394	5133	308	11830

*** Provisional.**

Table 3.5.4. *Nephrops*. Scottish sampling levels all FUs in 6.a (including N. Irish for Clyde).

		2013		2014		2015	
FU		N trips*	N measured	N trips*	N measured	N trips*	N measured
North Minch	Landings	57	35 314	40	28 859	36	20 993
	Discards	36	2276	24	3806	14	2382
South Minch	Landings	61	35 800	44	28 378	52	30 546
	Discards	46	2137	21	3503	21	2988
Clyde	Landings	29	26 436	32	20 968	38	26 283
	N.Irish Landings	14	10 380	12	7283	4	2206
	Discards	62	3617	19	2977	21	3467

***Number of trips expressed as number of hauls for discards.**

Table 3.5.5. *Nephrops*, North Minch (FU11), Nominal Landings of *Nephrops*, 1981–2015.

	UK SCOTLAND				OTHER UK & IRELAND	TOTAL
year	*Nephrops* trawl	other trawls	creel	Subtotal		
1981	2320	171	370	2861	0	2861
1982	2323	105	371	2799	0	2799
1983	2784	96	317	3197	0	3197
1984	3449	160	534	4143	0	4143
1985	3235	117	708	4060	0	4060
1986	2641	203	537	3381	0	3381
1987	3459	143	482	4084	0	4084
1988	3450	148	437	4035	0	4035
1989	2603	112	490	3205	0	3205
1990	1941	134	471	2546	0	2546
1991	2229	126	438	2793	0	2793
1992	2978	149	432	3559	0	3559
1993	2699	86	408	3193	0	3193
1994	2916	246	453	3614	0	3614
1995	2940	183	532	3655	0	3655
1996	2354	148	370	2872	0	2872
1997	2553	102	391	3046	0	3046
1998	2023	68	350	2441	0	2441
1999	2792	56	409	3257	0	3257
2000	2695	28	524	3247	0	3247
2001	2649	42	568	3259	0	3259
2002	2775	79	586	3440	0	3440
2003	2606	45	618	3269	0	3269
2004	2391	30	661	3082	0	3082
2005	2270	23	656	2949	0	2949
2006	3446	23	697	4166	0	4166
2007	3361	26	591	3978	0	3978
2008	3229	13	557	3799	0	3799
2009	2849	34	613	3496	0	3496
2010	1783	9	621	2413	0	2413
2011	2109	17	571	2697	0	2697
2012	2963	12	565	3540	2	3542
2013	2356	480	575	3411	2	3413
2014	2177	586	490	3253	2	3255
2015*	1858	720	417	2995	0	2995

*** Provisional. Note that 2014 provisional landings were revised from previous report.**

Table 3.5.6. ***Nephrops*****, North Minch (FU11): Results of the 2015 TV survey.**

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance	Survey Precision Level (RSE)
2015 TV survey								
VMS	2908	41	0.497	0.166	1445.1	34273	1	
Total	2908	41			1445.1	34273	1	0.128

Table 3.5.7. ***Nephrops*****, North Minch (FU11): Results of the 1994–2015 TV surveys (values adjusted for bias).**

Year	Number of valid stations	Mean density burrows/m²	Abundance (sediment) millions	95% confidence interval (sediment)	Abundance (VMS) millions	95% confidence interval (VMS millions)
1994	41	0.29	500	74	820	-
1995	No survey					
1996	38	0.19	330	47	541	-
1997	No survey					
1998	38	0.31	547	77	898	-
1999	36	0.27	484	89	794	-
2000	39	0.40	711	82	1166	-
2001	56	0.38	666	81	1092	-
2002	37	0.46	815	91	1337	-
2003	41	0.60	1068	129	1751	-
2004	38	0.60	1068	107	1751	-
2005	41	0.53	939	100	1540	-
2006	30	0.61	1075	101	1762	-
2007	36	0.41	736	91	1206	-
2008	41	0.36	638	95	1047	-
2009	26	0.41	729	138	1195	-
2010	37	0.44	-	-	1293	231
2011	41	0.59	-	-	1726	226
2012	41	0.31	-	-	891	181
2013	41	0.48	-	-	1403	206
2014	44	0.43	-	-	1251	171
2015	41	0.50	-	-	1445	370

Table 3.5.8. *Nephrops* mean weight in the landings (FU11–13).

Year	FU11	FU12	FU13 Firth of Clyde
1990	21.39	19.99	24.27
1991	25.35	21.74	20.65
1992	21.66	24.1	25.16
1993	20.79	21.26	29.44
1994	23.45	24.96	25.28
1995	22.24	21.96	19.24
1996	26.68	23.1	21.68
1997	21.71	23.37	24.21
1998	23.65	22.18	18.13
1999*	22.7	25.14	17.4
2000	24.19	27.3	20.09
2001	25.33	23.79	19.69
2002	25.93	26.83	16.34
2003	26.03	27.86	19.02
2004	25.16	27.37	18.7
2005	27.65	28.11	17.9
2006	24.52	26.24	19.14
2007	23.61	23.95	19.06
2008	23.9	23.91	16.58
2009	25.42	23.87	18.19
2010	29.39	25.86	21.26
2011	27.56	31.1	19.34
2012	23.43	29.17	21.84
2013	27.52	27.48	20.72
2014	27.96	29.91	20.79
2015	29.93	28.15	22.21
Average**	25.90	26.83	21.24

***From 1999 onwards mean weights are shown for trawl and creels combined.**

**** Average for North Minch and South Minch (1999–2015); Clyde (2013–2015).**

Table 3.5.9. ***Nephrops*, North Minch (FU11): Adjusted TV survey abundance, landings, discard rate (proportion by number) and estimated harvest rate.**

Year	Landings in number (millions)	Discards in number (millions)	Removals in number (millions)**	Adjusted survey sediment (millions)	Adjusted survey VMS*	Harvest ratio VMS	Harvest ratio sediment	Landings (tonnes)	Discard (tonnes)	Discard rate	Dead discard rate***	Mean weight in landings*** (g)	Mean weight in discards*** (g)
1999	144	28	165	484	794	20.7	33.8	3257	273	16.4	12.8	22.7	9.69
2000	134	10	142	711	1166	12.1	19.9	3247	100	6.9	5.2	24.19	10.08
2001	129	17	141	666	1092	13	21.2	3259	160	11.7	9.1	25.33	9.32
2002	133	28	154	815	1337	11.5	18.7	3440	277	17.6	13.8	25.93	9.78
2003	126	30	148	1068	1751	8.5	13.8	3269	299	19.2	15.2	26.03	10
2004	122	18	136	1068	1751	7.8	12.7	3082	202	13	10.1	25.16	11.02
2005	107	50	144	939	1540	9.4	15.3	2949	507	32	26.1	27.65	10.09
2006	170	74	225	1074	1762	12.8	20.7	4166	757	30.3	24.6	24.52	10.27
2007	168	12	177	735	1206	14.7	24.1	3978	214	6.5	5	23.61	18.1
2008	159	19	173	638	1047	16.5	27.1	3799	194	10.5	8.1	23.9	10.36
2009	138	35	164	729	1195	13.7	22.5	3496	327	20.3	16	25.42	9.34
2010	82	12	91	-	1293	7	-	2413	128	12.4	9.6	29.39	10.98
2011	96	16	108	-	1726	6.3	-	2697	154	14.2	11	27.56	9.66
2012	152	21	167	-	891	18.8	-	3542	213	12	9.3	23.43	10.33
2013	122	24	140	-	1403	10	-	3413	364	16.4	12.8	27.52	15.18
2014	115	8	121	-	1251	9.6	-	3255	77	6.3	4.8	27.96	9.99
2015	99	15	110	-	1445	7.6	-	2995	143	13.1	10.1	29.93	9.66
Average											9.23%	25.89	10.81

***harvest rates previous to 2006 are unreliable.**

**** Removals numbers take the dead discard rate into account.**

***** Dead discard average: 2013–2015; Mean weight in landings and discards average: 1999–2015.**

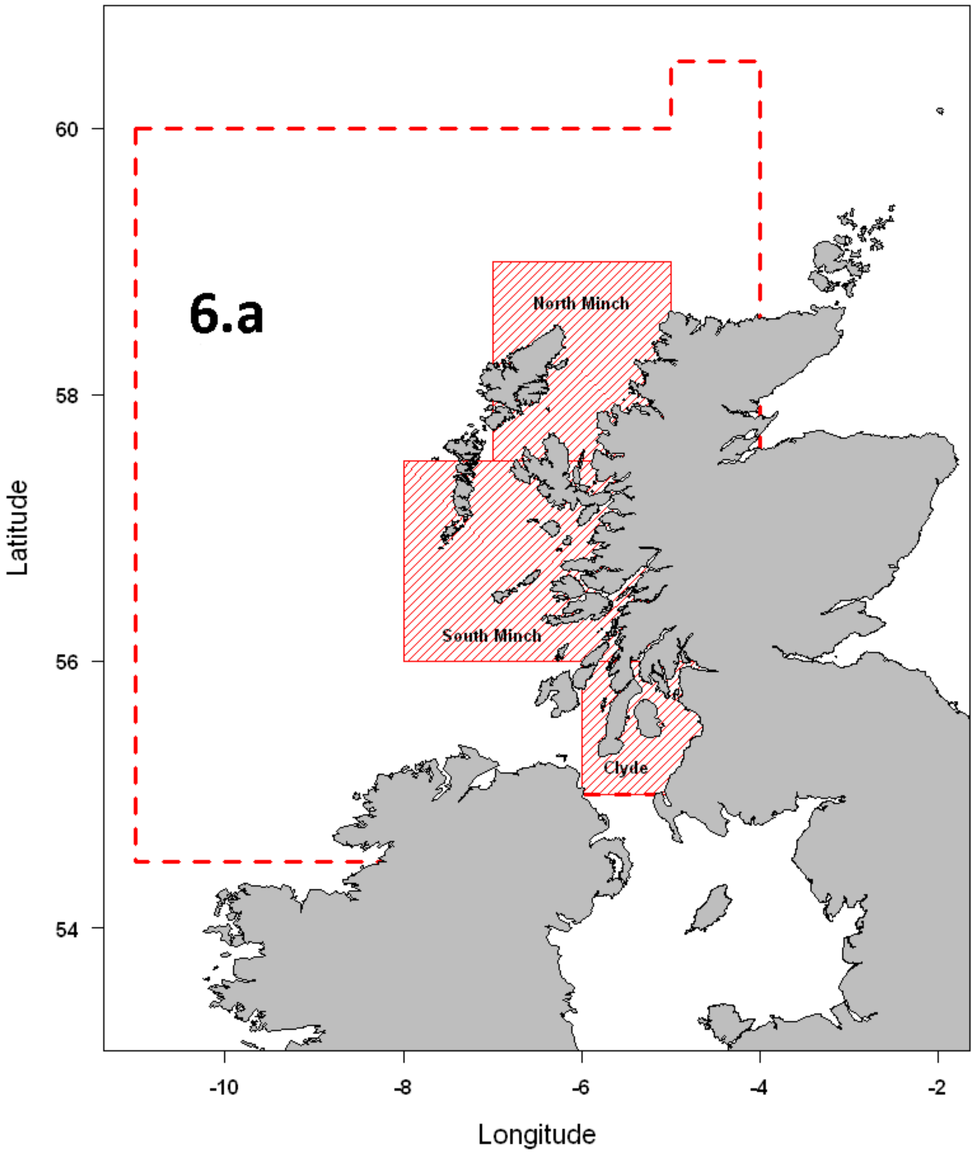


Figure 3.5.1. ***Nephrops*** **Functional Units in 6.a. North Minch (FU11), South Minch (FU12), Clyde (FU13).**

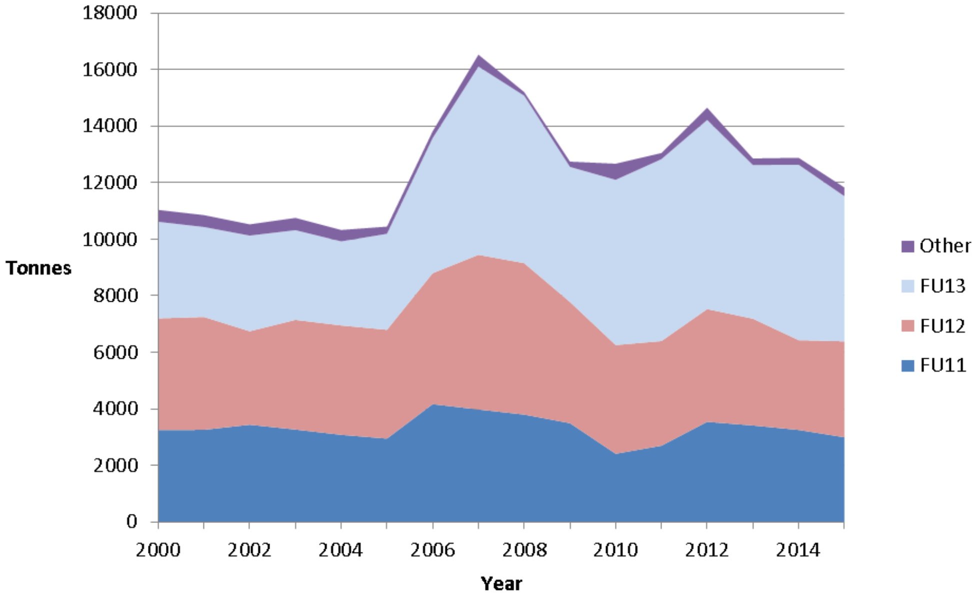
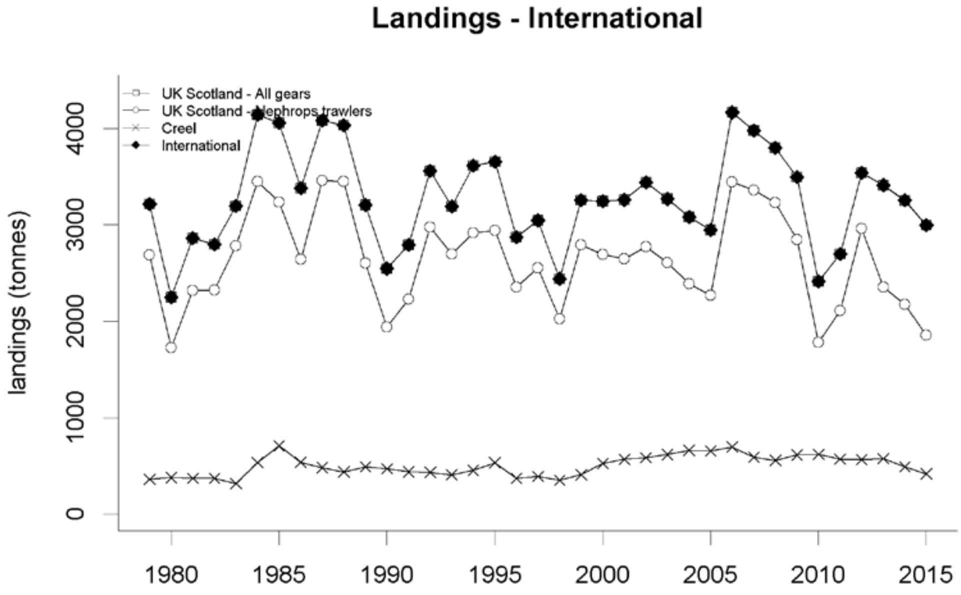


Figure 3.5.2. ***Nephrops*** **in Division 6.a. Landings (tonnes) by FU and Other rectangles.**



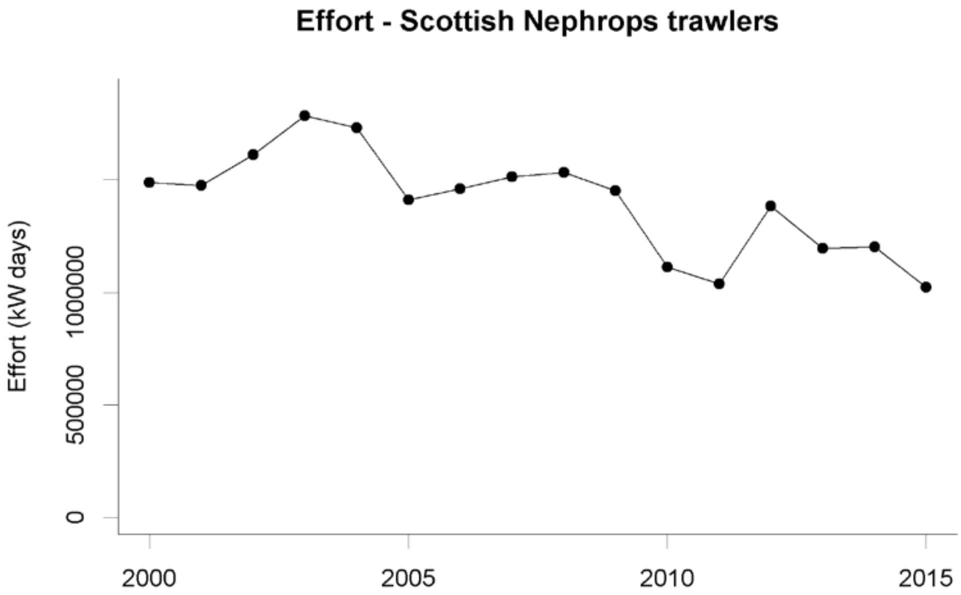
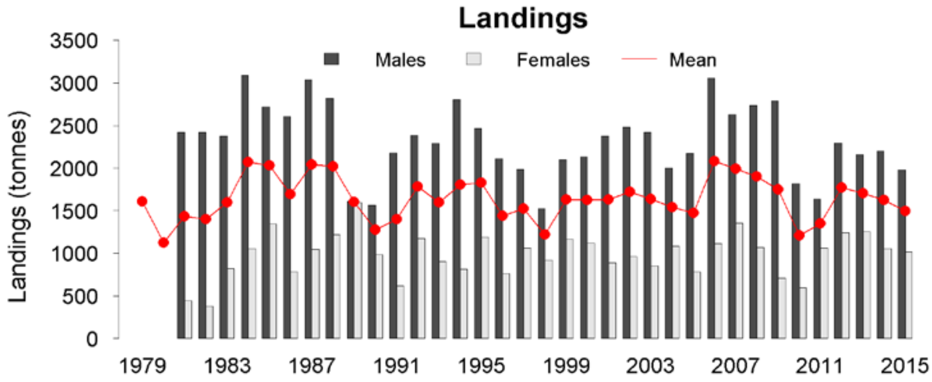


Figure 3.5.3. ***Nephrops*, North Minch (FU11). Long-term landings and effort.**



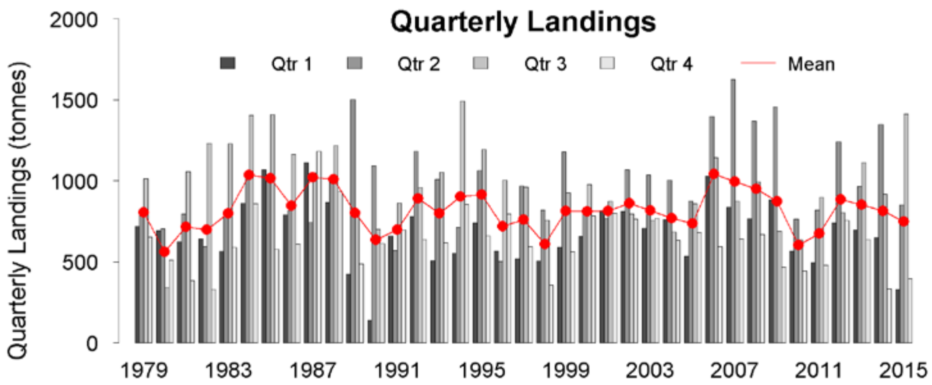


Figure 3.5.4. (a) ***Nephrops,*** **North Minch (FU11), Landings by quarter and sex from Scottish trawlers.**

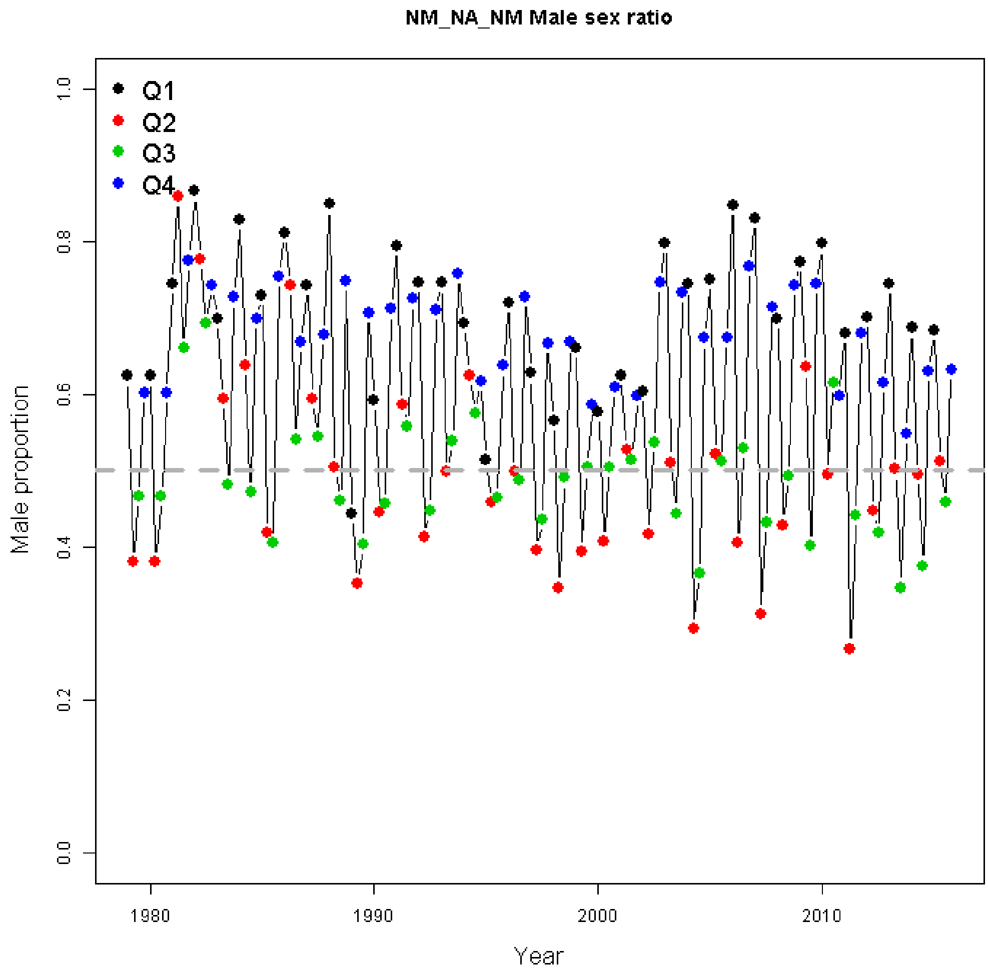


Figure 3.5.4. (b) *Nephrops,* North Minch (FU11), Proportion of males by quarter (1980–2015).

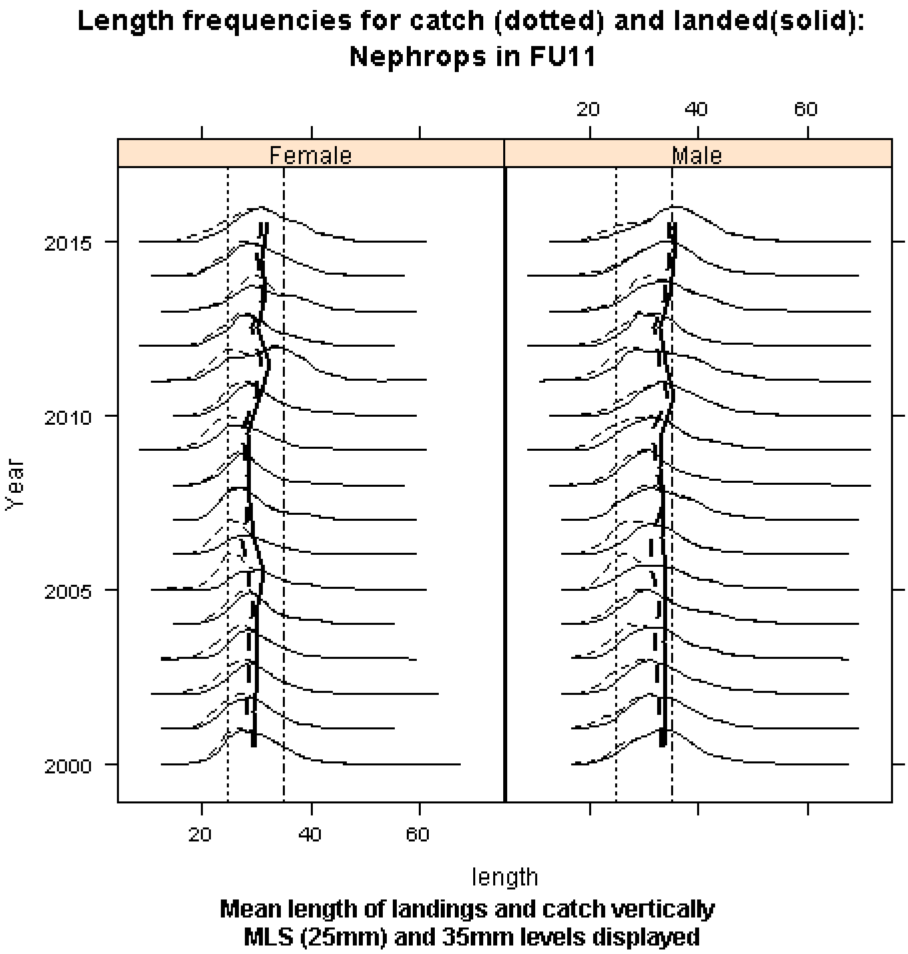


Figure 3.5.5. ***Nephrops*, North Minch (FU11), Catch length–frequency distribution and mean sizes (red line) for *Nephrops* in the North Minch, 2000–2015.**

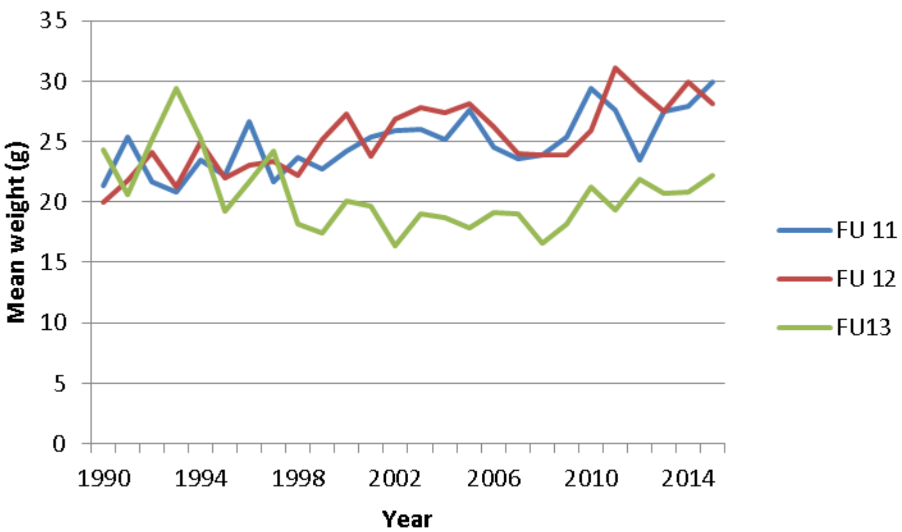


Figure 3.5.6. ***Nephrops*, (FU11 North Minch, FU12 South Minch and FU13 Clyde), mean weight in the landings from 1990–2015 (from Scottish market sampling data).**

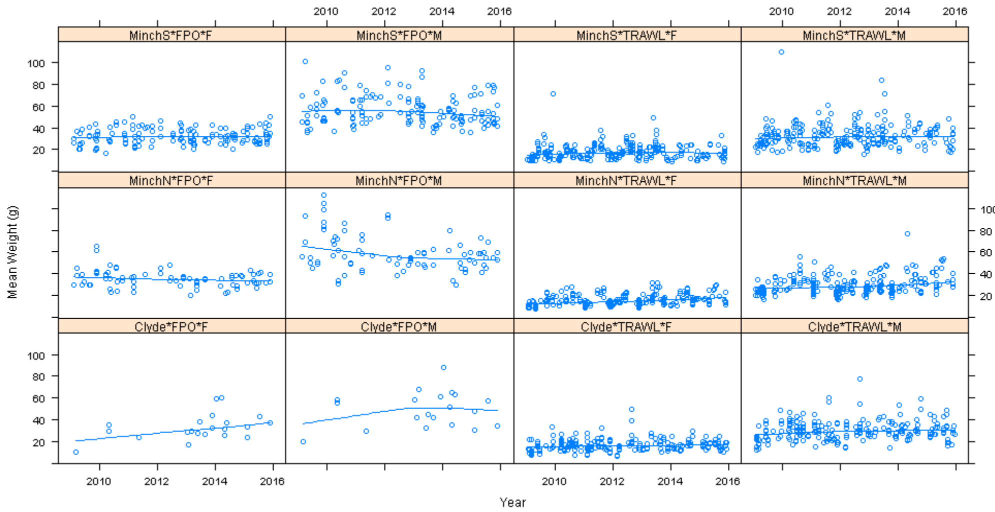


Figure 3.5.7. ***Nephrops*, (FU11 North Minch, FU12 South Minch, FU13 Clyde), mean weight in landings 2009–2015 by sample date, sex, métier and functional unit.**

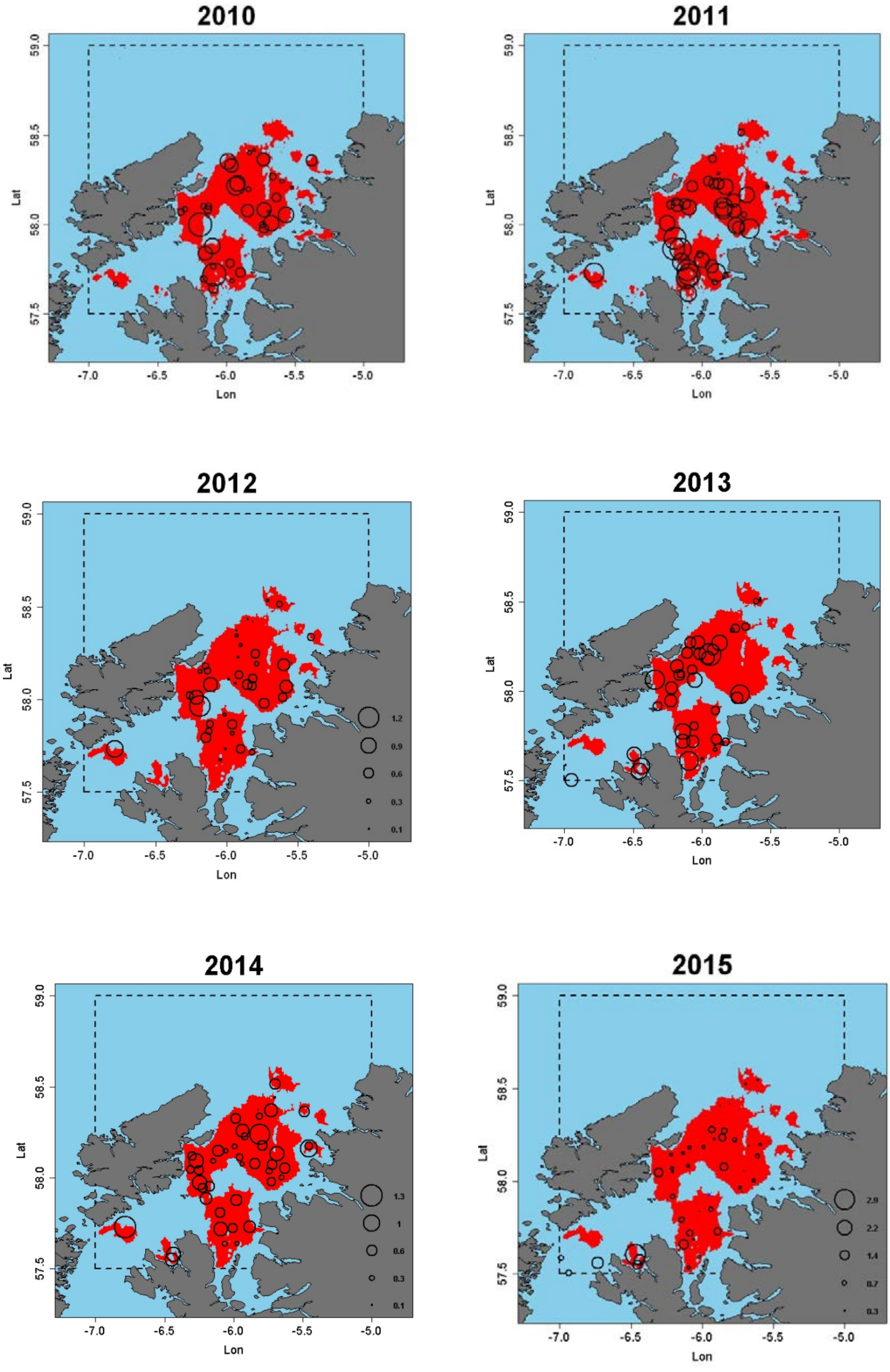


Figure 3.5.8. ***Nephrops*, North Minch (FU11), TV survey station distribution and relative density (burrows/m²), 2010–2015. Bubbles in these figures are all scaled the same. Crosses represent zero observations.**

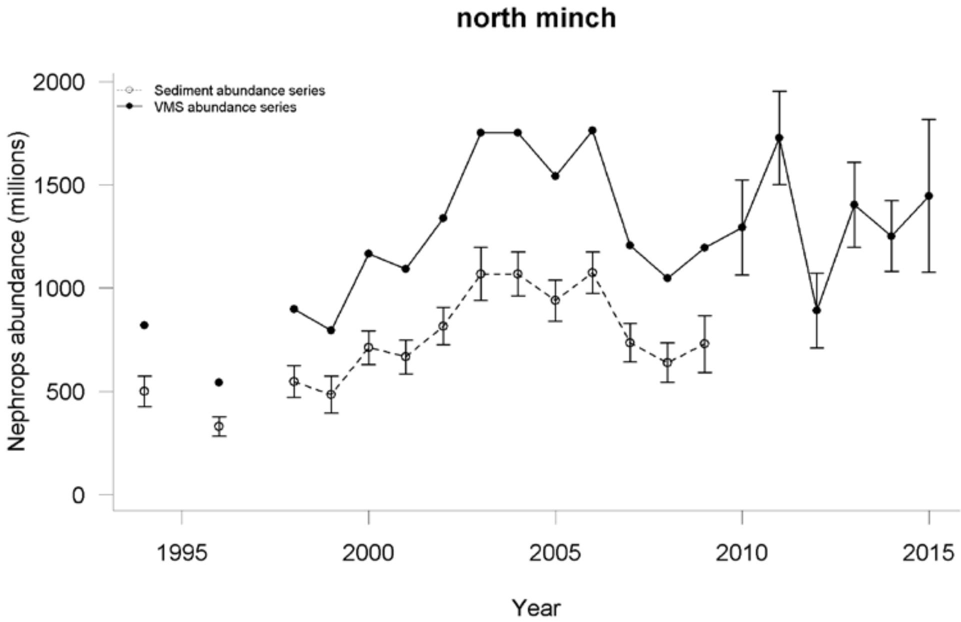


Figure 3.5.9. ***Nephrops*, North Minch (FU11), time-series of revised TV survey abundance estimates (adjusted for bias), with 95% confidence intervals, 1994–2015 (no survey in 1995 and 1997). The dashed and solid lines are the abundance estimated raised to the sediment area and VMS area, respectively.**

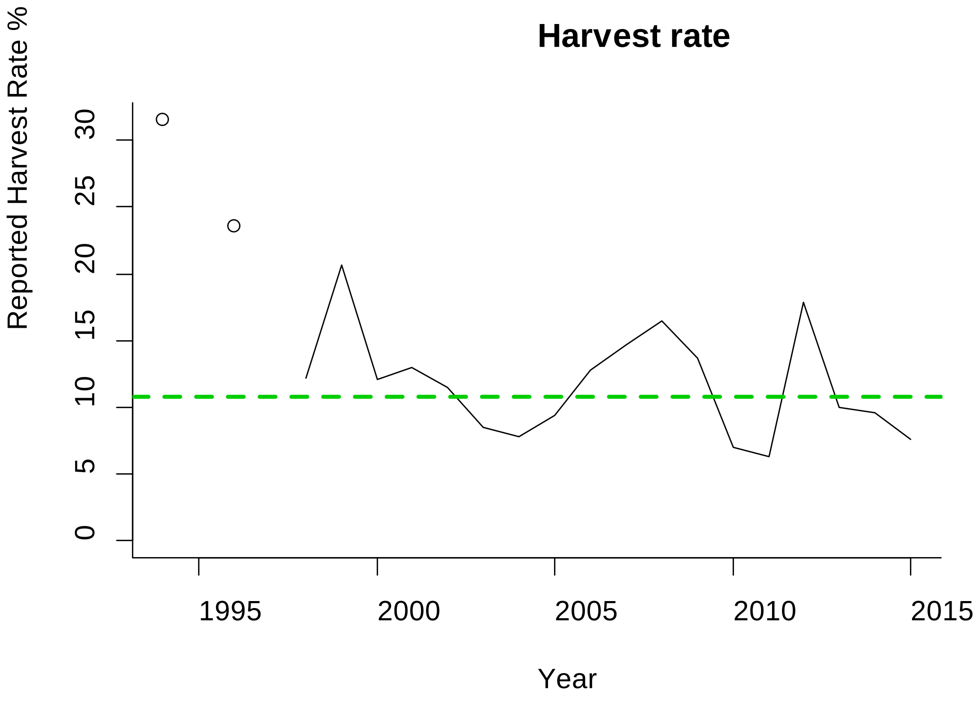


Figure 3.5.10. ***Nephrops*, North Minch (FU11), harvest rate, 1995–2015 (no survey data in 1995 and 1997). The dashed and solid lines are the MSY proxy and the harvest rate respectively.**

3.6 South Minch, FU12

Type of assessment in 2016

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 (WKNEPH, 2009; WKNEPH, 2013). Full details are provided in the stock annex.

ICES advice applicable to 2015

'ICES advises, on the basis of the MSY approach and considering that no discard ban is in place in 2015, that landings should be no more than 6382 t. Assuming that discard rates do not change from the average of the last three years (2011–2013) the resulting catch would be no more than 6567 t.'

ICES advice applicable to 2016

'ICES advises that when the MSY approach is applied, catches in 2016 (assuming zero discards) should be no more than 6163 tonnes. If instead discard rates continue at recent values (average of 2012–2014) and there is no change in assumed discard survival rate, this implies landings of no more than 6073 tonnes.'

3.6.1 General

Stock description

The South Minch (FU12) is located midway down the west coast of Scotland (North Minch report, Section 3.5, Figure 3.5.1). The area is characterised by numerous islands of varying size, and sea lochs occur along the mainland coast. These topographical features create a diverse habitat with complex hydrography and a patchy distribution of soft sediments. Further details are provided in the stock annex.

Management applicable to 2015 and 2016

Management is at the ICES subarea level as described at the beginning of Section 3.5 (FU11 North Minch report).

Ecosystem aspects

Details of the ecosystem aspects for this functional unit are provided in the stock annex where available.

Fishery description

Information on developments in the fishery was provided by Marine Scotland staff, including fishery officers and scientists sampling in the ports and on board vessels.

In 2015 the fishery was described as similar to the previous year with poor weather in the winter and elusive prawns throughout the year. There was a continued pattern of visiting east coast vessels which arrived around April/May and stayed for approximatley five months. Two distinct fleets continued to operate in the South Minch, landing into the two main ports of Oban and Mallaig. Inshore, a fleet of smaller vessels including creel boats operated throughout the year, while some larger twin riggers fish further offshore. Most of these boats are thought to fish for *Nephrops* at some time. The local Mallaig fleet tend to fish closer to shore on harder ground and land better quality *Nephrops* than visitor boats. Most boats land once or twice per week.

There are very few vessels (2–3) that landed on a daily basis. During the winter months, fishing activity is usually reduced in the South Minch due to the weather and small boats are often restricted to trawling in the sheltered sea-lochs.

There is increasing overlap of the areas exploited by trawl and creel fishing and this has led to some gear conflict issues. Since 2009, vessels have been required to fit 120 mm square meshed panels, in accordance with the west coast emergency measures (Council Reg. (EU) 43/2009). Large SMPs (200 mm) are also widely used in the North Minch and are mandatory for all TR2 vessels with power >112 kW fishing under the Scottish Conservation Credits scheme. Twin rig vessels tend to use a 200 mm square mesh panel with a 100 mm or larger mesh codend. These vessels do not catch bulk quantities and this leads to prawns of better average size and quality.

There is very little fish bycatch landed due to the restrictions on cod, haddock and whiting. Estimates of discard rates of haddock and whiting remain high.

3.6.2 Data available

InterCatch

Data for 2015 were successfully uploaded into InterCatch prior to the 2016 WG meeting according with the deadline proposed. Uploaded data were worked up in InterCatch to generate 2015 raised international length–frequency distributions. Allocation schemes for any unsampled fleets are described in the stock annex. Data exploration in InterCatch has previously shown that outputs of raised data were very close to those generated by the previous method applied internally with differences being <0.1%. As such, InterCatch length–frequency outputs have been used in the stock assessment since 2012.

Commercial catch

Official catch statistics (landings) reported to ICES are shown in Table 3.5.2 (see FU11 North Minch report, Section 3.5). These relate to the whole of 6.a of which the South Minch is a part. Landings for FU12 provided through national laboratories are presented in Table 3.6.1, broken down by country and by gear type. Landings from this fishery are predominantly reported from Scotland, with low levels reported from the rest of the UK and Ireland. Total reported Scottish landings in 2015 were 3339 tonnes (plus 22 tonnes from other UK vessels and 33 tonnes from Ireland), consisting of 2681 tonnes (80%) landed by trawlers and 658 tonnes (20%) landed by Scottish creel vessels. The proportion of creel caught landings has remained relatively stable over the last five years.

Effort data

In 2015 WGCSE agreed that effort should be reported in Kw days as this is likely to be more informative about changes in the actual fleet effort. Effort shows an overall decreasing trend since 2003 but there are peaks in 2008 and 2012 which can be attributed to visting North Sea trawlers, (Figure 3.6.1) and then effort falls to levels comparable with 2011. Note that the effort time-series range (2000–2015) do not match with the more extensive year range available for landings due to a lack of reliable effort data in the Marine Scotland Science in-house database.

Sampling levels

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. These sampling levels are shown in Table 3.5.4 (see FU11 North Minch report, Section 3.5). Length compositions for the creel fishery are available for landings only as the small numbers of discards survive well and are not considered to be removed from the population.

Length compositions

Figure 3.6.3 shows a series of annual length–frequency distributions from 2000 onwards and appears fairly stable over the time-series.. Catch (removals) length compositions are shown for each sex along with the mean size for both. Examination of the tails of the distributions above 35 mm (the length beyond which the effects of recruitment pulses and discarding are considered to be negligible) show small increases in mean size and stability in relative numbers of larger animals. This parameter might be expected to reduce in size if overexploitation were taking place.

Sex ratio

The sex ratio in the South Minch shows some variation but males consistently make the largest contribution to the annual landings. Males are available throughout the year while females are mainly caught in the summer when they emerge from the burrow after egg hatching. In 2014 the proportion of males by weight was lower than in previous years but this increased again in 2015 (Figure 3.6.2. (a)). Poor weather in the first and fourth quarters of 2014, resulted in reduced effort during the winter months when predominantly males are taken, and a greater proportion of landings in quarter two and three when females become more available to the trawl fishery. Figure 3.6.2 (b) illustrates the sex ratio by season. There are no particularly anomalous values evident in 2015.

Mean weights

The mean weight in the landings (Figures 3.5.6 and 3.5.7; see FU11 North Minch report,; Table 3.6.5) has fluctuated at a high level (in comparison to values for 2006 to 2010) since 2011. Seasonal variability (and occasional outliers) in mean weights is seen in the individual sample estimates (Figure 3.5.7). The estimate of mean weight in the landings has an effect on the catch forecast. Over the time-series it appears to be an increasing trend in mean weights in the landings. This can be explained by the increasing proportion of creel samples (which tend to catch and land larger *Nephrops*).

Discarding

Discarding of undersized 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 have varied considerably over the years, ranging from as low as 3% to over over 25%. In 2015 it is 7.7% which is lower than in 2014 (15.6%) (Table 3.6.4).

Studies (Charuau *et al.*, 1982; Sangster *et al.*, 1997; Wileman *et al.*, 1999) suggest 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. The discard survival rate for creel caught *Nephrops* has been shown to be high (WKNEPH 2013) and a value of 100% is used. The discard rate for use in the forecast adjusted to account for some survival was estimated by taking a three year average 2013–2015 and amounts to 6.8%.

Abundance indices from UWTV surveys

Underwater TV surveys using a stratified random approach are available for this stock since 1995. TV surveys are targeted at known areas of mud, sandy mud and muddy sand in which *Nephrops* construct burrows. The numbers of valid stations used in the final analysis in each year are shown in Table 3.6.3. On average, 35 stations have been considered valid each year, and raised to a stock area of 5072 km^2 (derived from BGS sediment data). In 2015, 35 valid stations were used in the survey final analysis (Table 3.6.3).

TV survey abundance estimates from 1999–2015 are shown in Table 3.6.4 and Figure 3.6.5. They show that the *Nephrops* population in the South Minch experienced several years of high abundance in the early mid-2000s. Aside from this it has fluctuated without obvious trend over the period of the survey (Figure 3.6.5). The recently observed 2015 abundance represents a 3.6% decrease in relation to 2014.

Table 3.6.2 shows analysis more detailed summary for the three most recent TV surveys conducted in FU12. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. Mean burrow density decreased slightly in 2015, in comparison to the 2014 survey. Densities are generally lower in the western parts of the area towards the Outer Hebrides and higher in the inshore areas to the south west of Skye (Figure 3.6.4). CVs for the three most recent TV surveys (Table 3.6.2) are lower than the precision level agreed (2015; 12%). Figure 3.6.5 show the time-series 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; ICES, 2013). A number of potential biases were highlighted including those due to edge effects, species burrow misidentification and burrow occupancy. The cumulative relative to absolute conversion factor estimated for FU12 was 1.32 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 32%.

3.6.3 Assessment

Comparison with previous assessments

The assessment follows the same procedure as last year and is based on a combination of examining trends in fishery indicators and underwater TV abundance estimates. The process was defined by the benchmark WG and is described in the stock annex.

No major issues were highlighted by the audit conducted last year.

State of the stock

The underwater TV survey is presented as the best available information on the South Minch (FU12) *Nephrops* stock. The details of the 2015 survey are shown in Table 3.6.2 and compared with the 2013 and 2014 outcomes. At present it is not possible to extract any length or age structure information from the survey and therefore it provides information on abundance over the area of the survey.

TV survey estimated stock abundance in 2015 was 1998 million individuals, a 4% decrease from the 2014 estimate but well above the MSY $B_{trigger}$ value of 1016 million.

The calculated harvest ratio in 2015 (dead removals/TV abundance = 6.4%) was below the MSY proxy for this stock (the value associated with high long-term yield and low risk depletion) of 11.7%.

Fishing pressure						Stock size				
		2012	2013	2014			2013	2014	2015	
Maximum sustainable yield	F_{MSY}	✘	✔	✔	Below	MSY $B_{trigger}$	✔	✔	✔	Above trigger
Precautionary approach	F_{pa}, F_{lim}	?	✔	✔	Below possible reference points	B_{pa}, B_{lim}	✔	✔	✔	Above possible reference points
Management plan	F_{MGT}	-	-	-	Not applicable	SSB_{MGT}	-	-	-	Not applicable

3.6.4 Catch option table

Landings predictions and catch options at various harvest ratios (based on principles established at WKNEPH (ICES, 2009)), will be made on the basis of the 2016 UWTV survey conducted in June. These will be presented in October 2016 for the provision of advice.

Catch option table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 3.6.4 and summarised below. The calculation of catch options for the South Minch follows the procedure outlined in the stock annex.

Given the variability in mean weights it was considered more appropriate to use a full time-series average, from 1999 (first year with creel and trawl length distributions combined) until 2015.

The table below shows the agreed inputs to the catch options table.

Input	Data	2016 assessment
Survey abundance (millions)	UWTV 2016	Not yet known
Mean weight in landings	1999–2015	26.8
Mean weight in discards	1999–2015	9.9
Average dead discard rate	Last three years	6.8%

3.6.5 Reference points

New reference points were derived for this stock at WKMSYRef4 (ICES, 2016,)These are updated on the basis of an average of estimated F_{MSY} proxy harvest rates over a period of years, this corresponds more closely to the methodology for finfish. In cases where there is a clear trend in the values a five year average was chosen. Similarly, the five year average of the F at 95% of the YPR obtained at the F_{MSY} proxy reference point was proposed as the F_{MSY} lower bound and the five year average of the F above

F_{max} that leads to YPR of 95% of the maximum as the upper bound. Using an average value also has the advantage of reducing the effect of any unusually high or low estimates of the F_{MSY} proxy which occasionally appear. For this stock the F_{MSY} proxy has been revised from 12.3% to 11.7%.

For *Nephrops* stocks MSY $B_{trigger}$ has been defined as the lowest stock size from which the abundance has increasedand is calculated as 1016 million individuals. This value was rounded to 1020 million, in the advice from WKMSYRef4 on MSY $B_{trigger}$. Full details are contained in the stock annex.

These should remain under review by WGCSE and may be revised should improved data become available.

Table 3.6.4 and Figure 3.6.6 show the harvest ratios for FU12. The harvest ratio has fluctuated over the time-series and and was below the MSY proxy in 2014 at 5.8% and 2015 at 6.4% due to a combination of lower landings and higher abundance. It is likely that prior to 2006, the harvest ratios are underestimates due to under-reported landings.

3.6.6 Management strategies

Scotland has recently established a network of regional Inshore Fisheries Groups (rIFGs), non-statutory bodies that aim to improve the management of Scotland's inshore fisheries out to six nautical miles, and to give commercial inshore fishermen a strong voice in wider marine management developments. The rIFGs will contribute to regional policies and initiatives relating to management and conservation of inshore fisheries, including impacts on the marine environment and the maintenance of sustainable fishing communities and measures designed to better conserve and sustainably exploit stocks of shellfish and sea fish (including salmon) in their local waters. Although no IFG proposals specific to the management of *Nephrops* fisheries have yet been adopted, some of the IFG management plans for the Scottish West Coast include spatial management of *Nephrops* fisheries and the introduction of creel limits.

3.6.7 Quality of assessment and forecast

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 trawl fishery adequately. The landings length compositions from 1999 onwards are derived from both creel and trawl samples. The creel fishery, which accounts for over 20% of the landings and increasingly operates over similar areas to trawling, and exhibits a length composition composed of larger animals.

There are concerns over the accuracy of historical landings and effort data prior to 2006 when Buyers and Sellers legislation was introduced and the reliability began to improve. Because of this, the final assessment adopted is independent of official statistics. Harvest ratios since 2006 are also considered more reliable due to more accurate landings data reported under new legislation. Incorporation of creel length compositions has also improved estimates of harvest ratios.

Underwater TV surveys have been conducted for this stock every year since 1995. The number of valid stations in the survey has remained relatively stable throughout the time period. The UWTV-FU12 is targeted at known areas of mud, sandy mud and muddy sand within the South Minch. The variance of density estimates in the South

Minch is relatively high, particularly in the sandy mud strata,which result in large confidence intervals and a greater uncertainty on the abundance estimates. This makes it difficult to determine which population changes are significant.

There is a need to explore options to implement further stratification for the South Minch survey area. In the provision of catch options based on the absolute survey estimates, additional uncertainties related to mean weight in the landings and the discard rates also arise. A three year average (2013–2015) of discard rates (adjusted to account for some survival of discarded animals) has been used in the calculation of catch options.

The cumulative relative to absolute conversion factor estimates for FU12 are largely based on expert opinion. The precision of these bias corrections cannot yet be characterised. The landings derived in the forecast (catch options table) are sensitive to the input dead discard rate and mean weights in landings, and this introduces uncertainties in the catch forecasts. Precision estimates are needed for these forecast inputs.

The overall area of the ground is estimated from the available BGS contoured sediment data and at present is considered to be a minimum estimate. Work is underway to improve the area estimation. VMS data, recently made available and linked to landings (from queries of the Scottish FIN database), suggest no major differences between areas fished and the mud sediment maps. Two other factors however, are likely to increase the estimate of ground area available for *Nephrops* and *Nephrops* directed fishing. Firstly, the inclusion of vessels smaller than 15 m would likely increase the fished area in some of the inshore locations and secondly, it is known that most of the sea lochs have areas of mud substrate and are typically fished by creel boats. In recent years, limited TV surveys have taken place in some of the sea lochs and attempts are being made to utilise these data to improve estimates of mud area and *Nephrops* abundance in the South Minch.

3.6.8 Recommendation for next benchmark

This stock was last benchmarked in 2009. WGCSE will keep the stock under close review and recommend future benchmark as required.

3.6.9 Management considerations

ICES 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 controls to ensure effort and catch were in line with resources available.

Creel fishing takes place in this area but overall effort in terms of creel numbers is not known and measures to control numbers are not in place. There is a need to ensure that the combined effort from all forms of fishing is taken into account when managing this stock.

There is a bycatch of other species in the area of the South Minch and estimated discards of whiting and haddock by the TR2 fleet are high in 6.a generally. It is important that efforts are made to ensure that unwanted bycatch is kept to a minimum in this fishery. Current efforts to reduce discards and unwanted bycatches of cod include the implementation of large square meshed panels (SMPs) of 120 mm under the west coast emergency measures, and SMPs of 200 mm under Scottish Conservation Credits scheme.

3.6.10 References

Afonso-Dias, M. S. 1998. Variability of *Nephrops norvegicus* (L.) populations in Scottish waters in relation to the sediment characteristics of the seabed. PhD Thesis University of Aberdeen. 282 pp.

Charuau A., Morizur Y., Rivoalen J.J. 1982. Survival of discarded *Nephrops norvegicus* in the Bay of Biscay and in the Celtic Sea, ICES-CM-1982/B:13.

Council Reg. (EU) 43/2009.

Howard F.G. and Hall, W.B. 1983. Some observations on the biometrics of *Nephrops norvegicus* (L.) in Scottish waters. ICES, Doc.ShellfishComm.,CM1983/K:36.

ICES. 2010. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 9–11 November 2010, Lisbon, Portugal. ICES CM 2010/SSGESST:22. 95 pp.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 6–8 March 2012, Acona, Italy. ICES CM 2012/SSGESST:19. 36 pp.

ICES. 2013. Report of the Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM 2013/45 230 pp.

ICES. 2016. EU request to ICES to provide FMSY ranges for selected stocks in ICES subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

Sangster, G.I., Breen, M., Bova, D.J., Kynoch, R., O'Neill, F.G., Lowry. N., Moth-Poulsen, T. Hansen, U.J., Ulmestrand, M., Valentinsson, D., Hallback, H., Soldal, A.V., and Hoddevik, B. 1997. *Nephrops* survival after escape and discard from commercial fishing gear. Presented at ICES FTFB Working Group, Hamburg, Germany 14–17 April, 1997, ICES CM 1997 CM/B.

Wileman, D.A., Sangster, G.I., Breen, M., Ulmestrand, M., Soldal, A.V. and Harris, R.R. 1999. Roundfish and *Nephrops* survival after escape from commercial fishing gear. EU Contract Final Report. EC Contract No: FAIR-CT95-0753.

Table 3.6.1. ***Nephrops*****, South Minch (FU12), ICES estimates of landings of** ***Nephrops*****, 1981–2015.**

	UK Scotland						
year	*Nephrops* trawl	other trawl	creel	subtotal	other UK	Ireland	total
1981	2,966	254	432	3,652	0	0	3,652
1982	2,925	206	421	3,552	0	0	3,552
1983	2,595	362	456	3,413	0	0	3,413
1984	3,229	477	594	4,300	0	0	4,300
1985	3,096	424	488	4,008	0	0	4,008
1986	2,694	288	502	3,484	0	0	3,484
1987	2,928	418	546	3,892	0	0	3,892
1988	3,544	364	555	4,463	10	0	4,473
1989	3,846	338	561	4,745	0	0	4,745
1990	3,732	263	435	4,430	0	0	4,430
1991	3,596	342	503	4,441	1	0	4,442
1992	3,478	209	549	4,236	1	0	4,237
1993	3,609	194	650	4,453	5	0	4,458
1994	3,742	264	405	4,411	3	0	4,414
1995	3,443	717	508	4,668	14	0	4,682
1996	3,108	417	469	3,994	1	0	3,995
1997	3,518	329	493	4,340	3	1	4,344
1998	2,851	340	538	3,729	0	1	3,730
1999	3,165	359	514	4,038	0	14	4,052
2000	2,940	311	700	3,951	0	2	3,953
2001	2,823	391	768	3,982	0	9	3,991
2002	2,234	314	743	3,291	0	14	3,305
2003	2,812	203	858	3,873	0	6	3,879
2004	2,864	105	879	3,848	0	21	3,869
2005	2,812	46	955	3,813	1	34	3,848
2006	3,570	97	922	4,589	9	35	4,633
2007	4,437	21	959	5,417	19	35	5,471
2008	4,433	12	896	5,341	2	13	5,356
2009	3,346	24	900	4,270	4	11	4,285
2010	2,836	19	969	3,824	16	6	3,846
2011	2,876	11	783	3,670	23	9	3,702
2012	3,159	32	773	3,964	19	6	3,989
2013	2,490	543	729	3,762	13	1	3,776
2014	2,067	422	637	3,126	32	17	3,175
2015*	2,173	508	658	3,339	22	33	3,394

*** Provisional NA = not available. Note that 2014 landings were revised.**

Table 3.6.2. ***Nephrops*** **South Minch (FU12). Results by stratum of the 2013–2015 TV surveys. Note that stratification was based on a series of sediment strata (M – Mud, SM – Sandy mud, MS – Muddy sand).**

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance	Survey Precision Level (RSE)
2013 TV Survey								
M	303	3	0.318	0.018	96.2	560	0.01	
SM	2741	19	0.413	0.113	1131.1	44628	0.769	
MS	2028	16	0.242	0.05	490.9	12825	0.021	
Total	5072	38			1718.2	58013	1	0.137
2014 TV Survey								
M	303	4	0.212	0.001	64.3	32	0	
SM	2741	16	0.52	0.115	1424.8	53930	0.769	
MS	2028	16	0.288	0.063	583.7	16174	0.231	
Total	5072	36			2072.8	70135	1	0.123
2015 TV Survey								
M	303	4	0.509	0.141	154.4	3236	0.049	
SM	2741	16	0.486	0.114	1330.1	53565	0.811	
MS	2028	15	0.253	0.034	513	9215	0.14	
Total	5072	35			1997.5	66016	1	0.125

Table 3.6.3. *Nephrops*, South Minch (FU12): Results of the 1995–2015 TV surveys (adjusted for bias).

YEAR	STATIONS	MEAN DENSITY BURROWS/M^2	ABUNDANCE MILLIONS	95% CONFIDENCE INTERVAL MILLIONS
1995	33	0.227	1152	251
1996	21	0.288	1473	530
1997	36	0.212	1086	185
1998	38	0.288	1452	232
1999	37	0.212	1086	260
2000	41	0.364	1854	348
2001	47	0.402	2037	459
2002	31	0.371	1899	567
2003	25	0.424	2157	756
2004	38	0.508	2558	473
2005	33	0.432	2208	740
2006	36	0.364	1845	598
2007	39	0.197	1016	155
2008	33	0.318	1608	415
2009	25	0.303	1542	634
2010	34	0.409	2076	665
2011	36	0.383	1945	779
2012	38	0.182	919	185
2013	38	0.339	1718	365
2014	36	0.409	2073	530
2015	35	0.394	1998	514

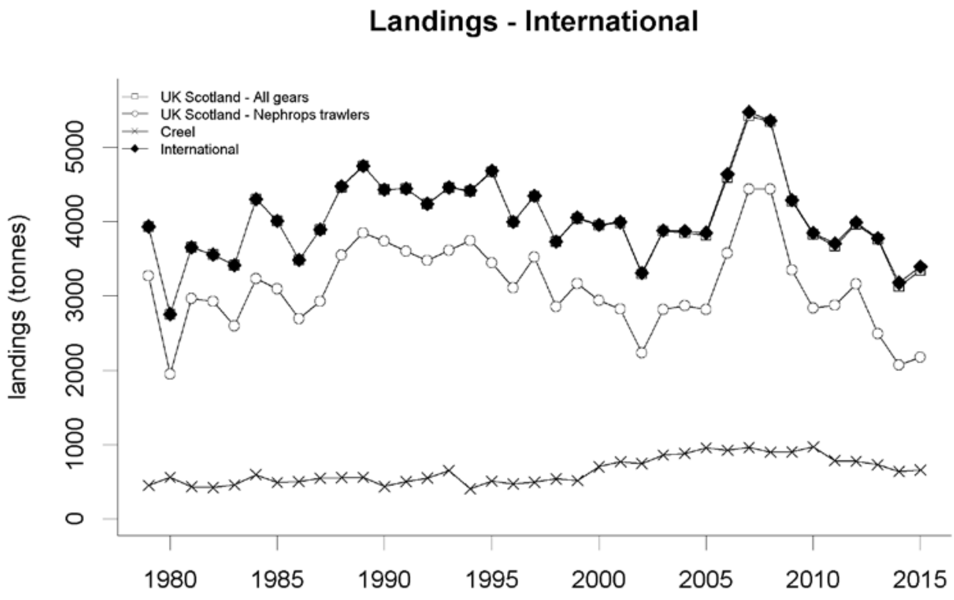
Table 3.6.4. *Nephrops*, South Minch (FU12): Adjusted TV survey abundance, landings, discard rate proportion by number) and estimated harvest rate.

YEAR	LANDINGS IN NUMBER (MILLION)	DISCARDS IN NUMBERS (MILLIONS)	REMOVALS IN NUMBER (MILLIONS)**	ADJUSTED SURVEY (MILLIONS)	HARVEST RATIO*	LANDINGS (TONNES)	DISCARDS (TONNES)	DISCARD RATE	DEAD DISCARD RATE	MEAN WEIGHT IN LANDINGS (G)	MEAN WEIGHT IN DISCARDS (G)
1999	161	29	183	1086	16.9	4,052	206	15.4	12	25.14	7
2000	145	33	170	1854	9.2	3,953	284	18.7	14.7	27.3	8.5
2001	168	65	216	2037	10.6	3,991	591	27.9	22.5	23.79	9.11
2002	123	26	143	1899	7.5	3,305	247	17.6	13.8	26.83	9.37
2003	139	38	168	2157	7.8	3,879	381	21.3	16.9	27.86	10.1
2004	141	44	175	2558	6.8	3,869	454	23.8	19	27.37	10.26
2005	137	49	174	2208	7.9	3,848	452	26.5	21.2	28.11	9.17
2006	177	30	199	1845	10.8	4,633	324	14.3	11.1	26.24	10.97
2007	228	66	278	1016	27.3	5,471	903	22.4	17.8	23.95	13.73
2008	224	74	279	1608	17.4	5,356	605	24.7	19.8	23.91	8.23
2009	179	26	199	1542	12.9	4,285	216	12.5	9.6	23.87	8.44
2010	149	12	158	2076	7.6	3,846	133	7.7	5.9	25.86	10.76
2011	118	11	126	1945	6.5	3,702	92	8.2	6.3	31.1	8.78
2012	136	16	149	919	16.2	3,989	149	10.8	8.3	29.17	9.05
2013	136	4	140	1718	8.1	3,776	50	3.1	2.4	27.48	11.31
2014	105	19	120	2073	5.8	3,175	233	15.6	12.1	29.91	12.04
2015	120	10	128	1998	6.4	3,394	121	7.7	5.9	28.15	12.04
Average***									6.80%	26.8	9.9

***Harvest rates previous to 2006 are unreliable.**

**** Removals numbers take the dead discard rate into account.**

***** Dead discard average: 2013–2015; Mean weight in landings and discards average: 1999–2015.**



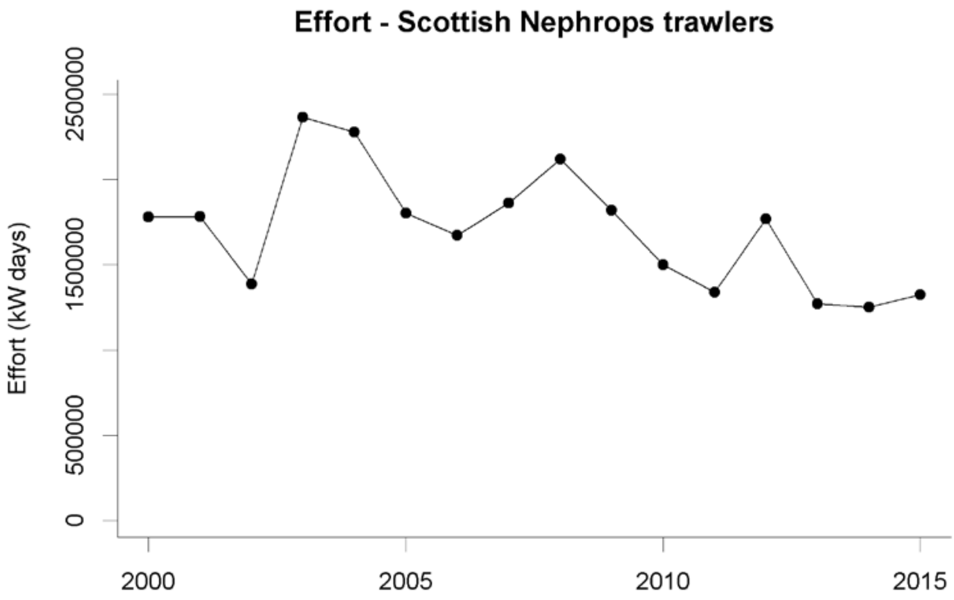
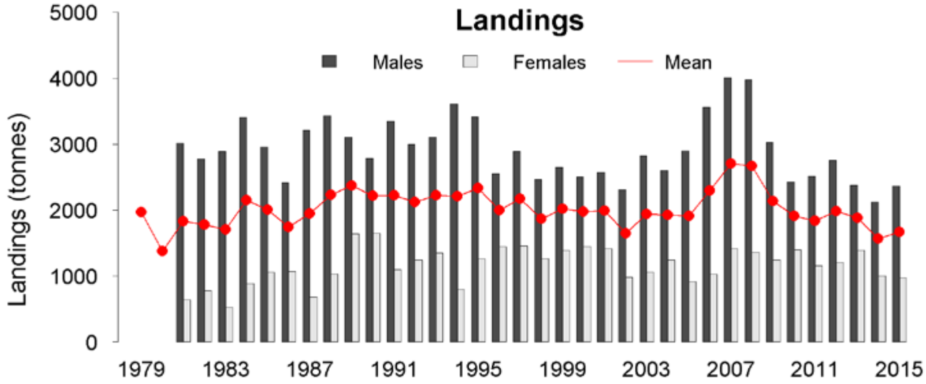


Figure 3.6.1. ***Nephrops,*** **South Minch (FU12). Long-term landings and effort.**



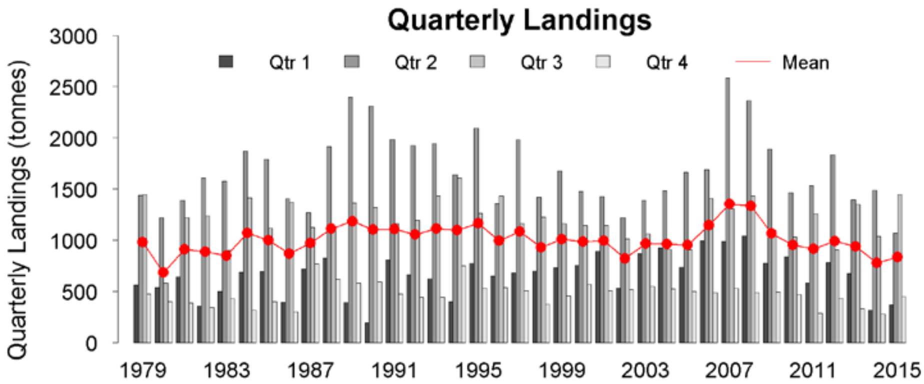


Figure 3.6.2. (a) ***Nephrops*****, South Minch (FU12). Landings by sex and quarter from Scottish trawlers.**

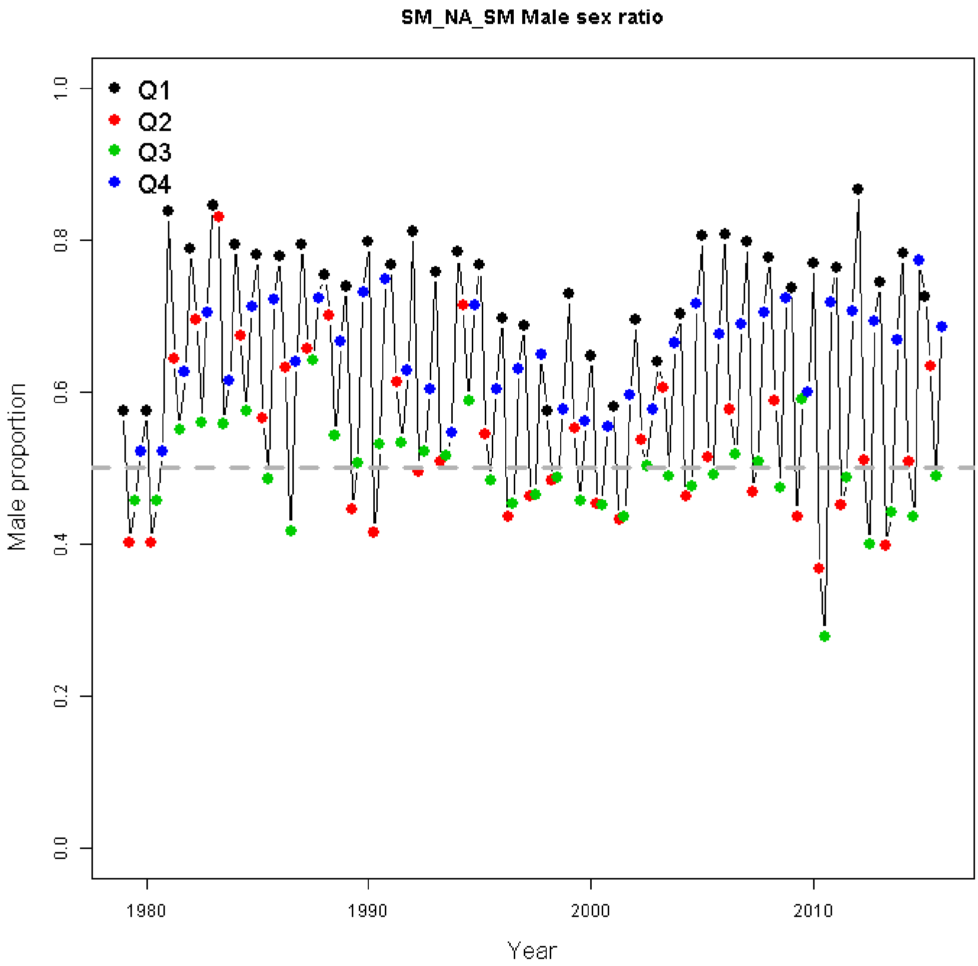


Figure 3.6.2. (b) ***Nephrops,*** **South Minch (FU12), Proportion of males by quarter (1980–2015).**

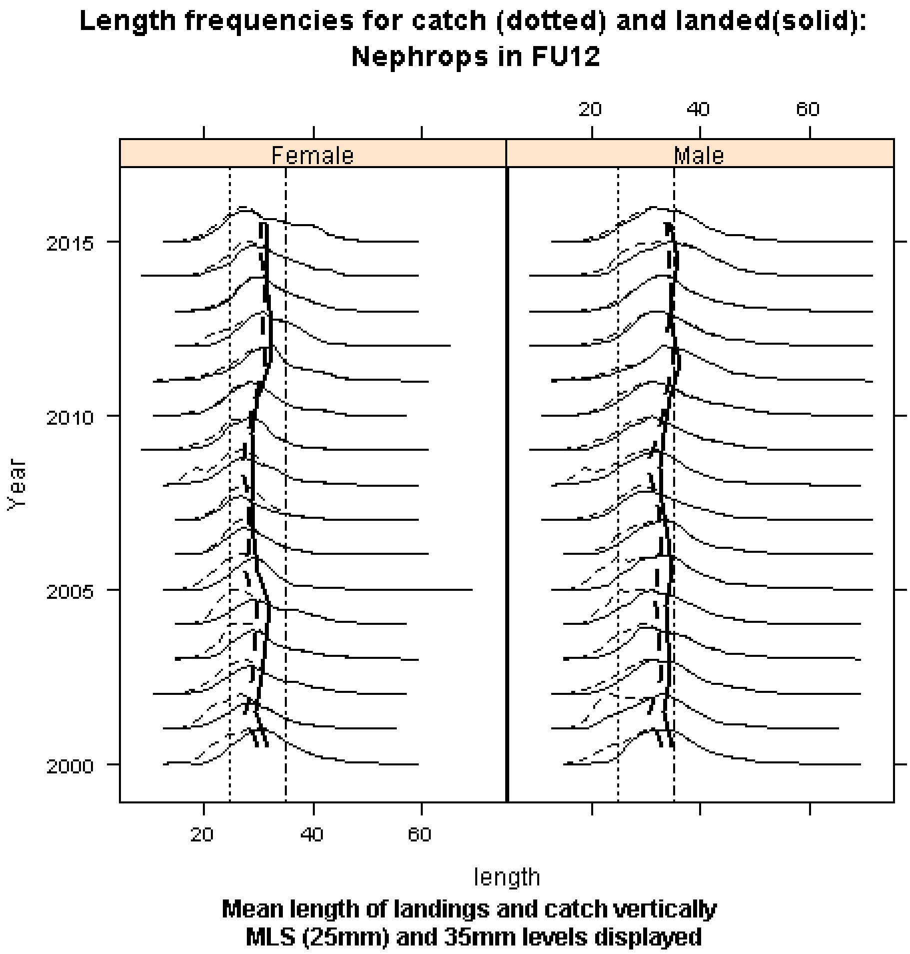


Figure 3.6.3. ***Nephrops*****. South Minch (FU12). Catch length–frequency distribution and mean sizes (red line) for** ***Nephrops*** **in the South Minch, 2000–2015.**

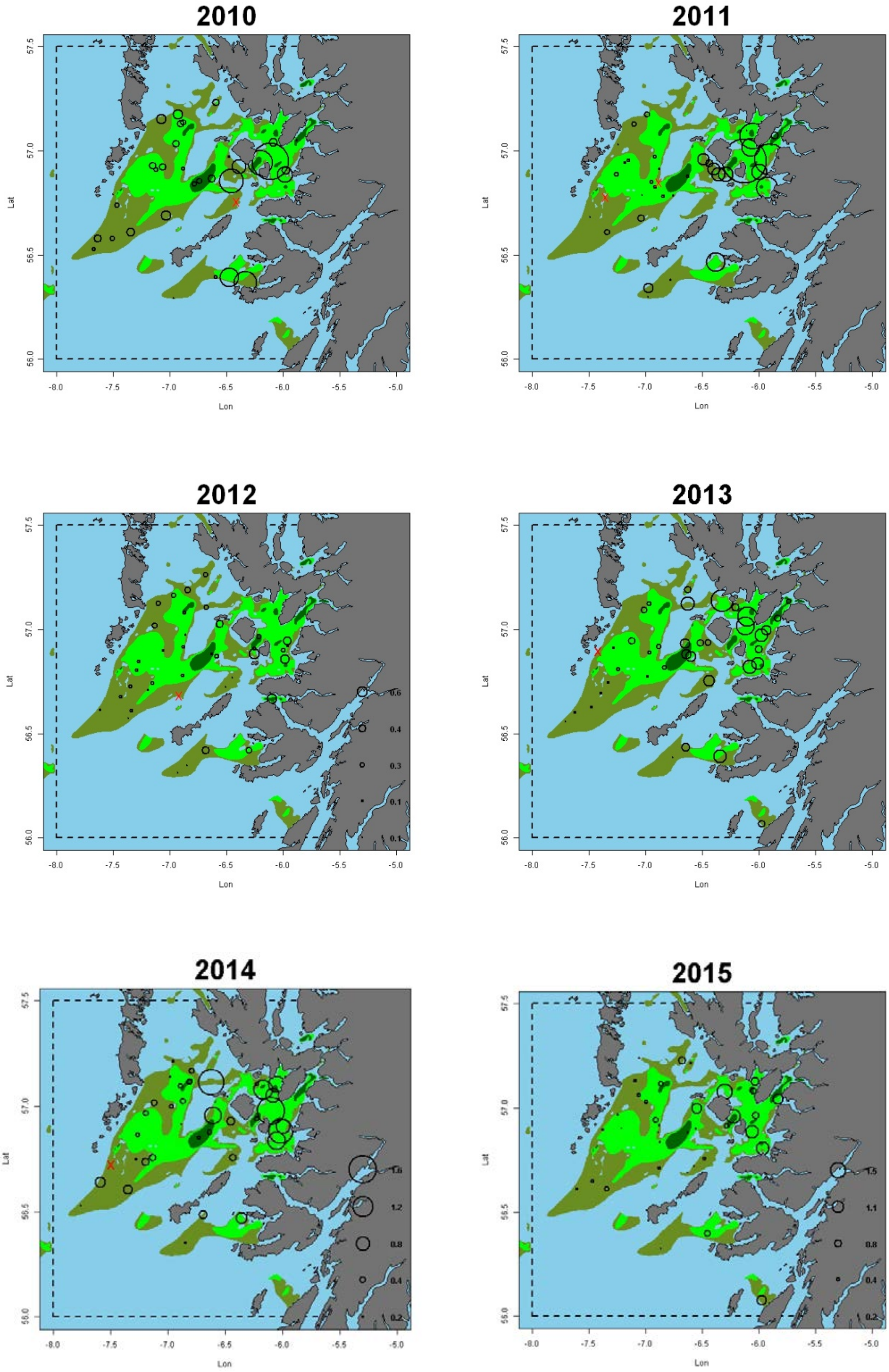


Figure 3.6.4. ***Nephrops*, South Minch (FU12), TV survey station distribution and relative density (burrows/m²), 2010–2015. Shaded green and brown areas represent areas of suitable sediment for *Nephrops*. Bubbles in this figure are all scaled the same. Red crosses represent zero observations.**

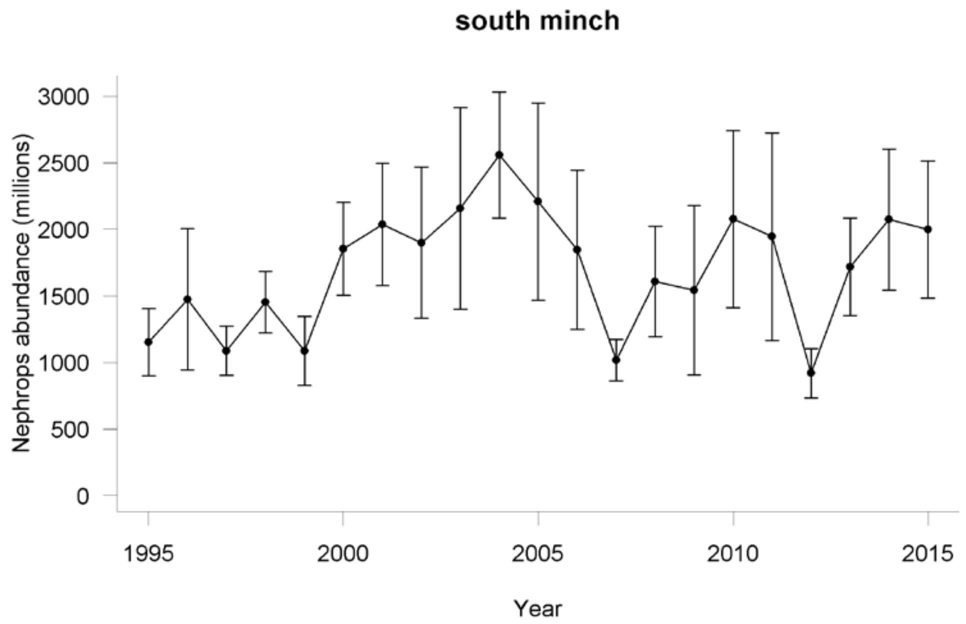


Figure 3.6.5. ***Nephrops*****, South Minch (FU12), Time-series of TV survey abundance estimate (adjusted for bias), with 95% confidence intervals, 1995–2015.**

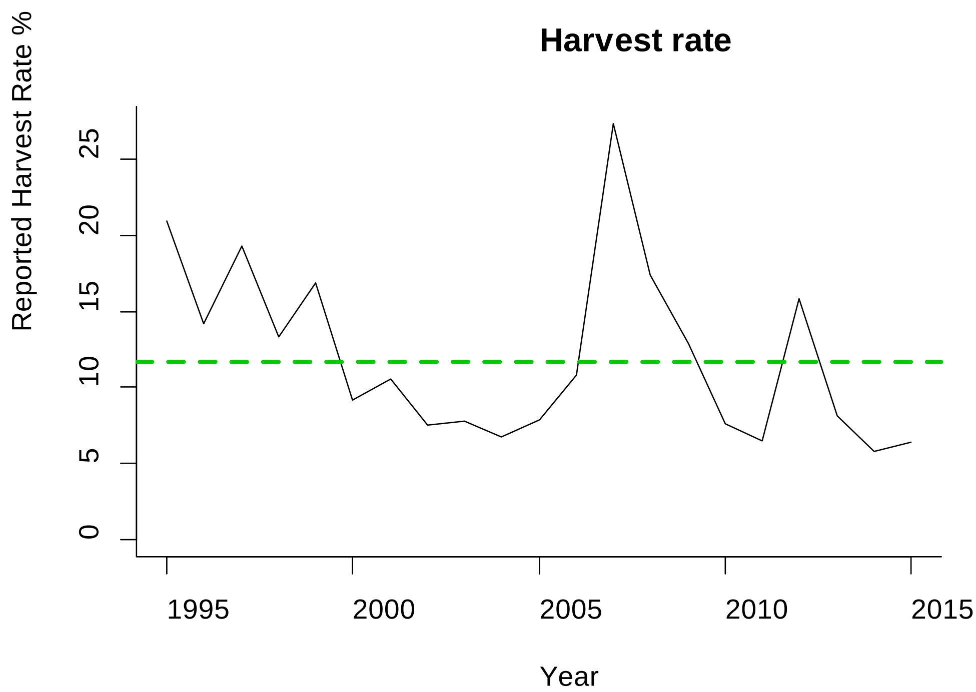


Figure 3.6.6. Nephrops, South Minch (FU12), harvest rate, 1995–2015. The dashed and solid lines are the MSY proxy and the harvest rate respectively.

3.7 Clyde, FU13

Type of assessment in 2016

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 (WKNEPH, 2009; WKNEPH, 2013). Full details are provided in the stock annex.

ICES advice applicable to 2015

"ICES advises, on the basis of the MSY approach and considering that no discard ban is in place in 2015, that landings should be no more than 4390 tonnes (3776 t for the Firth of Clyde and 614 t for the Sound of Jura). Assuming that discard rates do not change from the average of the last three years (2011–2013) the resulting total catch would be no more than 4861 t (4184 t for the Firth of Clyde and 677 t for the Sound of Jura)."

ICES advice applicable to 2016

"ICES advises that when the MSY approach is applied, catches in 2016 (assuming zero discards) should be no more than 6568 tonnes (5554 tonnes for the Firth of Clyde and 1014 tonnes for the Sound of Jura). If instead discard rates continue at recent values (average of 2012–2014) and there is no change in assumed discard survival rate, this implies landings of no more than 6206 tonnes (5247 tonnes for the Firth of Clyde and 959 tonnes for the Sound of Jura)."

3.7.1 General

Stock description

The Clyde FU comprises two distinct patches in the Firth of Clyde and the Sound of Jura, to the east and west of the Mull of Kintyre respectively. The hydrography of the two subareas differs, with the Sound of Jura characterised by stronger tidal currents and the Firth of Clyde exhibiting features of a lower energy environment with a shallow entrance sill. Owing to its burrowing behaviour, the distribution of *Nephrops* is restricted to areas of mud, sandy mud and muddy sand. Within the two distinct patches these substrates are distributed according to prevailing hydrographic and bathymetric conditions. The available area of suitable sediment is smaller in the Sound of Jura, occupying only the deepest parts of the Sound, while in the Firth of Clyde these sediments predominate. Further details are provided in the stock annex.

Management applicable to 2015 and 2016

Management is at the ICES subarea level as described at the beginning of Section 3.5 (FU11 North Minch report).

Ecosystem aspects

Details of the ecosystem aspects for this functional unit are provided in the stock annex where available.

Fishery description

Information on developments in the fishery was provided by Marine Scotland staff, including fishery officers and scientists sampling in the ports and on board vessels.

The fishery in 2015 was described as "stable; not great" and it was noted that many vessels were switching between both sides of the peninsula (fishing Clyde and the Sound of Jura). The fishing was again poor during the winter months. There was a noticeable decrease in the influx of Northern Irish vessels in 2015, because the fishing was reported to be good in their local areas. Lower fuel costs and strong prices for *Nephrops* meant good profit margins for the fleet.

The resident fleet is composed of 14 vessels from Tarbert, ten vessels from Campbeltown and four vessels from Carradale, that operate predominantly *Nephrops* trawls. There are also ~30 under 10 meters vessels working *Nephrops* creels. All trawlers use 80 mm single or twin rigs with square mesh panels (SMP) of at least 120 mm, in accordance with west coast emergency measures conditions (Council Reg. (EU) 43/2009). Under the Scottish Conservation Credits scheme, vessels with power >112 kW are required to use a 200 mm SMP. The most significant landings were from the main landing ports of Troon, Girvan and Largs on the east side of the Clyde, and Campbeltown, Tarbert and Carradale on the west side of the Clyde. Almost all of the Clyde *Nephrops* fleet are day trippers although it has been reported that a number of vessels will stay out for two or three days to save fuel costs.

Mobile gear is banned in the Inshore Clyde from Friday night to Sunday night as are vessels greater than 21 m in length. A number of creel boats operate in the Clyde, most of them with two crew members and operating around 1000 creels. Creeling activity now takes place quite widely in the northern parts of the Firth operating on some of the same grounds but often taking place during the weekend trawling ban.

3.7.2 Data available

InterCatch

Data for 2015 were successfully uploaded into InterCatch prior to the 2016 WG meeting according with the deadline proposed. Uploaded data were worked up in InterCatch to generate 2015 raised international length–frequency distributions. Data exploration in InterCatch has previously shown that outputs of raised data were very close to those generated by the previous method applied internally with differences being <0.1%. As such, InterCatch length–frequency outputs have been used in the stock assessment since 2012.

Commercial catch

Official catch statistics (landings) reported to ICES are shown in Table 3.5.2 (see FU11 North Minch report, Section 3.5). These relate to the whole of 6.a of which the Clyde FU is a part. Landings statistics for FU13 provided through national laboratories are presented in Table 3.7.1, broken down by country and by gear type. Landings from this fishery are predominantly reported from Scotland, although Northern Ireland contributed 16% in 2015. Total reported Scottish landings in 2015 were 4235 tonnes (plus 898 tonnes from other UK vessels), consisting of 4029 tonnes landed by trawlers (95%) and 206 tonnes (5%) landed by Scottish creel vessels. Creel landings have generally increased in the most recent years (although fell slightly in 2015) but remain at a low level compared to other gears and to the creel fisheries elsewhere on the west coast of Scotland.

Statistical rectangle 40E4 covers parts of both the Firth of Clyde and the Sound of Jura. Table 3.7.2 shows the split in landings between the two subareas comprising FU13. The allocation of landings to the two components of FU13 relies in part on the fishery office having detailed knowledge of where vessels have been fishing within 40E4. The sudden decline in landings from the Sound of Jura in 2001 does not seem to be associated with a sudden change in fishing practices and may instead be due to changes in fishery office recording practices. For this reason, the commercial landings data are now presented for the combined Firth of Clyde and Sound of Jura.

Effort data

In 2015 WGCSE agreed that effort should be reported in Kw days as this is likely to be more informative about changes in the actual fleet effort. Effort shows an overall decreasing trend but was stable through 2010 to 2012 (Figure 3.7.1). Effort decreased in 2015 which may explain the decline in landings. Note that the effort time-series range (2000–2015) do not match with the more extensive year range available for landings due to a lack of reliable effort data in the Marine Scotland Science in-house database.

Sampling levels

Length compositions of landings and discards are obtained during market and on-board observer sampling respectively. These sampling levels are shown in Table 3.5.4 (see FU11 North Minch report, Section 3.5). Sampling of landings length compositions in the Sound of Jura is more infrequent but samples have been included in the FU13 raising procedure when available. Length compositions for the creel fishery are available for landings only. The small numbers of discards from this fishery have a survival rate and are not considered to be removed from the population.

Length compositions

Although assessments based on detailed catch analysis are not presently carried out, examination of length compositions can provide a preliminary indication of exploitation effects. Figure 3.7.3 shows a series of annual Clyde length–frequency distributions for the period 2000 to 2015. Catch (removals) length compositions are shown for each sex along with the mean size for both. In both sexes the mean sizes have been fairly stable over time. Examination of the tails of the distributions above 35 mm shows no evidence of reductions in relative numbers of larger animals. This parameter might be expected to reduce in size if overexploitation was taking place but there is no evidence of this.

Sex ratio

Sex ratio in the Clyde shows some variation but males generally make the largest contribution to the annual landings shown in Figure 3.7.2(a). This occurs because males are available throughout the year and the fishery takes place in all quarters, although effort is reduced during the winter months because of poor weather. Females on the other hand are mainly taken in the summer when they emerge after egg hatching. The seasonal change in proportion of males to females is evident in Figure 3.7.2(b) where males typically dominate in quarters one and four but the ratio is generally more even in quarters two and three. In 2014 and 2015 we can see that males were dominant in quarters one, two and four.

Mean weights

The mean weights in the landings have remained relatively stable in the FU and show a slight increase in 2015 compared to 2014 (Table 3.7.7). There is a trend of increasing mean weights in the samples of landings for creel catches particularly for male *Nephrops,* although sampling levels are very low especially in the earlier years of the time-series (Figures 3.5.6 and 3.5.7; see FU11North Minch report, Section 3.5).

Discarding

Discarding of undersized and unwanted *Nephrops* occurs in the Clyde fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discard rates have been high in this FU and have averaged around 30% by number in this FU since 1999. Since 2010, discard rates have been estimated to be substantially lower than the average and there was a slight decrease in 2015 compared to 2014 (Table 3.7.7).

Studies (Charuau *et al*., 1982; Sangster *et al*., 1997; Wileman *et al*., 1999) suggest 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. The discard survival rate for creel caught *Nephrops* has been shown to be high (WKNEPH, 2013) and a value of 100% is used. The discard rate for use in the forecast adjusted to account for some survival was estimated to be 15.5% (taking a three year average 2013–2015).

Abundance indices from UWTV surveys

Underwater TV surveys are available for both subareas since 1995 although the Sound of Jura has been surveyed more infrequently. Underwater television surveys of *Nephrops* burrow distributions avoid the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*. TV surveys are targeted at known areas of mud, sandy mud and muddy sand in which *Nephrops* construct burrows. On average, 38 stations have been considered valid each year (for the Firth of Clyde) and then raised to the estimated ground area available for *Nephrops*; in total 2080 km^2 based on contoured superficial sediment information (British Geological Surveys). In 2015, 37 valid stations were used in the survey final analysis for the Firth of Clyde (Table 3.7.4) and 12 stations for the Sound of Jura (Table 3.7.6).

Full details of the UWTV approach can be found in the stock annex and the report of (WKNEPH) in 2009 (ICES, 2009). Table 3.7.3 shows detailed analysis for the most recent TV surveys conducted in the Firth of Clyde. This includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. Details for the Sound of Jura are shown in Table 3.7.5. A CV (relative standard error) of <20% is considered an acceptable precision level for UWTV survey estimates of abundance. CVs for the three most recent TV surveys in Firth of Clyde and Sound of Jura (Tables 3.7.3 and 3.7.5) are lower than the precision level agreed.

Figure 3.7.4 shows the distribution of stations in recent TV surveys (2010–2015) across FU13 (the two distinct subareas can be clearly seen) with the size of the symbols proportional to the *Nephrops* burrow density. Table 3.7.4 and Figure 3.7.5 show the time-series estimated abundance for the TV surveys in the Firth of Clyde, with 95% confidence intervals on annual estimates. Similar information for the Sound of Jura is shown in Table 3.7.6 and Figure 3.7.6. The most recent survey suggests continued higher density in the south part of the functional unit.

The TV survey estimates of abundance for *Nephrops* in the Firth of Clyde suggest that the population increased until the mid-2000s implying a sustained period of increased recruitment. Following this, abundance has declined and fluctuated around the values previously observed in the early 2000s (Figure 3.7.5).

There is not a continuous time-series of abundance in the Sound of Jura and in some years (particularly 2002 and 2006), estimates are associated with large confidence intervals. Abundance has fluctuated with no obvious trend. In 2013 the abundance was at the second lowest point in the time-series. Abundance increased in 2014 and 2015 (Figure 3.7.6).

3.7.3 Assessment

Comparison with previous assessments

The assessment in 2016 is based on a combination of examining trends in fishery indicators and underwater TV using an extensive data series for the Firth of Clyde component of FU13 and a more limited time-series of UWTV data from the Sound of Jura subarea. The assessment in 2016 follows that of 2015 in that the commercial data for Clyde and Sound of Jura have been combined because of concerns regarding the accuracy of the landings data. There are also no discard samples and limited market samples available for the Sound of Jura. Therefore the harvest rate and catches for the two areas are presented as a combined total. *Nephrops* abundance will continue to be monitored separately, with a TV survey in both subareas.

State of the stock

The underwater TV surveys are presented as the best available information on the stocks of *Nephrops* in the two subareas of FU13. The surveys provide fishery-independent estimates of *Nephrops* abundance. The details of the 2015 Firth of Clyde survey are shown in Table 3.7.3 and compared with the 2013 and 2014 outcomes. The details of the 2015 Sound of Jura survey are shown in Table 3.7.5. 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.

TV survey estimated stock abundance for the Firth of Clyde in 2015 was 1820 million individuals, a 27% increase from the 2014 estimate and well above the $B_{-trigger}$ value of 579 million. TV survey estimated stock abundance for the Sound of Jura in 2015 was 376 million individuals, a 63% increase on the 2014 estimate and above the $B_{-trigger}$ value of 160 million.

The calculated harvest ratio for the FU13 in 2015 (dead removals for both subareas/Firth of Clyde TV abundance = 15%) was just below the MSY_{proxy} for this stock (the value associated with high long-term yield and low risk depletion) of 15.1%. Note the MSY proxy for this stock was revised in October 2015 at WKMSYRef4 (ICES, 2015).

Firth of Clyde

		Fishing pressure				Stock size			
		2012	2013	2014			2013	2014	2015	
Maximum sustainable yield	F_{MSY}	✗	✓	✗	Above target	MSY $B_{trigger}$	✓	✓	✓	Above trigger
Precautionary approach	F_{pa}, F_{lim}	?	✓	?	Undefined	B_{pa}, B_{lim}	✓	✓	✓	Above possible reference points
Management plan	F_{MGT}	-	-	-	Not applicable	SSB_{MGT}	-	-	-	Not applicable

Sound of Jura

		Fishing pressure				Stock size			
		2012	2013	2014			2013	2014	2015	
Maximum sustainable yield	F_{MSY}	?	?	?	Undefined	MSY $B_{trigger}$	?	?	?	Undefined
Precautionary approach	F_{pa}, F_{lim}	?	?	?	Undefined	B_{pa}, B_{lim}	?	?	?	Undefined
Management plan	F_{MGT}	-	-	-	Not applicable	SSB_{MGT}	-	-	-	Not applicable

3.7.4 Catch option table

Landings predictions and catch options at various harvest ratios (based on principles established at WKNEPH (ICES, 2009)), will be made on the basis of the 2016 UWTV survey conducted in June. These will be presented in October 2016 for the provision of advice.

Catch option table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 3.7.7 and summarised below. The calculation of catch options for the FU13 follows the procedure outlined in the stock annex.

The table below shows the agreed inputs to the catch options table.

Input	Data	2016 assessment
Survey abundance (millions)	UWTV 2016	Not yet known
Mean weight in landings	2013–2015	21.2
Mean weight in discards	2013–2015	7.9
Average dead discard rate	Last three years	15.5%

3.7.5 Reference points

F_{MSY} proxy for this stock was revised in October 2015 at WKMSYRef4 (ICES, 2016a; ICES, 2016b) These are updated on the basis of an average of estimated F_{MSY} proxy harvest rates over a period of years, this corresponds more closely to the methodology for finfish. In cases where there is a clear trend in the values a five year average was chosen. Similarly, the five year average of the F at 95% of the YPR obtained at the F_{MSY} proxy reference point was proposed as the F_{MSY} lower bound and the five year average of the F above F_{max} that leads to YPR of 95% of the maximum as the upper bound. Using an average value also has the advantage of reducing the effect of any unusually high or low estimates of the F_{MSY} proxy which occasionally appear. For this stock the F_{MSY} proxy has been revised from 16.4% to 11.7%.

For *Nephrops* stocks MSY $B_{trigger}$ has been defined as the lowest stock size from which the abundance has increased and is calculated as 579 million individuals for the Firth of Clyde. The advice from WKMSYRef4 (ICES, 2016b) rounded this value to give an MSY $B_{trigger}$ of 580 million.

An MSY $B_{trigger}$ was not previously proposed for FU13 (SJ) as there were few points in the survey series (due to missing years). WKMSYRef4 stated that the survey series is now considered to be of sufficient length to allow the B_{loss} (abundance in 1995) to be proposed as the MSY $B_{trigger}$. This results in a value of 160 million (ICES, 2016b). Full details are contained in the stock annex.

These should remain under review by WGCSE and may be revised should improved data become available.

Table 3.7.7 and Figure 3.7.7 show the estimated harvest ratios over this period. The harvest rate was calculated from the total dead removals for both subareas divided by the Firth of Clyde TV abundance (we do not have a full time-series of TV surveys for the Sound of Jura). Harvest rates in the Clyde peaked in 2007 at 52% before declining to around the MSY proxy level in 2010–2011. The harvest rate has fluctuated since then and fell from 26.6% in 2014 to 15% in 2015. It is unlikely that prior to 2006, the estimated harvest ratios are representative of actual harvest ratios due to underreporting of landings.

3.7.6 Management strategies

Scotland has recently established a network of regional Inshore Fisheries Groups (rIFGs), non-statutory bodies that aim to improve the management of Scotland's inshore fisheries out to six nautical miles, and to give commercial inshore fishermen a strong voice in wider marine management developments. The rIFGs will contribute to regional policies and initiatives relating to management and conservation of inshore fisheries, including impacts on the marine environment and the maintenance of sustainable fishing communities and measures designed to better conserve and sustainably exploit stocks of shellfish and sea fish (including salmon) in their local waters. Although no IFG proposals specific to the management of *Nephrops* fisheries have yet been adopted, some of the IFG management plans for the Scottish West Coast include spatial management of *Nephrops* fisheries and the introduction of creel limits.

A weekend ban on mobile gear was introduced in the Clyde in 1986 under a Scottish Statutory Instrument. Mobile gear is banned in the Inshore Clyde from Friday night to Sunday night as are vessels greater than 21 m in length.

3.7.7 Quality of assessment and forecast

There are concerns over the accuracy of historical landings and effort data and because of this the final assessment adopted is independent of official statistics. Harvest ratios since 2006 are also considered more reliable due to more accurate landings data reported under new legislation.

One of the main issues for this FU is the problem of not being able to split the landings between the Sound of Jura and Firth of Clyde. This means that we are unable to provide harvest ratios for the two subareas separately. What is currently provided is not actually a harvest ratio for either sub area; but is likely more representative of the Firth of Clyde. This has an impact on the quality of the assessment but not on the forecast.

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 the Firth of Clyde subarea fishery since 1990, and is considered to represent the fishery adequately. There are few samples available from the Sound of Jura and these have been included in the FU13 raising procedure.

Underwater TV surveys have been conducted for this stock every year since 1995. The number of valid stations in the survey has remained relatively stable throughout the time period. Confidence intervals around the abundance estimates are stable throughout the series and relatively low compared with other FUs in 6.a. In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. A three year average (2013–2015) of discard rate (adjusted to account for some survival of discarded animals) has been used in the calculation of catch options.

The cumulative relative to absolute conversion factor estimates for FU13 component is largely based on expert opinion (see stock annex). The precision of these bias corrections cannot yet be characterised. The method to derive landings for the catch options is sensitive to the input dead discard rate and mean weight in landings and this introduces uncertainties in the catch forecasts. Precision estimates are needed for these forecast inputs.

The overall area of the ground is estimated from the available BGS contoured sediment data and at present is considered to be a minimum estimate. VMS data, recently made available and linked to landings (from queries of the Scottish FIN database) suggest no major differences between areas fished and the mud sediment maps. The inclusion of vessels smaller than 15 m would likely increase the fished area in some of the inshore locations, while in the Clyde the non-estimated sea loch areas are relatively small.

3.7.8 Recommendation for next benchmark

This stock was last benchmarked in 2009 (ICES, 2009). WGCSE recommends that the issue concerning the split of landings between Sound of Jura and the Firth of Clyde be examined.

3.7.9 Management considerations

The ICES 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 controls to ensure effort and catch were in line with resources available. In this FU the two subareas imply that additional controls may be required to ensure that the landings taken in each subarea are in line with the landings advice.

Creel fishing takes place in part of this area although the relative scale of the fishery is smaller than in the Minches. Overall effort in terms of creel numbers is not known and measures to control numbers are not in place. There is a need to ensure that the combined effort from all forms of fishing is taken into account when managing this stock.

There is a bycatch of other species in the area of the Firth of Clyde and estimated discards of whiting and haddock by the TR2 fleet are generally high in 6.a. It is important that efforts are made to ensure that unwanted bycatch is kept to a minimum in this fishery. Current efforts to reduce discards and unwanted bycatches of cod include the implementation of large square meshed panels (SMPs) of 120 mm under the west coast emergency measures, and SMPs of 200 mm under Scottish Conservation Credits scheme. A seasonal closure (early spring) in the southwest part of the Firth of Clyde is in place to protect spawning cod although *Nephrops* vessels are derogated to fish in those parts where mud sediments are distributed.

3.7.10 References

Bailey, N. and Chapman, C. J. 1983. A comparison of density, length composition and growth of two populations off the West coast of Scotland. ICES C. M. 1983/K:42.

Charuau A., Morizur Y., Rivoalen J.J. 1982. Survival of discarded *Nephrops norvegicus* in the Bay of Biscay and in the Celtic Sea, ICES-CM-1982/B:13.

Council Reg. (EU) 43/2009.

ICES. 2010. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 9–11 November 2010, Lisbon, Portugal. ICES CM 2010/SSGESST:22. 95 pp.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 6–8 March 2012, Acona, Italy. ICES CM 2012/SSGESST:19. 36 pp.

ICES. 2013. Report of the Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM 2013/ACOM:45. 230 pp.

ICES. 2016a. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

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

Sangster, G.I., Breen, M., Bova, D.J., Kynoch, R., O'Neill, F.G., Lowry. N., Moth-Poulsen, T. Hansen, U.J., Ulmestrand, M., Valentinsson, D., Hallback, H., Soldal, A.V., and Hoddevik, B. 1997. *Nephrops* survival after escape and discard from commercial fishing gear. Presented at ICES FTFB Working Group, Hamburg, Germany 14–17 April, 1997, ICES CM 1997 CM/B.

Tuck, I.D., Chapman C.J. and Atkinson, R.J.A. 1997. Population biology of the Norway lobster, *Nephrops norvegicus* (L.) in the Firth of Clyde, Scotland. I: Growth and density. ICES J. Mar.Sci 54, 125–135.

Tuck, I.D., Bailey, N., Atkinson, R.J.A. and Marrs, S.J. 1999. Changes in *Nephrops* density in the Clyde Sea area from UWTV survey data. ICES, Doc. Living Resources Comm., CM 1999/G:13 (mimeo).

Wileman, D.A., Sangster, G.I., Breen, M., Ulmestrand, M., Soldal, A.V. and Harris, R.R. 1999. Roundfish and *Nephrops* survival after escape from commercial fishing gear. EU Contract Final Report. EC Contract No: FAIR-CT95-0753.

Table 3.7.1. *Nephrops,* Clyde and Sound of Jura (FU13), ICES estimates of landings of *Nephrops,* 1981–2015.

	UK Scotland				other UK	total
year	*Nephrops* trawl	other trawl	creel	subtotal		
1981	2498	404	66	2968	0	2968
1982	2372	169	79	2620	0	2620
1983	3889	121	52	4062	14	4076
1984	3070	153	77	3300	10	3310
1985	3921	293	65	4279	7	4286
1986	4073	176	79	4328	13	4341
1987	2860	82	64	3006	3	3009
1988	3507	107	43	3657	7	3664
1989	2577	184	35	2796	16	2812
1990	2731	121	23	2875	34	2909
1991	2844	145	26	3015	23	3038
1992	2530	247	9	2786	17	2803
1993	3200	110	5	3315	28	3343
1994	2503	50	28	2581	49	2630
1995	3766	131	26	3923	64	3987
1996	3880	108	27	4015	42	4057
1997	3486	46	26	3558	63	3621
1998	4540	79	39	4658	183	4841
1999	3476	29	37	3542	210	3752
2000	3142	63	75	3280	137	3417
2001	2890	65	95	3050	132	3182
2002	3075	53	105	3233	151	3384
2003	2954	20	119	3093	80	3173
2004	2619	8	88	2715	258	2973
2005	3148	5	94	3247	148	3395
2006	4356	1	179	4536	244	4780
2007	6069	4	221	6294	366	6660
2008	5320	3	184	5507	416	5923
2009	4304	1	191	4496	283	4779
2010	5162	5	211	5378	465	5843
2011	5664	9	219	5892	540	6432
2012	5617	4	203	5824	863	6687
2013	4708	4	212	4924	511	5435
2014	4769	1	258	5028	1178	6206
2015*	4012	17	206	4235	898	5133

*** provisional. ** Total also includes Rep. of Ireland. 2014 updated.**

Table 3.7.2. *Nephrops,* Clyde (FU13), ICES estimated landings of *Nephrops*, in each of the subareas (Firth of Clyde and Sound of Jura 1981–2015).

YEAR	UK		
	Firth of Clyde	Sound of Jura	All subareas
1981	2277	691	2968
1982	1983	637	2620
1983	3395	681	4076
1984	2600	710	3310
1985	3561	725	4286
1986	3228	1113	4341
1987	2408	601	3009
1988	3509	155	3664
1989	2595	217	2812
1990	2592	317	2909
1991	2654	384	3038
1992	2383	420	2803
1993	2766	577	3343
1994	2095	535	2630
1995	3692	295	3987
1996	3671	386	4057
1997	3135	486	3621
1998	4373	468	4841
1999	3423	329	3752
2000	3229	188	3417
2001	2979	203	3182
2002	3350	34	3384
2003	3154	19	3173
2004	2965	8	2973
2005	3388	7	3395
2006	4768	12	4780
2007	6580	80	6660
2008	5845	78	5923
2009	4688	91	4779
2010	5782	61	5843
2011	6363	69	6432
2012	6634	53	6687
2013			5435
2014			6206
2015*			5133

*** Provisional. 2014 updated.**

Table 3.7.3. ***Nephrops,*** **Clyde (FU13): Firth of Clyde subarea. Results by stratum of the 2013–2015 TV surveys. Note that stratification was based on a series of sediment strata (M – Mud, SM – Sandy mud, MS – Muddy sand).**

Stratum	Area	Number of	Mean burrow	Observed variance	Abundance	Stratum	Proportion	Survey
	(km²)	Stations	density		(millions)	variance	of total	Precision
			(no./m²)				variance	Level
								(RSE)
2013 TV survey								
M	717	13	0.696	0.082	498.3	3242	0.152	
SM	699	10	1.316	0.271	920.2	12033	0.563	
MS	665	11	0.859	0.138	571.4	6092	0.285	
Total	2081	34			1989.9	21367	1	0.073
2014 TV survey								
M	717	11	0.545	0.03	391	1397	0.099	
SM	699	11	0.842	0.18	588.2	7990	0.567	
MS	665	13	0.525	0.138	349.2	4713	0.334	
Total	2081	35			1328.4	14099	1	0.09
2015 TV survey								
M	717	13	0.917	0.213	657.1	8407	0.273	
SM	699	14	0.963	0.328	673	11422	0.37	
MS	665	10	0.737	0.249	489.8	11006	0.357	
Total	2081	37			1819.9	30835	1	0.09

Table 3.7.4. *Nephrops*, Clyde (FU13): Firth of Clyde subarea. Results of the 1995–2015 TV surveys (values adjusted for bias).

Year	Stations	Mean density burrows/m^2	Abundance millions	95% confidence interval millions
1995	29	0.277	579	176
1996	38	0.454	935	242
1997	31	0.571	1198	262
1998	38	0.605	1262	213
1999	39	0.445	930	289
2000	40	0.681	1411	246
2001	39	0.714	1486	268
2002	36	0.756	1571	288
2003	37	0.874	1817	292
2004	32	0.95	1970	367
2005	44	0.941	1959	287
2006	43	0.882	1851	257
2007	40	0.597	1233	218
2008	38	0.849	1769	291
2009	39	0.723	1499	210
2010	37	0.84	1750	327
2011	40	1.041	2165	305
2012	37	0.681	1421	227
2013	34	0.956	1990	246
2014	35	0.639	1328	237
2015	37	0.875	1820	351

Table 3.7.5. *Nephrops,* Clyde (FU13): Sound of Jura subarea. Results by stratum of the 2013–2015 TV surveys. Note that stratification was based on a series of sediment strata.

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance	Survey Precision Level (RSE)
2013 TV survey								
M	90	1	0.328	0.01	29.4	78	0.184	
SM	150	4	0.779	0.026	116.8	144	0.338	
MS	142	4	0.361	0.04	51.3	203	0.478	
Total	382	9			197.5	425	1	0.107
2014 TV survey								
M	90	3	0.619	0.202	55.7	545	0.269	
SM	150	2	0.702	0.099	105.2	1116	0.552	
MS	142	4	0.496	0.072	70.4	362	0.179	
Total	382	9			231.3	2023	1	0.199
2015 TV survey								
M	90	2	1.328	0.326	119.5	1318	0.327	
SM	150	5	1.103	0.18	165.4	810	0.201	
MS	142	5	0.642	0.47	91.2	1897	0.471	
Total	382	12			376.1	4024	0.999	0.177

Table 3.7.6. *Nephrops*, Clyde (FU13): Sound of Jura subarea. Results of the 1995–2015 TV surveys (values adjusted for bias).

Year	Stations	Mean density burrows/m²	Abundance millions	95% confidence interval millions
1995	7	0.42	160	58
1996	10	0.45	171	26
1997	no surveys			
1998				
1999				
2000				
2001	13	0.71	272	76
2002	9	1.04	398	167
2003	12	0.68	260	68
2004	no survey			
2005	11	0.79	303	84
2006	10	1.13	430	134
2007	10	0.68	255	58
2008	no survey			
2009	12	0.66	251	68
2010	12	0.98	376	39
2011	12	0.82	312	73
2012	12	0.98	371	61
2013	9	0.52	198	35
2014	9	0.61	231	90
2015	12	0.98	376	127

Table 3.7.7. *Nephrops*, Clyde (FU13): Firth of Clyde and Sound of Jura combined. Adjusted TV survey abundance (Firth of Clyde subarea), landings, discard rate (proportion by number) and estimated harvest rate. The harvest rate was calculated from the total dead removals for both subareas divided by the Firth of Clyde TV abundance.

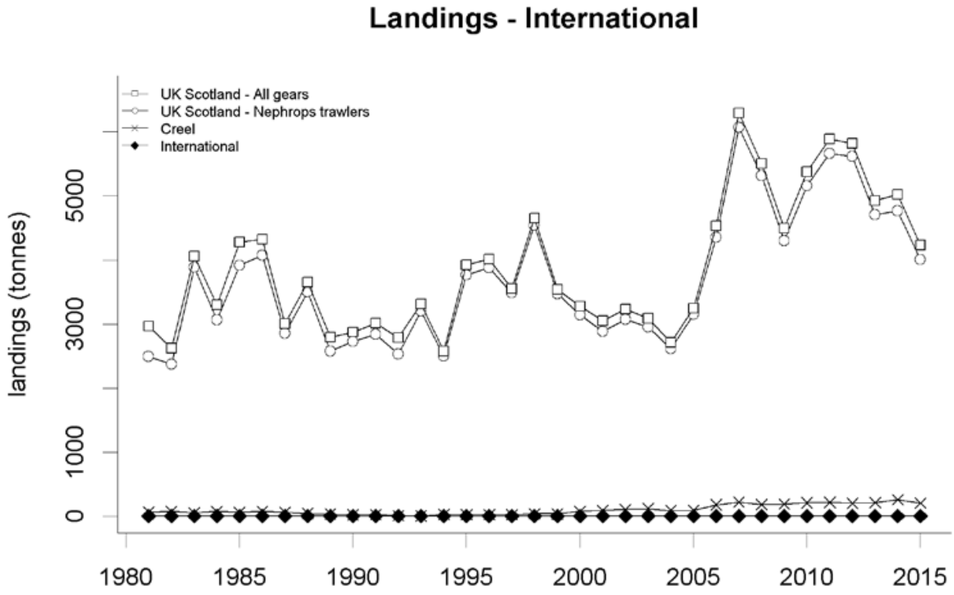
Year	Landings in Number (millions)	Discards in Number (millions)	Removals in Number (millions)	Adjusted survey (millions)	Harvest ratio*	Landings (tonnex)	Discard (tonnes)	Discard rate	Dead discard rate	Mean weight in landings (g)	Mean weight in discards (g)
1995	207	82	269	579	46.4	3987	619	28.4	22.9	19.24	7.54
1996	187	61	233	935	24.9	4057	635	24.7	19.7	21.68	10.35
1997	150	70	202	1198	16.9	3621	598	32	26.1	24.21	8.5
1998	269	187	409	1262	32.4	4841	1292	41	34.2	17.98	6.92
1999	216	93	286	930	30.7	3752	566	30.2	24.5	17.39	6.05
2000	171	48	207	1411	14.7	3417	470	22	17.4	19.96	9.75
2001	164	82	225	1486	15.2	3182	677	33.5	27.4	19.46	8.23
2002	207	50	245	1571	15.6	3384	406	19.5	15.4	16.35	8.12
2003	166	134	266	1817	14.7	3173	1247	44.7	37.7	19.13	9.31
2004	158	168	284	1970	14.4	2973	1435	51.5	44.3	18.8	8.54
2005	189	69	241	1959	12.3	3395	611	26.8	21.6	17.96	8.81
2006	248	55	290	1851	15.6	4780	515	18.2	14.3	19.27	9.31
2007	350	387	640	1233	51.9	6660	2566	52.5	45.3	19.05	6.64
2008	357	207	512	1769	28.9	5923	1433	36.6	30.3	16.59	6.94
2009	261	169	388	1499	25.9	4779	1390	39.3	32.7	18.31	8.23
2010	276	55	317	1750	18.1	5843	536	16.7	13.1	21.21	9.68
2011	333	74	388	2165	17.9	6432	568	18.2	14.3	19.34	7.65
2012	306	93	376	1421	26.5	6687	1066	23.4	18.6	21.83	11.42
2013	262	62	309	1990	15.5	5435	454	19	15	20.72	7.37
2014	295	78	353	1328	26.6	6206	696	20.9	16.6	20.79	8.92
2015	232	54	273	1820	15	5133	401	18.9	14.8	22.21	7.43
Average									15.46%	21.2	7.9

*** Harvest rates previous to 2006 are unreliable.**

**** Removals numbers take the dead discard rate into account.**

***** Dead discard average: 2013–2015; Mean weight in landings and discard average: 2013–2015.**

This table contains commercial data for Clyde and Sound of Jura.



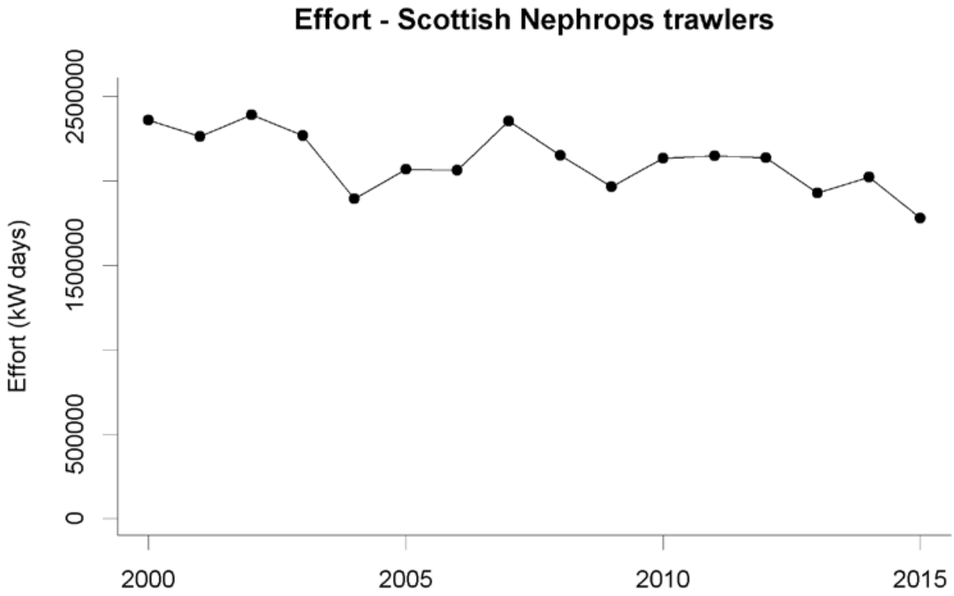
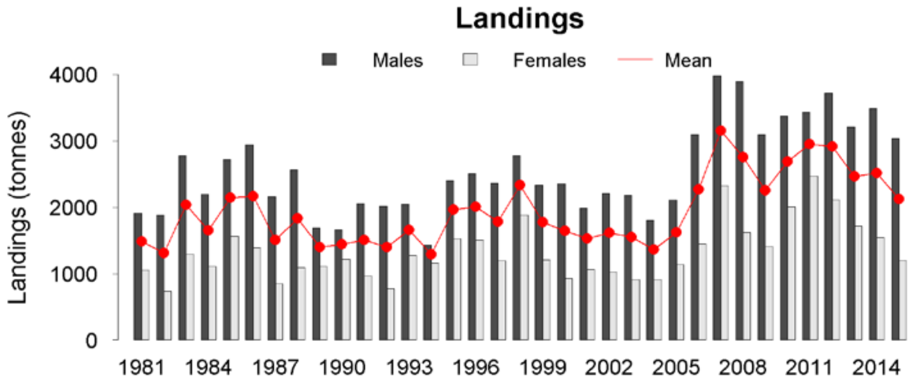


Figure 3.7.1. ***Nephrops*****, Clyde (FU13). Long-term landings and effort.**



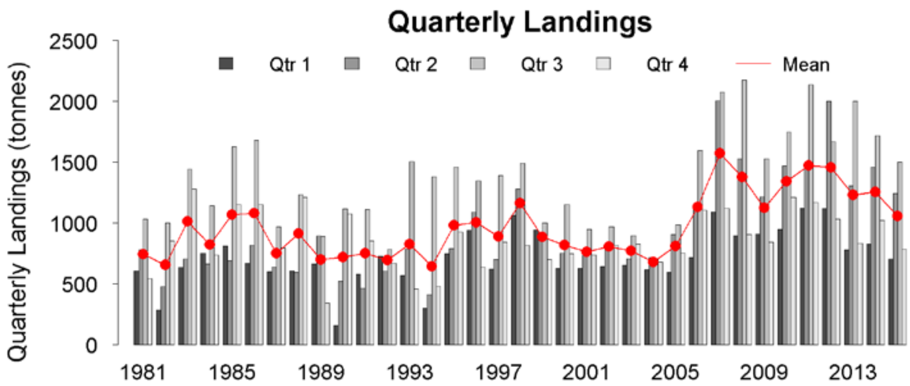


Figure 3.7.2.(a) ***Nephrops*, Clyde (FU13). Landings by quarter and sex from Scottish trawlers.**

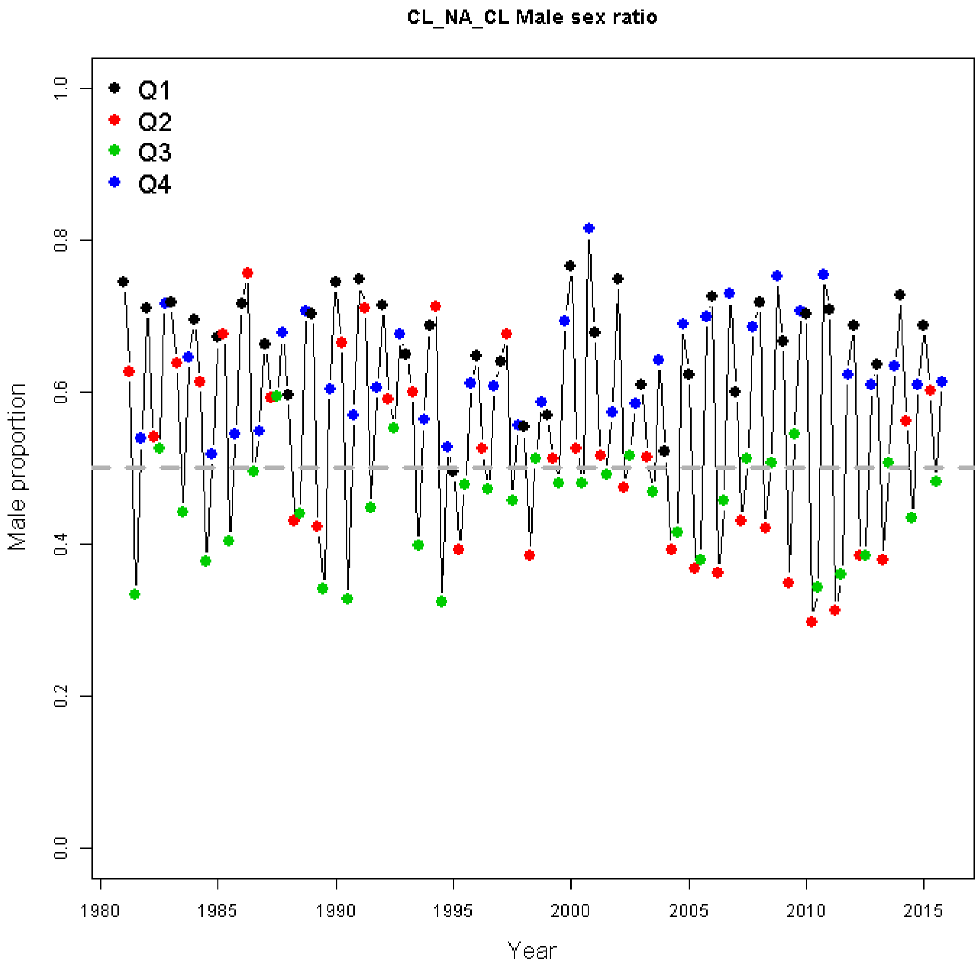


Figure 3.7.2. (b) *Nephrops,* Clyde (FU13), Proportion of males by quarter (1980–2015).

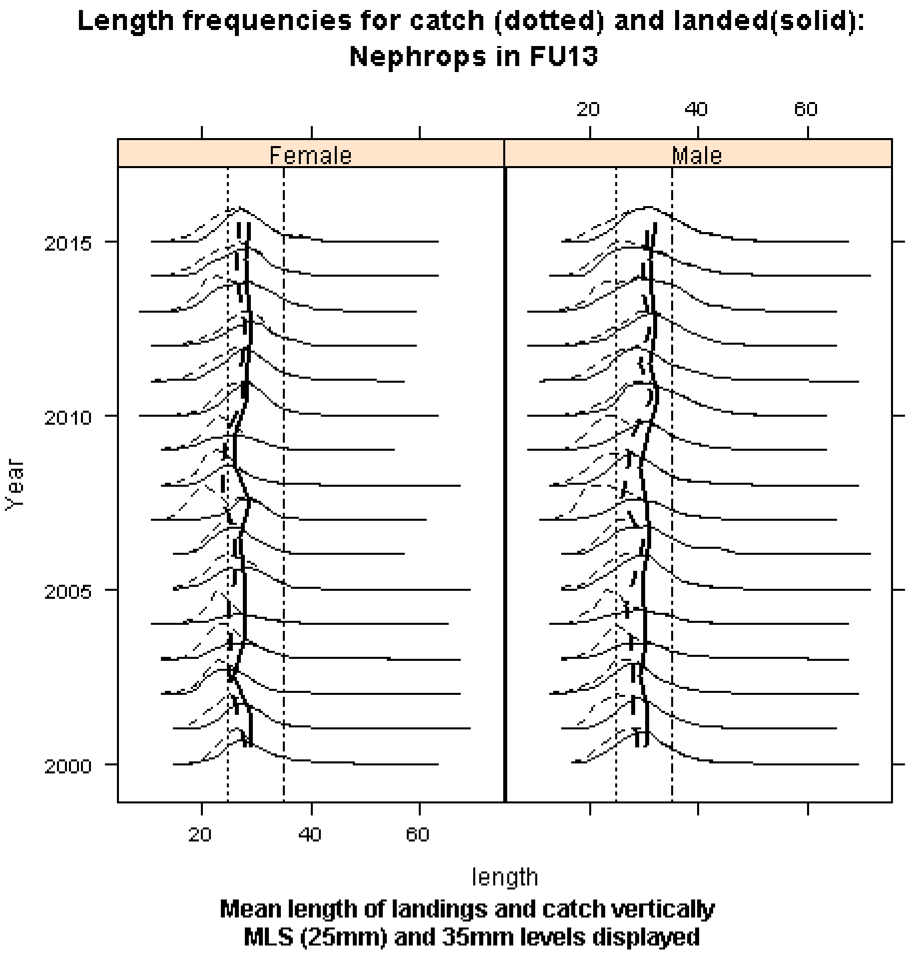


Figure 3.7.3. ***Nephrops*, Clyde (FU13). Catch length–frequency distribution and mean sizes (red line) for *Nephrops*, 2000–2015.**

Figure 3.7.4. ***Nephrops*, Clyde (FU13), TV survey station distribution and relative density (burrows/m²) for Firth of Clyde and Sound of Jura subareas, 2010–2015. Sound of Jura located to the east. Shaded green and brown areas represent areas of suitable sediment for *Nephrops*. Bubbles scaled the same. Red crosses represent zero observations.**

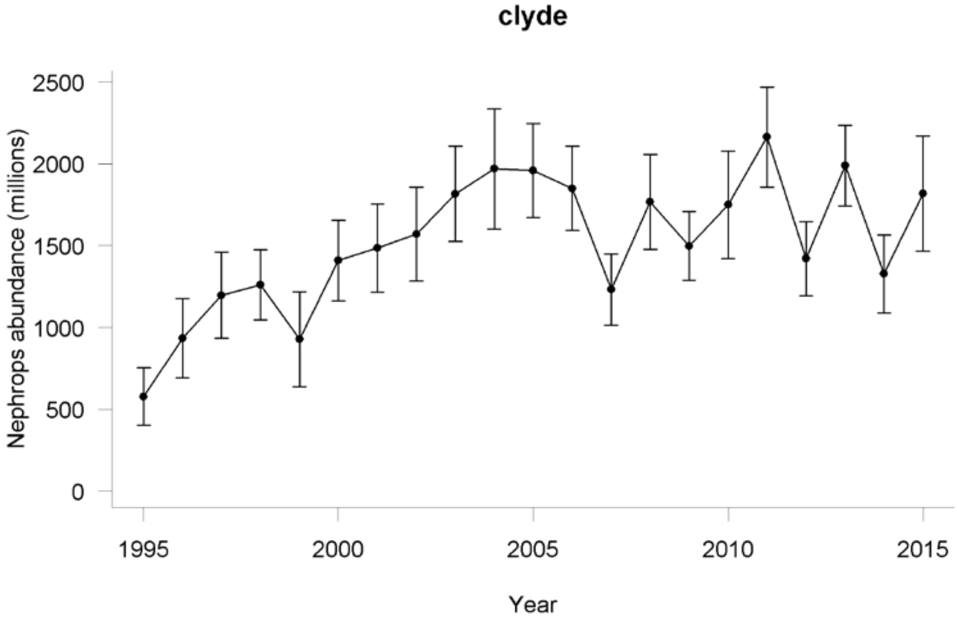


Figure 3.7.5. ***Nephrops*****, Clyde (FU13): Firth of Clyde subarea. Time-series of revised TV survey abundance estimates (adjusted for bias), with 95% confidence intervals, 1995–2015.**

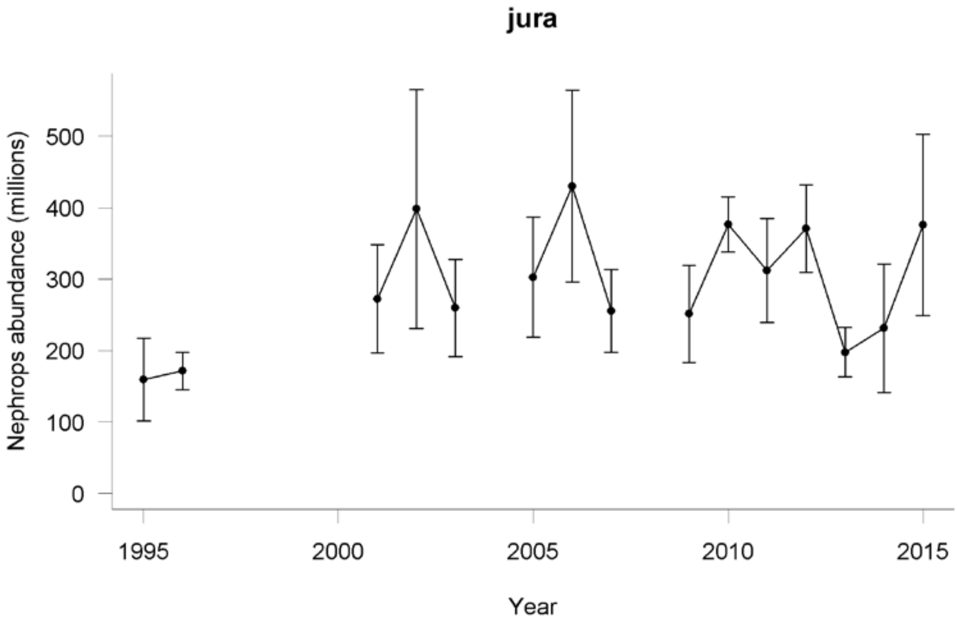


Figure 3.7.6. ***Nephrops*****, Clyde (FU13): Sound of Jura subarea. Time-series of TV survey abundance estimates (adjusted for bias) with 95% confidence intervals, 1995–2015.**

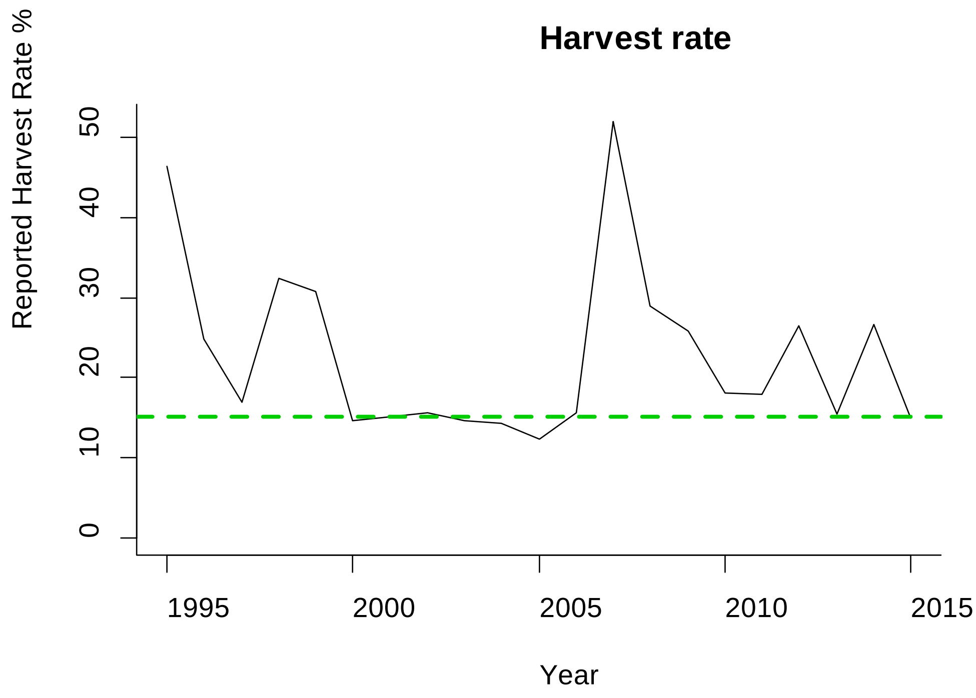


Figure 3.7.7. Clyde (FU13) *Nephrops* harvest rate, 1995–2015. The harvest rate is calculated by dead removals (both subareas combined)/Firth of Clyde TV abundance. The dashed and solid lines are the MSY proxy and the Harvest rate respectively.

4.2 Cod in Division VIb

Type of assessment in 2016

No assessment was performed in 2016.

ICES advice applicable in 2016–2017

In 2015, ICES provided biennial advice:

ICES advises that when the precautionary approach is applied, catches should be no more than 17 tonnes in each of the years 2016 and 2017.

THE ICES framework for category 6 stocks was applied. For stock without information on abundance or exploitation, ICES considers that a precautionary reduction of catches should be implemented. Given that recent landings continued to decline and other sources (lpue for Scottish and Irish trawl fisheries) also suggest low stock size, the ICES advice is updated based on the most recent three-year average landings (2012-2014). The precautionary buffer was previously applied in 2012. The advice this year (based on recent landings) implies a 76 % reduction with respect to the previous catch advice and no additional precautionary buffer is considered necessary.

ICES advice applicable in 2013–2015

In 2012, ICES provided biennial advice for 2013 and 2014. In 2014 there were no new data available that changed the perception of the stock and therefore the same catch advice was considered to be applicable for 2015 and is given below.

Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 70 tonnes.

This is the first year that ICES is providing quantitative advice for data-limited stocks (see Quality considerations).

No analytical assessment is available for this stock. The main cause of this is lack of data. Therefore, fishing possibilities cannot be projected.

ICES approach to data-limited stocks

For data-limited stocks without information on abundance or exploitation ICES considers that a precautionary reduction of catches should be implemented, unless there is ancillary information clearly indicating that the current level of exploitation is appropriate for the stock.

For this stock, ICES advises that catches should decrease by 20% in relation to the last three years average landings, corresponding to catches of no more than 70 t.

4.2.1 General

Management applicable to 2013–2016

The TAC for cod at Rockall covers ICES Division VIb, EU and international waters of Division Vb west of 12°00′W and Subareas XII and XIV. The following is applicable to 2013–2016:

Species:	Cod *Gadus morhua*	Zone:	VIb; Union and international waters of Vb west of 12° 00′ W and of XII and XIV (COD/5W6-14)
Belgium	0		
Germany	1		
France	12		
Ireland	16		
United Kingdom	45		
Union	74		
TAC	74		Precautionary TAC

The fishery in 2015

No specific information is available for 2015. Cod at Rockall are taken as a bycatch in fisheries for other species such as haddock and anglerfish.

4.2.2 Data

Official landings data for cod in VIb are shown by nation in Table 4.2.1 and Figure 4.2.1. Total reported landings were 41 tonnes in 2015. There were no updates to landings from previous years. In the past, official landings have shown very high inter-annual variation and it is not known whether these are a true reflection of removals.

Landings data have been uploaded to InterCatch for 2015. In addition, some landings age compositions and discard data were also uploaded to IC. Data uploaded to IC are shown below.

Country	Discards (t)	Landings (t)
Ireland		5.1
Norway		17.8
UK (E &W)		0.1
UK(Scotland)	9.7	18.0
Grand Total		41

Irish and Scottish landings, effort and lpue are presented in Figures 4.2.2 and 4.2.3 and Tables 4.2.2 and 4.2.3. Figure 4.2.2 shows a large decline in the Irish lpue between 1995 and 2003 followed by relatively stable values at a level much lower than at the start of the time-series. The recording of Scottish hours fished data is not mandatory in the logsheets and the data are incomplete. Scottish otter-trawl fleet data are therefore in units of kg/kWday. The Scottish time-series is much shorter and relatively more noisy.

Survey catch rates of cod at Rockall are low and are therefore unlikely to provide a reliable index of abundance (Table 4.2.4).

Catches of cod (both survey and commercial) are too low to support the collection of the necessary information for an assessment of stock status.

Table 4.2.1. Cod in Division VIb (Rockall). Official catch statistics.

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Faroe Islands	18	-	1	-	31	5	-	-	-	1	-	-	-	-	-	-	-
France	9	17	5	7	2	-	-	-	-	-	-	-	-	-	-	-	+
Germany	-	3	-	-	3	-	-	126	2	-	-	-	10	22	3	11	1
Ireland	-	-	-	-	-	-	400	236	235	472	280	477	436	153	227	148	119
Norway	373	202	95	130	195	148	119	312	199	199	120	92	91	55	52	85	152
Portugal	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-
Russia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
Spain	241	1200	1219	808	1345	-	64	70	-	-	-	2	5	1	6	4	3
UK (E. & W. & N.I.)	161	114	93	69	56	131	8	23	26	103	25	90	23	20	32	22	4
UK (Scotland)	221	437	187	284	254	265	758	829	714	322	236	370	210	706	341	389	286
UK																	
Total	1023	1973	1600	1298	1886	549	1349	1596	1176	1097	661	1031	775	962	661	659	572

Table 4.2.1. Continued. Cod in Division VIb (Rockall). Official catch statistics.

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015*
Faroe Islands	-	-	-	-	-	-	-	-	3	5					
France	-	+	+	-	-		-			-					
Germany	-	-					-								
Ireland	40	18	11	7	12	23	24	41	20	6	12.0	1.0	2.0	5.6	5.07
Norway	89	28	25	23	7	7	12	12	25	27	49.0	11.0	3.0	+	17.81
Portugal	-	-					-								
Russia	26	-					-		1						
Spain	1		6				-								
UK (E. & W. & N.I.)	2	2	3	-	-	-	-	-	-	-	-	-	-		
UK (Scotland)	176	67	57	45	43	29	26	41	48	23	37.0	11.0	9.0		
UK														9.8	18.03
Total	334	115	102	75	62	58	62	94	97	61	98.0	23.0	14.0	15.4	40.91

*** Preliminary**

Table 4.2.2. Cod in VIb. Landings, effort and lpue data from Irish otter-trawl fleet.

Year	Landings tonnes	Effort '000s Hrs	LPUE Kg/Hr
1995	415	9.14225	45.39
1996	402	7.219	55.68
1997	130	7.169	18.20
1998	207	7.337	28.16
1999	138	8.68	15.88
2000	101	9.883	10.23
2001	33	7.232	4.60
2002	16	2.626	6.18
2003	10	4.542	2.18
2004	7	2.233	3.08
2005	9	3.283	2.68
2006	22	5.9	3.76
2007	24	6.587	3.62
2008	40	9.898	4.08
2009	22	4.353	4.97
2010	7	3.28	2.03
2011	9	2.534	3.56
2012	1	3.248	0.31
2013	1.8	3.809	0.46
2014	5.6	4.2	1.34
2015	4.1	4.7	0.87

Table 4.2.3. Cod in VIb. Landings, effort and lpue data from the Scottish TR1 fleet.

YEAR	LNDS(T)	EFF(KWDAYS)	LPUE(KG/KWDAY)
2003	64.09	2504466	0.0256
2004	39.76	1842103	0.0216
2005	42.98	1217357	0.0353
2006	28.25	1011354	0.0279
2007	25.98	1060551	0.0245
2008	40.29	1124197	0.0358
2009	47.76	1631239	0.0293
2010	22.65	1744452	0.0130
2011	36.54	1565753	0.0233
2012	10.78	901552	0.0120
2013	9.09	532767	0.0171
2014	9.70	668665	0.0145
2015	19.92	563098	0.0354

Table 4.2.4. Cod in VIb. Survey data made available to the WG: Scottish Q3 groundfish survey ((Rock-WIBTS-Q3)). Catch rates are given as number per 10 hours.

2011	2015									
1	1	0.66	0.75							
0	9									
10	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
10	0	0.493	0.493	0	0	0	0	0	0.403	0
10	0	0.279	0.894	0	0	0	0	0	0	0
10	0	0	0.922	0.307	0	0	0	0	0	0.307

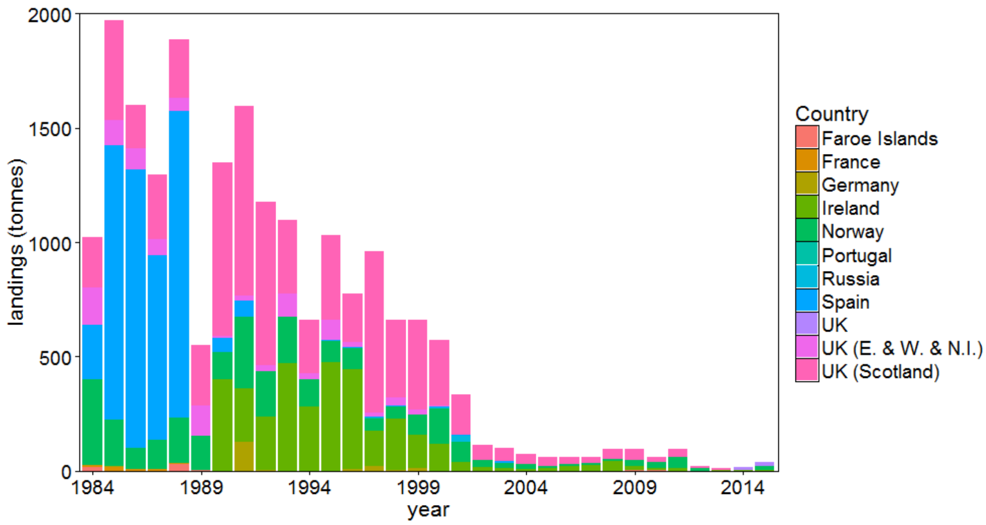


Figure 4.2.1. Cod in Division VIb. Total of official catch (all nations combined). Values for 2015 are provisional.

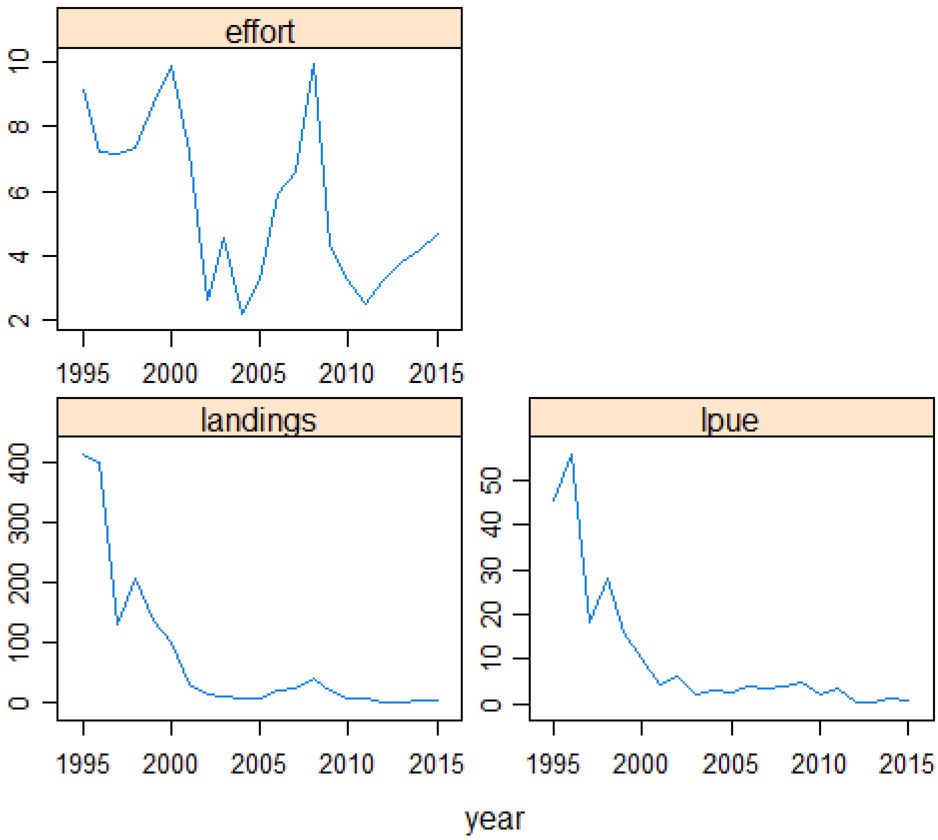


Figure 4.2.2. Cod in Division VIb. Landings, effort and lpue (kg/hr) from the Irish Otter-trawl fleet.

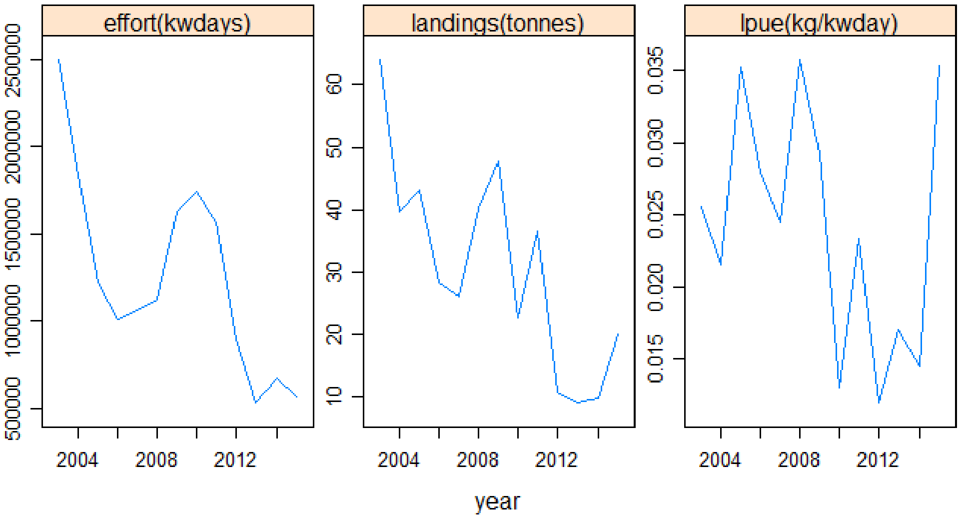


Figure 4.2.3. Cod in Division VIb. Landings, effort and lpue (Kg/kWday) from the Scottish TR1 fleet.

4.3 Haddock in Division VIb (Rockall)

Type of assessment in 2015: Update assessment

The current assessment is an update of last year's assessment. The same approach has been used in the annual assessment since 2005 when on the recommendation of RGNSDS, adopted a new assessment approach, which allows modelling of the total catch (including discards) when no on-board observations were available (for details see the Stock Annex).

ICES advice applicable to 2015

ICES advice applicable to 2015 can be found here:

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/had-rock.pdf

ICES advice applicable to 2016

ICES advice applicable to 2016 can be found here:

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/had-rock.pdf

4.3.1 General

Stock description and management units

The haddock stock at Rockall is an entirely separate stock from that inhabiting the continental shelf of the British Isles. Since 2004, the EU TAC for haddock in 6.b has been included with Divisions XII and XIV. For details of the earlier management units see the Stock Annex.

Management applicable to 2015 and 2016

The EU TAC for VIb, XII and XIV was set at 2580 t in 2015 (a 113% increasing compared to TAC for 2014).

Species:	Haddock	**Zone:** EU and international waters of VIb, XII and XIV
Belgium	6	
Germany	7	
France	285	
Ireland	203	
United Kingdom	2 079	
Union	2 580	
TAC	2 580	Analytical TAC

The EU TAC for VIb, XII and XIV was set at 3225 t in 2016 (a 25% increasing compared to TAC for 2015).

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	Union and international waters of VIb, XII and XIV (HAD/6B1214)
Belgium	7		
Germany	24		
France	332		
Ireland	353		
United Kingdom	2 509		
Union	3 225		
TAC	3 225		Analytical TAC

The ICES advice, agreed TAC for EU waters, and WG estimates of landings during 2002–2016 are summarised below. All values are in thousand tonnes.

YEAR	PREDICTED CATCH CORRESP. TO ADVICE	PREDICTED LANDINGS CORRESP. TO ADVICE	BASIS	AGREED TAC[a]	WG LANDINGS
2002	<1.30		Reduce F below 0.2		3.0
2003	-		Lowest possible F		6.1
2004	-		Lowest possible F [b]	0.702	6.3
2005	-		Lowest possible F [b]	0.702	5.2
2006	-		Lowest possible F [b]	0.597	2.8
2007	< 7.10		Reduce F below F_{PA} [b]	4.615	3.3
2008	< 10.64		Keep F below F_{PA} [b]	6.916	4.2
2009		< 4.3	No long-term gains in increasing F [b]	5.879	3.8
2010		< 3.3	Little gain on the long-term yield by increasing F [b]	4.997	3.4
2011		<2.7	Reduction in F is needed to keep SSB to above B_{PA} in 2012	3.748	1.9
2012		< 3.3	MSY approach	3.300	0.7
2013	0	0	No directed fisheries, minimize bycatch and discards	0.99	0.8
2014	<1.62[c]	<0.98	MSY approch	1.21	1.7
2015	<4.31	<2.93	MSY approch	2.58	2.5
2016	< 3.932	< 3.225#	MSY approach	3.225	

[a]Before 2014 TAC was set for Divisions VIa and VIb (plus Vb1, XII and XIV) combined with restrictions on quantity that can be taken in Vb and VIa. The quantity shown here is the total area TAC minus the maximum amount which is allowed to be taken from Vb and VIa. In 2004, the EU TAC for Division VI was split and the VIb TAC for haddock was included with XII and XIV. This value is the TAC for VIb, XII and XIV.

[b] Single-stock boundary and the exploitation of this stock should be conducted in the context of mixed fisheries, protecting stocks outside safe biological limits.

 # Wanted catch.

The minimum landing size of haddock taken by EU vessels at Rockall is 30 cm. There is no minimum landing size for haddock taken by non-EU vessels in international waters.

In order to protect the pre-recruit stock, the International Waters component of the statistical rectangle 42D5 has been closed for fishing since 2001 and its EU component, since 2002 (see the Stock Annex). The protected area (the whole rectangle) is referred to as Rockall Haddock Box. In order to protect cold-water corals, three further areas (North West Rockall, Logachev Mounds and West Rockall Mounds) were closed since January 2007 (see the Stock Annex). A new area to protect cold-water corals (Empress of British Banks) was established by the NEAFC in 2007 and 2012.

Since 2009 in NEAFC regulatory are, including international waters of Rockall, was established a ban on discards.

Fishery in 2015

Russian fishery in 2015

In March–May and October 2015 (one hauling was in October) 2015, 136 tons of haddock were caught. Other demersal fish species were caught in small numbers as by-catch. The vessel operated in international waters outside the areas closed for fishing. Russian effort in Rockall declined in 2009–2015 (Figure 4.3.6).

Scottish fishery in 2015

The number of Scottish vessels fishing for haddock and the number of trips made to Rockall declined substantially from 2000 onwards (WD6 to WGNSDS 2004). The declining trend was reversed in 2007. The number of vessels increased from 22 in 2007 to 28 in 2008, and 37 in 2009. Total Scottish demersal landings in VIb in 2009 were estimated to be 4585 t, of which 2951 t were haddock, and that remained stable in 2010 with 2931 t. In 2011, landings declined to 1738 t of haddock and in 2012–2013 to about 600 t. In 2014 landings increased to 1152 t. In 2015 landings increased to 2052 t (Table 4.3.1). Other important target species included anglerfish (*Lophius* spp.), saithe, ling and megrim. Scottish effort presented in Table 4.3.2 and 4.3.3.

Irish fishery in 2015

Irish effort in Rockall declined in 2009–2015 (Table 4.3.2).

Landings totalling 190 t were reported from Irish otter trawlers in 2015 (increased from 93 t in 2014; Table 4.3.1). Irish vessels used single otter trawls with a mesh size ranging from 100 to 120 mm together with a square mesh panel.

Norwegian fishery in 2015

Norwegian landings declined in 2008 to 36 t. In 2009 landings increased to 71 t and 65 t in 2010 which was a two-fold increase compared to 2008. In 2011–2012 landing 40–48 t were reported. Landings of haddock at Rockall increased in 2013 to 121 t and declined in 2014 to 40 t. Norwegian demersal fleet fishing on the Rockall Bank consisted mainly of longliners and targeted mainly ling and tusk.

Total Norwegian landings 66 t of haddock at Rockall were reported in 2015.

4.3.2 Data

Landings

Nominal landings as reported to ICES are given in Table 4.3.1, along with Working Group estimates of total estimated landings. Revisions to official catch statistics for previous years are also shown in Table 4.3.1.

Anecdotal evidence suggests that misreporting of haddock from Rockall have occurred historically (which may have led to discrepancies in assessment), but a quantitative estimation of the degree of misreporting is not possible.

International age composition and mean weight-at-age in the landings were compiled according to the methods described in the Stock Annex.

Discards

Historically, the discard rate was as high as 12–87% by numbers according to the results of discards trips (see the Stock Annex). The methods used to reconstruct the historical time-series of discards is described in the Stock Annex.

The discards for 2010–2015 in the 2016 assessment were estimated from sampling aboard Scottish and Irish vessels collected in 2010–2015 (Table 4.3.4–4.3.6). On Russian vessels, the whole catch of haddock is kept on board and therefore, total catch is equivalent to landings and there is no need to calculate discards. In 2015 the discard rate was estimate at 52% and 38% by numbers on Irish and Scottish observer trips (Table 4.3.4–4.3.7).

Biological

There was no change in biological parameters compared to the 2015 assessment (see the Stock Annex).

Surveys

There is only one abundance index available for this stock the Scottish Rock-IBTS-Q3 survey (Figure 4.3.1). The survey is co-ordinated by IBTS and described further in the IBTS reports and Stock Annex.

The survey coverage, has been extended in recent years (Figure 4.3.2). But the 2016 indices were obtained from the standard survey area, i.e. same indices as last year's for the final run (Table 4.3.8).

Additional abundance and biomass estimates are calculated using three types of stratification of the survey area:

1) by geographic strata of 15' latitude wide and 15' longitude long (Figure 4.3.3.);
2) by five bathymetric strata depending on depth: <150 m, 150–175 m, 176–200 m, 201–225 m and >225 m (Figure 4.3.4);
3) the whole survey area is taken for one strata without substratification (Figure 4.3.5).

All three methods show similar patterns (Figures 4.3.3–4.3.5).

In 2011, the gear was changed on the Scottish survey and an analysis showed that there was no detectable difference between the older and new survey on haddock indices in neighbouring areas (IBTSWG 2012).

The Russian trawl acoustic survey conducted in 2005 provided information on the size and biomass of the haddock stock both in the EU zone and in international waters. The acoustic survey yielded a biomass estimate of 60 000 t and an abundance estimate of 225.9 million (for the details see the Stock Annex). No such survey has been conducted in subsequent years.

Commercial effort, lpue and cpue

Commercial effort series are available for Scottish trawlers, light trawlers, seiners, Irish otter trawlers and Russian trawlers fishing in Division VIb. The effort data for these fleets are shown in Figure 4.3.6 and Table 4.3.2–4.3.3. Effort data in hours from the Scottish fleets are discontinued after 2008 and provided in KWDays after 2003 (Table 4.3.3. Effort by the Scottish and Irish fleets has been relatively stable at a low level in the last three years.

Commercial lpue for the Irish and Scottish fleets and cpue for the Russian fleet are shown in Figure 4.3.7. The WG decided that the commercial cpue and lpue data, which do not include discards and have not been corrected for changes in fishing power despite known changes in vessel size, engine power, fish-finding technology and net design, were unsuitable for catch-at-age tuning.

4.3.3 Description of stock assessment approach

Model used:

The assessment is based on catch-at-age data and one survey index (Scottish Rock-IBTS-Q3) and conducted using the XSA method.

Software used:

The same software was used as in the last year's assessment (XSA from Lowestoft suite of VPA programs).

Model Options chosen:

Settings for the final XSA assessment did not change compared to the previous assessment (see the Stock Annex) and were as follows:

Assessment model: XSA

Tuning indices: one survey index (Scottish Rock-IBTS-Q3)

Time-series weights: none

Catchability dependent for ages <4

Regression type: C

Minimum number of points used for regression: 10

Q plateau: 5

Shrinkage stand. error: 1.0

Shrinkage age, year: 4 years, 3 ages

Minimum stand. error: 0.3

Plus group: 7+

FBAR: 2–5

Input data types and characteristics:

There were no changes in data types and characteristics compared to the previous assessment:

Year range: 1991–2015

Age range: 1–7+

For tuning data the following year and age ranges were used:

Year range: 1991–2015

Age range: 1–6

Data screening

Figures 4.3.9 and 4.3.10 as well as Tables 4.3.9 show landings, discards and total catch by number and weight. Landings, discards and total catch-at-age by number are shown in Tables 4.3.10–4.3.12.

Mean weights-at-age in total catch, landings, discards and stock are shown in Tables 4.3.13–4.3.16. The mean weights-at-age in the stock are assumed to be the same as the catch weights. In 2012, the discard rate was relatively low and a small number of samples of discarded haddock were collected (especially for older ages). As a result, mean weights-at-age 3 and 7+ in discards were higher in 2012 compared to previous years (Figure 4.3.11). This increase in mean weight-at-age 3 and 7+ was observed in the Scottish samples. Mean weights and accordingly numbers of Scottish discards at-age 3 and 7+ for 2011 has been recalculated using linear regression by analogy with haddock 6.a as in last year’s assessment (Figure 4.3.11). Given the low numbers of discards, these recalculations did not significantly affect the mean weights-at-age of the total catch.

Mean weight-at-age 6 in landings was significant higher in 2012 compared to previous years (Figure 4.3.12). Mean weights and accordingly numbers of landings at-age 6 for 2012 have been recalculated using linear regression (Figure 4.3.12).

In 2014 for runs weight-at-age in landings was used same as weight-at-age observed in samples without recalculations.

The mean weights-at-age in the total catch (including discards) and in the stock are shown in Figure 4.3.13.

There were small landings of haddock aged 1 in 2010–2012 and very few aged 2 to 6 compared to historical values. Haddock aged 7 dominated landings. But in 2013 landings and discards of haddock aged 1 significant increased. Discarded fish are, primarily, haddock aged 1–2 (see Tables 4.3.1 and 4.3.2 in the Stock Annex). Figures of log catch by age show that these values are much less variable when discards are included (Figures 4.3.14–4.3.20). Data on catches, landings and discards-at-age are given in Tables 4.3.10–4.3.12.

The Scottish Rock-IBTS-Q3 was the only survey index available to the working group. Plots of log cpue by age, year and year class are shown in Figures 4.3.21 and 4.3.23.

A SURBA 3.0 run was carried out to analyse the survey data. Previous working groups have concluded that the first three years of the survey should not be used in assessments and that age 0 data were a poor indicator of year-class strength. Here, the runs were actually conducted using the survey data from 1991 onwards to be consistent with the period over which the catch-at-age assessment could be run (the settings:

lambda = 1.0, reference age = 3). A summary of the results are shown in Figure 4.3.25. SSB shows a declining trend from 1995, an increase in 2003–2004 and a general decrease in subsequent years. The estimates of the temporal component of Z are very noisy, but indicate a steep decline between 2000 and 2003 followed by an upward trend. Retrospective analysis showed consistent estimation of SSB and Z (2–5) (Figure 4.3.26).

Comparative scatterplots of log index at-age are shown in Figure 4.3.27. The survey shows relatively good internal consistency in tracking year-class strength through time.

Final update assessment

Final run

Settings for the final XSA assessment are shown in Section C of the Stock Annex. There have been no changes to assessment settings since 2013.

The diagnostics file of the final XSA run is given in Table 4.3.17 and Figure 4.3.28. Adjusted survey cpue against XSA population estimates are shown in Figures 4.3.30 and 4.3.31. The analysis of residuals and retrospective analysis (Figures 4.3.31, 4.3.32) show that applying the chosen parameters for XSA (as in the Stock Annex) improves the residual patterns compared to other exploratory settings. However, the same trends are still apparent in the log catchability residuals. The results of the retrospective analysis conducted by the Working Group in 2002 and 2003 indicated that using shrinkage values of more than 0.5 improved the retrospective curves and showed convergence. In this year's analysis, only 22 years of data were available for the retrospective analysis, but a good year to year consistency was obtained. Dynamics of fishing mortality-at-age are presented in Figure 4.3.330. The final XSA results are given in Tables 4.3.18–4.3.20. The final XSA and SURBA results are compared in Figure 4.3.35. The SURBA estimates are more variable, but there is a good overall consistency between estimates by the two methods.

Summary plots from the final XSA assessment are shown in Figure 4.3.36.

Further exploratory run

Haddock of 2007–2011 year classes are poor and rarely caught in commercial and survey. That leads to the high variability of assessment of their numbers. This is especially evident when was assessed the number of haddock of the poor 2011 year class by the survey. In the first years of life a generation was underestimated. However, in 2015 the Survey showed that year class is stronger and no tendency in dynamic of the Survey indices of that year class (Table 4.3.8, 4.3.17 and Figure 4.3.21). Analysis showed high catchability residual for these year classes (Figure 4.3.28).

To reconstruction of the indexes 2011 year class and two points of 2010 and 2009 classes was applied the linear regression. Corrected Survey indexes presented in the Table 4.3.9 and Figure 4.3.22. The exploratory runs with revised indexes led to a decreasing of catchability residual (Figure 4.3.29). The WG concluded as last year that the run without this adjustment was more appropriate and the assessment was not overly biased by this weak year class in the index.

Comparison of final and experimental XSA runs shown in Figure 4.3.34.

Comparison with previous assessments

The estimates from this year's assessment are reasonably consistent with the assessments carried out in previous years (Figure 4.3.37). SSB in 2015 has been revised up by 35% and F in 2014 has been revised down by 9% in this year's assessment.

State of the stock

The stock summary relative to reference points is plotted in Figure 4.3.36.

The spawning–stock biomass (SSB) has increased from the lowest observed in 2014 and is estimated to be above MSY $B_{trigger}$ in 2016. Fishing mortality (F) has declined over time but has been above F_{MSY} since 2014. Recruitment during 2008–2012 is estimated to be extremely weak. Recruitment has improved in 2013–2014 and decreased again in 2015 and is still lower than the values estimated at the beginning of the time-series.

Statistical catch-at-age analysis (SCAA)

For Statistical catch-at-age analysis, StatCam model was used (J. Brodziak, 2005). VPA and SCAA used identical survey and catch data. For StatCam runs two scenarios were used: First scenario, non-parametric model; second, parametric model.

StatCam model shows good conformity between observed and predicted survey index and catch biomass. Log residuals were less than 0.4 for total survey index (Figures 4.3.38–4.3.39).

StatCam summary plots are shown in Figure 4.3.40.

Both Statistical catch-at-age analysis and VPA results show a similar tendency for the SSB dynamics. However, the assessment of the stock size depends on the choice of the model. SSB and TSB plots from the XSA and SCAA assessment are compared in Figure 4.3.41.

4.3.4 Short-term projections

Estimating year-class abundance

In 2007–2011, the abundance of age 0 individuals in the survey index were estimated to be extremely weak. In 2012, the observed large in number 0-group. Year classes 2013 and 2014 were below average but above levels 2008–2012 (Figure 4.3.42). In 2015 was observed poor 0-group. VPA abundance for age 1 has been highly correlated with age 0 indices for 1993–2015 (Figure 4.3.43).

The recruitment (age 1) in 2013–2016 was therefore estimated using RCT3 regression (Shepherd, 1997) relating survey indices to stock abundance. The recruitment in 2016 was estimated at 11 287 thousand, one of the lowest values of the time-series. Poor year classes may be related to environmental factors including rising seawater temperatures in Rockall Bank, a reduction in ephausiids and *Calanus finmarhicus* abundance and the negative impact of predation on eggs and larvae and food competition from the grey gurnard.

For forecasting recruitment (age 1) in 2017 and thereafter, the WG recommended the same procedure as last year using the 25th percentile over the whole time-series.

Many definitions of how to compute the percentile may be found in the literature. The WG chose the simple rounding of the result to the nearest integer and taking the value that corresponded to that rank of percentile. The rank of percentile was determined by the following equation:

$$n = \frac{P}{100} * N + \frac{1}{2}$$

P being the percentile value (here P=25), and N the length of the time-series (here N=21). The rank of 25th percentile for the recruitment is then 6. The 6th lowest value of the time-series corresponds to a value of 10 633 thousands in 2015.

The input data for the short-term forecast can be found in Table 4.3.21.

Catch constraint

A catch is used for 2016. The assumed catch in 2016 of 3602 t is estimated based on and EU TAC of 3225 t and estimated Russian catch 377 t. Recent EU quota uptake has been high and the Russian fishery has already taken place in 2016, so the catch constraint forecast, as last year, is considered to be the best approach by the WG.

Results of forecast are shown in Tables 4.3.22–4.3.23.

Mean weights and F pattern

Haddock with age 3 year and older are rare in samples because the years classes were very weak this also increases the uncertainty of the assessment this leads to higher variability in catch and survey estimates of those year classes. To mitigate against this in the forecast a five year mean was used for weight-at-age and fishing pattern was used (as last year).

Partitioning of catch into discards and landings

An important uncertainty in the assessment and forecast concerns the estimates of discards. The number of sampled discard trips in the last years has been very low. According that results discard ratio-at-age varies considerably from year to year. As was done last year and mean discard ratio-at-age from 2006 was used for forecasting discards in the short term (Tables 4.3.7–4.3.10; Figure 4.3.48).

STF results

Results obtained from the forecast (including discards) are given in Tables 4.3.22–4.3.23. The short-term forecast is also shown in Figure 4.3.45.

The sensitivity analysis of the forecast is shown in Figures 4.3.46. The probability of SSB in 2018 being below B_{pa} is about 8% and below B_{lim} is about 1% (Figure 4.3.47).

Stock numbers of recruits and their source for recent year classes used in the predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes are shown in Table 4.3.24.

4.3.5 MSY evaluations and Biological reference points

ICES carried out and evaluation of MSY and PA reference points for this stock last year at WKMSYREF4 (ICES, 2016a). The results have been published earlier this year (ICES, 2016b) are summarized below:

FRAMEWORK	REFERENCE POINT	VALUE	TECHNICAL BASIS	SOURCE
MSY approach	MSY $B_{trigger}$	13 690 t	B_{pa}.	ICES, 2016
	F_{MSY}	0.2	Based on the peak of the median landings yield curve (WKMSYREF4). (MSY Range 0.13–0.2)	ICES, 2016
Precautionary approach	B_{lim}	6800 t	$B_{lim} = B_{loss}$, the lowest observed spawning stock estimated in previous assessments.	ICES, 2016
	B_{pa}	10 200 t	$B_{pa} = B_{lim} \times 1.5$. This is considered to be the minimum SSB required to obtain a high probability of maintaining SSB above B_{lim}, taking into account the uncertainty of assessments.	ICES, 2016
	F_{lim}	0.69	Based on a 50% probability of being above B_{lim} in a stochastic simulation with a segmented regression using breakpoint at B_{lim}	ICES, 2016
	F_{pa}	0.46	F_{pa} = Flim/1.5	ICES, 2016
Management plan	SSB_{MGT}	10 200 t	B_{pa}	ICES, 2013
	F_{MGT}	0.2	Based on harvest control rule evaluations.	ICES, 2013

The stock–recruitment scatterplot is shown in Figure 4.3.48.

4.3.6 Management plans

In September 2011 and 2012 in accordance with the conclusions of the 2010–2011 Annual Meeting of the NEAFC, a delegation from the RF and EU considered the management plan. In the light of the ICES comments, were considered the necessary adjustments required to the draft plan. The revised proposal for a harvest control component of a long-term management plan for haddock at Rockall was forwarded to NEAFC at the opportunity for approval at the 2012 Annual Meeting. ICES is requested to evaluate the EU-Russia proposal for the harvest control component of the management plan for Rockall haddock and to evaluate the proposals on the protection of juvenile Rockall haddock. According the management plan the measure shall be put in place to ensure that total catch does not exceed the established TAC including measures to record and minimise discards. It is the consideration of 2004 Expert Group the basic measure to reduce discards should be effort regulation along with the biological reasonable the minimum landings size.

ICES evaluated a new HCR proposal RF and EU for the Rockall haddock stock in August 2013 (ICES, 2013) and found that a maximum F of 0.2 was required in the HCR to ensure consistency with the precautionary approach, under the low recruitment conditions observed since 2004.

The management plan additionally indicates that measures should be put in place to ensure that total catch does not exceed the established TAC, including measures to record and minimize discards. After the introduction of these measures, the human consumption TAC method currently used by ICES (advice based on landings) should not be applied.

By NEAFC opinion the measures to reduce discards for whole area distribution of stock need to develop and to implement on practice, while also reducing the TAC to take into account any discarding that is still taking place for realization of management plan. In NEAFC regulatory area (RA) established a ban on discards. The remainder of the management plan for this species is considered to be suitable and has been agreed by the Contracting Parties (NEAFC, 2015).

4.3.7 Uncertainties and bias in assessment and forecast

The WG considers that the long-term trends in the XSA assessment and survey biomass estimates/indices are indicative of the general stock trends. The assessment has become increasingly uncertainty in recent years as catch and sampling levels have declined to low levels. In the catch options five-year average values were used and a catch constraint applied in the intermediate year.

4.3.8 Recommendation for next benchmark

In recent years WGCSE have highlighted an increasing number of issues to be addressed when this stock is benchmarked.

1) There are concerns over the accuracy of landings statistics from Rockall in earlier years.

2) There was no analysis of which method is better to use when in terms poor information by result discards trips: the method of estimating discards from survey data or the results poor discards, especially in 2010 where an average rate had to be used since the survey could not take place.

3) Historically, there is poor agreement between survey and XSA estimates of population numbers during some periods. This may be related to potential inaccuracies in the landings statistics.

4) In 1999, the gear and tow duration were changed on the Scottish survey. There were no calibrations completed to assess possible impacts on catchability for this survey.

5) In 2011, the gear was changed on the Scottish survey and an analysis showed that there was no detectable difference between the older and new survey on haddock indices in neighbouring areas (IBTSWG 2012).

6) The XSA assessment shows trends in catchability, even if reduced by weak shrinkage.

7) There are doubts on the level of agreement of age reading by international experts.

8) The XSA assessment diagnostics give quite large standard errors on survivors' estimates (0.3–0.4) and there are often quite different values given by Scottish Rock-IBTS-Q3, F-shrinkage and P-shrinkage.

9) The determination of the fishing mortality for last strong year class (2005) is uncertain because same time included in plus group.

10) Haddock poor year classes 2007–2011 are rare in samples this leads to higher variability in catch and survey estimates of those year classes.

11) The WG considers that a longer series of more accurate landings, discards (for non-Russian fleets) and survey data will be necessary to overcome these deficiencies.

12) The survey covers only part of the currently known distribution area of haddock that raises uncertainty in the assessment.

13) The main conclusion of WGCSE is that a longer time-series of available landings and discard data is needed before progress can be made towards the next benchmark assessment of this stock.

14) The indices obtained from the standard survey area must be used for the next assessment on account of the heterogeneity in the abundance and length–age composition of the haddock stock in different parts of the bank. New survey indexes from whole area will be used for the assessment once the time-series for the whole area of haddock distribution is of sufficient length.

15) An improved time-series of landings and discards for ages 7 and older is needed for this assessment. It is necessary for separate estimation of fishing mortality of haddock included in the age plus group.

16) It is recommended to analyse the opportunity of using new estimation models including Statistical catch-at-age analysis which could improve the quality of the assessment. Finally, it would be beneficial to develop and introduce standardization methods for reading the age for haddock.

No timeframe for the next benchmark could be proposed at this stage.

4.3.9 Management considerations

The new F_{MSY} estimate is consistent with the F in the management plan previously evaluated by ICES. The stock appears to be recovering after a period of very low recruitment. Incoming recruitment is still not a strong as it was historically. So a sudden expansion of the fishery at Rockall should be avoided.

A discards ban has been in place in the NEAFC regulatory area since 2009. Haddock in VIb have not yet been included under the EU landings obligation in 2016 (EC, 2015). It would be beneficial to develop and introduce into fisheries practice measures aimed at preventing discards of haddock. Elaboration of such measures complies with recommendations under the UNGA Resolution 61/105 that urges states to take action to reduce or eliminate fish discards (UNGA Resolution 61/105, 2007, Chapter VIII, item 60).

4.3.10 References

Blacker R.W. 1982. Rockall and its fishery. Laboratory Leaflet, Lowestoft. No 55. 23 pp.

Brodziak J. 2005. Technical Description of STATCAM Version 1.2. Northeast Fisheries Science Center 166 Water Street Woods Hole, MA 02543. 39 pp.

Chuksin, Yu. V. and Gerber, E. M. 1976. Soviet fishery in the Rockall and Porcupine areas. Zaprybpromrazvedka. Kaliningrad, 8 pp.

EC. 2015. Commission Delegated Regulation (EU) 2015/2438 of 12 October 2015 establishing a discard plan for certain demersal fisheries in north-western waters.

Finina E.A., Khlivnoy V.N., Vinnichenko V.I. 2009. The Reproductive Biology of Haddock (*Mellanogrammus aeglefinus*) at the Rockall Bank. Journal of Northwest Atlantic Fishery Science, Vol. 40: pp. 59–73.

ICES. 2004. Report of an Expert Group on Rockall Haddock Recovery Plans following a request for advice made on behalf of the European Community and the Russian Federation. 13–15 January 2004. Galway, Ireland. ICES/ACFM. 300 p.

ICES. 2013. ICES Advice 5.3.2.2. Special request Advice August 2013. Request from NEAFC to evaluate the proposals for the harvest control components of the management plan for Rockall haddock fisheries. ICES CM 2013/ACOM. 8 p.

ICES. 2016. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4). ICES CM 2015/ACOM:58. 183 p.

Khlivnoy V.N., Sentiabov E.V. 2009. Influence of environmental factors on formation of year classes of haddock (*Melanogrammus aeglefinus*) at the Rockall Bank. Theses and reports of X All-Russian conference on problems of fishery forecasting, Murmansk: PINRO. pp. 137.

Newton, A. W., Peach, K. J., Coull, K. A., Gault, M. and Needle, C. L. 2008. Rockall and the Scottish haddock fishery. Fisheries Research, 94: pp.133–140.

Shestov, V. P. 1977. Rockall haddock. Fishery biological resources of the North Atlantic and adjacent seas of the Arctic Ocean. Moscow, pp.344–346.

Sonina M.A. 1976. The condition of the Arcto-Norwegian haddock stock and the factors determining the population size. // The Edition of the PINRO works. Vol. 37. pp. 129–150.

Tormosova I.D. 1978. The survival of North Sea haddock eggs at different stages of development and its determining factors. // The Edition of the AtlantNIRO works. Vol. 81. pp. 7–18.

Table 4.3.1. Nominal catch (tonnes) of haddock in Division VIb, 1993–2013, as officially reported to ICES.

Country	1995	1996	1997		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015[5]
Faroe Islands	-	-	-	-		-	n/a	n/a	-	-	-	-	2	2	16	-	42	2	53	-	<1	<1
France	…[2]	-	-	-			5	2	-	1	-	-	-	-	-	-	-	<1	-	-	<1	-
Iceland	-	-	-	-		167	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ireland	677	747	895	704		1,021	824	357	206	169	19	105	41	338	721	352	169	123	31	105	94	190
Norway	29	24	24	40		61	152	70	49	60	32	33	123	84	36	71	65	40	48	121	41	66
Portugal	-	-	-	4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Russian Federation	-	-	-	-		458	2,154	630	1,630	4,237	5,844	4,708	2,154	1,282	1669	55	198	-	1	4	388	136
Spain	28	1	22	21		25	47	51	7	19	-	-	5	-	-	-	-	-	-	-	-	-
UK (E, W & NI)	318	293	165	561		288	36	-	-	56	-	-	-	-	-	-	-	-	-	-	-	-
UK (Scotland)	4,439	5,753	4,114	3,768		3,970	2,470	1,205	1,145[3]	1,607	411[3]	332[3]	440[3]	1,643[3]	1,779[3]	2,951[3]	2,931[3]	1,738[3]	577[3]	596[3]	1,152[3]	2,052[3]
Total	5,491	6,818	5,220	5,098		5,990	5,688	2,315	3,037	6,148	6,306	5,178	2,765	3,349	4,221	3,429	3,405	1,903	710	826	1,675	2,445
Unallocated catch	-379	-543	-591	-599		-851	-357	-279	299	94	139	1	0	0	0	-192	0	0	0	0	0	0
WG estimate	5,112	6,275	4,629	4,499		5,139	5,331[4]	2,036[4]	3,336[4]	6.242[4]	6,445	5,179	2,765	3,349	4,221	3,237	3,405	1,903	710	826	1,675	2,445

[1]Preliminary.

[2]Included in Division VIa.

[3]Includes Scotland, England, Wales and NI landings.

[4]Includes the total Russian catch.

n/a = not available.

Table 4.3.2. Details of Scottish and Irish effort (in hours) from 1985–2015 (preliminary data).

Year	Scottish fleet			Irish fleet
	SCOTRL*	SCOLTR*	SCOSEI*	IROTB*
1985	8421	3081	1677	
1986	7465	4783	507	
1987	8786	9737	402	
1988	12450	5521	261	
1989	10161	11946	1411	
1990	3249	5335	4552	
1991	2995	11464	6733	
1992	2402	9623	3948	
1993	1632	11540	1756	
1994	2305	15543	399	
1995	1789	13517	1383	9142
1996	1627	17324	952	7219
1997	563	16096	1061	7169
1998	1332	12263	456	7461
1999	11336	9424	456	8680
2000	12951	8586	80	9883
2001	7838	1037	42	7244
2002	8304	1100	0	2626
2003	15000	500	50	4618
2004	15200	300	50	2070
2005	7788	32	0	2693
2006	9990	231	0	5903
2007	4534	319	44	6589
2008	2497	1016	82	9740
2009	NA	NA	NA	4354
2010	NA	NA	NA	3280
2011	NA	NA	NA	2495
2012	NA	NA	NA	3291
2013	NA	NA	NA	2947
2014	NA	NA	NA	3159
2015	NA	NA	NA	3053

SCOTRL* – Scottish Heavy Trawl, SCOLTR* – Scottish Light Trawl, SCOSEI* – Scottish Seine, IROTB* – Irish bottom otter trawl.

Table 4.3.3. Effort from the Scottish TR1 fleet (see the Section Cod VIb).

YEAR	EFFORT (KWDAYS)
2003	2 504 466
2004	1 842 103
2005	1 217 357
2006	1 011 354
2007	1 060 551
2008	1 124 197
2009	1 631 239
2010	1 744 452
2011	1 565 753
2012	901 552
2013	532 767
2014	668 665
2015	563 098

Table 4.3.4. Discards and retained catches of haddock (number per trip) by Irish discard trips in the Rockall area from 2007–2009 and 2011–2012.

YEAR	2007		2008		2009		2011		2012	
Length (cm)	Discards	Retained Catch	Discards	Retained Catch	Discards	Retained Catch	Discards	Retained Catch	Discards	Retained Catch
10									1	
11									1	
12									1	
13									1	
14										
15										
16										
17										
18										
19	1.3									
20										
21										
22	1.6		14.8							
23	4.6		66.2				13.1			
24	7.3		183.8				98.9	5.7		
25	22.7		576.9		15.6		53.9	5.7		
26	54.2		1424.9		30.4		75.3	11.4		
27	104.6		3024.6		25.2		121.3	34.3	2	
28	256.9		6274.7		228.2		96.4	108.5		
29	386.5	7.9	7193.3		180.6		33.6	62.8		
30	533.4	17.6	7813.5	13.9	573.2	9.9	73.9	5.7	3	2
31	462.6	47.2	7573.7	40.6	1338.1	9.9	28.6	17.1	6	3
32	298.8	88.3	4639.0	77.8	1762.8	57.8	46.9	125.3	7	4
33	227.3	99.4	3664.7	126.8	2256.5	235.9	20.7	92.4	9	5
34	120.8	139.2	2391.8	277.4	1496.5	397.3	16.0	196.8	7	7
35	78.3	118.8	1590.1	503.6	656.6	614.8	4.8	118.6	6	8
36	27.4	187.0	871.7	580.5	423.5	567.1	0.3	340.4	2	6
37	26.1	139.8	280.3	640.9	66.9	526.8	0.0	235.8	1	11
38	24.3	142.7	78.3	581.9	57.4	421.4	0.0	632.2		8
39	3.4	162.5	206.6	443.0	23.1	346.9	4.8	312.7		11
40	8.7	119.4	37.5	535.6		281.4		158.9		9
41	1.3	133.8	5.2	310.7		197.9		203.4		12
42	4.6	133.1	5.2	334.7		155.7		348.1		13
43	3.2	109.3		333.5		195.1		225.4		11
44		118.6		291.1		201.7		305.4		13
45		97.9		253.6		149.9		226.0		10
>45 cm		574.5	0.0	1791.2	0.0	1001.7		2490.8	1	144
Total	2659.9	2436.9	47916.8	7136.8	9134.4	5371.3	688.6	6263.7	48.0	277.0
Discard rate, %	52.2		87.0		63.0		10.0		14.8	

Table 4.3.5. Length composition of Irish discards and landings of haddock (number) by results of Irish discard trips in the Rockall area in 2014–2015.

YEAR	2014		2015	
Length (cm)	Discards	Landings	Discards	Landings
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20	508.86			
21	1249.21		68.03	
22	3757.56		136.45	
23	9882.93		548.57	
24	17742.15		2466.15	
25	26690.88		5489.88	
26	29456.22	206.22	8664.85	
27	27737.04	1787.22	17011.27	
28	28506.24	4605.52	23581.32	
29	23556.01	5224.18	28730.09	
30	22791.88	4261.83	33689.11	274.85
31	25734.19	4330.57	32838.74	742.11
32	25404.86	3436.96	33210.44	1044.45
33	17211.02	4880.48	25934.47	2308.78
34	8877.72	6392.74	17534.75	2666.09
35	4733.26	7217.61	7589.53	8300.60
36	2034.38	6324.00	4142.17	9702.36
37	918.99	5774.09	854.19	16628.69
38	77.02	4674.26	110.53	10636.86
39	153.20	3780.65	88.60	13495.35
40	0.00	4949.22		14787.16
41	39.00	4949.22		12808.21
42	51.67	7011.39		17425.77
43	12.67	4743.00		14732.19
44	12.67	4055.61		11488.91
45	25.34	2680.83		11186.57
>45 cm	290.53	30520.19		77254.68
Total	277455.52	121805.80	242689.10	225483.63
Discard rate, %	69.5		51.8	

Table 4.3.6. Discards and retained catches of haddock (number per trip) by Scottish discard trips in the Rockall area in 2009 and 2011–2015.

Length (cm)	2009		2011		2012		2013*		2014*		2015*	
	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings
9					1.0							
10					3.0							
11					5.2							
12					66.5							
13					233.3							
14					313.0							
15					842.8							
16					516.7		226		1493			
17					247.3		0		7817		138	
18					341.7		0		22709		957	
19					81.5		135		39126		4591	
20					4.7		39		37513		9278	
21							357		25979		15194	
22							1322		8774		16591	
23					4.0		2201		14104		19529	
24					23.0		3665		28818		42079	
25					18.9		6643		64709		122065	
26			3.8		36.4		6714		118616		206928	
27			3.8		15.9		6424		164637		254254	
28	24.2		17.4		22.6		5018		142534		305155	

Length (cm)	2009		2011		2012		2013*		2014*		2015*	
	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings
29	14.7		78.6		53.4		3599		121740	1422	342216	
30			53.0		77.9	37.3	2326		78972	7965	330023	10543
31	5.3	26.4	17.4		126.6	76.1	1286	894	58592	25316	178402	31628
32	12.0		35.2	317.1	119.9	161.9	1181	2682	31670	30389	94018	84630
33	20.1	47.1	28.0	463.7	160.4	464.8	643	6454	13957	33340	23867	195299
34		201.7		637.4	71.0	1093.8	208	18902	10246	52890	9191	271402
35		220.2	139.8	1171.2	25.6	1366.4	101	23579	3404	47790		328955
36		269.0	139.8	1709.7	42.0	1872.7	39	34036		60976		241848
37		296.5		1668.7	10.1	2164.3		35748		57701		277221
38		353.1	139.8	2032.6	17.5	1917.5		33986		57472		197661
39		193.2		1927.7		2393.7	39	27892		61971		256136
40		237.9	139.8	1233.5		2091.6		36058		45808		188271
41		131.7		1020.3	1.5	1876.3		23821		42575		189250
42		107.9		959.1		1247.9		18935		50824		123229
43		181.9		641.2	118.0	1416.8		23001		48330		150363
44		96.8	139.8	406.0	118.0	1288.2		20654		48019		108077
45		72.1		233.1		1326.8		22804		40359		75009
46		82.4	139.8	138.1	2.1	1252.9		22272		34162		78581
47		46.8		122.2	193.5	1023.0		22565		36909		39233
48		47.0	139.8	55.9		833.8		17565		33530		43136
49		33.3	1.0	49.9	194.5	711.7		18802		29220		48753
50		19.3		36.2	1.0	651.6		17499		28263		42833

Length (cm)	2009		2011		2012		2013*		2014*		2015*	
	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings
51		8.9		37.5		410.3		12020		22682		50870
52		4.8		14.7		315.2		14866		23089		72142
53		5.1		20.5		206.1		12313		27292		40558
54		3.2		8.4		210.4		18722		34873		9895
55		2.3		5.4		98.8	26	11861		23816		34552
56		4.6		3.4		203.3		19573		18753		12660
57		2.7		1.6		408.4		14254		17896		9895
58		1.9		3.1		404.8		8962		16511		9506
59		1.7		9.1		87.8		6702		21930		7518
60		1.2				189.9		9813		20822		2765
61		1.7		2.7		190.7		5851		12248		
62		1.1		1.3		213.7		6436		20519		5531
63		0.5		2.4		210.2		4016		9150		
64		1.3				97.7		6675		7792		1166
65				1.1		45.1		5212		9321		
66				1.1		105.2		2314		13225		
67						45.0		3830		14393		
68				1.0		24.3		1649		9712		3154
69						63.1		1649		3359		
70				0.9		58.0		1915		4556		
71						47.9		665		2406		
72						42.2		1782		190		

Length (cm)	2009		2011		2012		2013*		2014*		2015*	
	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings
73						20.1		1117		1102		2765
74						20.6		133		2181		
76						5.7						
77						8.6				71		
78				0.7		4.1				759		
82				0.6								
Total	76.3	2705.3	1216.8	14939.0	4110.5	29006.3	42218	600479	995410	1214092	1974476	3245035
Discard rate, %	2.7		7.5		12.4		6.6		45.0		37.8	

***Retained discards and landings**

Table 4.3.7. Discards and retained catches of haddock (number) by Scottish and Irish discard trips in the Rockall area in 2013–2015.

Year	Country		Age						
			1	2	3	4	5	6	7+
2013	Scotland	Landings	116013	9886	1154	33064	4373	33020	3387
		Discards	4666330	28973	0	0	0	0	11791
	Ireland*	Landings	–	–	–	–	–	–	–
		Discards	55362.11	51894.97	93897.72	38160.66	31041.36	35875.62	0
	Ireland**	Landings	–	–	–	–	–	–	–
		Discards	3061.12	2869.41	5191.86	2110.01	1716.36	1983.66	0
2014	Scotland	Landings	577.68	2.252	0.21	87.22	18.17	577.68	528.56
		Discards	142.26	853.15	–	–	–	–	–
	Ireland	Landings	4.19	58.64	2.35	1.28	21.08	7.63	26.63
		Discards	15.65	261.80	–	–	–	–	–
2015	Scotland	Landings	–	464407.22	2679181.53	1619.87	1170.97	24139.36	88331.55
		Discards	70128.49	1935828.82	45430.69	–	–	–	–
	Ireland	Landings	–	2277.02	159849.03	3767.07	3661.75	42685.16	13243.61
		Discards	–	149260.90	93428.22	–	–	–	–

*** Mesh size 110–119 mm.**

**** Mesh size 70–99 mm.**

Table 4.3.8. Haddock in VIb. Tuning data available from the Scottish groundfish survey conducted in September. In bold, the data used in the assessment. Final runs.

HADDOCK WGCSE 2015 ROCKALL
101
SCOGFS
1991 2015
1 1 0.66 0.75
0 8

1	14458	**16398**	**4431**	**683**	**315**	**228**	**37**	64	3
1	20336	**44912**	**14631**	**3150**	**647**	**127**	**200**	4	32
1	15220	**37959**	**15689**	**3716**	**1104**	**183**	**38**	73	21
1	23474	**13287**	**11399**	**4314**	**969**	**203**	**30**	12	4
1	16923	**16971**	**6648**	**5993**	**1935**	**483**	**200**	16	-1
1	33578	**19420**	**5903**	**1940**	**1317**	**325**	**69**	6	1
1	28897	**10693**	**2384**	**538**	**292**	**281**	**71**	9	1
1	-1	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	-1	-1
1	10178	**9969**	**2410**	**708**	**279**	**172**	**90**	64	32
1	-1	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	-1	-1
1	31813	**7455**	**521**	**284**	**154**	**39**	**14**	12	14
1	11704	**20925**	**2464**	**173**	**105**	**65**	**20**	10	15
1	2526	**10114**	**10927**	**1656**	**138**	**97**	**100**	26	6
1	-1	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	-1	-1
1	24452	**4082**	**920**	**1506**	**2107**	**231**	**33**	13	7
1	3570	**18715**	**2562**	**256**	**1402**	**1694**	**349**	16	6
1	558	**2671**	**6019**	**570**	**254**	**516**	**367**	28	2
1	85	**560**	**966**	**3813**	**182**	**41**	**282**	249	49
1	132	**139**	**323**	**488**	**1651**	**40**	**9**	54	17
1	-1	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	-1	-1
1	13	**17**	**96**	**22**	**42**	**88**	**607**	4	4
1	39619	**4**	**12**	**73**	**14**	**75**	**50**	635	9
1	6035	**14179**	**5**	**8**	**8**	**9**	**11**	23	166
1	3044	**7232**	**4692**	**5**	**0**	**13**	**0**	11	10
1	1997	**2908**	**5634**	**3304**	**28**	**28**	**16**	2	19

Table 4.3.9. Haddock in VIb. Exploratory runs. Corrected tuning data available from the Scottish groundfish survey conducted in September. In bold, the data used in the assessment.

HADDOCK WGCSE 2015 ROCKALL
101
SCOGFS
1991 2015
1 1 0.66 0.75
0 8

1	14458	**16398**	**4431**	**683**	**315**	**228**	**37**	64	3
1	20336	**44912**	**14631**	**3150**	**647**	**127**	**200**	4	32
1	15220	**37959**	**15689**	**3716**	**1104**	**183**	**38**	73	21
1	23474	**13287**	**11399**	**4314**	**969**	**203**	**30**	12	4
1	16923	**16971**	**6648**	**5993**	**1935**	**483**	**200**	16	-1
1	33578	**19420**	**5903**	**1940**	**1317**	**325**	**69**	6	1
1	28897	**10693**	**2384**	**538**	**292**	**281**	**71**	9	1
1	-1	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	-1	-1
1	10178	**9969**	**2410**	**708**	**279**	**172**	**90**	64	32
1	-1	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	-1	-1
1	31813	**7455**	**521**	**284**	**154**	**39**	**14**	12	14
1	11704	**20925**	**2464**	**173**	**105**	**65**	**20**	10	15
1	2526	**10114**	**10927**	**1656**	**138**	**97**	**100**	26	6
1	-1	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	-1	-1
1	24452	**4082**	**920**	**1506**	**2107**	**231**	**33**	13	7
1	3570	**18715**	**2562**	**256**	**1402**	**1694**	**349**	16	6
1	558	**2671**	**6019**	**570**	**254**	**516**	**367**	28	2
1	85	**560**	**966**	**3813**	**182**	**41**	**282**	249	49
1	132	**139**	**323**	**488**	**1651**	**40**	**9**	54	17
1	-1	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	-1	-1
1	*71*	**17**	**96**	**22**	**42**	**88**	**607**	4	4
1	39619	***55***	**12**	**73**	**14**	**75**	**50**	635	9
1	6035	**14179**	***39***	**8**	***36***	**9**	**11**	23	166
1	3044	**7232**	**4692**	***23***	**0**	**13**	**0**	11	10
1	1997	**2908**	**5634**	**3304**	***7***	***6***	**16**	2	19

Table 4.3.10. Haddock in VIb. International landings, discards and total catch.

Year	Num (*1000)			Weight, tonnes		
	Landings	Discards	Total Catch[1]	Landings	Discards	Total Catch[1]
1991	12302	65832	78134	5656	13228	18884
1992	11418	55964	67383	5321	11871	17192
1993	8767	44656	53423	4781	9853	14634
1994	11400	46628	58028	5732	11023	16755
1995	11784	35467	47251	5587	9168	14756
1996	14066	41506	55572	7072	9356	16428
1997	9966	26980	36945	5167	5894	11061
1998	9034	47831	56865	4986	10862	15848
1999	12930	52881	65811	6086	11062	16418
2000	15999	26033	42031	7218	6609	12053
2001	5361	9222	14583	2428	1535	3658
2002	11167	21899	33066	5141	4152	7270
2003	24409	25087	49496	5969	5521	11490
2004	22705	3989	26694	6437	883	7321
2005	19505	1877	21382	5189	505	5696
2006	9605	1667	11272	2756	386	3142
2007	8936	12261	21197	3348	2242	5590
2008	10209	7603	17812	4221	2100	6320
2009	6709	4765	11474	3237	1557	4794
2010	5265	878	6144	3404	306	3710
2011	3156	389	3545	1905	152	2056
2012	749	44	793	710	16	726
2013	782	5552	6334	825	1143	1968
2014	2862	1378	4240	1675	274	1949
2015	4097	2294	6391	2446	527	2973

[1] Landings and discards.

Table 4.3.11. Haddock in VIb. International catch (landings and discards) numbers (*103) at-age.

AGE	YEAR										
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	21186	16084	11178	8170	2749	12096	9957	14224	17282	8222	7667
2	33847	24711	19375	20623	9831	18811	10535	19807	21949	12581	1961
3	15189	18584	15494	17868	21585	10911	5388	10173	12203	10697	1815
4	5341	5361	4938	8210	9756	9612	4098	4763	5499	4917	1018
5	1704	1761	1617	2449	2464	3299	5002	3740	3419	2050	1038
6	346	676	461	476	787	751	1758	2767	2684	1498	484
+gp	522	206	359	233	79	92	207	1391	2776	2066	601
TOTAL	78134	67383	53423	58028	47251	55572	36945	56865	65811	42031	14583

AGE	YEAR											
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1	13364	6576	932	1061	2880	1491	476	223	0.05	4	4	5606
2	11119	23606	4112	3723	1475	9829	2207	707	118	59	6	51
3	4536	14559	10282	7420	1626	3605	11437	1237	264	107	156	11
4	2445	2063	9212	8124	2414	1503	1291	8046	426	186	63	43
5	898	1285	1386	753	2291	2213	507	495	4718	188	3	9
6	260	925	296	109	436	1816	964	263	308	2725	65	46
+gp	444	483	474	193	151	741	930	504	310	276	496	556
TOTAL	33066	49496	26694	21382	11273	21198	17812	11474	6144	3545	793	6323

AGE	YEAR	
	2014	2015
1	370	74
2	2636	2741
3	418	3284
4	44	105
5	127	7
6	38	68
+gp	607	112
TOTAL	4240	6391

Table 4.3.11. Haddock in VIb. International landings numbers (*10³) at-age.

AGE	YEAR										
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	87	86	28	30	1	2	1	4	245	33	399
2	6807	3642	1919	1160	146	5149	319	392	2600	3445	941
3	3011	5624	4740	5299	5205	1861	2102	1815	2994	5081	1232
4	1344	964	1157	3665	4791	4149	2155	1340	1972	3006	752
5	558	580	489	1040	1319	2347	3658	1898	1228	1295	988
6	32	364	144	66	279	473	1540	2284	1600	1176	470
+gp	464	160	290	141	43	85	192	1301	2291	1963	579
TOTAL	12302	11418	8767	11400	11784	14066	9966	9034	12930	15999	5361

AGE	YEAR											
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1	657	920	197	887	2344	31	17	5	0.03	2	0	139
2	2983	8103	1765	2835	768	1220	749	11	71	23	0	12
3	3998	11001	9502	6866	1290	2709	6191	244	196	102	147	1
4	2111	1846	9119	7913	2356	1074	1164	5243	352	180	56	39
5	809	1188	1364	725	2269	1539	479	460	4078	188	1	6
6	217	878	286	98	428	1623	761	261	274	2412	65	43
+gp	392	475	472	182	150	740	848	486	294	249	480	542
TOTAL	11167	24409	22705	19505	9605	8936	10209	6709	5265	3156	749	782

AGE	YEAR	
	2014	2015
1	202	4
2	1425	656
3	418	3145
4	44	105
5	127	7
6	38	68
+gp	607	112
TOTAL	2862	4097

Table 4.3.12. Haddock in VIb. International discards numbers (*10³) at-age.

AGE	YEAR										
	1991	1992	1993	1994	1995*	1996	1997*	1998	1999*	2000	2001*
1	21099	15998	11151	8140	2748	12094	9957	14220	17037	8189	7268
2	27040	21069	17456	19464	9685	13662	10216	19415	19349	9136	1020
3	12178	12961	10755	12570	16379	9051	3287	8357	9210	5616	583
4	3998	4397	3781	4545	4965	5463	1944	3423	3526	1912	266
5	1146	1182	1128	1409	1145	952	1344	1842	2191	755	50
6	313	312	317	410	509	278	218	483	1084	322	15
+gp	58	46	69	91	36	7	15	91	485	103	21
TOTAL	65832	55964	44656	46628	35467	41506	26980	47831	52881	26033	9222

AGE	YEAR											
	2002	2003	2004	2005	2006	2007	2008	2009	2010*	2011*	2012*	2013*
1	12706	5655	736	174	536	1459	458	218	0.02	2	4	5468
2	8136	15503	2346	888	707	8610	1458	696	47	36	6	39
3	539	3558	781	554	336	896	5246	993	68	4	9	10
4	334	217	93	210	58	429	128	2803	74	6	7	4
5	89	97	22	28	22	674	28	36	640	1	2	3
6	43	48	10	11	8	193	203	2	33	313	0.04	4
+gp	51	8	2	11	1	1	82	18	16	27	16	14
TOTAL	21899	25087	3989	1877	1667	12261	7603	4765	878	389	44	5541

AGE	YEAR	
	2014*	2015*
1	168	70
2	1211	2085
3	0	139
4	0	0
5	0	0
6	0	0
+gp	0	0
TOTAL	1378	2294

*** data calculated using estimates from discard observer trips.**

Table 4.3.13. Haddock in VIb. International catch (landings and discards) weights-at-age (kg).

YEAR	AGE						
	1	2	3	4	5	6	7
1991	0.142	0.240	0.291	0.378	0.469	0.414	0.679
1992	0.133	0.239	0.318	0.362	0.423	0.567	0.844
1993	0.137	0.238	0.334	0.400	0.493	0.503	0.874
1994	0.153	0.233	0.319	0.420	0.469	0.477	0.721
1995	0.118	0.222	0.309	0.401	0.501	0.460	0.843
1996	0.136	0.278	0.314	0.395	0.553	0.575	0.763
1997	0.136	0.240	0.322	0.382	0.512	0.634	0.944
1998	0.141	0.250	0.308	0.354	0.436	0.546	0.662
1999	0.138	0.208	0.272	0.334	0.379	0.483	0.618
2000	0.189	0.250	0.267	0.321	0.382	0.451	0.707
2001	0.133	0.257	0.320	0.416	0.432	0.521	0.713
2002	0.135	0.239	0.237	0.325	0.509	0.580	0.753
2003	0.153	0.203	0.256	0.350	0.384	0.424	0.753
2004	0.147	0.198	0.244	0.294	0.444	0.609	0.753
2005	0.114	0.197	0.234	0.311	0.458	0.599	0.806
2006	0.093	0.198	0.245	0.329	0.441	0.595	0.787
2007	0.114	0.186	0.266	0.296	0.387	0.497	0.569
2008	0.199	0.241	0.291	0.437	0.571	0.669	0.932
2009	0.248	0.288	0.339	0.391	0.668	0.513	1.005
2010	0.100	0.352	0.460	0.437	0.560	0.741	0.902
2011	0.198	0.280	0.422	0.454	0.701	0.573	0.785
2012	0.263	0.295	0.544	0.708	0.529	0.817	1.088
2013	0.207	0.447	0.287	0.843	0.968	0.824	1.226
2014	0.117	0.285	0.268	0.488	1.031	1.099	1.396
2015	0.105	0.256	0.605	0.362	1.169	0.949	1.481

Table 4.3.15. Haddock in VIb. International landings weights-at-age (kg).

YEAR	AGE						
	1	2	3	4	5	6	7
1991	0.302	0.402	0.444	0.592	0.724	0.963	0.704
1992	0.136	0.366	0.455	0.658	0.612	0.759	0.954
1993	0.305	0.402	0.503	0.701	0.830	0.820	0.972
1994	0.314	0.356	0.452	0.558	0.638	1.224	0.890
1995	0.377	0.311	0.414	0.479	0.640	0.699	1.236
1996	0.327	0.436	0.501	0.487	0.627	0.709	0.783
1997	0.000	0.315	0.401	0.444	0.564	0.661	0.973
1998	0.256	0.344	0.494	0.517	0.542	0.591	0.678
1999	0.274	0.338	0.390	0.440	0.505	0.601	0.665
2000	0.272	0.404	0.379	0.407	0.473	0.513	0.740
2001	0.274	0.426	0.383	0.518	0.426	0.518	0.677
2002	0.240	0.422	0.416	0.541	0.565	0.649	0.818
2003	0.100	0.164	0.246	0.351	0.388	0.423	0.758
2004	0.142	0.172	0.241	0.293	0.446	0.617	0.754
2005	0.103	0.184	0.230	0.310	0.461	0.614	0.824
2006	0.084	0.167	0.223	0.327	0.440	0.598	0.789
2007	0.096	0.238	0.275	0.322	0.450	0.523	0.570
2008	0.125	0.197	0.302	0.444	0.583	0.752	0.984
2009	0.300	0.346	0.420	0.416	0.692	0.512	1.020
2010	0.052	0.428	0.520	0.459	0.591	0.990	1.451
2011	0.214	0.329	0.427	0.459	0.702	0.595	0.817
2012	0.189	0.368	0.555	0.747	0.912	0.817	1.110
2013	0.507	0.531	0.665	0.887	1.358	0.836	1.233
2014	0.148	0.345	0.268	0.488	1.031	1.099	1.396
2015	0.115	0.349	0.617	0.362	1.169	0.949	1.481

Table 4.3.15. Haddock in VIb. International discards weights-at-age (kg).

YEAR	AGE						
	1	2	3	4	5	6	7
1991	0.142	0.199	0.253	0.306	0.345	0.358	0.478
1992	0.133	0.217	0.258	0.298	0.330	0.342	0.464
1993	0.137	0.220	0.260	0.307	0.346	0.359	0.462
1994	0.153	0.226	0.263	0.308	0.345	0.356	0.458
1995	0.118	0.220	0.276	0.325	0.341	0.329	0.379
1996	0.136	0.218	0.276	0.326	0.370	0.348	0.524
1997	0.136	0.238	0.272	0.312	0.372	0.442	0.568
1998	0.141	0.248	0.267	0.291	0.327	0.336	0.436
1999	0.139	0.212	0.255	0.288	0.313	0.318	0.410
2000	0.189	0.267	0.289	0.311	0.330	0.334	0.462
2001	0.135	0.247	0.294	0.344	0.412	0.440	0.495
2002	0.137	0.254	0.308	0.335	0.398	0.338	0.367
2003	0.161	0.223	0.287	0.342	0.337	0.440	0.510
2004	0.148	0.218	0.282	0.343	0.324	0.371	0.469
2005	0.171	0.240	0.298	0.357	0.387	0.473	0.506
2006	0.132	0.233	0.334	0.420	0.495	0.435	0.435
2007	0.115	0.179	0.239	0.232	0.244	0.280	0.406
2008	0.202	0.264	0.279	0.370	0.351	0.358	0.392
2009	0.246	0.287	0.319	0.343	0.360	0.662	0.593
2010	0.161	0.239	0.289	0.335	0.359	0.404	0.458
2011	0.178	0.248	0.300	0.302	0.406	0.403	0.481
2012	0.263	0.295	0.356	0.372	0.340	0.733	0.440
2013	0.202	0.421	0,228	0.397	0.247	0.679	0.980
2014	0.080	0.215	-	-	-	-	-
2015	0.104	0.227	0.338	-	-	-	-

Table 4.3.16. Haddock VIb. Stock weights-at-age (kg).

YEAR	AGE						
	1	2	3	4	5	6	7
1991	0.142	0.240	0.291	0.378	0.469	0.414	0.679
1992	0.133	0.239	0.318	0.362	0.423	0.567	0.844
1993	0.137	0.238	0.334	0.400	0.493	0.503	0.874
1994	0.153	0.233	0.319	0.420	0.469	0.477	0.721
1995	0.118	0.222	0.309	0.401	0.501	0.460	0.843
1996	0.136	0.278	0.314	0.395	0.553	0.575	0.763
1997	0.136	0.240	0.322	0.382	0.512	0.634	0.944
1998	0.141	0.250	0.308	0.354	0.436	0.546	0.662
1999	0.138	0.208	0.272	0.334	0.379	0.483	0.618
2000	0.189	0.250	0.267	0.321	0.382	0.451	0.707
2001	0.133	0.257	0.320	0.416	0.432	0.521	0.713
2002	0.135	0.239	0.237	0.325	0.509	0.580	0.753
2003	0.153	0.203	0.256	0.350	0.384	0.424	0.753
2004	0.147	0.198	0.244	0.294	0.444	0.609	0.753
2005	0.114	0.197	0.234	0.311	0.458	0.599	0.806
2006	0.093	0.198	0.245	0.329	0.441	0.595	0.787
2007	0.114	0.186	0.266	0.296	0.387	0.497	0.569
2008	0.199	0.241	0.291	0.437	0.571	0.669	0.932
2009	0.248	0.288	0.339	0.391	0.668	0.513	1.005
2010	0.100	0.352	0.460	0.437	0.560	0.741	0.902
2011	0.198	0.280	0.422	0.454	0.701	0.573	0.785
2012	0.263	0.295	0.544	0.707	0.529	0.817	1.088
2013	0.210	0.466	0.665	0.887	1.358	0.836	1.226
2014	0.117	0.285	0.268	0.488	1.031	1.099	1.396
2015	0.105	0.256	0.605	0.362	1.169	0.949	1.481

Table 4.3.17. XSA diagnostics from the assessment of Haddock in VIb. Final runs.

Lowestoft VPA Version 3.1

At 11/05/2016 19:13

Extended Survivors Analysis

HADDOCK LANDISC 2004 ROCKALL

CPUE data from file had6b.tun

Catch data for 25 years. 1991 to 2015. Ages 1 to 7.

Fleet	Fi year	Last year	First age	Last age	Alpha	Beta
SCOGFS	1991	2015	0	6	0.66	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability dependent on stock size for ages < 4

Regression type = C
Minimum of 10 points used for regression
Survivor estimates shrunk to the population mean for ages < 4

Catchability independent of age for ages >= 5

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 4 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 24 iterations

1

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0.035	0.172	0.184	0.254	0	0.008	0.004	0.134	0.009	0.007
2	0.148	0.16	0.413	0.456	0.206	0.056	0.015	0.057	0.085	0.085
3	0.399	0.647	0.284	0.431	0.306	0.292	0.205	0.036	0.894	0.144
4	0.23	0.808	0.507	0.331	0.258	0.368	0.28	0.08	0.2	0.583
5	0.242	0.342	0.717	0.37	0.33	0.173	0.01	0.058	0.358	0.046
6	0.118	0.308	0.245	1.091	0.416	0.323	0.083	0.183	0.369	0.328

1

XSA population numbers (Thousands)

	AGE					
YEAR	1	2	3	4	5	6
2006	9.28E+04	1.18E+04	5.46E+03	1.30E+04	1.18E+04	4.33E+03
2007	1.04E+04	7.33E+04	8.37E+03	3.00E+03	8.44E+03	7.58E+03
2008	3.13E+03	7.20E+03	5.12E+04	3.59E+03	1.09E+03	4.90E+03
2009	1.10E+03	2.13E+03	3.90E+03	3.15E+04	1.77E+03	4.37E+02
2010	1.47E+03	6.97E+02	1.11E+03	2.07E+03	1.85E+04	1.00E+03
2011	5.23E+02	1.20E+03	4.64E+02	6.67E+02	1.31E+03	1.09E+04
2012	1.24E+03	4.25E+02	9.29E+02	2.84E+02	3.78E+02	9.04E+02
2013	5.01E+04	1.01E+03	3.43E+02	6.19E+02	1.76E+02	3.07E+02
2014	4.60E+04	3.59E+04	7.81E+02	2.71E+02	4.68E+02	1.36E+02
2015	1.06E+04	3.74E+04	2.70E+04	2.62E+02	1.81E+02	2.68E+02

Table 4.3.17. Continued.

Estimated population abundance at 1st Jan 2016

0.00E+00	8.64E+03	2.81E+04	1.92E+04	1.20E+02	1.42E+02

Taper weighted geometric mean of the VPA populations:

2.35E+04	1.82E+04	1.08E+04	5.16E+03	2.78E+03	1.39E+03

Standard error of the weighted Log(VPA populations) :

1.6683	1.6626	1.5851	1.4976	1.2697	1.1371

Log catchability residuals.

Fleet : SCOGFS

Age	1991	1992	1993	1994	1995
1	-0.39	0.31	0.03	-0.12	0.12
2	-0.51	0.51	0.42	-0.04	0.14
3	-0.53	0.39	0.48	0.36	0.37
4	-0.14	0.64	0.49	0.54	0.87
5	-0.19	0.18	0.6	-0.42	0.94
6	0.04	0.21	-0.02	-0.12	0.15

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.3	-0.31	99.99	0.19	99.99	-0.7	-0.23	0.03	99.99	0.47
2	0.25	-0.41	99.99	-0.33	99.99	-0.75	-0.81	0.2	99.99	0.25
3	0	-0.81	99.99	-0.29	99.99	-0.4	-0.87	-0.29	99.99	0
4	0.03	-1.1	99.99	-0.27	99.99	-0.72	-0.78	-0.51	99.99	0.57
5	0.05	-0.69	99.99	-0.33	99.99	-0.42	-1.01	0.38	99.99	-0.48
6	-0.14	-0.36	99.99	-0.15	99.99	-0.4	-0.05	0.25	99.99	0.09

Age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	-0.23	0.62	0.7	0.78	99.99	-0.12	-2.03	0.23	-0.23	0.58
2	0.77	-0.39	0.65	1.05	99.99	0.47	-0.13	-1.65	0.09	0.19
3	0.03	0.4	-0.07	0.91	99.99	0.44	0.67	-0.23	-0.94	0.37
4	0.58	0.74	0.01	-0.08	99.99	0.13	-0.17	-1.65	99.99	0.81
5	0.93	0.15	-0.08	-0.83	99.99	0.12	1.09	-0.23	-0.63	0.86
6	0.26	-0.11	0.02	-0.42	99.99	0.04	-0.14	-0.5	99.99	0.11

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

Age	4	5	6
Mean Log q	-2.4972	-2.5577	-2.5577
S.E(Log q)	0.6898	0.6166	0.233

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.72	3.383	3.99	0.89	21	0.62	-1.61
2	0.77	2.63	3.89	0.88	21	0.63	-2.13
3	0.81	2.526	3.78	0.91	21	0.53	-2.53

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
4	0.93	0.74	2.95	0.85	20	0.65	-2.5
5	1.08	-0.709	2.12	0.79	21	0.68	-2.56
6	0.94	1.502	2.92	0.97	20	0.2	-2.62

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2014

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	15399	0.638	0	0	1	0.642	0.004
P shrinkage mean	18245	1.66				0.095	0.003
F shrinkage mean	1614	1				0.263	0.039

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8642	0.51	0.82	3	1.6	0.007

Table 4.3.17. Continued.

1							
Age 2 Catchability dependent on age and year class strength							
Year class = 2013							
Fleet		Int	Ext	Var	N	Scaled	Estimated
		s.e	s.e	Ratio		Weights	F
SCOGFS	27501	0.456	0.211	0.46	2	0.759	0.086
P shrink	10779	1.59				0.069	0.207
F shrink	45242	1				0.173	0.053
Weighted prediction :							
Survivors	Int	Ext	N	Var	F		
at end of y	s.e	s.e		Ratio			
28101	0.4	0.21	4	0.532	0.085		
Age 3 Catchability dependent on age and year class strength							
Year class = 2012							
Fleet		Int	Ext	Var	N	Scaled	Estimated
		s.e	s.e	Ratio		Weights	F
SCOGFS	24637	0.354	0.083	0.23	3	0.816	0.114
P shrink	5160	1.5				0.057	0.455
F shrink	6873	1				0.128	0.359
Weighted prediction :							
Survivors	Int	Ext	N	Var	F		
at end of y	s.e	s.e		Ratio			
19155	0.33	0.3	5	0.916	0.144		
1							
Age 4 Catchability constant w.r.t. time and dependent on age							
Year class = 2011							
Fleet		Int	Ext	Var	N	Scaled	Estimated
		s.e	s.e	Ratio		Weights	F
SCOGFS	77	0.383	0.675	1.76	4	0.716	0.799
F shrink	360	1				0.284	0.233
Weighted prediction :							
Survivors	Int	Ext	N	Var	F		
at end of y	s.e	s.e		Ratio			
120	0.39	0.64	5	1.628	0.583		
Age 5 Catchability constant w.r.t. time and dependent on age							
Year class = 2010							
Fleet		Int	Ext	Var	N	Scaled	Estimated
		s.e	s.e	Ratio		Weights	F
SCOGFS	168	0.333	0.28	0.84	4	0.88	0.039
F shrink	41	1				0.12	0.15
Weighted prediction :							
Survivors	Int	Ext	N	Var	F		
at end of y	s.e	s.e		Ratio			
142	0.32	0.33	5	1.051	0.046		
1							
Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5							
Year class = 2009							
Fleet		Int	Ext	Var	N	Scaled	Estimated
		s.e	s.e	Ratio		Weights	F
SCOGFS	155	0.226	0.281	1.25	5	0.924	0.334
F shrink	208	1				0.076	0.259
Weighted prediction :							
Survivors	Int	Ext	N	Var	F		
at end of y	s.e	s.e		Ratio			
158	0.22	0.24	6	1.102	0.328		

Table 4.3.18. Haddock in VIb. Final XSA runs. Fishing mortality-at-age.

Run title : HADDOCK LANDISC 2004 ROCKALL											
At 11/05/2016 19:13											
Terminal Fs derived using XSA (With F shrinkage)											
Table 8	Fishing mortality (F) at age										
YEAR	1991	1992	1993	1994	1995						
AGE											
1	0.2397	0.1771	0.1058	0.141	0.0507						
2	0.6019	0.4876	0.3357	0.2898	0.2518						
3	0.8961	0.8068	0.6564	0.5965	0.5616						
4	0.9328	0.981	0.5152	0.9175	0.7854						
5	0.4196	0.9698	0.9526	0.5247	0.8007						
6	0.6278	0.291	0.7421	0.85	0.3159						
+gp	0.6278	0.291	0.7421	0.85	0.3159						
0 FBAR 2-	0.7126	0.8113	0.615	0.5821	0.5999						
Table 8	Fishing mortality (F) at age										
YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	
AGE											
1	0.2406	0.1664	0.2442	0.4974	0.3884	0.1125	0.1498	0.1617	0.0753	0.0779	
2	0.5708	0.3416	0.5798	0.7367	0.851	0.1488	0.2368	0.4286	0.1439	0.4807	
3	0.4913	0.3137	0.6543	0.8946	1.0449	0.2698	0.604	0.5574	0.335	0.4171	
4	0.5272	0.344	0.5073	0.9413	1.2441	0.241	0.7125	0.6175	0.8594	0.4846	
5	0.679	0.5821	0.612	0.866	1.2444	1.0133	0.3476	1.0991	1.2074	0.146	
6	0.6101	1.0014	0.7629	1.3462	1.3354	1.248	0.7707	0.7409	0.8296	0.2551	
+gp	0.6101	1.0014	0.7629	1.3462	1.3354	1.248	0.7707	0.7409	0.8296	0.2551	
0 FBAR 2-	0.5671	0.3954	0.5884	0.8596	1.0961	0.4182	0.4752	0.6756	0.6364	0.3821	
1											
Run title : HADDOCK LANDISC 2004 ROCKALL											
At 11/05/2016 19:13											
Terminal Fs derived using XSA (With F shrinkage)											
Table 8	Fishing mortality (F) at age										
YEAR	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	FBAR **-**
AGE											
1	0.0349	0.1717	0.1837	0.2539	0	0.0076	0.0038	0.1335	0.0089	0.0073	0.0499
2	0.148	0.1603	0.4134	0.4564	0.2065	0.0561	0.0149	0.0573	0.0846	0.0846	0.0755
3	0.3994	0.6468	0.2838	0.4314	0.3061	0.2924	0.2054	0.0361	0.894	0.1442	0.3581
4	0.2303	0.8077	0.5073	0.3313	0.2576	0.3677	0.2795	0.0804	0.1998	0.5825	0.2876
5	0.2418	0.3424	0.7171	0.3703	0.3303	0.1726	0.01	0.0582	0.3576	0.0461	0.1539
6	0.1179	0.3077	0.245	1.0913	0.416	0.3231	0.0828	0.1826	0.3686	0.328	0.2931
+gp	0.1179	0.3077	0.245	1.0913	0.416	0.3231	0.0828	0.1826	0.3686	0.328	
0 FBAR 2-	0.2549	0.4893	0.4804	0.3974	0.2751	0.2222	0.1275	0.058	0.384	0.2144	
1											

Table 4.3.19. Haddock in VIb. Final XSA runs. Stock numbers (*10³) at-age.

Run title : HADDOCK LANDISC 2004 ROCKALL

At 11/05/2016 19:13

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1991	1992	1993	1994	1995
	AGE					
	1	109846	109500	123014	68640	61422
	2	82712	70765	75097	90601	48806
	3	28364	37093	35578	43953	55517
	4	9732	9478	13553	15109	19818
	5	5495	3135	2910	6629	4942
	6	819	2957	973	919	3211
	+gp	1222	896	748	442	320
0	TOTA	238190	233825	251873	226293	194036

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	AGE										
	1	62517	71771	72553	48739	28231	79660	106180	48686	14198	15644
	2	47800	40239	49752	46532	24266	15674	58283	74841	33911	10781
	3	31064	22114	23413	22811	18237	8484	11059	37657	39915	24043
	4	25923	15560	13230	9964	7635	5252	5303	4949	17657	23376
	5	7398	12527	9031	6522	3183	1801	3379	2129	2185	6121
	6	1817	3072	5730	4009	2246	751	535	1954	581	535
	+gp	220	354	2841	4051	3027	911	900	1006	915	942
0	TOTA	176738	165637	176550	142628	86824	112532	185639	171222	109362	81442
	1										

Run title : HADDOCK LANDISC 2004 ROCKALL

At 11/05/2016 19:13

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	GMST 91-**	AMST 91-**
	AGE													
	1	92765	10444	3131	1097	1466	523	1239	50139	46030	10633	0	23672	51365
	2	11848	73344	7202	2133	697	1200	425	1010	35920	37351	8642	17172	37736
	3	5458	8365	51155	3900	1107	464	929	343	781	27024	28101	11608	22218
	4	12971	2997	3587	31534	2074	667	284	619	271	262	19155	6677	10925
	5	11788	8436	1094	1768	18537	1312	378	176	468	181	120	3387	5256
	6	4331	7579	4904	437	1000	10908	904	307	136	268	142	1652	2630
	+gp	1497	3070	4705	822	998	1097	6880	3666	2157	439	417		
0	TOTA	140657	114235	75779	41691	25878	16172	11039	56260	85763	76157	56577		
	1													

Table 4.3.20. Haddock in VIb. Final XSA run. Summary table.

Run title : HADDOCK LANDISC 2004 ROCKALL						
At 11/05/2016 19:13						
Table 16 Summary (without SOP correction)						
Terminal Fs derived using XSA (With F shrinkage)						
	RECI	TOTALBI	TOTSPBI	LANDIN	YIELD/SS	FBAR 2- 5
	Age 1					
1991	109846	51128	15679	5655	0.3607	0.7126
1992	109500	50462	18986	5320	0.2802	0.8113
1993	123014	54608	19882	4784	0.2406	0.615
1994	68640	55845	24233	5733	0.2366	0.5821
1995	61422	47407	29325	5587	0.1905	0.5999
1996	62517	47088	25297	7075	0.2797	0.5671
1997	71771	41179	21760	5166	0.2374	0.3954
1998	72553	43509	20841	4984	0.2391	0.5884
1999	48739	32849	16445	5221	0.3175	0.8596
2000	28231	23091	11689	4558	0.39	1.0961
2001	79660	21341	6718	1918	0.2855	0.4182
2002	106180	35316	7052	2571	0.3645	0.4752
2003	48686	36418	13776	5961	0.4327	0.6756
2004	14198	25745	16944	6400	0.3777	0.6364
2005	15644	20686	16779	5191	0.3094	0.3821
2006	92765	25531	14558	2759	0.1895	0.2549
2007	10444	26723	11890	3348	0.2816	0.4893
2008	3131	27103	24745	4205	0.1699	0.4804
2009	1097	16770	15883	3237	0.2038	0.3974
2010	1466	13829	13437	3404	0.2533	0.2751
2011	523	8970	8530	1905	0.2233	0.2222
2012	1239	9582	9131	710	0.0778	0.1275
2013	50139	16766	5766	825	0.1431	0.058
2014	46030	19607	3985	1675	0.4204	0.384
2015	10633	28302	17560	2445	0.1392	0.2144
Arith.						
Mean	49523	31194	15636	4025	0.2658	0.4927
0 Units	(Thousar	(Tonnes	(Tonnes	(Tonnes)		
1						

Table 4.3.21. Haddock in VIb. Detailed short-term forecast output.

MFDP version 1a												
Run: ghj												
Time and date: 18:28 11.05.2016												
Fbar age range (Total) : 2-5												
Fbar age range Fleet 1 : 2-5												
Year:	2016	F multipli	0.653	Fleet1 HC	0.1073	Fleet1 DF	0.0356					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNo	DYield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0086	87	14	0.024	241	40	11287	2020	0	0	0	0
2	0.0148	113	44	0.0345	264	74	8642	2696	0	0	0	0
3	0.1638	3735	1890	0.07	1596	488	28101	11943	28101	11943	28101	11943
4	0.1661	2637	1550	0.0217	345	123	19155	10938	19155	10938	19155	10938
5	0.0844	9	9	0.0161	2	1	120	106	120	106	120	106
6	0.1791	21	18	0.0123	1	1	142	121	142	121	142	121
7	0.185	64	77	0.0064	2	1	417	498	417	498	417	498
Total		6666	3602		2452	728	67864	28322	47935	23605	47935	23605
Year:	2017	F multipli	1	Fleet1 HC	0.1643	Fleet1 DF	0.0545					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNo	DYield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0132	124	20	0.0367	345	57	10633	1903	0	0	0	0
2	0.0227	177	69	0.0528	413	116	8945	2791	0	0	0	0
3	0.2509	1295	655	0.1072	553	169	6735	2862	6735	2862	6735	2862
4	0.2543	3665	2155	0.0333	480	171	18210	10398	18210	10398	18210	10398
5	0.1293	1415	1464	0.0246	269	89	12998	11438	12998	11438	12998	11438
6	0.2742	19	17	0.0189	1	1	89	76	89	76	89	76
7	0.2833	85	102	0.0098	3	2	378	452	378	452	378	452
Total		6781	4481		2065	605	57987	29920	38409	25225	38409	25225
Year:	2018	F multipli	1	Fleet1 HC	0.1643	Fleet1 DF	0.0545					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNo	DYield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0132	124	20	0.0367	345	57	10633	1903	0	0	0	0
2	0.0227	164	64	0.0528	382	107	8282	2584	0	0	0	0
3	0.2509	1306	661	0.1072	558	171	6791	2886	6791	2886	6791	2886
4	0.2543	776	456	0.0333	102	36	3854	2201	3854	2201	3854	2201
5	0.1293	1218	1259	0.0246	232	77	11183	9841	11183	9841	11183	9841
6	0.2742	1975	1696	0.0189	136	82	9124	7773	9124	7773	9124	7773
7	0.2833	64	77	0.0098	2	1	285	341	285	341	285	341
Total		5626	4233		1757	532	50151	27529	31237	23042	31237	23042
Input units are thousands and kg - output in tonnes												

Table 4.3.22. Haddock in VIb. Input data for the short-term forecast.

2016						
Age	N	M	Mat	PF	PM	SWt
1	11287	0.2	0	0	0	0.179
2	8642	0.2	0	0	0	0.312
3	28101	0.2	1	0	0	0.425
4	19155	0.2	1	0	0	0.571
5	120	0.2	1	0	0	0.88
6	142	0.2	1	0	0	0.852
7	417	0.2	1	0	0	1.195
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.0132	0.159	0.0367	0.165		
2	0.0227	0.388	0.0528	0.281		
3	0.2509	0.506	0.1072	0.306		
4	0.2543	0.588	0.0333	0.357		
5	0.1293	1.034	0.0246	0.331		
6	0.2742	0.859	0.0189	0.605		
7	0.2833	1.207	0.0098	0.634		
2017						
Age	N	M	Mat	PF	PM	SWt
1	10633	0.2	0	0	0	0.179
2	.	0.2	0	0	0	0.312
3	.	0.2	1	0	0	0.425
4	.	0.2	1	0	0	0.571
5	.	0.2	1	0	0	0.88
6	.	0.2	1	0	0	0.852
7	.	0.2	1	0	0	1.195
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.0132	0.159	0.0367	0.165		
2	0.0227	0.388	0.0528	0.281		
3	0.2509	0.506	0.1072	0.306		
4	0.2543	0.588	0.0333	0.357		
5	0.1293	1.034	0.0246	0.331		
6	0.2742	0.859	0.0189	0.605		
7	0.2833	1.207	0.0098	0.634		
2018						
Age	N	M	Mat	PF	PM	SWt
1	10633	0.2	0	0	0	0.179
2	.	0.2	0	0	0	0.312
3	.	0.2	1	0	0	0.425
4	.	0.2	1	0	0	0.571
5	.	0.2	1	0	0	0.88
6	.	0.2	1	0	0	0.852
7	.	0.2	1	0	0	1.195
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.0132	0.159	0.0367	0.165		
2	0.0227	0.388	0.0528	0.281		
3	0.2509	0.506	0.1072	0.306		
4	0.2543	0.588	0.0333	0.357		
5	0.1293	1.034	0.0246	0.331		
6	0.2742	0.859	0.0189	0.605		
7	0.2833	1.207	0.0098	0.634		
Input units are thousands and kg - output in tonnes						

Table 4.3.23. Haddock in VIb. Short-term forecast output.

MFDP version 1a								
Run: ghj								
Time and date: 18:28 11.05.2016								
Fbar age range (Total) : 2-5								
Fbar age range Fleet 1 : 2-5								
2016								
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield		
28322	23605	0.653	0.1073	3602	0.0356	730		
2017							2018	
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	Biomass	SSB
29920	25225	0	0	0	0	0	33524	28904
.	25225	0.1	0.0164	498	0.0054	67	32852	28246
.	25225	0.2	0.0329	985	0.0109	132	32198	27606
.	25225	0.3	0.0493	1460	0.0163	196	31561	26982
.	25225	0.4	0.0657	1923	0.0218	258	30940	26374
.	25225	0.5	0.0822	2375	0.0272	319	30334	25782
.	25225	0.6	0.0986	2817	0.0327	379	29744	25205
.	25225	0.7	0.115	3248	0.0381	437	29169	24643
.	25225	0.8	0.1314	3669	0.0436	495	28608	24095
.	25225	0.9	0.1479	4080	0.049	551	28062	23562
.	25225	1	0.1643	4481	0.0545	605	27529	23042
.	25225	1.1	0.1807	4873	0.0599	659	27009	22535
.	25225	1.2	0.1972	5255	0.0654	712	26503	22041
.	25225	1.3	0.2136	5629	0.0708	763	26009	21560
.	25225	1.4	0.23	5994	0.0763	814	25527	21091
.	25225	1.5	0.2465	6351	0.0817	863	25057	20634
.	25225	1.6	0.2629	6699	0.0872	912	24599	20188
.	25225	1.7	0.2793	7039	0.0926	959	24152	19754
.	25225	1.8	0.2957	7372	0.0981	1006	23716	19330
.	25225	1.9	0.3122	7696	0.1035	1052	23291	18917
.	25225	2	0.3286	8014	0.109	1096	22876	18514
Input units are thousands and kg - output in tonnes								

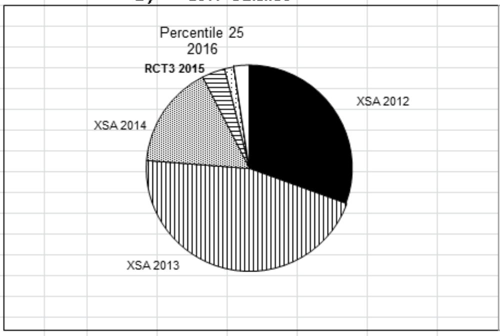
Table 4.3.24. Haddock VIb. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

Year-class			2012	2013	2014	2015	2016
Stock No. (thousands)			50139	46030	10633	11287	10633
of	1	year-olds					
Source			XSA	XSA	XSA	RCT3	Percentile 25
Status Quo F:							
% in	2016	landings	38.6	54.9	2.7	1.2	-
% in	2017	landings	30.5	45.7	16.2	3.6	1.5
% in	2016	SSB	46.3	50.6	0.0	0.0	-
% in	2017	SSB	45.3	41.2	11.3	0.0	0.0
% in	2018	SSB	33.7	42.7	9.6	12.5	0.0

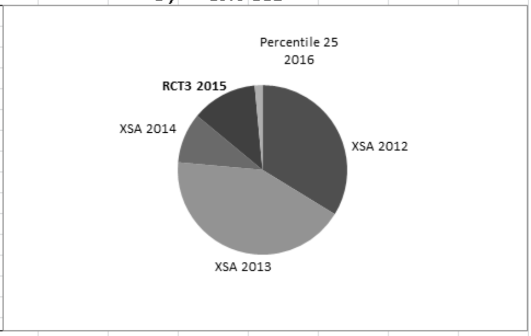
GM : geometric mean recruitment

Haddock VIb : Year-class % contribution to

a) 2017 Catches



b) 2018 SSB



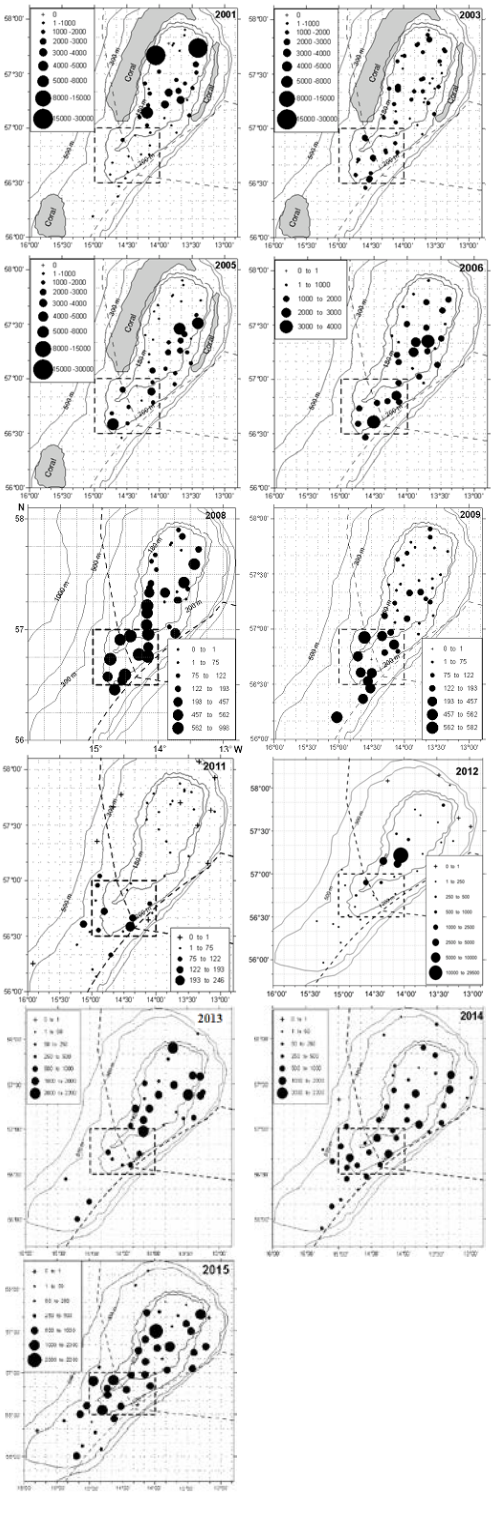


Figure 4.3.1. Distribution of haddock (catch N per 30 minutes) on the Rockall Bank in 2001–2015 from the Scottish trawl survey (Scottish Rock-IBTS-Q3).

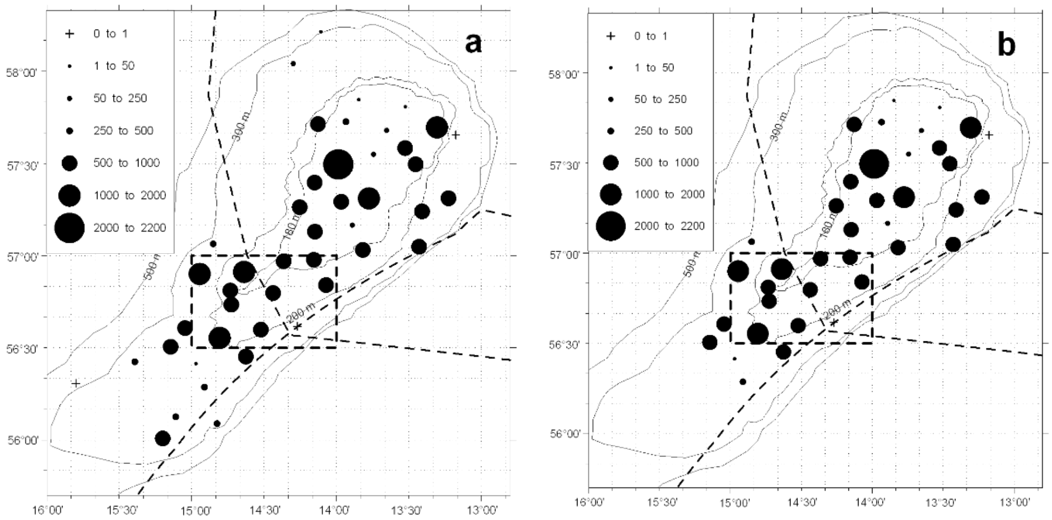


Figure 4.3.2. Haulings pattern during bottom survey by RV 'Scotia' in September 2015: a) the whole area; b) the standard area.

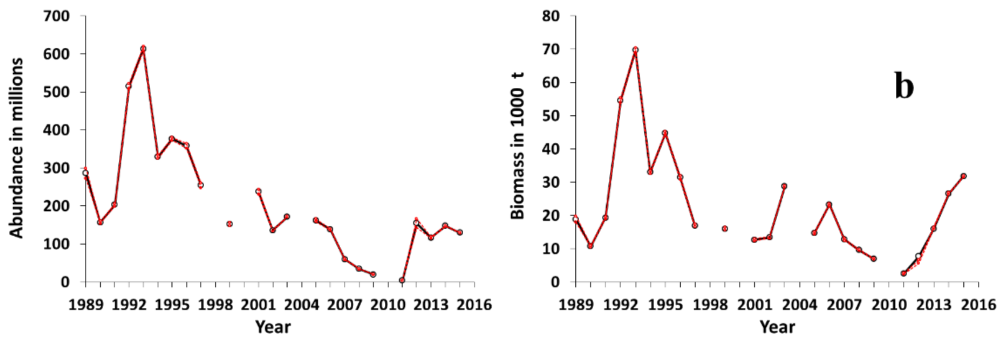


Figure 4.3.3. Abundance (a) and biomass (b) of haddock, assessed with the trawl survey method with geographical stratification based on rectangles of 15′ latitude and 15′ longitude by RV 'Scotia' survey. Red dashed line indicates the confidence interval with 0.95 reliability level.

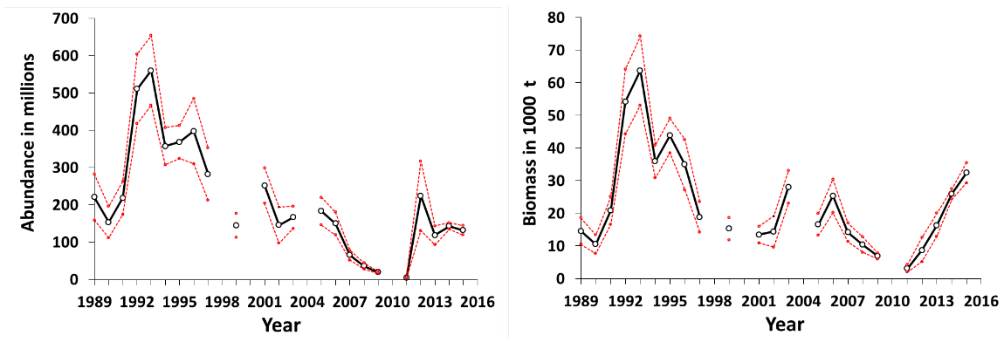


Figure 4.3.4. Abundance (a) and biomass (b) of haddock, assessed with the trawl survey method with geographical stratification based on bathymetry by RV 'Scotia' survey. Red dashed line indicates the confidence interval with 0.95 reliability level.

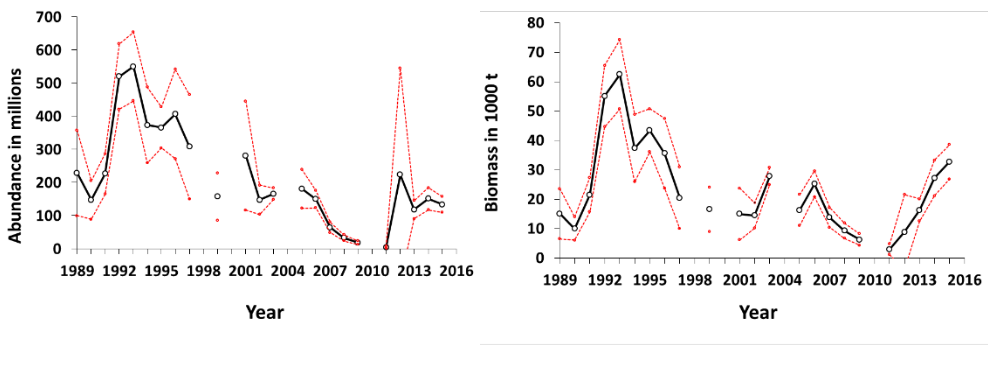


Figure 4.3.5. Abundance (a) and biomass (b) of haddock, assessed with the trawl survey method without geographical stratification by RV 'Scotia' survey. Red dashed line indicates the confidence interval with 0.95 reliability level.

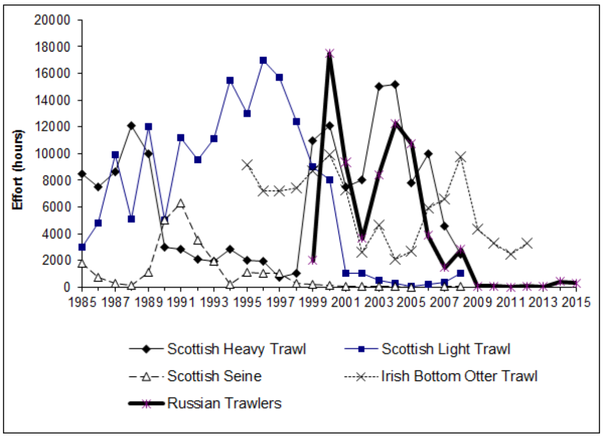


Figure 4.3.6. Rockall haddock in VIb. Scottish, Irish effort in 1985–2012 and Russian effort in 1999–2015.

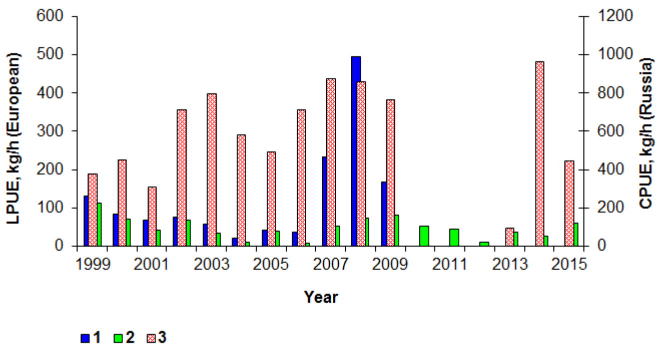


Figure 4.3.7. Lpue and cpue of the fleets fishing for Rockall haddock. Note that Scottish and Irish effort data are not reliable because reporting is not mandatory.

1 – Scottish lpue (all gears).

2 – Irish trawlers lpue.

3 – Cpue of Russian trawlers (BMRT type, tonnage class 10 in 1999–2007, and tonnage class 9 in 2008–2009, 2013–2015).

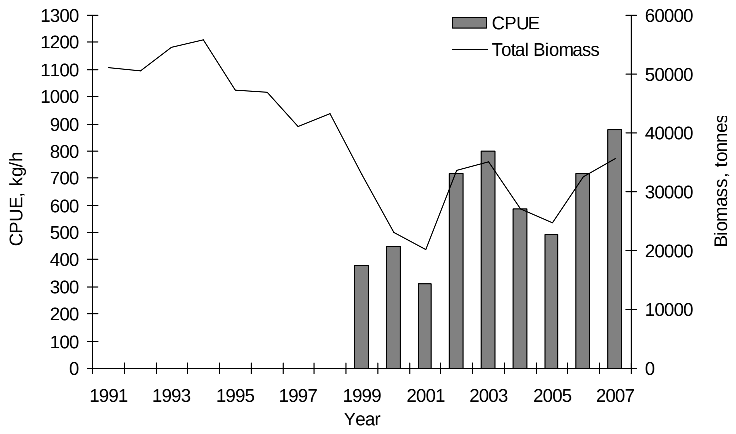


Figure 4.3.8. Dynamics of haddock total biomass (ICES, 2008a; ICES, 2008b) and directed fishing efficiency (t per a trawling hour) for tonnage class 10 vessels in 1999–2007.

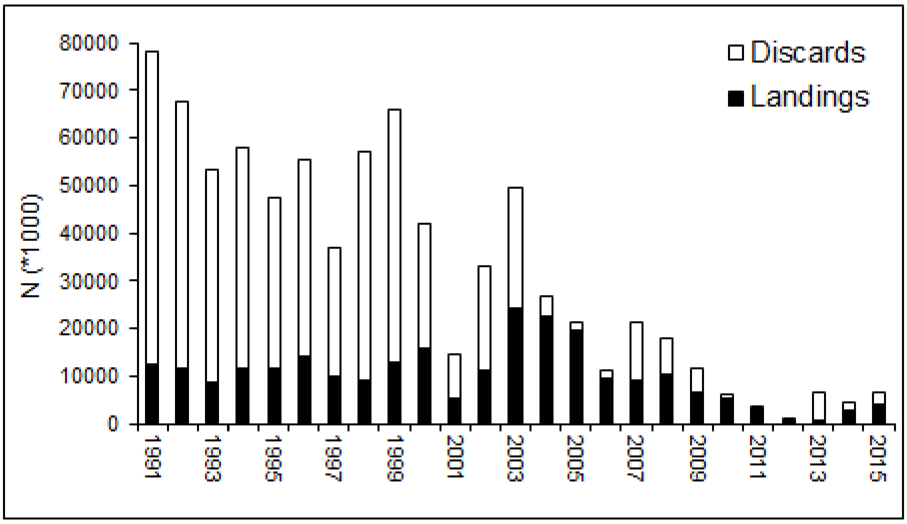


Figure 4.3.9. Total landings and discards of Rockall haddock (‘000 individuals).

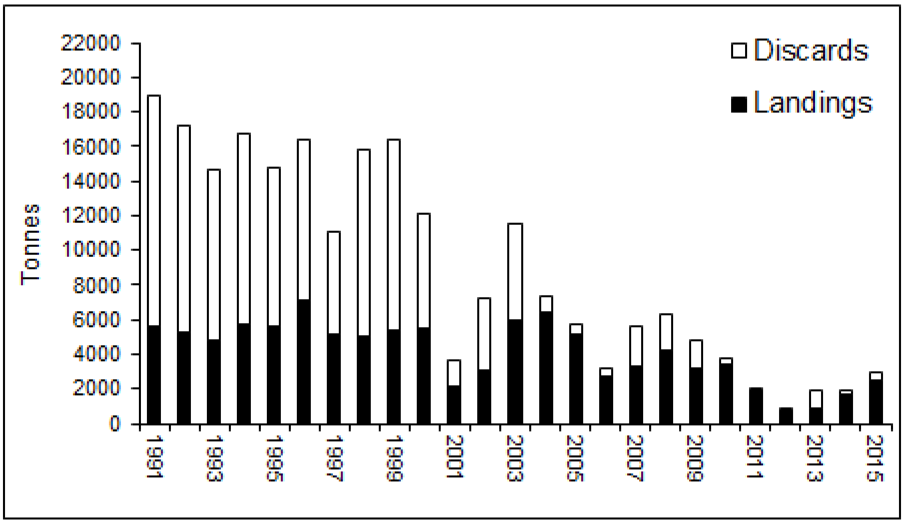


Figure 4.3.10. Total landings and discards of Rockall haddock (tonnes).

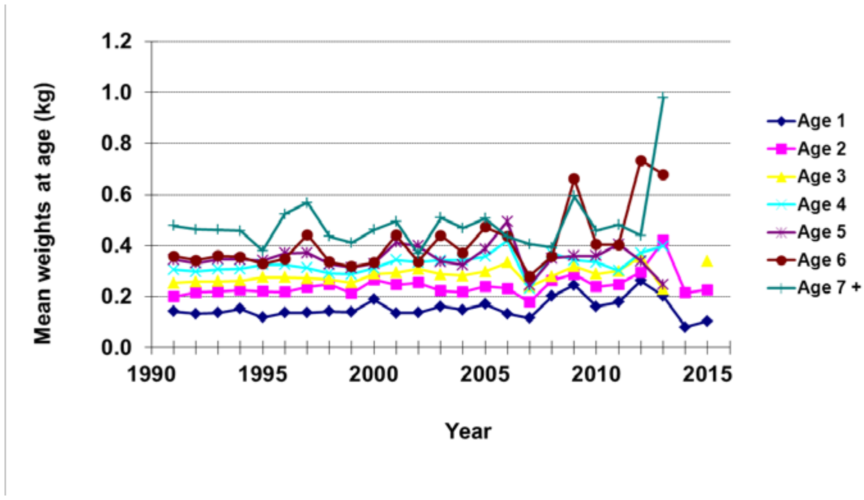


Figure 4.3.11. Haddock in VIb. Mean weights-at-age in discards.

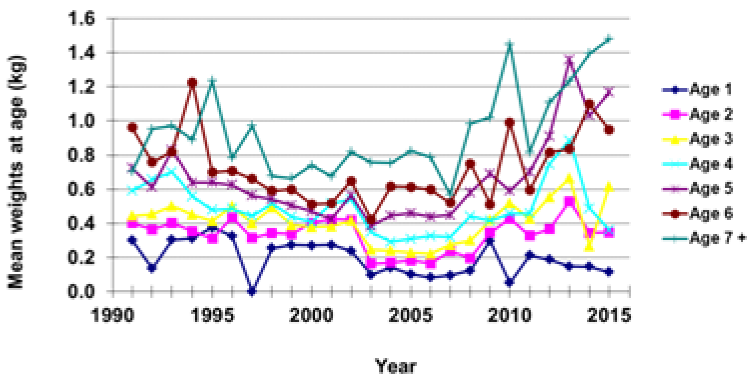
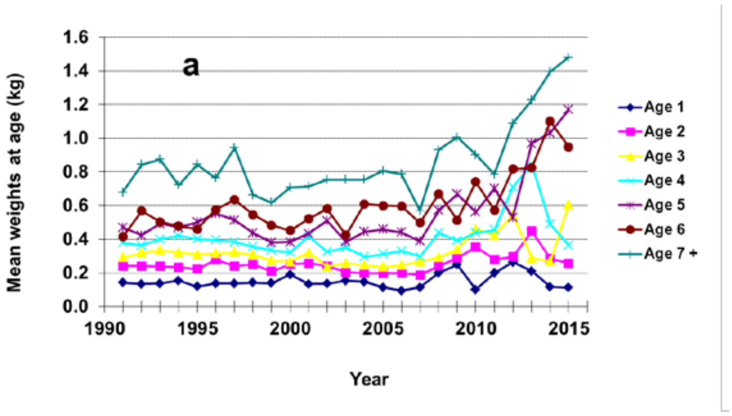


Figure 4.3.12. Haddock in VIb. Mean weights-at-age in landings.



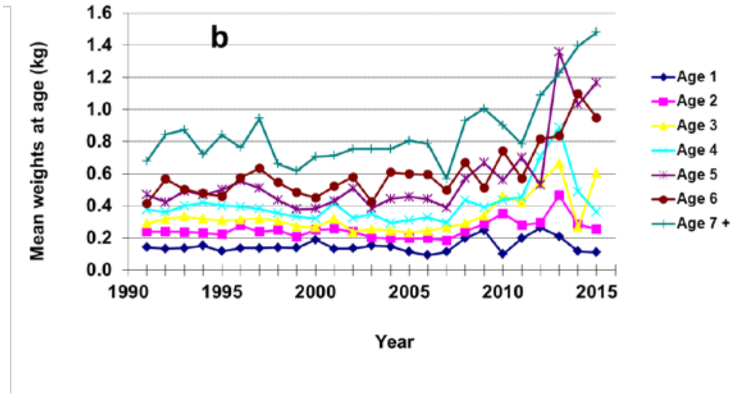


Figure 4.3.13. Haddock in VIb. Mean weights-at-age in catch (a) and in stock (b).

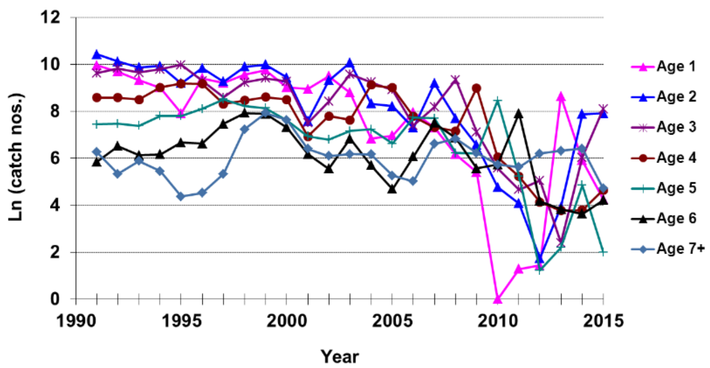


Figure 4.3.14. Haddock in VIb. Log catch (with discards in numbers) at-age by year.

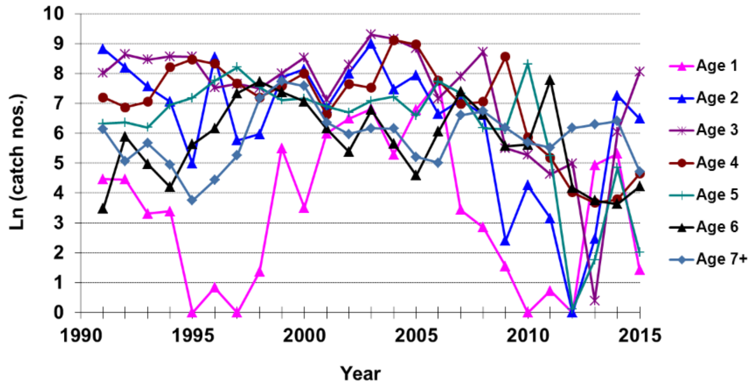


Figure 4.3.15. Haddock in VIb. Log landings (in numbers) at-age by year.

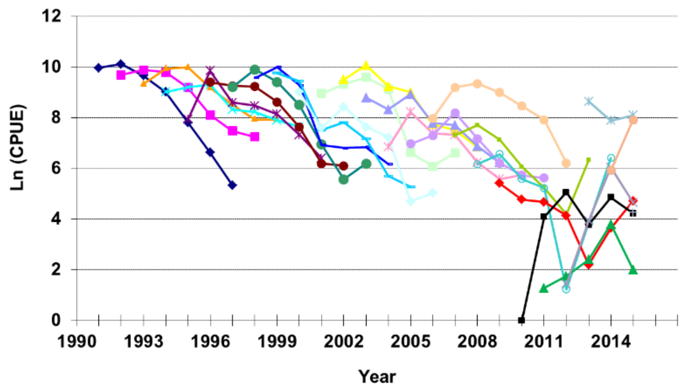


Figure 4.3.16. Haddock in VIb. Log catch (with discards, in numbers) at-age by year class.

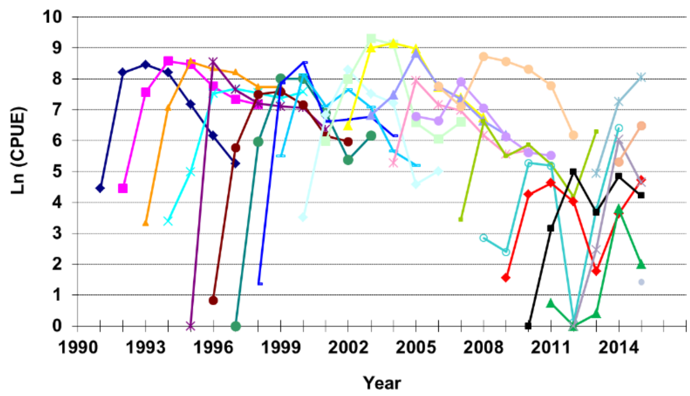


Figure 4.3.17. Haddock in VIb. Log landings (without registered discards, in numbers) at-age by year class.

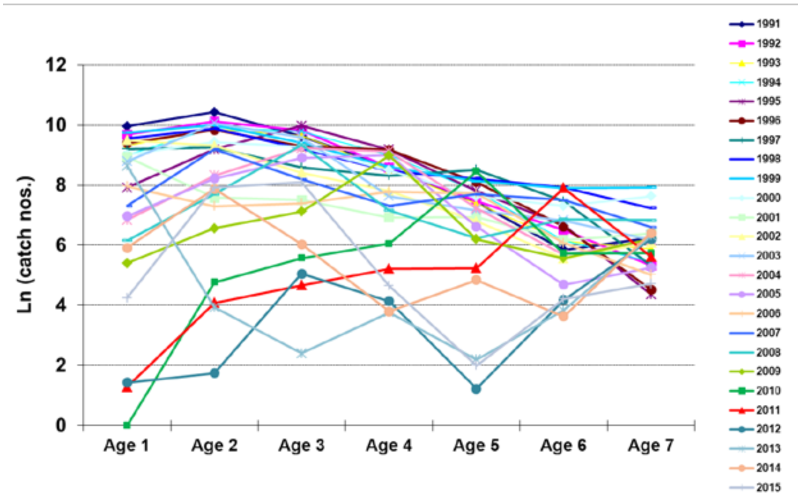


Figure 4.3.18. Haddock in VIb. Catch curves (with registered discards).

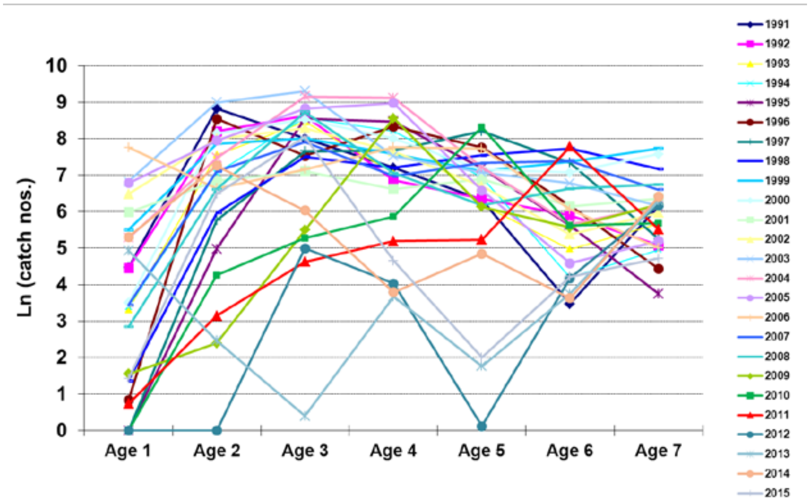


Figure 4.3.19. Haddock in VIb. Catch curves (landings without registered discards).

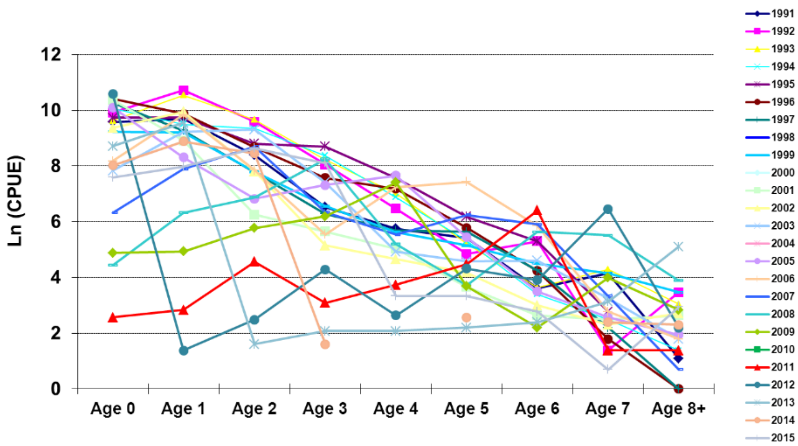


Figure 4.3.20. Haddock in VIb. Log survey cpue at-age by year.

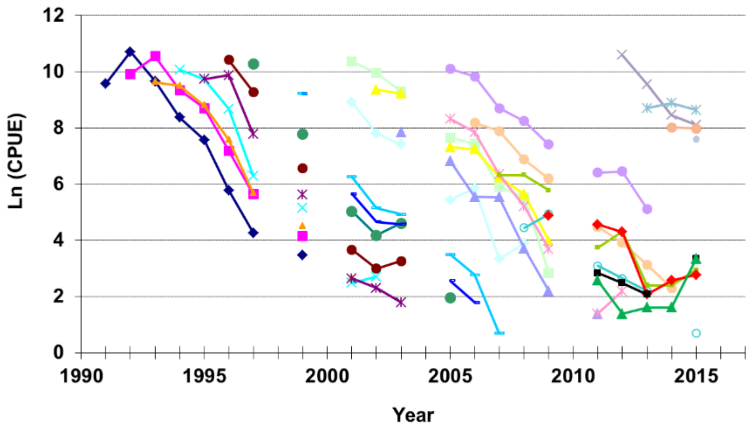


Figure 4.3.21. Haddock in VIb. Final XSA run. Log survey cpue by year class.

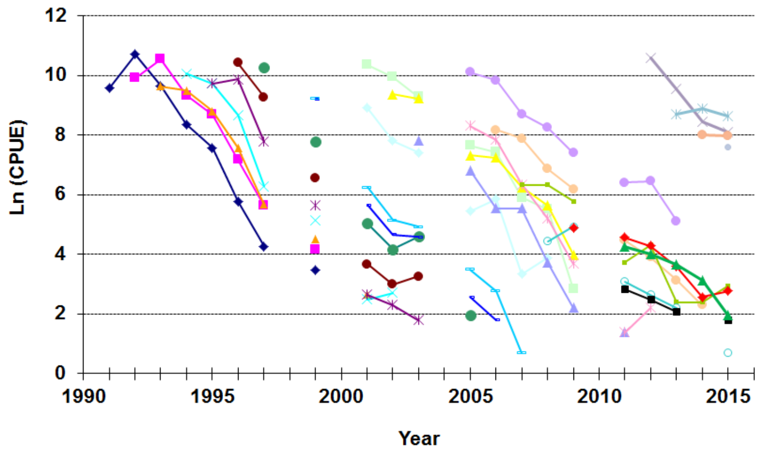


Figure 4.3.22. Haddock in VIb. Exploratory run. Log survey cpue by year class.

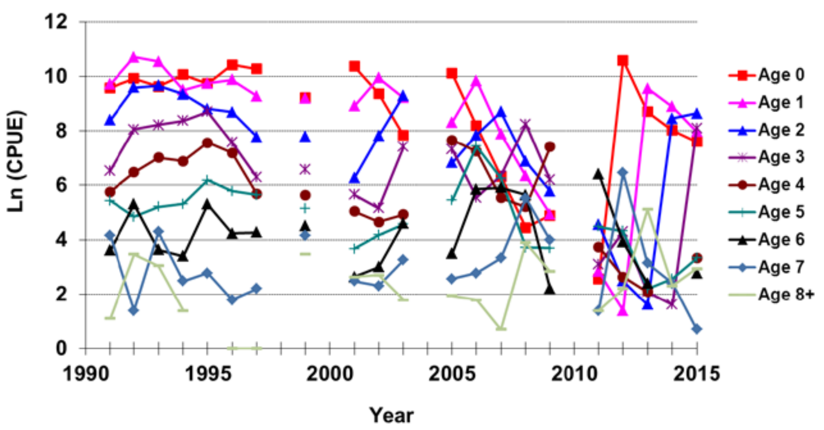


Figure 4.3.23. Haddock in VIb. Final XSA run. Log survey cpue at-age.

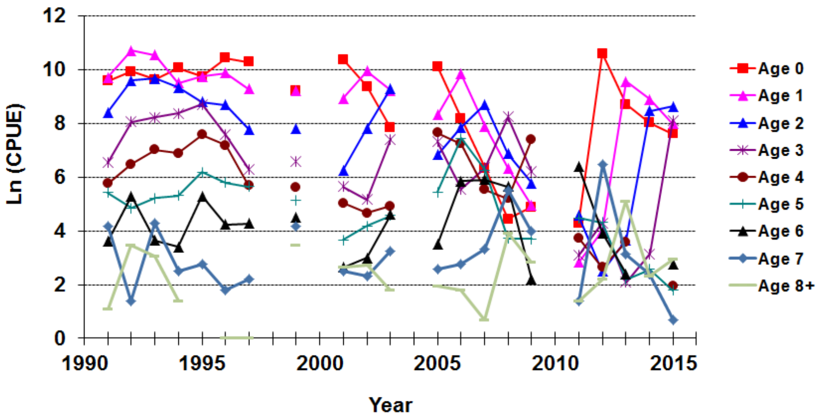


Figure 4.3.24. Haddock in VIb. Exploratory run. Log survey cpue at-age.

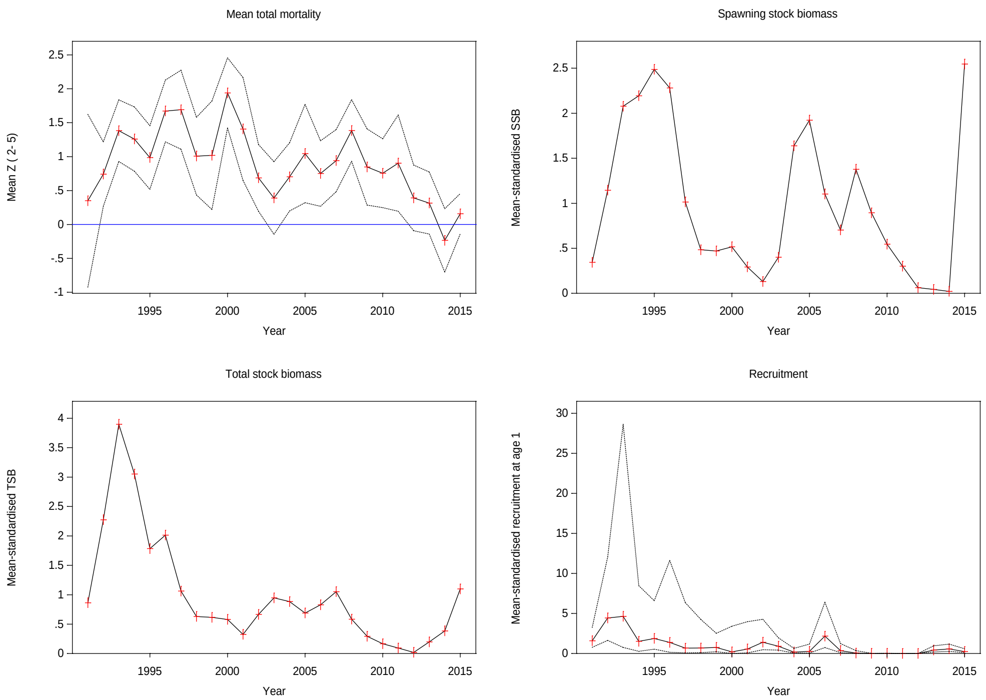


Figure 4.3.25. SURBA analysis for Rockall haddock.

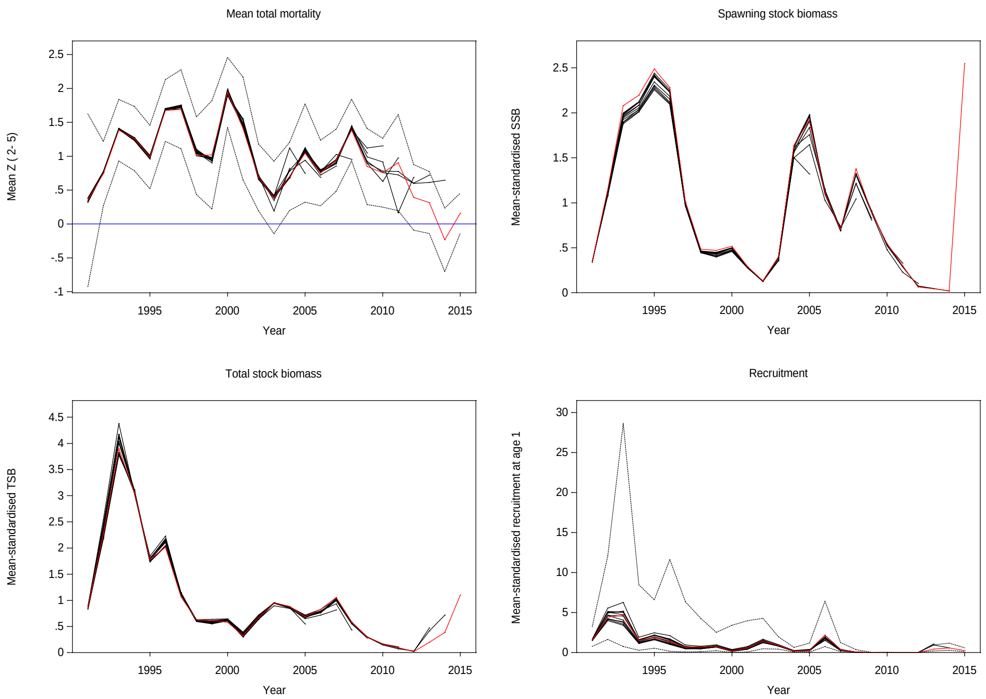


Figure 4.3.26. SURBA analysis for Rockall haddock. Retrospective plots.

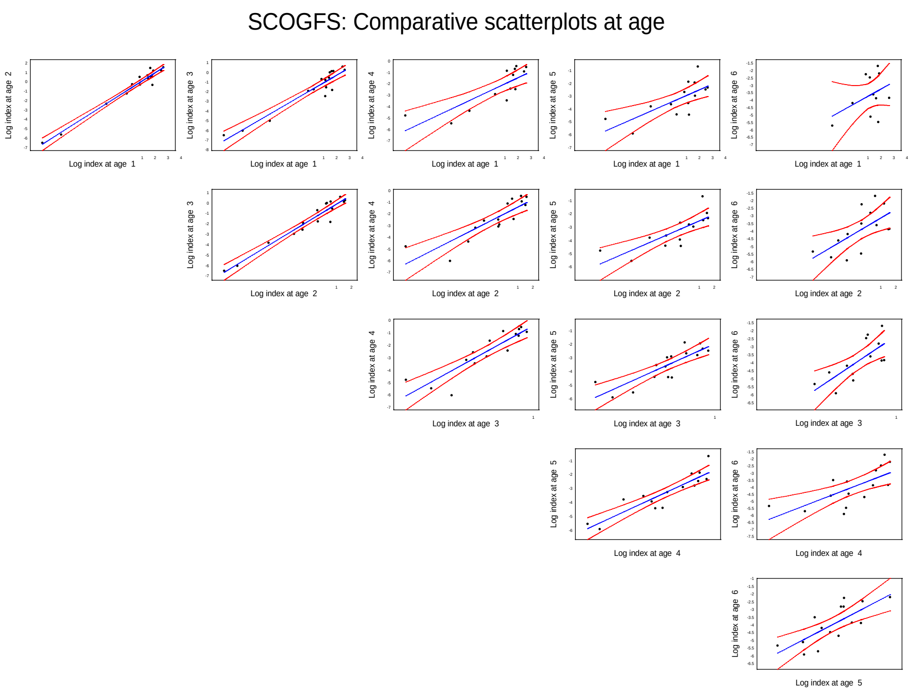


Figure 4.3.27. SURBA analysis for Rockall haddock. Pairwise plots of age.

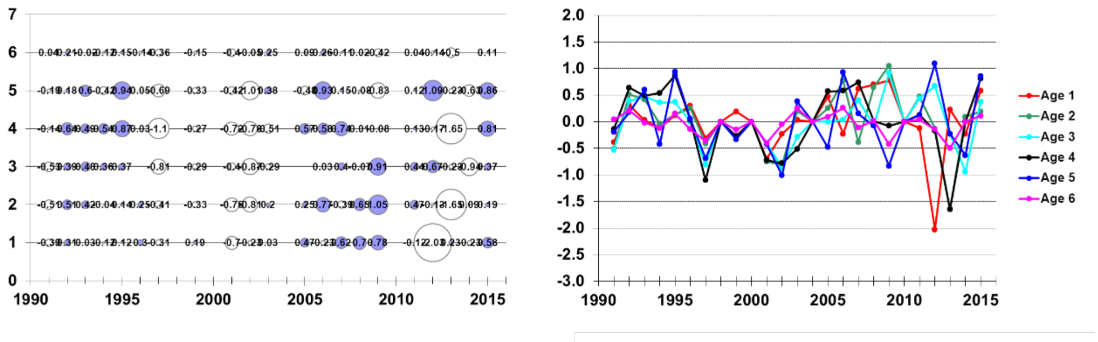


Figure 4.3.28. Haddock in VIb. Log catchability residual plots (shrinkage 1.0, catchability dependent on stock size at-ages <4). Final XSA.

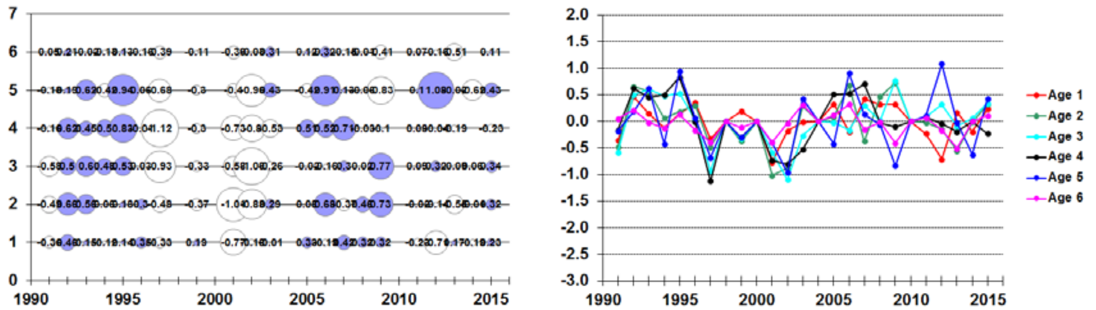


Figure 4.3.29. Haddock in VIb. Exploratory run. Log catchability residual plots (shrinkage 1.0, catchability dependent on stock size at-ages <4).

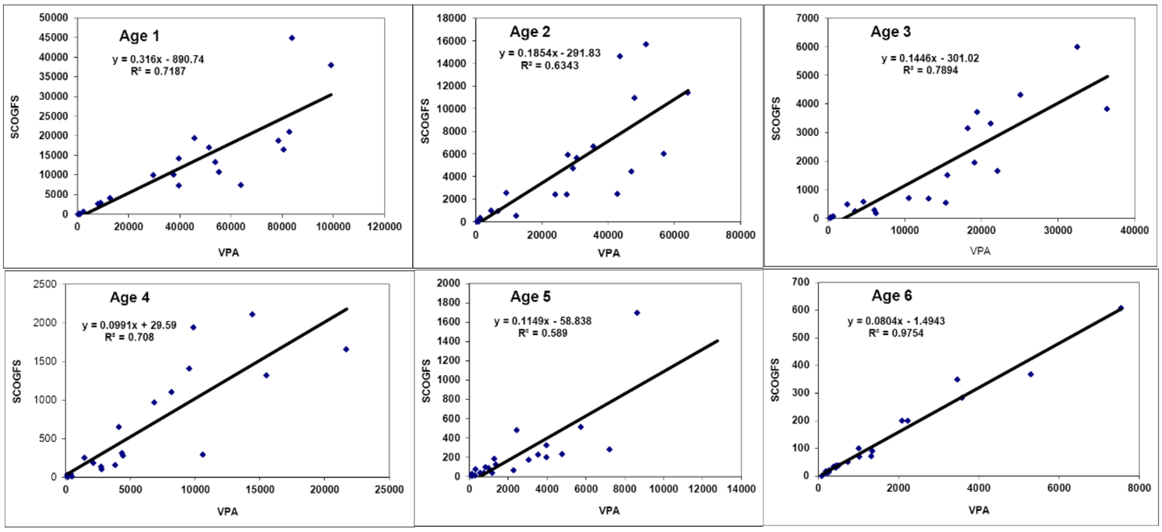


Figure 4.3.30. Haddock in VIb. Adjusted Scottish groundfish survey cpue from the final XSA run plotted against VPA numbers (shrinkage 1.0) at-age. Catchability dependent on stock size at-ages <4.

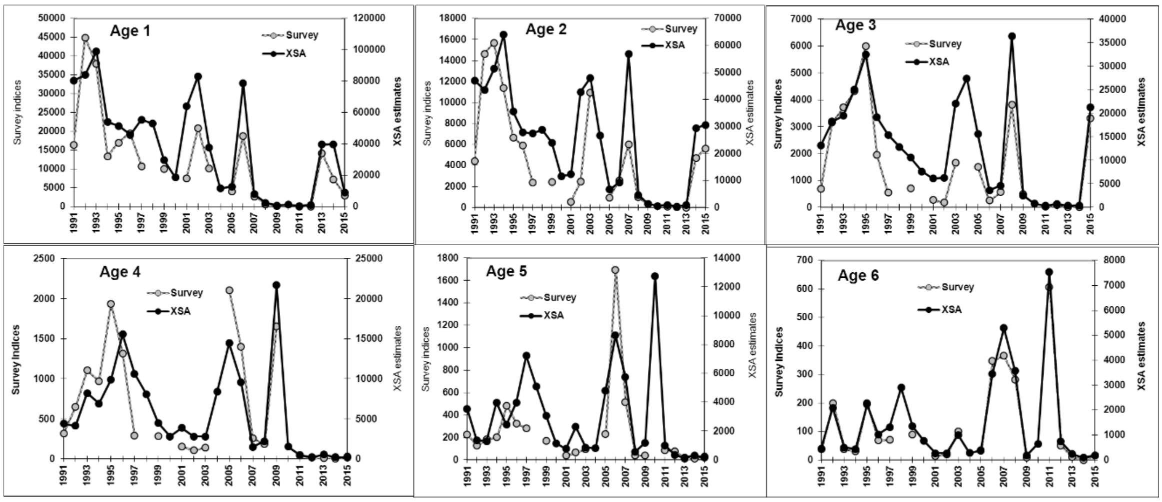


Figure 4.3.31. Haddock in VIb. Survey indices and XSA estimates (shrinkage 1.0) at-age. Final XSA: catchability dependent on stock size at-ages <4.

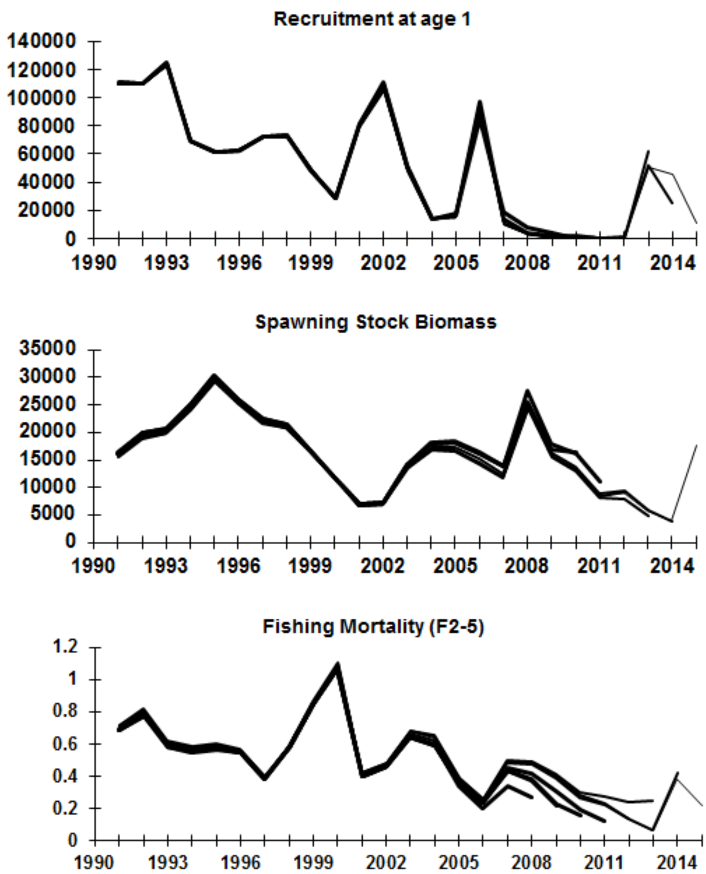


Figure 4.3.32. Haddock in VIb. Retrospective analyses (F shrinkage 1.0).

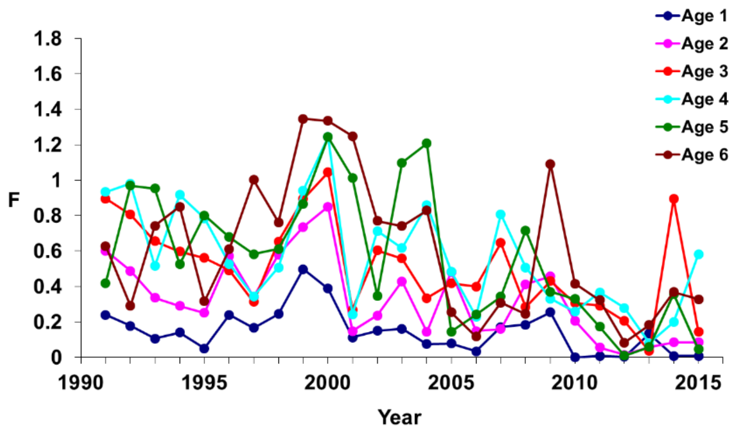


Figure 4.3.33. Haddock in VIb. F at-age (F shrinkage 1.0).

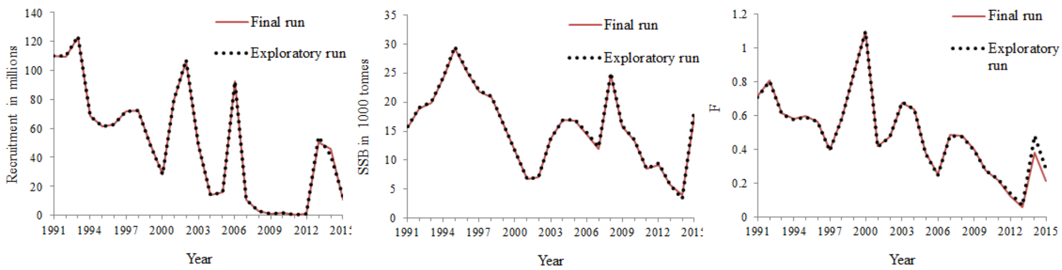


Figure 4.3.34. Haddock in VIb. Comparison of the final XSA and exploratory XSA assessments.

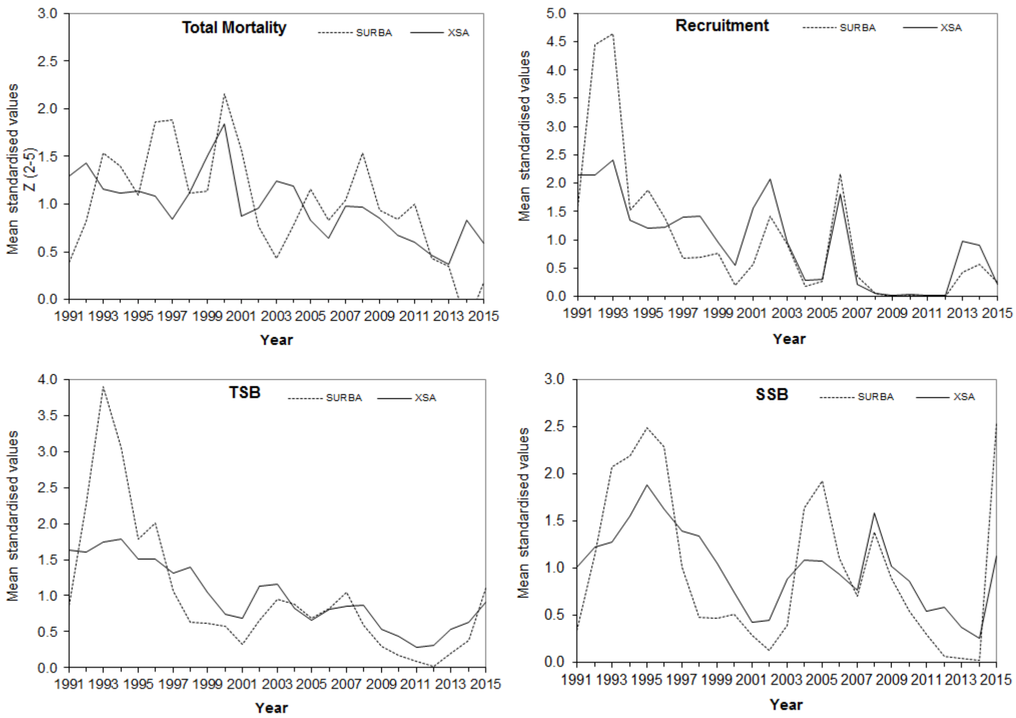


Figure 4.3.35. Haddock in VIb. Comparison of the final runs XSA and SURBA output.

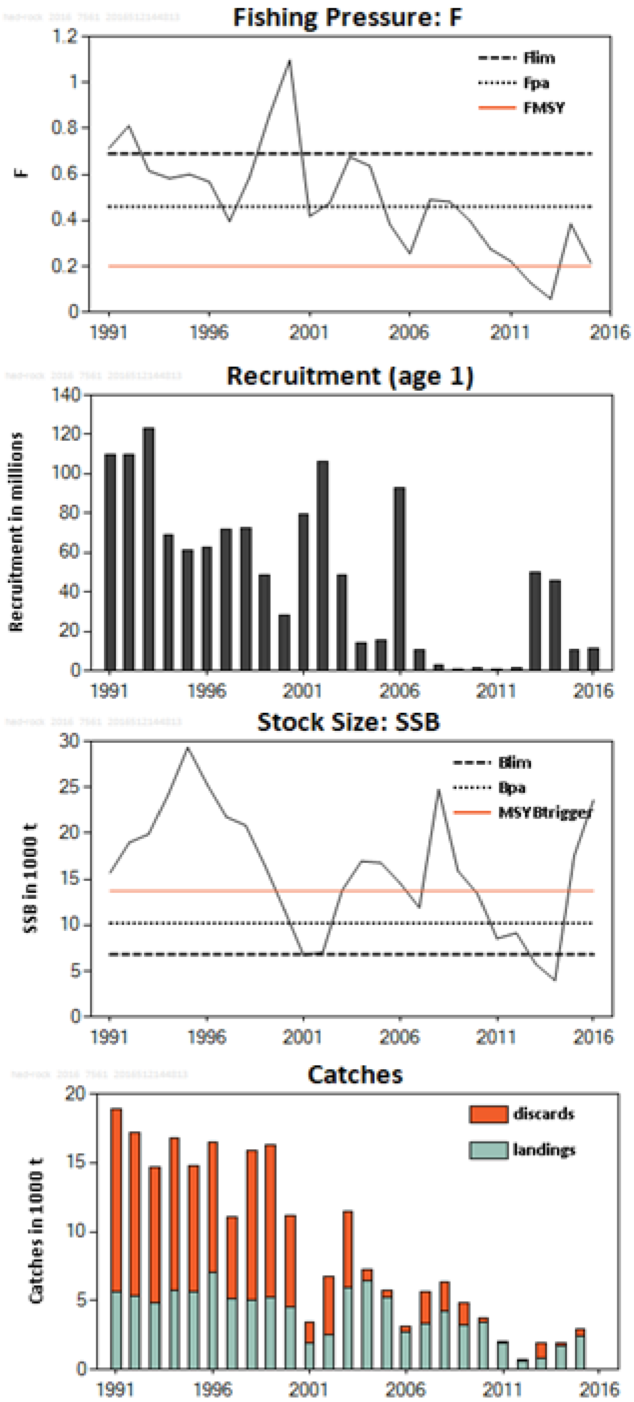


Figure 4.3.36. Haddock in VIb. Summary plots.

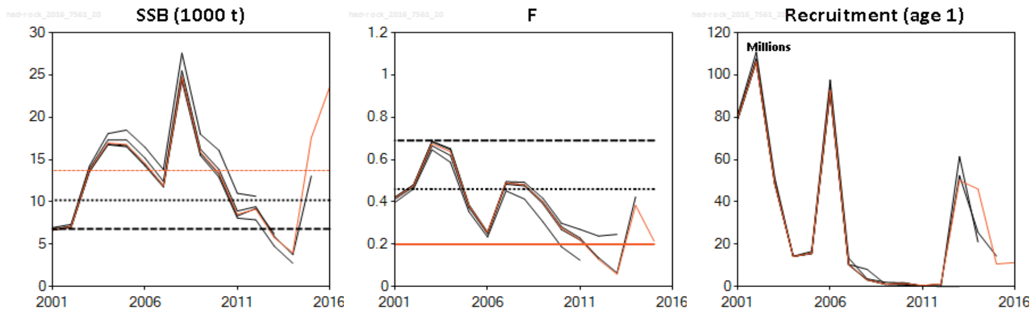


Figure 4.3.37. Haddock in VIb. Comparison of the current final assessment (in red) with the previous one (in black). In the SSB plot, the solid blue line indicates B_{pa} and the dotted blue line refers to B_{lim}. In the fishing mortality plot, the solid blue line signifies F_{pa}.

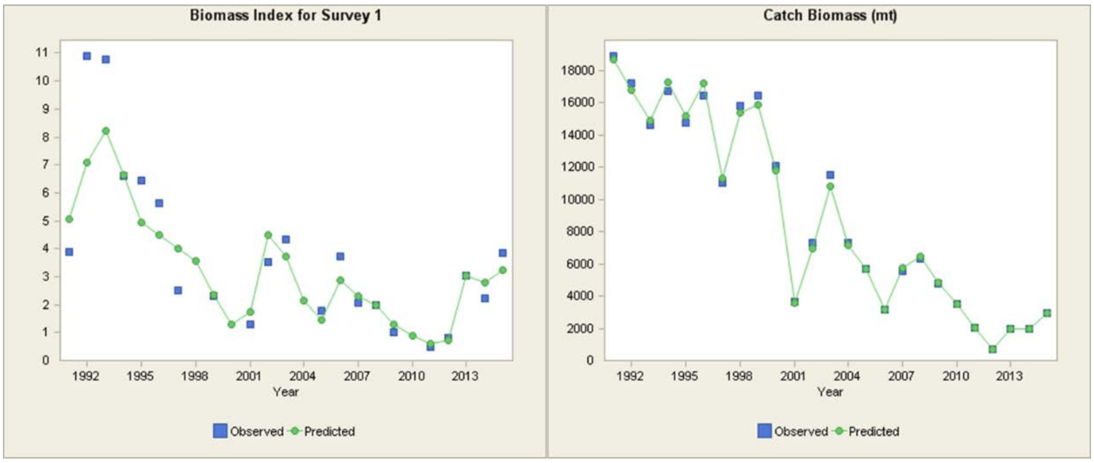


Figure 4.3.38. Haddock in VIb. Comparison of observed and predicted survey and catch biomass derived from StatCam, Scenario 2.

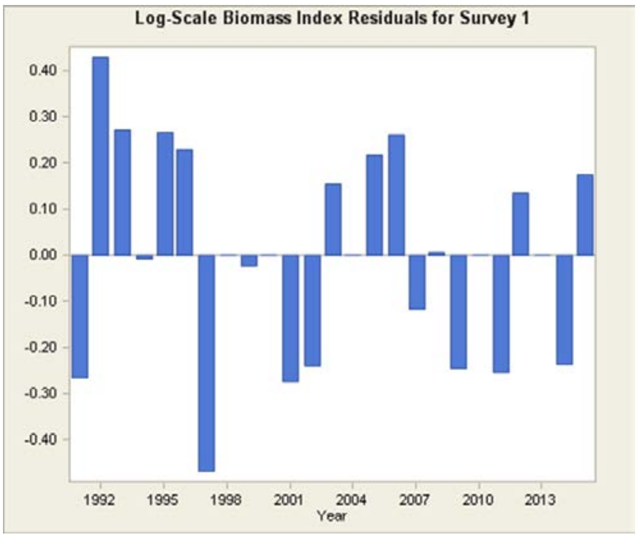


Figure 4.3.39. Haddock in VIb. Log catchability residuals plot for survey biomass index. Scenario 2 of StatCam run.

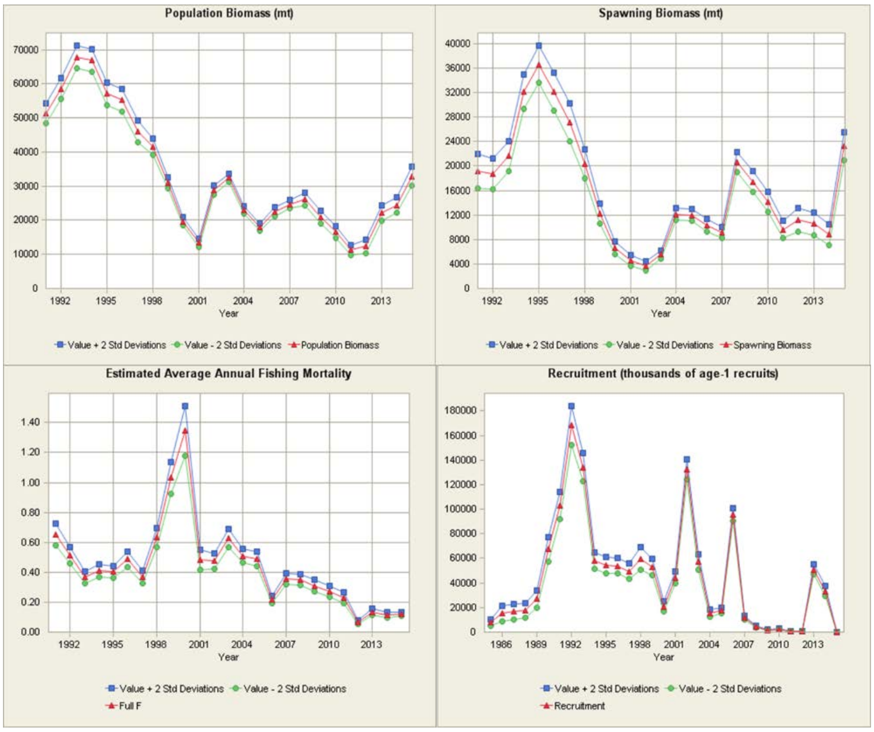


Figure 4.3.40. Haddock in VIb. Population biomass, SSB, fishing mortality and recruitment by StatCam estimation. Scenario 2.

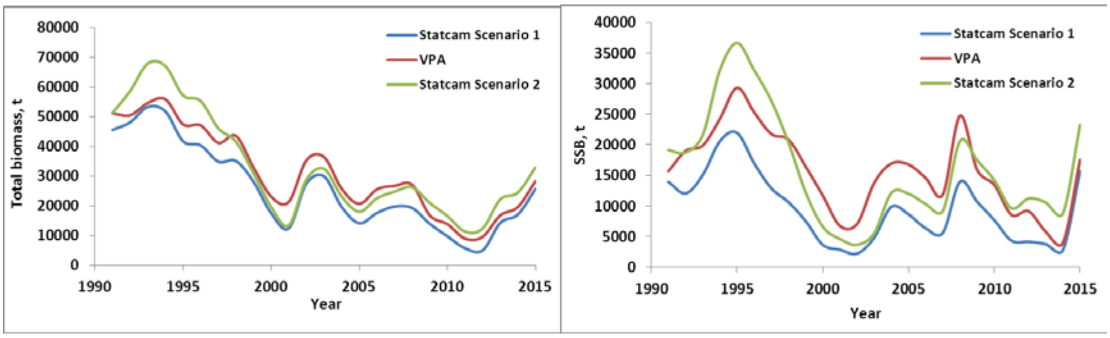


Figure 4.3.41. Haddock in VIb. Comparison of the final XSA (VPA) assessment with the statistical catch-at-age model StatCam assessment.

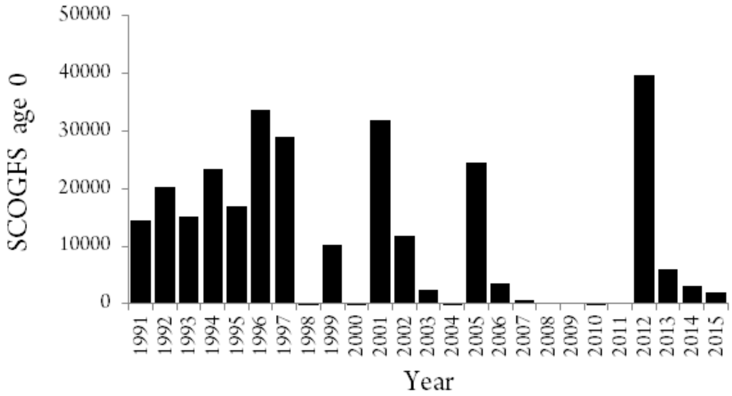


Figure 4.3.42. Haddock in VIb. Scottish Groundfish survey indices of haddock abundance-at-age 0.

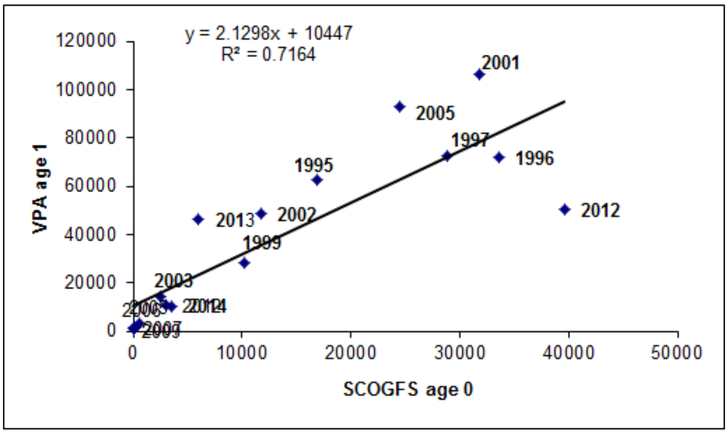


Figure 4.3.43. Haddock in VIb. VPA numbers-at-age 1 from XSA plotted against Scottish Groundfish survey indices of haddock at-age 0.

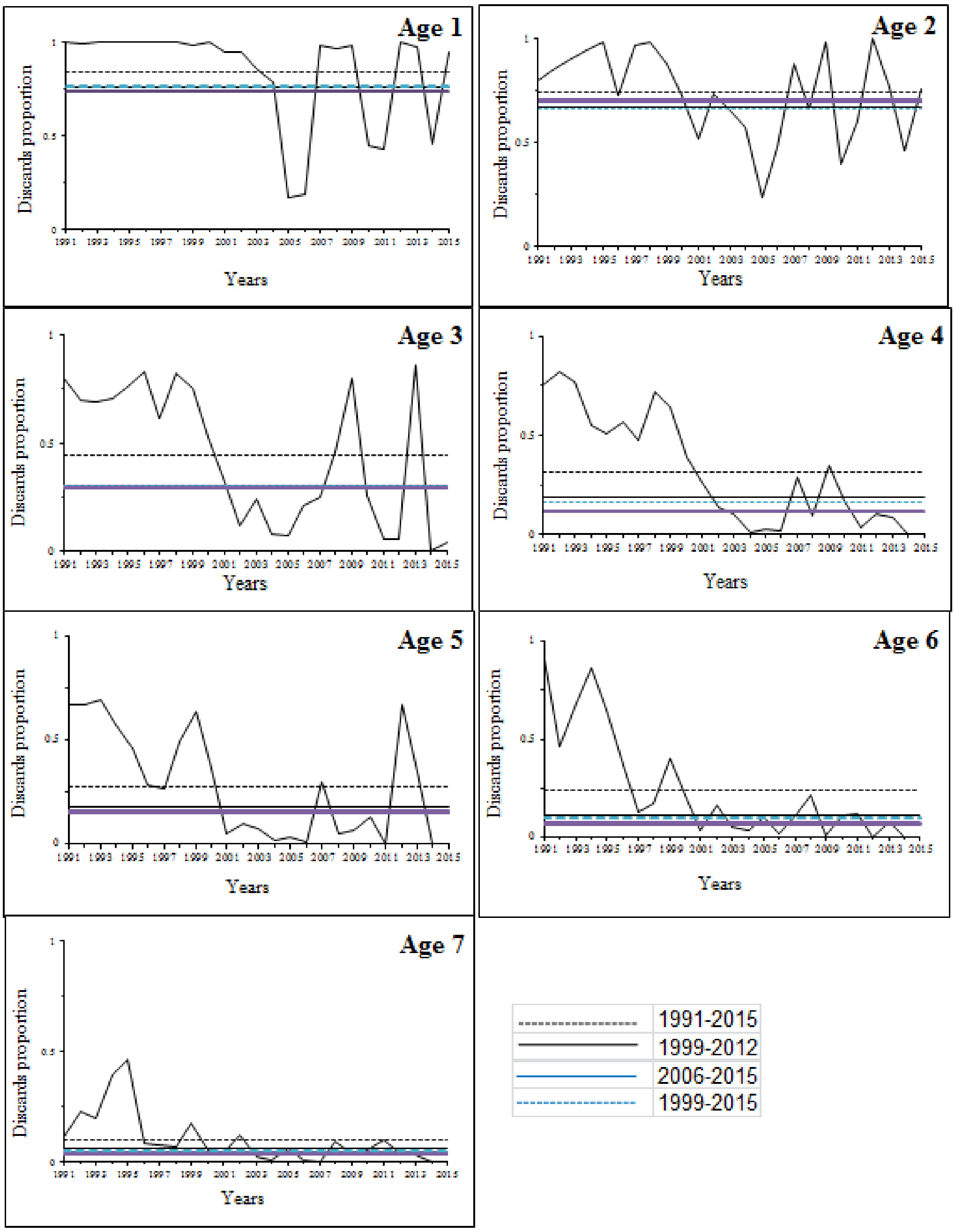


Figure 4.3.44. Haddock in Division VI b. Discard proportion-at-age by year, and mean discard proportion-at-age for two periods: 1991–2014, 1999–2012, 2006–2014 and 1999–2014.

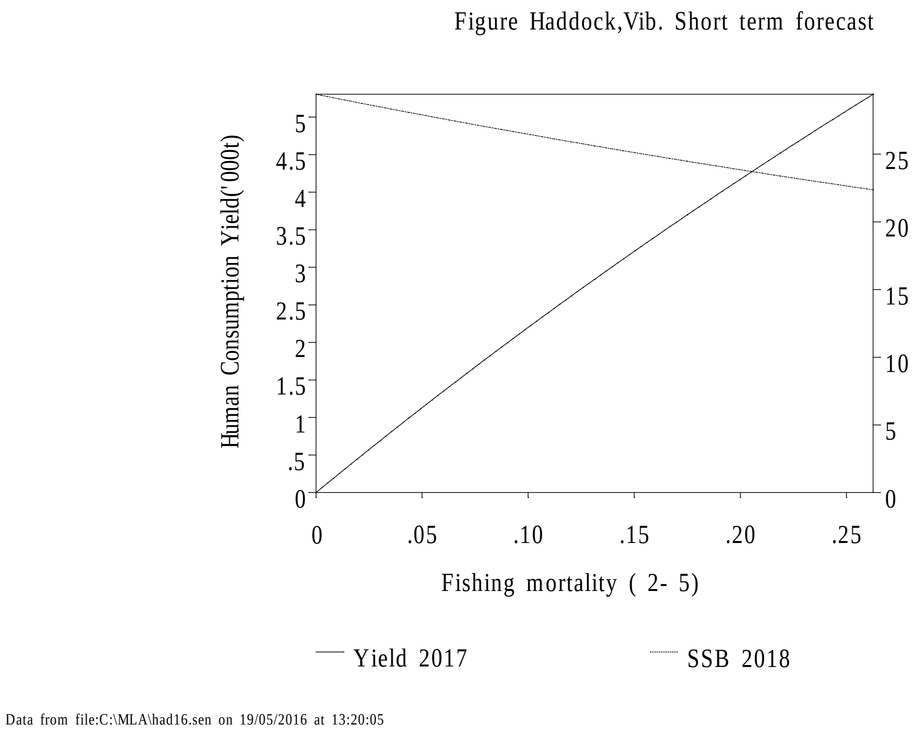


Figure 4.3.45. Haddock in VIb. Short-term forecast.

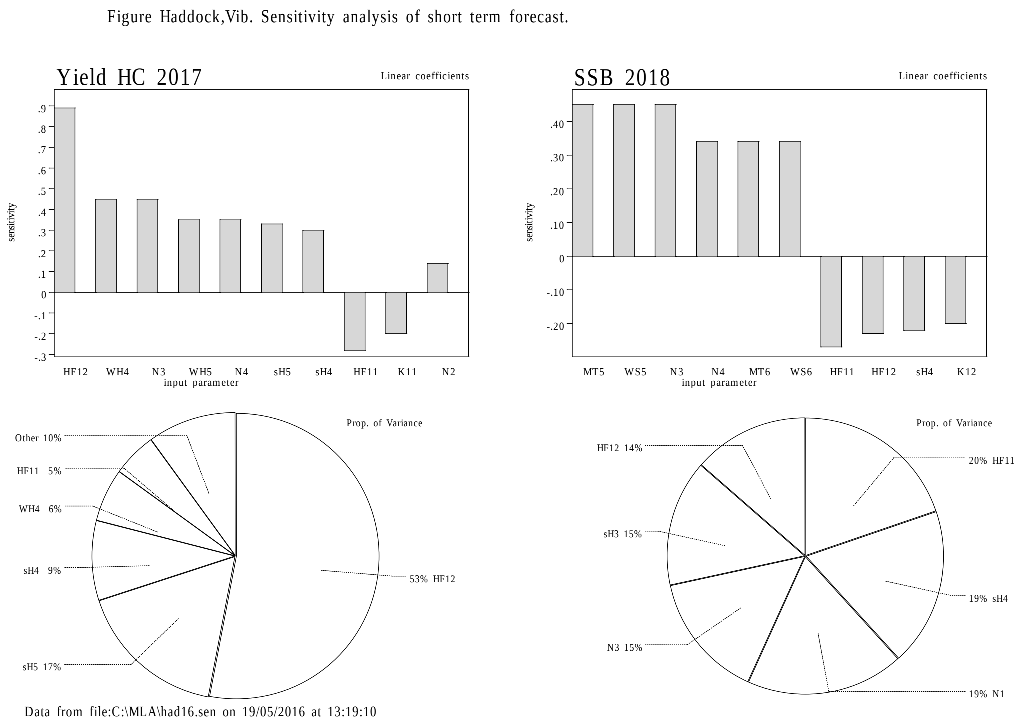


Figure 4.3.46. Haddock in VIb. Delta plots from the sensitivity analysis of the short-term forecast.

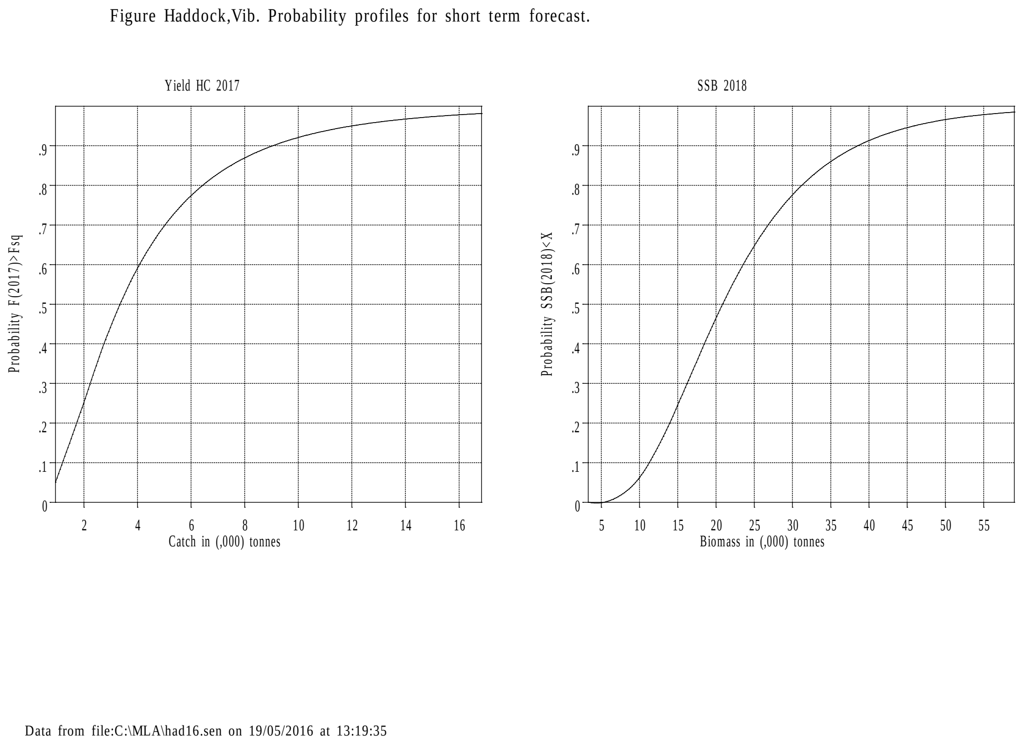


Figure 4.3.47. Haddock in VIb. Probability plots for yield in 2017 and SSB in 2018.

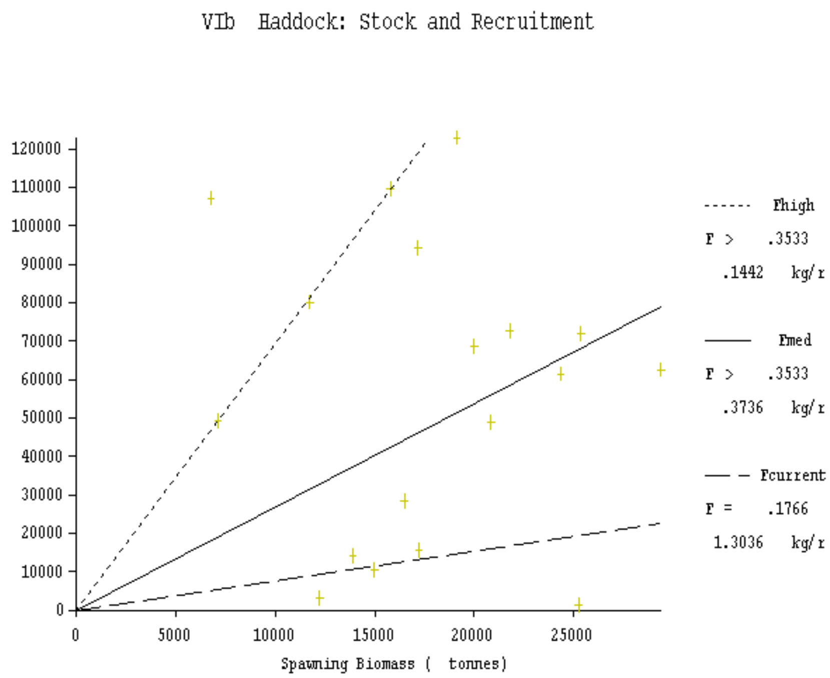


Figure 4.3.48. Haddock in VIb. SSB and recruitment in 1991–2012. Runs 2013.

4.3.11 Audit of Haddock in Rockall (Division 6b)

Date: 13/5/2016

Auditor: Tim Earl

General

For single stock summary sheet advice:

XSA assessment using catch data and survey

1) Assessment type: update
2) Assessment: analytical
3) Forecast: presented
4) Assessment model: XSA: An age-based assessment tuned with one age-structured survey, using combined landings and discards data.
5) Data issues: No issues
6) Consistency: Consistent with last year
7) Stock status: F marginally below F_{MSY}, but below F_{pa}. B above B_{MSY}.
8) Management Plan: Not agreed, would keep F below 0.2. Plan has been evaluated by ICES.

General comments

The report is clearly laid out, and covers the stock information, data and stock assessment.

- Biomass reference points could usefully be added to Figure 4.3.47.
- In the advice for 2015/2016 sections, the years referred to in the first sentences don't seem to match up with the headings. I think that both those in the text need to be incremented.
- In Figure 4.3.41 it would be better to turn off the smoothing of the data done by Excel, to plot the underlying data more clearly.

Technical comments

- The assessment was run according to the stock annex, except that the value of Minimum number of points used for regression should be included in the annex, as the value of 10 used is different to the default.
- On page 12, the report refers to re-calculating numbers and weights-at-age 6 in 2012. My understanding is that this was exploratory and not used in the reported model run. The report should clarify this at this point in the report.

Conclusions

The assessment has been performed correctly

Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? Yes
- Is the assessment according to the stock annex description? Yes, except that the setting for number of years for regression isn't mentioned in annex.

- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?
- Have the data been used as specified in the stock annex? Yes
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes

4.4 Whiting in Subarea VIb

Type of assessment in 2016

No assessment was performed in 2016.

ICES advice applicable in 2016–2018

In 2015, ICES provided multiyear advice:

ICES advises that when the precautionary approach is applied, catches should be no more than 11 tonnes in each of the years 2016, 2017 and 2018.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/whg-rock.pdf

ICES advice applicable in 2013–2015

In 2012, ICES provided biennial advice for 2013 and 2014. In 2014 there were no new data available that changed the perception of the stock and therefore the same catch advice was considered to be applicable for 2015 and is given below.

Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 11 tonnes.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2012/2012/whg-rock.pdf

4.4.1 General

Stock description

There is an absence of information on whiting stock structure in this region and whiting caught at Rockall may potentially be part of the adjacent VIa stock.

Management applicable to 2015–2016

The TAC for whiting is set for ICES Subareas VI, XII and XIV and EU and international waters of ICES Subdivision Vb. The following TACs and quotas have been applicable in recent years:

2016

Species:	Whiting *Merlangius merlangus*	**Zone:**	VI; Union and international waters of Vb; international waters of XII and XIV (WHG/56-14)
Germany	1		
France	26		
Ireland	64		
United Kingdom	122		
Union	213		
TAC	213		Analytical TAC

2015

Species:	Whiting *Merlangius merlangus*	**Zone:**	VI; Union and international waters of Vb; international waters of XII and XIV (WHG/56-14)
Germany	2		
France	32		
Ireland	79		
United Kingdom	150		
Union	263		
TAC	263		Analytical TAC

The fishery in 2015

No specific information is available for 2015. Whiting at Rockall are taken as a bycatch in fisheries for other species such as haddock and anglerfish.

4.4.2 Data

Landings data for whiting in VIb are shown by nation in Table 4.4.1 and Figure 4.4.1. Total officially reported landings were 52 t in 2015, of which 46 t were reported by the UK and the remainder by Ireland. In the past, official landings have shown very high interannual variation and it is not known whether these are a true reflection of removals.

Landings data have been uploaded to InterCatch for 2015. In addition, some landings and discards age compositions were also uploaded to IC. Over 85% of the landings (45 t) are from the Scottish TR1 fleet which, based on two sampled trips has a 0% discard rate. A discard trip allocated to the Scottish miscellaneous fleet category (vessel targeting squid) discarded 544 kg of whiting out of a total catch of approximately 2 tonnes. The data available in InterCatch are shown below.

Country	Discards (t)	Landings (t)	Total
Ireland		5.83	5.83
UK(Scotland)	0.54	46.32	46.86
Grand Total	0.61	52.15	52.76

Survey catch rates of whiting at Rockall are extremely low (Table 4.4.2) and are therefore unlikely to provide a reliable index of abundance.

Catches of whiting (both survey and commercial) are too low to support the collection of the necessary information for an assessment of stock status.

4.4.3 Target category

In 2012, advice was provided using the DL approach for category 6.2.0; stocks with negligible landings stocks and stocks caught in minor amounts as bycatch with no indication of F in relation to reference points and no marked positive trends in stock indicators. WKLIFE has previously suggested a target category of 4 for this stock. Given the comments in Section 4.4.2 regarding the potential unreliability of landings data and lack of sampled data, WGCSE considers that whiting in VIb is likely to remain a category 6 stock.

4.4.4 Management considerations

Rockall whiting is managed under a TAC for the combined Area VIa and VIb and therefore cannot be effective in limiting catches in Rockall.

Table 4.4.1. Whiting in VIb. Nominal landings (t) of WHITING in Division VIb, as officially reported to ICES.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ireland	-	-	-	-	32	10	4	23	3	1	-	-	10		2	3	3	104
Spain	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
UK (E.& W, NI)	16	6	1	5	10	2	5	26	49	20	+	+	-	-	-	-	-	-
UK (Scotland)	18	482	459	283	86	68	53	36	65	23	44	58	4	7	11	1	1	1
UK (all)																		
Total	34	488	460	288	128	80	62	85	117	44	44	58	14	7	13	4	4	105

Country	2007	2008	2009	2010	2011	2012	2013	2014	2015*
Faroe Islands	-	-	-	.	-				
France	+	.	.	.	-				
Ireland	16	23	4	2	3		0.29	6.15	5.83
Spain	.	.	.	.	-				
UK (E.& W, NI)	0	0	0	0	-				
UK (Scotland)	1	8	12	16	6	1	2.6	22.5	
UK (all)									46.32
Total	17	31	16	18	9	1	3	28	52

*** Preliminary.**

+ < 0.5

Table 4.4.2. Whiting in VIb. Survey data made available to the WG: Scottish Q3 groundfish survey ((Rock-WIBTS-Q3)). Catch rates are given as number per ten hours.

2011	2015							
1	1	0.66	0.75					
0	7							
10	0	0	0	0	0	0	0	0
10	33.279	0	0.358	0	0	0	0	0
10	6.687	1.924	0	0	0	0	0	0
10	17.425	3.426	0.838	0.307	0	0	0	0
10	8.853	0.559	0.559	0.55	0	0	0	0

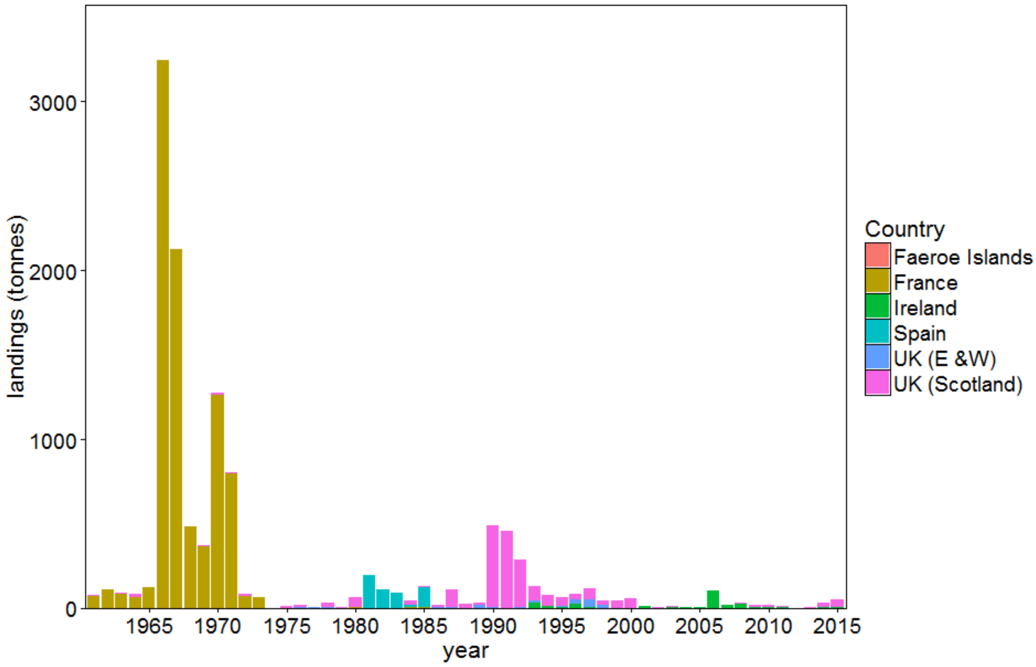


Figure 4.4.1. Whiting in Subarea VIb. Official landings of whiting in VIb by nation.

4.4.5 Audit of whg-rock

Date 17 May 2016

Auditor: Sara-Jane Moore

General

No assessment was carried out. In 2015, ICES provided multi-year advice that is there should be no more than 11 t in each of 2016, 2017 and 2018.

For single stock summary sheet advice

1) Assessment type: not applicable
2) Assessment: no assessment was carried out
3) Forecast: not applicable
4) Assessment model: not applicable (N/A)

5) Data issues: absence of information on stock structure, may be part of VIa stock. Catches of whiting are too low to support collection of data necessary for an assessment of the stock.

6) Consistency: (N/A)

7) Stock status: (N/A)

8) Man. Plan.: (N/A)

9) General comments: (N/A)

Technical comments

WGCSE considers that whiting in VIb is likely to remain a category 6 stock given the unreliability of landings data and lack of sampled data.

Conclusions

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice?
- Is the assessment according to the stock annex description?
- Is general ecosystem information provided and is it used in the individual stock sections.
- If a management plan has been agreed, has the plan been evaluated?

For update assessments

- Have the data been used as specified in the stock annex?
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex?
- Is there any **major** reason to deviate from the standard procedure for this stock?
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

5.2 Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Division 3.a, Subarea 4 and 6

Assessment in 2016

In 2015, the assessment was based on a stock size indicator from survey data and the advice followed the agreed procedures for category 3.2.0 of ICES RGLIFE data limited stock (DLS) methods as set out in the stock annex. The advice is issued in October each year following the work up of the spring survey which is not available in time for the WG. This report therefore summarises last year's assessment and describes the commercial data available for 2015. The survey work up will be provided in a working document ahead of the autumn ADG.

ICES advice applicable to 2015 and 2016

ICES advice for 2015

ICES advises on the basis of the data-limited approach but cannot quantify the resulting catches. The implied landings should be no more than 14 702 tonnes. ICES advises that the management area should be consistent with the assessment area.

ICES advice for 2016

ICES advises that when the precautionary approach is applied, catches in 2016 should be no more than 18 435 tonnes. If discard rates do not change from the average of the last three years (2012–2014), this implies landings of no more than 17 642 tonnes.

5.2.1 General

Stock description and management units

The anglerfish stock on the Northern Shelf is considered to occur in Division 3.a (Skagerrak and Kattegat), Subarea 4 (the North Sea) and Subarea 6 (West of Scotland plus Rockall). Anglerfish in the North Sea and Skagerrak/Kattegat were considered by this Working Group for the first time in 1999. The WGNSDS in 2004 considered the stock structure of anglerfish on a wider European scale, and found no conclusive evidence to indicate an extension of the stock area northwards to include Division 2.a. In 2013, Division 2.a was removed from WGCSE ToR.

Management applicable to 2015 and 2016

SPECIES:	ANGLERFISH	ZONE:	UNION WATERS OF IIA AND IV
	Lophiidae		(ANF/2AC4-C)
Belgium		332	
Denmark		737	
Germany		357	
France		68	
The Netherlands		251	
Sweden		9	
United Kingdom		7641	
Union		9390	
TAC		9390	Analytical TAC

Species:	Anglerfish Zone:		Norwegian waters of 4
	Lophiidae		(ANF/04-N.)
Belgium		45	
Denmark		1152	
Germany		18	
The Netherlands		16	Analytical TAC
United Kingdom		269	Article 3 of Regulation (EC)
Union		1500	No 847/96 shall not apply
TAC	Not relevant		Article 4 of Regulation (EC)
			No 847/96 shall not apply

Species:	Anglerfish Zone:		6; Union and international waters of
	Lophiidae		5.b; international waters of 7 and 14
			(ANF/56-14)
Belgium		191	
Germany		218	
Spain		204	
France		2350	
Ireland		531	
The Netherlands		184	
United Kingdom		1635	
Union		5313	
TAC		5313	Precautionary TAC

COUNCIL REGULATION (EU) No 43/2014 of 19 January 2015 fixing for 2015 the fishing opportunities available to EU vessels for certain fish stocks and groups of fish stocks which are not subject to international negotiations or agreements.

SPECIES:	ANGLERFISH ZONE:		UNION WATERS OF 2.A AND 4
	Lophiidae		(ANF/2AC4-C)
Belgium		398	
Denmark		878	
Germany		429	
France		82	
The Netherlands		301	
Sweden		10	
United Kingdom		9169	
Union		11 267	
TAC		11 267	Analytical TAC

Species:	Anglerfish Zone:		Norwegian waters of 4
	Lophiidae		(ANF/04-N.)
Belgium		45	

Denmark		1152	
Germany		18	
The Netherlands		16	Analytical TAC
United Kingdom		269	Article 3 of Regulation (EC)
Union		1500	No 847/96 shall not apply
TAC	Not relevant		Article 4 of Regulation (EC)
			No 847/96 shall not apply
Species:	**Anglerfish**	**Zone:**	**6; Union and international waters of**
	Lophiidae		5.b; international waters of 7 and 14
			(ANF/56-14)
Belgium		229	
Germany		262	
Spain		245	
France		2 818	
Ireland		638	
The Netherlands		221	
United Kingdom		1962	
Union		6375	
TAC		6375	Precautionary TAC

COUNCIL REGULATION (EU) No 72/2016 of 22 January 2016 fixing for 2016 the fishing opportunities available to EU vessels for certain fish stocks and groups of fish stocks which are not subject to international negotiations or agreements.

Management of Northern Shelf anglerfish is based on separate TAC for the North Sea Subarea 4 and West of Scotland Subarea 6, there is no TAC for Skagerrak and Kattegat Division 3.a. Table 5.2.1 summarises the ICES advice and actual management applicable for Northern Shelf anglerfish during 2003–2015.

Fishery description

A more detailed description of the fisheries can be found in the Stock Annex. The official national landings as reported to ICES are given in Table 5.2.2, the breakdown by country in Tables 5.2.3–5.2.5. Minor revisions were made to tables from 2006 onwards with the most up to date values from the ICES Official Nominal Catches 2006–2014 catch statistics dataset. Total officially reported landings of anglerfish from the Northern Shelf are shown in Figure 5.2.1.

The fishery in 2015

Official landings in 2015 for Subareas 6 and 4 were 15 563 t (4924 t and 10 639 t), giving a 4% undershoot of the combined TAC of 16 203 t (93% and 98% respectively). In Subarea 6 Belgium (0%), the Netherlands (0%) and France (56%) had noticeably low uptakes. These were the same countries observed to significantly undertake their quota in Subarea 4 Belgium (51%), France (38%) and the Netherlands (30%). The UK was over quota in both Subarea 4 (by 5%) and 6 (by 61%), this was due to bringing in additional quota from other EU member states, carrying forward unutilised quota from 2014 and using a flexibility allowance whereby 10% of 4 TAC can be utilised to reattribute landings from Subarea 6. Based on data submitted to ICES the fishery was principally prosecuted by vessels using demersal trawls targeting either white fish (69% of total landings by weight) or *Nephrops* (7%). Alongside these fleets there was also a moderate gillnet fishery (18%), as well as an assortment of gears in which small quantities of anglerfish are caught as bycatch that have been grouped here as miscellaneous (6%). UK (Scottish) vessels accounted for the majority of reported anglerfish landings from the combined Northern Shelf area, taking approximately 66% of the landings overall. Scottish, Danish and Norwegian vessels took 76%, 13% and 4%, respectively, of the North Sea (Divisions 4.a–4.c) landings. Scottish, French and Irish vessels took 52%, 26% and 12%, respectively, of the West Coast (Subarea 6) landings. Since 2002 combined official ICES landings of anglerfish for Subareas 4 and 6 have fluctuated between 12 500–17 500 t. Prior to the strong 2013 year class entering the fishery there was a slow decline in survey abundance leading to more restrictive TAC.

Uptake of EC quota in 2015, based on the preliminary officially reported landings, was as follows:

	TAC 6	Landings 6	Uptake (%)	TAC 4 (Norwegian)	TAC 2.a & 4	TAC 2.a & 4(total)	Landings 4	Uptake (%)
Belgium	191	-	0%	45	332	377	193	51%
Denmark	-	-	-	1152	732	1884	1 336	71%
Estonia	-	-	-	-	-	-	-	-
Faroes	-	-	-	-	-	-	-	-
France	2350	1326	56%	-	68	68	29	38%
Germany	218	201	92%	18	357	375	338	82%
Ireland	531	602	113%	-	-	-	-	-
Netherlands	184	-	0%	16	251	267	104	30%
Norway	-	8	-	-	-	-	533	-
Portugal	-	-	-	-	-	-	-	-
Russia	-	2	-	-	-	-	-	-
Spain	204	149	73%	-	-	-	-	-
Sweden	-	-	-	-	9	9	7	100%
UK (total)	1635	2636	161%	269	7641	7910	8277	105%
Total	5313	4924	93%	1500	9390	10 890	10 639	98%

[1] TAC applies to 6, 5.b(EC), and international waters of 7 and 14.

[2] Norwegian waters.

Landings in Division 3.a are not regulated: Table 5.2.5 shows the official landings which have been in the region of 400–500 t since 2005.

5.2.2 Data

Landings

National landings data as reported to ICES and Working Group estimates of total landings are given in Table 5.2.2. The working group procedures used to determine the total international landings numbers and weights-at-length are documented in the stock annex. It is acknowledged that throughout the landings time-series there have consistently been differences between the total official landings and the landings as estimated by the WG. This is likely due to differences in the data provided to the WG by national scientists and administrators.

Due to restrictive TACs, the likelihood of misreporting and underreporting of anglerfish landings in the past is considered to have been high, particularly during the period 2003–2005. During the benchmark (WKROUND 2013), it was agreed that recent landings are likely to be more accurate due to, i) less restrictive TACs, ii) the introduction of buyers and sellers legislation in the UK Ireland and iii) the offshore gillnet fishery for anglerfish historically conducted by Spanish flagged vessels and thought to under-report landings, is now much reduced. During the period 2005–2010 landings data were not provided to the Working Group by some of the major nations exploiting the fishery and hence WG estimates of the actual Subarea 6 and 4 landings have not been calculated for this period.

Discards

Discard estimates have been available for 2012–2015. The breakdown of landings and discards by main gear group and area for 2015 is given in Table 5.2.6. Discard data indicate that discarding in this fishery is relatively low due to high market value and no MLS. Overall discarding was 2.6% of total catch in 2015, a slight decrease from the 2014 rate of 3.1%. Demersal TR2 trawlers had the highest discard rate (22.8%) due to more restrictive TAC allowances from POs, whereas TR1 trawlers, gillnets and miscellaneous gear types had much lower rates of 1.1%, 2.0% and 1.9% respectively. Discards in Subarea 4 were slightly higher than Subarea 6 (228 t and 190 t) however the percentage of discards was higher for Subarea 6 (2.1% and 3.8%).

Figures 5.2.3(a–c) show the percentage of landed weight by fleet, country and area. Length–frequency samples for catch in 2015 were submitted by the UK, France, Denmark and Ireland. There was good coverage of the demersal TR1 fleet in Subarea 4 and Division 6.a as well as for the demersal TR2 fleet in Subarea 4 and Division 6.a. However there were very poor levels of sampling for the TR1 fleet in Division 6.b with only two samples for landings and the same for discards. The gillnet fleet on the whole was poorly sampled in all areas, with no samples from UK-flag vessels which accounted for approximately 10% of all landings.

Discard data are used in the provision of catch advice which is based on the DLS approach (ICES, 2012).

Biological

An anglerfish ageing exchange was held in 2011 to investigate the possibility of the collation of an international landings-at-age dataset, however little agreement was found between methods or readers. This was acknowledged in the findings of the WKROUND report on current assessment and issues with data and assessment of this stock. Recommendations of this report included examining the suitability of growth model for this stock, exploring simple harvest control rules with appropriate biological reference points and collating an international catch-at-length dataset for use in an integrated stock synthesis assessment as is applied in southern anglerfish stocks.

Research vessel surveys

The SCO-IV-VI-AMISS-Q2 survey is described in the Stock Annexe. This is a targeted anglerfish survey using commercial gear, covering Subareas 4 and 6. The abundance and biomass estimates from the surveys are presented in Tables 5.2.7 and 5.2.8. The total biomass estimates for the Northern Shelf in 2014 and 2015 were 52 884 t and 67 915 t respectively.

Total numbers and total biomass have been increasing since 2011 (Table 5.2.8 and Figure 5.2.6). The substantial increases in numbers and biomass in 2014 and again in 2015 is due to a large number of small fish entering the stock in 2013, mainly in Division 6.a (Figure 5.2.6). The scale of this year class has not previously been seen in the SCO-IV-VI-AMISS-Q2 survey (for years for which length data are currently available 2007–2015) (Figure 5.2.8). However, the effect on the biomass is less pronounced (Figure 5.2.5 and 5.2.9).

In Subarea 4, the time-series of estimates indicate a sharp decline in numbers and biomass between 2008 and 2009, followed by relative stability in biomass but a continued reduction in numbers (Figure 5.2.6). Biomass estimates for 6.a are relatively stable over the time-series, again with a sharp increase in numbers since 2013.

Whilst estimates of the ratio of survey biomass between Subareas 4 and 6 have fluctuated around being more or less equal since 2013 the proportion of biomass in Subarea 4 has been increasing. This is a result of the biomass of Division 6.b remaining relatively stable whilst the biomass of both Subarea 4 and Division 6.a have increased at a similar rate (Figure 5.2.10). The percentage biomass in 4 compared to that in 4 and 6 is 40% in 2015 and 48% on average (Table 5.2.7).

Commercial catch-effort data

Trends in nominal international fishing effort in Skagerrak, North Sea and Eastern Channel and West of Scotland collated by STECF for the Evaluation of Fishing Effort Regimes in European Waters are shown in Figure 5.2.2. Whilst there is a minor increase in TR effort in Subarea 4 the majority of anglerfish fleets saw a continuing trend of decline in effort. A change in this overall trend is not anticipated with the introduction of 2015 data.

There is now a time-series of catch-at-length data for 2012–2015 (Figure 5.2.4). 2012–2014 show similar landing length–frequency profiles, while both the number of and mean length of fish being discarded has reduced over this period. Catch composition of lengths was markedly different in 2015 with the bulk of landings being between 30–50 cm in length with steep tails either side. Discard levels in 2015 were the lowest in the time-series however the landings of <30 cm fish were also lower, suggesting this reduction was due to catch composition rather than fisher behaviour. The strong year 2013 year class observed in the survey length–frequency plots is not apparent in the commercial catch.

5.2.3 Historical stock development

There has been no analytic assessment of Northern Shelf anglerfish since 2003, due to a combination of unreliable commercial data, landings misreporting, uncertain effort data and poor catchability of anglerfish in traditional research surveys. The Scottish Irish anglerfish and megrim industry science survey (SCO-IV-VI-AMISS-Q2) initiated by Marine Scotland Science in 2005, along with official logbook data and tally-book data schemes have addressed some of these issues, providing valuable information to fishery managers as well as minimum absolute abundance and biomass estimates annually. Since 2012 assessment has followed the ICES RGLIFE data-limited stock (DLS) 3.2.0 method of survey based indicative trends (ICES, 2012).

5.2.4 Short-term projections

In the absence of an age-based assessment, there are no short-term projections for this stock.

5.2.5 Biological reference points

Precautionary approach reference points

	Type	Value	Technical basis
Precautionary approach	B_{lim}	Not defined	There is currently no biological basis for defining B_{lim}
	B_{pa}	Not defined	
	F_{lim}	Not defined	There is currently no biological basis for defining F_{lim}
	F_{pa}	0.30	$F_{35\%SPR}$ = 0.30. This fishing mortality corresponds to 35% of the unfished SSB/R. It is considered to be an approximation of F_{MSY}.
Targets	F_y	Not defined	

(unchanged since 1998).

Yield-per-recruit analysis and harvest rates

One suggested method for future assessment is a *Nephrops*-like harvest-ratio approach which creates a catch-options table based on a range of harvest ratios. However to date no MSY reference points have been determined for Northern shelf anglerfish with WKProxy (ICES, 2016) citing limited data, dome-shaped selectivity and uncertain life-history parameters as inhibiting factors. Previous attempts to determine suitable harvesting rates, based on a yield-per-recruit analysis, estimated F_{MAX} to be 0.19 (ICES, 2004). The southern stock has recently been benchmarked and an F_{MAX} of 0.28 was used there (ICES, 2012b). This needs to be revisited for this stock. In the case of *Nephrops* the technical basis for MSY $B_{trigger}$ is the bias-adjusted lowest observed UWTV survey estimate of abundance, however for anglerfish, whilst abundances from SCO-IV-VI-AMISS-Q2 were initially intended to be an absolute measure of abundance they are now considered to be only a relative index so this may not be appropriate.

An exploratory plot of harvest rates (catch/relative survey abundance) for the period 2012–2015 is included (Figure 5.2.11) and whilst there are no reference levels to relate these harvest rates to, trends can still be interpreted. Harvest rate by number of individuals shows a much steeper curve than harvest rate by biomass, this is likely due to the influx of the substantial 2013 year class and not a change in fishing behaviour. Considering that this young recruitment has not yet been seen in the catch due perhaps to selectivity and geographical distribution it may be more appropriate to use a harvest rate which is measured over a given length range of fish which make up the bulk of catch. In Figure 5.2.11 the harvest ratios for length ranges of fish greater than 30 cm show very different trends than the harvest ratio by numbers plot. Looking at the harvest rate for fish greater than 50 cm or 60 cm it can be seen that there have in fact been increases in exploitation in 2013 and 2015 despite a marked overall decline in the harvest rate of fish greater than 30 cm.

5.2.6 Management plans

There is no management plan for this stock.

5.2.7 Uncertainties and bias in assessment and forecast

The WGCSE has previously attempted assessments of the anglerfish stock(s) within its remit using a number of different approaches. As yet none have proved entirely satisfactory. The catch-at-length analysis used in previous years appears to have addressed a number of the suspected problems with the data due to the rapid development of the fishery, and has also provided a satisfactory fit to the catch-at-length distribution data. However, since 2003, the WG has been unable to present an analytic assessment due to the lack of reliable fishery and insufficient survey information, and in addition it is not known to what extent the dynamic pool assumptions of the traditional assessment model are valid for anglerfish. A catch-at-age model has been presented to two benchmark working groups (WKFLAT 2012 and WKROUND 2013) but has not yet been accepted due to concerns over age reading.

Commercial data

For a number of years the WG has expressed concerns over the quality of the commercial catch-at-length data because of:

- Accuracy of landings statistics due to species and area misreporting.
- Lack of information on total catch and catch composition of gillnetters operating on the continental slope to the northwest of the British Isles (See the stock annex for further details of this fishery).
- Lack of catch information submitted to ICES by several key exploiters of the fishery between 2006–2010.

Survey data

There are still several factors which make the survey estimates likely to be underestimates or minimum estimates. Firstly, although experiments have been carried out to estimate escapes from under the footrope, and a model applied to account for this component of catchability, the estimates of smaller anglerfish still look to be underestimated (Figure 5.2.7). This could be due to either a net selectivity issue, or an availability [to the trawl] issue, as it is known that younger fish occur in shallower water (Hislop *et al*., 2001), or both. Secondly, the area considered is not complete, as the survey does not cover some of Division 4.a and none of 4.b or 4.c. However, numbers are thought to be low in these areas.

Biological information

Knowledge of the biology of anglerfish is improving, with some basic biological parameters suitable for use in future assessments, such as mean weight-at-age in the stock, now becoming available from the industry–science surveys. Difficulties still remain in finding mature females. A further discussion of the biology can be found in the stock annex.

In addition, ageing has not been validated and should still be regarded as uncertain. An ageing exchange was carried out in 2011 and found little agreement between methods or readers using the same method.

Stock structure

Currently, anglerfish on the Northern Shelf are split into Subarea 6 (including 5.b(EC), 7 and 14) and the North Sea (& 2.a (EC)) for management purposes. However, genetic studies have found no evidence of separate stocks over these two regions (including Rockall) and particle-tracking studies have indicated interchange of larvae between the two areas (Hislop *et al*., 2001). So, at previous WGs, assessments have been made for the whole Northern Shelf area combined. In fact, both microsatellite DNA analysis (O'Sullivan *et al*., 2005) and particle tracking studies carried out as part of EC 98/096 (Anon, 2001) also suggested that anglerfish from further south (Subarea 7) could also be part of the same stock.

5.2.8 Recommendations for next Benchmark

This stock was last benchmarked in February 2013 at WKROUND and is due to be benchmarked in 2017. WKROUND recommended significant work to be carried out before the next benchmark. WGCSE short-listed the following tasks:

- Compile historical catch-at-length time data.
- Investigate growth models appropriate for anglerfish Subareas 4 and 6.
- Assess within reader variability for otolith readers used on the SCO-AMISS-IV-VI-Q2 survey.
- Investigate a *Nephrops*-like harvest-ratio approach.
- Investigate length-based stock assessment using, for example, the SS3 approach applied to southern anglerfish stocks.
- Investigate an age-aggregated production/depletion model.
- Determine the best way to incorporate *Lophius budegassa* into assessment and advice.
- Develop the "q1" assessment model (WKROUND 2013) and test sensitivities as described in WKROUND 2013.

  At this stage the focus of the current benchmark process moving forward is to ascertain what commercial sampling data (length, age, weight) are currently held internationally, to construct an appropriate data call to compile length–frequency, age composition and additional pertinent survey data.

5.2.9 Management considerations

Up to and including 2011 ICES provided qualitative advice regarding the future exploitation of 'data-limited' stocks where there was either limited knowledge of their biology or a lack of data on their exploitation. However in response to a strong interest from advice recipients to base advice on the information available, ICES developed the data-limited stocks (DLS) approach framework, for which anglerfish is a category 3 data-limited stock. This requires the application of an uncertainty cap and/or precautionary buffer to a survey adjusted *status quo* catch.

A comparison of mean biomass estimates from the SCO-IV-VI-AMISS-Q2 surveys (Table 5.2.9) shows that the mean biomass in Subareas 4 and 6 combined has increased by 67.3% from 2011–2013 to 2014–2015. Application of the uncertainty cap implied advice for catches in 2016 to be no more than 20% greater than the previously advised catch. The clear decrease in international effort by the main fisheries in the stock area since 2003 meant that a precautionary buffer should not be applied.

Area flexibility is also an issue which can be considered in the light of the survey data. The TACs in Subareas 4 (including Norwegian waters) and 6 until 2010 were split 67:33%, since 2011 they have been split 64:36%. In 2015, 10% of the TAC for 4 and 2.a could be taken from Division 5.b, or Subareas 6, 7 and 9. However the stock is fairly evenly distributed across the two areas (Table 5.2.7 and Figure 5.2.10). Over the course of the surveys the 4:6 split has fluctuated around 50:50 (48% on average), decreasing as the stock in 6.b increases. Note that the North Sea is only partially surveyed: however, the area covered does encompass most of the distribution of anglerfish.

Ideally, the management of the fishery should be based on a specific plan, or harvest control rule, after an evaluation of various stakeholder-led suggestions of alternative options. This still needs to be pursued in consultation with stakeholders such as the North Western Waters Advisory Council.

5.2.10 References

Anon. 2001. The distribution and biology of anglerfish and megrim in waters to the west of Scotland. EC Study Contract 98/096 Final Report August 2001.

COUNCIL REGULATION(EC) No 2406/96 of 26 November 1996 laying down common marketing standards for certain fishery products (OJ L 334, 23.12.1996, p. 1).

COUNCIL REGULATION (EU) No 43/2014 of 19 January 2015 fixing for 2015 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union vessels, in certain non-Union waters, amending Regulation (EU) No 43/2014 and repealing Regulation (EU) No 779/2014. 145 pp.

COUNCIL REGULATION (EU) No 72/2016 of 22 January 2016 fixing for 2016 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, and amending Regulation (EU) 2015/104.165 pp.

Hislop, J. R. G., Gallego, A., Heath, M. R., Kennedy, F. M., Reeves, S. A., and Wright, P. J. 2001. A synthesis of the early life history of the anglerfish, *Lophius piscatorius* (Linnaeus, 1758) in Northern British waters. ICES Journal of Marine Science 58:70–86.

ICES. 2004. Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks. *ICES CM 2004/**ACFM:01**.* 558 pp.

ICES. 2009. Report of the Workshop on Anglerfish and Megrim (WKAGME). ICES CM 2009/ACOM:28. 112 pp.

ICES. 2010. Report of the Planning Group on Commercial Catches, Discards and biological Sampling (PGCCDBS), 1–5 March 2010, Lisbon, Portugal. ICES CM 2010/ACOM:39. 174 pp.

ICES. 2012. Report of the ICES Advisory Committee on ICES implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM:68. 42 pp.

ICES. 2012b. Report of the Benchmark Workshop on Flatfish Species and Anglerfish (WKFLAT), 1–8 March 2012, Bilbao, Spain. ICES CM 2012/ACOM:46. 283 pp.

ICES. 2016. Report of the Workshop to consider MSY proxies for stocks in ICES category 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015, ICES Head-quarters, Copenhagen. ICES CM 2015/ACOM:61. 183 pp.

Landa, J., Duarte, R., and Quincoces, I. 2008. Growth of white anglerfish (*Lophius piscatorius*) tagged in the Northeast Atlantic, and a review of age studies on anglerfish. ICES Journal of Marine Science, 65: 72–80.

O'Sullivan, M., Wright, P., Vespoor, E., Knox, D. and Piertny, S. 2005. Microsatellite DNA polymorphism indicates an absence of population structure in monkfish *Lophius piscatorius* in its northern distribution. *ICES CM2005/T:18 (poster).*

STECF. 2014. No 14-20. Evaluation of fishing effort regimes in European waters - part 2 (EWG 14–13).

Table 5.2.1 ICES advice and actual management applicable for Northern Shelf anglerfish during 2003–2015.

Year	Single stock exploitation boundary	Basis	West of Scotland (6.a–6.b)			North Sea (4.a–4.c)		
			TAC[4)]	% change in F associated with TAC	WGCSE landings	TAC[5)]	% change in F associated with TAC	WGCSE landings
2003	<6700[1)]	Reduce F below F_{pa}	3180	49% reduction	4126	7000	49% reduction	8268
2004	<8800[2)]	Reduce F below F_{pa} [2)]	3180	48% reduction	3296	7000	48% reduction	9027
2005	-	No effort increase[2)]	4686	-	-	10 314	-	-
2006	-	No effort increase[2)]	4686	-	-	10 314	-	-
2007	-	No effort increase[2)]	5155	-	-	11 345	-	-
2008	-	No effort increase[3)]	5155	-	-	11 345	-	-
2009	-	No effort increase[3)]	5567	-	-	11 345	-	-
2010	-	No effort increase[3)]	5567	-	-	11 345	-	-
2011	-	Decrease effort	5456	-	-	9643	-	-
2012	-	Reduce catches	5183	-	4763	9161	-	7211
2013	-	DLS approach[3)]	4924	-	4730	8703	-	6874
2014	-	DLS approach[2)]	4432	-	4328	7833[6)]	-	8465
2015	-	DLS approach[2)]	5313	-	5140[(7)]	9390[6)]	-	10 918[(7)]

All values raised to nearest tonne.

1) Advice for Division 3.a, Subarea 4 and Subarea 6.a combined.

2) Advice for Division 3.a, Subarea 4 and Subarea 6 combined.

3) Advice for Division 2.a, Division 3.a, Subarea 4 and Subarea 6 combined.

4) TAC applies to 5.b(EC), 6, 7 and 14.

5) TAC applies to 2.a & 4 (EC).

6) of which up to 10 % may be fished in: 5.b(EC), 6, 7 and 14.

(7)Landings including raised discards.

Although there is no minimum landing size for this species, there is an EU minimum weight of 500 g for marketing purposes (EC Regulation 2406/96).

An additional quota of 1500 t was also available for EU vessels fishing in the Norwegian zone of Subarea 4 in 2011–2015.

Table 5.2.2. Anglerfish on the Northern Shelf (3.a, 4 & 6). Total official landings by area (tonnes).

	3.a	4.a	4.b	4.c	6.a	6.b	4	6	Total (3.a, 4,6)	WG Landings	WG Discards
1973	140	2085	575	41	9221	127	2701	9348	12189	-	-
1974	202	2737	1171	39	3217	435	3947	3652	7801	-	-
1975	291	2887	1864	59	3122	76	4810	3198	8299	-	-
1976	641	3624	1252	49	3383	72	4925	3455	9021	-	-
1977	643	3264	1278	54	3457	78	4596	3535	8774	-	-
1978	509	3111	1260	72	3117	103	4443	3220	8172	-	-
1979	687	2972	1578	112	2745	29	4662	2774	8123	-	-
1980	652	3450	1374	175	2634	200	4999	2834	8485	-	-
1981	549	2472	752	132	1387	331	3356	1718	5623	-	-
1982	529	2214	654	99	3154	454	2967	3608	7104	-	-
1983	506	2465	1540	181	3417	433	4186	3850	8542	-	-
1984	568	3874	1803	188	3935	707	5865	4642	11075	-	-
1985	578	4569	1798	77	4043	1013	6444	5056	12078	-	-
1986	524	5594	1762	47	3090	1326	7403	4416	12343	-	-
1987	589	7705	1768	66	3955	1294	9539	5249	15377	-	-
1988	347	7737	2061	95	6003	1730	9893	7733	17973	-	-
1989	334	7868	2121	86	5729	313	10075	6042	16451	-	-
1990	570	8387	2177	34	5615	822	10598	6437	17605	-	-
1991	595	9235	2522	26	5061	923	11783	5984	18362	16846	-
1992	938	10209	3053	39	5479	1089	13301	6568	20807	20934	-
1993	843	12309	3144	66	5553	681	15519	6234	22596	23128	-
1994	811	14505	3445	210	5273	777	18160	6050	25021	24246	-
1995	823	17891	2627	402	6354	830	20920	7184	28927	28090	-
1996	702	25176	1847	304	6408	602	27327	7010	35039	34398	-
1997	776	23425	2172	160	5330	899	25757	6229	32762	31952	-
1998	626	16860	2088	78	4506	900	19026	5406	25058	24667	-
1999	660	13344	1517	24	4284	1401	14885	5685	21230	21194	-
2000	602	12338	1617	31	3311	1074	13986	4385	18973	19080	-
2001	621	12861	1832	21	2660	1309	14714	3969	19304	18536	-
2002	667	11048	1244	21	2280	718	12313	2998	15978	15167	-
2003	478	8523	847	20	2493	643	9390	3136	13004	12539	-
2004	519	8987	851	15	2453	671	9853	3124	13496	14210	-
2005	458	8424	688	5	3019	958	9117	3977	13552	-	-
2006	425	10339	683	3	2785	915	11026	3699	15150	-	-
2007	433	10632	748	4	3353	1261	11384	4613	16431	-	-
2008	486	11038	769	5	3373	1247	11813	4619	16918	-	-
2009	479	10067	652	9	2983	1821	10727	4804	16011	-	-
2010	434	8190	614	11	3041	1606	8816	4646	13896	-	-
2011	406	7759	764	9	2871	1871	8532	4741	13680	13770	-
2012	422	6460	714	3	2835	1831	7177	4666	12265	11894	498
2013	407	6392	546	4	2666	2124	6943	4789	12139	12062	787
2014	439	7629	823	27	2610	1755	8479	4366	13283	13211	416
2015*	480	9669	960	9	3365	1559	10639	4924	16042	16132	420

Table 5.2.3. Anglerfish in Subarea 6. Nominal landings (t) as officially reported to ICES.

Division 6.a (West of Scotland)

***Preliminary.**

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015*
Belgium	3	2	9	6	5	-	5	2	-	-	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Denmark	1	3	4	5	10	4	1	2	1	+	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-
Faroe Is.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	3	2	1	2	4	1	-	-	-	-
France	1910	2308	2467	2382	2648	2899	2058	1634	1814	1132	943	739	1212	1191	1392	1314	1764	1746	1513	1206	1168	1166	1114	1098	1107
Germany	1	2	60	67	77	35	72	137	50	39	11	3	27	39	39	1	-	54	79	79	59	63	48	85	63
Ireland	250	403	428	303	720	717	625	749	617	515	475	304	322	219	356	392	470	295	328	510	488	346	336	410	446
Netherlands	-	-	-	-	-	-	27	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Norway	6	14	8	6	4	4	1	3	1	3	2	1	+	+	1	1	1	2	-	2	1	-	1	1	-
Russia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spain	7	11	8	1	37	33	63	86	53	82	70	101	196	110	82	76	3	174	185	197	138	69	123	54	105
UK(E,W&NI)	270	351	223	370	320	201	156	119	60	44	40	32	31	30	20	24	42	5	12	3	-	12	6	-	-
UK(Scot.)	2613	2385	2346	2133	2533	2515	2322	1773	1688	1496	1119	1100	705	862	1127	974	1071	1096	864	1040	-	1179	1038	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	998	1113	1101	876	1043	1016	1191	1044	962	1643
Total	5061	5479	5553	5273	6354	6408	5330	4506	4284	3311	2660	2280	2493	2453	3019	2785	3353	3373	2983	3041	2871	2835	2666	2610	3365
Unallocated	296	2638	3816	2766	5112	11148	7506	5234	3799	3114	2068	1882	985	1938	-	-	-	-	-	-	110	59	-37	-58	-5
As used by WG	5357	8117	9369	8039	11466	17556	12836	9740	8083	6425	4728	4162	3478	4391	-	-	-	-	-	-	2981	2894	2629	2552	3360

Table 5.2.3. Continued. Anglerfish in Subarea 6. Nominal landings (t) as officially reported to ICES.

Division 6.b (Rockall)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015*
Faroe Is.	-	2	-	-	-	15	4	2	2	-	1	-	-	-	-	-	-	1	4	8	-	5	-	1	-
France	-	-	29	-	-	-	1	1	-	48	192	43	191	175	293	224	327	327	339	168	508	456	663	148	219
Germany	-	-	103	73	83	78	177	132	144	119	67	35	64	66	77	72	222	93	132	87	90	79	88	66	139
Ireland	272	417	96	135	133	90	139	130	75	81	134	51	26	13	35	53	70	76	91	107	108	235	237	162	156
Norway	18	10	17	24	14	11	4	6	5	11	5	3	6	5	4	6	7	5	9	12	7	5	9	3	6
Portugal	-	-	-	-	-	-	-	+	429	20	18	8	4	19	63	-	-	-	-	-	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-	-	-	1	-	-	2	4	1	1	35	-	-	-	-	-	1	2
Spain	333	263	178	214	296	196	171	252	291	149	327	128	59	43	34	36	12	85	57	32	29	36	-	27	44
UK(E,W&NI)	99	173	76	50	105	144	247	188	111	272	197	133	133	54	93	45	147	-	48	-	-	120	395	-	-
UK(Scot)	201	224	182	281	199	68	156	189	344	374	367	317	160	294	355	478	475	-	1141	-	-	895	732	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	523	622	625	1189	1192	1129	1015	1127	1347	993
Total	923	1089	681	777	830	602	899	900	1401	1074	1309	718	643	671	958	915	1261	1247	1821	1606	1871	1831	2124	1755	1559
Unallocated	-	-	-	-	-	-	-	-	-9	17	-178	-47	145	121	-	-	-	-	-	-	-296	-214	-25	-50	-7
As used by WG	923	1089	681	777	830	602	899	900	1392	1091	1131	671	788	792	-	-	-	-	-	-	1575	1617	2099	1705	1552

***Preliminary.**

Table 5.2.3 continued. Anglerfish in Subarea 6. Nominal landings (t) as officially reported to ICES.

Subarea 6 (West of Scotland and Rockall)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015*
Belgium	3	2	9	6	5	-	5	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Denmark	1	3	4	5	10	4	1	2	1	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-
Faroe Is.	-	2	-	-	-	15	4	2	2	-	1	-	-	2	2	3	2	2	6	12	1	5	-	1	+
France	1910	2308	2496	2382	2648	2899	2059	1635	1814	1180	1135	782	1403	1366	1685	1537	2090	2073	1852	1374	1676	1622	1777	1246	1326
Germany	1	2	163	140	160	113	249	269	194	158	78	38	91	105	116	73	222	146	211	166	149	142	136	151	201
Ireland	522	820	524	438	853	807	764	879	692	596	609	355	348	232	391	445	540	371	419	617	596	581	572	572	602
Norway	18	10	17	24	14	11	31	7	5	11	5	3	6	5	4	7	8	7	9	14	7	6	10	4	8
Portugal	6	14	8	6	4	4	1	3	430	23	20	9	4	19	64	-	-	-	-	-	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-	-	-	1	-		2	4	1	1	35	-	-	-	-	-	1	2
Spain	340	274	186	215	333	229	234	338	344	231	397	229	255	153	116	112	15	259	242	229	167	105	123	81	149
UK(E,W&NI)	369	524	299	420	425	345	403	307	171	316	237	165	164	84	113	70	-	-	60	-	-	132	401	-	-
UK(Scot)	2814	2609	2528	2414	2732	2583	2478	1962	2032	1870	1486	1417	865	1156	1482	1451	-	-	2005	-	-	2073	1770	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1521	1735	1726	2065	2234	2145	2205	2171	2310	2636
Total	5984	6568	6234	6050	7184	7010	6229	5406	5685	4385	3969	2998	3136	3124	3977	3699	4613	4619	4804	4646	4741	4666	4789	4366	4924
Unallocated	296	2638	3816	2766	5112	11148	7506	5234	3790	3131	1890	1835	1130	2059	-	-	-	-	-	-	-185	-155	-61	-109	-12
As used by WG	6280	9206	10050	8816	12296	18158	13735	10640	9475	7516	5859	4833	4266	5183	-	-	-	-	-	-	4556	4511	4728	4257	4912

***Preliminary.**

Table 5.2.4. Nominal landings (t) of Anglerfish in the North Sea, as officially reported to ICES.

Northern North Sea (4.a)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015*
Belgium	2	9	3	3	2	8	4	1	5	12	-	8	1	-	-	-	-	-	-	-	-	-	+	-	-
Denmark	1245	1265	946	1157	732	1239	1155	1024	1128	1087	1289	1308	1523	1538	1379	1311	961	1071	1134	1143	841	821	854	801	962
Faroes	1	-	10	18	20	-	15	10	6	-	2	+	3	11	22	2	+	-	4	-	-	-	-	-	-
France	124	151	69	28	18	7	7	3	18	8	9	8	8	8	4	7	13	13	20	23	20	14	15	27	26
Germany	71	68	100	84	613	292	601	873	454	182	95	95	65	20	84	173	186	344	216	124	46	265	274	321	286
Netherlands	23	44	78	38	13	25	12	-	15	12	3	8	9	38	13	14	14	12	5	8	5	5	-	16	-
Norway	587	635	1224	1318	657	821	672	954	1219	1182	1212	928	769	999	880	1006	831	860	859	791	494	485	545	521	406
Sweden	14	7	7	7	2	1	2	8	8	78	44	56	8	6	5	5	20	67	-	-	-	-	-	-	6
UK(E, W&NI)	129	143	160	169	176	439	2174	668	781	218	183	98	104	83	34	99	303	13	320	371	-	248	550	-	-
UK (Scotland)	7039	7887	9712	11683	15658	22344	18783	13319	9710	9559	10024	8539	6033	6284	6003	7722	8304	8658	7509	5730	-	4622	4154	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7821	8607	8671	7829	6101	6353	4870	4704	5943	7983
Total	9235	10209	12309	14505	17891	25176	23425	16860	13344	12338	12861	11048	8523	8987	8424	10339	10632	11038	10067	8190	7759	6460	6392	7629	9669

***Preliminary.**

Table 5.2.4. Continued. Nominal landings (t) of Anglerfish in the North Sea, as officially reported to ICES.

Central North Sea (4.b)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015*
Belgium	357	538	558	713	579	287	336	371	270	449	579	435	180	260	207	138	179	181	134	124	111	131	135	213	189
Denmark	345	421	347	350	295	225	334	432	368	260	251	255	191	274	237	276	173	237	248	194	286	301	192	334	369
Faroes	-	-	2	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-
France	-	1	-	2	-	-	-	-	-	-	-	-	-	+	-	-	-	-	3	6	2	-	-	1	-
Germany	4	2	13	15	10	9	18	19	9	14	9	17	11	11	9	14	12	22	17	21	17	10	10	17	23
Ireland	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	285	356	467	510	335	159	237	223	141	141	123	62	42	25	31	33	61	58	36	46	53	61	41	72	74
Norway	17	4	3	11	15	29	6	13	17	9	15	10	12	22	16	12	24	15	21	10	11	11	26	11	9
Sweden	-	-	-	3	2	1	3	3	4	3	2	9	2	1	4	4	6	9	-	-	-	-	-	-	3
UK(E, W&NI)	669	998	1285	1277	919	662	664	603	364	423	475	236	167	120	96	108	121	105	-	88	-	85	70	-	-
UK (Scotland)	845	733	469	564	472	475	574	424	344	318	378	210	241	138	88	98	172	142	-	125	-	115	72	-	-
UK (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	206	293	247	193	213	284	200	142	175	293
Total	2522	3053	3144	3445	2627	1847	2172	2088	1517	1617	1832	1244	847	851	688	683	748	769	652	614	764	714	546	823	960

*** Preliminary**

Table 5.2.4. Continued. Nominal landings (t) of Anglerfish in the North Sea as officially reported to ICES.

Southern North Sea (4.c)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015*
Belgium	13	12	34	37	26	28	17	17	11	15	15	16	9	5	4	3	3	4	6	7	6	2	2	4	4
Denmark	2	+	-	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	+	-	-
France	-	-	-	-	-	-	-	10	-	+	-	+	-	-	-	-	-	-	1	1	1	-	-	1	+
Germany	-	-	-	-	-	-	-	-	-	+	-	+	+	-	-	-	-	-	-	-	-	-	+		+
Netherlands	5	10	14	20	15	17	11	15	10	15	6	5	1	-	1	-	1	1	-	2	1	1	1	19	4
Norway	-	-	-	-	+	-	-	-	+	-	+	-	-	-	-	-	-	-	1	-	-	-	-	1	+
UK(E&W &NI)	6	17	18	136	361	256	131	36	3	1	-	-	10	3	-	-	-	-	1	1	-	-	1	-	-
UK (Scotland)	-	-	-	17	-	3	1	+	+	+	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-
UK (Total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	1	2	1
Total	26	39	66	210	402	304	160	78	24	31	21	21	20	15	5	3	4	5	9	11	9	3	4	27	9

*** Preliminary.**

Table 5.2.4. Continued. Nominal landings (t) of Anglerfish in the North Sea as officially reported to ICES.

Subarea 4 (North Sea)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015*
Belgium	372	559	595	753	607	323	357	389	286	476	594	459	190	265	211	141	181	185	140	131	116	133	137	217	193
Denmark	1592	1686	1293	1507	1027	1464	1489	1456	1496	1347	1540	1563	1714	1812	1616	1587	1134	1308	1382	1337	1127	1122	1046	1135	1331
Faroes	1	-	12	18	20	-	15	10	6	-	2	10	3	11	22	2	-	-	4	-	-	-	-	-	-
France	124	152	69	30	18	7	7	13	18	8	9	8	8	8	4	7	14	13	23	30	24	15	15	30	26
Germany	75	70	113	99	623	301	619	892	463	196	104	112	76	31	93	187	198	367	233	145	63	275	284	339	309
Ireland	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	313	410	559	568	363	201	260	238	166	168	132	75	52	63	45	47	76	71	41	56	59	67	42	108	79
Norway	604	639	1227	1329	672	850	678	967	1236	1191	1227	938	781	1021	896	1018	855	875	881	802	505	496	572	533	415
Sweden	14	7	7	10	4	2	5	11	12	81	46	65	10	7	9	10	26	76	-	-	-	-	-	-	9
UK(E&W&NI)	804	1158	1463	1582	1456	1357	2969	1307	1148	642	658	334	281	206	130	207	425	118	-	460	-	333	621	-	-
UK (Scotland)	7884	8620	10181	12264	16130	22822	19358	13743	10054	9877	10402	8749	6274	6429	6091	7820	8476	8800	-	5855	-	4736	4226	-	-
UK (Total)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8027	8901	8918	8023	6315	6638	5069	4847	6120	8277
Total	11783	13301	15519	18160	20920	27327	25757	19026	14885	13986	14714	12313	9390	9853	9117	11026	11385	11813	10727	8816	8532	7177	6943	8482	10639
Unallocated	-1217	-1573	-2441	-2730	-5126	11087	-7540	-4999	-3166	-2422	-2037	-1979	-1117	-826	-	-	-	-	-	-	167	-269	-59	-17	89
WG estimate	10566	11728	13078	15430	15794	16240	18217	14027	11719	11564	12677	10334	8273	9027	-	-	-	-	-	-	8699	6908	6884	8465	10728

***Preliminary.**

Table 5.2.5. Nominal landings (t) of Anglerfish in Division 3.a, as officially reported to ICES.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015*
Belgium	15	48	34	21	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Denmark	493	658	565	459	312	367	550	415	362	377	375	369	215	311	274	227	255	287	344	270	251	307	298	309	336
France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Germany	-	-	1	-	-	1	1	1	2	1	-	1	-	1	1	2	1	1	1	1	2	-	1	-	1
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	3	4	4	3	1	3	-	5	-	-	-	4	9
Norway	64	170	154	263	440	309	186	177	260	197	200	242	189	130	100	139	132	144	134	158	153	115	108	126	91
Sweden	23	62	89	68	36	25	39	33	36	27	46	55	71	73	79	54	44	51	-	0	0	0	0	-	43
Total	595	938	843	811	823	702	776	626	660	602	621	667	478	519	458	425	433	486	479	434	406	422	407	439	480
Unallocated	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35	53	43	50	12
As used by WG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	441	475	450	489	492

***Preliminary.**

Table 5.2.6. Breakdown of WG estimates of commercial catches for 2015 by main gear group and area.

	3.a		4		6.a		6.b		Total		Percentage of Total	
Fleet	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings	Discards
Demersal trawl	53	-	7896	68	2645	41	715	14	11309	123	70	29
Nephrops trawl	298	1	531	113	134	106	-	-	963	220	6	52
Gillnets	115	-	1915	39	63	3	825	17	2918	59	18	14
Other/Not specified	26	1	386	8	518	9	12	-	942	18	6	4
Total	492	2	10728	228	3360	159	1552	31	16132	420	100.0	100.0

Table 5.2.7. Total biomass estimates with confidence intervals and relative standard errors from the 2005–2015 SCO-IV-VI-AMISS-Q2 surveys.

Year	Biomass (t)	Confidence Interval		RSE	Percentage Biomass in subarea 4
2005	38.617	23.479	53.755	20.0	48.27%
2006	40.985	34.478	47.492	8.1	53.49%
2007	50.392	43.676	57.108	6.8	56.62%
2008	53.546	42.421	64.671	10.6	55.51%
2009	38.060	32.987	43.133	6.8	44.82%
2010	42.279	30.429	54.129	14.3	51.90%
2011	33.254	24.846	41.662	12.9	44.96%
2012	36.325	29.704	42.946	9.3	41.58%
2013	38.395	31.020	45.770	9.8	37.04%
2014	52.884	42.769	62.999	5.2	40.25%
2015	67.915	58.782	77.047	6.9	39.24%

Table 5.2.8. Abundance and biomass estimates from the 2005–2015 SCO-IV-VI-AMISS-Q2 surveys by ICES Subareas and Divisions.

	Abundance (millions)										
ICES Subarea/Division	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Subarea 4 (partial)	11.168	12.844	15.304	12.613	8.279	7.366	5.15	5.432	8.470	17.553	18.266
Division 4.a	10.866	10.459	7.956	7.718	5.144	5.161	6.057	4.961	8.461	16.096	28.604
Division 4.b	1.8	3.174	4	3.952	3.688	3.131	3.669	5.135	4.885	6.488	5.496
Subarea 6	12.666	13.633	11.956	11.67	8.832	8.292	9.725	10.096	13.346	22.584	34.100
Northern Shelf (partial)	23.833	26.477	27.261	24.283	17.111	15.658	14.875	15.528	21.816	40.136	52.366

	Biomass (kilo tonnes)										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Subarea 4 (partial)	18.642	21.921	28.534	29.721	17.058	21.944	14.949	15.106	14.369	21.284	29.653
Division 6.a	14.096	12.175	11.072	14.383	8.15	11.59	9.33	9.213	10.801	16.633	24.047
Division 6.b	5.879	6.889	10.786	9.442	12.852	8.745	8.974	12.005	13.626	14.967	14.215
Subarea 6	19.975	19.064	21.858	23.825	21.002	20.334	18.305	21.218	24.427	31.600	38.262
Northern Shelf (partial)	38.617	40.985	50.392	53.546	38.06	42.279	33.254	36.325	38.796	52.884	67.915

Table 5.2.9. Percentage change in mean stock biomass from 2011–2013 to 2014–2015 in ICES Sub-areas 4 and 6 combined.

Average Biomass 2011–2013	Average Biomass 2014–2015	Percentage Change in Biomass
35.991	60.400	67.3%

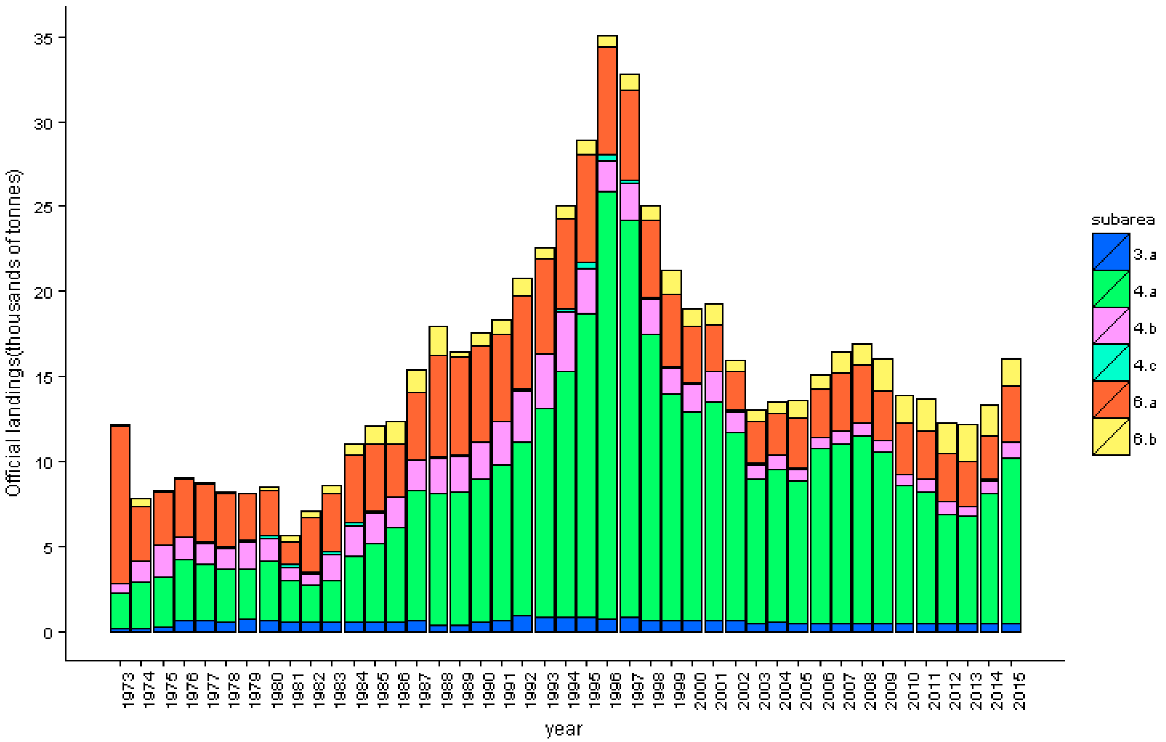


Figure 5.2.1. Northern Shelf anglerfish. Officially reported landings by ICES area (1973–2015).

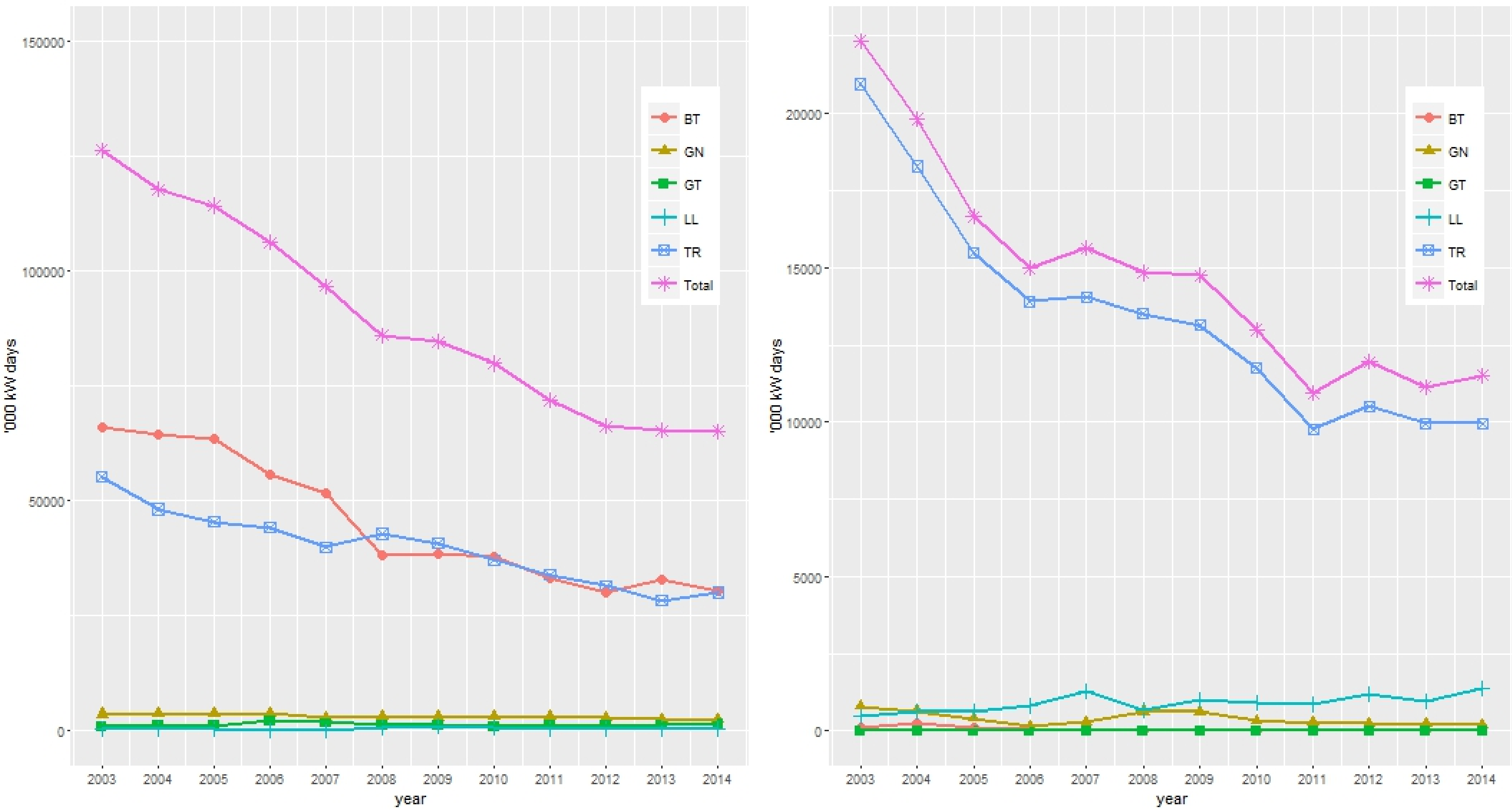


Figure 5.2.2. Trends in nominal international fishing effort in North Sea and II (EU) (left) and West of Scotland (right) collated by STECF for the Evaluation of Fishing Effort Regimes in European Waters.

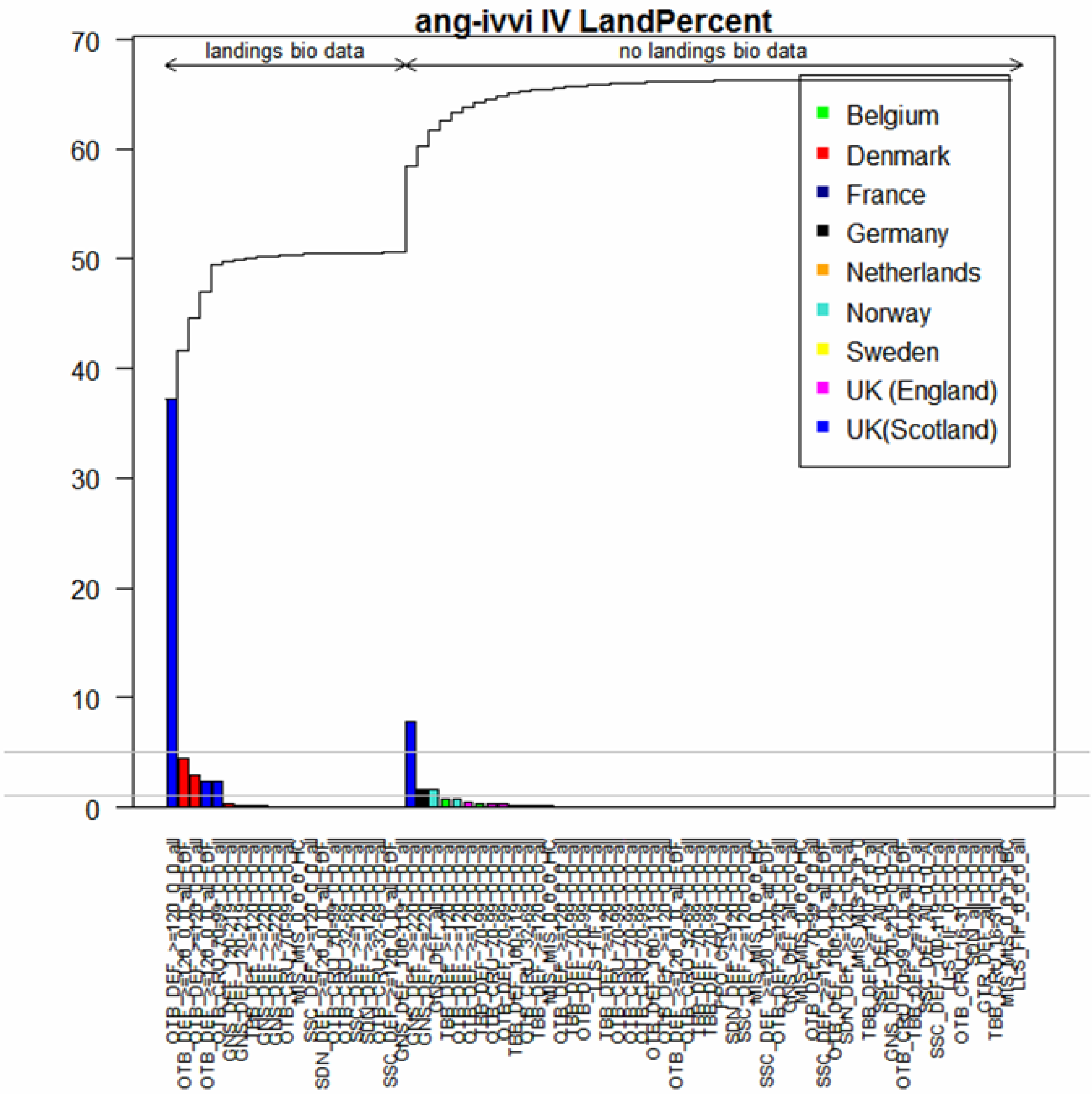


Figure 5.2.3a. Percentage of landings weight by fleet and country in 2015; Subarea 4.

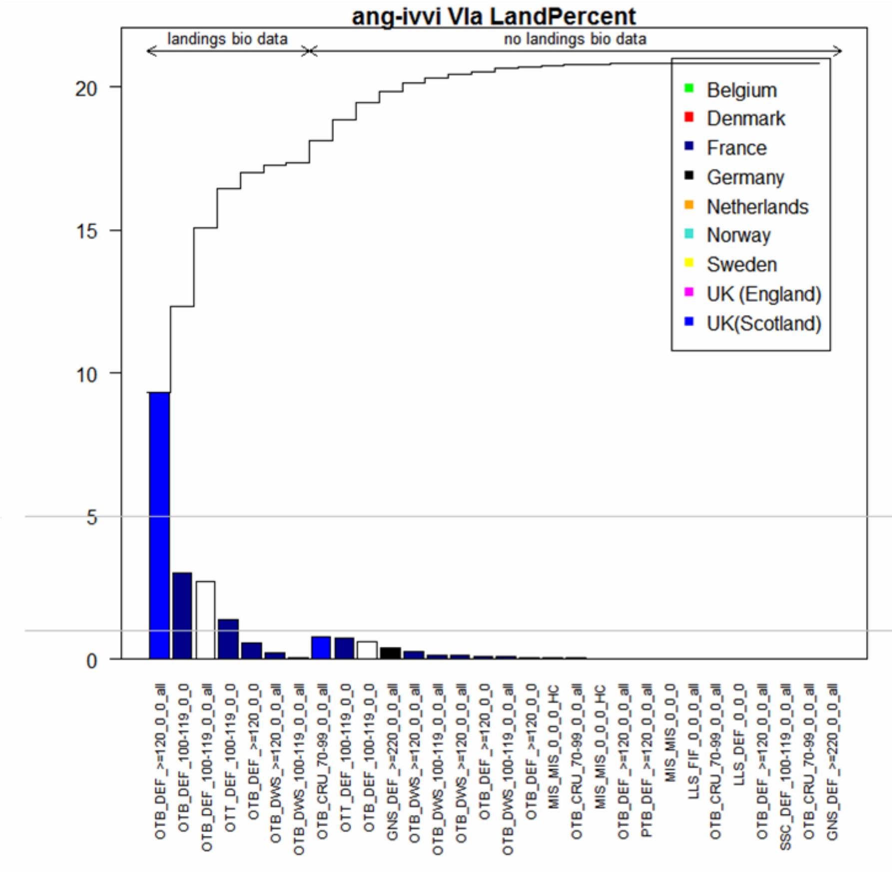


Figure 5.2.3b. Percentage of landings weight by fleet and country in 2015; Division 6.a.

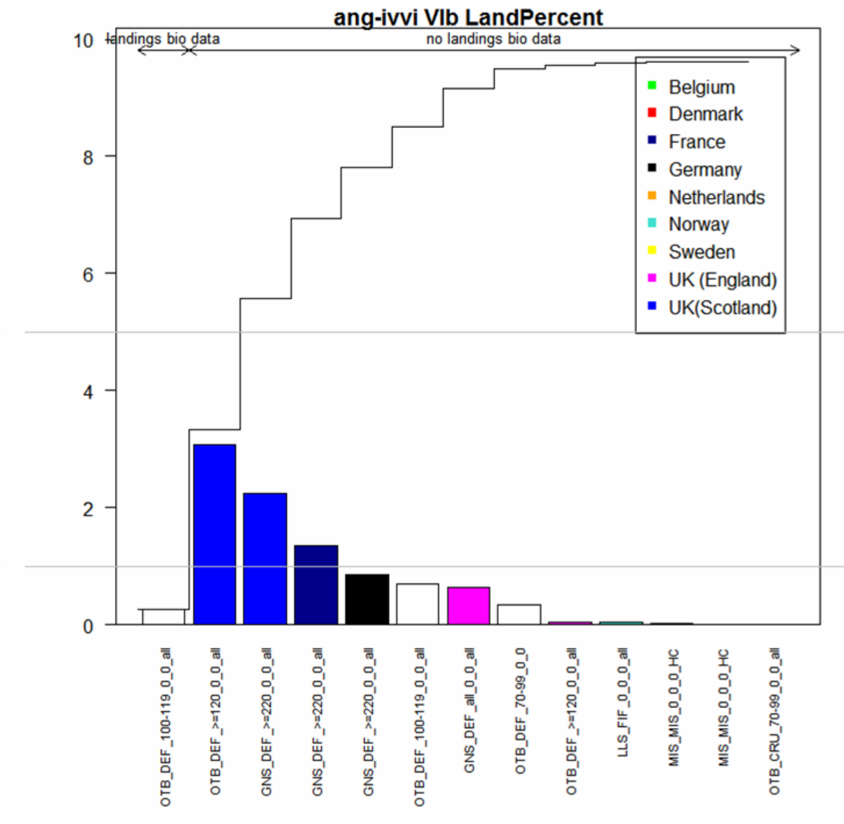


Figure 5.2.3c. Percentage of landings weight by fleet and country in 2015; Division 6.b.

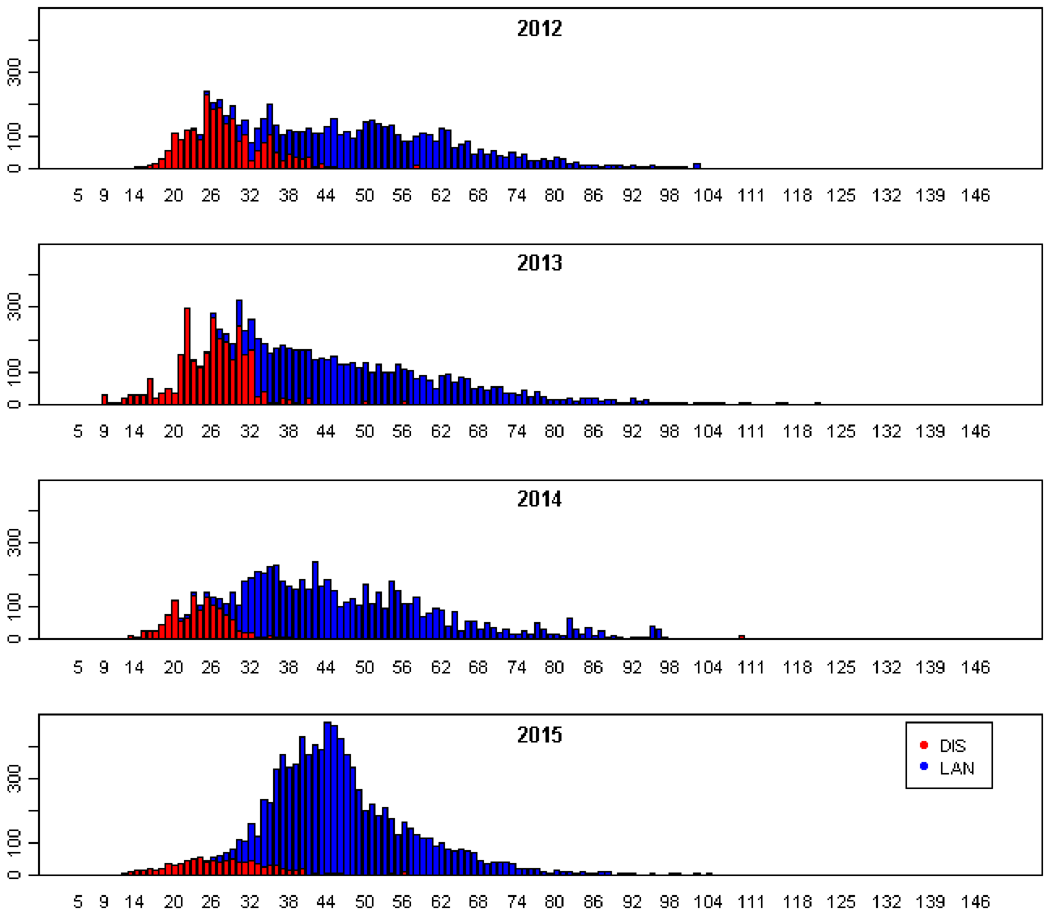


Figure 5.2.4. WGCSE Landed numbers ('00 thousands) at-length (cm) 2012–2015.

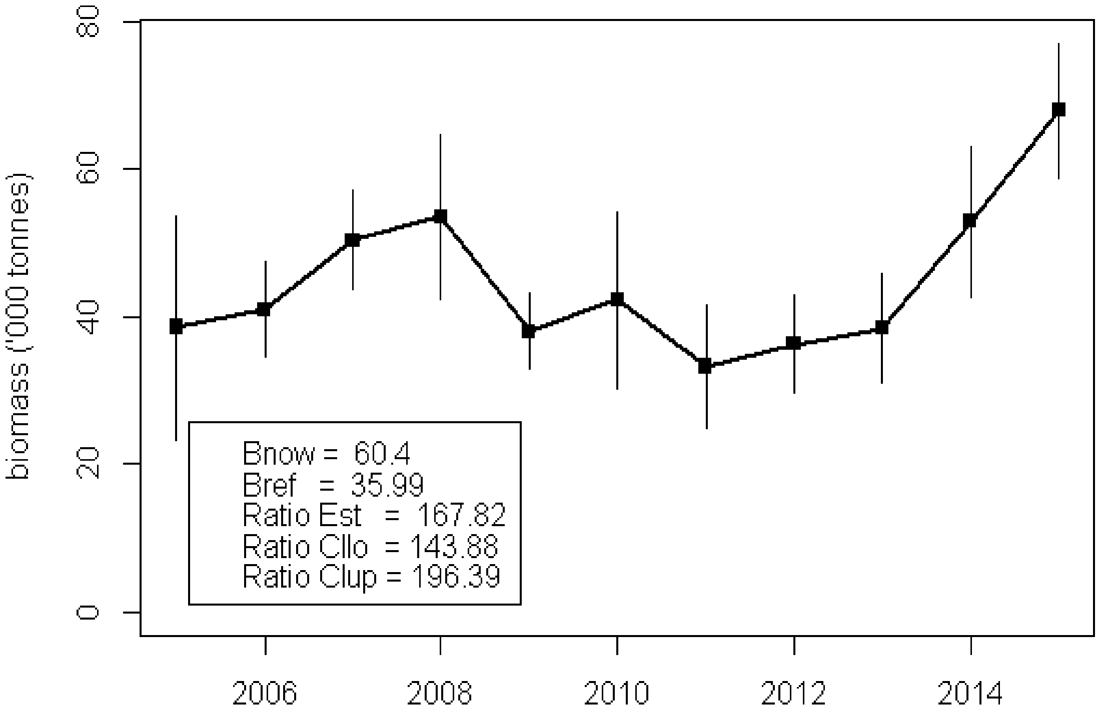


Figure 5.2.5. SCO-IV_VI-AMISS-Q2 estimates of total biomass, with confidence intervals, for Subareas 4 and 6 combined, 2005–2015. Bnow is the average biomass for 2014–2015, Bref is the average biomass for 2011–2013; both marked on the graph in their respective years. Ratio Est is the ratio of Bnow to Bref, expressed as a percentage, with confidence intervals (Ratio CIlo, Ratio CIup).

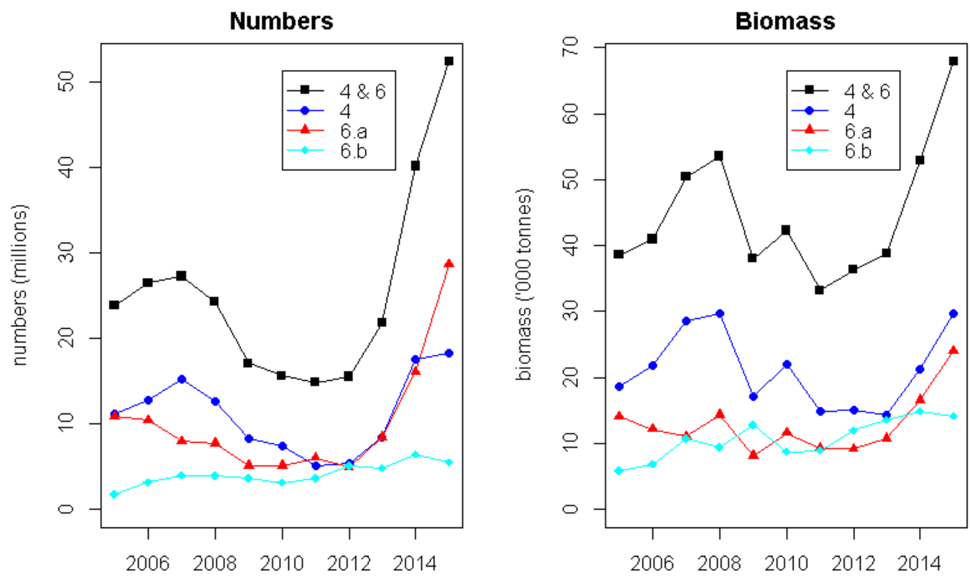


Figure 5.2.6. SCO-IV-VI-AMISS-Q2 estimates of total abundance (left) and biomass (right) of anglerfish for the Northern Shelf (black filled squares) 2005–2015. Estimates are also provided for ICES Subarea 4 (blue filled circles), Division 6.a (red triangles) and Division 6.b (turquoise diamonds).

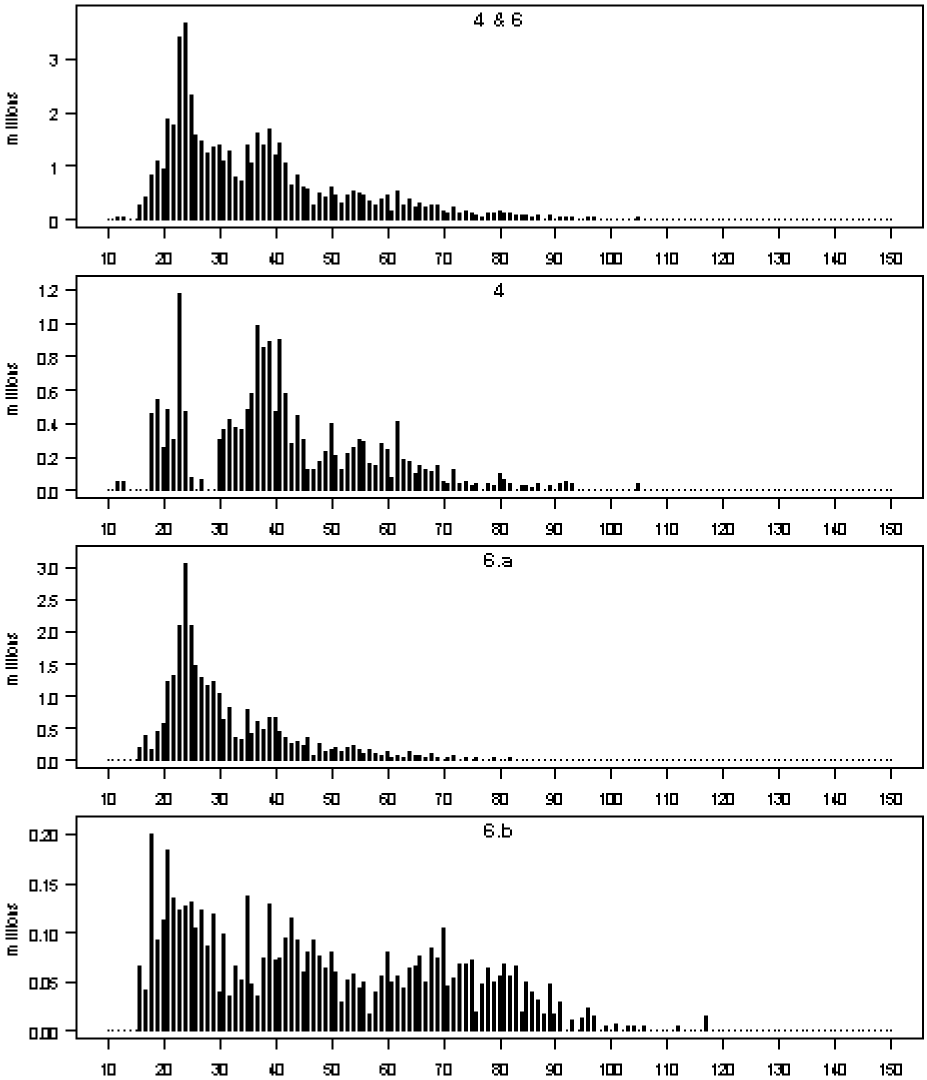


Figure 5.2.7. SCO-IV-VI-AMISS-Q2 estimates of total numbers (millions) at-length (cm) for Sub-areas 4.a-c and 6.a–b, 2015.

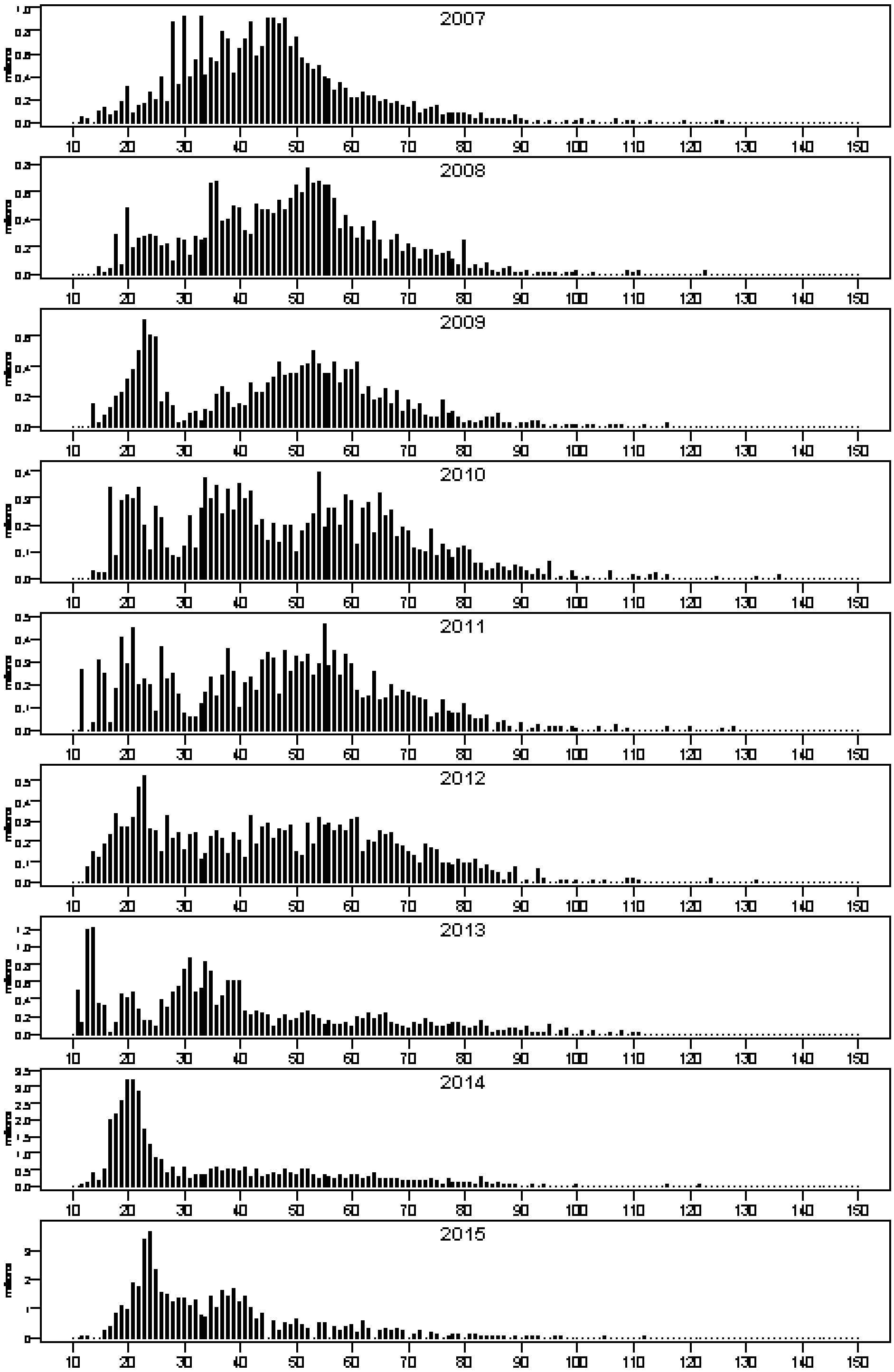


Figure 5.2.8. SCO-IV-VI-AMISS-Q2 estimates of total numbers (millions) at-length (cm) for Sub-areas 4.a–c and 6.a–b combined, 2007–2015.

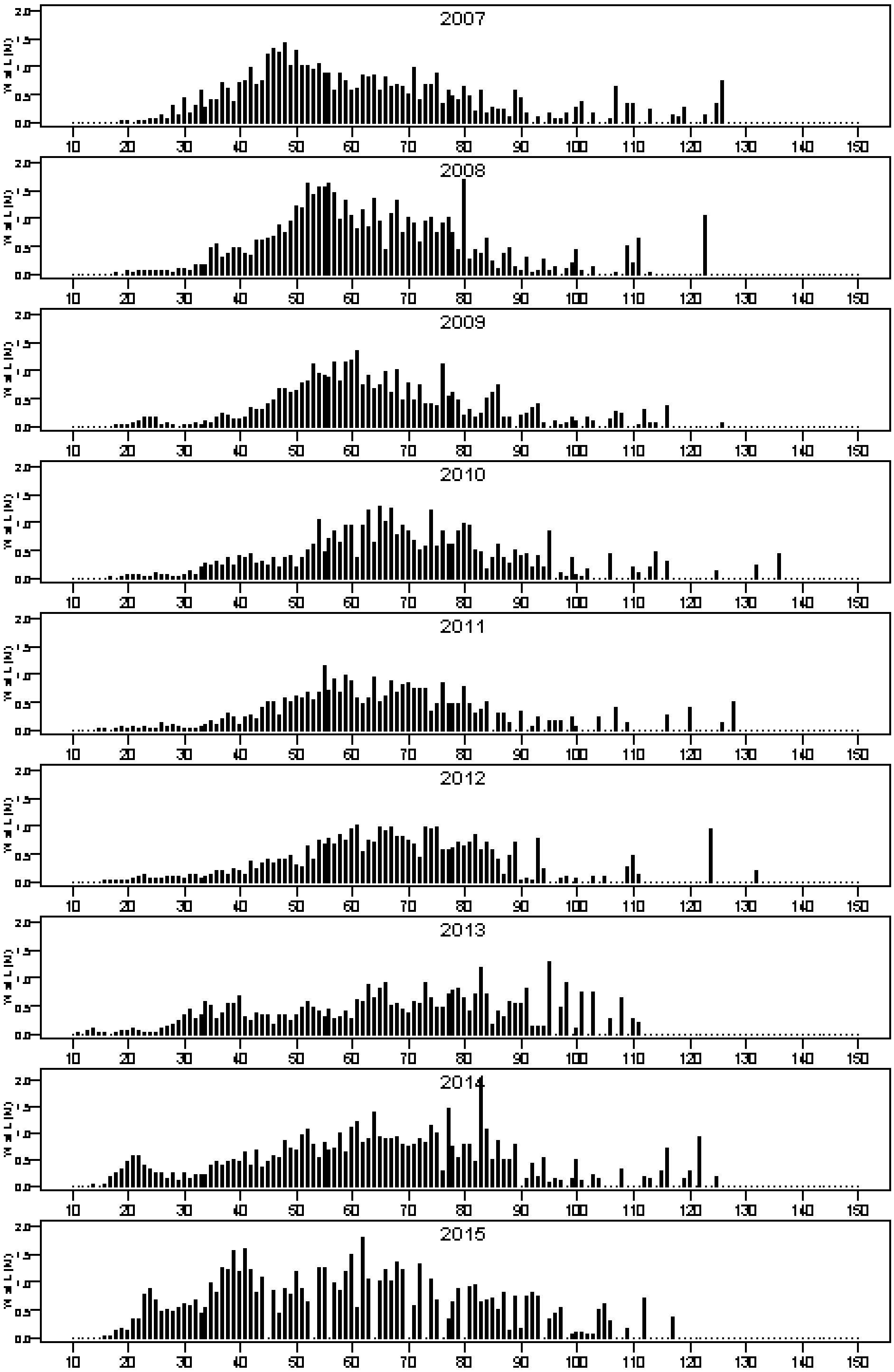


Figure 5.2.9. SCO-IV-VI-AMISS-Q2 estimates of total biomass (kt) at-length (cm) for Subareas 4.a–c and 6.a–b combined, 2007–2015.

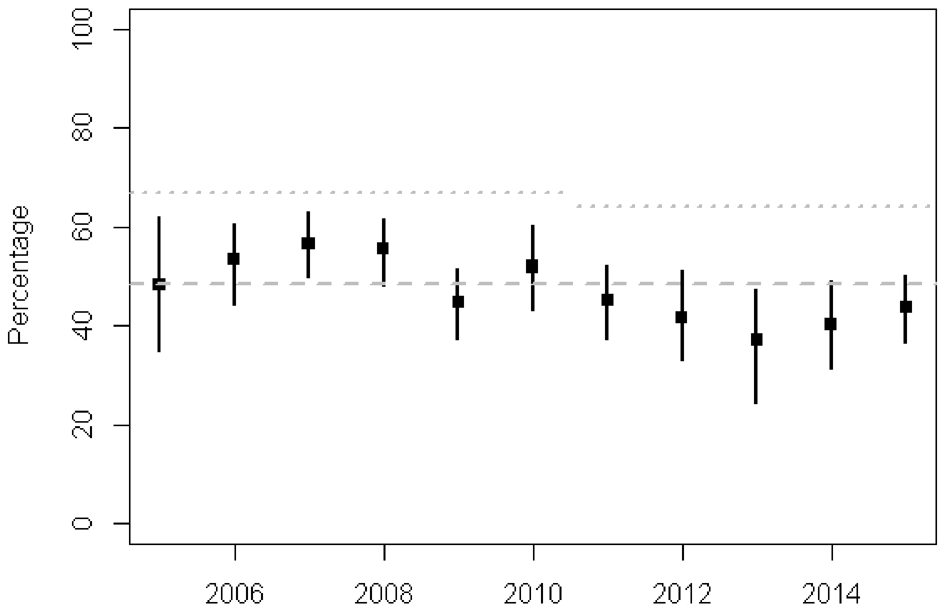


Figure 5.2.10. Percentage of SCO-IV-VI-AMISS-Q2 total biomass, with confidence intervals, estimated to be in Subareas 4.a–c compared with Subareas 4.a–c and 6.a–b combined. The full grey line represents the average of these percentages over the time-series (2005–2015) 4 (48%). The dotted grey lines represent the percentage of TAC allocated for Subareas 4.a–c compared to the total of the TAC for Subareas 4.a–c and 6.a–b, (67% in 2005–2010, 64% in 2011–2015).

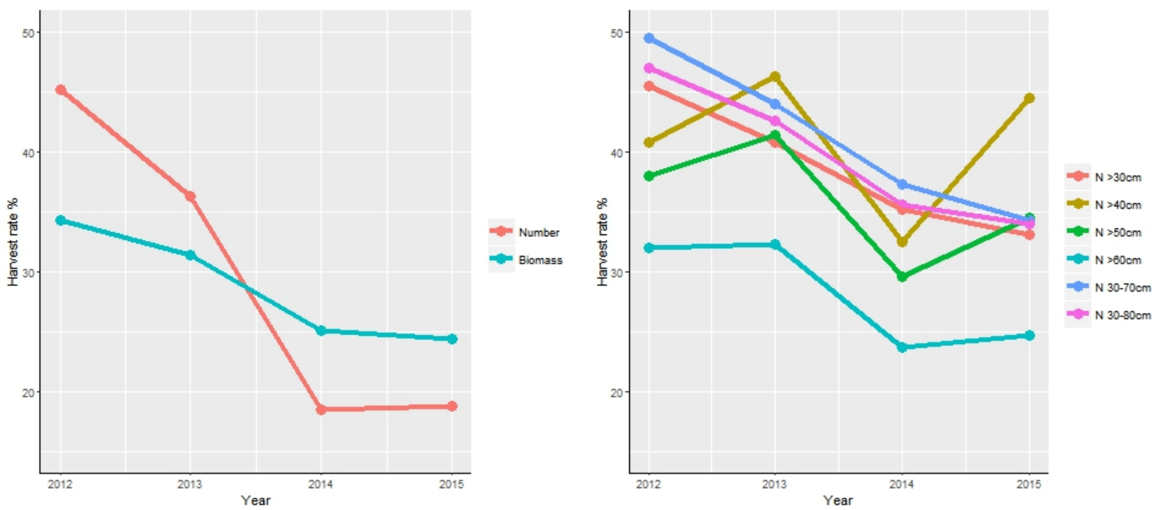


Figure 5.2.11. Northern Shelf anglerfish harvest rate (% removed (numbers or biomass)/SCO-IV-VI-AMISS-Q2 total numbers or biomass).

5.3 Megrim in 4.a and 6.a (Northern North Sea and West of Scotland) and Megrim in 6.b (Rockall)

5.3.1 Megrim in Divisions 4.a and 6.a (Northern North Sea and West of Scotland)

Type of assessment in 2016

Update of 2015 assessment with new landings and survey data. The model used to carry out the assessment is the Schaefar Surplus production process model in R and Winbugs.

ICES advice applicable to 2015

ICES advises if discard rates do not change from the average of the last three years (2012–2014), this implies landings of no more than 7539 tonnes.

ICES advice applicable to 2016 and 2017

ICES advises that when the MSY approach is applied, catches in each of the years 2016 and 2017 should be no more than 8567 tonnes. If discard rates do not change from the average of the last three years (2012–2014), this implies landings of no more than 7539 tonnes.

5.3.1.1 General

Stock description and management units

Megrim stock structure is uncertain and historically the Working Group has considered megrim populations in 6.a and 6.b as separate stocks. The review group questioned the basis for this in 2004. Data collected during an EC study contract (98/096) on the 'Distribution and biology of anglerfish and megrim in the waters to the West of Scotland' showed significantly different growth parameters and significant population structure difference between megrim sampled in 6.a and 6.b (Anon, 2001). Spawning fish occur in both areas but whether these populations are reproductively isolated is not clear. As noted by WGNSDS (2008), megrim in 4.a has historically not been considered by ICES and WGNSDS (2008). Since 2009 data from 4 and 2.a are included in this report, but international catch and weight-at-age data for 4 prior 2006 was not available to the working group or WKFLAT (2011). Given that there is little evidence to suggest that megrim in 6.a and 4.a are separate stocks, based on a visual inspection of the spatial distribution of commercial landings and fishery-independent survey data, WKFLAT (2011) concluded that megrim in 6.a and 4.a should be considered as a single stock. This has subsequently been supported through recent genetic studies (MacDonald and Prieto, 2012) indicating that there is one stock consisting of Divisions 4.a (northern North Sea) and 6.a (West of Scotland) and another separate stock in Division 6.b (Rockall).

Management area (red boxes) and assessment area (blue hatched boxes)

Species:	Megrims *Lepidorhombus* spp.	**Zone:**	Union waters of IIa and IV (LEZ/2AC4-C)
Belgium	8		
Denmark	7		
Germany	7		
France	43		
The Netherlands	34		
United Kingdom	2 540		
Union	2 639		
TAC	2 639		Analytical TAC

Species:	Megrims *Lepidorhombus* spp.	**Zone:**	Union and international waters of Vb; VI; international waters of XII and XIV (LEZ/56-14)
Spain	592		
France	2 312		
Ireland	675		
United Kingdom	1 635		
Union	5 214		
TAC	5 214		Analytical TAC Article 7(2) of this Regulation applies

2016 TAC for 6, EC waters of 5.b and International waters of 12 and 14 (lower) and TAC for 4 and 2.a (upper).

Species: Megrims *Lepidorhombus* spp.	Zone: Union waters of IIa and IV (LEZ/2AC4-C)
Belgium	6
Denmark	5
Germany	5
France	34
The Netherlands	27
United Kingdom	2 006
Union	2 083
TAC	2 083

Analytical TAC

Species: Megrims *Lepidorhombus* spp.	Zone: Union and international waters of Vb; VI; international waters of XII and XIV (LEZ/56-14)
Spain	463
France	1 805
Ireland	528
United Kingdom	1 278
Union	4 074
TAC	4 074

Analytical TAC

2015 TAC for 6, EC waters of 5.b and International waters of 12 and 14 (lower) and TAC for 4 and 2.a (upper).

	TAC	WG LANDINGS1	% UPTAKE
Spain	592	140	24%
France	2312	140	6%
Ireland	675	311	46%
UK	1635	520	32%
EU	5214		
TAC	5214	1477	28%

2016 TAC for VI, EC waters of Vb and International waters of XII and XIV (lower).

	TAC	WG LANDINGS1	% UPTAKE
Spain		140	
Belgium	8		
Denmark	7	26	371%
Germany	7	1	14%
France	43	147	342%
Netherlands	34	0	
UK	2540	1696	67%
Ireland		311	
EU	2639		
TAC	2639	2331	88%

2016 TAC for IV and IIa (upper).

The uptake of the TAC for ICES Division 6 and EU waters of 5.b was 28% in 2016. Uptake varied considerably between countries. France, which holds much of the quota allocation, utilised only 6% of its allocation.

In ICES Area 4 and 2.a, 88% of the TAC was used in 2016. The majority of available TAC is allocated to the UK.

Fishery in 2015

Landings

Official landings data for each country together with Working Group best estimates of landings from 6.a are shown in Table 5.3.1.1 and for 4.a in Table 5.3.1.2. The WG best estimates of landings are those supplied by stock coordinators of the various countries and differ from the official statistics in some years. Landings have increased in recent years and are more in line with historical trends.

Catches of megrim comprise two species, *Lepidorhombus whiffiagonis* and *L. boscii*. Information available to the Working Group indicates that *L. boscii*, are a negligible proportion of the Scottish and Irish megrim catch (Kunzlik *et al*., 1995; Anon, 2001).

Landings estimates 2015

The catch estimates submitted to ICES are used. To estimate ICES landings we take InterCatch estimates and if unavailable we use official estimates. There are a few discrepencies with the estimates for example there are no French data in InterCatch.

The official catch estimate is 2331 tonnes. The intercatch catch estimate is 2287 tonnes. The total ICES landings are way below the TAC. There is a discard estimate for IRE and UK and this equates to 6% of the total catch.

Commercial catches are dominated by female megrim, typically 90% of the total catch. Analysis of Irish logbook data by Anon (2002) showed that cpue trends varied throughout the year, showing a maximum in late spring/early summer following the spawning period and at their lowest in late autumn.

Discards

International landings data collated by the ICES Working Group on the Celtic Seas Ecoregion (WGCSE) are used as an estimate of landings. However, discarding is a feature of the key fisheries but note that discard data are not available for the entire time-series. The availability or raised discard data are highly variable across fleets and areas and prior to 2000, discard data from 6.a and 6.b were combined into a single 6 estimate.

Raised discard data were made available by Scotland (6.a and 4.a) and Ireland (6.a). Scottish data give a discard rate (by weight) of 5.6% and 14.7% for 4.a and 6.a respectively. Irish discards were 3.5% by weight. Discards were estimated to be 7.1% by weight for the stock area in 2015.

Prior distributions on parameters in the model are shown in Table 5.3.1.5 and model priors are presented in Table 5.3.1.6. The final run assumed a linear decline in discards from 30 to 15% over time between 1985 and 2012 and from 2013 onwards discard data have been made available for UK, Ireland and Denmark. For countries where discard data have not been made available, discards are estimated using the aggregated discard rate from the UK, Ireland and Denmark, there is no deviation from the agreed stock annex.

Surveys

Indices from six fishery-independent surveys are used in the assessment. The surveys are outlined in Table 5.3.1.3 below and details can be viewed in the stock annex.

Table 5.3.1.3. Summary indices used for surplus production model.

NUMBER	SURVEY	NATIONALITY	AREA	TIME-SERIES	DEPTH RANGE(M)
1	Sco-IBTS-Q3	Scotland	IVa	1987–2015	<400 m
2	Sco-IBTS-Q1	Scotland	IVa	1987–2015	<400 m
3	ScoGFS-WIBTS-Q1	Scotland	VIa	1986–2010	40–400
4	ScoGFS-WIBTS-Q4	Scotland	VIa	1986–2010	50–300
5	SAMISS-Q2	Scotland	VIa/IVa	2005–2015	50–1050
6	IAMISS-Q2	Ireland	VIa	2005–2015	50–850

The SAMISS and IAMISS surveys were combined for assessment purposes.

Figures 5.3.1.6 to 5.3.1.9 present the megrim biomass maps for IBTS surveys. Figures 5.3.1.6 (Sco-IBTS-Q3 4.a) and 5.3.1.7 (Sco-IBTS-Q1 4.a) show an increase in biomass over time. In the northern area there is an increase in abundance whereas in the southern area the abundance is still quite low.

Figures 5.3.1.8 (Sco-GFS-Q1 4.a) and 5.3.1.8 (Sco-GFS-Q4 4.a) show an increase in biomass in 2013-2014 and a slight increase in 2015.

After 2010 the ScoGFS-WIBTS-Q1 and the ScoGFS-WIBTS-Q4 seems to fit the model quite well even though these data are not included. The introductions of the ScoGFS-WIBTS-Q1 and the ScoGFS-WIBTS-Q4 data from 2011 to present have been recommended for the 2017 assessment.

5.3.1.2 Estimation of survey cpue indices

Cpue trends of survey data

The modelled cpue trends from the Sco-WIBTS-Q3 and Sco-WIBTS-Q1 surveys indicate that there is an increase in cpue earlier when compared to the other surveys (Figure 5.3.1.1).

The survey cpue indices and landings data used are provided in Table 5.3.1.4.

The data from the surveys exhibit a relatively large proportion of zeros, therefore the delta method of Stefánsson (1996) was used to extract indices. This method (delta-gamma model) comprises fitting two generalized linear models. The first model (binomial GLM) is used to obtain the proportion of non-zero tows and is fit to the data coded as 1 or 0 if the tow contained a positive or zero cpue, respectively. The second model is fit to the positive only cpue data using a gamma or lognormal GLM.

Commercial cpue

Commercial cpue data have not been updated compared to last year and are not used in the assessment.

5.3.1.3 Stock assessment

The input data for the stock assessment are given in Table 5.3.1.4. This comprises of a time-series from all six surveys and landings data presented to the working group.

2015 Final run

Figure 5.3.1.2 shows the trends in landings of 6.a and 4.a (solid line) with an overall catch estimate (dashed line) and estimated trends in total biomass and exploitation rate (upper panels). Trends in annual cpue estimates from all the surveys used in the surplus production model are shown. The solid line is the modelled cpue trend across all surveys with 95% error intervals. A plot contrasting the prior and posterior assumed and estimated is given in Figure 5.3.1.3.

It is noted that the modelled cpue trend tends to deviate in recent years from the raw cpues for the SCO Q1 4.a and SCO Q3 4.a surveys. This can be seen more clearly in the survey residuals plot in Figure 5.3.1.4 with a sequence of positive residuals from 2005 onwards. This is a consequence of the low interannual variation in cpue from the monk 6.a (SAMISSQ2/IAMISSQ2) and monk 4.a (SAMISSQ2) surveys and the in comparison to the much higher interannual variation seen in the other 'IBTS' surveys. As a result the model places more weighting on the two 'monk' surveys as observed already last year.

The model output in terms of current stock status and exploitation relative to biomass and mortality reference levels are presented in Table 5.3.1.6. The MSY is estimated at 5362 tonnes and fishing mortality in 2015 was estimated at 0.07, considerably lower than F_{MSY} (0.26). The trends in F and biomass over the full time-series are shown in together with the ratio of B/B_{MSY} and F/F_{MSY} in Table 5.3.1.7.

Table 5.3.1.5 presents estimates megrim biomass from SAMISS and IAMISS surveys in 4 and 6.a respectively.

Figure 5.3.1.10 contrasts the outcome of the 2016 assessment with those from 2013 to 2015. However, there is little difference when comparing the 2015 and 2016 assessments and this year's assessment is overall consistent with 2015.

State of the stock

The state of the stock has not changed since last year. Fishing mortality has been below F_{MSY} for almost the full time-series and has an overall declining trend since the late 1990s. Biomass has consistently been above MSY $B_{trigger}$ and has steadily increased since 2005. The stock is estimated 1.7 times B_{MSY}. The fishing mortality is estimated to be greater than 10% of F_{MSY}.

5.3.1.4 Short-term projections

Short-term projections have not been updated.

5.3.1.5 Biological reference points

Precautionary approach reference points

F_{MSY}, B_{MSY} and the yield at MSY are all directly estimated in the model. It should be noted that these will vary when new survey and catch information is added. $B_{trigger}$ and B_{lim} are defined as 50%B_{MSY} and 30%B_{MSY} respectively. F_{lim} is defined as 1.7 F_{MSY} and is the F that drives the stock to B_{lim} assuming B_{lim}=30%B_{MSY}. The derivation is given below:

$P=rB(1-B/K)$

The surplus productivity associated with *Blim* is:

$Plim=rBlim(1-Blim/K)$

The corresponding *F* is:

$Flim=rBlim(1-Blim/K)/Blim = r(1-Blim/K)$

$Blim=0.3Bmsy = 0.3K/2$

$Flim = r(1-0.3K/(2K)) = r(1-0.3/2) =0.85r$

$Fmsy=r/2$, let x denote the proportionality between *Fmsy* and *Flim*

$xFmsy=Flim$

$x(r/2)=0.85r$

$x=2*0.85$

$x=1.7$

MSY reference points

In 2015 ICES provided precautionary F_{MSY} ranges that are derived to deliver no more than a 5% reduction in long-term yield compared with MSY. Details of this analysis are given in WKMSYREF3 (ICES, 2015) and the advice given is repeated below.

	MSY F_{LOWER} B)	F_{MSY} B)	MSY F_{UPPER} B) WITH AR	MSY $B_{TRIGGER}$
Megrim in Divisions 4.a and 6.a	0.39 × r d)	r/2 d)	r/2 d)	0.25 × K d)

5.3.1.6 Uncertainties and bias in assessment and forecast

The age-aggregated biomass dynamic model provides estimates of total fishing mortality. Biomass estimates are influenced by one of surveys (IAMISS/SAMISS 6.a) although the trends in biomass are consistent with the other surveys used in the assessment and used as trend indicators.

The quality of the available landings data (unknown area misreporting), discard information, lack of effort data and cpue data for the main fleet in the fishery, and disaggregated landings-at-age data at an appropriate area level severely hamper the ability of ICES to carry out an assessment for this stock.

5.3.1.7 Recommendation for next Benchmark

This stock was recently subject to an inter-benchmark (IBP-MEG, 2012). Due to incomplete age data, particularly for 4.a, a Bayesian state–space surplus production model has been used. Further work is proposed to investigate the utility of new survey data as an estimate of recruitment.

Recommendations

- Merging of monk survey data: the monk survey data are inputted as two separate surveys in the model at present.
- Introduction of Sco 6.a Q1/Q4 WIBTS 2011+: the Sco 6.a Q1/Q4 WIBTS survey time-series seems to fit the model quite well so we intend to do a run to introduce these data.
- Introduction of IGFS data time-series.
- Add code to introduce Sco 6.a Q1/Q4 WIBTS 2011+ as separate survey.
- Explore splitting out lengths <L50 of monk survey gear or L50mat – intend to do a run where the indices are based on a length cut-off so that it is representative of the exploited biomass.
- Explore length data as basis of recruitment index.

Data explorations will be carried out in advance of WGCSE 2017 and the requirement for a new benchmark will be considered at that point.

5.3.1.8 Management considerations

The TAC in 6 has not been fully utilised. However, the uptake rate is country specific, with some Member States reporting landings above their quota in the North Sea. Partial quota uptake by individual Member States may be linked to reduction in effort rather than reflective of a reduction in biomass. The TAC and assessment area are incompatible. There are two separate TAC areas covering ICES Areas 6 and 4 whereas the assessment covers ICES Divisions 6.a and 4.a combined. Due consideration of the inconsistency between management and assessment area is required when setting fishing opportunities for this stock and the separate 6.b Rockall stock. ICES (2013) have advised the EC that the TAC areas should be consistent with the assessment area and that ICES has no basis on how to split the catch advice so that it is consistent with the TAC areas.

5.3.1.9 References

ICES. 2015. Report of the Joint ICES-MYFISH Workshop to consider the basis for F_{MSY} ranges for all stocks (WKMSYREF3), 17–21 November 2014, Charlottenlund, Denmark.

ICES CM 2014/ACOM:64. 156 pp. ICES. 2012. Report of the Inter-benchmark Protocol for Megrim in Subarea IV and Division IVa (IBPMeg), 2–6 April 2012. By correspondence. ICES CM 2012/ACOM:67. 23 pp.

ICES. 2011. Report of the Benchmark Workshop on Flatfish (WKFLAT), 1–8 February 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:39. 257 pp.

ICES. 2011. Report of the Working Group for Celtic Seas Ecoregion (WGCSE), 11–19 May 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:12. 1573 pp.

Kunzlik, P. A., A. W. Newton and A. W. Jermyn. 1995. Exploitation of monks (*Lophius* spp.) and megrims (*Lepidorhombus* spp.) by Scottish fishermen in ICES Division VIa (west of Scotland). Final report EU FAR contract MA-2-520.

Laurenson, C. and MacDonald, P. 2008. Collection of fisheries and biological data on megrim in ICES Subarea IVa. Scottish Industry Science Partnership Report No 05/08.

Meyer and Millar. 1999. BUGS in Bayesian stock assessments. Canadian Journal of Fisheries and Aquatic Sciences; Jun 1999; 56, 6; Canadian Periodicals pg. 1078.

Reid, D.G., Allen, V.J., Bova, D.J., Jones, E.G., Kynoch, R.J., Peach, K.J., Fernandes, P.G. and Turrell, W.R. 2007. Angler fish catchability for swept area abundance estimates in a new survey trawl. ICES J. Mar. Sci. 64.

Stefánsson, G. 1996. Analysis of groundfish survey abundance data: combining the GLM and delta approaches. *ICES Journal of Marine Science*, 53, 577–588.

5.3.2 Megrim in 6.b

Type of assessment in 2016

Based on the recommendation of WGNSDS (2008), in addition to megrim in 6, WGCSE now also considers megrim in 4.a and 2.a. Spatial data from both the commercial fishery (using VMS and catches by statistical rectangle) and from fishery-independent surveys provide little evidence to support the view that megrim in 6.a and 4.a are indeed separate stocks. Based on the recommendations from WKFLAT (2011) Megrim in 6.b is considered a separate stock unit for assessment purposes.

The stock was benchmarked in 2011 (WKFLAT, 2011) and an exploration of landings numbers-at-age for 6.a only was undertaken. However, due to lack of specific ageing data from 6.b, precludes the development of an age-based assessment.

The current assessment is based on survey trends in relative biomass from the ISP-Anglerfish survey conducted annually in 6.a, 4.a and 6.b.

ICES advice applicable to 2015

ICES advises on the basis of precautionary considerations that there should be no increase in catch.

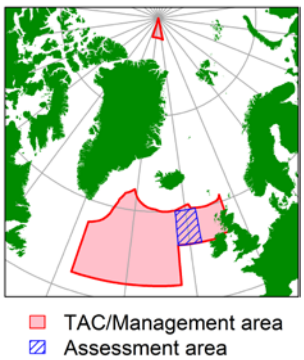
ICES advice applicable to 2016

Based on ICES approach to data-limited stocks, ICES advises that landings and catches should be no more than 343 t and 380 t respectively in 2016.

5.3.2.1 General

Stock description and management units

Megrim stock structure is uncertain and historically the Working Group has considered megrim populations in 6.a and 6.b as separate stocks. The review group questioned the basis for this in 2004. Data collected during an EC study contract (98/096) on the 'Distribution and biology of anglerfish and megrim in the waters to the West of Scotland' showed significantly different growth parameters and significant population structure difference between megrim sampled in 6.a and 6.b (Anon, 2001). Spawning fish occur in both areas but whether these populations are reproductively isolated is not clear. WKFLAT (2011) concluded that megrim in 6.b should continue to be considered as a separate stock until further information is available.



Management area (red box) and assessment area (blue hatched area).

The recent TACs are presented above in Section 5.3.1.1.

Fishery in 2015

Scottish effort has declined in 6.b since 2003 (see Figure 4.2.3) and is close to the lowest levels observed in 2015. Irish effort has increased in 2015 (see Figure 4.2.2). Based on landings data presented to the Working Group, only 28% of the overall TAC for 6, EC waters of 5.b and international waters of 12 and 14 was taken.

2016 TAC for 6, EC waters of 5.b and International waters of 12 and 14.

	TAC	WG LANDINGS1	% UPTAKE
Spain	592	140	24%
France	2312	140	6%
Ireland	675	311	46%
UK	1635	520	32%
EU	5214		
TAC	5214	1477	28%

5.3.2.2 Data

As part of the 2011 benchmark, landings-at-age data were compiled from 1990 to 2010. However, there are very sparse age data available from 6.b and prior to 2002 a common Subarea 6 ALK was applied to megrim from 6.a and 6.b. Commencing in 2012, area specific age data will be gathered during the anglerfish survey.

Landings

Official landings data for each country together with Working Group best estimates of landings from 6.b are shown in Table 5.3.1.8. The WG best estimates of landings are the same as the official statistics.

Catches of megrim comprise two species, *Lepidorhombus whiffiagonis* and *L. boscii*. Information available to the Working Group indicates that *L. boscii*, are a negligible proportion of the Scottish and Irish megrim catch (Kunzlik *et al*., 1995; Anon, 2001). It is not clear to the WG whether landings of other countries are accurately partitioned by megrim species. Megrim are caught in association with anglerfish by some fleets and are area-misreported along with anglerfish. However, it is unknown whether misreporting from Division 6.b is an issue.

Discards

Discard data were available from Ireland and Scotland in 2015 in InterCatch. Discard data for 2014 were available for Ireland in Intercatch but the estimate for Scotland based on discard rates in Area 6 were as reported to STECF and landings of 95 t. Total discard estimates were available from 2005–2013. To estimate catches prior to 2005, for the SPiCT analysis, a catch over landing ratio of 1.2 was used (derived from that observed ratio between 2005–2010).

Surveys

In 2005, Scotland initiated a new industry–science partnership survey to provide an absolute abundance estimate for anglerfish. Eleven years of survey data are available and these cover the main distribution of the anglerfish fishery. The survey is also considered to have greater spatial coverage for megrim and as such is recommended by WKAGME (2008) as the main source of data of megrim relative biomass for all megrim stocks in the Northern Shelf.

The survey index for 6.b is presented in Table 5.3.1.9. There is an increasing trend in both abundance and biomass in 6.b since 2005 (Figure 5.3.1.11.). The dip in 2011 appears to be a year effect. The area stratified survey provides a minimum estimate of absolute biomass as the survey catches are raised based on swept area raised and weighted by area. The survey assumes that all megrim in the trawl path are retained e.g. q=1. Assuming full retention is overly optimistic therefore providing a minimum estimate of stock biomass. However, the biomass dynamic model used for 6.a/4.a megrim assessment provides megrim catchability estimates for SAIMISS-Q2/IAMISS-Q2 6.a and 4.a surveys. These are estimated to be in the region of 0.2–0.3. Using the upper q estimate of 0.3 in combination to scale the survey biomass estimate to provide an absolute biomass estimate, and catch estimate have been used to provide a broad estimate of the relative harvest ratio of megrim in 6.b (Table 5.3.1.9). This shows that the harvest ratio for megrim to be in the range 2 to 25% over the time-series and this has been very low in recent years typically less than 6%.

5.3.2.3 Historical stock development

No analytical assessment has been agreed for this stock since 1999.

State of the stock

The state of the stock is unknown.

5.3.2.4 Short-term projections

There is no accepted analytical assessment for this stock.

5.3.2.5 Biological & MSY reference points

Precautionary approach reference points

No precautionary reference points have been defined for this stock.

MSY evaluations

Proxy reference points (F_{MSY} and $B_{trigger}$) were explored for the stock at WKProxy (ICES, 2016). A biomass dynamic model (SPiCT-Stochastic Production model in Continuous Time) was used to explore these reference points. This analysis was updated by WGCSE 2016 using an updated catch time-series and the biomass index series. The results are available at www.stockassessment.org run title is meg_rock_2016. The summary plots are shown in Figure 5.3.1.12. The stochastic reference point estimates are shown below. These are significantly different from the results obtained by WKProxy because a significantly longer time-series of catch has been used.

Reference point	Estimate	CIlow	CIupp	est.in.log
B_{MSYS}	2542	1195	5408	7.8
F_{MSYS}	0.30	0.13	0.72	-1.2
MSYs	759	486	1186	6.6

The general conclusion of WKProxy is still valid that the stock is currently exploited well below F_{MSY} proxy reference points and SSB is well above the proxy for MSY $B_{trigger}$.

Yield-per-recruit analysis

It was not possible to define $F_{0.1}$ and F_{MAX} values for this stock due to the lack of international catch-at-age data and recent changes in fleet selectivity due to likely changes in targeting behaviour and recent changes in mesh selectivity, which, if fully implemented, will result in a significant change in age selectivity of the gear.

5.3.2.6 Uncertainties and bias in assessment and forecast

There is no accepted analytical assessment for this stock.

5.3.2.7 Recommendation for next Benchmark

This stock was recently subject to benchmark. Due to lack of age data specific to megrim in 6.b, it was not possible to undertake any exploratory age-based assessments. Age data will be gathered during the surveys from 2012 onwards.

Management considerations

The TAC in 6 has not been fully utilised. However, the uptake rate is country specific, with full uptake being reported by some Member States. Partial quota by individual Member States may be an artefact of reduction in effort rather than reflective of a reduction in biomass. The TAC and assessment area are incompatible.

5.3.2.8 References

Kunzlik, P. A., A. W. Newton and A. W. Jermyn. 1995. Exploitation of monks (*Lophius* spp.) and megrims (*Lepidorhombus* spp.) by Scottish fishermen in ICES Division VIa (west of Scotland). Final report EU FAR contract MA-2-520.

Laurenson, C. and MacDonald, P. 2008. Collection of fisheries and biological data on megrim in ICES Subarea IVa. Scottish Industry Science Partnership Report No 05/08.

ICES. 2016. Report of the Workshop to consider MSY proxies for stocks in ICES cate-gory 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015, ICES Head-quarters, Copenhagen. ICES CM 2015/ACOM:61. 183 pp.

Table 5.3.1.1. Megrim in Subarea 6.a. Nominal catch (t) of Megrim West of Scotland, as officially reported to ICES and WG best estimates of landings. The shaded cells show updates in official data compared with last year.

Year	Belgium	Denmark	France	Ireland	Netherlands	Spain	UK – Eng, Wales & N.Irl.	UK – Scotland	UK	Official Total	ICES landings**
1990	0	0	398	317	0	91	25	1093	-	1924	2210
1991	1	0	455	260	0	48	167	1223	-	2154	2432
1992	0	0	504	317	0	25	392	887	-	2125	2549
1993	0	0	517	329	0	7	298	896	-	2047	2721
1994	1	0	408	304	0	1	327	866	-	1907	2693
1995	0	0	618	535	0	24	322	952	-	2451	3498
1996	0	0	462	460	0	22	156	944	-	2044	4054
1997	0	0	192	438	1	87	123	954	-	1795	3272
1998	0	0	172	433	0	111	65	841	-	1622	2705
1999	0	0	0	438	0	83	42	831	-	1394	2648
2000	0	0	135	417	0	98	20	754	-	1424	2247
2001	0	0	252	509	0	92	7	770	-	1630	2473
2002	0	0	79	280	0	89	14	643	-	1105	1828
2003	0	0	92	344	0	98	13	558	-	1105	1642
2004	0	0	50	278	0	45	17	469	-	859	1328
2005	0	0	48	156	0	69	10	269	-	552	561
2006	0	0	53	221	0	52	-	-	346	672	875
2007	0	0	104	191	0	5	-	-	667	967	1301
2008	0	0	92	172	0	149	-	-	874	1287	1545
2009	0	0	174	188	0	112	-	-	953	1427	1387
2010	0	0	271	318	0	288	-	-	822	1699	1698
2011	0	0	153	227	0	217	-	-	715	1312	1297
2012	0	0	140	214	0	142	-	-	590	1086	1132
2013	0	0	105	203	0	213	-	-	470	991	949
2014	0	0	126	246	0	57	-	-	465	894	948
2015*	0	0	140	311		140	-	-	520	1110	1110

*** Preliminary.**

**** Historical landings data have been adjusted for area misreporting, mainly from Division 4.a to Division 6.a.**

Official Landings estimates were updated in shaded cells due to changes in Official Landings data.

Table 5.3.1.2. Megrim in Subarea 4 and 2.a. Nominal catch (t) of Megrim North Sea, as officially reported to ICES and WG best estimates of landings.

Country	Belgium	Denmark	France	Germany	Germany, Fed. Rep. of	Ireland	Netherlands	Norway	Spain	Sweden	UK – Eng, Wales & N.Irl.	UK – England & Wales	UK – N. Ireland	UK – Scotland	UK	Official total	ICES landings**
1990	4	2	-	-	3	-	24	-	-	-	17	-	-	1126	-	1176	837
1991	3	1	-	6	-	-	28	-	-	-	9	-	-	1169	-	1216	878
1992	2	4	36	3	-	-	27	-	-	-	47	-	-	1372	-	1491	1025
1993	7	6	25	4	-	-	30	-	-	-	8	-	-	1736	-	1816	1081
1994	2	1	27	1	-	-	28	-	-	-	19	-	-	2000	-	2078	1207
1995	7	2	24	2	-	-	26	-	-	-	44	-	-	2193	-	2298	1172
1996	5	7	14	1	-	-	9	-	-	-	4	-	-	3221	-	3261	1199
1997	3	5	16	2	-	-	20	-	-	-	3	-	-	3091	-	3140	1584
1998	5	18	14	4	-	-	30	-	-	-	5	-	-	2628	-	2704	1548
1999	4	21	.	1	-	-	26	-	-	-	4	-	-	2121	-	2177	1111
2000	10	29	7	3	-	-	20	-	-	-	2	-	-	2044	-	2115	1247
2001	2	52	5	1	-	-	11	-	-	-	2	-	-	1854	-	1927	1098
2002	5	8	6	-	-	-	9	-	-	-	3	-	-	1675	-	1706	975
2003	3	11	11	2	-	1	7	<0.5	-	-	1	-	-	1235	-	1271	727
2004	-	7	9	2	-	-	11	<0.5	-	-	1	-	-	1130	-	1160	739
2005	-	1	3	4	-	-	19	<0.5	-	-	1	-	-	958	-	986	n/a
2006	2	6	4	7	-	-	22	1	-	-	9	-	-	1340	1349	1391	1179
2007	6	11	19	16	-	.	20	1	-	-	17	-	-	1436	1458	1525	1047
2008	3	31	21	5	-		3	4	-	-	-	6	-	1526	1532	1599	1349
2009	2	54	11	4	-		1	6	-	-	-	-	-	-	1477	1484	1484
2010	6	24	3	3	-		8	2	-	-	-	-	-	-	1442	1499	1499
2011	2	25	10	5	-	-	17	1	-	-	-	-	-	-	1398	1421	1421
2012	0	35	6	4	-	-	16	1	-	-	-	-	-	-	1399	1458	1458
2013	0	49	8	4			18	17							1692	1788	1788
2014	10	36	8	2			9	12							1480	1551	1551
2015*		26	8	1			1	8							1177	1221	2331

*** Preliminary.**

**** Historical landings data have been adjusted for area misreporting, mainly from Division 4.a to Division 6.a.**

Official Landings estimates were updated in shaded cells due to changes in Official Landings data.

Table 5.3.1.4. Time-series of survey indices and catches of megrim in ICES Area 6.a and Division 4 as used in the 2016 surplus production model.

Year	ScoGFS WIBTS-Q1	ScoGFS WIBTS-Q4	Sco-IBTS-Q1	Sco-IBTS-Q3	SAMISS-Q2/ IAMISS-Q2	SAMISS-Q2	VIa & IVa Catch
1985	3.00	NA	NA	NA	NA	NA	6427
1986	2.01	NA	1.27	NA	NA	NA	4051
1987	1.39	NA	1.33	NA	NA	NA	6488
1988	2.12	NA	1.67	NA	NA	NA	7273
1989	1.25	NA	1.35	NA	NA	NA	4778
1990	1.17	1.87	0.70	NA	NA	NA	4187
1991	0.85	1.41	0.50	0.34	NA	NA	4514
1992	0.94	2.07	0.67	0.33	NA	NA	4837
1993	0.97	2.51	1.12	0.32	NA	NA	5107
1994	1.77	4.00	0.25	0.40	NA	NA	5200
1995	1.70	2.01	0.00	0.40	NA	NA	6181
1996	2.06	2.30	0.51	0.64	NA	NA	6902
1997	1.24	1.23	0.43	0.45	NA	NA	6334
1998	1.18	2.11	0.79	0.25	NA	NA	5507
1999	1.49	2.39	1.00	0.25	NA	NA	4833
2000	1.70	2.31	1.04	0.32	NA	NA	4460
2001	1.62	1.74	0.36	0.09	NA	NA	4527
2002	1.25	2.07	1.46	0.52	NA	NA	3528
2003	1.33	1.36	0.50	0.35	NA	NA	2961
2004	1.39	1.22	0.27	0.50	NA	NA	2566
2005	0.75	1.18	0.60	0.90	1660.38	4753.22	1883
2006	1.10	1.35	0.81	1.06	2688.94	3345.00	2515
2007	1.01	1.41	0.89	1.46	3380.35	6347.54	2856
2008	1.36	1.07	1.57	1.27	2467.08	7754.14	3496
2009	1.85	1.62	1.92	1.12	3830.67	5946.95	3445
2010	1.36	NA	1.73	1.76	3312.13	5394.95	3811
2011	NA	NA	1.87	1.66	2501.99	4683.59	3857
2012	NA	NA	2.53	1.56	3450.81	4839.47	3186
2013	NA	NA	2.66	1.49	6174.86	6460.01	3064
2014	NA	NA	2.17	1.28	3033.07	11970.30	2809
2015	NA	NA	3.03	1.39	2563.10	4986.90	2623

Table 5.3.1.5. ***Lepidorhombus whiffiagonis*** **in ICES Areas 6.a and 4.a. Prior distributions on parameters.**

Parameter	Symbol	Prior distribution	Notes
Intrinsic rate of population growth	r	$\mathrm{Uniform}(0.001, 2.0)$	
Carrying capacity	K	$\mathrm{Uniform}\left(\ln\left(\max(C)\right), \ln\left(10 \times \sum_{t=1985}^{2010} C_t\right)\right)$	From the maximum catch to ten times the cumulative catch across all years assuming uniform distribution on the logarithmic scale
Catchabilities	$\log(q_j)$	$\mathrm{Uniform}(-11.0, 0.0)$	Uniformly distributed on log-scale. See catchability sensitivity in Section 2.2.3.1
Process error variance	$\frac{1}{\sigma_u^2}$	$\mathrm{Gamma}(\mathrm{shape} = 0.001, \mathrm{rate} = 0.001)$	Gamma distributed on inverse variance (precision) scale
Measurement error variances	$\frac{1}{\sigma_{\varepsilon,j}^2}$	$\mathrm{Gamma}(\mathrm{shape} = 0.001, \mathrm{rate} = 0.001)$	Gamma distributed on inverse variance (precision) scale
Proportion of *K* in 1985	a	$\mathrm{Uniform}(0.01, 2.0)$	

Table 5.3.1.6. Comparison of the 2014 and 2015 assessment outputs of MSY, F_{MSY}, B_{MSY}, Biomass, Fishing mortality, with reference points of $B_{trigger}$ (50% B_{MSY}) and B_{lim} (30% B_{MSY}).

Parameter	Estimates 2013 Final run	Estimates 2014 Final run	Estimates 2015 Final run	Estimates 2016 Final run
r.hat	0.67	0.55	0.51	0.51
K.hat	39 346	43 134	47 216	46 840
MSY	6037	5660	5612	5362
F_{MSY}	0.33	0.28	0.26	0.26
B_{MSY}	19 673	21 567	23 608	23 420
B	3624	4109	42 416	42 356
F	0.09	0.08	0.07	0.07
B_{lim}	5902	6470	7082	7026
B_{trig}	9837	10783	11 804	11 710

Table 5.3.1.7. Time-series of biomass and fishing mortality estimates and ratios of B/B_{MSY} and F/F_{MSY}.

YEAR	B/BMSY	F/FMSY	BIOMASS	MEAN F
1985	2.54	0.59	56320	0.14
1986	1.72	0.49	38750	0.12
1987	1.53	0.90	34145	0.22
1988	1.56	1.02	34778	0.25
1989	1.20	0.81	27012	0.20
1990	1.08	0.78	24112	0.19
1991	0.95	0.95	21256	0.23
1992	1.03	0.96	22885	0.23
1993	1.13	0.92	25277	0.22
1994	1.36	0.80	30313	0.19
1995	1.39	0.95	30816	0.23
1996	1.38	1.09	30640	0.26
1997	1.11	1.20	24802	0.29
1998	1.12	1.02	25069	0.25
1999	1.23	0.82	27310	0.20
2000	1.27	0.73	28296	0.18
2001	1.16	0.80	25932	0.19
2002	1.12	0.63	25049	0.15
2003	1.03	0.56	23032	0.14
2004	0.97	0.51	21551	0.12
2005	0.88	0.40	19601	0.10
2006	1.01	0.48	22558	0.11
2007	1.15	0.48	25657	0.12
2008	1.24	0.56	27743	0.14
2009	1.44	0.48	31969	0.12
2010	1.40	0.55	31202	0.13
2011	1.42	0.45	31664	0.11
2012	1.61	0.38	35807	0.09
2013	1.92	0.33	42798	0.08
2014	1.87	0.31	42020	0.08
2015	1.01	0.31	42416	0.07

Table 5.3.1.8. Megrim in Subarea 6.b. Nominal catch (t) of Megrim Rockall, as officially reported to ICES and WG best estimates of landings.

Year	Belgium	France	Ireland	Spain	UK – Eng+Wales+N.Irl.	UK – England & Wales	UK – Scotland	UK	Official total	ICES landings	ICES Discards
1991			240	587	14		204		1045	1045	
1992			139	683	53		198		1073	1073	
1993			128	594	56		147		925	925	
1994			176	574	38		258		1046	1046	
1995			117	520	27		152		816	816	
1996			124	515	92		112		843	843	
1997			141	628	76		164		1009	1009	
1998			218	549	116		208		1091	1091	
1999			127	404	57		278		866	866	
2000		4	167	427	57		309		964	964	
2001		< 0.5	176	370	42		236		824	824	
2002		< 0.5	87	120	41		207		455	455	
2003			83	93	74		382		632	632	
2004			43	71	42		372		528	528	
2005			68	88	19		207		382	382	87
2006			95	59	9		181		344	344	75
2007			87	19					106	106	22
2008			68	84		1	141		294	294	59
2009			48	0			178		226	226	44
2010			47	0				92	139	139	26
2011			72	17				66	155	155	7
2012			120	15				89	224	224	21
2013			181	39				58	278	278	15
2014			230	18				95	343	343	15
2015			256	67				130	453	453	85

Table 5.3.1.9. Estimates of 6.b (Rockall) megrim biomass and harvest ratio from SAMISS surveys.

Year	Survey Biomass	Survey q	Raised Biomass	Landings	Discards	Catch	Harvest Ratio
2005	566	0.3	1886	382	87	469	0.25
2006	929	0.3	3098	344	75	419	0.14
2007	1267	0.3	4224	106	22	128	0.03
2008	1728	0.3	5759	294	59	353	0.06
2009	1605	0.3	5349	226	44	270	0.05
2010	1991	0.3	6636	139	26	165	0.02
2011	885	0.3	2949	155	7	162	0.05
2012	4320	0.3	14401	224	21	245	0.02
2013	3030	0.3	10101	278	15	293	0.03
2014	3318	0.3	11060	343	15	358	0.03
2015	3262	0.3	10872	453	85	538	0.05
2016	4507	0.3	15024				

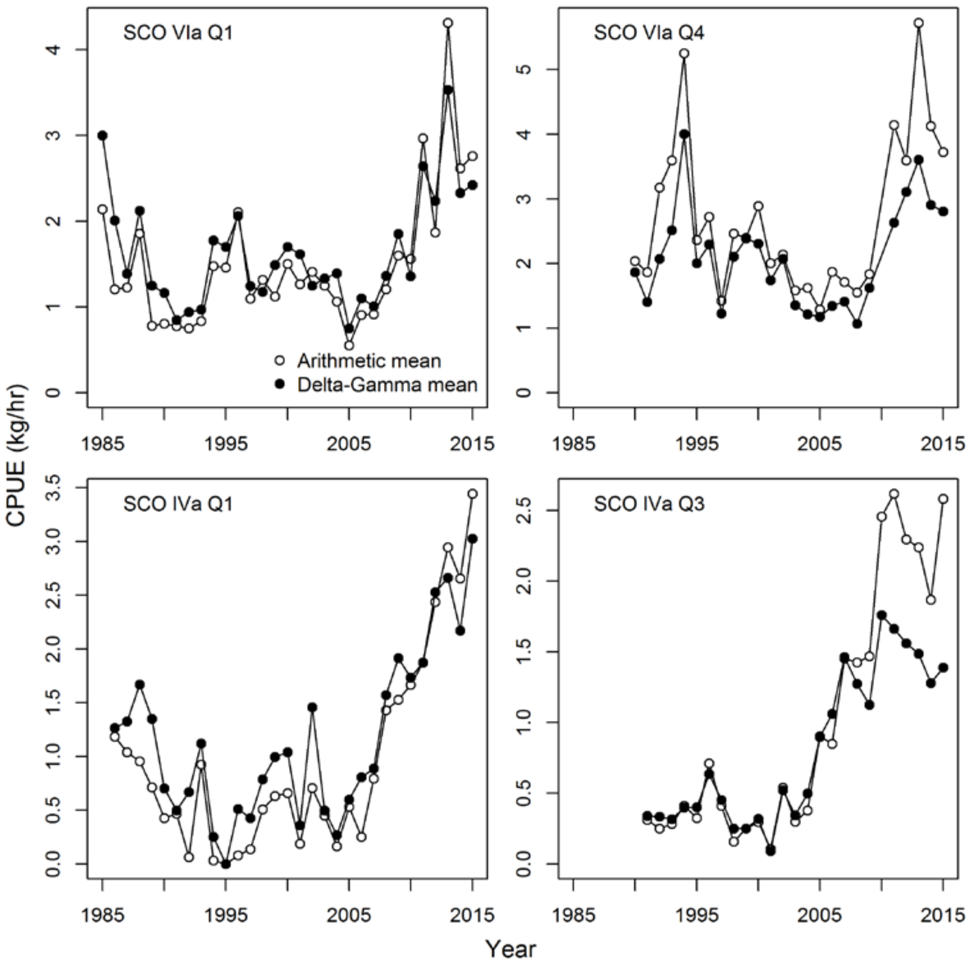


Figure 5.3.1.1. Comparison of revised survey indices.

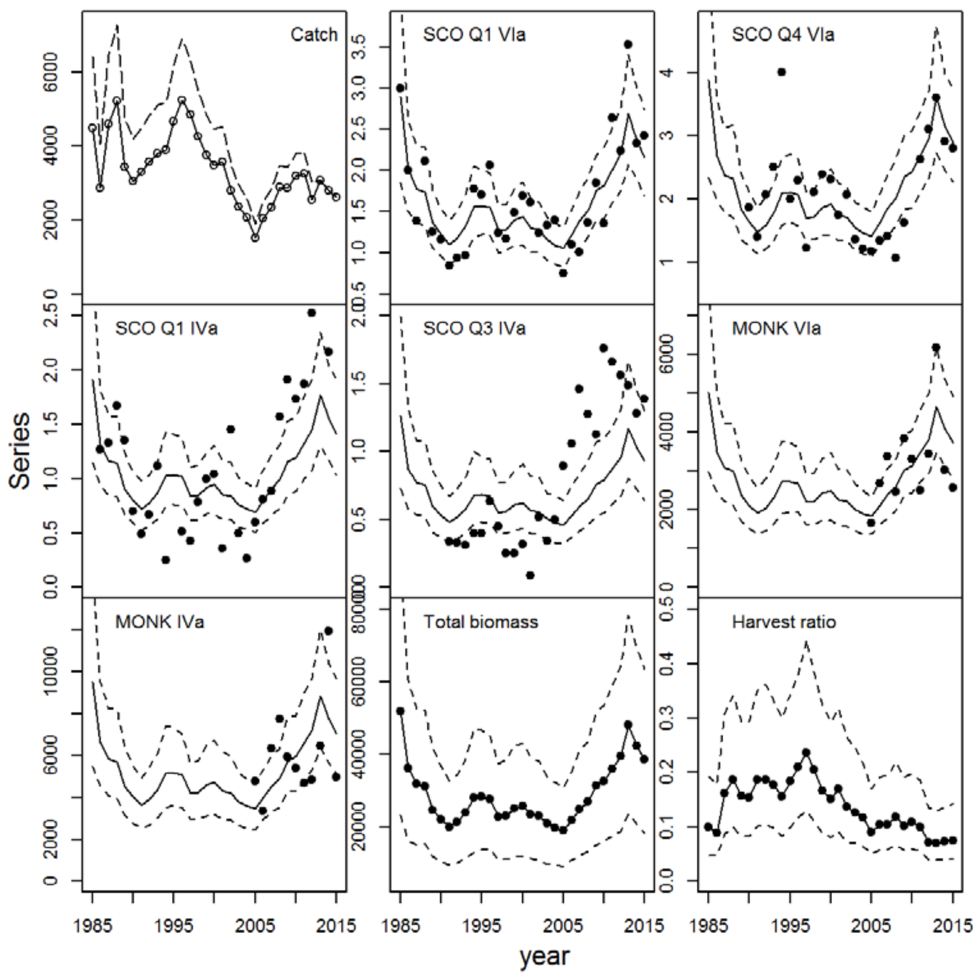


Figure 5.3.1.2. Trends in landings of 6.a and 4.a (solid line) with catch estimate (dashed line) assuming a linear decline in discards from 30 to 15% over the time-series, estimated trends in total biomass and exploitation rate. Trends in annual cpue from the NS-IBTS, W-IBTS and IRE-IV.VI.-AMISS-Q2 and SCO-IV.VI.AMISS-Q2 surveys used in the surplus production model. The solid line is the modelled cpue trend across all surveys with 95% error intervals.

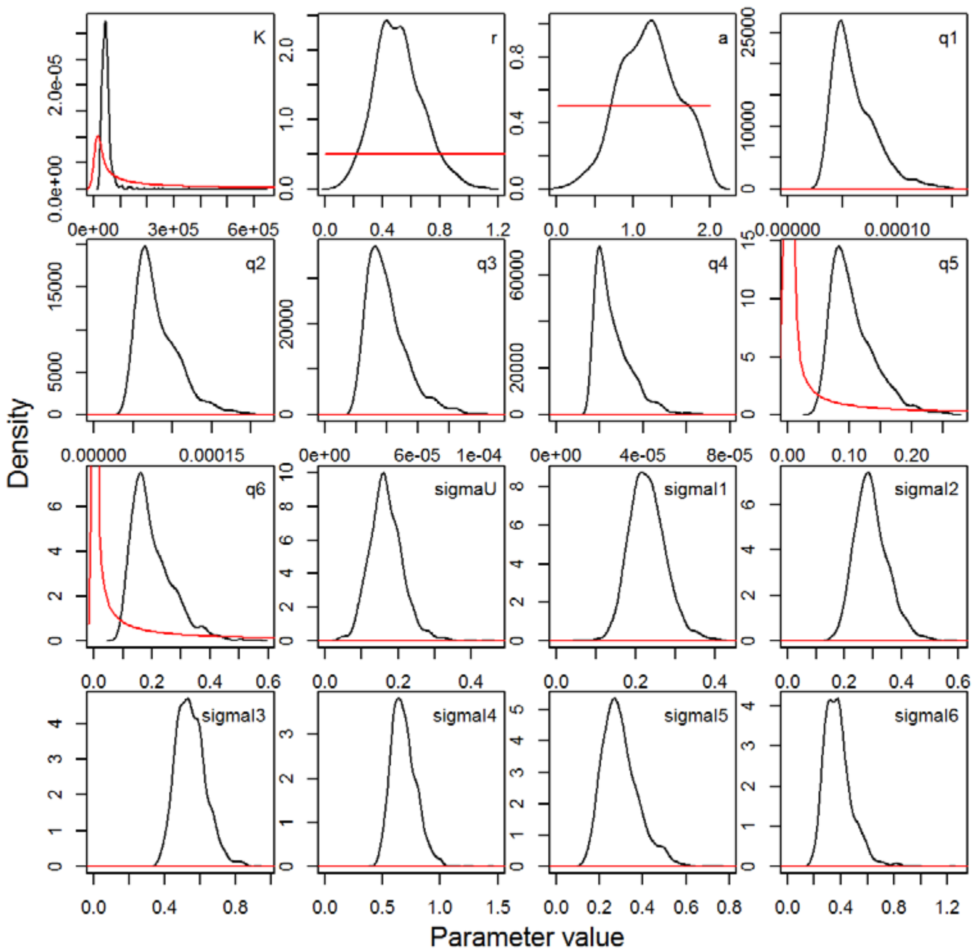


Figure 5.3.1.3. Prior and posterior distributions assumed and estimated.

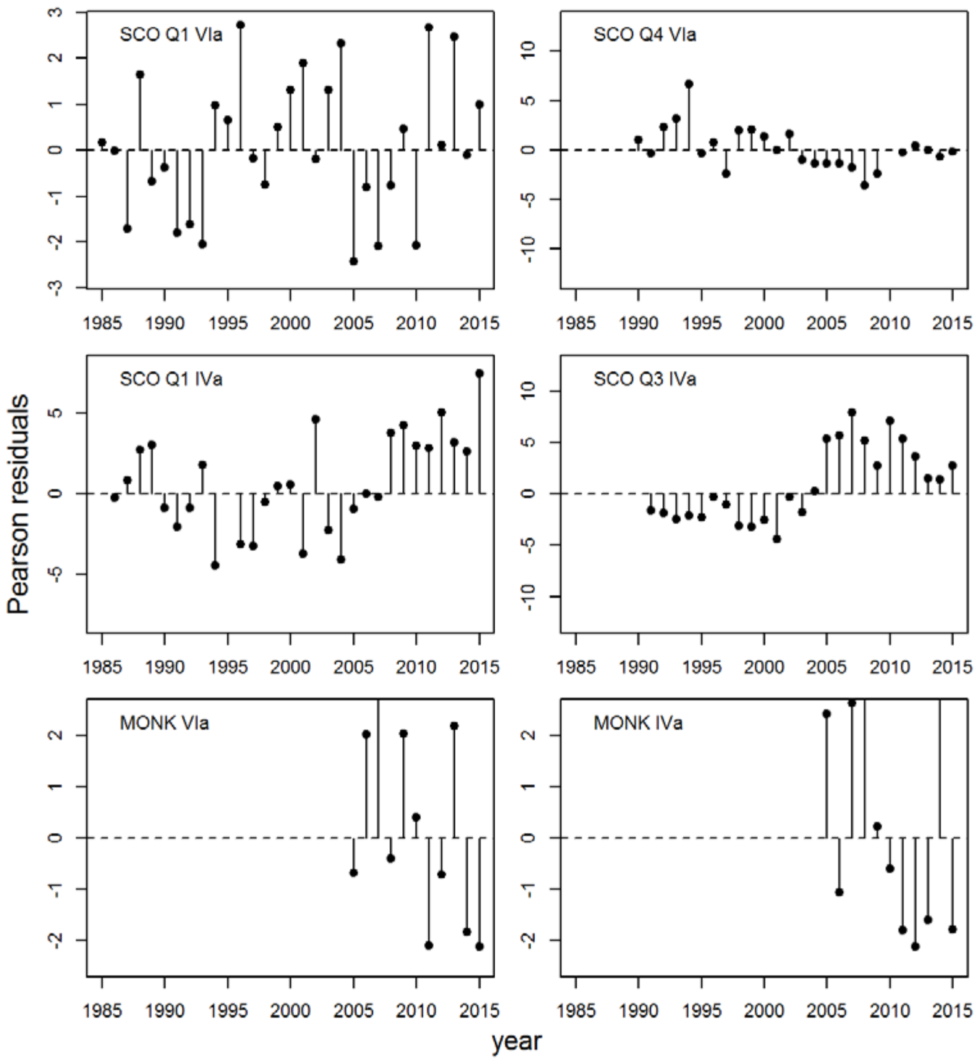


Figure 5.3.1.4. Pearson residuals for the six survey indices.

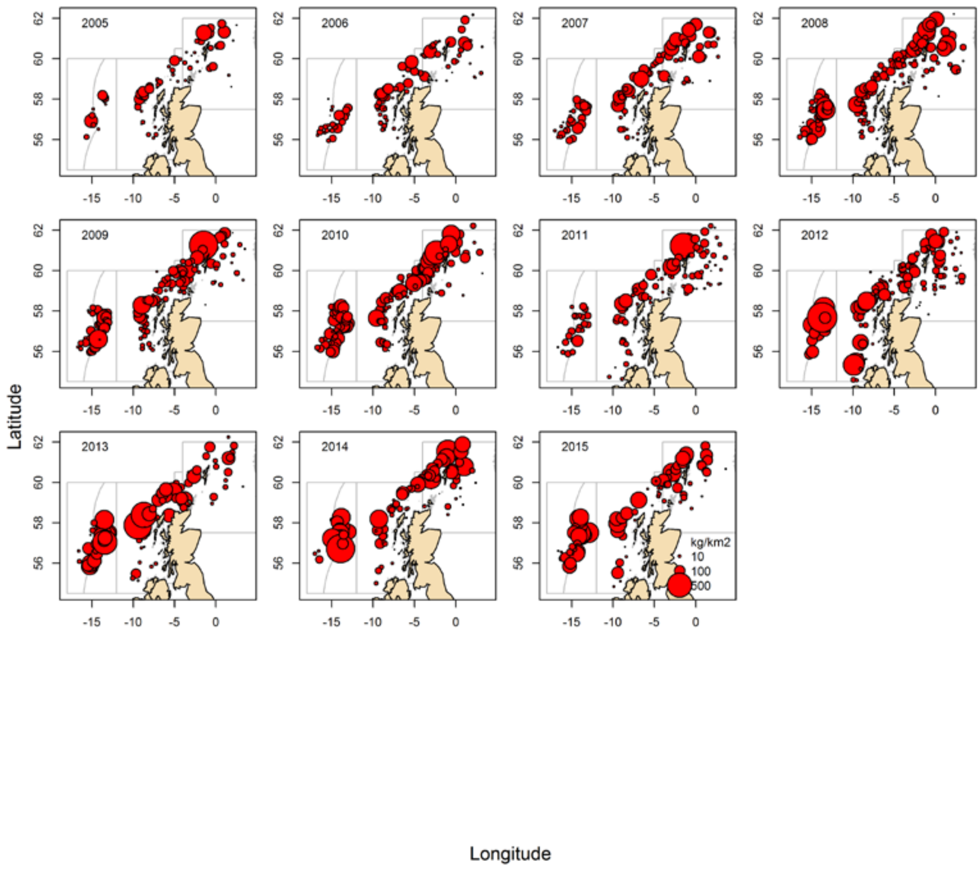


Figure 5.3.1.5. Maps of the northern continental shelf around the British Isles showing the biomass of megrim during the anglerfish surveys (SAMISS and IAMISS) 2005–2015.

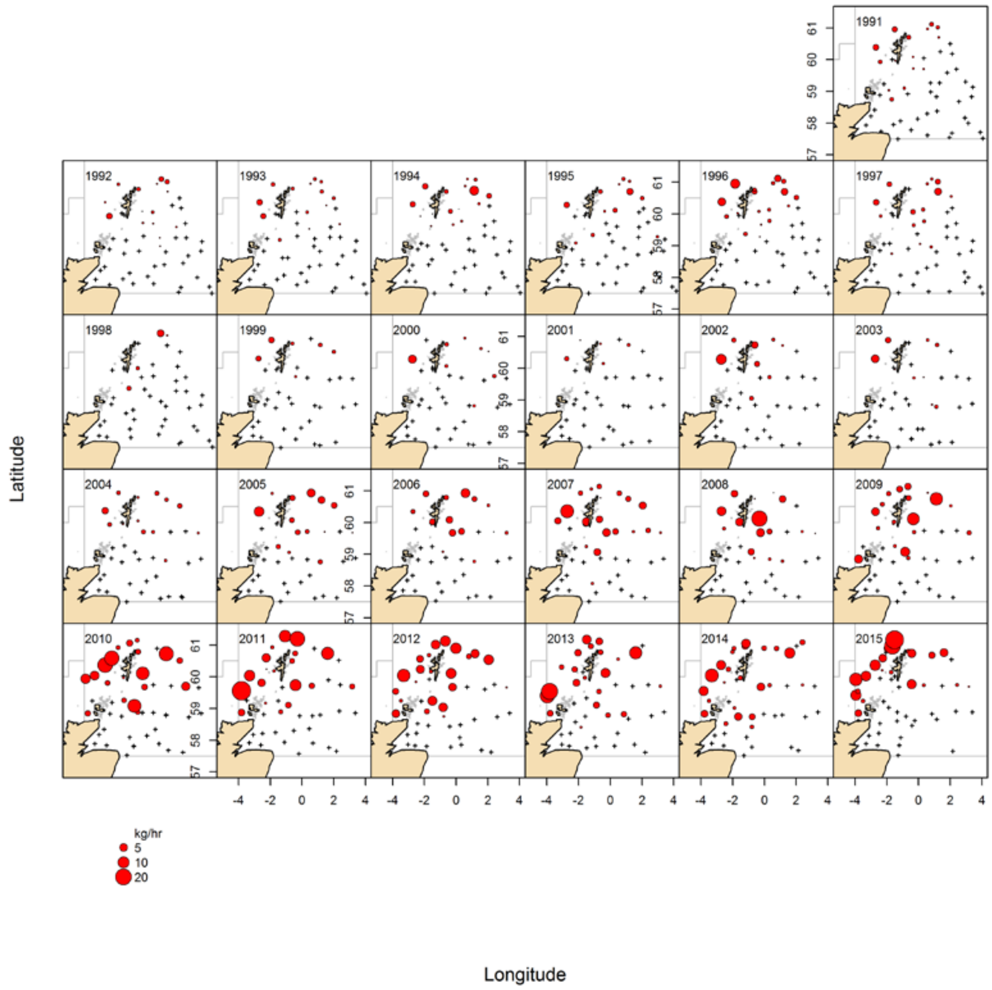


Figure 5.3.1.6. Scottish IBTS Q3 4.a megrim biomass maps.

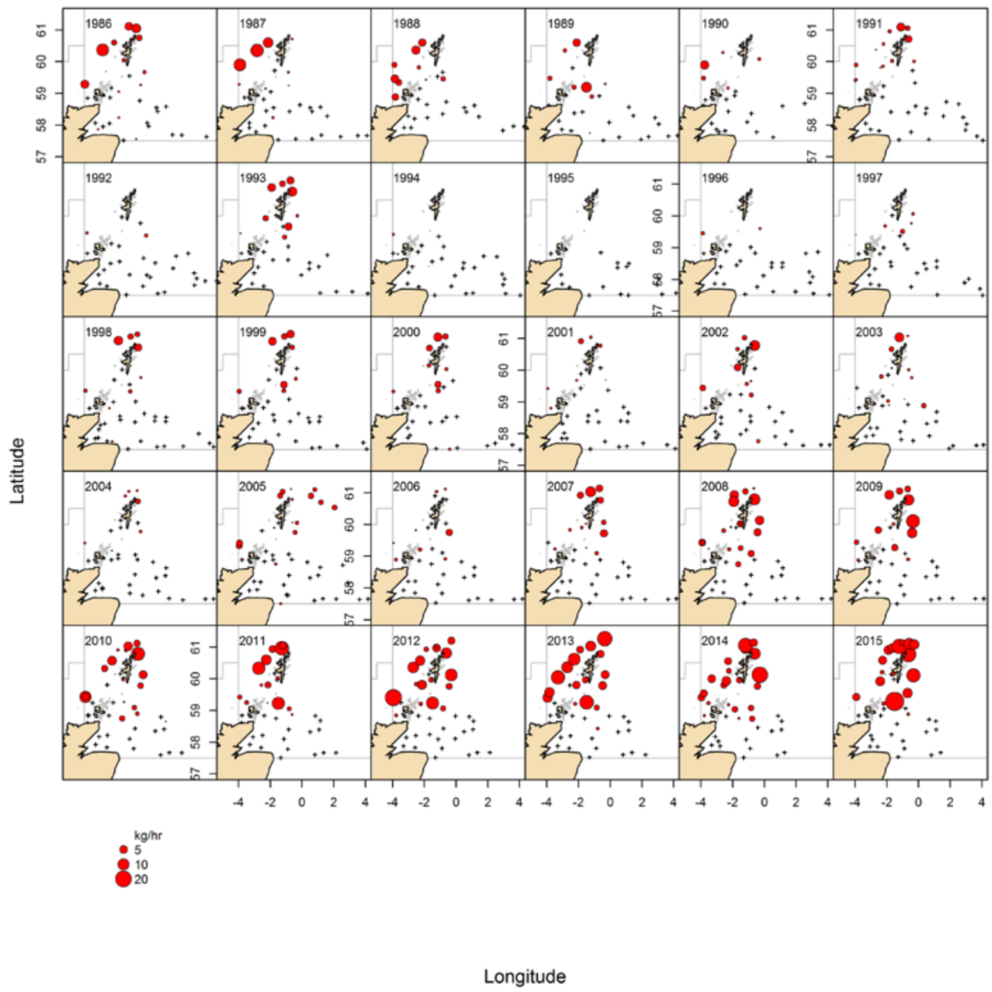


Figure 5.3.1.7. Scottish IBTS Q1 4.a megrim biomass maps.

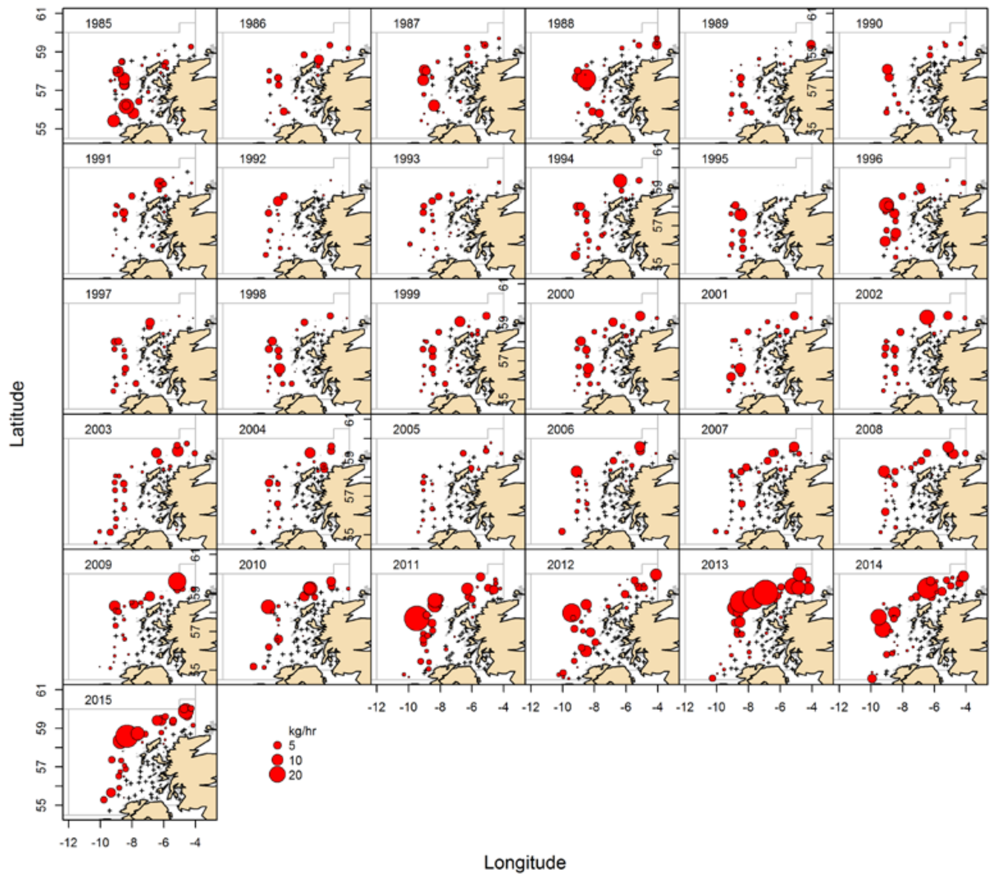


Figure 5.3.1.8. Scottish IBTS Q1 4.a megrim biomass maps.

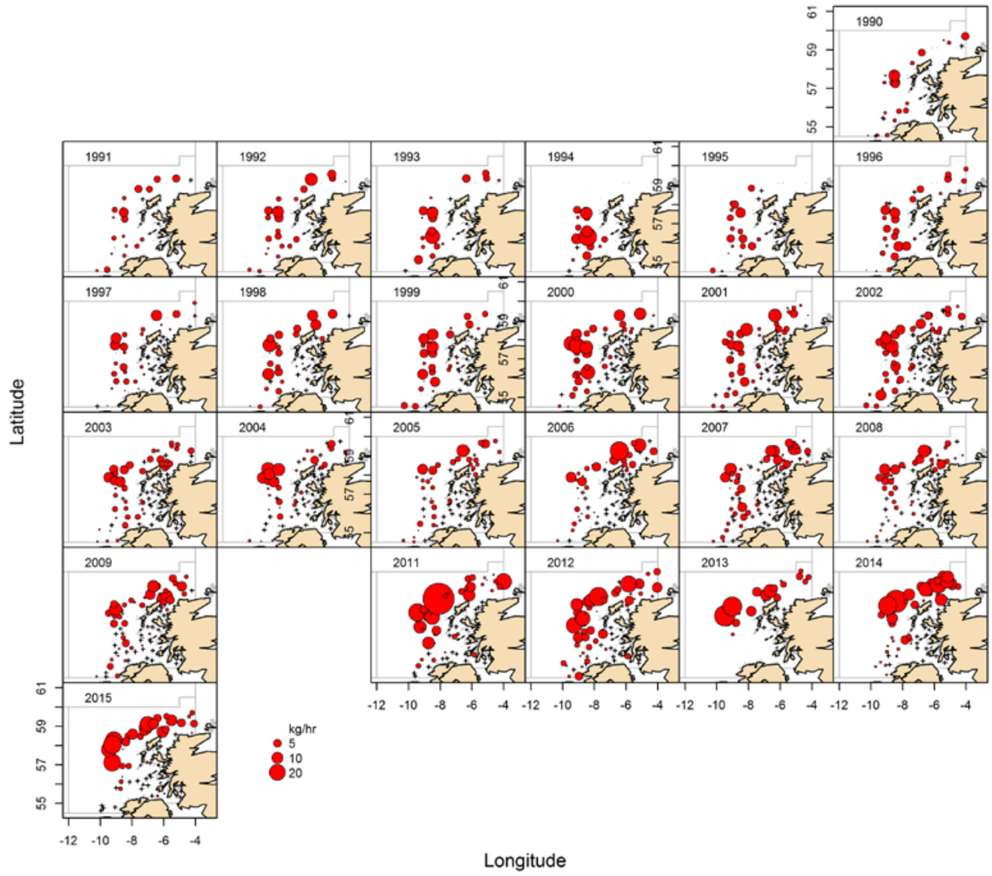


Figure 5.3.1.9. Scottish IBTS Q4 6.a megrim biomass maps.

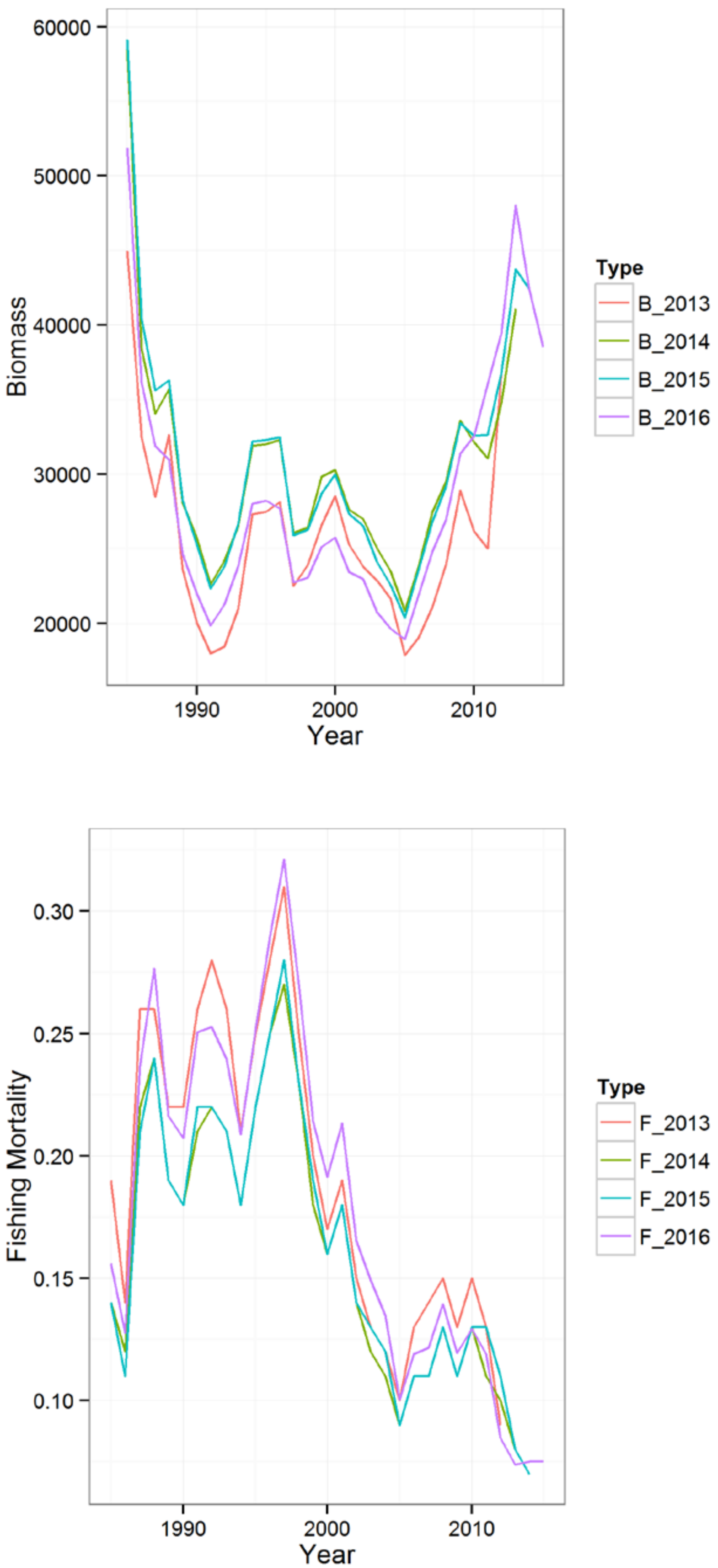


Figure 5.3.1.10. Comparison of assessments 2013 to 2016.

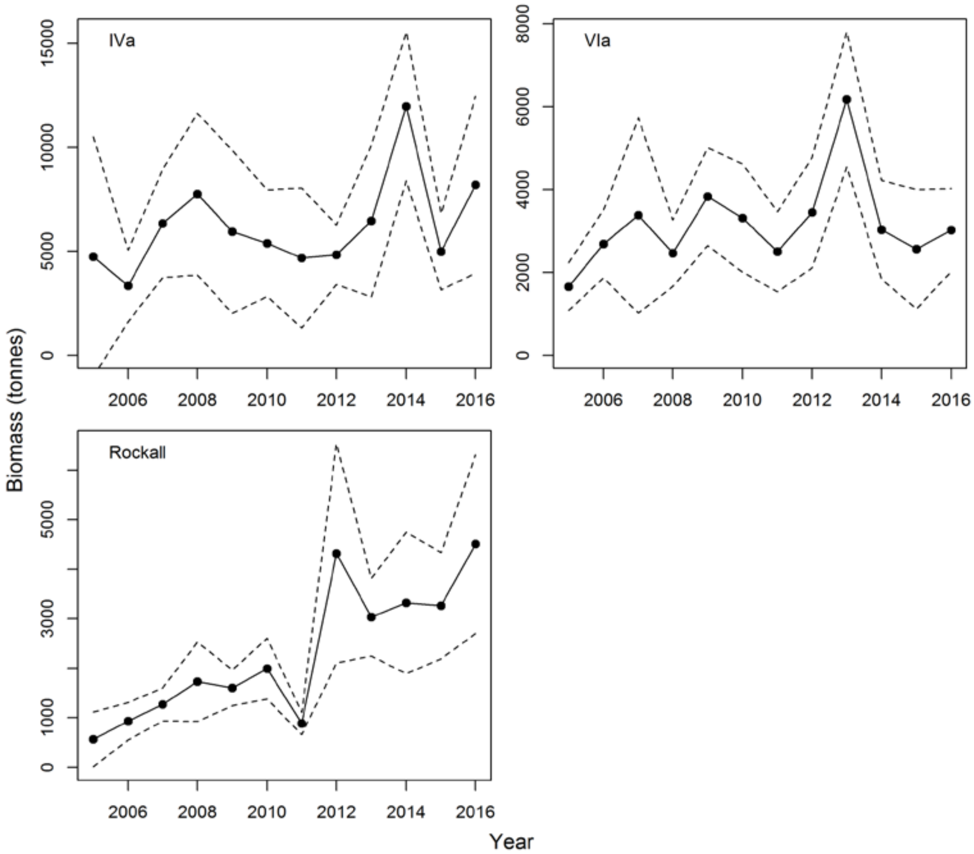


Figure 5.3.1.11. Megrim biomass estimates in ICES Division 4, 6.a and 6.b from the anglerfish (SAMISS) survey.

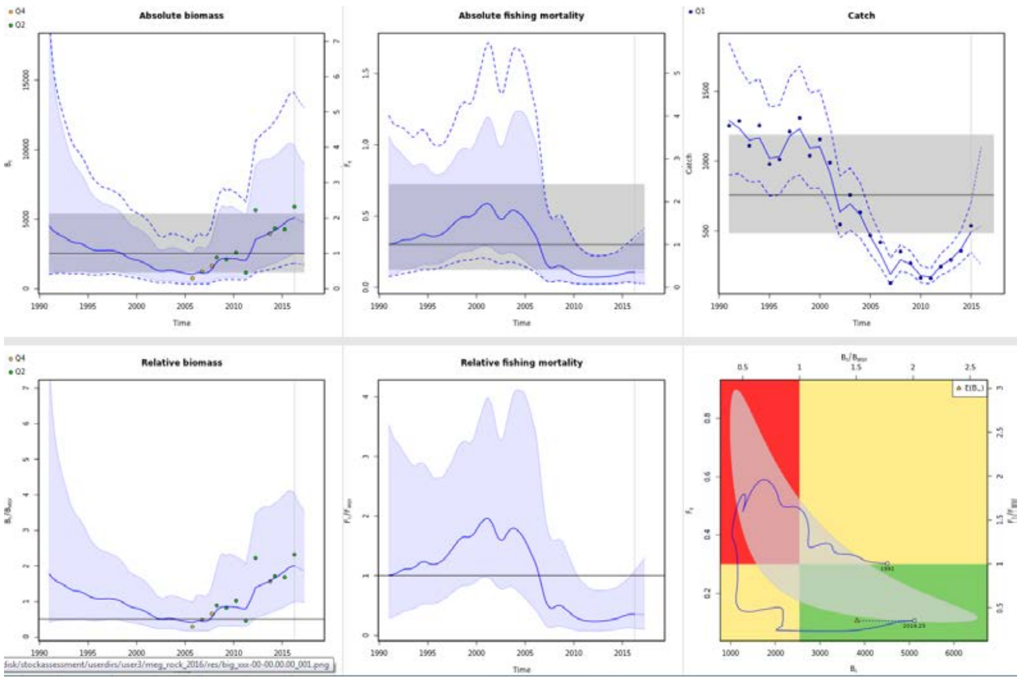


Figure 5.3.1.12. Meg-rock SPiCT model output. Top Right: observed and fitted catch with 95 ci. Bottom left: relative biomass (the timing of the survey varied throughout the time-series: the green (Q2) and yellow (Q4) dots are observations from the same survey). Bottom Centre: F relative to F_{MSY}. Corresponding MSY quantities are shown in each plot as horizontal lines ($0.5B_{MSY}$ in the case of the relative biomass plot), and in the case of the catch (top right plot), the MSY level is accompanied by a 95% confidence interval (shaded area).

5.3.3 Audit of Megrim in 4.a and 6.a

Date: 25/05/16 Auditor: Helen Holah

General

No assessment was carried out. In 2015 ICES provided multi-annual landings (wanted catch) advice for this stock based on the MSY approach that there should be no more than 7539 t in each of 2016 and 2017.

Last benchmarked at WKFLAT (ICES, 2011) and at IBPMEG (ICES, 2012).

For single stock summary sheet advice:

1. **Assessment type: update/SALY:** update of figures and tables with new 2015 landings & survey data.
2. **Assessment**: Bayesian state–space biomass dynamic model that uses commercial catches and indices of abundance from six fishery-independent surveys (SCO-IBTS-Q3, SCO-IBTS-Q1, SCO-WIBTS-Q4 (until 2010), SCO-WIBTS-Q1 (until 2010), SAMISS-Q2 and IAMISS-Q2) in the model and forecast.
3. **Forecast**: not presented, advice for 2016 and 2017 given in 2015. The short-term projections have not been updated.
4. **Assessment model**: Biomass dynamic model
5. **Data issues:** 2015 French data missing from InterCatch?
6. Consistency: n/a

7. **Stock status**: The stock has been moderately exploited with low fishing mortality, below F_{MSY} for almost the entire time-series and has a declining trend since the late 1990s. Stock biomass has been consistently above MSY $B_{trigger}$ and has steadily increased since 2005.
8. **Management Plan**: There is no management plan for this stock.

General comments

The report content is generally well written and easy to follow however both text and tables/figures are incomplete in several areas, some suggestions for improvements are given below.

Technical comments

- Should split the table of quota/uptake into 4.a and 6.a
- Paragraph of text summarizing quota incomplete missing values.
- Paragraph on discards incomplete missing values.
- Stock annex lists the model discard runs as 20% fixed rate over time-series or linear decline 30–10% and has WG estimated being used from 2011, however report section states 15% fixed rate, 30-15% decline and WG estimates from 2012 onwards; perhaps amend one.
- Paragraph on '2-15 final run' model outputs incomplete missing values.
- Tables; 5.3.1, 5.3.3, 5.3.6 all need entries for 2015, some also no 2014 entries.
- Table 5.3.11 duplicated between 5.3.7 and 5.3.8?
- Figures; 5.3.1, 5.3.2, 5.3.5, 5.3.6 all missing 2015 entries, some also 2014 entries.
- No figures numbered 5.3.11 or 5.3.12 jumps straight from 5.3.10 to 5.3.13.
- Perhaps some length frequency figures of the catch/survey data to show the high grading due to damage & TAC restriction and differences between 6.a & 4.a and 6.b.

Minor editorial and grammatical changes have been made to the report using track changes.

Conclusions

No assessment was performed.

Checklist for audit process

General aspects

- Has the EG answered those ToRs relevant to providing advice? n/a
- Is the assessment according to the stock annex description? n/a
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? n/a
- Have the data been used as specified in the stock annex? n/a
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? n/a

- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? n/a

5.3.4 Audit of Megrim in 6.b

Date: 25/05/16 Auditor: Helen Holah

General

ICES advice is issued in October following the work up of the spring survey which is not available in time for the WG. Report section summarizes last year's assessment and describes commercial data available for 2015. ICES advice in 2015 was that landings should be no more than 207 t.

Last benchmarked at WKFLAT (ICES, 2011).

For single stock summary sheet advice

1. **Assessment type: update/SALY:** update of figures and tables with new landings & survey data.
2. **Assessment**: survey trends in relative biomass; commercial landings & one survey index (SCO-IV-VI-AMISS-Q2)
3. **Forecast**: not presented, advice forecast to be given in October 2016.
4. **Assessment model**: no analytical model
5. **Data issues:** Discarding remains unknown therefore ICES cannot quantify the corresponding catch advice, only landings. The harvest rate was computed based on the available landings data and assuming a survey catchability of 0.3. There is some uncertainty surrounding this catchability value, but it is believed to be in the range of 0.2–0.3.
6. Consistency: n/a
7. **Stock status**: The state of the stock is unknown, there are no accepted precautionary reference points. Landings have been increasing since 2010, biomass throughout the survey time-series has shown an increasing trend despite two dips in 2011 and 2013. The harvest rate has fluctuated but remained relatively low since 2007.
8. **Management Plan**: There is no management plan for this stock.

General comments

The report content is generally well written and easy to follow however both text and tables/figures are incomplete in several areas, some suggestions for improvements are given below.

Technical comments

- No description or summary in text of the fishery in 2015, i.e. landings, discards, sampling levels (last year's advice sheet mentions effort to improve sampling coverage by Scottish observers; any update on this?).
- Table 5.3.8; 6.b nominal catch not updated for 2015.
- Table 5.3.9; 6.b survey index not updated for 2014 or 2015.

- Table 5.3.10; 6.b changes in relative survey abundance & biomass table not updated for 2015.
- Table 5.3.11; 6.b estimates of biomass from sco/ire anglerfish survey no 2015 update.
- Figure 5.3.15; 6.b change in biomass not updated for 2014 or 2015.
- Figure 5.3.16; 6.b change in commercial and survey cpue not updated 2014 or 2015.

Minor editorial and grammatical changes have been made to the report using track changes.

Conclusions

No assessment was performed.

Checklist for audit process

General aspects

- Has the EG answered those ToRs relevant to providing advice? n/a
- Is the assessment according to the stock annex description? n/a
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? n/a
- Have the data been used as specified in the stock annex? n/a
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? n/a
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? n/a

6.1 Irish Sea overview

Situated between Ireland and Great Britain the Irish Sea (7.a) is connected by to the Celtic Sea (7.g) at its southern extreme by the St George's Channel and in north is linked to sea region West of Scotland (6.a) by the Northern Channel. The average depth is 50 m but the area is contrasted between a deeper channel, in the west, and shallower bays in the east. The channel has a maximum depth exceeding 275 m whilst the eastern bays have depths less than 50 m. Distinct habitat patches result from a combination of bathymetry, topographical features and hydrography. The seabed of the eastern Irish Sea is dominated by fine sediment plains with some small areas of areas of mud habitat, the fine sediments graduate to more coarse material in central areas. A large well defined deep-water mud basin is located in the northwestern region close to the Northern Irish and Irish coast.

Irish Sea fisheries are predominantly demersal trawling and seining with demersal trawling for *Nephrops* dominating effort with vessels using mesh in the range 70–99 mm. Effort using fishing gear with ≥100 mm mesh sizes is currently at a low level compared to historic activity, a considerable decline in effort was observed between 2003 and 2007 and has continued at a slower rate. The species composition of catches by vessels in using ≥100 mm mesh consists of primarily haddock, with lower quantities of hake. At present there is no commercial towed gear fishery for cod permitted. Beam trawls operating within the Irish Sea with mesh sizes in the range 80–119 mm, targeting sole, plaice, and rays. A seasonal pelagic and gillnet herring fishery operates in late summer–early autumn in the pre and post spawning period. Dredge fisheries target king and queen scallops, with king scallops in coastal areas with the queen scallop fishery operating in the central area south of the Isle of Man, to a lesser extent queen scallops are also targeted using trawl nets, during the late summer when swimming activity is most pronounced.

6.2 Cod in 7.a

This section is not currently available. Should it become updated, it will appear in an annex.

6.3 Haddock in Division 7.a

Type of assessment

Update of SURBA assessment.

ICES advice applicable to 2015

Based on ICES approach to data-limited stocks, ICES advises that catches should be no more than 893 tonnes. If discard rates do not change from the average of the last three years (2011–2013), this implies landings of no more than 425 tonnes.

Further technical measures should be introduced to reduce discards.

ICES advice applicable to 2016

ICES advises that when the precautionary approach is applied, catches in 2016 should be no more than 1072 tonnes. If this stock is not under the EU landing obligation in 2016 and discard rates do not change from the average of the last three years (2012–2014), this implies landings of no more than 481 tonnes.

6.3.1 General

Stock descriptions and management units

The stock and management units are both ICES Division 7.a (Irish Sea). Landing taken or reported by Irish vessels in the southern most rectangles of 7.a have been reassigned to the 7.b–k stock since 2003 because they are believed to be part of the Celtic Sea stock (See Section 7.4).

Management applicable to 2015 and 2016

Management measures include TAC and effort restrictions as well as technical measures. Due to the bycatch of cod in the haddock fishery, the regulations affecting Irish Sea haddock remain linked to those implemented under the cod recovery plan.

TAC regulations for 2015 and 2016 are given below:

2015 management (Council Regulation (EU) 2015/104)

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	VIIa (HAD/07A.)
Belgium	19		
France	85		
Ireland	511		
United Kingdom	566		
Union	1 181		
TAC	1 181		Analytical TAC

2016 management (Council Regulation (EU) 2016/72)

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	VIIa (HAD/07A.)
Belgium	26		
France	120		
Ireland	716		
United Kingdom	792		
Union	1 654		
TAC	1 654		Analytical TAC

The minimum landing size for haddock in the Irish Sea is 30 cm.

Landings obligation

In 2016 the landings obligation will apply for this stock for the first time. According to the delegate regulation (EC, 2015) vessels where more than 25% of their landings using trawls and seines in the reference years (2013 & 2014) and area were specified gadoids (Cod, Haddock, Whiting & Saithe) will be covered by the Landings Obligation. This implies that all catches of haddock in the Irish Sea by those vessels must be landed. However a 7% *de minimus* will also apply, meaning that these vessels can discard up to 7% of the haddock they catch. It is difficult to assess how this might impact of the fishery, the stock, the scientific data and the advice given for 2017 at this stage.

Fishery in 2015

The characteristics of the fishery are described in the stock annex.

The fishery in 2015 was prosecuted by the same fleets and gears as in recent years, with directed fishing prevented inside the cod closure in spring. The targeted whitefish fishery that developed during the 1990 using semi-pelagic trawls and was in continual decline underwent a slight increase in activity in 2014–2015 due to developing stock and increased fishing opportunity. This, however, continues to be pursued by a small number of vessel (<10 m). Whitefish directed effort is now low and dependent on available cod quota. A large proportion of the TAC is taken as bycatch in the *Nephrops* fishery.

Recently the reported uptake of TAC had been poor since 2004, with the exception of 2007. The estimated percentage uptake of UK and Ireland in 2014 was UK; 73% (412 t of 566 t), Ireland; 105% (534 t of 511 t). In 2015 the uptake was UK; 80% (633 t of 792 t), Ireland; 71% (507 t of 716 t), Belgium; 27% (7 t of 26 t) and France; 6% (7 t of 120 t). The figures for Ireland have been corrected to (pre-adjustment–507 t) account for reallocation of landings from southern rectangles of 7.a to 7.g as it is believed that these fish do not belong to the 7.a stock.

Table 6.3.1 gives nominal landings of haddock from the Irish Sea (Division 7.a) as reported by each country to ICES since 1984.

6.3.2 Data

An overview of the data requested and provided through the ICES data call is given in the table below. Data provided are shown in green, data not provided are shown in red.

Country	Aggregation level of the InterCatch data	Landings (quantity)	Age comp landings	Length comp landings	Discards (quantity)	Age comp discards	Length comp discards	Mean weight at age in the landings	Mean weight at age in the discards	Mean weight at length in the landings	Mean weight at length in the discards	Effort	Comm. tuning indices	Sexual maturity data
Belgium		IC			AC							AC1		
France		IC			AC							AC1		
Ireland		IC	IC		AC	AC	AC	IC	AC		AC	AC1		
UK EW		IC			AC		AC				AC	AC1		
UK IOM		IC			AC							AC1		
UK NI		IC	IC		AC	AC	AC	IC	AC		AC	AC1		AC
UK Sco		IC			AC							AC1		

The landings of the fleets sampled by quarter comprise 75% of the international total in 2015. No sampling information is available for some of the smaller fleets contributing to the international landings.

Landings

Table 6.3.2 gives the long-term trend of nominal landings of haddock from the Irish Sea (Division 7.a) as reported to ICES since 1972, together with Working Group estimates. The 1993–2005 WG estimates include sampled-based estimates of landings into a number of Irish Sea ports. Sampled-based evidence suggests that WG estimates are similar to reported landings since 2006. Following the benchmark (WKROUND 2013) the landings have been revised since 1993 and exclude landings from the southern rectangles in the Irish Sea as they not are believed to be part of this stock.

The methods for estimating quantities and composition of haddock landings from 7.a, used in previous years, are described in the stock annex (Annex 6.3). The series of numbers-at-age in the international commercial landings is given in Table 6.3.3. Sampling levels were not considered adequate to derive catch age compositions in 2003. The time-series mean weight-at-age in the landings is given Table 6.3.4.

Discards

The series of raised discard data were updated for Ireland and Northern Ireland. Discard numbers-at-age for the different sampled fleets are given in the stock annex (Annex 6.3). The proportions of discards-by-age for the different sampled fleets are given in the stock annex (Annex 6.3). Issues relating to the reliability of the data were addressed at the benchmark assessment for this stock (WKROUND 2013).

Methods for estimating quantities and composition of discards from UK (NI) and Irish *Nephrops* trawlers are described in the stock annex (Annex 6.3). Sampling levels have increased in recent years. The very large estimates of discarding for *Nephrops* fleets observed by previous WG are still evident. A time-series of discard numbers-at-age was constructed at the benchmark (Annex 6.3), but this still need some refinement in terms of the raising methodology used. Discard rates are very variable between fleets. Discard estimates since 2010 were nevertheless calculated, including raising the estimates to unsampled fleets, in 2016 raising and allocation methods have been applied by using the discard rates of sampled fleets to unsampled fleets in ICES-InterCatch and ICES accession submissions Table 6.3.2. This equates to discard rates of 20–65% in weight for the fleet. Discarding of adult age 2+ fish (spawning–stock biomass) are considerably lower at 70–170 t, highlighting the majority of discarding is at juvenile ages.

Biological data

The derivation of biological parameters and variables is described in the stock annex. Natural mortality-at-age was calculated using the methods proposed by Lorenzen (1996) at WKROUND (2013). The proportions mature-at-age was also recalculated at the benchmark and based on the mean proportion observed during the NIGFS-WIBTS-Q1 survey. Maturity-at-age is considered 0 at age 1, 0.72 at age 2, .97 at age 3 and fully mature at age 4+.

There is evidence of trends in mean length-at-age over time (Figure 6.3.1), which needs to be reflected in the stock weights-at-age. Since 2001 the WG calculated stock weights by fitting a von Bertalanffy growth curve to all available survey estimates of mean length-at-age in March, described in the Stock Annex 6.3. The procedure was updated this year using NIGFS-WIBTS-Q1 (2016) and quarter one commercial landings data for 2015. The time-series of length–weight parameters indicate a reduction in expected weight-at-length since 1996 although this strength of this decline has reduced in recent years (see stock annex for historical data):

	Length–weight parameters		Expected weight-at-length	
Year	A	B	30 cm	40 cm
2006	0.00506	3.165	239	595
2007	0.00469	3.194	244	612
2008	0.00523	3.159	242	601
2009	0.00431	3.224	249	629
2010	0.00413	3.238	250	635
2011	0.00457	3.207	250	629
2012	0.00499	3.174	243	606
2013	0.00451	3.208	247	622
2014	0.00591	3.121	241	591
2015	0.00423	3.232	251	637
2016	0.00420	3.233	250	634

The following parameter estimates were obtained (last year's estimates in parentheses):

Mean LI_{yc} = 82.5 cm (80.0); K = 0.178 (0. 186); t_0 = -0.452 (-0.453)

Year-class effects giving estimates of asymptotic length relative to the mean were as follows (2014 and 2015 data were combined as there is only one observation for the 2015 year class):

Year class	Effect	Year class	Effect
1990	1.195	2003	0.869
1991	1.133	2004	0.840
1992	1.106	2005	0.848
1993	1.120	2006	0.862
1994	1.114	2007	0.892
1995	1.056	2008	0.904
1996	1.000	2009	0.933
1997	0.995	2010	0.983
1998	0.977	2011	1.004
1999	0.963	2012	0.942
2000	0.986	2013	0.903
2001	0.980	2014/2015	0.938
2002	0.933		

The year-class effects show a smooth decline from the mid-1990s coincident with the rapid growth of the stock and may represent density-dependent growth effects, although other environmental factors may contribute. Although there is some evidence in a reversal of this trend in recent years. The close fit of the model to observed length-at-age data is shown by year classes in Figure 6.3.1. The resultant stock weights-at-age are given in Table 6.3.5. The weight-at-age in the stock shows a very clear decreasing trend over time, stabilizing in more recent years.

Surveys

The survey data considered in the assessment for this stock are given in Table 6.3.7. Survey-series for haddock available to the Working Group are described in the stock annex for 7a haddock. The following age-structured abundance indices were used in the assessment:

- UK (NI) groundfish survey (NIGFS) in March (age classes 1 to 5, years 1992–2016). Acronym NIGFS-WIBTS-Q1.

Additional age-structured abundance indices, that provided auxiliary information, are available from the following sources:

- UK (NI) groundfish survey (NIGFS) in October (age classes 0 to 3; years 1991 to 2015). Acronym NIGFS-WIBTS-Q4.

- UK (NI) Methot–Isaacs–Kidd (NI-MIK) net survey in June (age 0; years 1994–2015).
- UK Fishery Science Partnership (FSP) western Irish Sea roundfish survey, 2004–2016 (the survey was not conducted in 2014) (www.cefas.co.uk/fsp).
- UK Irish Sea Annual Egg Production Method survey (AEPM), 2006–2010 (see WGCSE 2011 for details).

The relative abundance indices are plotted against time in Figure 6.3.2. Surveys give similar signals for all ages (0–4). The two 0-group indices indicate decreased recruitment since 2010, with only the 2009 recruitment above average since 2007. A high 0-group index is shown in the 2015 NI-MIK net survey although this is not reflected in the NIGFS-WIBTS-Q1 0-group index. The strong 2013 year class continues to be tracked in all indices, indicating that the different surveys are capturing the prominent year-class signals in this stock (Figure 6.3.3). Correlation between survey indices by age is positive for all surveys and show high consistency within each fleet, but with some variability between the fleets (Stock Annex 6.3). The indices from the UK FSP survey in the western Irish Sea also show similar year-class signals to the other survey-series, but are noisy with strong year effects (Figure 6.3.2). Haddock SSB estimates derived from an annual egg production method in the Irish Sea show a similar trends as the SURBA estimates from NIGFS-WIBTS-Q1 data (Figure 6.3.4), where SSB decreased substantially in 2010 from the high 2006–2008 levels. The international landings-at-age (excluding 2003) show similar patterns of year-class variation to the surveys (Figure 6.3.2), giving confidence in the combined ability of the surveys to track year classes through time. The signal from the landings-at-age data is, however, much reduced since 2004.

The empirical trend in SSB from both the NIGFS series show the growth in SSB in the mid-1990s, a decline to 2000 and a subsequent variable trend (Figure 6.3.5). In recent years, both surveys show a decreasing trend in SSB from 2007–2010 (diverging considerably in 2008) and an increasing trend in the last three years. Recent trends (2015–2016) have shown a strong increase in the empirical SSB. Both the NIGFS-WIBTS-Q1 and the NI-MIK survey show high levels of recruitment in 2013, this is reflected in a steep increase in the 2015 estimates of SSB in both empirical survey results (Figure 6.3.4) and model predictions (Figure 6.3.5).

Commercial cpue

Commercial cpue data are available for this stock but are not currently used in the assessment.

6.3.3 Historical stock development

Deviation from stock annex

The assessment presented is the single fleet SURBA analysis, using only the NIGFS-WIBTS-Q1 survey. The assessment does not deviate from the procedure described in the stock annex.

SURBA was used for the assessment and model settings (as used last year's assessment) are given below:

	WGCSE 2016
Year range:	1992–2015
Age range:	1–5
Catchability:	1.0 at all ages
Age weighting	1.0 at all ages
Smoothing (Lambda):	1.0
Cohort weighting:	not applied
Reference age	2
Survey used	NIGFS-WIBTS-Q1

Data screening

Screening of internal and between survey consistency is described in Section 6.3.2.

Final update assessment

SURBA model residuals (log-population indices) for the NIGFS-WIBTS-Q1 survey show noisy residuals (Figure 6.3.6). Residuals show some evidence of year effects in older ages in some years. The age 2 residual pattern from the NIGFS-WIBTS-Q1 survey continue to show a better pattern than the other ages. The NIGFS-WIBTS-Q1 survey model show no obvious retrospective patters in SSB (Figure 6.3.6).

Trends in Z, SSB and recruitment for the assessment using the NIGFS-WIBTS-Q1 survey data, and the model residuals are given in Figures 6.3.7 and 6.3.8. The SURBA fitted numbers-at-age and total mortality-at-age given in Table 6.3.8. The SURBA index of Z generally follows the much noisier empirical estimates (Figures 6.3.7). The index of total mortality appears relatively stable. Both the empirical and SURBA estimates of SSB give a similar increasing trend from 2005–2008 followed by in decrease in 2009–2010, SSB has increased since 2011, the 2013 year class is estimated to the strongest in the series and current SSB has increased to the highest value in 2016. The strength of the 2013 appears strong with agreement between available survey indices (Figure 6.3.3). In general, the SURBA results capture similar year-class dynamics than observed from the raw survey indices (Figure 6.3.2).

Comparison with previous assessments

Consistent with last year’s assessment the perception of the stock is that that due to high recruitment in 2013 a rise in SSB is predicted. Figure 6.3.9 compares the relative trends between the SURBA fitted estimates from this year’s to last year’s assessment. There are negligible differences in the Z patterns between years with the variability in Z that has been seen in pervious assessments reducing but overall Z estimated due to the change in the maturity-at-age profile. The most recent SSB estimate indicates that the stock has increased following the strong recruitment in 2013. The relative SSB estimate for 2016 is the highest observed in the time-series.

The assessment methodology was the same as last year applied using SURBA R (R v2.15–32b) implementation.

State of the stock

Following a period of sustained decline, since 2008, SSB increase during 2010–2013. A short-term decline was observed in 2014 but was reversed, and since 2014 the SSB has increased markedly. The stock is characterized by highly variable recruitment. The model indicates above average recruitment for the 2009–2011 year class after below average recruitment for the 2007 and 2008 year classes. Recruitment in 2013 is amongst the highest observed in the time-series. There are conflicting indicators of recruitment from different surveys in 2015. Total mortality remains stable.

6.3.4 Short-term projections

No short-term forecast has been performed for this stock. This year the WG projected the SSB for 2017 using the 2015 survey information. SSB for 2017 was projected using an average of the last three years total mortality from the SURBA model, a three year average of stock weights (2013–2015) and ten year geometric mean recruitment.

The projected SSB trend is illustrated in Figure 6.3.10, indicating a decline in the SSB into 2017 as the abundance of the strong 2013 year-class declines and following periods of average recruitment. SURBA fitted recruitment estimates are also compared to recruitment from the 0-gp indices (NIGF-WIBTS-Q4 and NI-MIK). During the period 1992–2006 the model underestimates the 0-gp strength compared to the n the NIGF-WIBTS-Q4, this pattern switches to overestimate pattern in 2007–2012. There is close fit of the model predicted 0-gp index to that detected in NIGF-WIBTS-Q4 index in recent years. Across the time series both the NIGF-WIBTS-Q4 and model estimates both tend toward higher estimates than that shown by the NI-MIK index. The NI-MIK survey shows a strongly contrasting signal to that of the SURBA model fit and NIGF-WIBTS-Q4 index.

Applying catch option rule proposed for this stock category the last two years SSB is 247% higher than the SSB in the three years previous to that. The catch and landings advice consistent with the ICES approach is given below.

Index A (2015–2016)		2.31
Index B (2012–2014)		0.93
Index ratio (A/B)		2.48
Uncertainty cap	Applied	
Recent advised catch		1072
Discard rate		47%
Precautionary buffer	Not applied	
Catch advice*		1286
Wanted catch** corresponding to the catch advice		682

*** Recent advice × cap.**

**** "Wanted catch" is used to describe fish that would be landed in the absence of the EU landing obligation.**

6.3.5 Biological reference points

MSY evaluations

Proxy reference points (F_{MSY} and $B_{trigger}$) were explored for the stock at WKProxy (ICES, 2015b). A landings and biomass index series was used to explore these reference points by applying a biomass dynamic model (SPiCT-Stochastic Production model in Continuous Time). Given the marked expansion of the stock biomass in the mid–

1990s and the related rapid growth of the fishery caution was advised when assessing the historic status of haddock in 7.a. The catch information is more uncertain in the early part of the time-series, when catches were less restricted by the TAC compared the catches since the mid–2000s. In recent years there has been a highly restricted or no directed fishery for haddock in 7.a due to a restricted TAC and curtailment related cod management. The conclusion from WKProxy (ICES, 2016) stated that the current perception of the stock is that it is being exploited below F_{MSY} and that the Biomass is above B_{MSY}.

	Fishing pressure		
	2012	2013	2014
MSY (F_{MSY})	✓	✓	✓

	Stock size		
	2012	2013	2014
MSY ($B_{trigger}$)	✓	✓	✓

Precautionary approach reference points

There is currently no basis for defining precautionary reference points. Details of previous PA reference points for this stock are provided in the stock annex.

Yield and biomass-per-recruit

Not available for this stock, previous explorations are detailed in the stock annex.

6.3.6 Management plans

There is no specific management plan for haddock in the Irish Sea. The regulations affecting Irish Sea haddock remain linked to those implemented under the cod management plan due to potential for bycatch of cod in a fishery targeting haddock (Council Regulation (EC) 1342/2008).

6.3.7 Uncertainties and bias in assessment and forecast

Due to the uncertainty in the mortality estimates for the stock, the advice is based only on the SSB estimated from the assessment used as indicator of stock size. Recruitment and SSB estimates are relative as survey catchabilities-at-age are not known.

The perception of the stock from this year's assessment does not differ qualitatively from that obtained last year.

6.3.8 Recommendations for next benchmark assessment

This stock will be benchmarked through the WKIRISH process in 2016–2017. Sampling information has improved significantly in the last four years. The 2013 benchmark constructed an international catch-at-age matrix. A full analytical assessment was not possible due to the uncertainty in the mortality estimates for the stock. This needs further investigation and possibly dealt with through choice of assessment methods.

The main tasks for the benchmark focus on the following areas:

- Review stock structure and evidence of mixing;
- Life-history parameters (e.g. growth parameters, maturity ogives, fecundity, natural mortality), for use in assessments;
- History of fishery management regulations;
- Time-series of commercial and recreational fishery catch estimates;
- Derive fishery-specific landings and discard series;
- Fishery-specific length and age distributions of landings and discards, with associated measures or indicators of bias and precision;
- Explore need to address fishery selectivity (pattern of catchability at length or age) in the assessment model;
- Recommend values for discard mortality rates and indicate the range of uncertainty in values;
- Review of all available and relevant fishery dependent data sources on fish abundance;
- Review fishery-independent data sources on fish abundance and provide up to date survey working document describing the aggregation procedure and precision estimation;
- Investigate changes in environmental drivers known to influence distribution, growth, recruitment, natural mortality or other aspects of productivity which are relevant for assessments and forecasts;
- Collate assessment model input data that reflects the decisions and recommendations of the Data Workshop.

6.3.9 A number of priority data compilation tasks have been discussed and agreed following the "Guidelines for Benchmark Data Evaluation process for stock assessments". These case be found on the ICES SharePoint Site for WKIRISH. Management considerations

Last year's advice was based on the precautionary approach. This year new MSY proxies have been estimated (ICES, 2016). The stock status and exploitation indicators suggest that the stock is in good condition relative to these proxy reference points.

Landings have been adjusted since 2003 to exclude landings taken from the southern rectangles (33E2 and 33E3) in the Irish Sea as they are not believed to be part of this stock (Table 5.3.15.8). This needs to be considered when setting catch options for Divisions 7.a and 6.b–k haddock. Vessels actively targeting haddock are subject to the landings obligation in 2016. Other fleets, in which haddock is a bycatch species, are not currently under a landings obligation (EC, 2015).

Following decades of very low recruitment and biomass as indicated by very low fishery catches, this stock grew substantially in the 1990s following strong pulses of recruitment, and has gone from a minor bycatch species to one of the most economically valuable target species in the Irish Sea. Since the mid-1990s the haddock population in the Irish Sea is experiencing one of the largest and most sustained period of growth. The recruitment signals are clearly revealed by surveys, but the steep age profile in the catches and the resultant dependence of the fishery on highly variable recent year classes means that catch and SSB forecasts will be uncertain. The prevention of directed fishing for haddock during the cod closures in 2000–2013, other than during limited fishing experiments, should have curtailed the directed fisheries on mature haddock that occur in spring. EU has adopted a long-term plan for cod stocks and the fisheries exploiting those stocks (Council Regulation (EC) 1342/2008). The long-term management plan for cod implemented in the Irish Sea from 2008 will affect catches of species caught in related fisheries, including haddock.

Given the pulses of strong recruitment observed in fishery it is considered that the current TAC management measures are not responsive enough considering the dynamic nature of changes in stock abundance. The ICES framework for category 3 stocks with uncertainty cap of 20% is considered insufficiently responsive to the dynamic nature of changes in the stock, i.e. high variability in recruitment.

Recent rates of observer coverage of whitefish vessels targeting haddock have been high since 2013, and show low rates of discards (2% in 2015). Sampling schemes in the *Nephrops* fleet since the 1990s have shown high rates of discarding of haddock less than three years old and variable discarding of 3-year-olds in fisheries using 70–90 mm mesh nets. A conditional national licence has been introduced by Ireland since March 2012, making the highly selective gears ('Swedish' Sorting Grid, Inclined Separator, SELTRA "300" Sorting Box or 300mm Square Mesh Panel) mandatory for all boats fishing with 70–99 mesh otter trawls in the Irish Sea. Since October 2012, all vessels using with 70–99 mesh otter trawls in the UK(Northern Ireland) fleet are required to use a highly selective fishing gear to reduce overall discarding of fish.

The landings since 1993 have been revised and exclude landings from the southern rectangles in the Irish Sea as they not are believed to be part of this stock. Restrictive quotas for some countries caused extensive misreporting during the 1990s prior to the introduction of a separate TAC allocation for the Irish Sea. Estimates of misreporting have been included in the estimates of landings, except for 2003. The recent implementation of buyers and sellers legislation has improved the quality of the landings data since 2006.

The SSB indices appear to respond dynamically to the very variable recruitment, as would be expected given the steep age profile in the surveys. Stock trends indicate an increase in SSB over the time-series followed by a decrease since 2008 due to some below-average year classes. The rapid decline in SURBA SSB index from 2009 to 2010 is also reflected in the AEPM egg survey biomass estimates, indicating that year classes are depleted rapidly. However the catches in 2006 and 2008 were quite small relative to the AEPM SSB estimates, suggesting low mortality. This conundrum (continuing apparent very steep age profile despite large reductions in whitefish fishing effort) is the same as with cod and whiting in 7.a.

6.3.10 References

EC. 2015. Commission Delegated Regulation (EU) 2015/2438 of 12 October 2015 establishing a discard plan for certain demersal fisheries in north-western waters.

Table 6.3.1. Nominal landings (t) of HADDOCK in Division 7.a, 1984–2012, as officially reported to ICES. (Working Group figures are given in Table 6.3.2)

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	3	4	5	10	12	4	4	1	8	18
France	38	31	39	50	47	n/a	n/a	n/a	73	41
Ireland	199	341	275	797	363	215	80	254	251	252
Netherlands	-	-	-	-	-	-	-	-	-	-
UK(E&W)[1]	29	28	22	41	74	252	177	204	244	260
UK (Isle of Man)	2	5	4	3	3	3	5	14	13	19
UK (N. Ireland)	38	215	358	230	196	…	…	…	…	…
UK (Scotland)	78	104	23	156	52	86	316	143	114	140
Total	387	728	726	1,287	747	560	582	616	703	730

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Belgium	22	32	34	55	104	53	22	68	44	20
France	22	58	105	74	86	n/a	49	184	72	146
Ireland	246	320	798	1,005	1,699	759	1,238	652	401	229
Netherlands	-	-	1	14	10	5	2	-	-	-
UK(E&W)[1]	301	294	463	717	1,023	1,479	1,061	1,238	551	248
UK (Isle of Man)	24	27	38	9	13	7	19	1	-	-
UK (N. Ireland)	…	…	…	…	…	…	…	…	…	…
UK (Scotland)	66	110	14	51	80	67	56	86	47	31
Total	681	841	1,453	1,925	3,015	2,370	2,447	2,229	1,115	674

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Belgium	15	22	23	30	15	7	9	16	13	6.2
France	20	36	20	11	6	3	2	8	3	.7
Ireland	296	139	184	477	319	388	333	434	561	492
Netherlands	-	-		-	-	-	-	-	-	-
UK (England & Wales)[1]	421	344	419	559	521	446	593	355	236	154
UK (Isle of Man)	-	-	-	-	1	1	-	-	<1	<.1
UK (N. Ireland)	…	…	…	…	…	…	…	…	...	...
UK (Scotland)	9	6	9	1	17	1	2			-
United Kingdom									236	154
Total	761	547	655	1078	879	846	939	813	813	654

Country	2014	2015
Belgium	7	7*
France	0	7*
Ireland	541	507*
Netherlands	-	-
UK (England & Wales)[1]	-	-
UK (Isle of Man)	<1	<1*
UK (N. Ireland)	...	-
UK (Scotland)	-	-
United Kingdom	426	633*
Total	974	1154

* Preliminary.

[1] 1989–2015 Northern Ireland included with England and Wales.

n/a = not available.

Table 6.3.2. Haddock in 7.a. Total international landings of haddock from the Irish Sea, 1972–2015, as officially reported to ICES. Working Group figures, assuming 1972–1992 official landings to be correct, are also given. The 1993–2005 WG estimates include sampled-based estimates of landings at a number of Irish Sea ports. Sample-based evidence confirms more accurate catch reporting since 2006. Landings in tonnes live weight. Since 1993 the landings have been corrected to exclude catches from the southernmost rectangles, which are not considered part of this stock.

Year	Official landings	WG landings	ICES discards**	ICES catch	% Discard	Landings taken or reported in rectangles 33E2 and 33E3
1972	2204	2204				
1973	2169	2169				
1974	683	683				
1975	276	276				
1976	345	345				
1977	188	188				
1978	131	131				
1979	146	146				
1980	418	418				
1981	445	445				
1982	303	303				
1983	299	299				
1984	387	387				
1985	728	728				
1986	726	726				
1987	1287	1287				
1988	747	747				
1989	560	560				
1990	582	582				
1991	616	616				
1992	703	656				
1993	730	813				
1994	681	1042				
1995	841	1736	780	2516	31%	16
1996	1453	2981	709	3690	19%	33
1997	1925	3547	895	4442	20%	36
1998	3015	4874	1015	5889	17%	28
1999	2370	4095	634	4729	13%	34
2000	2447	1357	802	2159	37%	11
2001	2229	2246	269	2515	11%	74
2002	1115	1817	387	2204	18%	82
2003	674	659	-	-	-	64
2004	761	1217	392	1609	24%	53
2005	547	666	551	1217	45%	35
2006	655	633	306	939	33%	26
2007	1078	886	722	1608	45%	222
2008	879	786	643	1429	45%	194

Year	Official landings	WG landings	ICES discards**	ICES catch	% Discard	Landings taken or reported in rectangles 33E2 and 33E3
2009	846	581	579	1160	50%	285
2010	939	679	508	1187	43%	267
2011	813	446	307	753	41%	374
2012	n/a	343	599	942	64%	473
2013	654	254	283	537	53%	410
2014	953	518	488	1006	49%	444
2015	1154	833	652	1451	44%	322

Table 6.3.3. Haddock in 7.a: Catch numbers-at-age (=landings number-at-age; no discard data included).

Table 1	Landings numbers-at-age				Numbers*10**-3																		
YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
AGE																							
0	0	0	0	0	0	0	924	1	0	0	n/a	0	0	0	0	0	0	0	0	0	0	0	0
1	94	30	1329	108	1272	601	287	548	13	290	n/a	72	69	13	23	129	33	18	44	9	38	30	0
2	1250	123	1310	4568	693	8353	916	575	2741	697	n/a	220	473	519	911	336	451	430	550	232	210	642	971
3	18	861	106	727	2387	252	4773	438	1074	2036	n/a	753	226	519	495	718	549	409	148	170	125	176	321
4	1	3	220	16	201	488	25	457	30	142	n/a	46	193	63	60	242	121	309	97	27	41	17	63
+gp	1	2	5	30	16	42	57	418	89	18	n/a	78	34	51	47	36	36	59	52	28	18	10	5
0 TOTALNUM	1364	1019	2970	5449	4569	9736	6982	2437	3947	3183	n/a	1169	995	1165	1536	1461	1190	1225	891	466	433	876	1360
TONSLAND	813	1042	1736	2981	3547	4874	4095	1357	2246	1817	659	1217	666	633	886	786	581	679	446	343	254	518	833
SOPCOF %	100	100	100	100	95	100	100	97	100	100	n/a	100	99	100	100	100	100	100	100	100	100	100	100

Table 6.3.4. Haddock in 7.a: catch weights-at-age (=landings weight-at-age; no discard data included).

CATCH WEIGHTS-AT-AGE (KG)																								
	YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	AGE																							
0		0	0	0	0	0	0	0.013	0.135	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0
1		0.351	0.346	0.361	0.346	0.348	0.235	0.189	0.26	0.405	0.244	NA	0.438	0.299	0.309	0.246	0.278	0.291	0.315	0.233	0.362	0.350	0.452	0.340
2		0.596	0.56	0.545	0.474	0.592	0.428	0.399	0.372	0.46	0.339	NA	0.612	0.381	0.397	0.441	0.387	0.388	0.362	0.411	0.477	0.475	0.525	0.494
3		1.688	1.103	0.898	0.917	1.002	1.066	0.726	0.46	0.734	0.644	NA	1.055	0.642	0.498	0.659	0.538	0.468	0.499	0.673	0.809	0.649	0.742	0.837
4		2.52	2.73	1.983	2.034	1.349	1.63	1.951	0.984	1.317	1.165	NA	1.566	1.342	0.949	1.082	0.763	0.793	0.747	0.588	1.383	0.852	1.129	1.178
	+gp	2.52	2.522	2.178	2.682	1.955	2.27	2.646	0.836	1.714	1.811	NA	2.376	1.797	2.027	1.853	1.368	1.195	1.405	1.003	2.143	1.105	1.681	1.837
0	SOPCOFAC	0.9995	1.0008	1.0007	1.0029	0.9465	0.9958	0.9996	0.9675	1.0002	0.9991													

Table 6.3.5. Haddock in 7.a: stock weights-at-age.

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.093	0.082	0.095	0.083	0.085	0.083	0.070	0.060	0.057	0.048	0.051	0.056	0.050	0.041	0.031
2	0.432	0.348	0.420	0.338	0.347	0.359	0.357	0.253	0.226	0.230	0.201	0.215	0.229	0.199	0.165
3	1.126	0.991	1.043	0.968	0.785	0.788	0.863	0.743	0.561	0.510	0.548	0.472	0.485	0.509	0.459
4	1.857	2.122	1.759	1.999	1.708	1.319	1.435	1.384	1.294	0.966	0.930	0.983	0.798	0.816	0.902
+gp	2.635	3.122	2.563	3.028	3.219	2.718	2.391	2.165	2.262	2.123	1.822	1.637	1.520	1.306	1.347
YEAR	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016				
AGE															
0	0	0	0	0	0	0	0	0	0	0	xx				
1	0.033	0.034	0.037	0.042	0.040	0.052	0.057	0.059	0.038	0.046	0.047				
2	0.128	0.136	0.139	0.153	0.176	0.167	0.209	0.233	0.238	0.153	0.192				
3	0.378	0.299	0.310	0.326	0.357	0.407	0.375	0.491	0.512	0.577	0.354				
4	0.803	0.680	0.515	0.563	0.580	0.624	0.688	0.673	0.812	0.970	1.015				
+gp	1.435	1.402	1.167	0.980	0.945	0.937	0.960	1.115	1.040	1.371	1.533				

Table 6.3.7. Haddock in 7.a: Available tuning data (file name: h7ani.tun).

```
IRISH SEA haddock, 2013 WG,ANON,COMBSEX,TUNING DATA(effort, nos at age)
104
NIGFS-WIBTS-Q1
1992 2016
1 1 0.21 0.25
1 5
       1   1525    23     0     0   0  0
       1    139   569    31     0   0  0
       1    644    58   183     0   0  0
       1  24823   437     0    43   0  0
       1   1065  3743    67     3   1  0
       1  25118   474  1457    44   0  2
       1   3913  8694    70   105   1  0
       1   6058   680  2072    16  11  0
       1  14028  1853    64   147   2  3
       1   3277  6990   770    40  20  0
       1  28755   842  1059    78   1  0
       1   6966 14162   341   356  26  0
       1  19945  2379  2206    45  35  0
       1  24488  6454   406   234  13  2
       1  13444 12721  2194    91  33  0
       1  20918 11325  3661   240  16 11
       1   7480 12009  2559   495  48  0
       1   9345  3888  2877   163  37  5
       1  17058  1765   524   239  26  1
       1  17278  5543   299    67  46  4
       1  13509  5266  1095    38   6  7
       1   8245  5202   751   119  11  9
       1  33807  2260   773   108  20  2
       1  15495  22420 1297   407  40  4
       1  14418  9109   5594  205  38  2


NIGFS-WIBTS-Q4
1991 2015
1 1 0.83  0.88
0 3
       1      15780   70      0       0       0       0       0
       1      124     784     151     0       0       0       0
       1      4462    101     375     3       0       0       0
       1      56683   1137    12      79      0       0       1
       1      1661    10153   74      0       5       0       0
       1      143300  1167    1480    13      0       0       0
       1      16400   39680   174     98      1       0       0
       1      41820   1243    3778     22     3       4       0
       1      80674   2835    71      145     0       1       0
       1      6545    8598    763      31     39      0       0
       1      75017   2003    2742     311    0       20      0
       1      15116   10501   86      365     0       0       0
       1      53922   7125    3008    59      79      0       0
       1      70337   14413   1261    649     0       0       0
       1      47030   12962   1743    59      8       0       0
       1      35748   10788   3607    392     52      0       0
       1      9654    9804    4050    1057    41      0       0
       1      9037    4880    2242    277     24      0       0
       1      45869   4269    951     459     29      12      3
       1      22538   8433    587     197     85      0       3
       1      20678   4234    1086    140     49      16      5
       1      10673   8042    1549    193     0       0       0
       1      100367  780     227     38      0       0       0
       1      35509   30775   6005    272     13      0       0
       1      45655   8133     10671  291      40      0       0
NIMIK
1994 2013
1 1 0.38 0.47
0 0
        1     47000
        1      1700
        1     47800
        1     14500
        1      2500
        1     15400
```

```
          1       1700
          1      17100
          1       1200
          1       4250
          1      25970
          1       8250
          1      40240
          1       3820
          1       6638
          1      18540
         1       4532
         1       6606
         1       9818
         1      28325
         1      12892
         1      48463

UKFspW
2005 2016
1 1 0.15 0.25
1 7
1       0.000   1.774   1.506   4.981   0.291   0.256   0.018
1       0.308   7.749   7.336   0.546   1.115   0.043   0.048
1       0.208   42.727  37.286  6.289   0.697   0.147   0.020
1       0.000   4.657   12.836  7.213   0.794   0.126   0.062
1       0.000   0.662   3.990   1.443   0.541   0.115   0.031
1       0.627   1.422   3.780   2.753   0.866   0.104   0.037
1       0.048   0.598   1.976   1.121   0.810   0.184   0.058
1       0.270   4.135   4.772   0.790   0.226   0.443   0.054
1       0.035   3.684   7.674   1.742   0.176   0.162   0.045
1       0.434   32.100  19.729  5.160   0.563   0.189   0.036
1       0.000   0.000   59.769  12.592  6.205   0.832   0.531
```

Table 6.3.8. Haddock in 7.a: SURBA fitted numbers-at-age, total mortality-at-age, SSB and Z using the NIGFS-WIBTS-Q1 survey data.

Numbers-at-age						Total mortality-at-age				
	Age					Age				
Year	1	2	3	4	5	1	2	3	4	5
1992	0.205	0.004	0.001	0.000	0.000	0.005	0.007	0.014	0.012	0.012
1993	0.028	0.204	0.004	0.001	0.000	0.450	0.674	1.262	1.082	1.082
1994	0.218	0.018	0.104	0.001	0.000	0.980	1.466	2.745	2.352	2.352
1995	2.153	0.082	0.004	0.007	0.000	0.665	0.994	1.862	1.596	1.596
1996	0.310	1.108	0.030	0.001	0.001	0.499	0.747	1.399	1.198	1.198
1997	8.044	0.188	0.525	0.007	0.000	0.853	1.277	2.391	2.049	2.049
1998	0.773	3.427	0.053	0.048	0.001	0.874	1.308	2.449	2.098	2.098
1999	1.404	0.323	0.927	0.005	0.006	0.962	1.439	2.695	2.309	2.309
2000	3.707	0.536	0.077	0.063	0.000	0.812	1.215	2.275	1.949	1.949
2001	0.817	1.646	0.159	0.008	0.009	0.671	1.005	1.881	1.612	1.612
2002	3.358	0.418	0.603	0.024	0.002	0.510	0.763	1.429	1.225	1.225
2003	1.537	2.016	0.195	0.144	0.007	0.778	1.164	2.179	1.867	1.867
2004	4.080	0.706	0.630	0.022	0.022	0.808	1.209	2.264	1.940	1.940
2005	7.367	1.819	0.211	0.065	0.003	0.545	0.815	1.527	1.308	1.308
2006	6.521	4.273	0.805	0.046	0.018	0.564	0.844	1.580	1.354	1.354
2007	12.286	3.711	1.838	0.166	0.012	1.006	1.506	2.820	2.416	2.416
2008	3.284	4.491	0.823	0.109	0.015	1.121	1.677	3.141	2.691	2.691
2009	1.481	1.071	0.839	0.036	0.007	0.656	0.981	1.837	1.574	1.574
2010	5.216	0.769	0.401	0.134	0.007	0.811	1.214	2.273	1.947	1.947
2011	5.777	2.318	0.228	0.041	0.019	0.985	1.475	2.761	2.366	2.366
2012	3.608	2.156	0.531	0.014	0.004	0.927	1.387	2.598	2.226	2.226
2013	3.871	1.428	0.539	0.039	0.002	0.975	1.459	2.733	2.341	2.341
2014	7.782	1.460	0.332	0.035	0.004	0.312	0.467	0.875	0.750	0.750
2015	9.566	5.695	0.915	0.138	0.017	0.808	1.210	2.265	1.940	1.940

Stock summary						
Year	**Recruits (age 1)**	**log SE (rec)**	**SSB**	**TSB**	**Z(2–3)**	**SE (Z)**
1992	0.194	0.002	0.004	0.000	0.024	0.000
1993	0.029	0.000	0.062	0.001	0.086	0.001
1994	0.304	0.003	0.082	0.001	0.111	0.001
1995	3.898	0.044	0.049	0.000	0.391	0.004
1996	0.407	0.004	0.436	0.004	0.628	0.006
1997	9.573	0.106	0.640	0.007	1.350	0.011
1998	0.706	0.008	0.706	0.008	0.972	0.010
1999	2.867	0.032	0.459	0.005	0.650	0.006
2000	5.366	0.057	0.273	0.003	0.595	0.005
2001	1.137	0.012	0.483	0.004	0.664	0.006
2002	7.194	0.072	0.350	0.003	0.786	0.006
2003	2.117	0.023	0.751	0.007	1.081	0.010
2004	6.655	0.072	0.700	0.007	1.039	0.008
2005	9.534	0.099	0.523	0.005	0.936	0.007
2006	6.570	0.071	0.681	0.006	1.045	0.008
2007	10.693	0.108	0.746	0.007	1.231	0.009
2008	2.928	0.033	0.862	0.007	1.156	0.009
2009	2.291	0.026	0.553	0.005	0.705	0.006
2010	5.527	0.057	0.282	0.003	0.546	0.004
2011	4.778	0.054	0.361	0.003	0.706	0.006
2012	4.313	0.046	0.453	0.004	0.804	0.006
2013	2.667	0.030	0.530	0.005	0.800	0.006
2014	12.644	0.150	0.447	0.004	1.002	0.008
2015	5.910	0.079	1.063	0.010	1.618	0.014
2016	4.826	0.086	1.296	0.011	1.696	0.013

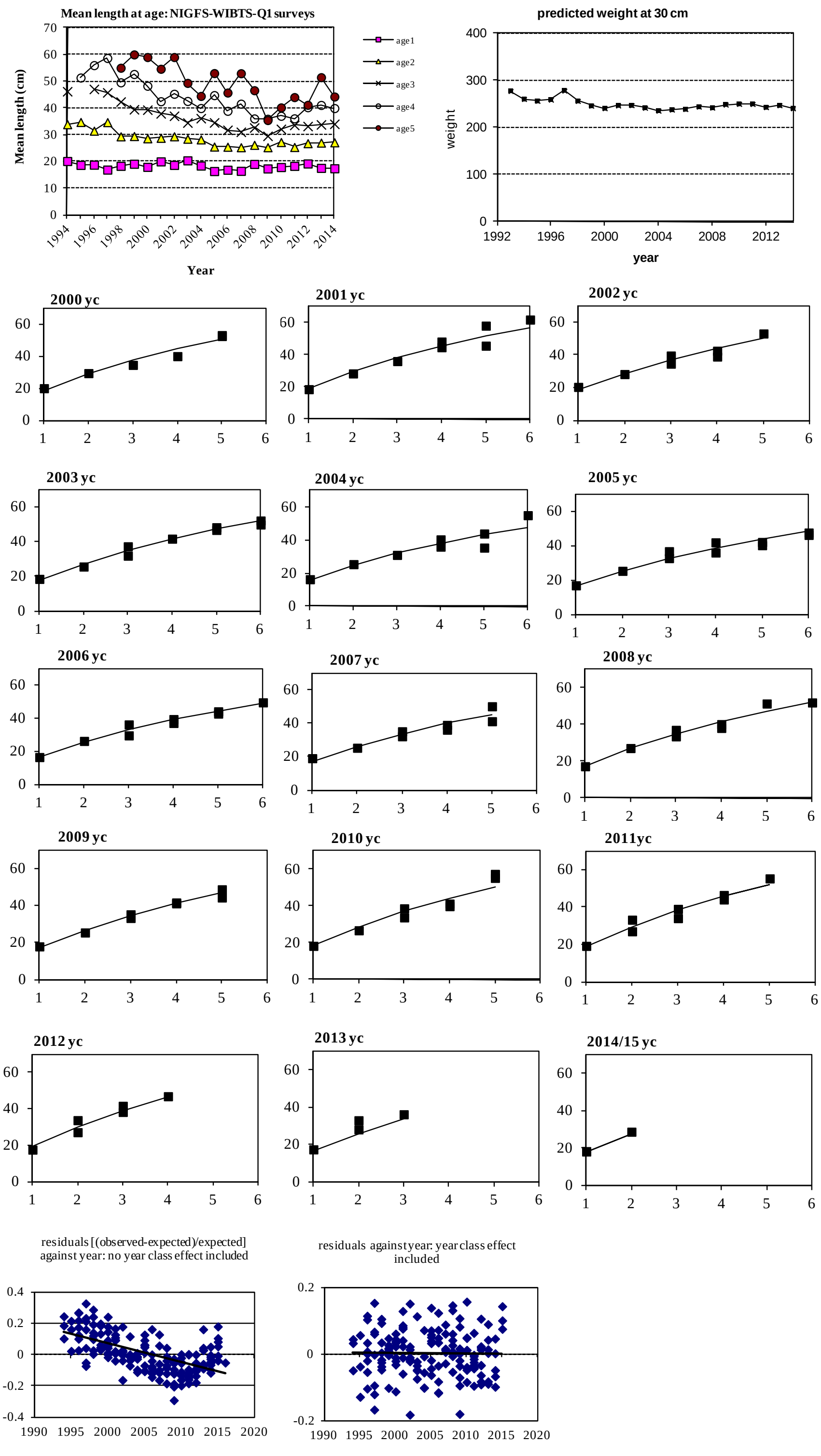


Figure 6.3.1. Haddock in 7.a: Growth of haddock in the Irish Sea. Top two panels: mean length-at-age in UK(NI) groundfish surveys in March (NIGFS-WIBTS-Q1), by year and age, and expected mean weight-at-length based on length–weight parameters from each survey. Lower panels: mean length-at-age from March surveys, and from Quarter 1 commercial landings at-age 3 and over, by year class. Lines are von Bertalanffy model fits with year-class effect included. Model residuals are shown for the fit without year-class effects, and for the fit with year-class effects.

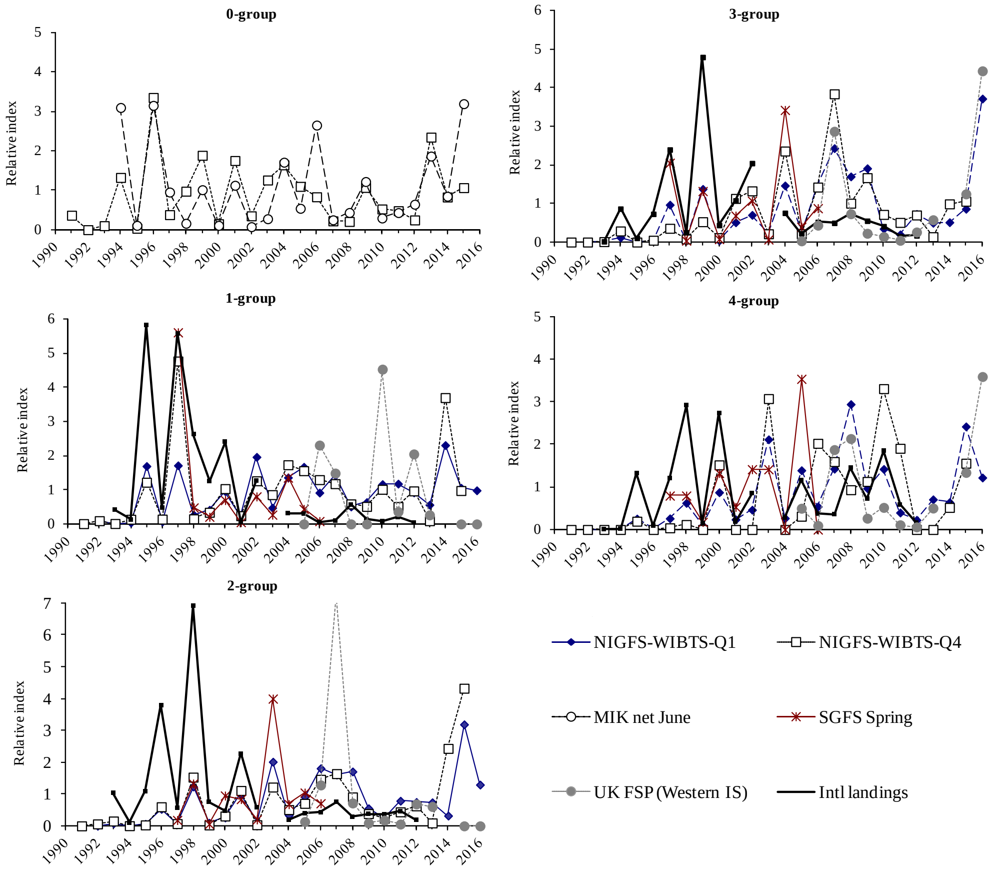


Figure 6.3.2. Haddock in 7.a: Trends in raw survey indices compared with international landings, by age class and year. All values are standardised to the mean for years common to all series in each plot (except for short FSP series).

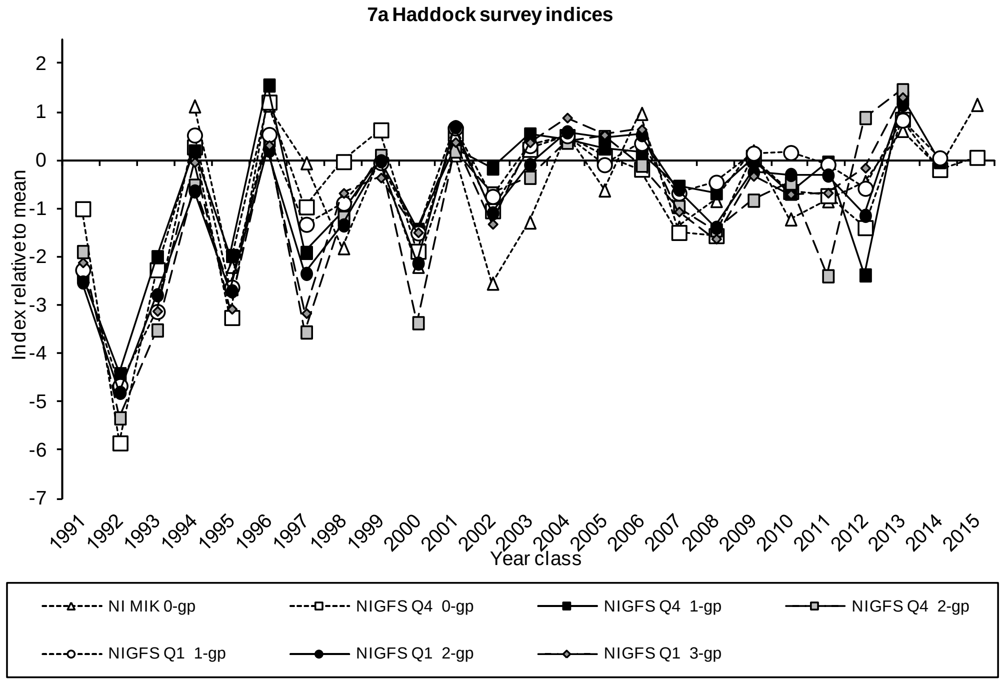


Figure 6.3.3. Haddock in 7.a: Time-series plots of the logarithms of survey indices at-age by year class, after standardising by dividing by the series mean for years from 1991. Data have only been illustrated for the most abundant ages for comparison of year-class signals.

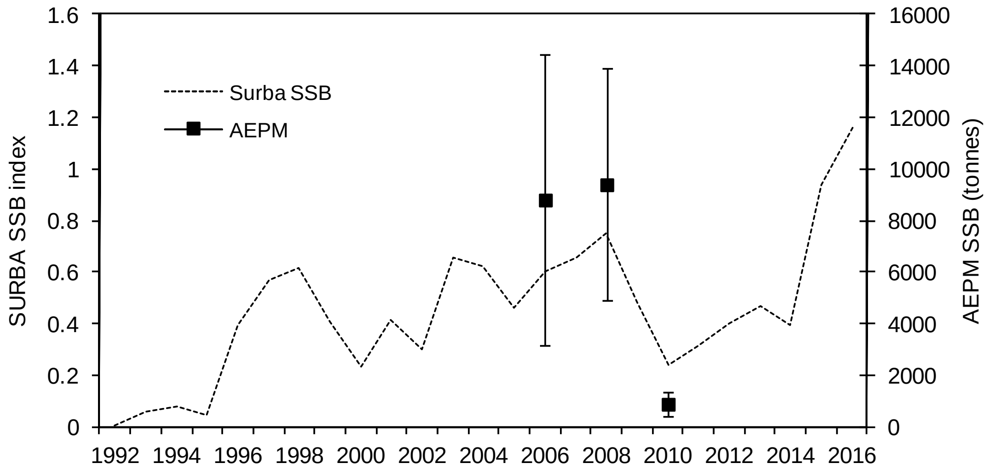


Figure 6.3.4. Haddock in 7.a: Comparison in the relative trends of SSB from 2013 SURBA run and the Irish Sea annual egg production method survey estimates of SSB (+ 2 SE).

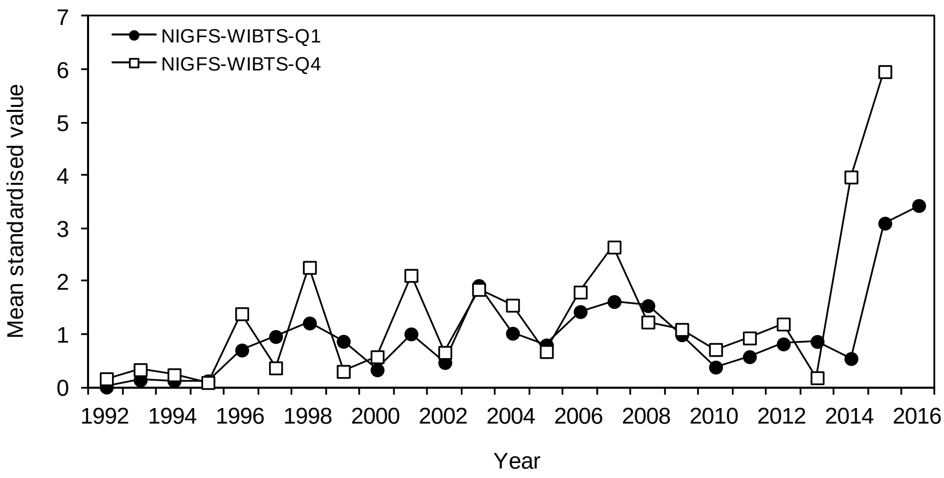


Figure 6.3.5. Haddock in 7.a: Mean Standardised empirical SSB indices from the NIGFS-WIBTS-Q1 and NIGFS- WIBTS-Q4 surveys, based on raw indices up to age 6.

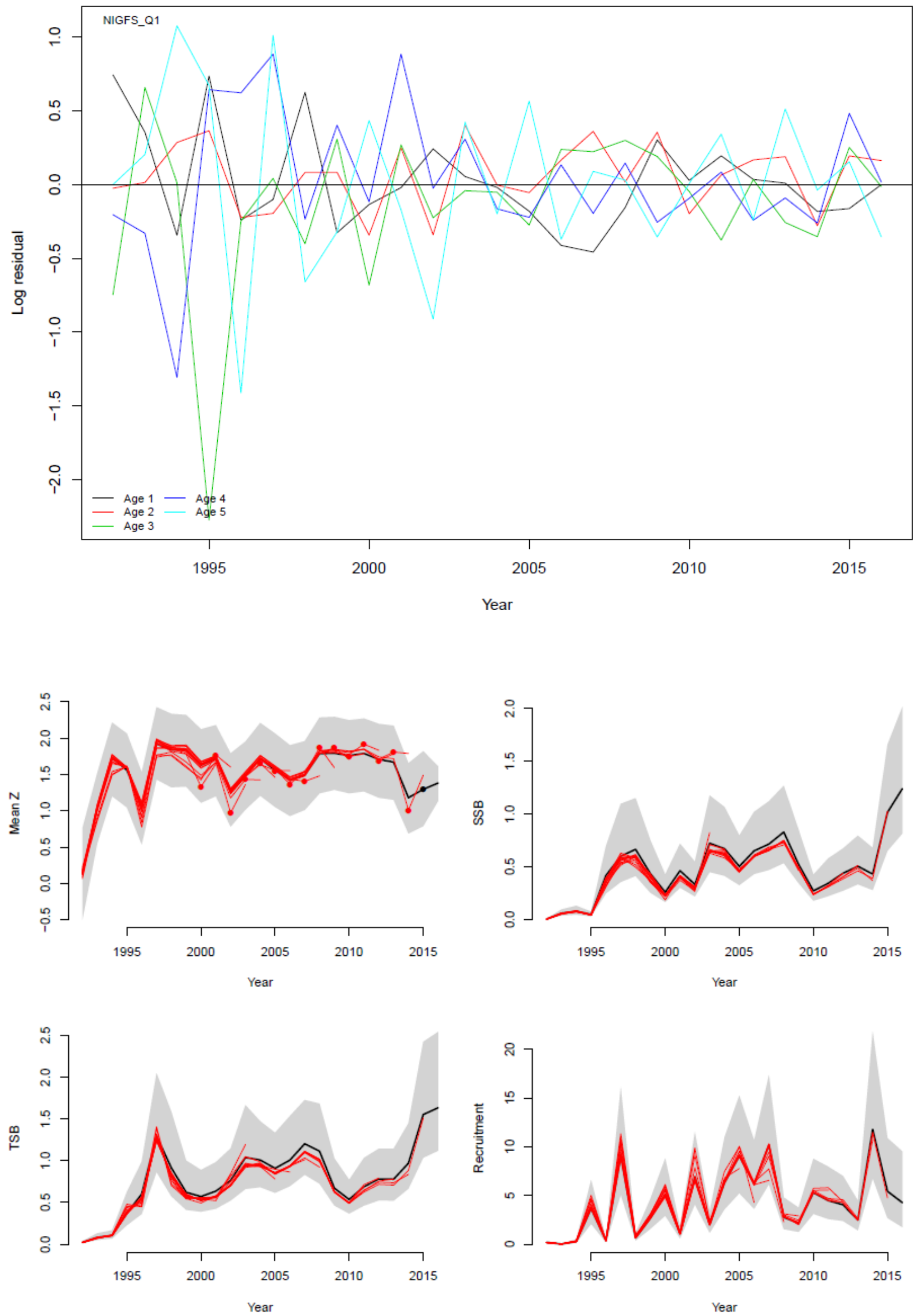


Figure 6.3.6. Haddock 7.a: SURBA Residuals at-age (top panel) and retrospective plots (bottom panel) for the NIGFS-WIBTS-Q1 survey.

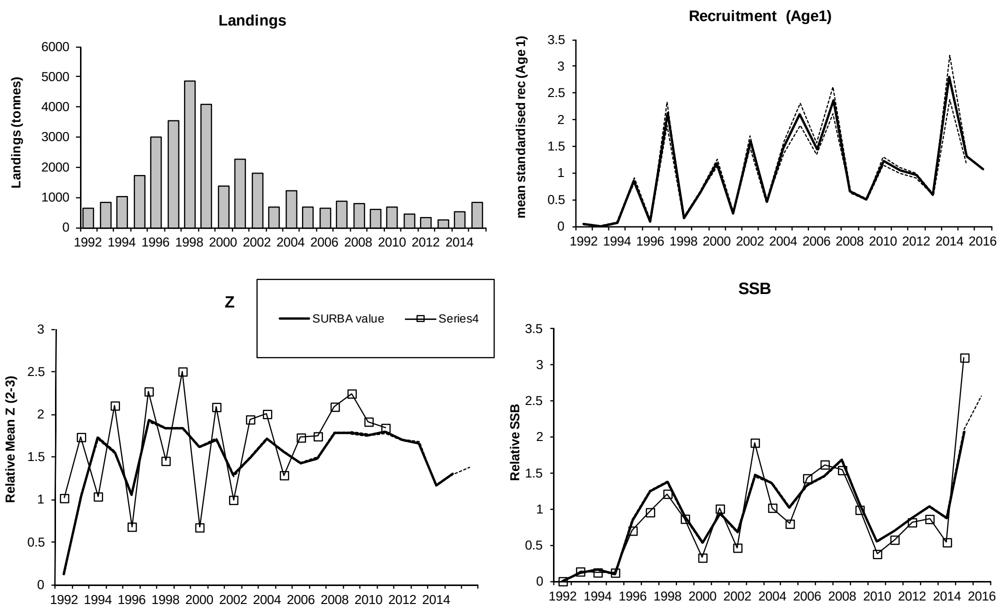


Figure 6.3.7. Haddock 7.a: Summary plots of landings and results of final SURBA run using the NIGFS-WIBTS-Q1 survey data. Dotted lines are +/- 1SE. Empirical estimates of SSB and Z given by SURBA from the raw survey data are also shown.

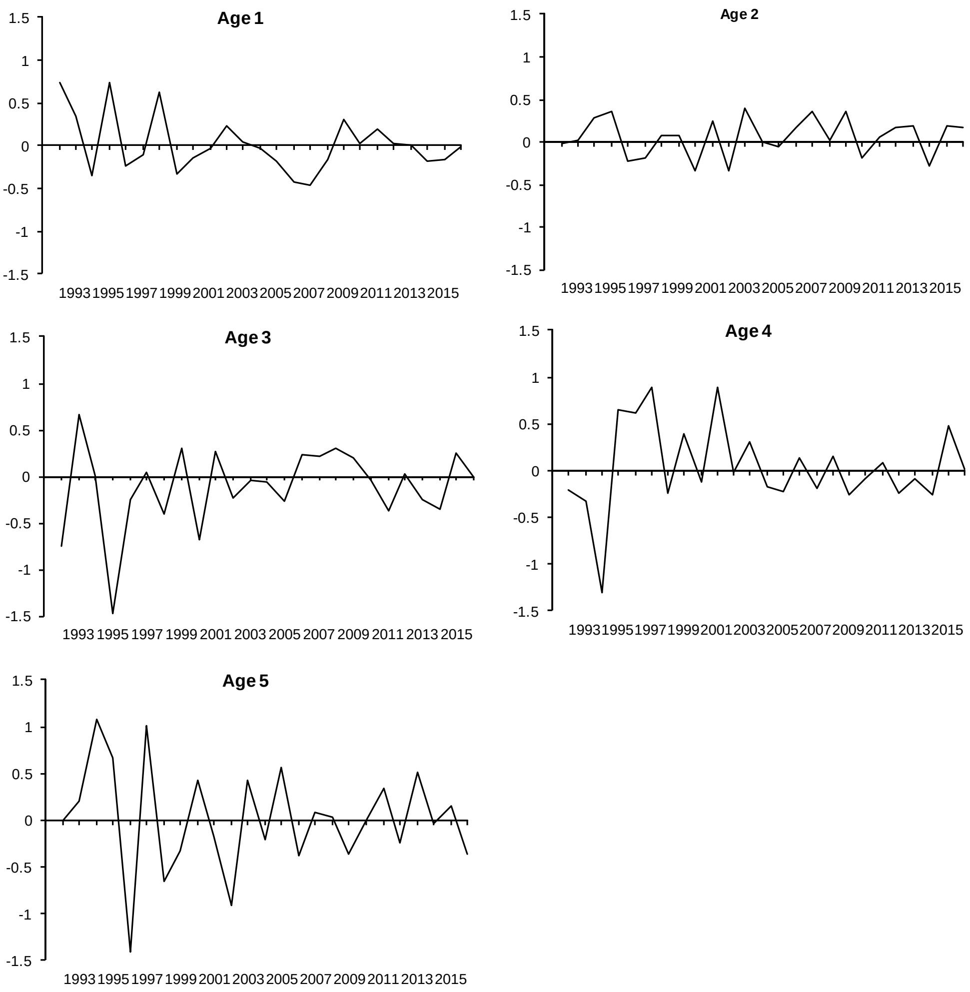


Figure 6.3.8. Haddock 7.a: SURBA Residuals at-age for final run using the NIGFS-WIBTS-Q1 survey data.

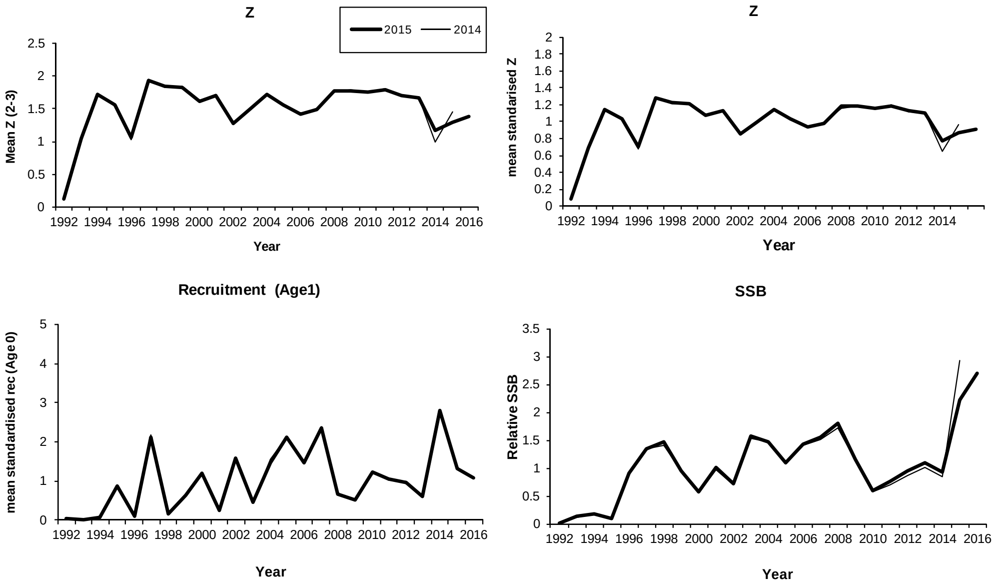


Figure 6.3.9. Haddock 7.a: Trends in SSB, recruitment and Z(2–3) from the 2015 and 2016 SURBA. SSB and recruitment are standardised to the mean for years common to all series (1992–2015) in each plot.

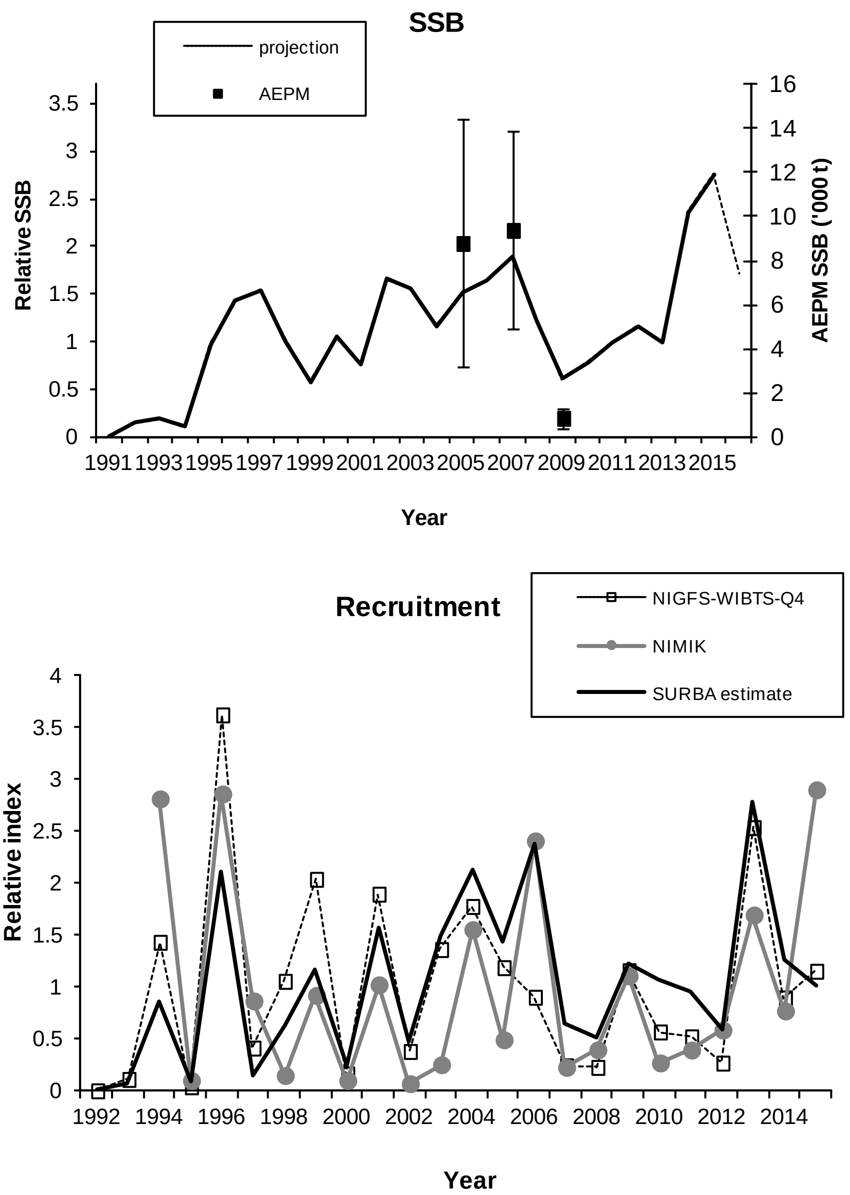


Figure 6.3.10. Haddock 7.a: Trend in SSB form 2015 SURBA projected to 2017 compared to the Irish Sea annual egg production method survey estimates of SSB (+ 2 SE) (top panel) and SURBA estimate of recruitment compared to available 0-gp indices (bottom panel). SSB and recruitment are standardised to the mean for years common to all series (1994–2015) in each plot.

6.3.11 Audit of Haddock in the Irish Sea

Date: 27/05/2016

Auditor: Andrzej Jaworski

General

ICES provides annual catch advice for this stock based on the precautionary approach to data-limited stocks. The assessment is based on survey trends only.

For single stock summary sheet advice

1) **Assessment type:** Update/SALY. The stock was benchmarked by WKROUND in 2013.
2) **Assessment**: Assessment indicative of trends. Data-Limited Stock Category 3.
3) **Forecast**: No forecast was presented.
4) **Assessment model**: SURBA using one survey index of abundance (NIGFS-WIBTS-Q1).
5) **Consistency**: 2015 ASAP assessment of SSB consistent with 2014. The differences in the Z patterns between this year's and last year's assessment are negligible.
6) **Stock status**: SSB has increased markedly following a short-time decline in 2014, being highest in the time-series. The stock is characterized by highly variable recruitment. The estimated recruitment in 2015 is uncertain due to conflicting survey indices.
7) **Man. Plan**: No management plan has been agreed or proposed.

General comments

The report was generally written and the assessment followed the methods detailed in the stock annex.

Technical comments

SURBA analysis was correctly performed. There were some small errors (mainly in editing), but they can be easily corrected.

Conclusions

The assessment has been performed correctly and provides an appropriate basis for providing catch advice.

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice? **Yes**
- Is the assessment according to the stock annex description? **Yes**
- Is general ecosystem information provided and is it used in the individual stock sections. **Yes**
- If a management plan has been agreed, has the plan been evaluated? **No management plan.**

For update assessments

- Have the data been used as specified in the stock annex? **Yes**
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? **Yes** (no forecast).
- Is there any **major** reason to deviate from the standard procedure for this stock? **Yes** (in order to improve data-limited status).

- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? **No** (not yet; this will be considered at the benchmark).

6.4 *Nephrops* in Division 7.a (Irish Sea East, FU14)

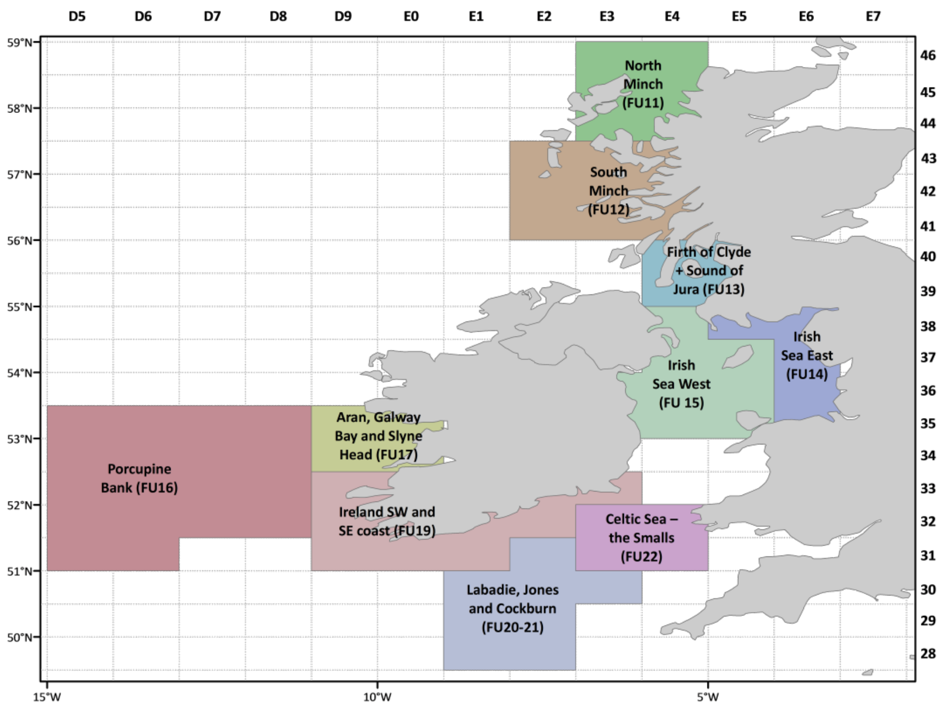
Nephrops Subarea 7 general section

Stock description and management units

A TAC is in place for ICES Area 7 which does not correspond to the assessment units. As *Nephrops* are limited to muddy habitats the distribution of suitable sediment defines the species distribution and the stocks are therefore assessed as eight separate Functional Units. There are also some smaller catches from areas outside these Functional Units. The ICES statistical rectangles covered by the Functional Units in ICES Area 7 are listed in the table below.

FU NO.	NAME	ICES DIVISIONS	ICES STATISTICAL RECTANGLES
14	Irish Sea East	7a	35–38E6; 38E5
15	Irish Sea West	7a	36E3; 35–37 E4–E5; 38E4
16	Porcupine Bank	7b,c,j,k	31–36 D5–D6; 32–35 D7–D8
17	Aran Grounds	7b	34–35 D9–E0
18	Northwest Irish Coast	7b	36-37 D9; 37E0-E1
19	Southeast and southwest Irish Coast	7a,g,j	31–33 D9–E0; 31E1; 32E1–E2; 33E2–E3
20-21	Labadie, Jones and Cockburn bank	7g,h	28 EO-E2; 29 E0-E3; 30E1-E3; 31E2
22	Smalls Ground	7g	31–32 E3, 31–32 E4

Nephrops Functional Units in Subarea 7. The TAC covers all of Subarea 7:



Minimum landing size

The MLS for the regions are 25-mm CL (or over 85 mm total length) in the North Sea (4, FUs 5–10), around Ireland (FUs 16–22) and the Norwegian Deep (FU 32), and 20 mm CL (or over 70 mm total length) on the West coast (6.a, FUs 11–13), the Irish Sea (7a, FUs 14–15) and the Bay of Biscay (7I), and the Iberian Peninsula (9); for Sweden, and Skagerrak and Kattegat (FUs 3 and 4), it is 40 mm CL (>13 cm total length).

The minimum landings size implemented by EC for the Irish Sea is 20 mm CL, which is less than the rest of the ICES Area 7 (set at 25 mm); this applies to the Irish and UK fleets. A more restrictive regulation is adopted by the French Producers' Organisations (35 mm CL i.e. 11.5 cm total length) to all French trawlers.

AREA	MLS (CL SIZE)
Area 7 (except 7a)	25 mm CL - Irish and UK fleets
Area 7a	20 mm CL - Irish and UK fleets
Area 7	35 mm CL – French trawlers

Management applicable in 2015 and 2016

The TAC is currently set for the whole Area 7. The TAC for 2016 was 23 348 t, this represented an increase of 8% in relation to 2015 with 21 619 t. The TAC area includes a number of *Nephrops* stocks showing different levels of exploitation. A single TAC covering a number of distinct stocks allows the possibility of unrestricted catches being taken from a heavily exploited stock when advice suggests they should be limited.

Details of all regulations including effort controls in place are provided in the stock annex for all Functional Units under this Subarea.

COUNCIL REGULATION (EU) No 43/2014 of 19 January 2015 fixing for 2015 the fishing opportunities available to EU vessels for certain fish stocks and groups of fish stocks which are not subject to international negotiations or agreements.

TAC in 2015

Species:	Norway lobster *Nephrops norvegicus*	**Zone:**	VII (NEP/07.)
Spain	1 297		
France	5 257		
Ireland	7 973		
United Kingdom	7 092		
Union	21 619		
TAC	21 619		Analytical TAC Article 11 of this Regulation applies

Special condition:

within the limits of the abovementioned quotas, no more than the quantities given below may be taken in the following zone:

	Functional Unit 16 of ICES Sub-area VII (NEP/*07U16):
Spain	558
France	349
Ireland	671
United Kingdom	272
Union	1 850

COUNCIL REGULATION (EU) 2016/72 of 22 January 2016 fixing for 2016 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, and amending Regulation (EU) 2015/104

TAC in 2016

Species:	Norway lobster *Nephrops norvegicus*	**Zone:**	VII (NEP/07.)
Spain	1 401		
France	5 678		
Ireland	8 610		
United Kingdom	7 659		
Union	23 348		
TAC	23 348		Analytical TAC Article 12(1) of this Regulation applies

Special condition:

within the limits of the abovementioned quotas, no more than the quantities given below may be taken in the following zone:

	Functional Unit 16 of ICES Subarea VII (NEP/*07U16):
Spain	558
France	349
Ireland	671
United Kingdom	272
Union	1 850

Landings area 7

Text table below gives the summary of reported landings by Functional Unit for ICES Area 7.

Year	FU 14 – Irish Sea East	FU 15 – Irish Sea West	FU 16 – Porcupine Bank	FU 17 – Aran Grounds	FU 18 – Ireland North West Coast	FU 19 – Ireland South West and South East coast	FU 20-21 – Labadie, Jones, Cockburn	FU 22 – Smalls Grounds	FUs 20+21+22 – All Celtic Sea FUs combined	Other statistical rectangles Outside FUs	Total Landings ICES Sub-area 7	TAC for 7
1978	961	7,296	1,744	481						249	10,730	
1979	900	8,948	2,269	452						237	12,807	
1980	730	4,578	2,925	442						205	8,880	
1981	829	7,249	3,381	414						382	12,255	
1982	869	9,315	4,289	210						234	14,917	
1983	763	9,448	3,426	131					3,667	174	17,609	
1984	602	7,760	3,571	324					3,653	187	16,097	
1985	498	6,901	3,919	207					3,599	194	15,317	
1986	671	9,978	2,591	147					2,638	113	16,138	
1987	449	9,753	2,499	62					3,409	107	16,279	24,700
1988	462	8,586	2,375	828					3,165	140	15,557	24,700
1989	401	8,128	2,115	344		899			4,005	134	16,026	26,000
1990	563	8,300	1,895	519		754			4,290	102	16,423	26,000
1991	747	9,554	1,640	410		1,077			3,295	169	16,892	26,000
1992	427	7,541	2,015	372		888			4,165	409	15,816	20,000
1993	515	8,102	1,857	372	10	905			4,648	455	16,863	20,000

Year	FU 14 – Irish Sea East	FU 15 – Irish Sea West	FU 16 – Porcupine Bank	FU 17 – Aran Grounds	FU 18 – Ireland North West Coast	FU 19 – Ireland South West and South East coast	FU 20-21 – Labadie, Jones, Cockburn	FU 22 – Smalls Grounds	FUs 20+21+22 – All Celtic Sea FUs combined	Other statistical rectangles Outside FUs	Total Landings ICES Sub-area 7	TAC for 7
1994	447	7,606	2,512	729	126	390			5,143	570	17,523	20,000
1995	584	7,796	2,936	866	26	695			5,505	397	18,805	23,000
1996	475	7,247	2,230	525	46	888			4,828	623	16,862	23,000
1997	566	9,971	2,409	841	15	756			4,240	340	19,138	23,000
1998	388	9,128	2,155	1,410	78	827			3,925	514	18,426	23,000
1999	624	10,786	2,289	1,140	16	579	1,152	1,788		322	18,699	23,000
2000	567	8,370	911	880	9	696	1,778	2,907		243	16,365	21,000
2001	532	7,441	1,222	913	2	815	1,833	2,935		368	16,064	18,900
2002	577	6,793	1,327	1,154	14	1,318	2,674	1,990		243	16,099	17,790
2003	376	7,052	907	933	16	1,239	2,953	2,050		186	15,712	17,790
2004	472	7,266	1,525	525	22	1,074	2,443	1,827		161	15,314	17,450
2005	570	6,529	2,312	778	15	711	2,469	2,425		180	16,042	19,544
2006	628	7,535	2,120	637	14	741	2,523	1,752		270	16,210	21,498
2007	959	8,424	2,186	1,096	3	957	2,419	2,881		206	19,130	25,153
2008	726	10,482	1,000	1,057	1	841	2,980	3,114		111	20,430	25,153
2009	693	9,166	825	625	10	833	3,145	2,245		81	17,619	24,650
2010	583	8,929	917	1,000	7	722	1,793	2,708		50	16,710	22,432
2011	561	10,159	1,187	600	13	608	1,237	1,617		109	16,092	21,759

Year	FU 14 – Irish Sea East	FU 15 – Irish Sea West	FU 16 – Porcupine Bank	FU 17 – Aran Grounds	FU 18 – Ireland North West Coast	FU 19 – Ireland South West and South East coast	FU 20-21 – Labadie, Jones, Cockburn	FU 22 – Smalls Grounds	FUs 20+21+22 – All Celtic Sea FUs combined	Other statistical rectangles Outside FUs	Total Landings ICES Sub-area 7	TAC for 7
2012	531	10,527	1,260	1,135	28	770	1,189	2,633		289	18,360	21,759
2013	495	8,672	1,142	1,295	-	781	1,387	2,255		49	16,076	23,605
2014	679	8,613	1,189	766	-	468	1,840	2,614		119	16,288	20,989
2015	378	8,632	1,394	370	-	507	2,116	2,368		65	15,830	21,619
Average	600	8,383	2,065	658	20	805	2,114	2,359	4,011	237	21,252	

Nephrops FU14 section

Type of assessment in 2016

This stock was inter-benchmarked in September 2015 (ICES, 2016) and 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 inter-benchmark process and described in the stock annex (updated at WGCSE 2016). The UWTV survey done in the summer 2016 will form the basis of advice for this stock in the autumn 2016.

ICES advice applicable to 2015

"ICES advise on the basis of the MSY approach that landings in 2015 should be no more than 662 tonnes. If total discard rates do not change from the average of 2006–2008, this implies total catches of no more than 715 tonnes. For this FU, no discards are expected to survive the discarding process.

In order to ensure the stock in this FU is exploited sustainably, management should be implemented at the functional unit level."

ICES advice applicable to 2016

"ICES advises that when the MSY approach is applied, catches in 2016 (assuming a landing obligation applies) should be no more than 1272 tonnes. If this stock is not under the EU landing obligation in 2016 and discard rates do not change from the average (2013-2014), this implies landings of no more than 1213 tonnes.

In order to ensure the stock in this FU is exploited sustainably, management should be implemented at the functional unit level."

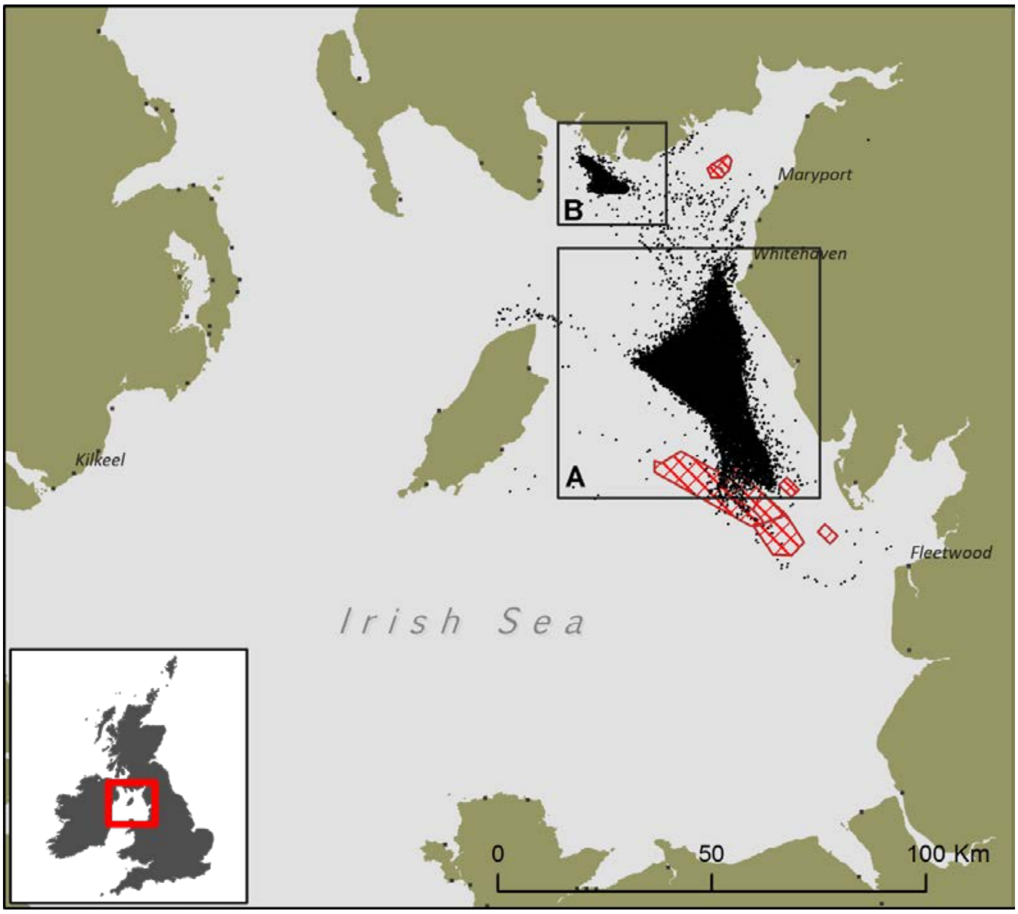
6.4.1 General

Stock description and management units

The Irish Sea East *Nephrops* stock (FU14) is in ICES Subarea 7, more specifically in area 7a which also includes the Irish Sea West (FU15) stock.

FU14 ICES rectangles: 38E5, 38E6, 37E6, 36E6, 35E5

In FU14 *Nephrops* are caught on two spatially discrete grounds. Most of the fishery takes place on the main ground located between the West coast of England and Island of Man, additionally there is also fishing activity in a small inshore ground known as Wigtown Bay.



East Irish Sea fishing grounds: A= Main fishing ground; B= Wigtown bay area. Windfarms represented by red polygons.

Main landing ports: Whitehaven, Fleetwood, Maryport and Kilkeel.

Fishery in 2015

The Eastern Irish Sea *Nephrops* fishery is an UK lead fishery, representing on average 92% of the reported annual international landings (2006–2015) and is considered to be a relative small fishery within area 7.a where landings fluctuated over the past ten years within 378–959 tonnes (Table 6.4.2.). In 2015 the reported landings decreased to the lowest value observed in the past ten years. The main fleets targeting *Nephrops* include directed single-rig and twin-rig otter trawlers operating out of ports in UK (NI), UK (E&W) and Republic of Ireland.

As in previous years, in 2015, the UK fleet accounts for the highest proportion of landings in tonnes, with a significant decrease from Northern Irish vessels (Figure 6.4.1)

Republic of Ireland vessels increased their share of the landings to 35% in 2002, showing a period of low landings for the following years (6%, average 2005 to 2014). In 2015 the Republic of Ireland vessels increased again their share of landings, representing 23% of the total landings reported for this year.

A more detailed historical fishery description is provided in the stock annex.

Information from stakeholders

No information provided.

6.4.2 Data

InterCatch

Data for 2015 were successfully uploaded into InterCatch prior the 2016 WG meeting. Uploaded data were worked-up in InterCatch to generate 2015 raised international length–frequency distributions and to derive catch and discard length frequencies for 2015.

Landings

Official landings as reported to ICES from FU14 are presented in Table 6.4.1 and were updated for 2015 data.

There are reported landings for this functional unit since 1973 with a minimum and maximum of 178.7 t (in 1974) and 960.5 t (in 1978), respectively. Between 1987 and 2006 landings from FU14 appeared relatively stable fluctuating around a long-term average of about 550 t. Landings in 2015 (378 t) decreased 44% in relation to 2014. The introduction of the buyers and sellers legislation in 2006 by the UK precludes direct comparison with previous years as reported levels are considered to have significantly improved.

Over the last ten years (2006–2015) UK vessels have landed, on average, ~92% of the reported annual international landings. Irish vessels increased their share of the landings to 35% in 2002 but it has declined since then to values generally <10% of the international landings. In 2015 the Republic of Ireland fleet landings increased significantly, accounting for 23% of the total landings (Table 6.4.2).

Effort

Following discussions at WGCSE it was concluded that effort should be reported in the WGCSE report in KWdays and lpue should be reported in KG/kwdays in the knowledge that the trend is likely to be a biased underestimate because it is not adjusted for efficiency or behavioural changes. The time-series of effort and lpue is updated in Table 6.4.3 and Figure 6.4.2. There was a significant decline in effort in 2015 which is due to decrease of Northern Ireland vessels on the ground.

Sampling levels

Sampling levels, data aggregating and raising procedures were reviewed by IBPNeph 2015 and are documented in the stock annex. Sampling levels in 2015 decreased in comparison with 2013–2014 levels.

Commercial Length–Frequency Distributions

The raised catch length distributions are shown in Figure 6.4.3. The mean sizes for both sexes from 2008 fluctuate considerably.

Length composition

Since 2009 sampling was considered insufficient to derive catch and discard length frequencies. As a result none of the length derived metrics have been updated for 2010, 2011 and 2012. However, due to increase in number of samples for 2013 and 2014 a full revision was done through an inter-benchmark process (ICES, 2015; described in the stock annex).

Data aggregating and raising procedures in 2015 were conducted according to benchmark procedures (ICES, 2005) and referred in the stock annex.

Updated historical trends in length distributions and proportion discarded are shown in Figure 6.4.3 and Table 6.4.4. Final discard selection for the East Irish Sea shows a L50= 23.54 and a L25=24.77 mm CL (Figure 6.4.4), which shows a selectivity at higher sizes compared with FU15.

Sex ratio

The catch sex ratio by year is shown in Figure 6.4.5. This shows some fluctuations over time, but showing for the last three year a proportion of around 50%. Between 2010 and 2012 due to poor sampling levels estimates of sex ratio are not reliable.

Mean weight explorations

The annual mean weight estimate for landings and discards is provided in Table 6.4.4 and in Figure 6.4.6. The mean weight for 2015 landings increased in relation to two previous years but is in line with mean historical values. Mean weight for discards decreased in relation to 2014, being very similar with 2013 estimates.

Discarding

Discard selection was revised at the IBP process in 2015 (ICES, 2015) and described in the stock annex. Figure 6.4.4 shows a single discard ogive fitted by pooling all years (2003–2014) and mesh sizes. Final discard selection for the East Irish Sea shows a L50= 23.54 and a L25=24.77 mm CL (Figure 4.3.4), which shows a selectivity at higher sizes compared with FU15. Discard ogive was not updated using 2015 data.

Table 6.4.5 gives raised international landings and discard weight and numbers by year.

At IBPNephs (ICES, 2015) it was agreed that the discard survival rate should be updated form 0% to 10%. Although there are no direct survivability studies available for this area it is expected that the survivability of discarded animals should be similar to the fishery in FU 15 where fishing practices are similar and both are largely spring/summer fisheries and animals discarded are exposed to warmer temperatures before returned to sea.

Abundance indices from UWTV surveys

In August of 2007–2016 the UK and the Republic of Ireland carried out an underwater TV survey of the *Nephrops* grounds in the eastern Irish Sea. The survey is of a fixed grid design and is carried out using the same protocols used in UWTV surveys in the western Irish Sea (ICES, 2007; ICES, 2014). The survey stations used in 2016 are presented in Figure 6.4.7.

Due to the construction of the wind farm in the southern part of the ground the survey area was reviewed at IBP 2015 but the protocols and standardised process to run the survey were not modified (see stock annex and IBP 2015 report ICES, 2015). The new survey area (based on a co-kriging model) is shown in Figure 6.4.8. The boundary used to define the ground limits for absolute abundance runs close to the outer survey stations.

GROUND	AREA KM²	SOURCE
Main ground 2008–2010	1032.75	WGCSE 2008
Main ground 2011–2016	1019.79	IBP 2015 – ICES, 2015
Wigtown Bay	67.21	IBP 2015 – ICES, 2015

Wigtown Bay in relation to Main ground = 6.6% * (increase from 1.9% prior to the windfarm construction).

Abundance indexes were revised back to 2011, year where the effect of effort displacement is clearly visible due to the wind farm construction. Final updated abundance burrow density estimates are presented in Figure 6.4.9 where the geo-spatial model was updated using the new area based on the co-kriging approach (1019.79 Km²) and the extrapolation to Wigtown Bay using 6.6%.

Abundance estimate for 2016 (432.9 million) decreased compared to 2015 figure of 590.5 million (Figure 6.4.10), but showing a similar abundance estimation of 2013 and 2014. The surveys show a clear spatial distribution pattern, with highest densities in the central north of the patch and variable in the area further south. The grounds are fairly well delineated by consistently low density ground to the northeast and west (Figure 6.4.9).

YEAR	NO VALID STATIONS	MEAN KRIGGED DENSITY (NO./M²)	ABUNDANCE (MILLIONS) INCLUDING WIGTOWN BAY (1.9% 2008-2010)	ABUNDANCE (MILLIONS) INCLUDING WIGTOWN BAY (6.6% 2011-2015)	95% CI	CV
2007	Unreliable data					
2008	32	0.38	407.6		63.0	
2009	32	0.33	350.0		76.0	
2010	26	0.4	422.0		103.0	
2011	26	0.41		449.2	98.8	11.8%
2012	26	0.64		693.8	99.0	7.8%
2013	31	0.45		487.0	81.6	9.1%
2014	34	0.41		449.1	91.8	10.7%
2015	42	0.54	590.5		86.0	7.9%
2016	48	0.40	432.9		106.3	-

As described in previous reports, the limited number of stations available on the 2007 survey and the poor quality of the data processed preclude its use in formal assessment. The subsequent surveys were far more successful. A new camera and sledge improved the resolution of the footage captured and the sea conditions were far better so the quality of the video data collected was much improved, thus the valid surveys dataseries started in 2008.

Changes to number of UWTV stations:

- Due to the construction of the Walney Offshore wind farm in the southern part of the ground, in 2010 and 2011 some stations were abandoned.

- In 2011 three new exploratory stations were added due to some VMS activity in that part of the ground. Although, those stations were very close to zero burrows counts and were not included in the calculations of the main area abundance.
- In 2012 another station was added in the eastern part of the ground, but no *Nephrops* burrows were observed in this station.
- In 2013 three stations were moved slightly due to the proximity of new windfarm.
- In 2015 new exploratory stations (14-AS, 14-AT, 14-AU, 14-AV and 14-AW) were added to support the benchmark process to review of the ground boundaries for this stock.
- In 2016, following the benchmark recommendations, new stations were added in Wigtown Bay area (14-BA, 14-AY, 14-AZ).

The use of the UWTV surveys for the provision of *Nephrops* management advice was extensively reviewed by WKNEPH (2009). A number of potential factors were highlighted including those due to edge effects; species burrow misidentification and burrow occupancy. Using the same process adopted at WKNEPH, a cumulative absolute conversion factor for this FU was predicted to be 1.2 for FU14 (see stock annex) which means the TV survey is likely to overestimate *Nephrops* abundance by 20%. The burrow abundances shown in Table 6.4.5 and Figure 6.4.9 have been adjusted using this conversion factor since 2008.

6.4.3 Assessment

Comparison with previous assessments

The WGCSE 2016 carried out an UWTV based assessment for this stock. The methods used were very much in line with WKNEPH (ICES, 2009) and the approach taken for other *Nephrops* stocks in 6 and 7 by WGCSE. This approach was inter-benchmarked at IBPNeph (ICES, 2015).

State of the stock

UWTV abundance estimates suggest that the stock size has fluctuated between abundance values of 350 and 694 million *Nephrops*. The 2016 estimate (432.9 millions) decreased in relation to 2015 although still in line with some historical figures and is above the MSY $B_{trigger}$ (350 millions).

The 2016 abundance is slightly below the average of the series 2008–2015 (geo-mean: 481 million). Table 6.4.5 and Figure 6.4.11 summarize the abundance estimated including the confidence intervals and the harvest ratios which have been above the $F_{MSYproxy}$.

6.4.4 Catch option table

Catch option table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 6.4.5 and summarised below. The calculation of catch options for the FU14 follows the procedure outlined in the stock annex.

The basis for the catch options:

VARIABLE	VALUE	NOTES
Stock abundance	432.9	UWTV Survey 2016
Mean weight in landings	22.1 g	Average 2013–2015
Mean weight in discards	8.4 g	Average 2013–2015
Discard rate	13.3%	Average (proportion by number) 2013–2015. Calculated as discards/(landings + discards).
Discard survival rate	10%	Only applies in scenarios where discarding is allowed.
Dead discard rate	12.2%	Average 2013–2015 (proportion by number). Calculated as dead discards divided by dead removals (landings + dead discards). Only applies in scenarios where discarding is allowed.

6.4.5 Reference points

New reference points were defined for this stock at the IBPNeph (ICES, 2015) and no new proposals were made by WKMSYRef4 (ICES, 2016a, 2016b).

Based on the fact that some biological parameters are poorly known; inconsistent biological sampling; uncertainties about the stability of the stock over the reference period and uncertainties about the variability of recruitment it is expected that a combined sex $F_{0.1}$ is a suitable F_{MSY} proxy for this stock. This corresponds to a harvest rate of 11% and this value is expected to deliver high long-term yield with a low probability of recruitment over-fishing. These calculations assume that the UWTV survey has knife-edge selectivity at 17 mm and that the supplied length frequencies represented the population in equilibrium. Currently this fishery is being harvest at 6.7% (Fsq_2013–2015 = 5.5%; F2015= 2.9%), and historically the available data show a maximum harvest rate of 8.2% in 2008 which is below the F_{MSY} proxy.

At the IBP a MSY $B_{trigger}$ was defined for this stock. Accordingly with this definition $B_{trigger}$ it was set for FU14 as 350 million, corresponded to the abundance observed in 2009.

FRAMEWORK	REFERENCE POINT	VALUE	TECHNICAL BASIS	SOURCE
MSY approach	MSY $B_{trigger}$	350 million individuals	The lowest observed abundance estimate from the UWTV survey time-series.	ICES (2015)
	F_{MSY}	11% harvest rate	F_{MSY} proxy equivalent to $F_{0.1}$ for combined sexes.	ICES (2015)

6.4.6 Management strategies

There are no explicit management strategies for this stock.

6.4.7 Quality of assessment and forecast

The quality of landings data has improved in the last four years but concerns over the accuracy of earlier years limits the period we can be confident about regarding trends in lpue and landings.

Underwater TV surveys have been conducted annually for this stock since 2007. The quality of the data from the first survey and the limited number of valid stations in the survey limits the number of useable surveys to 2008–2013.

The revised algorithm used to derive distance covered by the sledge is considered as significantly more robust than the previous algorithm.

The IBP 2015 managed to address key points:

- Revisions to the area of the *Nephrops* grounds based on new available data: VMS, UWTV data and sediment information
- A review of fishery data and raising procedures.
- Review of Reference points: F_{MSY} proxies and MSY $B_{trigger}$.

After this revision the quality of the assessment improved. Although there are still specific uncertainties and assumptions that need to be examined further for the East Irish Sea before less conservative F_{MSY} proxies could be considered.

There are several key uncertainties and bias sources in the method proposed (these are discussed further in ICES, 2009a). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (ICES, 2007; ICES, 2008; ICES, 2009b). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that is more accurate but no more precise (ICES, 2009a).

The cumulative absolute conversion factor estimates for FU14 are largely based on expert opinion. However these were based on experience on other grounds and relatively limited experience on these grounds which would make this less reliable. The precision of these cannot yet be characterised. Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates.

The effect of this assumption on realised harvest rates has not been investigated but remains a key uncertainty.

6.4.8 Recommendation for next benchmark

This stock was last benchmarked by IBPNeph (ICES, 2015). WGCSE will keep the stock under close review and recommend future benchmark as required.

At IBP 2015 it was mentioned that there are specific uncertainties and assumptions that need to be examined further for the East Irish Sea before less conservative F_{MSY} proxies could be considered.

- More accurate mapping of the spatial extent of the grounds and fisheries, this includes having positional data for <12 meter vessels and more survey data in Wigtown Bay area to better define this ground. Station grid was extended to Wigtown Bay in 2016.
- For now the total abundance estimate for FU14 is based on the abundance estimates of the geospatial model for the main ground plus adding the area of Wigtown Bay. As this area is becoming a more significant fishing patch it is worth to consider the use of a separate geospatial model in this ground. This should be explored in a future benchmark work.
- Improvement of spatial coverage and sampling of landings and discards, this includes increasing the sampling levels to covers Northern Irish ves-

sels, as the current sampling is mainly focused on local vessels form Whitehaven port.

- Area specific length–weight and maturity data to validate the parameters used for this FU.
- Better knowledge of the difference in growth and population structure across the area.

6.4.9 Management considerations

ICES 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 allow effort and catch to be controlled in line with the scale of the resource.

There are no explicit recruitment indices.

The UWTV survey data allow for the provision of catch options and also to adopt the MSY approach. The UWTV surveys are conducted annually and a benchmark process has been adopted in 2015. In the past this stock has only been assessed biannually. These data provide the opportunity to reassess this stock more reliably on an annual basis.

6.4.10 References

ICES. 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM:14.

ICES. 2008. Report of the Workshop and training course on *Nephrops* burrow identification (WKNEPHBID). ICES CM 2008/LRC:03.

ICES 2009a. Report of Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM:2009/ACOM:33.

ICES. 2009b. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2009/LRC: 15, pp 52.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS), 6–8 March 2012, Acona, Italy. ICES CM 2012/SSGESST:19. 36 pp.

ICES. 2014. Report of the Working Group on *Nephrops* Surveys (WGNEPS). ICES CM 2014/SSGESST:20. 57 pp.

ICES. 2015. Report of the Inter-Benchmark Protocol of *Nephrops* in FU 17 and 14 (IBPNeph), from June to September 2015, by correspondence. ICES CM 2015/ACOM:38. 86pp.

ICES. 2016a. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES Subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

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

Table 6.4.1. Irish Sea: Landings (tonnes) by FU, 2000–2012. 2015* refers to preliminary landings data. In 2012 and 2013 landings outside FU for Area 7a were not provided, so have been calculated from ICES official landings for 7a minus the FU areas.

YEAR	FU14	FU15	OTHER	TOTAL
2000	567	8370	1	8938
2001	532	7441	3	7976
2002	577	6793	1	7371
2003	376	7052	3	7431
2004	472	7267	25	7764
2005	570	6554	103	7227
2006	628	7561	52	8241
2007	959	8491	83	9533
2008	676	1050	122	11306
2009	708	9198	57	9963
2010	582	8963	23	9568
2011	561	10162	61	10784
2012	531	10527	208	11266
2013	495	8672	89	9256
2014	679	8613	NA	9292
2015*	378	8632	NA	9010

Table 6.4.2. Irish Sea East (FU14): Landings (tonnes) by country, 2000–2015.

YEAR	REP. OF IRELAND	UK	OTHER COUNTRIES	TOTAL
2000	114	451	2	567
2001	26	506	0	532
2002	203	373	1	577
2003	69	306	1	376
2004	62	409	1	472
2005	34	536	0	570
2006	34	594	0	628
2007	86	873	0	959
2008	29	652	0	681
2009	16	692	0	708
2010	45	538	0	583
2011	31	530	0	561
2012	53	478	0.123	531
2013	35	460	0.195	495
2014	31	648	0	679
2015	88	290	0	378

Table 6.4.3. Irish Sea East (FU14): Effort data for the UK and Irish trawl *Nephrops* directed fleet.

	UK direct fleet			Irish direct fleet		
YEAR	EFFORT (KW DAYS)	LANDINGS (TONNES)	LPUE/KWDAYS	EFFORT (KW DAYS)	LANDINGS (TONNES)	LPUE/KWDAYS
2000	145 794	393	6.8	47 958	109	2.3
2001	141 686	417	6.9	8691	21	2.4
2002	97 368	285	6.8	72 588	201	2.8
2003	114 096	226	4.5	23 269	41	1.8
2004	107 570	323	6.9	26 345	55	2.1
2005	124 349	395	6.6	17 504	34	1.9
2006	249 846	408	4.3	6932	18	2.7
2007	345 818	668	6.7	25 309	79	3.1
2008	308 427	508	4.3	8136	15	1.8
2009	262 030	499	5.1	5516	13	2.4
2010	217 937	356	4.8	13 496	45	3.3
2011	188 876	356	5.5	8955	31	3.4
2012	163 110	301	5.3	21 224	53	2.5
2013	170 799	339	5.6	11 304	35	3.1
2014	179 356	404	6.1	10 259	29	2.8
2015	79 960	155	5.0	27 128	84	3.1

Table 6.4.4. Irish Sea East (FU14): Mean size (CL) and weight combined by sex for total annual landings and discards and proportion discarded.

Year	Mean CL (mm) Landings	Mean CL (mm) Discards	Mean Weight (g) Landings	Mean Weight (g) Discards	Proportion discarded
2000	29.83	22.32	19.05	7.52	0.26
2001	30.59	22.74	20.87	7.97	0.17
2002	30.64	23.75	22.41	8.98	0.15
2003	33.69	22.43	29.12	7.62	0.10
2004	31.01	22.24	21.93	7.57	0.15
2005	30.74	23.16	21.48	8.44	0.13
2006	32.36	22.75	25.07	7.98	0.10
2007	31.81	21.92	23.94	7.33	0.14
2008	31.07	23.14	22.88	8.49	0.13
2009	35.57	23.21	36.49	8.58	0.04
2010*					
2011*					
2012*					
2013	30.14	22.43	19.94	7.87	0.16
2014	31.01	24.34	22.37	9.60	0.11
2015	32.05	22.57	25.19	7.82	0.13

*** Values for 2010, 2011 and 2012 are not reliable due to poor sampling.**

Table 6.4.5. Irish Sea East (FU14): Sumary table for forecast inputs (current used shaded in blue) and historical estimates of raised landings and discards, mean weight in landings and harvest rate.

Year	Landings in number	Total discards in number	Removals in number	Dead Discard Rate number	Discard Rate number	UWTV abundance estimate	95% Confidence Interval	Harvest rate	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	millions		%	tonnes	tonnes	gramme	gramme
2000	29.7	10.7	40.4	24.4	26.4				566.6	80.2	19.0	7.5
2001	25.5	5.2	30.7	15.5	17.0				532.3	41.6	20.9	8.0
2002	25.8	4.7	30.4	14.1	15.4				577.3	42.1	22.4	9.0
2003	12.9	1.4	14.3	9.0	9.9				376.0	10.8	29.1	7.6
2004	21.5	3.7	25.3	13.5	14.8				472.2	28.2	21.9	7.6
2005	26.5	4.0	30.5	11.8	13.0				569.7	33.4	21.5	8.4
2006	25.1	2.8	27.9	9.2	10.1				628.4	22.4	25.1	8.0
2007	40.1	6.4	46.5	12.5	13.8				959.0	46.8	23.9	7.3
2008	29.5	4.3	33.9	11.6	12.7	407.6	63.0	8.2	676.0	36.6	22.9	8.5
2009	19.4	0.7	20.1	3.3	3.7	350.0	76.0	5.7	707.0	6.3	36.5	8.6
2010			0.0			422.0	103.0		582.3			
2011			0.0			449.2	98.8		561.0			
2012			0.0			693.8	99.0		531.0			
2013	24.9	4.9	29.7	15.0	16.4	487.0	81.6	6.0	495.4	39.3	19.9	7.9
2014	30.3	3.7	34.0	9.8	10.8	449.1	91.8	7.5	678.5	32.4	22.4	9.6
2015	15.0	2.2	17.2	11.9	13.0	590.5	86.0	2.9	377.7	17.6	25.2	7.8
2016						432.9	106.3					

Note: Abundance is adjusted by using a cumulative absolute conversion factor of 1.2. Abundance (millions) including Wigtown Bay (1.9% 2008–2010; 6.6% 2011–2016). Due to poor sampling no estimates for 2010–2012.

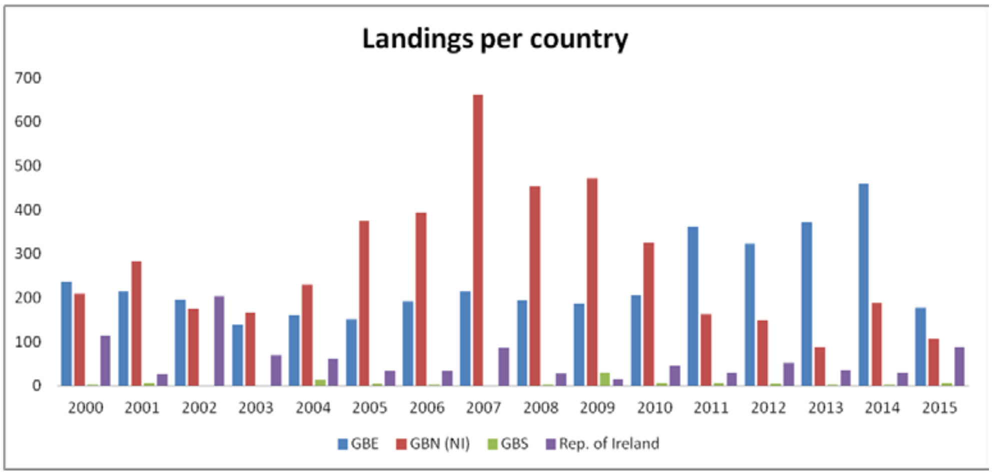


Figure 6.4.1. Irish Sea East (FU14): Landings in tonnes by country. GBE=England; GBN=Northern Ireland; GBS=Scotland; Rep. of Ireland=Republic of Ireland.

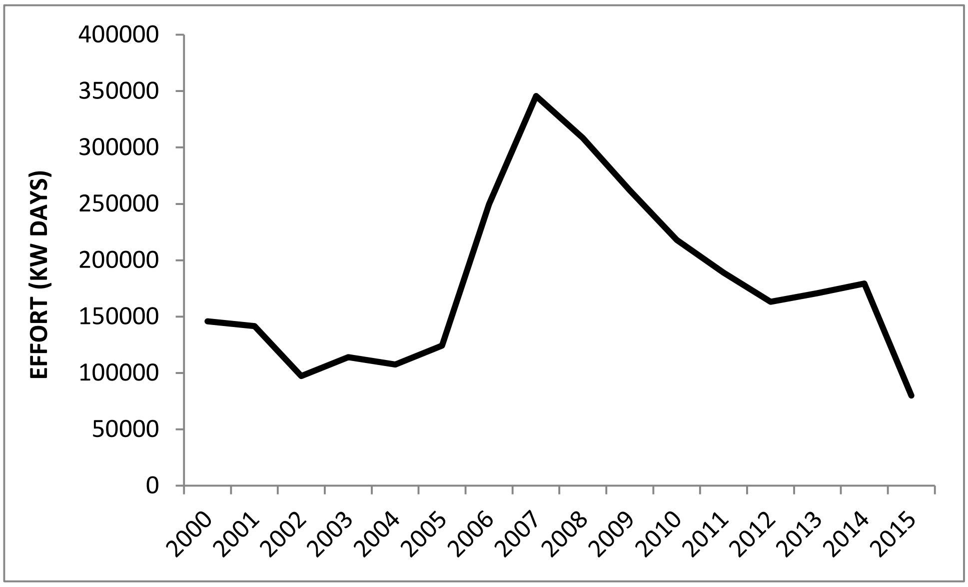


Figure 6.4.2. Irish Sea East (FU14): Effort data (KW days) for UK directed *Nephrops* fleet.

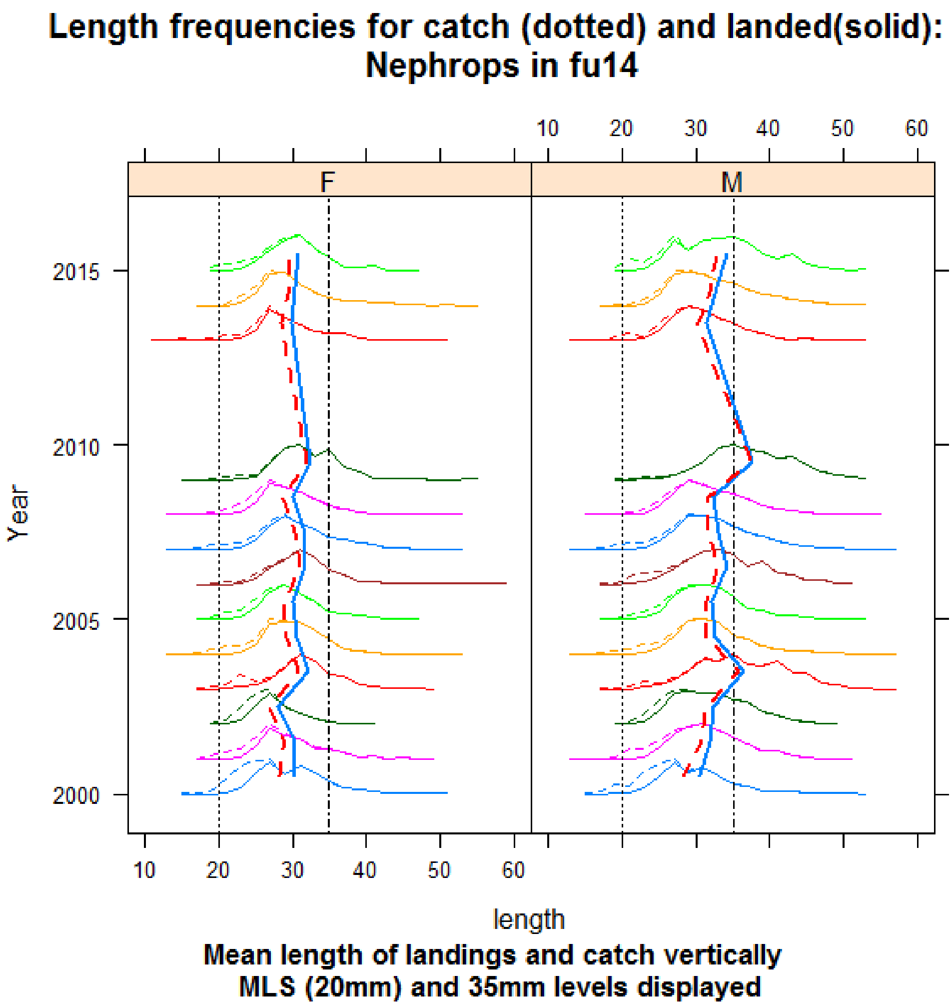


Figure 6.4.3. Irish Sea East (FU14): Length distribution of landings (solid lines) and catch (dotted lines), 2000–2015. Length frequencies for 2010–2012 are based in very poor sampling so not reliable. Figure shows a vertical display of MLS (20 mm CL) and 35 mm CL levels.

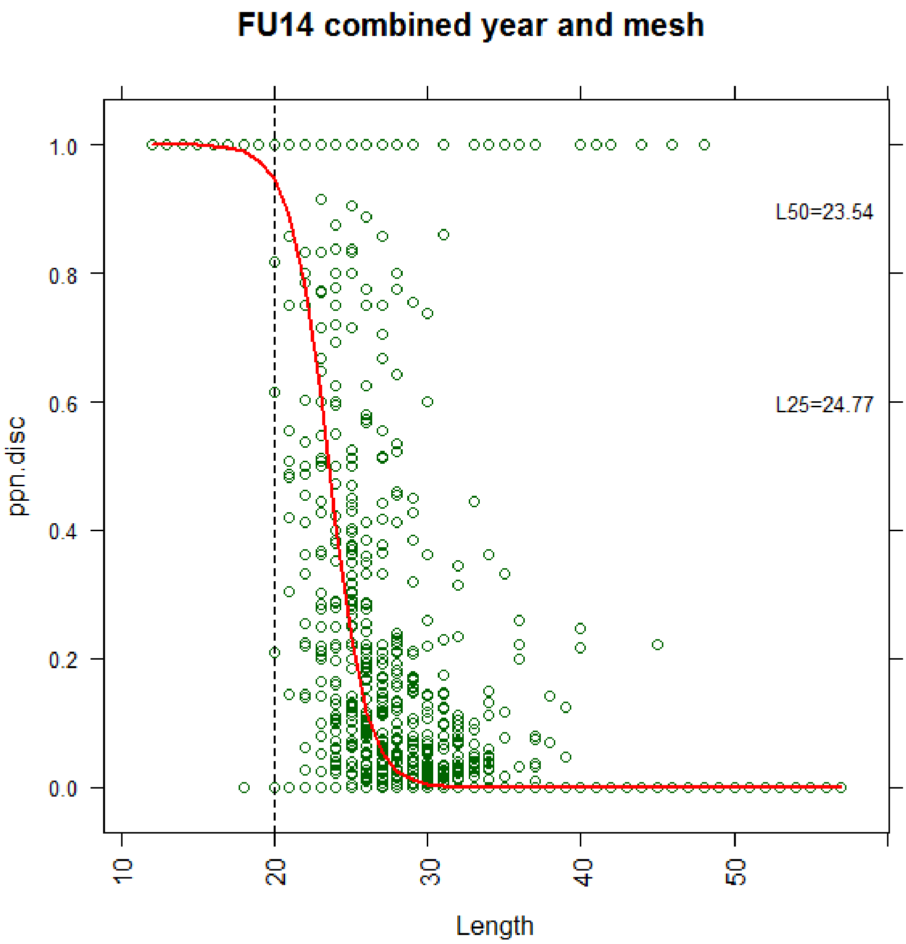


Figure 6.4.4. Irish Sea East (FU14): Final discard ogive pooled for all years and mesh sizes. L50=23.54 and L25=24.77.

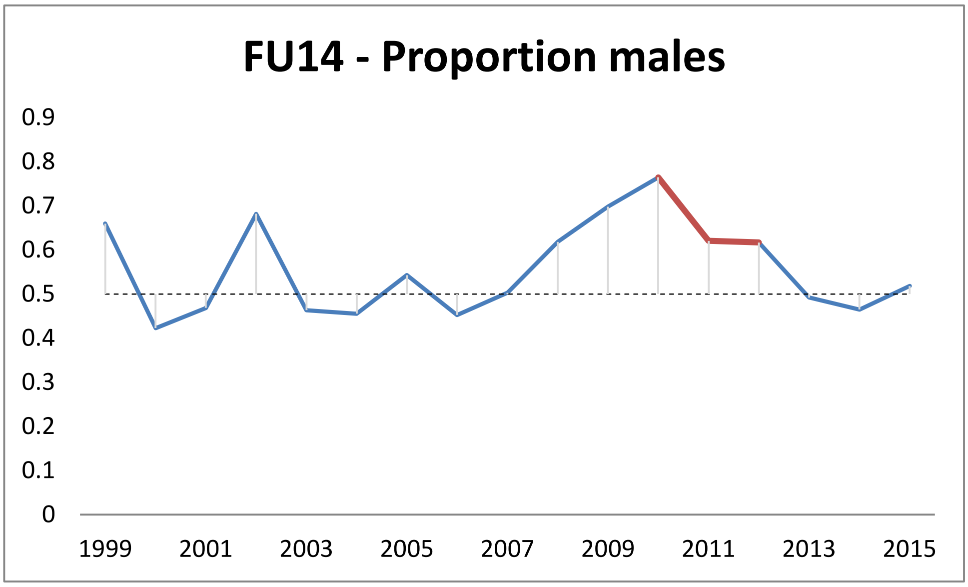


Figure 6.4.5. Irish Sea East (FU14): Proportion of males in catch since 2000. Between 2010 and 2012 due to poor sampling levels estimates of sex ratio are not reliable.

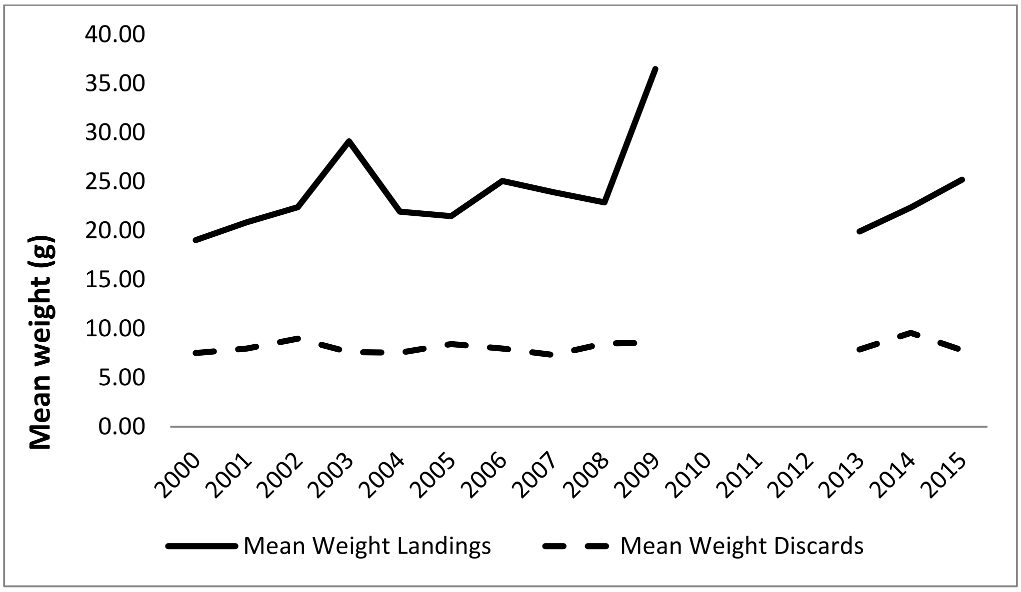


Figure 6.4.6. Irish Sea East (FU14): Mean weight (g) combined by sex for total annual landings and discards. Values for 2010, 2011 and 2012 are not reliable due to poor sampling.

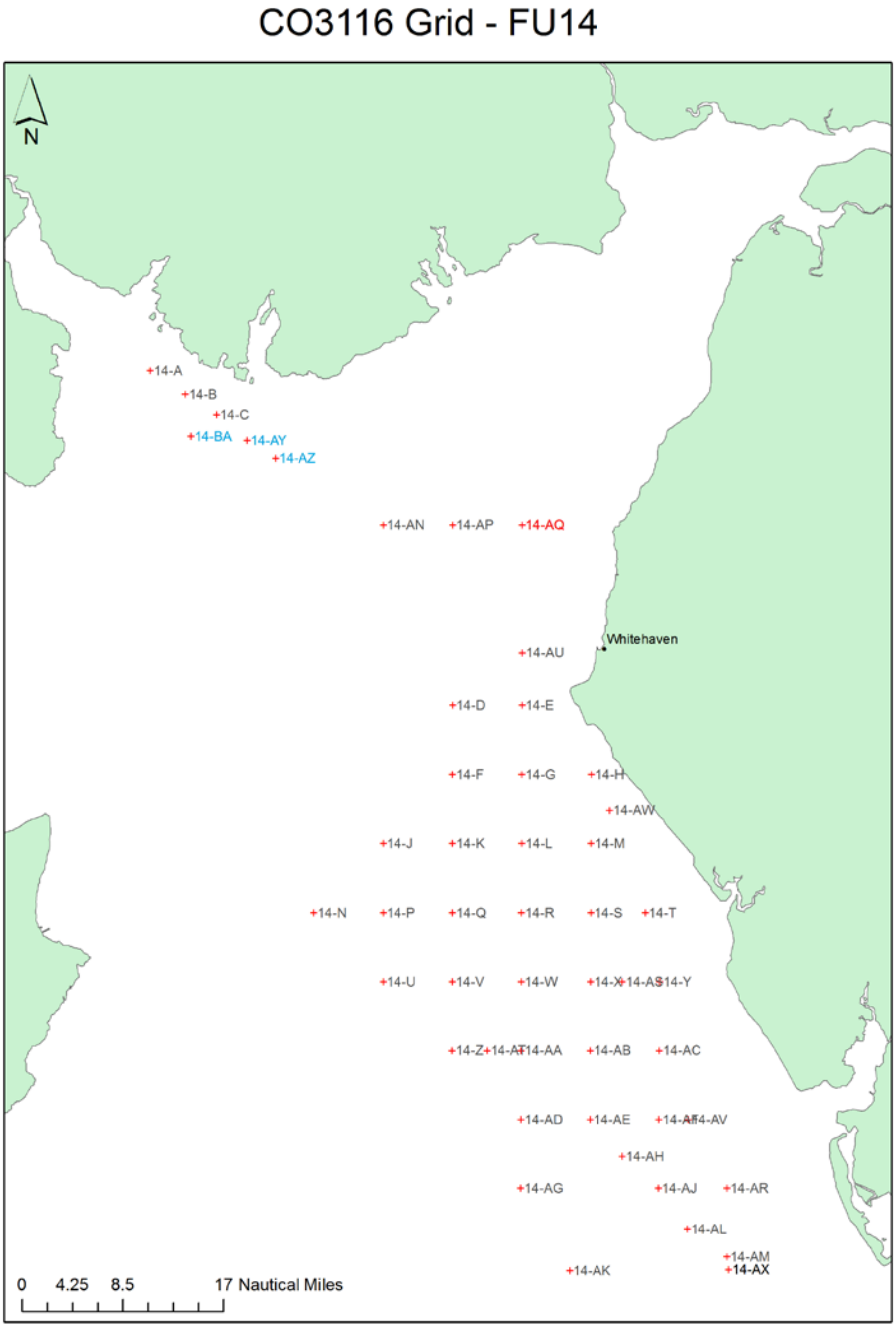
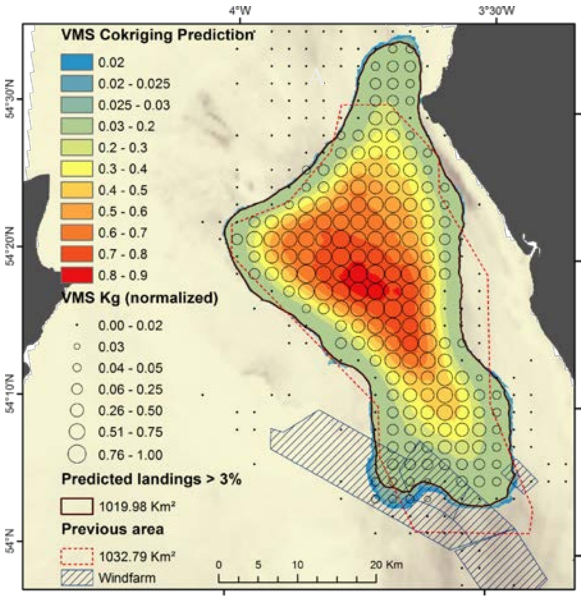


Figure 6.4.7. Irish Sea East (FU14): UWTV Survey stations for 2015, showing the Wigtown Bay. Blue stations added in 2016 in the Wigtown Bay area. Red station not surveyed.



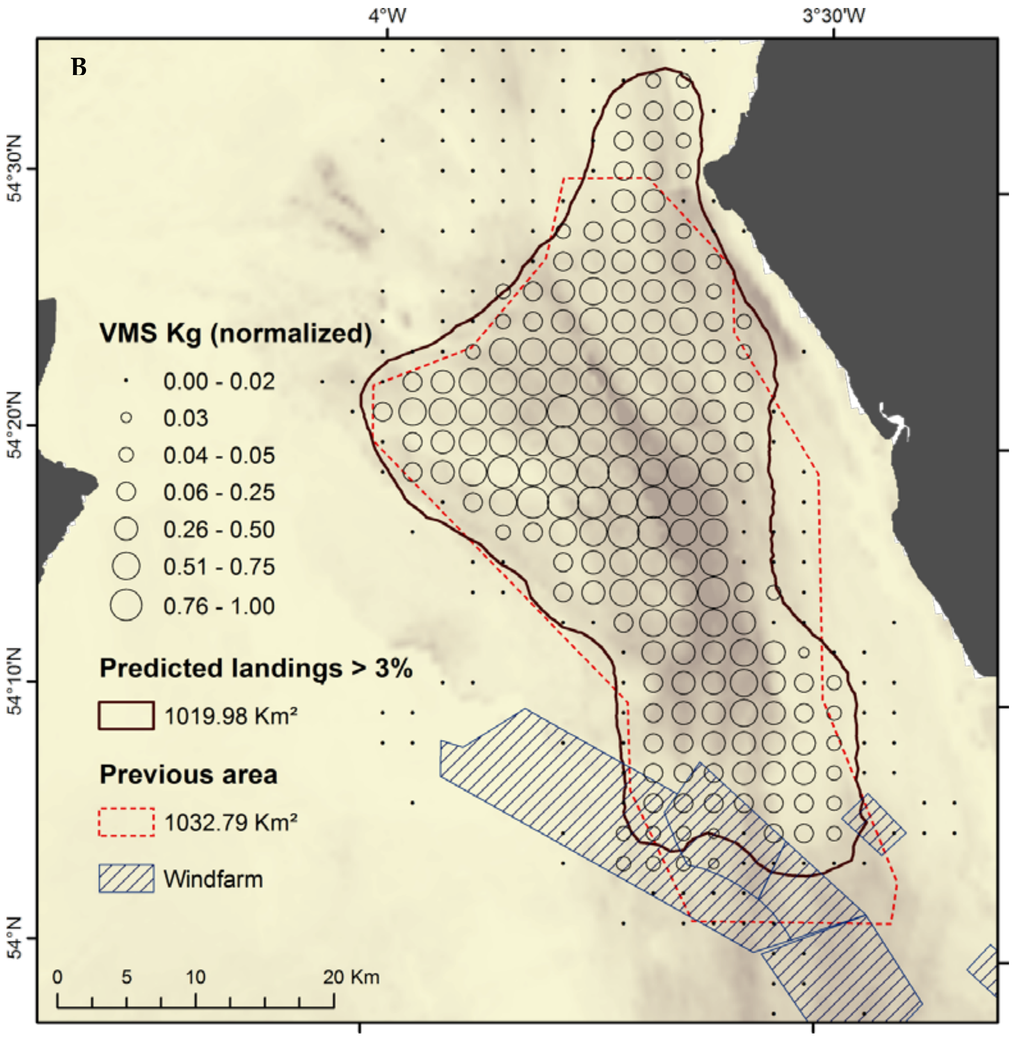
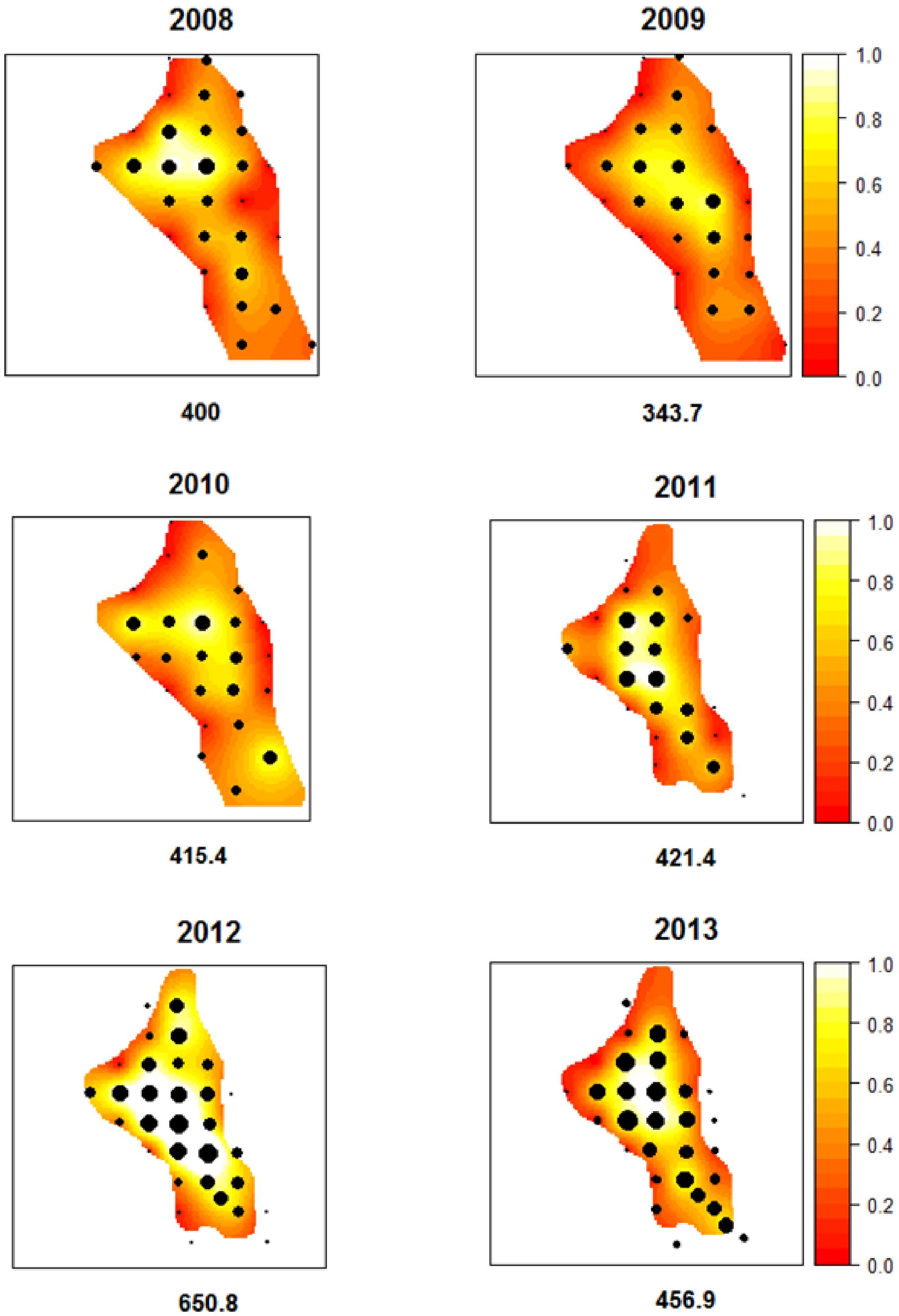


Figure 6.4.8. Irish Sea East (FU14): Co-kriging approach. Interpolation result of VMS (cut off 3%), survey density (2013–2015) data and mud distribution. A – model output; B – final polygon.


2008
400
2009
343.7
2010
415.4
2011
421.4
2012
650.8
2013
456.9
1.0
0.8
0.6
0.4
0.2
0.0

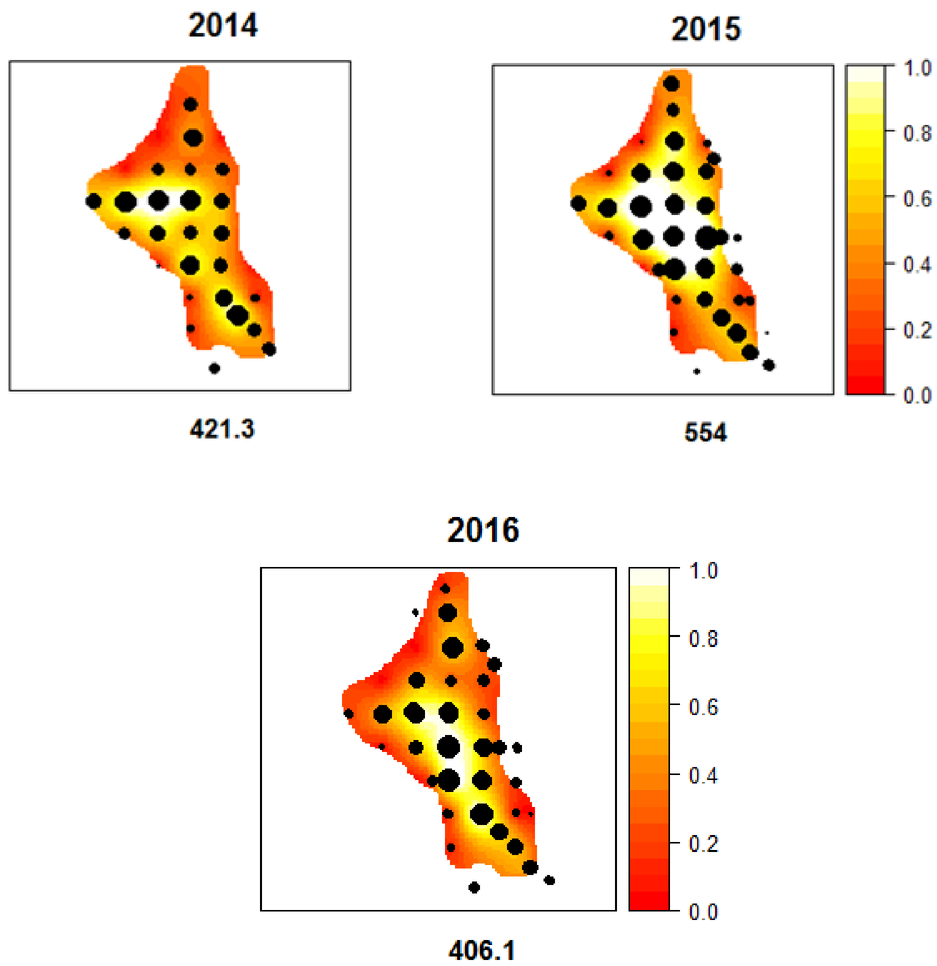


Figure 6.4.9. Irish Sea East (FU14): Burrow density estimates from the UWTV Survey 2008–2016. Abundance estimates given at the bottom of each plot are adjusted with the cumulative absolute conversion factor (but does not contain the additional area for Wigtown Bay). Area of ground = 1032.75 Km² for 2008–2010 and 1019.79Km² for 2011–2016.

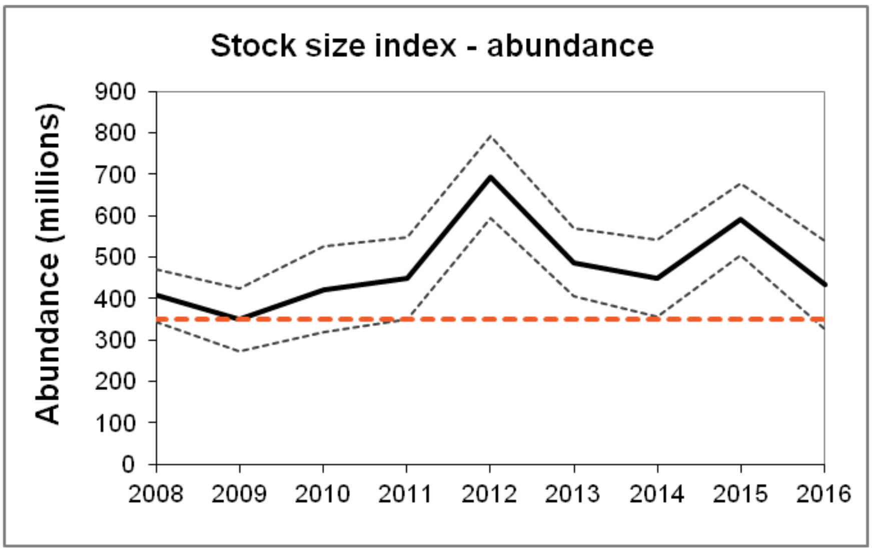


Figure 6.4.10. Irish Sea East (FU14): Burrow density estimates from the UWTV Survey 2008–2016. $B_{trigger}$ set as 350 million (orange dashed line).

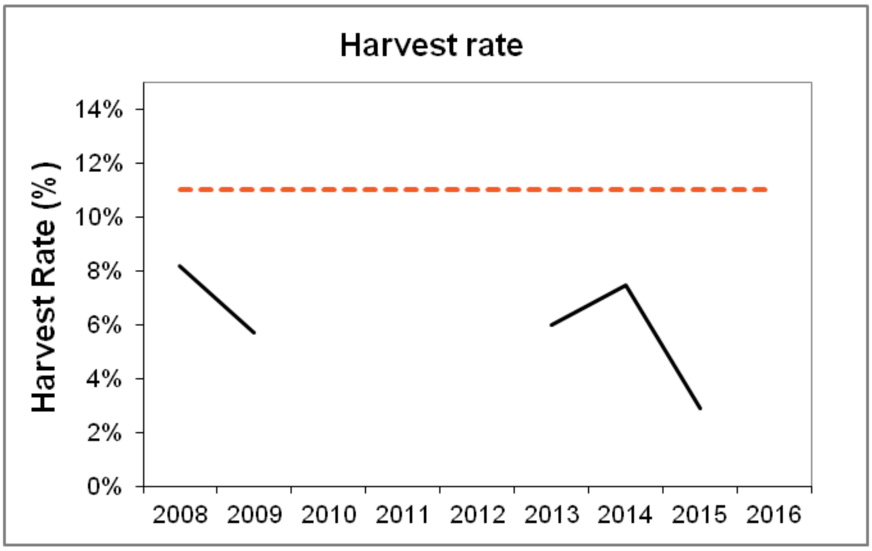


Figure 6.4.11. Irish Sea East (FU14): Harvest Rate (% dead removed/UWTV abundance). The dashed and solid lines are the MSY proxy (11%) and the harvest rate respectively. Between 2010 and 2012 due to poor sampling levels harvest rate estimates are not reliable.

6.4.11 Audit of eastern Irish Sea, FU14 Area 7.a

Date: 04/10/2016 Reviewer: Jennifer Doyle

General

For single stock summary sheet advice:

1) **Assessment type:** Update with one additional year of survey and catch data (benchmarked at IBPNeph 2015, stock annex updated at WGCSE 2016).

2) **Assessment**: Analytical (UWTV survey-based abundance assessment combined with commercial fishery data, follows the process defined by the benchmark WG (IBPNeph 2015and stock annex).

3) **Forecast**: A short-term projection was completed to produce a catch option table.

4) **Assessment model**: UWTV based approach.

5) Data issues:

It is not stated whether biological sampling for this FU is considered to be adequate.

UWTV for this stock since 2008 of reliable data. 95% CI for TV surveys presented but not the CVs on the surveys would be useful to present as SGNEPs recommend <20% precision level for UWTV surveys.

6) Consistency:

- The 2016 assessment is consistent with the 2015 assessment and with the assessment methods described at the 2015 benchmark.
- The assessment process is consistence with the stock annex.
- Given the fluctuations observed in mean weights for landings and discards an average from 2013 to 2015 is used in the calculation of catch options as set out in the stock annex.

7) Stock status:

- UWTV abundance estimates suggest that the stock size has fluctuated.
- 2016 TV survey estimated stock abundance for the FU14 was 432 million individuals, a 27% decrease from the 2015 estimate and well above the $B_{trigger}$ value of 350 million.
- Recent harvest ratios which have been below the F_{MSY} proxy for the last three years.
- The F_{MSY} proxy was not revised by WKMSYRef4 and was estimated by IBPNeph 2015: Rationale: F_{MSY} proxy equivalent to $F_{0.1}$ for combined sexes. =11%).
- The calculated harvest ratio for the FU14 in 2015 was well below the MSY proxy for this stock (the value associated with high long-term yield and low risk depletion) of 11%.

8) Management Plan:

- No specific management plan exists for this stock.
- ICES advices that to ensure that the stock in functional unit (FU) 12 is exploited sustainably, management should be implemented at the functional unit level.

General comments

- The assessment report needs some tidying and explanations were clear enough.
- The assessment is in accordance with the Stock Annex. Methods to derive F_{MSY} and landings predictions did not deviate from the benchmark process/stock annex.
- Clear description on how the InterCatch was used in the 2015 assessment. Data were available in InterCatch and used to generate 2015 raised international length–frequency distributions
- The discard rate applied in the assessment (three year average of 2013–2015 = 13.3%).
- No direct survivability studies available for this area. It is expected that the survivability of discarded animals should be similar to the fishery in FU15 where fishing practices are similar and both are largely spring/summer fisheries and animals discarded are exposed to warmer temperatures before returned to sea. Discard survival rate = 10%.

Technical comments

- Have made comments using track changes on document in SharePoint here
- Would be useful to have figure of FU14 calculated mean weight in landings and discards from Table 6.4.5 presented in report as is done for other *Nephrops* stocks.
- Stock annex here could do with some updates to reflect the benchmark process for deriving length–frequency distributions and also the revised area calculation so it is easy to find.
- Need to update F_{MSY} Ref4 References in stock annex here and to ensure that the text in report on reference points is same as that in SA.

Conclusions

- The assessment has been performed correctly for the basis of management advice. The stock appears to be stable in recent years and is above $B_{trigger}$. Although recent Harvest ratios are well below F_{MSY} (11.0%).

Checklist for review process

General aspects

- Has the EG answered those ToRs relevant to providing advice?
- Is the assessment according to the stock annex description?
- Is general ecosystem information provided and is it used in the individual stock sections.
- If a management plan has been agreed, has the plan been evaluated?

For update assessments

- Have the data been used as specified in the stock annex?
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex?
- Is there any **major** reason to deviate from the standard procedure for this stock?
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

6.5 Irish Sea West, FU15

This section is currently not available.

6.6 Whiting in VIIa

2016 Assessment and advice

Whiting in VIIa is currently classified in the summary sheet as category 2.1.3. This classification originates from ICES (2012) which states "For extremely low biomass, a recovery plan and possibly zero catch is advised". However the assessment is similar to category 3.20 because it is trends based on a survey. The stock was also considered by WKPROXY last year as category 3 stock where the overall perception was that it is exploited above the length-based indicator reference point proxies.

Type of assessment

This year the SURBA assessment has been updated and progress towards the upcoming WKIRISH benchmark was presented and discussed.

ICES advice applicable to 2016 and 2015

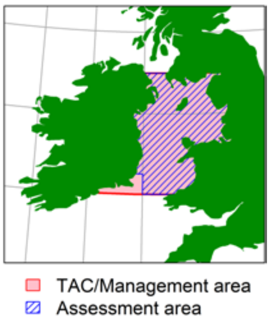
ICES advises that when the precautionary approach is applied, there should be no directed fisheries and all catches should be minimized in 2016.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/whg-iris.pdf

6.6.1 General

Stock description and management units

The stock and the management unit are both ICES Division VIIa (Irish Sea). Whiting landings taken or reported in ICES rectangles 33E2 and 33E3 have been reassigned to the VIIe–k whiting stock since 2012.



Management applicable to 2015 and 2016

The minimum landing size of whiting is 27 cm. The 2016 TAC for whiting VIIa was 80 t, the same as 2015. This TAC has not been considered restrictive, with officially reported VIIa landings totalling 59 t in 2015.

2015	2015 Quota	2015 Officially reported Landings
Belgium	0	1
France	3	<0.5
Ireland	46	49
The Netherlands	0	-
United Kingdom	31	8

Note for Ireland, 32 t were reallocated from rectangles 33E2 & 33E3.

TAC 2015

Species: Whiting *Merlangius merlangus*		Zone: VIIa (WHG/07A.)
Belgium	0	
France	3	
Ireland	46	
The Netherlands	0	
United Kingdom	31	
Union	80	
TAC	80	Analytical TAC

TAC 2016

Species: Whiting *Merlangius merlangus*		Zone: VIIa (WHG/07A.)
Belgium	0	
France	3	
Ireland	46	
The Netherlands	0	
United Kingdom	31	
Union	80	
TAC	80	Analytical TAC

Fishery in 2015

The characteristics of the fishery are described in the stock annex.

The fishery in 2015 was prosecuted by the same fleets and gears as in recent years.

Table 6.6.1(a) gives the official nominal landings of VIIa whiting as reported by each country to ICES. Working Group estimates of the landings and discards are given in Table 6.6.1(b). In recent years the values provided to the WG are very similar to officially reported landings. In 2015 international landings provided to the Working Group (28 t) were slightly higher than the 2014 landings of 28 t. The majority of the catch was discarded in the *Nephrops* fishery (1884 t) by UK-NI and IRE.

The Irish Sea whiting stock is primarily caught by otter trawlers and to a lesser extent, Scottish seines, beam trawls and gillnets. Otter trawlers utilize two main mesh size ranges, TR2 70–89 mm and TR1 100–119 mm. Effort of trawlers utilizing the larger mesh range, traditionally targeting whitefish (cod, haddock, whiting), has seen a large declined since 2003, partially as a result of effort management restrictions. The TR2 effort has remained relatively stable. The primary target species of this smaller mesh range is *Nephrops* from which whiting is discarded at a high rate.

The closure of the western Irish Sea to whitefish fishing from mid-February to the end of April, designed to protect cod, was continued in 2015 but is unlikely to have affected whiting catches which are mainly bycatch in the derogated *Nephrops* fishery. *Nephrops* vessels can obtain a derogation to fish in certain sections of the closed area, providing they fit separator panels to their nets to allow escape of cod and other fish. The TR2 fleet in VIIa are obliged to use one of four types of cod selective measures, namely a 'Swedish' grid; the inclined separator panel, SELTRA trawl or 300 square mesh panel.

6.6.2 Data

Data were provided by all countries according to the data call.

For WGCSE (2016) all data have been updated.

Fishery landings

Working Group estimates of catch available since 1980 are illustrated in Figure 6.6.1 and indicate the declining trend since the start of the time-series.

The introduction of UK and Irish legislation requiring registration of fish buyers and sellers may mean that the reported landings from 2006 onwards are more representative of actual landings.

Working group estimates of landings are corrected for misreporting in the past. There is information that officially reported landings of whiting, especially around the mid-1990s, have been inaccurate due to misreporting. Landings data have previously been partially corrected for by using sample-based estimates of landings at a number of Irish Sea ports. Due to the low level of landings recently, this has not been carried out since 2003. As for VIIa cod and haddock, the whiting landings taken or reported in ICES rectangles 33E2 and 33E3 have been reassigned to the VIIe–k whiting stock since 2012 (Table 6.6.1c).

Fishery discards

Discard estimates from the IR-OTB fleet and NI *Nephrops* fishery are available since 2003 and 2009, respectively. These are also presented in Table 6.6.1(b) but are imprecise. More detailed estimates of discards and landings by métier are available from the ICES InterCatch database are presented in Table 6.6.12. The most dominant métiers for discards are the Northern Irish "OTB_CRU_70-99_0_0_all" and the Irish "OTB_CRU_70-99_1_0_all" and "OTB_CRU_70-99_2_0_all" métiers. Note in 2014 the discards allocated by Ireland are for OTB as the data were not broken down by métier. Landings are predominantly in the OTB métiers in 2014.

Sampling and raising methods previously used are described in the stock annex for VIIa whiting. Methods for estimating quantities and composition of landings are described in the stock annex (Section B1.1).

Landings, discards and total catch numbers and weights-at-age for the period 1980 to 2002 as estimated by WGNSDS 2002 are given in Tables 6.6.3 to 6.6.8. The proportion of the total catch comprising of discards from the *Nephrops* fleets increased over time for ages 1 and above (Table 6.6.9), although this will also reflect trends in catch of vessels not sampled for discards. While the proportion of discarded fish has increased it is largely due to the decline in abundance of marketable sized whiting (>27 cm) and the total volume over time has declined as shown in Table 6.6.10. Mean weights-at-age for landings and discards are presented in Figure 6.6.3.

Since 2003 it has not been possible to construct catch numbers-at-age for this stock. This is due to a number of factors including low levels of landings, leading to low sampling levels, in addition to restricted access to some ports in some years.

Discards data

Discarding of whiting is high within the Irish Sea. The on-board observer trips carried out in 2015 by UK(E&W), UK (NI) and Ireland, showed negligible fish were retained on board, while high numbers of small fish were discarded. Raised discards from the main national fleets show greater than 1800 t in weight, were discarded in 2015.

Irish otter trawl fleet discard estimates (1998–2015) raised according to the methods described in Borges *et al.* (2005) were available to the Working Group (Table 6.6.11). These data show the two youngest ages are predominantly discarded, and to a lesser extent age 2. In some years up to age 4 fish are discarded. Numbers-at-age and mean weights-at-age for the Irish otter-trawl fleet are also presented in Figure 6.6.4.

Discard data available for the stock are also available from the NI *Nephrops* fishery raised to the fleet level and discard length frequencies for the UK(E&W) fleet. The length frequency of discards of national sampled fleets in 2015 is given in Figure 6.6.5. More detail information is available in the stock annex.

Biological data

The derivation of these parameters and variables is described in the stock annex 6.6.

Survey data used in assessment

Table 6.6.2 describes the survey data made available to the Working Group.

In 2016, the entire time-series of the UK (E&W)-BTS-Q3 survey data was revised so that only the selected prime stations are used.

Figure 6.6.2 provides a comparison of mean catch weights of whiting from the eastern and western Irish Sea for NIGFS-WIBTS-Q1 surveys from 1992 to 2016 indicating low level catch rates since 2003. The decline in catch rates for the eastern Irish Sea since 2003 has been evaluated by the working group but no apparent reasons for this decline were evident. There is a decrease in catch rates in both the western and eastern Irish Sea in 2016.

Survey series for whiting provided to the Working Group are further described in the stock annex for VIIa whiting (Section B.3).

Commercial cpue

Commercial catch and effort series data available to the Working Group are described in the stock annex for VIIa whiting (Section B.4). Effort data were provided for the UK(E&W) and Ireland. Figure 6.6.6 shows commercial lpue data from the IR-OTB fleet from 1995–2016. Although this may not be indicative of lpue trends due to the low levels of landings and changes in discard practices.

6.6.3 Stock assessment

The SURBA analysis was updated in 2016 according to the stock annex. An age-based analytical stock assessmenthas not been carried out since 2006 due to quality concerns about the catch-at-age data.

Data screening

The general methodology is outlined in the stock annex.

Final update assessment

Single fleet survey-based runs were carried out on the NIGFS-WIBTS-Q1 and NIGFS-WIBTS-Q4 surveys using SURBA (version 2.2). Default values were used for both catchability and smoothing settings.

Log-mean standardised indices and scatterplots of log-index at-age for the NIGFS-WIBTS-Q1 survey are presented in Figures 6.6.7(a) and 6.6.8(a), respectively. Both plots indicate poor internal consistency within the survey. The survey appears to track the 1991 year class, but examination of the internal consistency via the scatterplots indicates poor correlation between age classes. Corresponding figures for the NIGFS-WIBTS-Q4 are plotted in Figures 6.6.7(b) and 6.6.8(b). There is some indication of tracking for the 1991, 1994 and 1995 year class. Scatterplots at-age are noisy and do not show strong positive correlations for most ages although there is evidence of correlation between ages 0 and 1, 2 and 3 and 3 and 4.

Catch curves for the NIGFS- WIBTS-Q1 and NIGFS- WIBTS-Q4 survey are plotted in Figures 6.6.9(a) and (b). Both surveys show a steep decline in log numbers-at-age over time.

Empirical SSB estimates are presented in Figure 6.6.10 for the NIGFS-WIBTS-Q1 and the NIGFS-WIBTS-Q4 surveys. The NIGFS-WIBTS-Q1 survey shows a declining trend over the time-series with a slight increase in the terminal year. The NIGFS-WIBTS-Q4 survey shows a decrease in the terminal year and indicates a declining trend since 2004. Overall SSB is still at low levels compared to earlier on in the time-series.

Figure 6.6.11 shows the residual plots by age for the NIGFS-WIBTS-Q1 survey, the model fits well for age one but for older ages residuals are quite noisy, especially in the latter part of the time-series. Stock summary for the NIGFS-WIBTS-Q1 survey is shown in Figure 6.6.12. The temporal F trend is variable in later years. There are no extreme age or cohort effects. The plot of empirical SSB with model fit (bottom, centre) shows good fit in recent years. Figure 6.6.13 shows the retrospective summary plot for the NIGFS-WIBTS-Q1 survey. SSB is declining since 2002 but shows an increase since 2012. It is still at comparatively low levels and there is no apparent retrospective pattern. F shows an increasing trend over the time-series, although it appears to have declined since 2009 and increases slightly in 2016. Recruitment is also variable and shows an increase in the last two years. There is no strong retrospective pattern for recruitment and the previously seen noisy periods between 1995–2000 and 2004–2008 seem to have improved with the inclusion of the most recent data.

Residual plots by age for the NIGFS-WIBTS-Q4 survey are shown in Figure 6.6.14. Residuals are quite noisy for all ages apart from age 0. Figure 6.6.15 shows the stock summary plot for the NIGFS-WIBTS-Q4 survey. The temporal F trend is variable throughout the time-series. There appears to be an age effect for age 3 for this survey but no strong cohort effects. The plot of empirical SSB versus model estimates shows improved fit for the latter part of the time-series. Retrospective patterns for the summary plots (Figure 6.6.16) show a variable F trend over the time-series, with a decline in 2009. SSB has been declining since 2003 and shows an increase in 2010 and a steady decline since. There is a slight increase in 2015. Recruitment shows a large increase in 2013 and a subsequent decline since. No strong retrospective bias is evident in F, SSB or recruitment.

The state of the stock

The decline in fishery landings to under 50 t in recent years has been interpreted by the SURBA assessment models as a collapse in biomass. WKPROXY also considered that the stock was exploited above the length-based indicator reference point proxies.

Generally, trends in biomass have been declining in recent years. Recruitment also appears to have declined but has shown an increase in the terminal year in the NIGFS-WIBTS_Q1. However the long-term trends of recruitment for this stock are difficult to interpret given the uncertainty in discard estimates for younger ages.

6.6.4 Short-term predictions

No short-term forecast was carried out for this stock.

6.6.5 Medium-term projection

There is no analytical assessment for this stock.

6.6.6 Maximum sustainable yield evaluation

High discarding, low landings and poor sampling has led to uncertain catch data in recent years. These data do not support the evaluation or estimation of F_{MSY}. However, it is likely that recent F is above F_{MSY} at the current selection pattern.

6.6.7 Reference points

Precautionary approach reference points

There are no current PA reference points for this stock. Historical reference points are given in the stock annex.

MSY reference points

The year ICES provided MSY proxies for this stock based (ICES, 2016).

Stock status classification relative to MSY proxies is given below.

Exploitation				Stock abundance or biomass			
MSY proxy method used or attempted	Proxy for F_{MSY} (or indicator for exploitation rate corresponding to MSY); method used	Value of F_{MSY} proxy (years of data used)***	Stock status relative to F_{MSY} proxy*	Proxy for biomass corresponding to MSY $B_{trigger}$; method used	Value of MSY $B_{trigger}$ proxy (years of data used)***	Stock status relative to MSY $B_{trigger}$ proxy**	Overall status classification Desirable/ Undesirable/ Unknown
Length-based indicator (LBI) for fishing mortality. Biomass status from auxiliary information (surveys; ICES, 2015c).	Expected mean length of catch above L_c when F = M^^	22 cm (2014)		No proxy identified but information from surveys indicates very low stock abundance	N.A.		

6.6.8 Management plans

No management plan has been agreed or proposed.

6.6.9 Uncertainties and bias in assessment and forecast

There is no analytical assessment for this stock.

6.6.10 Recommendations for next benchmark assessment

The main tasks for the benchmark focus on the following areas:

- stock structure and mixing rates between stock areas;
- investigation of age, growth, maturity information;
- growth in surveys and recruitment signals in surveys;
- life-history parameters (e.g. growth parameters, maturity ogives, fecundity, natural mortality), for use in assessments;
- history of fishery management regulations;
- time-series of commercial and recreational fishery catch estimates;
- length and age distributions of fishery landings and discards if feasible, with associated measures or indicators of bias and precision;
- recommendations for addressing fishery selectivity (pattern of catchability at length or age) in the assessment model;
- recommend values for discard mortality rates and indicate the range of uncertainty in values;
- review of all available and relevant fishery-independent and dependent data sources on fish abundance, assessments and provide up to date survey working document describing the aggregation procedure and precision estimation;
- investigate changes in environmental drivers known to influence distribution, growth, recruitment, natural mortality or other aspects of productivity which are relevant for assessments and forecasts;
- update Irish Sea Ecosystem descriptions and environmental indicators;
- develop a spreadsheet of assessment model input data that reflects the decisions and recommendations of the Data Workshop.

6.6.11 Management considerations

Discarding of this stock is a major consideration and efforts should be made to reduce catches of undersized fish. Despite the implementaion of several technical measures, which experimentaly reduce whiting catches, as part of the cod long-term management plan the discards estimates still remain between 1000–2000 t. Given the continued high discards and low TAC, this stock could become a major 'choke species' for the 7.a *Nephrops* fishery in the context of the landing obligation.

Effort limitations are in force within the Irish Sea as a result of the cod long-term management plan. Although vessels catching whiting will be affected by this regulation, at present it is not believed that the effort limitations significant reduce mortality on whiting.

Whiting has a low market value, which is likely to contribute to discarding rates.

Technical measures applied to this stock include a minimum landing size (≥27 cm), whiting now mature well below this MLS.

6.6.12 References

ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM 68. 42 pp.

ICES. 2016. Report of the Workshop to consider MSY proxies for stocks in ICES category 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015, ICES Headquarters, Copenhagen, Denmark. ICES CM 2015/ACOM:61. 159 pp.

Table 6.6.1 (a). Official Landings (t) of whiting in Division 7.a, 1988–2015, as reported to ICES.

Year	Belgium	France	Ireland	Netherlands	UK(NI, Engl. & Wales)	Spain	UK (Isle of Man)	UK (Scotland)	UK	Total human consumption
1988	90	1,063	4,394		5,823		15	107		11,492
1989	92	533	3,871		6,652		26	154		11,328
1990	142	528	2,000		5,202		75	236		8,183
1991	53	611	2,200		4,250		74	223		7,411
1992	78	509	2,100		4,089		44	274		7,094
1993	50	255	1,440		3,859		55	318		5,977
1994	80	163	1,418		3,724		44	208		5,637
1995	92	169	1,840		3,125		41	198		5,465
1996	80	78	1,773	17	3,557		28	48		5,581
1997	47	86	1,119	14	3,152		24	30		4,472
1998	52	81	1,260	7	1,900		33	22		3,355
1999	46	150	509	6	1,229		5	44		1,989
2000	30	59	353	1	670		2	15		1,130
2001	27	25	482		506		1	25		1,066
2002	22	33	347		284		1	27		714
2003	13	29	265		130	85	1	31		554
2004	11	8	96		82		1	6		204
2005	10	13	94		47			<0.5		164
2006	4	4	55		22			<0.5		85
2007	3	3	187		3		1	<0.5		197
2008	2	2	68		11		1			84
2009	2		78		20					100
2010	5	3	97		16		<0.5			121
2011	4	3	95		16		<0.5			118
2012	5	1	58		10			1	11	86
2013	2	<0.5	44				<0.1	2	20	68
2014	2	<0.5	60		11		<0.1			73
2015*	1	<0.5	49		8					59

* Preliminary

Table 6.6.1 (b) Nominal Discards (t), Landings (t) and Catch (t) of WHITING in Division VIIa, 1988-2015, as officially reported to WGCSE Expert Group (EG).

Year	Discards by Country/Fleet						Discards	Landings	Catch
	Nephrops fishery [b]	IR-OTB fleet [ce]	IR-TBB	NI Nephrops fishery [d]	Belgium	UK (E&W) fleet			
1988	1.611						1.611	10.245	11.856
1989	2.103						2.103	11.305	13.408
1990	2.444						2.444	8.212	10.656
1991	2.598						2.598	7.348	9.946
1992	4.203						4.203	8.588	12.791
1993	2.707						2.707	6.523	9.230
1994	1.173						1.173	6.763	7.936
1995	2.151						2.151	4.893	7.044
1996	3.631						3.631	4.335	7.966
1997	1.928						1.928	2.277	4.205
1998	1.304						1.304	2.229	3.533
1999	1.092						1.092	1.670	2.762
2000	2.118						2.118	762	2.880
2001	1.012						1.012	733	1.745
2002	740						740	747	1.487
2003		524					524	676	1.200
2004		680					680	184	864
2005		201					201	158	359
2006		223					223	86	309
2007		1.545					1.545	196	1.741
2008		585					585	81	666
2009		892		1.019			1.911	102	2.013
2010		330		704			1.033	121	1.154
2011		269		903			1.172	74	1.246
2012		658	27	922	17	1	1.624	60	1.684
2013		85	1	832	17	3	938	33	971
2014		288		1.645	15	28	1.975	23	1.998
2015*		805		1.080	9	1	1.894	28	1.922

[b] Based on UK(N.Ireland) and Ireland data.

[c] Based on data from Ireland.

[d] Based on data from Northern Ireland.

* Preliminary (and rounded).

[e] Raised using Days

Table 6.6.1 (c) Whiting landings taken or reported in ICES rectangles 33E2, 33E3 and 33E4 have been reassigned to the VIIe–k whiting stock since 2012.

Year	Landings in Tonnes
2012	32
2013	34
2014	49
2015	32

Table 6.6.2. Whiting in 7.a. Survey data available to WGCSE 2016. Updated Survey Titles highlighted in bold.

NIGFS-WIBTS-Q4: Northern Ireland October Groundfish Survey - Irish Sea West - Nos. per 3 nm

1994	2015						
1	1 0.83	0.88					
0	5						
1	5903	1278	55	48.1	2.7	0.2	1994
1	4660	962	130	10.0	4.7	1.5	1995
1	5933	792	117	20.0	1.7	0.5	1996
1	8722	628	125	10.0	4.9	0.2	1997
1	8199	708	134	16.0	0.7	0.0	1998
1	7481	360	44	4.0	1.4	0.0	1999
1	4037	593	32	2.0	2.1	0.3	2000
1	15262	761	205	16.0	0.1	0.0	2001
1	7229	1712	114	11.7	0.9	0.5	2002
1	8487	1600	469	19.1	1.2	0.1	2003
1	11446	1119	124	12.0	0.0	0.0	2004
1	5433	299	54	7.2	0.5	0.0	2005
1	4625	173	22	4.7	0.5	0.0	2006
1	5932	1491	125	4.2	0.2	0.0	2007
1	13253	2814	294	10.0	0.0	0.0	2008
1	5927	555	117	14.5	1.9	0.1	2009
1	5532	542	87	4.1	0.2	0.0	2010
1	7827	712	205	17.9	5.8	0.0	2011
1	2611	740	140	2.6	0.0	0.0	2012
1	10585	337	38	8.3	0.3	0.0	2013
1	11016	1537	280	30.4	3.1	0.0	2014
1	4729	1052	135	7.5	0.2	0.0	2015

NIGFS-WIBTS-Q1: Northern Ireland March Groundfish Survey - Irish Sea West - Nos. per 3 nm

1994	2016					
1	1 0.21	0.25				
0	4					
1	4307	73	121	6	0	1994
1	3604	988	53	30	1	1995
1	2323	587	188	11	15	1996
1	3250	447	52	14	1	1997
1	3857	535	71	9	3	1998
1	2373	228	39	7	2	1999
1	4037	231	23	3	0	2000
1	1998	631	30	2	1	2001
1	3580	163	36	3	0	2002
1	2952	812	25	6	1	2003
1	3568	174	36	1	0	2004
1	1219	97	6	1	0	2005
1	1266	150	12	0	0	2006
1	1825	190	10	1	0	2007
1	1254	290	17	1	0	2008
1	1941	227	10	1	0	2009
1	1485	297	20	1	0	2010
1	818	211	32	1	0	2011
1	2054	148	18	4	0	2012
1	1077	585	21	2	0	2013
1	1243	257	51	3	0.3	2014
1	7747	325	15	4	0.0	2015
1	2352	1138	34	1	0.1	2016

Table 6.6.2. Continued. Whiting in 7.a. Survey data available to WGCSE 2016.

NIGFS-WIBTS-Q4-EAST: Northern Ireland October Groundfish Survey - Irish Sea East - Nos. per 3 nm

1994	2015						
1	1 0.83	0.88					
0	5						
1	749	472	179	165.0	29.0	3.0	1994
1	2515	259	178	41.0	47.0	9.0	1995
1	1005	517	127	64.0	15.0	10.0	1996
1	640	668	682	88.0	26.0	6.0	1997
1	1446	277	178	95.0	11.0	4.0	1998
1	2287	1388	260	102.0	79.0	3.0	1999
1	1972	1288	216	26.0	22.0	9.0	2000
1	2998	691	300	35.0	7.0	5.0	2001
1	1296	1285	349	76.0	8.5	2.0	2002
1	3783	1939	1104	155.4	25.0	3.2	2003
1	1820	521	347	109.1	7.7	1.7	2004
1	1247	865	296	17.5	1.9	0.6	2005
1	2304	150	52	9.0	2.1	0.0	2006
1	1094	827	165	18.4	2.9	3.1	2007
1	2329	873	81	1.3	0.2	0.0	2008
1	641	675	48	4.4	1.1	0.0	2009
1	807	260	326	9.1	1.4	0.3	2010
1	1638	230	47	18.2	2.8	1.1	2011
1	695	370	154	15.2	6.6	0.3	2012
1	5932	429	120	23.6	1.2	0.7	2013
1	889	754	140	22.1	1.7	0.0	2014
1	1909	759	85	5.6	0.7	0.0	2015

NIGFS-WIBTS-Q1-EAST: Northern Ireland March Groundfish Survey - Irish Sea East - Nos. per 3 nm

1993	2016					
1	1 0.21	0.25				
1	5					
1	611	290	390	47	12.0	1994
1	448	522	142	109	25.0	1995
1	1094	221	203	40	44.0	1996
1	561	1054	91	33	2.0	1997
1	409	903	522	32	11.0	1998
1	1023	407	135	52	6.0	1999
1	1481	524	229	35	4.0	2000
1	631	739	162	15	9.0	2001
1	869	1043	243	54	13.1	2002
1	1118	1328	178	24	5.7	2003
1	1026	302	69	4	1.6	2004
1	499	129	41	12	3.9	2005
1	964	323	39	10	0.7	2006
1	623	120	11	3	0	2007
1	669	417	51	3	0	2008
1	956	313	47	2	0	2009
1	671	357	24	2	2	2010
1	530	164	33	4	1	2011
1	703	418	43	6	1	2012
1	545	734	78	4	1	2013
1	907	451	90	6	0	2014
1	825	474	27	4	0	2014
1	1240	506	30	1	0	2016

Table 6.6.2. Continued. Whiting in 7.a. Survey data available to WGCSE 2016.

UK (E&W)-BTS-Q3: Corystes Irish Sea Beam-Trawl Survey (Sept) - Prime stations only - Effort and numbers at age (per km towed)

1988	2015		
1	1 0.75	0.79	
0	1		
1	96	26	1988
1	93	21	1989
1	99	33	1990
1	216	25	1991
1	405	206	1992
1	253	95	1993
1	205	125	1994
1	1949	87	1995
1	169	194	1996
1	409	254	1997
1	893	199	1998
1	550	137	1999
1	320	122	2000
1	585	195	2001
1	280	96	2002
1	456	229	2003
1	917	330	2004
1	849	294	2005
1	1010	228	2006
1	339	89	2007
1	780	72	2008
1	389	371	2009
1	324	33	2010
1	1002	341	2011
1	442	426	2012
1	1535	228	2013
1	261	113	2014
1	211	112	2015

Table 6.6.2. Continued. Whiting in 7.a. Survey data available to WGCSE 2016.

NIGFS-WIBTS-Q4-EAST & WEST: Northern Ireland October Groundfish Survey - Irish Sea East & West - Nos. per 3 nm

1992	2015						
1	1 0.83	0.88					
0	5						
1	1454	995	96	26.0	4.0	0.0	1992
1	1554	425	300	27.0	2.0	0.1	1993
1	2450	686	133	123.0	20.0	2.0	1994
1	3199	483	163	30.9	33.6	6.9	1995
1	2628	605	124	50.0	10.8	6.8	1996
1	3219	655	504	63.0	19.0	4.0	1997
1	3601	414	164	70.0	7.9	3.0	1998
1	3945	1060	191	70.0	54.1	1.7	1999
1	2631	1066	158	18.0	15.8	6.1	2000
1	6911	713	270	29.0	4.7	3.1	2001
1	3189	1421	274	55.4	6.1	1.5	2002
1	5284	1831	901	111.9	17.4	2.2	2003
1	4892	712	276	78.1	5.3	1.2	2004
1	2583	684	219	14.2	1.5	0.4	2005
1	3045	157	43	7.6	1.6	0.0	2006
1	2638	1039	153	13.8	2.0	2.1	2007
1	5815	1492	149	4.1	0.1	0.0	2008
1	2328	637	70	7.6	1.3	0.0	2009
1	2315	350	250	7.5	1.0	0.2	2010
1	3613	384	97	18.1	3.8	0.7	2011

NIGFS-WIBTS-Q4-EAST & WEST: Northern Ireland October Groundfish Survey - Irish Sea East & West - Nos. per 3 nm cont'd

1	1306	488	149	14.8	5.3	0.2	2012
1	7417	399	94	18.7	0.9	0.4	2013
1	4121	1004	184	24.8	2.2	0.0	2014
1	2809	853	101	6.2	0.5	0.0	2015

Table 6.6.2. Continued. Whiting in 7.a. Survey data available to WGCSE 2016.

NIGFS-WIBTS-Q1-EAST & WEST: Northern Ireland March Groundfish Survey- Irish Sea East & West - Nos. per 3 nm

1992	2016						
1	1 0.21	0.25					
1	5						
1	1477	456	94	29	5.0	0.0	1992
1	667	655	67	9	2.0	0.5	1993
1	1790	221	304	34	8.0	5.0	1994
1	1696	698	116	85	17.0	3.0	1995
1	1478	280	160	28	32.0	5.6	1996
1	1419	860	79	27	1.7	4.3	1997
1	1730	767	196	12	3.3	0.1	1998
1	1453	350	104	38	5.0	1.0	1999
1	2297	431	163	25	2.7	0.0	2000
1	1067	704	120	11	7	1.6	2001
1	1734	762	177	38	9	0.3	2002
1	1703	1163	129	18	4	0.0	2003
1	1837	261	59	3	1	0.1	2004
1	729	119	30	9	3	0.3	2005
1	1054	274	31	7	1	0.1	2006
1	1007	142	11	2	0.1	0.0	2007
1	856	376	40	3	0.2	0.0	2008
1	1270	285	35	1	0.1	0.1	2009
1	931	338	23	2	1.5	0.0	2010
1	622	179	33	3	0.4	0.0	2011
1	1134	331	35	5	0.8	0.0	2012
1	715	687	60	3	0.4	0.0	2013
1	1015	389	78	5	0.2	0.1	2014
1	3034	427	23	4	0.0	0.0	2015
1	1595	708	31	1	0.1	0.0	2016

Table 6.6.2. Continued. Whiting in 7.a. Survey data available to WGCSE 2016.

NIMIK : Northern Ireland MIK Net Survey

1994	2015	
1	1 0.46	0.50
0	0	
1	778	1994
1	225	1995
1	397	1996
1	205	1997
1	59	1998
1	91	1999
1	40	2000
1	167	2001
1	19	2002
1	148	2003
1	101	2004
1	135	2005
1	118	2006
1	82	2007
1	99	2008
1	173	2009
1	78	2010
1	122.2	2011
1	123.9	2012
1	197.6	2013
1	54.9	2014
1	59.5	2015

ScoGFS-WIBTS-Q1: Scottish groundfish survey in Spring

1996	2006								
1	1	0.15	0.21						
1	8								
1	11610	4051	1898	362	229	59	3	4	1996
1	16322	16200	2953	964	250	105	39	1	1997
1	22145	8187	3817	137	110	0	5	0	1998
1	19815	6642	1706	282	11	0	27	0	1999
1	13019	1662	169	71	36	6	0	0	2000
1	9419	4541	407	40	2	0	0	0	2001
1	15605	3060	430	34	1	0	0	0	2002
1	14798	5404	375	45	0	4	0	0	2003
1	9199	2219	583	27	1	0	0	0	2004
1	3783	899	200	56	3	0	0	0	2005
1	7317	1040	319	32	2	0	0	0	2006

ScoGFS-WIBTS-Q4: Scottish groundfish survey

1995	2005							
1	1	0.83	0.91					
0	6							
1								
1	30094	8827	2530	435	215	4	0	1997
1	18457	7166	1291	37	35	26	0	1998
1	73309	7357	2166	263	219	0	6	1999
1	16862	8677	503	242	25	12	0	2000
1	0	140	133	13	0	0	0	2001
1	30324	16655	1435	224	2	28	0	2002
1	26671	7170	1138	69	0	0	0	2003
1	42435	19333	3321	319	3	0	0	2004
1	16510	3382	97	4	2	3	0	2005

Table 6.6.2. Continued. Whiting in 7.a. Survey data available to WGCSE 2016.

IR-ISCSGFS : Irish Sea Celtic Sea GFS 4th Qtr - Effort min. towed - No. at age

1997	2002						
1	1 0.8	0.9					
0	5						
540	1566	3330	793	154	23	12	1997
1020	48396	6534	2249	170	15	0	1998
1170	208494	3302	624	24	28	2	1999
1128	97502	4402	25	1	0	0	2000
1221	28881	29577	3123	177	1	0	2001
1035	12112	10237	1497	225	33	5	2002

IR-Q4 IBTS: IRISH GFS RV Celtic Explorer: NUMBERS-AT-AGE

2003	2004						
1	1 0.89	0.91					
0	5						
1	72340	19658	13391	1617	605	0	2003
1	75196	14563	1293	147	5	2	2004

IR-OTB : Irish Otter trawl - Effort in h - VIIa Whiting numbers-at-age - Year

1995	2002						
1	1 0	1					
1	6						
80314	6	437	206	261	21	1	1995
64824	64	682	1528	266	71	4	1996
92178	3	368	494	418	55	19	1997
93533	20	395	838	117	27	30	1998
110275	34	398	531	130	19	3	1999
82690	40	192	155	58	8	0	2000
77541	13	397	444	42	22	3	2001
77863	21	173	383	88	8	8	2002

UKNI-Pelagic trawl : Northern Ireland Midwater trawlers - Effort in h - No per h fished

1993	2002					
1	1 0	1				
2	6					
74014	3174	1060	172	29.5	4.8	1993
73778	1706	4340	574	72.8	16.2	1994
52773	1997	416	719	37.9	7.2	1995
53083	1432	2276	361	327.4	41.8	1996
55863	1241	660	549	12.3	17.5	1997
61153	438	423	98	45.8	2.7	1998
72859	162	185	57	13.5	11.6	1999
46412	67	53	11	7.9	1.1	2000
50302	7	4	2	0.5	0.2	2001
57754	189	316	90	11	15	2002

Table 6.6.2. Continued. Whiting in 7.a. Survey data available to WGCSE 2016.

UKNI-Otter trawl : Northern Ireland single-rig otter trawlers - Effort in h - No per h fished - includes discards

1993	2002							
1	1 0	1						
0	6							
195323	10308	9217	21444	2791	261	28	2	1993
191705	3172	11286	3957	9723	747	75	16	1994
161025	5228	10692	8874	987	1312	17	1	1995
154418	8663	20784	6748	4623	551	460	56	1996
165612	4344	12001	5864	1292	528	7	7	1997
149088	5869	11381	2368	1135	200	50	1	1998
146990	14625	3517	1202	344	59	12	8	1999
130117	4403	12613	3082	520	61	14	8	2000
131418	10658	6663	1833	228	64	13	10	2001
108616	4601	8586	1068	265	44	3	2	2002

UKE&W-Otter trawl : England/Wales Otter Trawl

1981	2000						
1	1 0	1					
2	6						
107	906	766	162	103	4	1981	
127	1984	893	340	67	49	1982	
88	685	1065	227	67	21	1983	
103	1395	439	475	80	29	1984	
103	2077	889	148	125	25	1985	
90	2246	1006	158	20	17	1986	
131	2206	1505	316	58	5	1987	
132	1885	827	161	30	6	1988	
140	1344	1201	234	40	10	1989	
117	2076	671	222	35	14	1990	
107	2374	793	165	48	5	1991	
97	2072	1020	177	42	3	1992	
79	784	654	157	31	5	1993	
43	110	454	91	15	3	1994	
43	460	188	375	7	1	1995	Revised at NSWG 1997
42	260	604	102	90	10	1996	
40	331	211	155	7	1	1997	
37	311	355	81	28	1	1998	
23	194	175	46	11	8	1999	
27	186	134	47	36	4	2000	

Eastern Irish Sea FSP: Isadale 2005–2013: Numbers of fish per hour towed.

AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	TOTAL	2+ BIOMASS INDEX	
0.22	11.06	21.12	5.28	0.98	0	0.69	39.3	7.3	2005
8.69	46.65	15.22	1.85	0.53	0.013	0	73.0	9.5	2006
4.24	10.77	5.55	1.01	0.28	0.02	0	21.9	2.7	2007
3.70	10.29	8.58	1.99	0.38	0.29	0.00	25.2	3.9	2008
27.30	84.91	48.67	3.61	0.33	0.00	0.00	164.8	17.9	2009
4.54	57.92	43.50	4.95	0.16	0.05	0.02	111.1	15.9	2010
2.22	8.42	31.85	5.13	0.96	0.02	0.00	48.6	8.1	2011
5.15	80.90	29.75	22.08	1.24	0.13	0.00	139.2	19.6	2012
4.21	47.35	26.43	3.13	1.72	0.01	0.00	82.9	12.2	2013

Table 6.6.3. VIIa whiting International numbers-at-age ('000) for human consumption, 1980–2002 (partially corrected for misreporting). Estimates have not been possible since 2003 due to low landings and resulting poor sampling.

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	0	0	41	0	0	0	0	0	0	0
1	14520	11203	5427	4886	18254	15540	6306	10149	6983	11645
2	21811	29011	18098	9943	12683	35324	16839	21563	25768	14029
3	6468	16004	19340	9100	5257	8687	10809	6968	6989	13011
4	2548	2596	6108	4530	2571	996	1877	1943	1513	3645
5	350	821	813	1165	1045	675	285	242	396	490
6+	621	339	400	321	402	372	270	111	197	177

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0	102	0	38	0	0	129	0	0	1
1	9502	7426	8380	2742	3245	1124	1652	610	329	341
2	17604	18406	21907	21468	6983	10095	6162	4239	3287	2806
3	4734	5829	7959	7327	18509	3020	7432	2567	4727	2607
4	1477	993	1374	932	1801	4444	1263	1795	888	741
5	318	311	462	135	208	233	1082	87	261	160
6+	128	84	93	27	50	21	135	79	95	119

Age	2000	2001	2002
0	0	0	0
1	319	111	67
2	1364	1189	748
3	1002	1006	1480
4	299	171	376
5	115	53	48
6+	15	20	41

Table 6.6.4. VIIa whiting International discard numbers-at-age ('000), 1980–2002. Estimates have not been possible since 2003 due to low landings and resulting poor sampling.

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	12786	9865	4047	23847	26394	12380	28364	16594	6922	17247
1	32318	24935	8489	7328	33900	26461	21111	40598	17958	20701
2	6888	9162	560	2036	1568	1859	1464	1875	1940	2476
3	65	162	19	9	11	9	33	0	0	26
4	26	26	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6+	0	0	0	0	0	0	0	0	0	0

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	4216	20349	1497	12639	3731	7118	12732	8163	6096	20851
1	31810	29334	61451	13979	12063	17613	39647	25497	27131	7677
2	3353	3823	10404	17707	1812	7015	8168	5352	2293	2117
3	72	146	97	426	1702	492	1976	689	550	228
4	0	1	0	5	29	234	81	141	44	34
5	0	0	0	0	0	0	0	0	0	2
6+	0	0	0	0	0	0	0	0	0	2

Age	2000	2001	2002
0	7321	16940	8538
1	38922	12631	13412
2	4395	3150	1588
3	564	102	231
4	55	10	33
5	1	0	0
6+	10	0	1

Table 6.6.5. VIIa whiting International catch numbers-at-age ('000) combined landings and discards, 1980–2002. Estimates have not been possible since 2003 due to low landings and resulting poor sampling.

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	12786	9865	4088	23847	26394	12380	28364	16594	6922	17247
1	46838	36138	13916	12214	52154	42001	27417	50747	24941	32346
2	28699	38173	18658	11979	14251	37183	18303	23438	27708	16505
3	6533	16166	19359	9109	5268	8696	10842	6968	6989	13037
4	2574	2622	6108	4530	2571	996	1877	1943	1513	3645
5	350	821	813	1165	1045	675	285	242	396	490
6+	621	339	400	321	402	372	270	111	197	177

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	4216	20451	1497	12677	3731	7118	12861	8163	6096	20852
1	41312	36760	69831	16721	15308	18737	41299	26107	27460	8018
2	20957	22229	32311	39175	8795	17110	14330	9591	5580	4923
3	4806	5975	8056	7753	20211	3512	9408	3256	5277	2835
4	1477	994	1374	937	1830	4678	1344	1936	932	776
5	318	311	462	135	208	233	1082	87	261	161
6+	128	84	93	27	50	21	135	79	95	121

Age	2000	2001	2002
0	7321	16940	8538
1	39242	12742	13479
2	5758	4338	2336
3	1566	1108	1711
4	354	181	409
5	115	53	48
6+	25	20	42

Table 6.6.6. VIIa whiting International landings mean weight-at-age (kg), 1980–2002. Estimates have not been possible since 2003 due to low landings and resulting poor sampling.

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	0.133	0.133	0.133	0	0.144	0	0.134	0	0	0
1	0.216	0.216	0.216	0.215	0.208	0.174	0.184	0.173	0.152	0.197
2	0.269	0.269	0.269	0.279	0.257	0.250	0.225	0.223	0.214	0.209
3	0.365	0.365	0.365	0.397	0.403	0.333	0.342	0.363	0.330	0.269
4	0.533	0.533	0.533	0.491	0.550	0.478	0.512	0.535	0.547	0.433
5	0.630	0.630	0.630	0.605	0.699	0.567	0.709	0.720	0.763	0.680
6+	0.772	0.888	0.736	0.655	0.745	0.642	0.940	0.933	1.005	1.079

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0	0.115	0	0.117	0	0	0	0	0	0.120
1	0.198	0.172	0.160	0.151	0.169	0.188	0.196	0.171	0.169	0.166
2	0.220	0.210	0.198	0.186	0.198	0.219	0.217	0.219	0.202	0.218
3	0.313	0.266	0.274	0.233	0.227	0.273	0.244	0.244	0.240	0.255
4	0.436	0.352	0.361	0.332	0.304	0.334	0.288	0.296	0.274	0.328
5	0.676	0.453	0.513	0.454	0.378	0.551	0.365	0.396	0.350	0.352
6+	0.800	0.692	1.007	0.892	0.496	1.320	0.415	0.537	0.421	0.328

Age	2000	2001	2002
0	0.064	0	0
1	0.179	0.182	0.145
2	0.216	0.250	0.214
3	0.269	0.319	0.273
4	0.317	0.346	0.356
5	0.347	0.538	0.449
6+	0.412	0.337	0.428

Table 6.6.7. VIIa whiting International discard mean weight-at-age (kg), 1980–2002. Estimates have not been possible since 2003 due to low landings and resulting poor sampling.

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	0.034	0.034	0.029	0.033	0.024	0.022	0.023	0.024	0.021	0.026
1	0.062	0.062	0.072	0.101	0.075	0.080	0.058	0.078	0.069	0.063
2	0.125	0.125	0.125	0.147	0.130	0.137	0.126	0.157	0.114	0.105
3	0.230	0.230	0.141	0.245	0	0	0.155	0	0.449	0.091
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6+	0	0	0	0	0	0	0	0	0	0

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.034	0.030	0.014	0.029	0.029	0.031	0.026	0.026	0.017	0.028
1	0.060	0.051	0.050	0.050	0.048	0.055	0.051	0.041	0.034	0.038
2	0.113	0.115	0.110	0.089	0.123	0.120	0.111	0.101	0.090	0.086
3	0.115	0.130	0.137	0.143	0.154	0.153	0.161	0.141	0.130	0.147
4	0	0	0	0.175	0.149	0.179	0.186	0.170	0.145	0.237
5	0	0	0	0	0	0	0	0	0	0.218
6+	0	0	0	0	0	0	0	0	0	0.174

Age	2000	2001	2002
0	0.024	0.017	0.016
1	0.036	0.034	0.033
2	0.100	0.088	0.082
3	0.128	0.119	0.127
4	0.150	0.194	0.141
5	0.213	0	0
6+	0.152	0	0.213

Table 6.6.8. VIIa whiting International catch mean weight-at-age (kg) combined landings and discard, 1980–2002. Estimates have not been possible since 2003 due to low landings and resulting poor sampling.

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	0.034	0.040	0.031	0.033	0.032	0.021	0.025	0.024	0.021	0.026
1	0.110	0.118	0.135	0.146	0.125	0.107	0.100	0.101	0.088	0.111
2	0.235	0.240	0.265	0.256	0.244	0.245	0.217	0.217	0.201	0.193
3	0.363	0.364	0.365	0.397	0.403	0.333	0.342	0.363	0.330	0.269
4	0.529	0.529	0.533	0.491	0.550	0.478	0.512	0.535	0.547	0.433
5	0.630	0.630	0.630	0.605	0.700	0.567	0.709	0.720	0.763	0.680
6+	0.772	0.888	0.736	0.655	0.745	0.642	0.940	0.933	1.005	1.079

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.036	0.031	0.014	0.029	0.030	0.031	0.027	0.026	0.017	0.028
1	0.094	0.077	0.063	0.067	0.074	0.063	0.057	0.044	0.035	0.044
2	0.204	0.194	0.170	0.142	0.183	0.179	0.159	0.153	0.156	0.161
3	0.310	0.263	0.272	0.228	0.221	0.257	0.230	0.222	0.228	0.246
4	0.436	0.352	0.361	0.331	0.301	0.326	0.284	0.287	0.268	0.324
5	0.676	0.453	0.513	0.454	0.378	0.551	0.364	0.396	0.350	0.351
6+	0.800	0.692	1.007	0.892	0.496	1.320	0.715	0.679	0.421	0.325

Age	2000	2001	2002
0	0.024	0.017	0.016
1	0.038	0.036	0.033
2	0.127	0.132	0.124
3	0.218	0.301	0.253
4	0.291	0.338	0.339
5	0.347	0.538	0.449
6+	0.310	0.337	0.425

Table 6.6.9. VIIa whiting estimates of discard numbers-at-age from the *Nephrops* fleet as a proportion of total International numbers-at-age.

Age	0	1	2	3	4	5
1981	1.000	0.690	0.240	0.010	0.010	0
1982	0.990	0.610	0.030	0.001	0	0
1983	1.000	0.600	0.170	0.001	0	0
1984	1.000	0.650	0.110	0.002	0	0
1985	1.000	0.630	0.050	0.001	0	0
1986	1.000	0.770	0.080	0.003	0	0
1987	1.000	0.800	0.080	0	0	0
1988	1.000	0.720	0.070	0	0	0
1989	1.000	0.640	0.150	0.002	0	0
1990	1.000	0.770	0.160	0.015	0	0
1991	0.995	0.798	0.172	0.024	0.001	0
1992	1.000	0.880	0.322	0.012	0	0
1993	0.997	0.836	0.452	0.055	0.005	0
1994	1.000	0.788	0.206	0.084	0.016	0
1995	1.000	0.940	0.410	0.140	0.050	0
1996	0.990	0.960	0.570	0.210	0.060	0
1997	1.000	0.977	0.558	0.212	0.073	0
1998	1.000	0.988	0.411	0.104	0.047	0
1999	1.000	0.957	0.430	0.081	0.044	0.009
2000	1.000	0.992	0.763	0.360	0.154	0.005
2001	1.000	0.991	0.726	0.092	0.055	0
2002	1.000	0.995	0.680	0.135	0.081	0.000
Mean 81-02	0.999	0.817	0.311	0.070	0.027	0.001

Table 6.6.10. VIIa whiting estimated landed and discarded catch (t). Data partially corrected for misreporting.

	Catch (t)	
Year	Landed	Discarded
1980	13461	3324
1981	17646	2960
1982	17304	808
1983	10525	1820
1984	11802	3433
1985	15582	2654
1986	10300	2115
1987	10519	3899
1988	10245	1611
1989	11305	2103
1990	8212	2444
1991	7348	2598
1992	8588	4203
1993	6523	2707
1994	6763	1173
1995	4893	2151
1996	4335	3631
1997	2277	1928
1998	2229	1304
1999	1670	1092
2000	762	2118
2001	733	1012
2002	747	740
2003	401	n/a
Mean:	7990	2253

Table 6.6.11. VIIa whiting discard numbers- and mean weights-at-age from the Irish otter board trawl fleet 1998–2015.

	1998		1999		2000		2001		2002		2003		2004		2005	
Age	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)
0	5073.57	0.027	187.26	0.036	7850.12	0.033	20981.54	0.016	29017.16	0.021	1921.76	0.016	17091.56	0.018	442.07	0.010
1	5939.53	0.064	276.50	0.102	3098.24	0.047	8883.11	0.054	12097.93	0.033	2419.56	0.036	7347.29	0.034	2531.84	0.035
2	3826.20	0.107	150.99	0.174	137.80	0.153	1413.48	0.126	576.17	0.112	1287.21	0.178	731.35	0.101	783.68	0.091
3	440.05	0.185	43.70	0.235	30.31	0.229	479.38	0.133	152.95	0.105	603.20	0.246	142.50	0.165	129.28	0.159
4	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	108.64	0.268	96.30	0.218	40.12	0.154
5	0.00	0.000	0.00	0.000	0.00	0.000	22.95	0.136	17.66	0.123	0.00	0.000	0.00	0.000	24.48	0.371
6	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
7	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
8	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
9	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
10+	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
Total weight (t)		1010.3		71.6		434.3		1054.5		1100.9		523.6		680.3		201.3

Sampling Information	1998	1999	2000	2001	2002	2003	2004	2005
Number of Trips	7	4	10	2	1	9	11	8
Number of Hauls	58	40	111	34	7	60	122	96

	2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
Age	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)
0	1534.97	0.016	5138.89	0.043	4585.77	0.025	13319.29	0.028	1406.81	0.016	6293.64	0.018	1759.01	0.013	1476.87	0.012	984.15	0.038	247.42	0.009
1	1483.43	0.060	23000.16	0.038	7879.78	0.040	12913.10	0.036	4513.61	0.038	4912.12	0.026	14550.46	0.030	728.39	0.042	3059.39	0.050	12074.20	0.041
2	621.58	0.133	3282.67	0.095	1485.70	0.093	712.51	0.081	1383.11	0.084	307.09	0.080	431.71	0.093	301.28	0.101	558.80	0.121	2197.64	0.102
3	99.02	0.218	916.09	0.145	161.03	0.119	2.60	0.175	129.68	0.133	30.38	0.164	59.06	0.121	34.34	0.162	172.90	0.163	467.61	0.123
4	16.82	0.312	10.96	0.276	13.46	0.130	0.89	0.257	5.41	0.163	2.73	0.198	9.58	0.166	1.32	0.248	5.71	0.221	86.41	0.171
5	0.00	0.000	1.92	0.304	0.00	0.000	0.00	0.000	0.47	0.167	0.18	0.199	0.00	0.199	0.92	0.255	0.95	0.242	20.10	0.286
6	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000				
7	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000				
8	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000				
9	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000				
10+	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000				
Total weight (t)		223.2		1544.7		585.3		892.3		329.8		268.8		510.4		84.9		288.1		804.6

Sampling Information	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Number of Trips	5	15	18	12	4	6	6	14	11	17
Number of Hauls	56	90	91	55	29	74	74	131	168	242

Table 6.6.12 Discards and Landings (t) by métier and country of Whiting in VIIa, 2012–2015.

Year	2012		2013		2014		2015	
Country	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**
Belgium								
OTB_CRU_70-99_0_0_all		1.02		0.27		0.08		0.15
TBB_DEF_70-99_0_0_all	16.68	3.45	17.47	2.11	15.00	1.25	8.64	2.28
UK Northern Ireland								
OTB_CRU_70-99_0_0_all	922.22	1.45	832.78	16.80	1644.77	9.57	1079.02	6.91
OTB_DEF_100-119_0_0_all				0.37			0.65	1.03
OTB_DEF_70-99_0_0_all		0.03		0.00				
OTB_MOL_70-99_0_0_all			0.91	0.08				
OTM_DEF_100-119_0_0_all	1.24	0.14	0.08	0.15	0.29	0.93		
PTM_DEF_100-119_0_0_all				0.57				
PTM_SPF_32-69_0_0_all			1.28					
SSC_DEF_100-119_0_0_all	0.08	0.12	0.08			0.05	0.01	0.08
DRB_MOL_0_0_0_all					0.00		0.02	
Isle of Man								
C-Allgears		0.09		0.02		0.22		
UK England								
GNS_DEF_all_0_0_all				0.06		0.04		0.01
LLS_FIF_0_0_0_all		0.03						
MIS_MIS_0_0_0_HC		5.55				0.03		0.01
OTB_CRU_70-99_0_0_all	0.64	2.49	0.79	0.65	27.61	0.04	0.88	0.10
OTB_DEF_70-99_0_0_all							0.02	0.02
TBB_DEF_70-99_0_0_all		0.03		0.04		0.01		0.00
France								
GTR_DEF_100-119_0_0_all						0.06		
OTB_DEF_100-119_0_0						0.34		
MIS_MIS_0_0_0_HC		0.57						0.04
OTB_DEF_100-119_0_0_all				0.44				
OTT_DEF_100-119_0_0						0.00		
Ireland								
MIS_MIS_0_0_0_HC		44.89				3.94		2.36
OTB_CRU_100-119_1_0_all			0.01					
OTB_CRU_70-99_0_0_all	36.73						804.58	
OTB_CRU_70-99_1_0_all	442.58		63.74	0.09		0.36		
OTB_CRU_70-99_2_0_all	178.83		13.92					
OTB_DEF_100-119_0_0_all			4.14	5.92		4.27		10.65
OTB_DEF_70-99_0_0_all			3.06	4.16				
SSC_DEF_100-119_0_0_all				0.10		1.12		3.55
TBB_DEF_70-99_0_0_all			0.58	0.02				0.21
TBB_DEF_100-119_0_0_all	26.53							
OTB_DEF_100-119_1_0								
GNS_DEF_120-219_0_0								
OTB_DEF_100-119_1_0								
OTB					288			
UK Scotland								
OTB_DEF_>=120_0_0_all				1.34				0.05
OTB_CRU_70-99_0_0_all								0.10

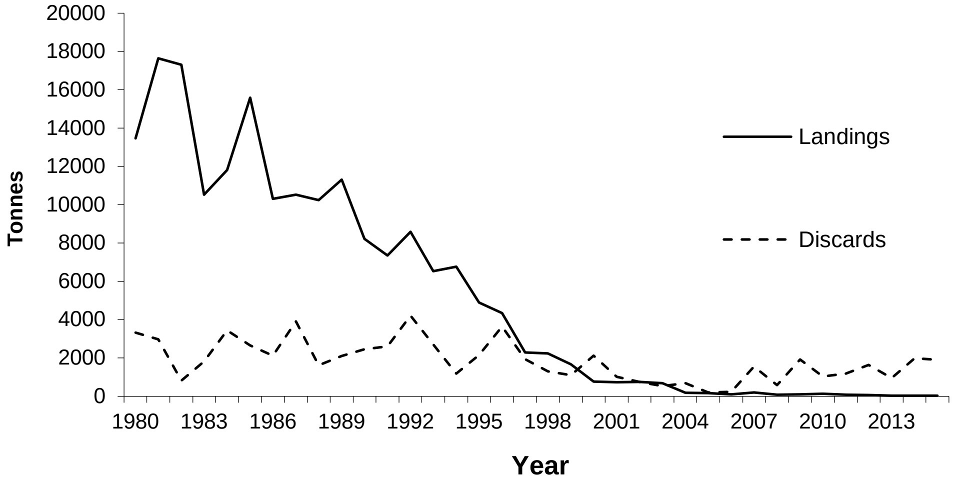


Figure 6.6.1. Whiting VIIa. Working group estimates of International landings and discards between 1980–2015.

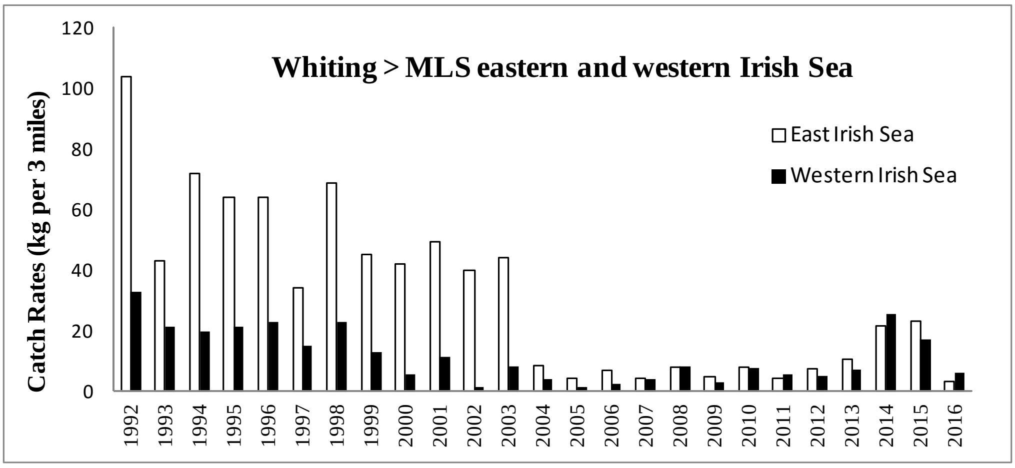
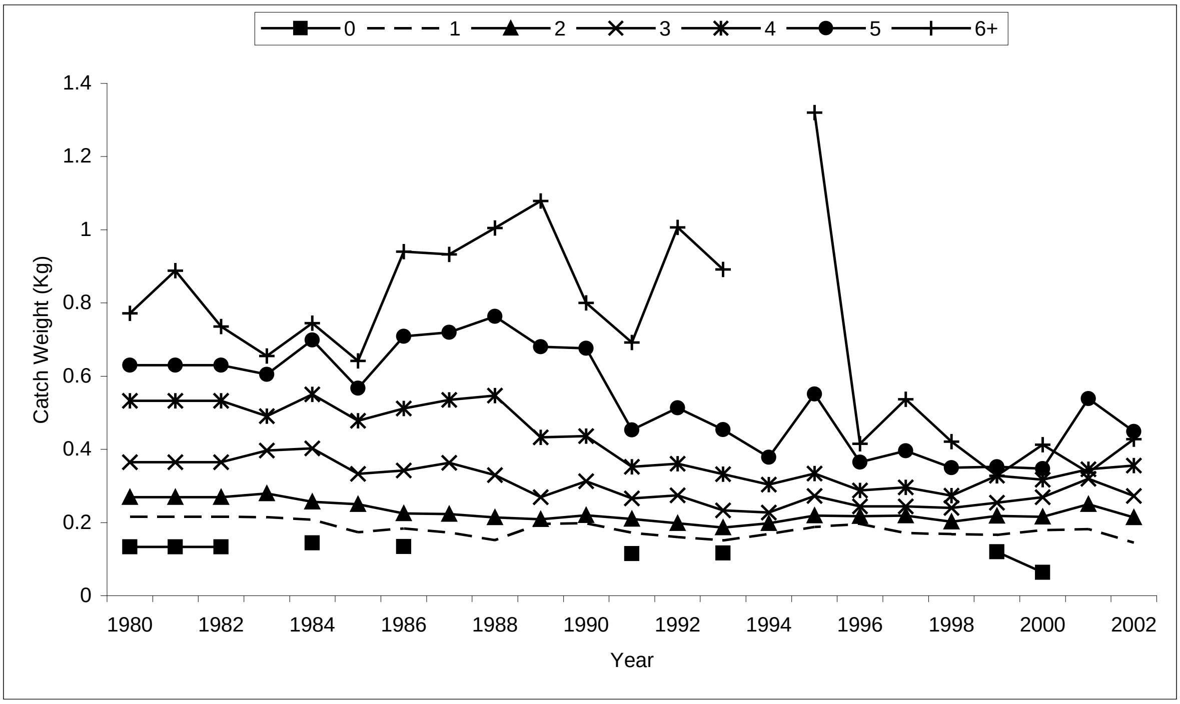


Figure 6.6.2. Eastern and western VIIa whiting mean catch rates in kg per 3-mile tow, for fish at and above the minimum landing size (27 cm) for NIGFS-WIBTS-Q1 survey in March 1992–2016.

a)



b)

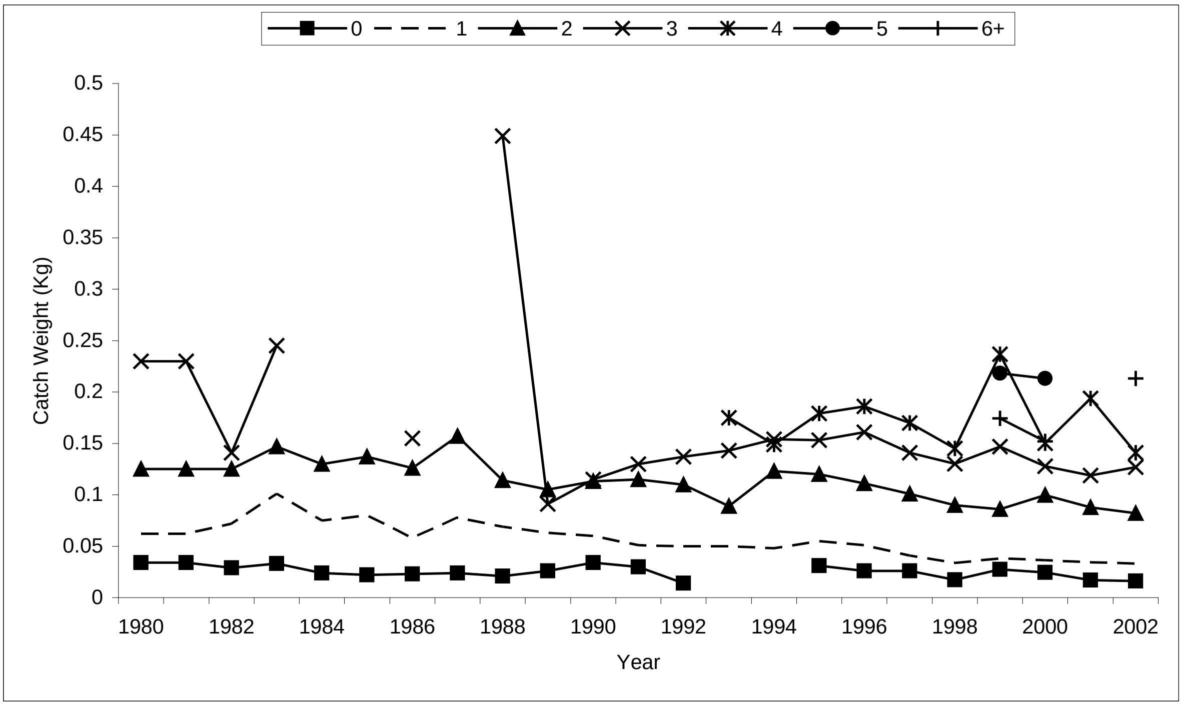
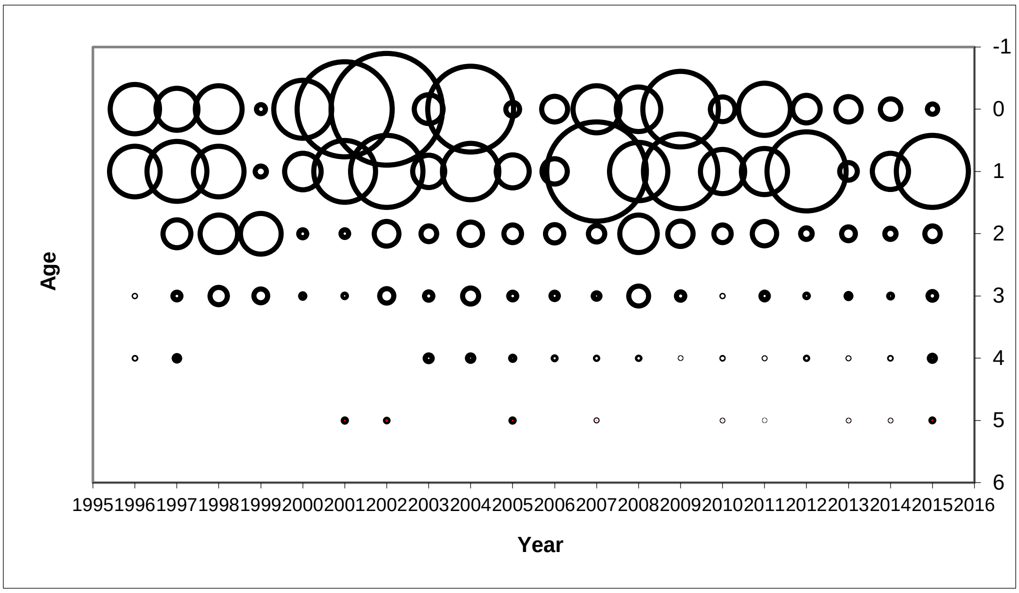


Figure 6.6.3. VIIa whiting International mean weights-at-age in (a) landings (Human Consumption Fishery) and (b) discards, 1980–2002.

a)



b)

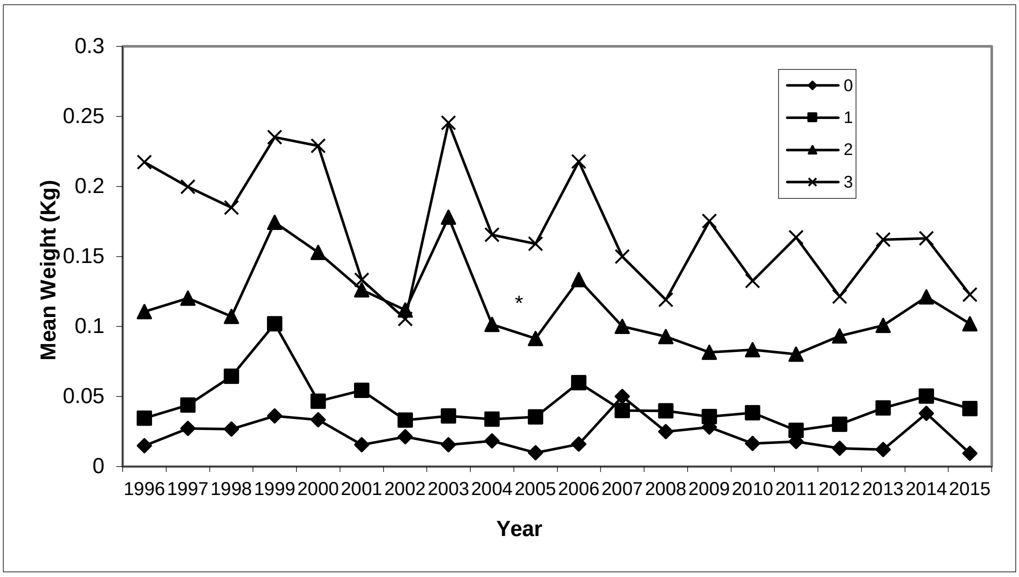
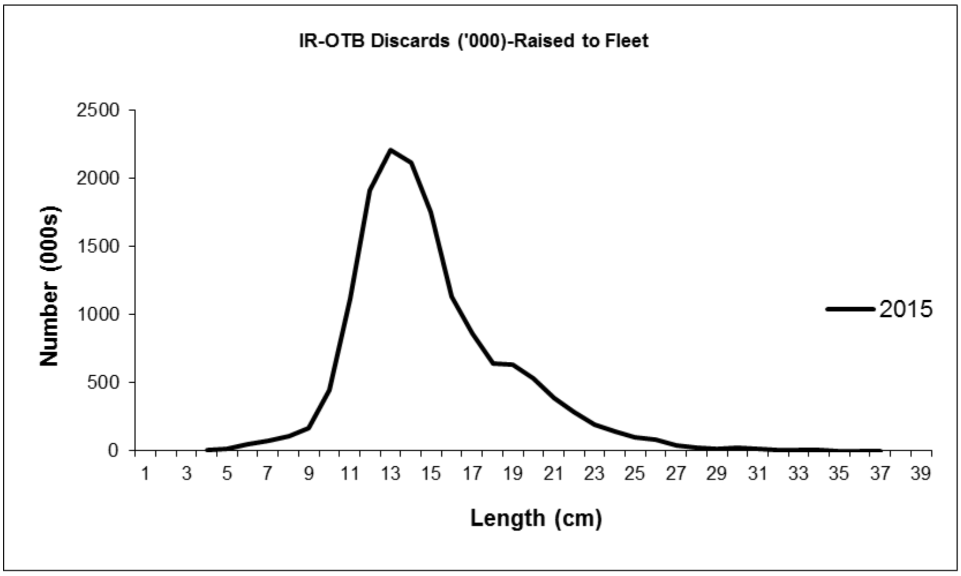
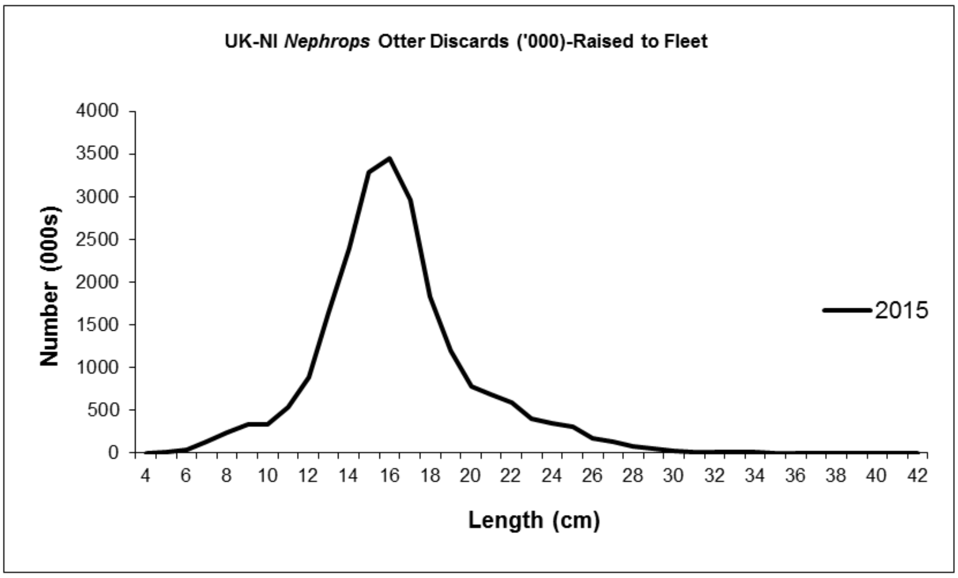


Figure 6.6.4. VIIa whiting discard information for the Irish commercial otter board trawl fleet (a) numbers-at-age and (b) mean weights-at-age, 1996–2015.





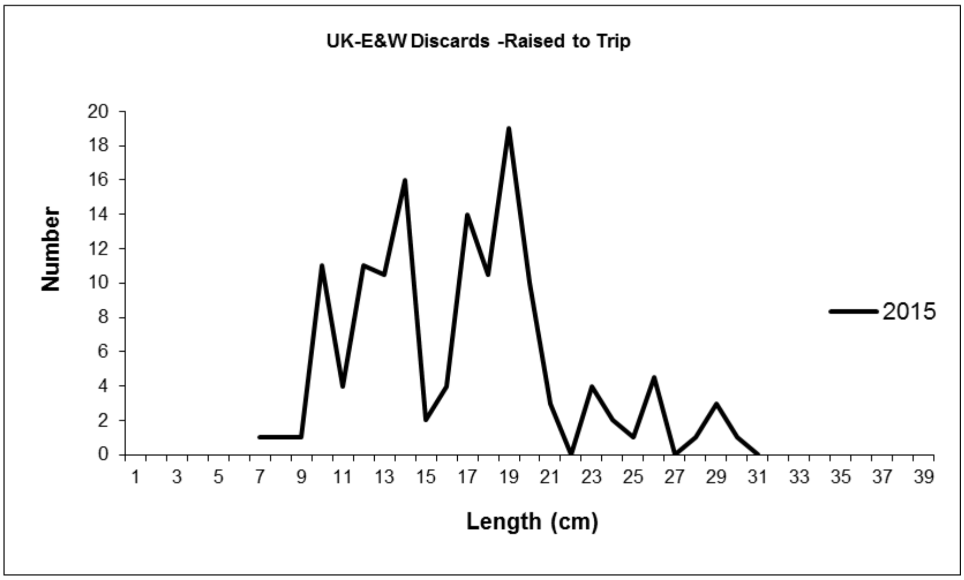


Figure 6.6.5. VIIa Whiting discard length–frequency by national fleets in 2015. Note due to low levels of retained catch, and hence low sampling, these data are not presented.

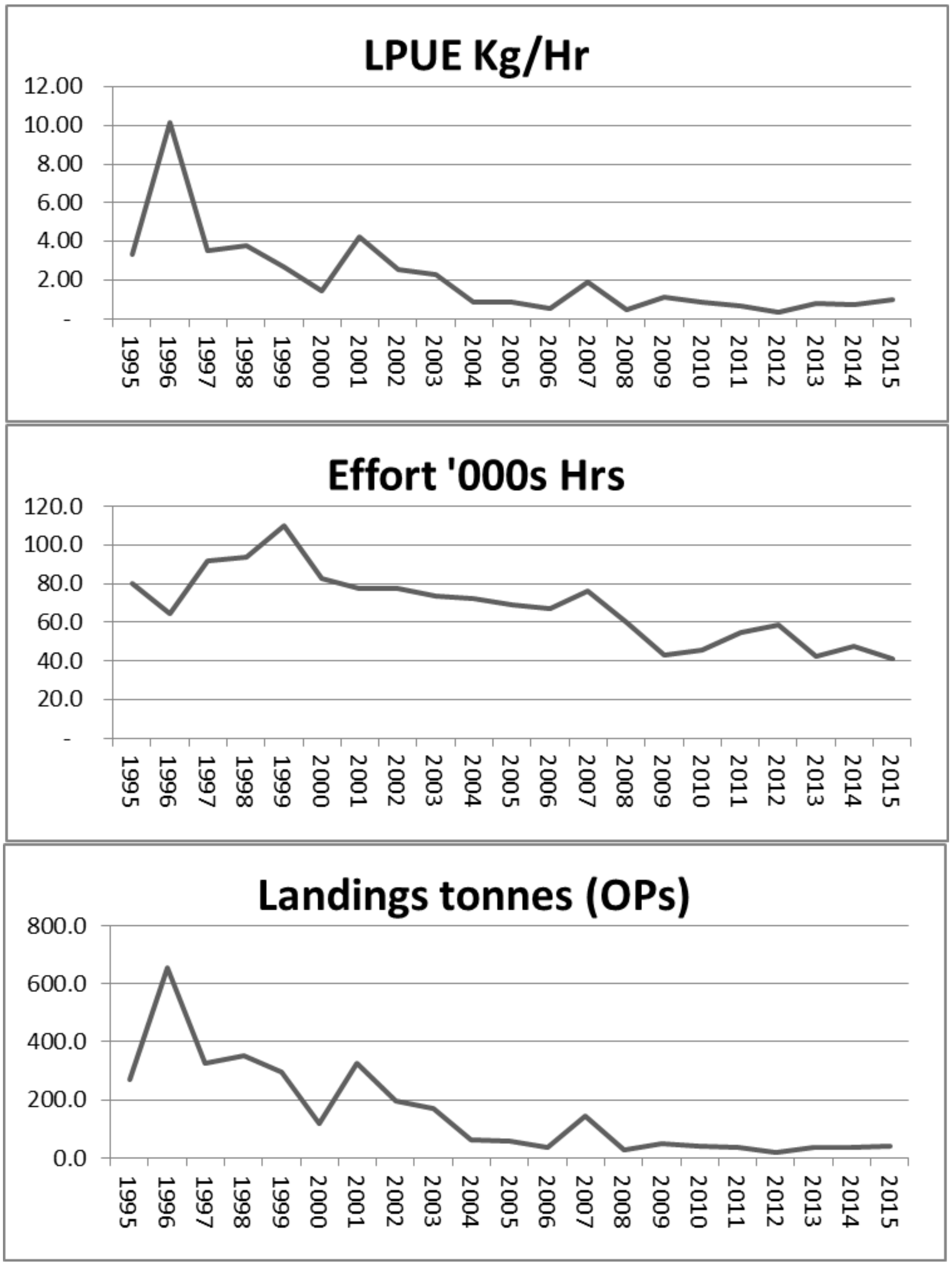
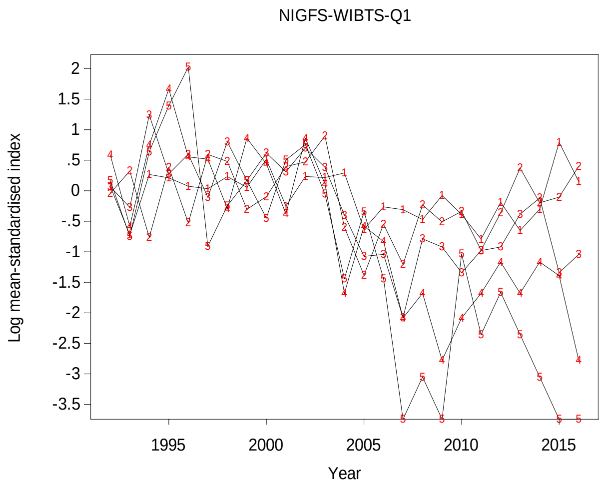
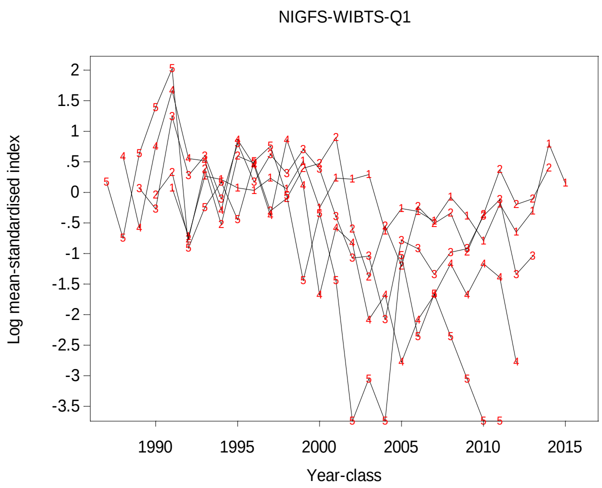


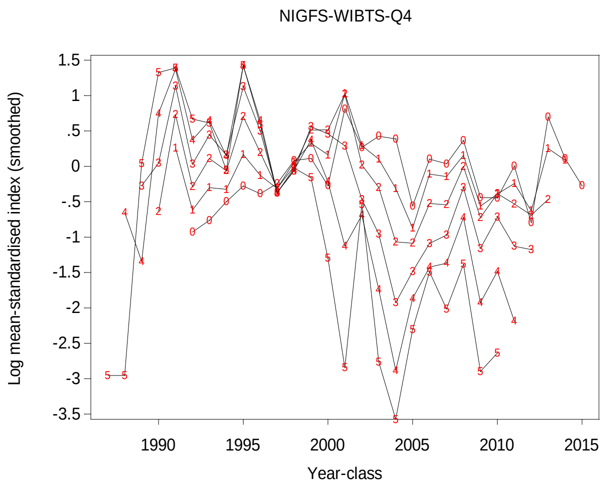
Figure 6.6.6. VIIa whiting Commercial cpue data from IR-OTB fleet 1995–2015.

a)





b)



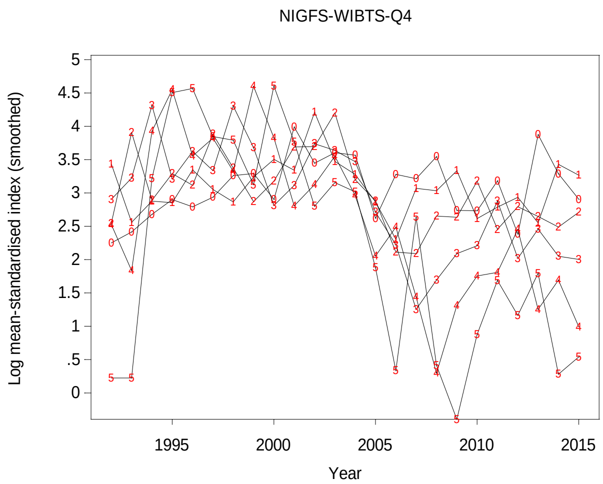
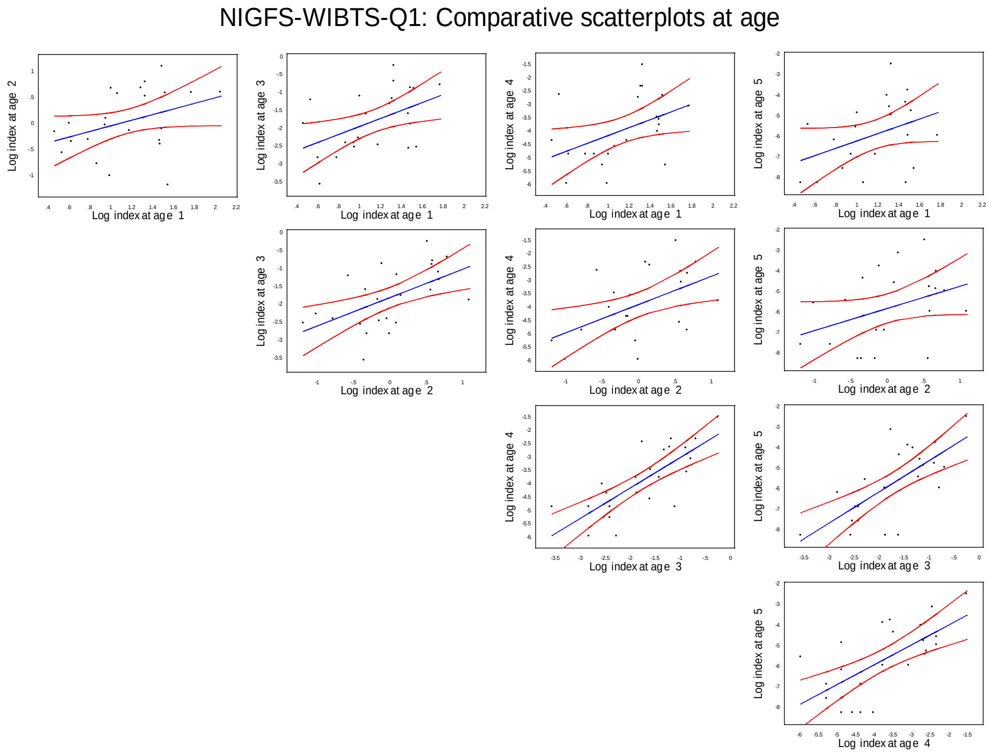


Figure 6.6.7. Log Mean Standardized Indices for (a) NIGFS-WIBTS-Q1 and (b) NIGFS-WIBTS-Q4 by year class and year.

a)



b)

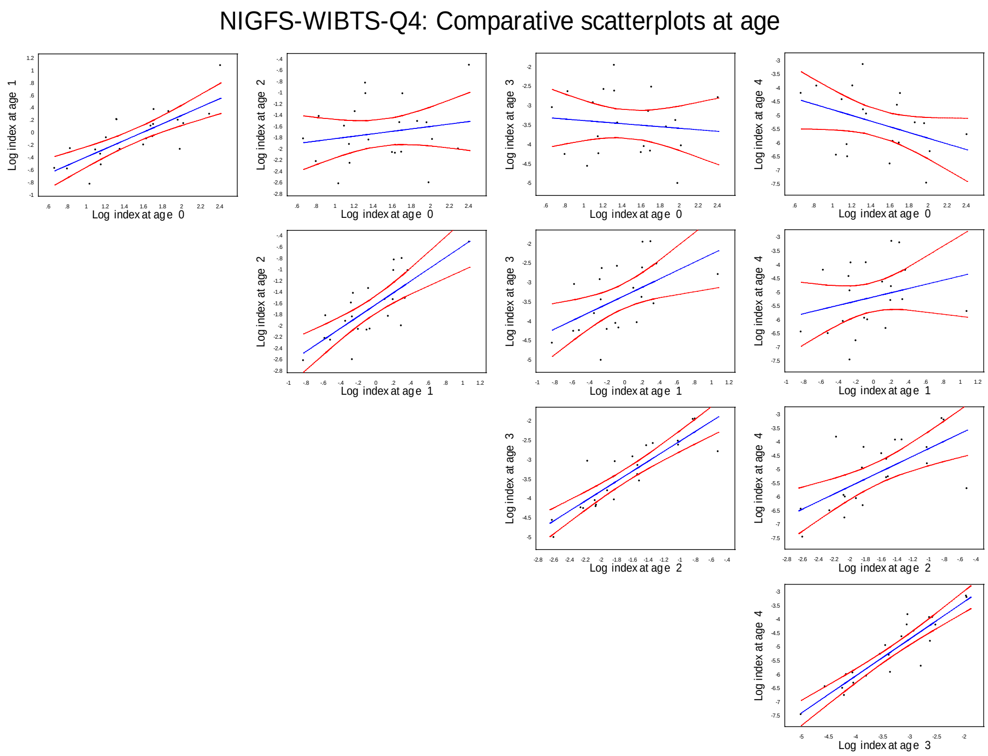
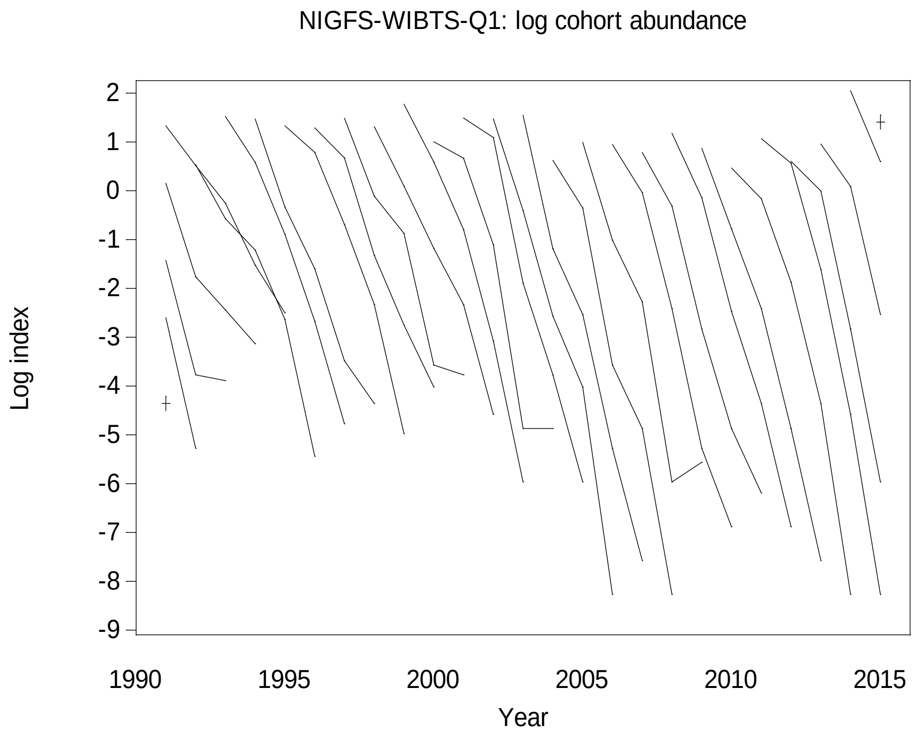


Figure 6.6.8. Scatterplots of Log index-at-age for the NIGFS-WIBTS-Q1 (a) and NIGFS-WIBTS-Q4 (b) surveys.

a)



b)

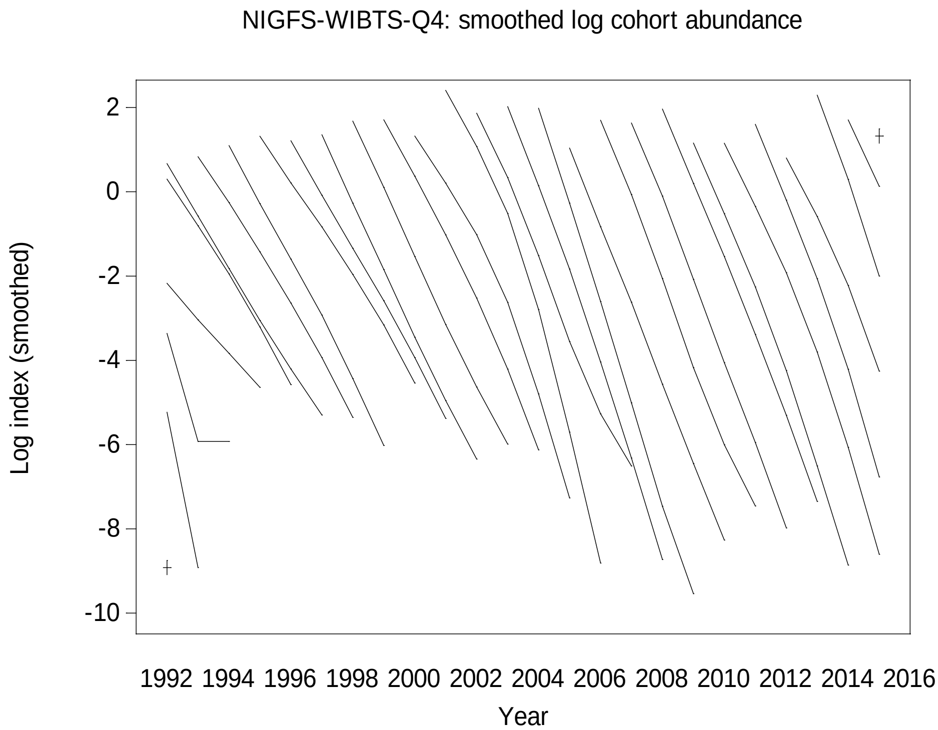
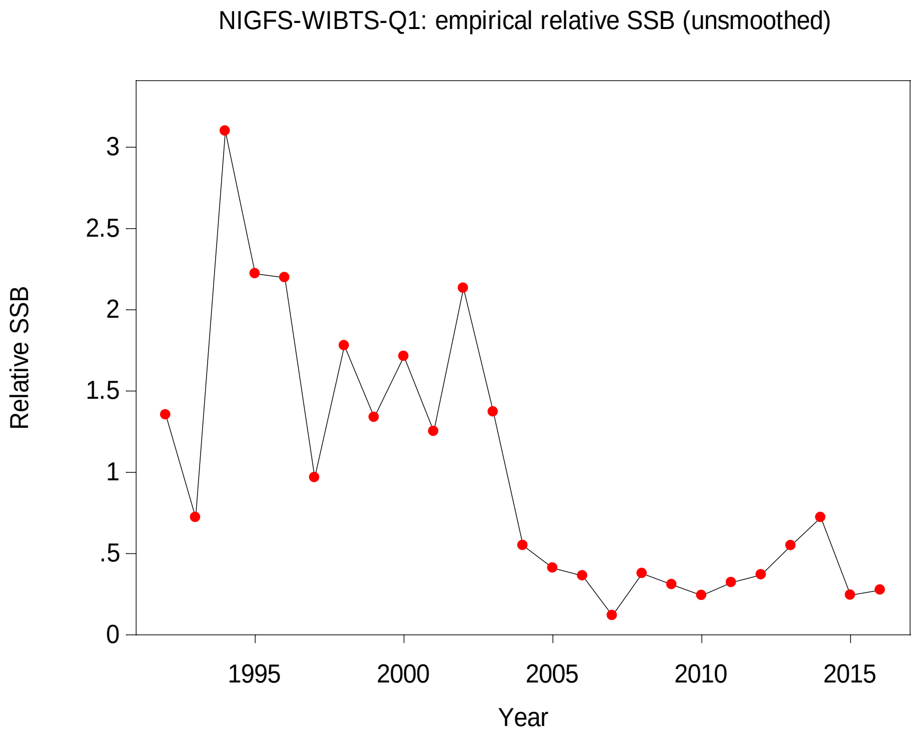


Figure 6.6.9. Catch Curves for NIGFS-WIBTS-Q1 (a) and NIGFS-WIBTS-Q4 (b) surveys.

a)



b)

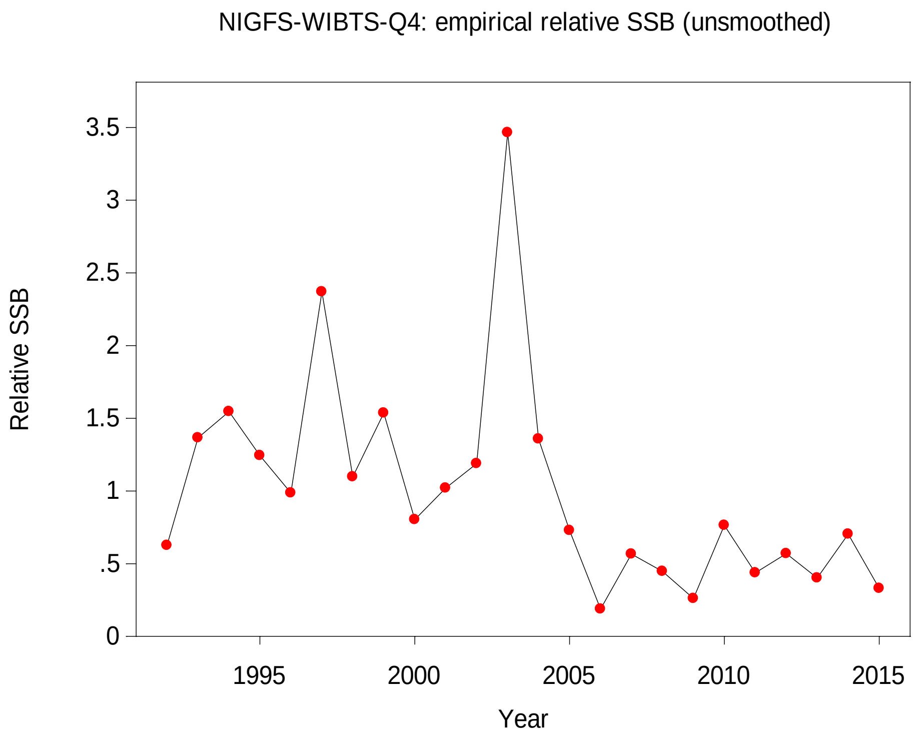


Figure 6.6.10. Empirical Estimates of SSB for NIGFS-WIBTS-Q1 (a) and NIGFS-WIBTS-Q4 (b) surveys.

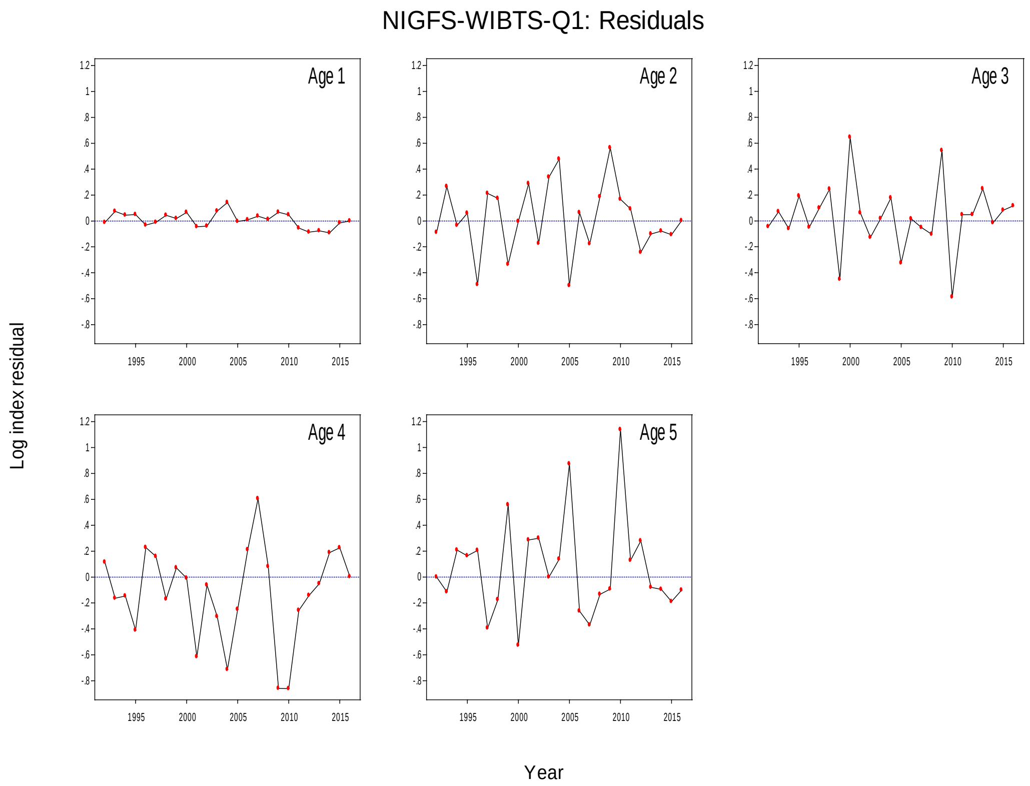


Figure 6.6.11. Residual Plots by Age of the NIGFS-WIBTS-Q1 survey.

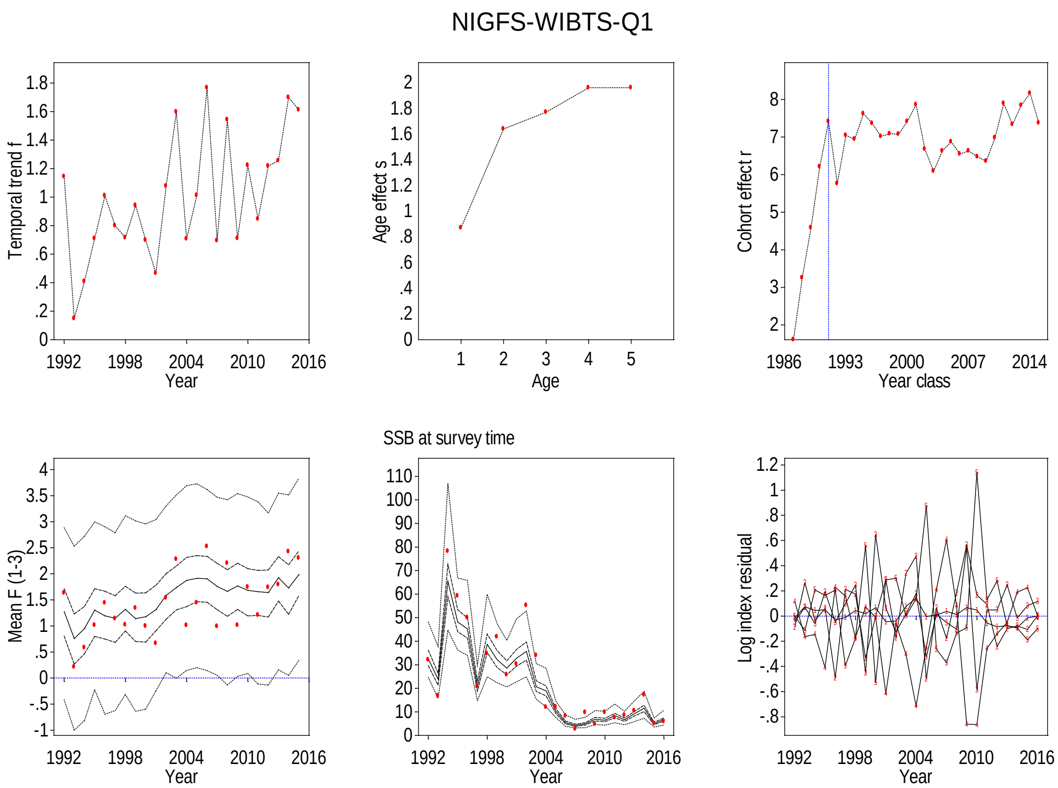


Figure 6.6.12. Stock Summary of the SURBA model fit for the NIGFS-WIBTS-Q1 survey. Empirical SSB (red dots) with model estimates of SSB (black line) are shown in bottom centre panel.

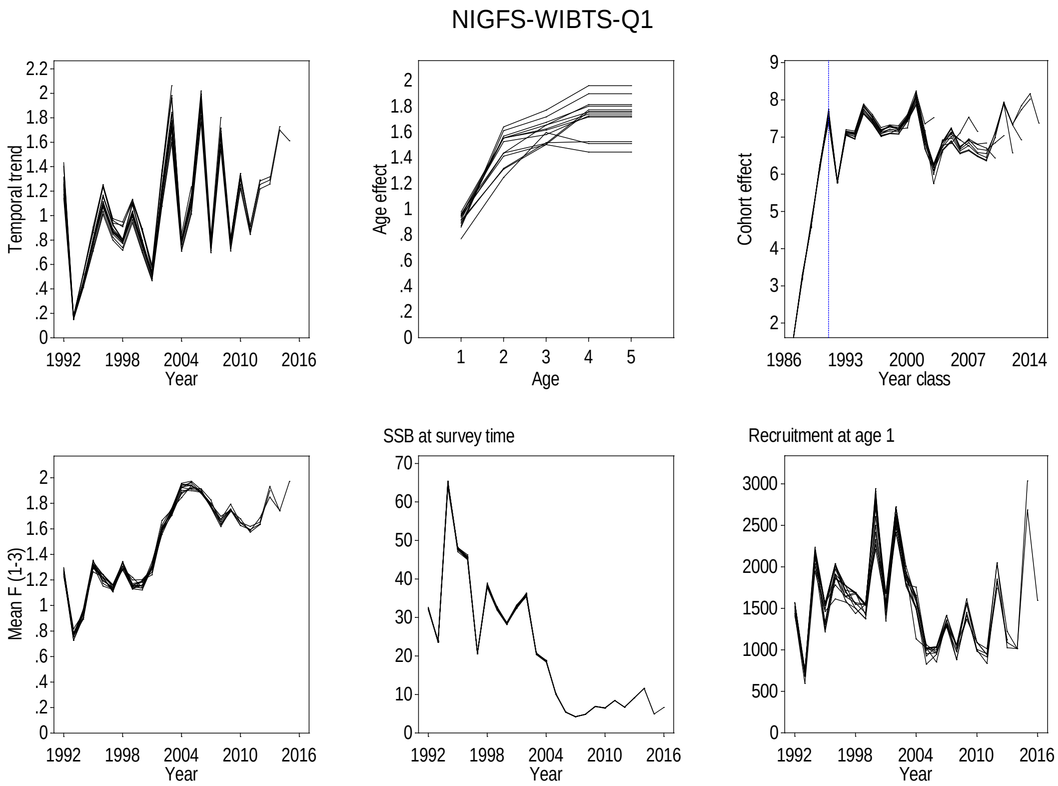


Figure 6.6.13. Retrospective pattern of Single fleet SURBA run for NIGFS-WIBTS-Q1 survey.

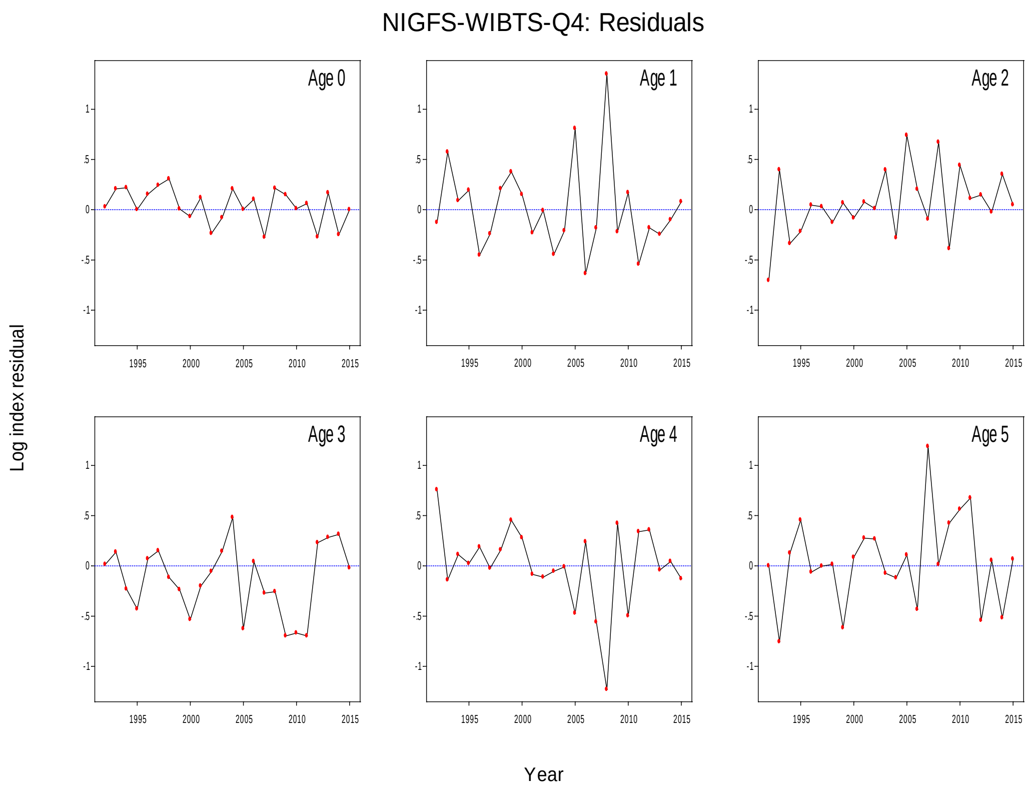


Figure 6.6.14. Residual Plots by Age of the NIGFS-WIBTS-Q4 survey.

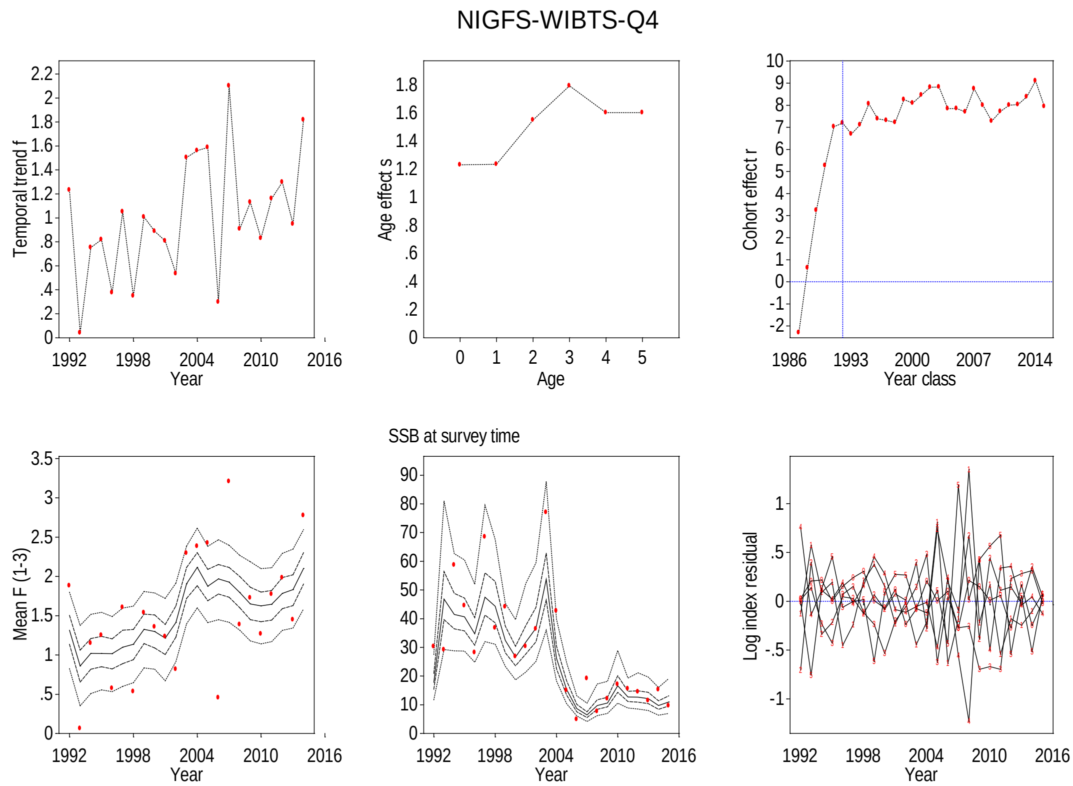


Figure 6.6.15. Stock Summary of the SURBA model fit for the NIGFS-WIBTS-Q4 survey. Empirical SSB (red dots) with model estimates of SSB (black line) are shown in bottom centre panel.

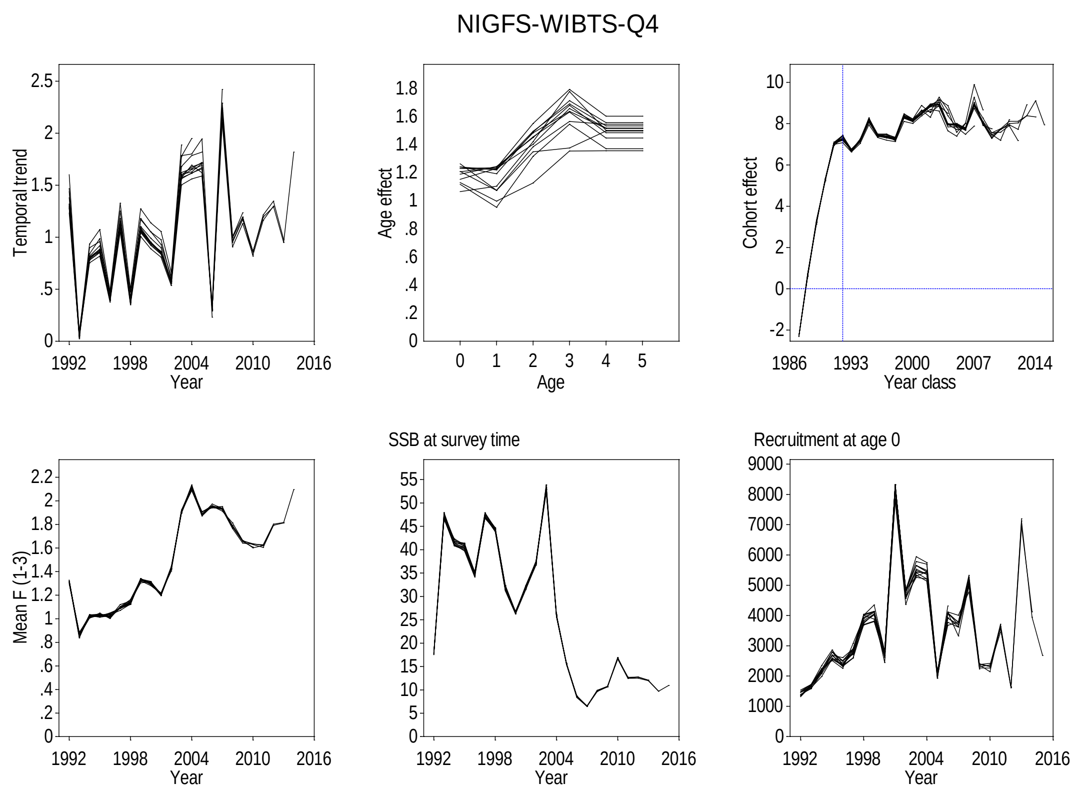


Figure 6.6.16. Retrospective pattern of Single fleet SURBA run for NIGFS-WIBTS-Q4 survey.

6.7 Plaice in Division 7.a (Irish Sea)

Type of assessment in 2016

Update of the analytic assessment used to derive relative trends. ICES WKFLAT (2011) benchmarked this assessment and included estimates of discards-at-age from 2004 into the catch matrix. However, considerable uncertainty exists regarding the historical levels of discarding. This uncertainty translates into uncertain stock size and unknown exploitation status, therefore the assessment is indicative of trends only.

ICES advice applicable to 2015

For this stock the biomass is estimated to have decreased by 7% between the periods 2009–2011 (average of the three years) and 2012–2013 (average of the two years). Considering the stable trend in SSB over the last decade and the large uncertainty in the annual estimates, this implies no changes in catches compared to the average of the last three years, corresponding to catches in 2015 of 1244 t. If discard rates do not change from the average of the last two years (68% in 2012–2013, a period that includes North Ireland discards), this implies landings in 2015 of no more than 394 t.

The recent harvest rate is considered to be very low (Figure 5.3.23.1), therefore no additional precautionary reduction is needed.

Based on ICES approach to data-limited stocks, ICES advises that catches should be no more than 1244 t in 2015. If discard rates do not change from the average of the last two years (2012–2013), this implies landings of no more than 394 t in 2015.

ICES advice applicable to 2016

ICES advises that when the precautionary approach is applied, catches in 2016 should be no more than 1244 tonnes. If this stock is not under the EU landing obligation in 2016 and discard rates do not change from the average of the last three years (2012–2014), this implies landings of no more than 343 tonnes.

6.7.1 General

Stock description and management units

The stock assessment area and the management unit are both Division 7.a (Irish Sea).

Management applicable in 2015 and 2016

Management of plaice in Division 7.a is by TAC and there is a minimum landing size (MLS) of 27 cm in force. The agreed TACs and associated implications for plaice in Division 7.a are detailed in the tables below.

2015

Species:	Plaice *Pleuronectes platessa*	Zone:	VIIa (PLE/07A.)
Belgium	28		
France	12		
Ireland	768		
The Netherlands	9		
United Kingdom	281		
Union	1 098		
TAC	1 098		Analytical TAC

2016

Species:	Plaice *Pleuronectes platessa*	Zone:	VIIa (PLE/07A.)
Belgium	28		
France	12		
Ireland	768		
The Netherlands	9		
United Kingdom	281		
Union	1 098		
TAC	1 098		Analytical TAC

The fishery in 2015

National landings data reported to ICES and Working Group estimates of total landings are given in Table 6.7.2.1. A summary by gear is given below.

Catch (2015)	Landings			Discards		
1005 t	39 beam trawl	51% otter trawl	10% other gear types	34% beam trawl	62% otter trawl	3% other gear types
	439 t			565 t		

The TAC in 2015 was 1098 tonnes and the working group estimate of landings in 2015 was 439 tonnes, which is a 56% increase in landings comparable to 2014 and only 40% of the 2015 TAC. This shortfall in estimated landings relative to the TAC has occurred in previous years, previously increasing steadily from 7% of the TAC in 2003 to 70% in 2008, 2009 and 2012 and around 80% in 2013 and 2014, before falling to 60% in 2015. The poor uptake of the quota is not a consequence of an inability to catch sufficient quantities of plaice greater than the MLS but rather is most likely due to the limited market demand and poor value of the catch.

Landings (based on working group estimates) by the Belgian, UK(E&W), NI, and Irish fleets comprised approximately 26%, 12%, 6% and 56% respectively of total landings in 2014. The landings of plaice are mainly split between beam trawlers (39%; primarily Belgian vessels then Irish vessels) targeting sole, and otter trawlers (51%; UK and Irish vessels). Historically, otter trawling was dominated by UK vessels fishing for whitefish, but in recent years many vessels have switched to target *Nephrops*

(Figure 6.7.2.1). Otter trawlers from Ireland and N. Ireland typically target *Nephrops* in the western Irish Sea.

High levels of discarding are known to occur in all fisheries that catch plaice in the Irish Sea (see Figures 6.7.2.3 to 6.7.2.5).

A general description of the fishery can be found in the stock annex (Annex 6.7) and also in 'Other Relevant Data' section below. For general mixed fisheries advice applicable to this stock and other species taken in the same fisheries, see Section 6.1.

6.7.2 Data

Landings

National landings data reported to ICES and Working Group estimates of total landings are given in Table 6.7.2.1. The working group procedures used to determine the total international landings numbers and weights-at-age are documented in the stock annex. As a result of increased rates of discarding, landed numbers-at-age for the younger ages (ages 2 to 4) have declined more rapidly over the last two decades than landings of older fish (Figure 6.7.2.2).

Discards

Discard sampling has been conducted by the UK(E&W) since 2002 and by Ireland since 1993; Northern Ireland has collected data from 1996 (but not between 2003 and 2005), and Belgium since 2003. Length distributions (LD) of landed and discarded fish estimates are presented for all UK(E&W) gears in Figure 6.7.2.3, for Irish otter trawls in Figure 6.7.2.4 and Belgian beam-trawl fleets in Figure 6.7.2.5. For all of the fleets illustrated the discarding pattern is dominated by discarding of small fish, below the MLS of 27 cm.

WKFLAT 2011 first estimated total international discards-at-age and introduced them to the assessment of the stock for the first time. Due to limitations in the data available by gear type, discards for Ireland, France and Northern Ireland, for the years 2004–2011 were raised using UK estimates on the basis of equivalent gear types. A raising factor based on tonnages landed for these countries was calculated and applied to the UK(E+W) estimates of discard numbers. Finally, these estimates were added to those calculated for Belgium to give estimates of total international discard numbers-at-age.

In 2012–2015 landings and discard estimates for UK(E&W), Ireland, Northern Ireland and Belgium were available by gear type and used to raise discards for France, Scotland and UK(IOM).

The total discard estimates (Table 6.7.2.1) confirm the significant proportion of discarding that occurs in the fishery which has increased in time to levels higher than landings since 2006 (Figure 6.7.2.8). The beam trawl survey (UK(E&W)-BTS-Q3) shows the strong 2006 year class at ages 1–5 (Figure 6.7.2.2) and this cohort is present in the discard data at-ages 2–4 before entering the landings at-age 5 in 2011.

There is a considerable historic time period (1972–2003) for which no international raised discard estimates are available; discards during 1993–2003 are estimated within the model.

Biological

Landings numbers-at-age are given in Table 6.7.2.5 and plotted in Figure 6.7.2.2. Weights-at-age in the landings and stock are given in Table 6.7.2.6. Discard weights-at-age are given in Table 6.7.2.7 and weights-at-age in the stock in Table 6.7.2.8. The history of the derivation of the landings weights and stock weights used in this assessment is described in the stock annex.

Mean weight-at-age in the landings and survey data indicate declines in both sexes throughout the Irish Sea since 1993 so that plaice at ages ≤4 are typically below MLS (see stock annex, Figure A2).

Surveys

All available tuning data are shown in Tables 6.7.2.2, 6.7.2.3 and 6.7.2.4. Due to inconsistencies in the available commercial tuning fleets, Irish Sea plaice assessments since 2004 have only included the UK(E&W) beam-trawl survey (UK(E&W)-BTS-Q3) and the two NIGFS-WIBTS spawning biomass indices based on ground fish surveys (NIGFS-WIBTS-Q1 and NIGFS-WIBTS-Q4). For more information see WGNSDS 2004. The UK(E&W)-BTS-Q3 index was revised by WKFLAT 2011 to include stations in the western Irish Sea and in St George's Channel.

Previous reviews of the UK(E&W)-BTS-Q3 mean standardised cpue trends have indicated that the survey has good internal consistency in monitoring trends across the stock area. For the entire Irish Sea, the biomass index of age 1–4 fish calculated from the UK(E&W)-BTS-Q3 indicates an upwards trend between 1993 and 2003 with stability at a high level subsequently. The trends are mainly driven by increases in the biomass in the eastern Irish Sea (Figure 6.7.2.9). The NIGFS-WIBTS surveys show similar increases in biomass between 1993 and 2003/4 and then a further increase subsequently.

The NIGFS-WIBTS survey strata can be disaggregated into eastern (Strata 4–7) and western (Strata 1–3) subareas, where the subareas are divided by the deep trench that runs roughly north–south to the west of the Isle of Man (Figure 6.7.2.7, Table 6.7.2.3). The notable difference in mean biomass between spring and autumn in the western area (Strata 1–3) suggests either that spawning fish migrate into the area during spring or that catchability of plaice increases during spawning.

The SSB of plaice in the Irish Sea is also independently estimated using the Annual Egg Production Method (AEPM, Figure 6.7.2.2):

YEAR	SSB (TONNES)	CATCH/SSB HARVEST RATE
1995	9081	
2000	13 303	
2006	14 417	15.16
2008	14 352	12.77
2010	15 071	19.5

Catch (discards available from 2004) to egg survey biomass ratios indicate historically that the plaice in the Irish Sea has been lightly exploited. Splitting the SSB estimates from the AEPM into eastern and western Irish Sea areas also indicates that the perceived increase in plaice biomass is due to increased production in the eastern Irish Sea only (For more details see stock annex).

In summary, the UK(E&W)-BTS-Q3 in September, the NIGFS-WIBTS-Q3 index in October (but not NIGFS-WIBTS-Q1 March), and the AEPM indicate a sustained increase in biomass in the eastern Irish Sea, but this rise does not appear to extend across the deep channel to plaice in the western Irish Sea (Figure 6.7.2.9).

Commercial cpue

All available tuning data are shown in Table 6.7.2.4. Age-based tuning data available for this assessment comprise three commercial fleets; the UK(E&W) otter trawl fleet (UK(E&W)OTB, from 2008), the UK(E&W) beam-trawl fleet (UK(E&W)BT, from 1989) and the Irish otter trawl fleet (IR-OTB, from 1995). Due to inconsistencies in the available tuning fleets, Irish Sea plaice assessments since 2004 have omitted these indices. For more information see WGNSDS 2004. The effort and catch by these commercial fleets has been very low in recent years, and the cpue data are no longer considered informative.

Other relevant data

Table 6.7.2.2 and Figure 6.7.2.1 show that effort levels have decreased since 2002 for the majority of fleets. Both the UK otter and beam-trawl fleets are close to their lowest recorded effort levels in time-series extending back to 1972 and 1978 respectively. Effort by UK *Nephrops* trawlers has increased since 2006 and this fleet is now the dominant UK fleet in terms of hours fished in 7.a. Belgian vessels operating in Division 7 typically move in and out of the Irish Sea, depending on the season, from specifically the Bristol Channel and Celtic Sea, the Bay of Biscay and the southern North Sea.

In 2013, 2014 and 2015, there was a problem with the gear effort information (000s hours fished) reported for the UK(E+W) commercial beam-trawl fleet. Effort information from this fleet was largely missing as a result of a larger component of the fleet using the EU electronic logbook system to report its activities. Gear effort information reporting has not been mandatory with this system to date. As a result, few trips reported their gear effort information rendering the overall effort reported and resulting lpue unusable. However an initial inspection of an alternate effort indicator for this gear (days fished) suggests that UK beam-trawl effort in 2013, 2014 and 2015 is at the level observed in 2012. The otter trawl fleet effort reporting was unaffected by this as these vessels were not reporting their landings via this method in these years.

6.7.3 Historical stock development

Model: Aarts and Poos (AP) modified in 2014 to correct for an error in coding selection patterns (ICES, 2014).

Software: R version 3.3.0 with additional packages (version in parenthesis):

FLCore (2.6.0); stats4 (3.3.0); grid (3.3.0); splines (3.3.0); boot (1.3–18); mvtnorm (1.0–2); MASS (7.3–45).

Model options chosen

Settings for this update stock assessment are given in the table below. The update AP assessment follows the same procedure as in the WKFLAT 2011 benchmark assessment as described in the stock annex. WKFLAT (2011) agreed that the model that will be used as a temporary basis for the assessment and provision of advice for the Irish Sea plaice. This was selected on the basis that it was the only model available to WKFLAT which reconstructs the historic discarding rates (derived from the survey dataseries). Although a good start, the AP model is not considered the definitive assessment tool for Irish Sea plaice but a temporary solution to the fitting of datasets which include recent discards estimates but for which historic discard information is not available. The model reconstructs historic discard rates using a time variant spline. Given that the spline extrapolates beyond the range of the recent data to which it is fitted, it can potentially result in spurious estimates of historic discarding, which may change markedly as new discard data are added to the short time-series. In addition, it is highly likely that the discard patterns currently observed differ from those that would have been observed historically as a result of substantial changes in the composition of the gear types that have been used to prosecute the fisheries in which plaice is caught. A model which incorporates estimates of historic discards that are derived from the proportional allocation of the effort deployed by the dominant gear types is considered more appropriate in the long term.

Input data types and characteristics

New data added to the update AP assessment are the fishery landings data for 2015; discard estimates for 2015 and survey data for 2015 for the following surveys: UK(E&W)-BTS-Q3, NIGFS-WIBTS-Q4, and 2015 for NIGFS-WIBTS-Q1. Discard age compositions, and the corresponding weights were updated for 2014 to use UK(England and Wales) age compositions that were not included in 2015.

Data screening

Data was screened as described in the stock annex.

Final update assessment

The assessment settings are shown in the following table, with changes to the previous year's settings highlighted in bold. Historic settings are given in the stock annex. Final model parameters and diagnostics are shown in Table 6.7.3.1.

Assessment year		2013	2014	2015	2016
Assessment model		AP	AP	AP	AP
Tuning fleets	UK (E&W)-BTS-Q3	Series omitted	Series omitted	Series omitted	Series omitted
	Extended UK (E&W)-BTS-Q3	1993–**2012**, ages 1–6	1993–**2013**, ages 1–6	1993–**2014**, ages 1–6	1993–**2015**, ages 1–6
	UK(E&W) BTS Mar	Survey omitted	Survey omitted	Survey omitted	Survey omitted
	UK(E&W) OTB	Series omitted	Series omitted	Series omitted	Series omitted
	UK(E&W) BT	Series omitted	Series omitted	Series omitted	Series omitted
	IR-OTB	Series omitted	Series omitted	Series omitted	Series omitted
	NIGFS-WIBTS-Q1*	1993–**2013**	1993–**2014**	1993–**2015**	1993–**2016**
	NIGFS-WIBTS-Q4	1993–**2012**	1993–**2013**	1993–**2014**	1993–**2015**
Time-series weights		n/a	n/a	n/a	n/a
Num yrs for separable		n/a	n/a	n/a	n/a
Reference age		n/a	n/a	n/a	n/a
Terminal S		n/a	n/a	n/a	n/a
Catchability model fitted		n/a	n/a	n/a	n/a
SRR fitted		n/a	n/a	n/a	n/a
Selectivity model		Linear Time Varying Spline at age (TVS)	Linear Time Varying Spline at age (TVS)	Linear Time Varying Spline at age (TVS)	Linear Time Varying Spline at age (TVS)
Discard fraction		Polynomial Time Varying Spline at-age (PTVS)	Polynomial Time Varying Spline at-age (PTVS)	Polynomial Time Varying Spline at-age (PTVS)	Polynomial Time Varying Spline at-age (PTVS)
Landings num-at-age, range:		1–9+	1–9+	1–9+	1–9+
Discards N at-age, yrs, ages		2004–**2012**, ages 1–5	2004–**2013**, ages 1–5	2004–**2014**, ages 1–5	2004–**2015**, ages 1–5

The estimated selectivity patterns, split into the landed and discarded components are shown in Figure 6.7.2.10; the landings selectivity is initially flat topped (indicating that older age fish are selected) but becomes dome shaped gradually during the 2000s and falls over time to very low values relative to the discard pattern which expands to the older aged fish during the 2000s (Figure 6.7.2.11). Catch and discard levels are estimated by the model, and these are shown in Figure 6.7.2.8. In the most recent four years, the estimated catch matches well with the input data, but prior to this the fit is less good.

The catchability of the UK(E&W)-BTS-Q3 survey is elevated for ages 1 and 2 and reflects the nature of the survey, which was designed as a recruit index (Figure 6.7.2.12).

Diagnostic output from the AP model is printed in Table 6.7.3.1. A year effect in 2004 is present in the UK(E&W)–BTS-Q3 residuals (Figure 6.7.2.13) which is the first year for which discard data are available. Although, the estimated recruitments from the AP model largely follow the UK(E&W)–BTS-Q3 numbers-at-age 1 there is some mismatch for the early years (1993–1994, Figure 6.7.2.14), which is a result of uncertain historic discards. A pattern of negative residuals between 2004 and 2009 is present in the residuals of the NIGFS-WIBTS due to large fluctuations in the SSB indices, which are due potentially to variable catchability of the survey (Figure 6.7.2.15). In the catch residuals (Figure 6.7.2.16), negative values are apparent in all ages in the discard matrix for 2011 and 2012 (the model overestimates discards greatly in this year), and there is an underestimate of the large peak of discards in 2010.

The estimated SSB from the AP model shows an increasing trend. This trend is largely in agreement with independent SSB estimates from the Annual Egg Production Method (AEPM, Figure 6.7.2.17), up to the most recent estimate in 2010. While this SSB pattern agrees well with the survey data used in the assessment between 1993 and 2003 (NIGFS-WIBTS-Q1 and -Q4; UK(E&W)-BTS-Q3, Figure 6.7.2.17), notable differences exist, particularly the low values of the groundfish survey indices (NIGFS-WIBTS-Q1 and -Q4) during 2006–2008.

The 2015 the biomass estimate increased substantially compared to previous years, and reached the largest value in the assessment period. This increase in biomass is attributable to growth in numbers in the plus group, which has greater numbers than the plus group in the previous year, added to the numbers at the last true age. This comes about because flat-topped selectivity is assumed. In 2016, the model estimates catch at the oldest true age (and hence F) lower than the reported catch, and applies this low exploitation rate to a relatively high plus-group catch to derive the high estimates of catch. This modelling problem makes the final year's SSB estimate particularly uncertain.

Estimates of numbers-at-age in the landings, discards and population, and fishing mortality numbers-at-age are given in Tables 6.7.3.2–6.7.3.5. A summary plot for the final update AP assessment is shown in Figure 6.7.2.18 and bootstrapped time-series estimates for F, SSB and recruitment are given in Table 6.7.3.6.

Comparison with previous assessments

Comparisons between this year's and previous years' AP assessment are shown in Figure 6.7.2.19. The six assessment models perform similarly in terms of temporal trends in SSB, recruitment (other than the initial years) and F_{BAR} during the 1990s, although there are some differences in the steepness of the trends.

State of the stock

Trends in F_{BAR}, SSB, recruitment and landings, for the full time-series, are shown in Table 6.7.3.6 and Figure 6.7.2.18. The assessment consistently estimates that fishing mortality declined from high levels in the early 1990s to very low levels since 2000, while SSB increased between 1995 and 2005 and has been stable thereafter. Estimated recruitments are highly variable. Landings have decreased to low levels, and discards are at a high level: the proportion by weight of the catch discarded has increased markedly between 2009 and 2013 (Figure 6.7.2.18), but is now decreasing.

6.7.4 Short-term projections

There are no short-term projections for this stock.

6.7.5 Medium-term projections

There are no medium-term projections for this stock.

6.7.6 MSY explorations

There are no MSY explorations for this stock.

6.7.7 Biological reference points

Precautionary approach reference points

The trends-based assessment considered in this working group provides no opportunity to evaluate the stock status compared to reference points, but work done in WKPROXY in 2015 (ICES, 2016) identified the following reference points:

Framework	Reference point	Value	Technical basis	Source	Status
MSY approach	MSY $B_{trigger}$	3700 t	0.5 x B_{MSY} (estimated by SPiCT from model parameters using data from 1988–2014)	ICES, 2016 (WKPROXY Report)	Biomass above MSY $B_{trigger}$
	F_{MSY}	0.50	F_{MSY} (estimated by SPiCT from model parameters using data from 1988–2014)	ICES, 2016 (WKPROXY Report)	Exploitation below F_{MSY}

Yield per Recruit analysis

There are no yield per recruit analyses for this stock.

6.7.8 Management plans

There are no management plans for this stock.

6.7.9 Uncertainties and bias in assessment and forecast

The assessment model is indicative of the long-term trend in stock development. However, there is high uncertainty in the annual SSB estimates making it difficult to detect interannual variations of SSB. The large SSB increase in the final year is also unrealistic. The assessment model fixes the proportion discarded at-age for 6+ at zero. This assumption is invalid, discard observations show large proportions of age 6+ fish do occur in the discards. The model diagnostics increasing show an unrealistic selection pattern. These issues would need to be address through a full benchmark of the assessment approach.

There are no raised estimates of discard levels for the period prior to 2004. The uncertainty in the discard data requires evaluation.

6.7.10 Recommendations for next benchmark

Plaice 7.a is included in the WKIRISH benchmark process ongoing in 2016 and 2017. An issue list is available on the ICES SharePoint site.

Further work on the discard raising procedures is required and bootstrap estimates of variability need to be developed. Historic data collected by N. Ireland require further evaluation. The length distribution in the discard data are much more reliable than the age information and given the biological changes observed in the stock (see Section 6.7.9) a length-based model would be more appropriate.

Although WKFLAT 2011 revised the UK(E&W)-BTS-Q3, there is still some disagreement between this survey and the NIGFS-WIBTS indices. Further work should focus on improving the NIGFS-WIBTS analysis of data to take into account spatial and temporal change in the maturity ogive and length–weight relationships.

There is evidence of a decline in weight-at-age from the raw commercial landings data and survey data. The UK(E&W)-BTS-Q3 survey data also indicate declines in length-at-age and maturity-at-age.

There is evidence of substantial substock structure and, if the catch data can be partitioned, then exploratory assessments for the eastern and western subareas would merit further study.

Annual maturity ogives should be determined from survey data and incorporated into the procedure for calculating the NIGFS-WIBTS indices.

Commercial indices and their horse-power (HP) corrections for the older ages should be reanalysed. Inclusion of the historic UK(E&W)-BTS-Q1 data may benefit the assessment in the historic period.

Ecosystem information ought to be explored.

Year	Candidate Stock	Supporting Justification	Suggested time	Indicate expertise necessary at benchmark meeting
2011	VIIa Plaice	Weights and lengths-at-age show trends in recent years. Maturity ogives appear to have changed. The NIGFS-WIBTS indices require recalculation. Variability in discards should be quantified. A length-based model with separate sexes should be developed. Catches by fleets should be included separately. Spatial structure in the stock should be reflected in the model.	2016/2017	Expert group members

6.7.11 Management considerations

The high level of discarding in this fishery indicates a mismatch between the minimum landing size and the mesh size of the gear being used. It is likely that a proportion of the discards survive there haven't been any studies in the Irish Sea. Any measures that effect a reduction in discards will result in increased future yield. However, the market demand for plaice is poor and small plaice are particularly undesirable. Strong year effects are seen in the discard data and these are likely due to spatial structure in the stock. Spatial management of fleets in the Irish Sea may reduce the discarding of plaice.

Whilst the precise levels of F_{BAR} and SSB are considered to be poorly estimated, the overall state of the stock is consistently estimated to have low fishing mortality and high spawning biomass. Therefore the stock is considered to be within safe biological limits.

Due to the uncertainty in the assessment the working group does not provide a short-term forecast.

Discarding has increased throughout the period in which data are available, while landings of plaice have decreased, even though the TAC is not restrictive. Effort has decreased in fisheries targeting plaice (including UK(E&W) and Belgian beam-trawl fisheries and UK(E&W) and Irish otter trawl fisheries targeting demersal fish). In contrast, effort by the UK(E&W) *Nephrops* fleet has increased, however, this is still small in comparison to effort by the Irish *Nephrops* fleet. The main *Nephrops* grounds are located in the western Irish Sea, where relatively small plaice are found. Technical measures to mitigate discarding by all *Nephrops* fleets could include the use of sorting grids: gear selectivity trials and monitoring from four Irish *Nephrops* trawlers using grids since 2009 indicate a potential reduction in fish discarding by 75% (BIM, 2009).

6.7.12 Sources

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

BIM. 2009. Summary report of Gear Trials to Support Ireland's Submission under Articles 11 & 13 of Reg. 1342/2008. *Nephrops* Fisheries VIIa & VIIb–k. Project 09.SM.T1.01. Bord Iascaigh Mhara (BIM) May 2009.

ICES. 2011. Report of the Benchmark Workshop on Flatfish (WKFLAT), 1–8 February 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:39.

ICES. 2016. Report of the Workshop to consider MSY proxies for stocks in ICES category 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015, ICES Head-quarters, Copenhagen. ICES CM 2015/ACOM:61. 183 pp.

Table 6.7.2.1. Nominal landings of Plaice in Division VIIa as officially reported to ICES.

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014[1]	2015
Belgium	327	344	459	327	275	325	482	636	628	431	566	343	194	157	197	138	332	236	144	100	115
France	10	11	8	8	5	14	9	8	7	2	9	2	2	2	0.4	0.2	0.28	0.08	0.29	0.03	0.01
Ireland	557	538	543	730	541	420	378	370	490	328	272	179	194	102	73	89	118	106	103	123	244
Netherlands	-	69	110	27	30	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (Eng.&Wales)[2]	1,050	878	798	679	687	610	607	569	409	369	422	413	412	300	185	148	145	154	91	59	80
UK (Isle of Man)	20	16	11	14	5	6	1	1	1	0	0	0	0	1	…	0.5	0.25	0.11	0.02	0.08	0
UK (Scotland)	60	18	25	18	23	21	11	7	9	4	1	0	0	1	2	3	0	0	0	0	0
Total	2,024	1,874	1,954	1,803	1,566	1,443	1,488	1,591	1,544	1,134	1,270	937	802	562	457	379	594	496	338	282	439
Discards	-	-	-	-	-	-	-	-	-	628	1,210	1,254	1,743	1,270	1,131	2,560	604	981	740	1,196	565
Unallocated	-150	-167	-83	-38	34	-72	-15	32	15	9	11	-3	3	1	0	-1	1	0	-29	0	1
Total figures used by the Working Group for stock assessment	1,874	1,707	1,871	1,765	1,600	1,371	1,473	1,623	1,559	1,771	2,491	2,188	2,548	1,834	1,588	2,938	1,198	1,477	1,049	1,478	1,005

[1] **Provisional.**

[2] **Northern Ireland included with England and Wales.**

Table 6.7.2.2. Irish Sea plaice: English standardised lpue and effort, Belgian beam-trawl lpue and effort and Irish otter trawl lpue and effort series.

Year	CPUE			LPUE					Effort ('000hrs)					
	UK(E&W) Beam trawl survey[4]			English[1]		Belgian[5]	Irish[7]		English			Belgian[5]	Irish	
	March	September Prime only	September Extended	Otter Trawl	Beam Trawl	Beam Trawl	Otter Trawl	Beam Trawl	Otter[2] Trawl	Beam[2] Trawl	Nephrops Trawl	Beam Trawl	Otter Trawl	Beam Trawl
1972				6.96		9.8			128.4			6.8		
1973				6.33		9.0			147.6			16.5		
1974				7.45		10.4			115.2			14.2		
1975				7.71		10.7			130.7			16.2		
1976				5.03		5.8			122.3			15.1		
1977				4.82		5.3			101.9			13.4		
1978				6.77	4.88	6.9			89.1	0.9		12.0		
1979				7.18	15.23	8.0			89.9	1.7		13.7		
1980				8.24	8.98	8.6			107.0	4.3		20.8		
1981				6.87	4.91	7.1			107.1	6.4		26.7		
1982				4.92	1.77	4.4			127.2	5.5		21.3		
1983				5.32	3.08	7.8			88.1	2.8		18.5		
1984				7.77	6.98	6.8			103.1	4.1		13.6		
1985				9.97	25.70	8.8			102.9	7.4		21.9		
1986				9.27	4.21	8.7			90.3	17.0		38.3		
1987				7.20	3.57	8.2			130.6	22.0		43.2		
1988		392		5.02	3.05	6.3			132.0	18.6		32.7		
1989		253		5.51	13.59	6.2			139.5	25.3		36.7		
1990		239		5.93	12.02	7.2			117.1	31.0		38.3		
1991		157		4.79	10.56	7.5			107.3	25.8		15.4		
1992		188		4.20	9.99	11.9			96.8	23.4		23.0		
1993	91	235	149	3.97	9.50	5.0			78.9	21.5		24.4		
1994	128	225	132	4.90	7.79	9.2			43.0	20.1	0.0	31.6		
1995	134	169	109	5.08	7.69	9.5	3.2	17.0	43.1	20.9	0.0	27.1	80.3	8.6
1996	-[6]	210	111	5.37	12.96	11.8	4.1	18.9	42.2	13.3	0.0	22.2	64.8	6.3
1997	147	262	148	5.25	7.66	13.9	3.1	13.7	39.9	10.8	0.0	29.3	92.2	9.0
1998	113	249	146	5.00	5.66	12.3	3.7	22.2	36.9	10.4	0.0	23.8	93.5	11.6
1999	-[6]	264	151	5.38	7.76	7.1	2.3	23.2	22.9	11.0	0.0	37.2	110.3	14.7
2000	-[6]	357	169	5.02	13.04	7.8	2.0	13.8	27.0	6.3	0.0	27.0	82.7	11.4
2001		281	147	3.35	8.33	9.2	2.5	10.8	33.0	12.5	0.0	41.9	77.5	13.1
2002		340	200	5.66	5.46	7.4	2.8	7.9	24.8	8.0	0.0	52.5	77.9	17.7
2003		503	247	2.60	3.76	7.5	4.1	9.5	23.9	14.0	0.0	48.7	73.8	18.7
2004		540	249	3.17	4.20	11.2	2.1	8.6	23.5	7.4	0.0	36.1	72.5	14.2
2005		367	177	4.85	4.67	12.8	2.0	8.0	16.7	11.6	1.0	42.1	68.3	14.7
2006		356	166	6.50	2.19	10.8	1.37	6.3	5.2	4.6	10.9	28.9	64.9	11.9
2007		432	190	17.94	4.22	6.9	1.20	6.1	4.4	3.2	12.6	23.8	73.2	14.0
2008		416	189	9.03	4.47	9.5	0.90	5.2	2.7	1.3	11.5	12.4	58.8	9.5
2009		467	199	6.46	1.21	10.1	1.03	3.8	1.5	0.46	10.0	14.7	41.5	7.6
2010		400	166	11.55	14.39	7.9	0.98	4.5	1.4	0.19	9.2	15.2	45.8	9.4
2011		417	155	4.35	11.95	18.7	1.17	5.5	0.69	1.56	11.7	16.4	54.5	8.1
2012		460	190	0.74	7.25	14.88	1.00	4.9	0.39	0.86	12.08	14.46	58.2	7.2
2013		550	211	7.41	-[8]	14.00	1.59	5.4	0.27	-[8]	10.63	8.89	42.7	5.0
2014		592	270	-	-[8]	13.89	1.50	8.3	0.00	-[8]	8.30	5.05	47.8	6.0
2015		564	235	-	-[8]	20.39	3.26	8.6	0.00	-[8]	4.50	4.59	41.0	8.3

1 Whole weight (kg) per corrected hour fished, weighted by area
2 Corrected for fishing power (GRT)
3 Kg/hr
4 Kg/100km. Sept Prime: ISS/ISN Traditional Prime Stations Only. Sept Extended: ISS/ISN/ISW/SGC All Stations.
5 Corrected for fishing power (HP) [data for 1999-2010, replaced at 2011WG following recalculation at WKFLAT 2011].
6 Carhelmar survey, Kg/100km not available
7 All years updated in 2007 due to slight historical differences
8 Effort not reported in hours for this fleet, see Section 6.7.2 for more detail

Fishing power corrections are detailed in Appendix 2 of the 2000 working group report

Table 6.7.2.3a. Irish Sea plaice: NIGFS-WIBTS-Q1 and Q4 indices of relative biomass trends by region.

NIGFS-WIBTS-Q1	Estimated mean abundance			Estimated standard error		
Mar (Spring)	Combined	West	East	Combined	West	East
Year	Str1–7	Str1–3	Str4–7	Str1–7	Str1–3	Str4–7
1992	9.59	6.40	10.54	4.39	2.13	5.66
1993	13.27	21.40	10.85	2.22	5.56	2.36
1994	10.09	5.38	11.50	2.56	1.83	3.27
1995	7.59	6.56	7.89	1.39	1.66	1.74
1996	7.96	14.41	6.04	1.68	5.94	1.28
1997	13.73	15.80	13.11	3.99	6.78	4.76
1998	12.50	19.61	10.38	3.62	10.88	3.39
1999	9.37	19.10	6.46	2.34	7.42	2.09
2000	15.79	35.36	9.96	5.40	22.56	1.97
2001	13.52	23.78	10.46	2.11	6.21	2.02
2002	13.36	25.65	9.70	3.24	8.93	3.25
2003	26.79	55.52	18.23	8.36	32.38	4.95
2004	10.55	8.60	11.13	4.77	5.23	7.58
2005	15.86	27.20	12.48	3.54	8.59	3.82
2006	9.57	16.33	7.55	1.80	6.15	1.45
2007	8.73	21.76	4.84	1.81	7.00	1.06
2008	6.33	9.26	5.46	0.90	5.71	1.01
2009	11.00	17.85	8.96	1.89	4.61	2.03
2010	22.67	16.49	24.51	3.80	4.49	4.75
2011	23.68	32.44	21.06	4.60	8.37	5.42
2012	17.87	30.15	14.21	3.12	10.89	2.42
2013	28.15	43.20	23.66	5.73	12.53	6.44
2014	14.03	15.14	13.70	2.76	6.13	3.08
2015	26.24	25.88	26.34	4.57	7.40	5.50
2016	50.65	45.59	52.16	12.70	15.06	15.87

Table 6.7.2.3b. Irish Sea plaice: NIGFS-WIBTS-Q1 and Q4 indices of relative biomass trends by region.

NIGFS-WIBTS-Q4	Estimated mean abundance			Estimated standard error		
Oct (Autumn)	Combined	West	East	Combined	West	East
Year	Str1–7	Str1–3	Str4–7	Str1–7	Str1–3	Str4–7
1991	0.81	3.38	0.04	0.39	1.71	0.03
1992	4.83	2.76	5.45	0.85	1.26	1.04
1993	4.64	2.91	5.16	0.95	1.18	1.18
1994	9.20	8.65	9.36	2.27	3.74	2.72
1995	4.77	8.31	3.72	1.28	3.52	1.29
1996	8.69	9.95	8.32	2.15	5.67	2.22
1997	8.22	7.67	8.38	2.18	2.80	2.71
1998	5.39	4.21	5.74	1.45	2.39	1.75
1999	6.90	4.91	7.50	2.29	3.12	2.82
2000	10.50	2.84	12.78	6.42	1.16	8.33
2001	13.93	4.03	16.88	6.45	1.96	8.35
2002	9.98	6.63	10.98	3.80	3.45	4.82
2003	18.65	10.09	21.20	5.41	4.87	6.87
2004	8.49	2.52	10.28	1.90	1.10	2.44
2005	11.58	3.88	13.88	4.39	2.39	5.66
2006	7.20	2.59	8.57	1.98	1.47	2.53
2007	8.48	6.09	9.19	1.69	2.55	2.05
2008	11.28	4.66	13.26	3.06	2.50	3.91
2009	14.83	5.36	17.66	3.25	3.71	4.07
2010	17.61	7.50	20.63	5.40	5.72	6.80
2011	17.54	6.94	20.70	5.32	3.07	6.84
2012	18.96	20.29	18.56	4.90	11.61	5.33
2013	21.07	16.30	22.49	4.92	13.04	5.07
2014	24.77	31.36	22.81	7.99	26.33	6.82
2015	22.72	13.06	25.60	5.00	8.54	5.97

Table 6.7.2.a. Irish Sea plaice: tuning fleet data available. Figures shown in bold are those used in the assessment.

Tuning index of the extended UK (E&W)-BTS-Q3 survey (extended area). Effort (km towed) and numbers-at-age.

year	Distance towed (kms)	0	1	2	3	4	5	6	7	8	9+
1993	292.77	58	1358	1179	265	126	7	14	37	1	10
1994	281.66	162	1162	699	401	90	24	15	6	19	14
1995	281.66	316	1566	553	237	117	24	16	8	0	22
1996	277.95	78	1611	604	146	53	55	20	1	0	4
1997	281.66	449	1539	820	356	78	45	47	21	0	8
1998	281.66	158	1269	1201	307	114	59	24	20	1	4
1999	277.95	726	1102	1086	553	190	81	31	30	0	0
2000	281.66	442	2462	788	415	313	133	50	41	3	3
2001	281.66	235	1686	1020	314	168	153	30	21	2	0
2002	281.66	111	1819	1392	639	247	150	147	29	5	0
2003	277.95	934	1701	1625	726	440	162	149	72	0	10
2004	281.66	306	2273	1510	1111	530	324	59	78	4	8
2005	281.66	584	1058	1337	558	400	227	144	38	25	0
2006	281.66	1004	1411	972	693	309	223	101	56	5	16
2007	281.66	475	2244	1258	467	337	182	71	83	38	0
2008	270.54	503	1266	1544	548	312	99	55	40	0	0
2009	281.66	345	1335	957	930	278	185	179	46	37	0
2010	277.95	560	1730	1199	568	401	183	152	104	78	12
2011	281.66	289	1896	1206	493	283	304	137	77	105	44
2012	281.66	396	1835	1794	483	289	134	149	82	62	94
2013	281.66	574	1219	1424	867	449	301	136	119	83	62
2014	203.83	132	1868	1607	835	593	247	210	123	43	48
2015	203.83	74	773	1807	667	470	248	192	105	59	45

Table 6.7.2.4b. Irish Sea plaice: tuning fleet data available.

UK BT SURVEY (Sept-Trad) - Prime stations only

1989	2015							
1	1	0.75	0.85					
1	8							
129.71	309	441	530	77	13	44	3	0
128.969	1688	405	176	90	54	30	3	1
123.78	591	481	68	47	4	4	24	3
129.525	1043	470	267	23	19	14	14	3
131.192	1106	812	136	101	16	8	21	4
124.892	815	608	307	68	33	12	17	8
126.004	1283	387	179	84	16	18	0	1
126.004	1701	601	124	74	49	9	11	1
126.004	1363	668	322	65	50	23	8	7
126.004	1167	767	212	95	34	23	14	3
126.004	1189	965	344	113	38	17	7	7
126.004	2112	659	298	141	73	22	7	3
126.004	1468	663	218	130	89	28	10	7
126.004	1734	1615	647	243	79	51	16	17
126.004	1480	1842	827	296	122	62	39	10
126.004	1816	1187	1184	404	261	57	57	14
122.298	869	1295	666	499	297	111	17	17
126.004	1120	840	722	411	177	83	59	16
126.004	2667	1255	525	417	196	95	45	37
122.298	1293	1900	619	339	244	76	55	33
126.004	1460	1083	1225	310	189	250	65	31
126.004	1823	1413	670	505	184	155	98	60
122.298	2168	1440	646	324	379	137	121	87
122.298	1941	1844	661	312	158	145	124	72
126.004	1493	1662	973	580	376	151	161	82
126.004	2763	2189	921	759	331	256	191	79
126.004	1126	2594	724	554	344	264	119	71

Table 6.7.2.4c. Irish Sea plaice: tuning fleet data available. Figures shown in bold are those used in the assessment.

UK(E+W)TRAWL FLEET (REVISED 1/4/2005 – CALCULATED USING ABBT AGE COMPOSITIONS)
1987 2015 Effort (thousand hours fishing) and catch from cpue program.
1 1 0 1 Numbers in thousands
1 14
9008.92 24.0 1451.7 1411.2 1567.3 402.3 286.5 30.9 46.1 16.6 23.8 11.0 1.4 3.2 3.6
8292.37 21.6 1351.1 1396.6 447.2 290.4 140.0 77.5 8.0 28.4 6.5 9.5 3.4 4.1 1.1
16161.44 10.6 770.5 2099.3 800.1 234.9 99.6 47.9 37.6 13.7 11.0 6.2 6.7 3.2 1.7
7724.48 8.2 500.8 1094.1 983.7 216.9 82.8 60.0 17.5 15.9 4.5 3.2 6.7 3.0 2.2
7081.07 94.4 950.1 451.4 419.6 245.1 99.7 35.2 38.7 12.1 11.1 0.6 3.6 1.8 1.5
6671.76 80.9 852.4 908.7 181.6 114.8 82.5 28.7 8.3 17.8 7.3 5.4 0.4 1.3 0.8
6013.12 15.5 465.7 623.6 441.7 76.3 66.9 83.4 26.2 6.2 12.9 3.2 1.3 0.0 0.3
3059.95 39.7 417.5 547.0 145.7 94.6 18.6 12.6 16.2 7.4 1.8 1.3 2.3 0.5 0.0
3356.96 7.5 359.0 525.5 262.2 91.1 47.3 11.2 4.9 8.5 2.4 1.7 0.7 0.2 0.2
3085.05 11.2 334.5 287.1 203.5 82.5 33.7 15.7 4.9 2.0 10.2 2.1 0.7 0.6 0.1
2903.27 11.3 251.3 215.3 125.5 74.4 37.6 12.8 12.4 1.8 0.8 1.4 0.4 0.2 0.7
2620.63 1.6 203.3 319.5 105.6 40.7 37.7 16.5 9.8 4.5 0.5 0.5 1.0 0.3 0.2
1803.5 17.7 139.6 201.1 120.3 35.1 14.0 9.0 5.5 1.6 0.8 0.2 0.1 0.1 0.0
2034.94 0.0 107.6 234.2 185.8 95.9 18.6 14.5 9.8 5.5 2.7 2.1 0.9 0.4 0.1
2352.89 5.5 66.6 131.7 125.2 109.8 53.7 17.6 10.7 6.5 3.0 0.5 0.7 0.1 0.1
1773.98 0.5 79.1 177.0 95.9 59.0 33.2 23.9 3.3 2.2 1.4 0.4 0.4 0.0 0.1
1728.28 0.0 34.4 80.2 89.4 35.9 16.2 12.4 7.4 1.9 0.4 0.3 0.2 0.0 0.2
1726.99 1.5 35.1 150.4 103.9 61.1 27.2 8.7 5.8 4.1 1.2 0.8 0.2 0.1 0.0
1313.61 0.0 33.0 53.2 109.4 96.3 40.5 18.0 7.6 6.4 1.7 1.3 0.6 0.2 0.1
478.45 0.8 15.1 47.0 34.8 55.3 23.4 14.0 4.9 2.6 1.9 0.7 0.6 0.1 0.0
397.24 0.0 2.5 34.0 95.2 58.8 50.8 17.5 16.8 2.2 1.5 0.5 0.3 0.1 0.0
320.38 0.1 6.6 31.7 43.2 46.6 27.3 17.5 8.3 3.3 1.3 0.5 0.2 0.2 0.0
157.73 0.0 0.2 4.5 9.5 8.1 7.2 3.4 2.1 0.9 0.5 0.1 0.1 0.0 0.0
150.98 0.0 0.1 1.8 8.1 8.0 4.8 3.6 2.0 1.4 0.6 0.4 0.2 0.0 0.0
72.68 0.0 0.1 0.8 0.8 1.4 0.7 0.3 0.2 0.1 0.1 0.1 0.0 0.0 0.0
84.97 0.0 0.1 1.3 1.1 1.2 2.4 1.6 1.1 0.5 0.2 0.2 0.1 0.0 0.0
31.91 0.0 0.0 0.1 0.2 0.4 0.2 0.3 0.2 0.1 0.1 0.0 0.0 0.0 0.0
16.14 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.00 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

Table 6.7.2.4d. Irish Sea plaice: tuning fleet data available. Figures shown in bold are those used in the assessment.

UK(E+W)BEAM TRAWL FLEET
1987 2015 Effort (thousand hours fishing) and catch from cpue program.
1 1 0 1 Numbers in thousands
1 14
1178.45 0.0 1.1 27.3 113.8 36.2 31.5 2.9 6.7 2.0 3.1 0.6 0.1 0.2 0.1
1019.23 0.0 2.1 50.4 24.9 25.6 13.8 8.9 1.5 2.7 1.7 1.6 0.6 0.8 0.3
1344.47 3.2 134.0 300.2 164.9 53.1 42.8 25.4 16.2 4.3 5.4 3.4 5.8 2.6 1.1
1473.12 2.2 133.5 384.3 354.1 76.7 29.6 16.9 8.2 3.5 1.4 1.8 3.7 1.3 0.5
1211.3 17.3 283.4 183.5 175.1 92.1 36.0 11.2 11.8 3.5 4.7 0.2 1.0 0.6 0.3
908.09 3.9 142.0 336.7 79.9 64.9 45.6 18.6 8.0 12.3 7.1 4.1 0.2 0.7 1.0
826.94 0.6 75.3 115.6 97.5 23.8 24.8 32.8 12.1 4.6 7.3 2.2 1.2 0.0 0.5
1451.61 13.7 155.2 190.4 40.8 26.6 7.0 6.7 8.0 3.6 1.3 0.9 1.2 0.2 0.0
1429.35 5.2 183.8 229.4 100.8 33.1 16.2 4.0 1.7 3.4 1.0 0.9 0.5 0.1 0.2
894.26 13.4 144.0 111.4 75.3 30.8 11.0 5.9 2.1 1.2 2.7 0.5 0.2 0.4 0.3
784.41 0.9 99.3 70.1 39.4 30.4 13.6 3.7 3.2 0.5 0.4 0.3 0.2 0.1 0.1
696.03 0.3 63.5 103.7 32.6 12.0 9.7 6.3 2.7 1.8 0.3 0.2 0.5 0.2 0.0
778.88 4.8 51.3 124.5 80.5 24.5 12.5 10.5 5.6 0.9 0.8 0.2 0.2 0.2 0.1
410.71 0.0 25.3 61.6 46.7 28.0 7.3 6.5 4.5 1.9 0.7 0.7 0.7 0.1 0.1
767.36 1.5 20.6 47.5 56.6 42.7 20.8 7.0 4.5 2.6 1.2 0.4 0.1 0.1 0.0
535.06 0.0 12.4 35.7 22.7 20.2 16.1 8.6 2.5 1.5 1.6 0.4 0.4 0.0 0.0
863.74 0.0 11.6 46.5 48.7 21.3 10.2 8.9 5.5 1.7 0.3 0.1 0.3 0.0 0.1
419.94 0.2 18.1 29.6 11.8 12.0 5.1 1.7 1.4 1.0 0.3 0.2 0.1 0.0 0.0
627.82 0.1 6.5 11.0 24.0 20.7 9.1 3.4 1.6 1.3 0.4 0.4 0.1 0.1 0.0
280.14 0.2 2.8 8.3 4.9 8.4 3.8 2.6 0.9 0.6 0.5 0.2 0.2 0.1 0.0
193.46 0.0 0.2 3.2 7.2 4.5 5.3 1.8 1.3 0.3 0.3 0.1 0.1 0.0 0.0
98 0.0 0.0 1.4 3.5 3.9 2.2 1.7 0.8 0.3 0.1 0.1 0.0 0.0 0.0
24.85 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
10.15 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
91.19 0.0 0.7 5.6 6.6 13.3 7.8 4.1 2.7 1.1 0.9 0.5 0.4 0.2 0.0
60.66 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
1.31 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.43 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.85 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

Table 6.7.2.4e Irish Sea plaice: tuning fleet data available. Figures shown in bold are those used in the assessment.

UK BT SURVEY (March) - Prime stations only

1993 1999

1 1 0.15 0.25

1 8

126.931 480 662 141 71 12 8 11 3

115.442 361 662 370 98 47 5 7 10

126.189 859 647 340 120 29 28 0 10

134.343 1559 908 295 98 49 16 8 1

121.742 967 905 351 63 39 31 10 13

130.081 648 957 217 82 24 23 12 1

130.822 570 770 389 98 26 11 9 6

IR-JPS : Irish Juvenile Plaice Survey 2nd Qtr - Effort min. towed - Plaice No.-at-age

1991 2004

1 1 0.37 0.43

1 7

555 185 206 60 21 9 1 1

570 1785 268 48 16 7 2 2

600 643 630 189 45 8 21 3

585 614 254 196 33 8 2 0

570 840 321 110 86 18 5 2

675 752 221 134 39 57 7 0

675 665 303 105 41 22 17 5

675 311 466 191 48 11 7 4

660 0 0 0 0 0 0 0

645 805 342 72 61 32 9 2

675 743 739 213 88 43 14 5

660 273 145 40 2 1 1 0

660 346 322 152 78 20 9 7

660 1046 501 171 86 50 10 6

Table 6.7.2.5. Irish Sea plaice: Landings number-at-age 1 to 15+ (thousands), where rows are years 1964–2015 and columns are ages 1 to 15+.

IRISH SEA PLAICE
1 2
1964 2015
1 15
1

0	997	1911	1680	446	851	480	140	26	155	30	2	1	1	10
28	1416	3155	2841	1115	555	309	300	17	20	5	2	1	1	1
0	120	4303	3605	2182	620	588	386	181	13	20	7	7	3	6
0	164	1477	5593	4217	995	642	267	210	176	86	35	5	6	1
0	171	1961	3410	4641	1611	319	113	135	24	17	3	4	1	1
59	430	2317	2932	2080	2227	779	184	58	100	80	22	9	4	1
9	803	2278	2179	1877	1028	899	239	64	29	52	51	20	3	2
0	427	3392	3882	1683	1371	491	497	244	60	65	36	11	9	1
0	142	3254	5136	1461	752	555	627	353	169	55	40	38	19	12
0	925	4091	5233	2682	642	345	238	183	238	129	40	14	11	17
7	1200	2530	2694	2125	1045	191	139	56	47	95	40	5	5	5
18	1370	4313	1902	1158	933	152	119	81	94	47	72	18	16	4
23	2553	4333	2425	902	563	391	198	59	79	47	22	58	11	5
565	4124	2767	2470	839	236	150	112	63	21	15	8	8	10	3
22	3063	5169	1535	542	202	98	54	52	43	10	9	4	4	2
12	3380	5679	1835	363	187	109	61	68	68	17	5	6	4	6
3	2783	6738	2560	646	312	125	64	24	54	16	13	7	5	5
22	1742	5939	2984	837	222	105	53	52	41	28	35	13	3	11
27	715	3288	3082	1358	330	137	69	44	36	11	15	11	14	13
51	2924	2494	3211	1521	648	211	110	53	30	13	15	9	11	11
41	3159	5179	1182	1054	459	299	113	60	13	22	15	10	6	13
4	2357	6152	3301	614	429	262	181	78	36	21	8	7	3	6
31	1652	5280	2942	1287	344	371	112	92	54	24	9	5	3	9
62	3717	5317	5252	1341	1072	123	121	75	74	25	8	10	12	13
46	2923	5040	2552	1400	750	316	84	112	44	41	28	38	21	37
24	1735	5945	2671	854	436	214	153	56	47	26	38	18	7	19
15	1019	2715	2935	1132	465	259	98	51	22	15	15	9	6	7
180	2008	1506	1929	1205	465	182	122	49	34	5	6	3	3	4
151	1958	3209	1435	1358	903	388	118	74	44	27	15	9	3	4
28	910	1649	1357	474	556	377	179	42	50	16	8	2	3	2
98	1146	2173	1309	644	318	245	134	86	18	6	9	6	1	3
21	961	1703	1936	764	318	138	70	47	23	9	4	1	1	3
37	856	1345	1196	943	370	128	44	25	37	14	7	5	1	2
28	830	1590	1513	1003	482	285	139	42	53	12	7	1	2	1
5	691	1739	1025	612	476	403	177	91	52	25	17	19	2	1
68	803	1505	1294	696	280	196	117	69	43	6	4	1	0	1
0	450	1174	1284	685	212	219	102	55	19	14	7	2	2	2
14	374	1138	1083	767	409	178	90	45	18	6	2	4	0	0
1	206	940	1482	842	539	318	96	48	17	4	3	0	0	0
0	286	1031	1314	707	415	253	127	48	22	12	7	1	3	0
7	198	967	1104	705	246	114	88	74	11	11	1	1	0	0
6	228	708	1177	890	461	204	92	55	37	12	12	4	2	1
5	180	620	550	684	346	220	87	53	46	20	6	2	1	1
0	64	350	859	506	401	150	114	27	14	5	3	0	0	0
1	99	386	389	409	215	141	61	36	9	7	3	1	1	0
0	13	204	374	351	272	116	73	26	12	4	2	1	1	1
0	7	75	271	306	193	160	57	31	13	8	3	1	0	0
2	53	199	357	483	305	194	101	43	27	10	6	3	0	1
0	8	149	288	295	358	211	119	48	24	16	9	4	0	2
1	16	87	203	166	149	144	107	30	18	6	2	0	0	1
2	6	73	173	158	144	68	72	36	19	8	8	1	0	0
0	2	27	97	198	222	146	113	79	43	45	31	24	1	1

Table 6.7.2.6. Irish Sea plaice: Landings weight-at-age 1 to 15+ (kg) (unsmoothed from 1995).

Plaice in 7.a
1 3
1964 2015
1 15
1

0.000	0.190	0.292	0.413	0.463	0.597	0.831	1.042	1.155	0.552	1.358	1.015	1.544	1.605	1.654
0.070	0.177	0.269	0.388	0.556	0.653	0.690	0.719	0.801	1.198	1.167	0.971	1.477	1.535	1.581
0.000	0.152	0.223	0.316	0.418	0.532	0.697	0.691	0.939	0.983	1.074	1.071	1.233	1.281	1.320
0.000	0.133	0.218	0.299	0.382	0.516	0.518	0.759	0.791	0.682	0.783	0.514	1.152	1.198	1.234
0.000	0.149	0.213	0.313	0.413	0.509	0.584	0.777	0.893	0.957	1.017	0.887	1.174	1.220	1.257
0.056	0.146	0.215	0.311	0.405	0.541	0.643	0.787	0.897	0.744	0.723	1.097	1.185	1.231	1.269
0.058	0.149	0.219	0.324	0.417	0.523	0.648	0.685	0.908	0.925	0.877	0.603	1.231	1.279	1.318
0.000	0.140	0.207	0.295	0.396	0.489	0.595	0.753	0.654	0.852	0.731	1.079	1.153	1.198	1.235
0.000	0.143	0.235	0.332	0.432	0.560	0.737	0.712	0.959	1.071	1.144	1.208	1.288	1.339	1.379
0.000	0.143	0.218	0.316	0.415	0.491	0.645	0.694	0.791	0.898	0.927	0.863	1.204	1.252	1.290
0.063	0.158	0.246	0.334	0.445	0.514	0.686	0.847	0.964	1.052	1.108	1.048	1.326	1.378	1.420
0.072	0.185	0.275	0.398	0.531	0.644	0.749	0.924	1.147	1.169	1.359	1.360	1.533	1.593	1.641
0.060	0.150	0.228	0.323	0.419	0.525	0.590	0.719	0.797	0.842	0.834	1.003	1.267	1.317	1.357
0.059	0.153	0.226	0.340	0.430	0.510	0.592	0.738	0.840	1.016	0.945	1.100	1.252	1.301	1.340
0.071	0.185	0.268	0.391	0.525	0.672	0.720	0.910	1.035	1.049	1.264	1.329	1.497	1.556	1.603
0.069	0.176	0.262	0.376	0.557	0.668	0.794	0.915	0.997	0.968	1.274	1.227	1.471	1.529	1.575
0.066	0.177	0.255	0.365	0.483	0.517	0.671	0.884	1.047	1.072	1.259	1.273	1.403	1.458	1.503
0.069	0.176	0.267	0.376	0.512	0.592	0.678	0.863	1.097	0.804	1.276	1.310	1.309	1.509	1.554
0.201	0.274	0.284	0.348	0.421	0.545	0.650	0.651	0.780	0.777	1.185	1.164	1.147	1.164	1.744
0.232	0.261	0.290	0.319	0.368	0.426	0.484	0.552	0.629	0.716	0.803	0.910	1.026	1.161	1.316
0.260	0.290	0.330	0.380	0.470	0.560	0.660	0.760	0.870	0.980	1.100	1.240	1.420	1.630	1.940
0.290	0.310	0.340	0.390	0.470	0.540	0.630	0.730	0.840	0.940	1.060	1.200	1.380	1.600	1.900
0.270	0.280	0.340	0.420	0.500	0.540	0.630	0.830	0.920	1.020	1.210	1.480	1.420	1.720	1.610
0.260	0.290	0.315	0.370	0.440	0.520	0.610	0.720	0.820	0.950	1.080	1.210	1.360	1.520	1.700
0.230	0.260	0.300	0.370	0.460	0.550	0.680	0.820	0.960	1.120	1.300	1.480	1.690	1.900	2.130
0.227	0.272	0.321	0.374	0.430	0.491	0.555	0.623	0.694	0.770	0.849	0.932	1.019	1.109	1.205
0.200	0.257	0.316	0.376	0.439	0.504	0.570	0.639	0.709	0.781	0.856	0.932	1.010	1.091	1.173
0.247	0.267	0.295	0.332	0.377	0.431	0.494	0.566	0.646	0.735	0.832	0.938	1.053	1.176	1.309
0.169	0.218	0.274	0.337	0.407	0.484	0.568	0.658	0.756	0.860	0.971	1.089	1.213	1.345	1.483
0.260	0.270	0.292	0.328	0.375	0.436	0.508	0.594	0.691	0.802	0.925	1.060	1.208	1.368	1.541
0.156	0.207	0.268	0.338	0.416	0.504	0.600	0.706	0.821	0.945	1.077	1.219	1.370	1.530	1.698
0.189	0.224	0.262	0.329	0.353	0.406	0.461	0.619	0.682	0.734	0.851	1.020	1.101	1.077	1.468
0.204	0.223	0.270	0.333	0.398	0.493	0.584	0.712	0.748	0.712	1.204	1.272	1.306	1.770	1.186
0.205	0.233	0.241	0.286	0.354	0.410	0.510	0.513	0.709	0.610	0.976	1.389	1.288	1.027	1.162
0.185	0.226	0.249	0.316	0.353	0.410	0.468	0.506	0.647	0.784	0.861	1.105	0.888	1.629	1.302
0.205	0.236	0.250	0.300	0.375	0.457	0.483	0.556	0.632	0.602	1.187	1.011	1.130	1.159	1.280
0.000	0.259	0.270	0.307	0.337	0.429	0.437	0.492	0.580	0.796	1.007	1.030	1.408	1.221	1.314
0.232	0.233	0.271	0.334	0.396	0.439	0.571	0.666	0.785	0.934	1.155	1.228	1.024	0.945	1.505
0.228	0.271	0.267	0.308	0.386	0.476	0.518	0.585	0.730	0.838	1.014	0.944	1.206	1.488	1.196
0.000	0.235	0.289	0.335	0.383	0.458	0.567	0.566	0.779	0.912	0.861	0.675	0.797	1.313	1.304
0.214	0.239	0.258	0.297	0.347	0.416	0.543	0.544	0.515	0.760	0.751	0.817	1.693	2.000	2.327
0.235	0.245	0.265	0.292	0.322	0.394	0.441	0.536	0.648	0.691	0.678	0.913	0.974	0.807	0.982
0.200	0.256	0.265	0.282	0.321	0.378	0.425	0.462	0.553	0.611	0.732	0.838	1.415	1.139	1.277
0.000	0.280	0.266	0.281	0.320	0.371	0.416	0.411	0.621	0.530	0.900	0.846	0.976	0.878	1.016
0.246	0.228	0.257	0.281	0.311	0.364	0.431	0.445	0.570	0.700	0.833	1.122	0.430	1.320	0.000
0.000	0.257	0.256	0.265	0.305	0.330	0.395	0.467	0.465	0.537	0.571	0.591	0.760	0.576	0.475
0.000	0.260	0.265	0.282	0.301	0.356	0.392	0.460	0.481	0.530	0.560	0.508	0.880	1.908	1.037
0.236	0.251	0.257	0.283	0.298	0.354	0.404	0.459	0.565	0.554	0.628	0.531	0.644	0.986	0.997
0.118	0.260	0.255	0.282	0.300	0.319	0.346	0.411	0.448	0.428	0.533	0.353	0.682	0.825	0.481
0.248	0.245	0.249	0.267	0.297	0.329	0.385	0.371	0.470	0.522	0.554	0.701	0.661	0.755	0.298
0.206	0.266	0.257	0.293	0.332	0.364	0.459	0.447	0.542	0.530	0.576	0.526	0.495	0.704	1.092
0.072	0.137	0.257	0.285	0.293	0.333	0.405	0.516	0.576	0.570	0.612	0.433	1.595	0.523	0.714

Table 6.7.2.7. Plaice 7.a: weight-at-age in the discards (unsmoothed).

IRISH SEA PLAICE, COMBSEX, PLUSGROUP, Discard weights-at-age (age 0 exc, 9+ set to 0).
1 3 2004 2015
1 151
0.057 0.115 0.145 0.164 0.211 0.290 0.238 0.210 0 0 0 0 0 0 0
0.099 0.117 0.134 0.179 0.178 0.277 0.644 0.356 0 0 0 0 0 0 0
0.141 0.113 0.141 0.145 0.162 0.210 0.274 0.077 0 0 0 0 0 0 0
0.044 0.081 0.113 0.140 0.150 0.205 0.219 0.243 0 0 0 0 0 0 0
0.096 0.097 0.116 0.135 0.151 0.173 0.217 0.170 0 0 0 0 0 0 0
0.033 0.080 0.119 0.147 0.165 0.196 0.232 0.276 0 0 0 0 0 0 0
0.083 0.101 0.138 0.183 0.201 0.140 0.194 0.225 0 0 0 0 0 0 0
0.077 0.098 0.116 0.141 0.157 0.168 0.164 0.176 0 0 0 0 0 0 0
0.026 0.038 0.081 0.119 0.162 0.200 0.157 0.168 0 0 0 0 0 0 0
0.063 0.066 0.090 0.114 0.144 0.156 0.181 0.188 0 0 0 0 0 0 0
0.054 0.082 0.092 0.133 0.129 0.166 0.167 0.143 0 0 0 0 0 0 0
0.079 0.059 0.077 0.099 0.092 0.125 0.152 0.108 0 0 0 0 0 0 0

Table 6.7.2.8. Irish Sea plaice: New stock weights-at-age modified to include discard element (kg).

IRISH SEA PLAICE, COMBSEX, PLUSGROUP, NEW stock weights (modified to inc disc element)
1 4
2004 2015
1 15
1

0.024	0.109	0.226	0.348	0.412	0.545	0.767	0.981	1.085	0.540	1.311	0.991	1.508	1.544	1.630
0.023	0.105	0.213	0.327	0.480	0.587	0.641	0.680	0.769	1.152	1.128	0.948	1.442	1.477	1.558
0.019	0.087	0.177	0.266	0.366	0.480	0.643	0.652	0.881	0.947	1.036	1.038	1.204	1.233	1.301
0.018	0.082	0.169	0.251	0.336	0.464	0.482	0.716	0.747	0.660	0.758	0.509	1.125	1.152	1.216
0.018	0.083	0.168	0.263	0.360	0.458	0.541	0.732	0.838	0.921	0.982	0.862	1.146	1.174	1.238
0.019	0.084	0.170	0.261	0.355	0.485	0.593	0.742	0.841	0.719	0.701	1.062	1.157	1.185	1.250
0.019	0.087	0.175	0.272	0.365	0.472	0.599	0.647	0.854	0.891	0.848	0.594	1.201	1.231	1.298
0.018	0.082	0.164	0.249	0.346	0.442	0.550	0.709	0.625	0.821	0.708	1.044	1.126	1.153	1.217
0.020	0.091	0.186	0.280	0.379	0.504	0.678	0.672	0.902	1.031	1.103	1.168	1.258	1.288	1.359
0.019	0.085	0.173	0.267	0.363	0.445	0.596	0.655	0.748	0.866	0.895	0.840	1.176	1.204	1.271
0.021	0.094	0.192	0.282	0.390	0.468	0.634	0.798	0.906	1.014	1.070	1.018	1.295	1.326	1.399
0.024	0.109	0.218	0.336	0.463	0.582	0.695	0.873	1.078	1.127	1.311	1.317	1.497	1.533	1.617
0.020	0.090	0.181	0.272	0.368	0.475	0.548	0.679	0.757	0.812	0.808	0.974	1.237	1.267	1.337
0.020	0.089	0.179	0.286	0.375	0.461	0.550	0.696	0.794	0.978	0.914	1.065	1.222	1.252	1.321
0.024	0.106	0.213	0.330	0.457	0.602	0.668	0.859	0.977	1.011	1.220	1.286	1.462	1.497	1.580
0.023	0.104	0.208	0.317	0.481	0.599	0.733	0.862	0.941	0.935	1.230	1.190	1.436	1.471	1.552
0.022	0.099	0.201	0.307	0.422	0.474	0.623	0.833	0.983	1.032	1.215	1.232	1.370	1.403	1.480
0.023	0.103	0.210	0.318	0.446	0.537	0.630	0.814	1.030	0.777	1.231	1.268	1.280	1.452	1.532
0.020	0.090	0.209	0.309	0.408	0.478	0.568	0.658	0.747	0.847	0.946	1.046	1.146	1.255	1.365
0.019	0.087	0.213	0.300	0.348	0.397	0.455	0.523	0.590	0.677	0.765	0.861	0.968	1.094	1.239
0.020	0.100	0.230	0.350	0.430	0.520	0.610	0.710	0.820	0.930	1.040	1.170	1.330	1.530	1.790
0.020	0.100	0.240	0.360	0.430	0.510	0.590	0.680	0.790	0.890	1.000	1.130	1.290	1.490	1.750
0.020	0.120	0.260	0.380	0.440	0.520	0.610	0.720	0.830	0.960	1.120	1.260	1.410	1.560	1.720
0.020	0.100	0.240	0.345	0.405	0.480	0.560	0.660	0.770	0.885	1.010	1.150	1.290	1.440	1.610
0.245	0.258	0.288	0.335	0.401	0.484	0.585	0.704	0.841	0.995	1.168	1.358	1.565	1.791	2.034
0.206	0.249	0.296	0.347	0.402	0.460	0.522	0.588	0.658	0.732	0.809	0.890	0.975	1.064	1.156
0.173	0.229	0.286	0.346	0.408	0.471	0.537	0.604	0.674	0.745	0.818	0.894	0.971	1.050	1.132
0.241	0.256	0.280	0.312	0.353	0.403	0.462	0.529	0.605	0.689	0.782	0.884	0.994	1.114	1.241
0.147	0.193	0.245	0.305	0.372	0.445	0.525	0.612	0.706	0.807	0.914	1.029	1.150	1.278	1.413
0.259	0.263	0.280	0.308	0.350	0.404	0.470	0.549	0.641	0.745	0.862	0.991	1.132	1.287	1.453
0.133	0.180	0.236	0.302	0.376	0.459	0.551	0.652	0.762	0.882	1.010	1.147	1.293	1.449	1.613
0.190	0.214	0.247	0.288	0.338	0.396	0.464	0.540	0.625	0.718	0.820	0.931	1.051	1.179	1.316
0.117	0.173	0.234	0.302	0.375	0.454	0.539	0.630	0.726	0.828	0.936	1.049	1.168	1.293	1.424
0.110	0.158	0.211	0.268	0.330	0.396	0.466	0.540	0.619	0.702	0.789	0.881	0.977	1.077	1.182
0.197	0.211	0.236	0.272	0.319	0.377	0.445	0.525	0.616	0.718	0.830	0.954	1.088	1.234	1.390
0.158	0.193	0.234	0.282	0.337	0.397	0.465	0.538	0.618	0.705	0.798	0.897	1.003	1.115	1.234
0.000	0.208	0.238	0.278	0.328	0.388	0.458	0.538	0.627	0.727	0.836	0.955	1.084	1.223	1.372
0.112	0.173	0.237	0.303	0.372	0.443	0.517	0.593	0.672	0.753	0.837	0.924	1.013	1.105	1.199
0.167	0.204	0.247	0.297	0.353	0.415	0.484	0.560	0.641	0.730	0.824	0.925	1.033	1.147	1.267
0.000	0.223	0.266	0.314	0.367	0.424	0.487	0.554	0.627	0.704	0.787	0.874	0.966	1.063	1.166
0.090	0.147	0.179	0.229	0.323	0.411	0.480	0.465	0.515	0.760	0.751	0.817	1.693	2.000	2.327
0.103	0.127	0.161	0.238	0.234	0.377	0.454	0.496	0.648	0.691	0.678	0.913	0.974	0.807	0.982
0.141	0.122	0.162	0.175	0.256	0.323	0.417	0.453	0.553	0.611	0.732	0.838	1.415	1.139	1.277
0.044	0.084	0.123	0.167	0.209	0.290	0.335	0.323	0.621	0.530	0.900	0.846	0.976	0.878	1.016
0.096	0.100	0.131	0.168	0.204	0.279	0.397	0.219	0.570	0.700	0.833	1.122	0.430	1.320	0.000
0.033	0.081	0.125	0.173	0.213	0.266	0.333	0.381	0.465	0.537	0.571	0.591	0.760	0.576	0.475
0.083	0.101	0.140	0.191	0.211	0.190	0.226	0.257	0.481	0.530	0.560	0.508	0.880	1.908	1.037
0.078	0.104	0.137	0.182	0.221	0.271	0.334	0.289	0.565	0.554	0.628	0.531	0.644	0.986	0.997
0.026	0.038	0.088	0.142	0.200	0.247	0.232	0.286	0.142	0.157	0.533	0.353	0.682	0.825	0.481
0.064	0.068	0.094	0.131	0.185	0.237	0.291	0.317	0.455	0.361	0.554	0.701	0.661	0.755	0.298
0.054	0.082	0.096	0.144	0.152	0.199	0.237	0.244	0.300	0.329	0.464	0.299	0.495	0.133	1.092
0.079	0.059	0.082	0.113	0.129	0.163	0.279	0.400	0.447	0.430	0.612	0.275	1.595	0.523	0.714

Table 6.7.3.1. Irish Sea plaice: Final AP output and diagnostics. note: (1) model takes log(Ftrend #) as input; (2) The log.recruitments 1–8 merely provide initial cohorts for each entry in the numbers-at-age matrix.

Age range for fishery selectivity:	1 to 8
Age range for discard fraction:	1 to 5
Age range for UK-BTS:	1 to 6

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SEL_MODEL	TV
DISC_MODEL	PTVS
INCL_EGG	FALSE
INCL_RELBIO	TRUE
INCL_PLUSGROUP_NIGFS	TRUE
EST_SD_BIO	TRUE
firstoptMETHOD	SANN
mainMETHOD	BFGS
BFGS_MAXIT	800
BFGS_RELTOL	1.00E-20
n.tries for uncertainty	1000
eigenvalues Hessian positive?	FALSE
negative log.likelihood	167.14
negative log.likelihood Landings	13.11
negative log.likelihood Discards	67.12
negative log.likelihood UK-BTS	13.47
negative log.likelihood NI-GFSs	73.42
AIC	512.27
Nparameters	89
Nobservations	464

Table 6.7.3.1 cont. Irish Sea plaice: Final AP output and diagnostics. note: (1) model takes log(Ftrend #) as input; (2) The log.recruitments 1–8 merely provide initial cohorts for each entry in the numbers-at-age matrix.

Final parameter values

Ftrend 1	0.57	logrecruitment 1	18.62	sel.U 1	7.29
Ftrend 2	0.57	logrecruitment 2	17.52	sel.U 2	-1.57
Ftrend 3	0.53	logrecruitment 3	16.43	sel.U 3	0.16
Ftrend 4	0.44	logrecruitment 4	15.36	sel.U 4	-0.81
Ftrend 5	0.54	logrecruitment 5	15.20	b1	6.18
Ftrend 6	0.45	logrecruitment 6	14.54	b2	0.65
Ftrend 7	0.37	logrecruitment 7	13.33	b3	0.70
Ftrend 8	0.29	logrecruitment 8	10.87	b4	-0.62
Ftrend 9	0.29	logrecruitment 9	10.56	b5	0.18
Ftrend 10	0.31	logrecruitment 10	10.51	b6	0.13
Ftrend 11	0.26	logrecruitment 11	10.70	b7	0.07
Ftrend 12	0.18	logrecruitment 12	10.75	b8	0.13
Ftrend 13	0.23	logrecruitment 13	10.47	b9	0.01
Ftrend 14	0.16	logrecruitment 14	10.39	b10	0.01
Ftrend 15	0.15	logrecruitment 15	10.70	b11	0.00
Ftrend 16	0.11	logrecruitment 16	10.67	b12	0.00
Ftrend 17	0.10	logrecruitment 17	10.71	sds.land1	-2.11
Ftrend 18	0.08	logrecruitment 18	10.43	sds.land2	-1.97
Ftrend 19	0.13	logrecruitment 19	10.71	sds.land3	3.38
Ftrend 20	0.12	logrecruitment 20	10.42	sds.disc1	-0.46
Ftrend 21	0.08	logrecruitment 21	10.55	sds.disc2	-0.82
Ftrend 22	0.07	logrecruitment 22	10.68	sds.disc3	0.75
Ftrend 23	0.07	logrecruitment 23	10.27	sds.tun1	-1.86
sel.C 1	-1.31	logrecruitment 24	10.44	sds.tun2	1.45
sel.C 2	10.05	logrecruitment 25	10.66	sds.tun3	-0.32
sel.C 3	-6.78	logrecruitment 26	10.85	sds.biotun1	0.21
sel.C 4	0.55	logrecruitment 27	10.70	sds.biotun2	-1.63
sel.C 5	-0.06	logrecruitment 28	10.64		
sel.C 6	1.19	logrecruitment 29	10.98		
sel.C 7	-0.65	logrecruitment 30	10.11		
sel.C 8	0.14	Catchability 1	-8.68		

Table 6.7.3.2. Irish Sea plaice: Estimated landed numbers-at-age (thousands).

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	117	66	45	35	34	17	10	9	7	6	3	2
2	1250	894	687	595	898	774	483	354	443	419	325	152
3	1648	2379	1704	1287	1721	1820	1639	1111	1040	1457	1082	750
4	1148	1412	1831	1190	1337	1213	1336	1319	1160	1235	1374	923
5	538	705	783	907	868	647	587	681	849	836	692	678
6	556	274	347	356	619	396	286	260	364	492	362	249
7	367	229	121	153	250	312	201	150	169	261	268	162
8	179	148	102	55	113	135	173	118	111	141	170	147
9+	123	129	87	91	118	208	125	101	76	74	94	98

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	1	1	1	0	0	0	0	0	0	0	0
2	216	98	88	57	27	20	30	26	10	6	7
3	684	563	363	258	226	104	158	143	87	54	41
4	1260	668	787	403	384	332	308	287	185	172	129
5	889	693	518	475	320	294	502	277	177	167	180
6	462	338	365	212	260	176	345	383	159	168	214
7	205	209	201	159	113	127	163	186	134	77	92
8	167	119	162	117	116	77	170	131	99	102	67
9+	121	131	50	58	46	58	90	250	66	126	279

Table 6.7.3.3. Irish Sea plaice: Estimated discarded numbers-at-age (thousands).

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	21305	12536	9042	7648	8155	4629	3103	3122	2741	2879	1708	1471
2	13597	9694	7547	6744	10671	9813	6650	5385	7562	8160	7343	4061
3	3535	5061	3646	2809	3887	4316	4137	3031	3107	4838	4051	3212
4	850	1061	1412	952	1122	1079	1273	1361	1310	1542	1918	1456
5	127	176	208	259	269	220	221	286	402	451	428	486
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	1323	1032	1053	472	468	453	834	654	378	455	187
2	6932	3837	4272	3536	2119	2090	4104	4781	2679	2324	3382
3	3397	3295	2534	2183	2347	1343	2584	2997	2387	1953	1957
4	2269	1390	1910	1154	1311	1363	1539	1768	1415	1660	1581
5	745	685	610	673	550	618	1303	897	722	864	1198
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

Table 6.7.3.4. Irish Sea plaice: Estimated population numbers-at-age (thousands).

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	52549	38623	36519	44516	46635	35299	32473	44313	43157	44750	33738	44629
1	35932	26557	22445	23863	32265	33670	26941	25874	36358	35693	36976	28314
2	12553	17973	13642	12195	14284	17779	19939	17203	17561	24732	23605	25596
3	4880	6283	8978	7091	6978	7418	10019	12268	11370	11683	16029	16117
4	1639	2458	3257	4925	4280	3884	4430	6438	8365	7765	7756	11125
5	1374	831	1355	1960	3273	2729	2631	3170	4801	6243	5678	5827
6	897	699	481	876	1404	2322	2048	2065	2567	3916	5075	4696
7	438	453	405	313	633	1010	1767	1627	1690	2118	3227	4249
8	301	394	347	522	663	1548	1272	1397	1159	1108	1787	2855
9+												
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
1	33413	38245	43443	28950	34277	42546	51538	44144	41954	58928	24664	
2	38196	28388	32949	37539	25232	29961	37309	44925	38537	36854	51837	
3	21153	27164	21480	25126	29915	20361	24588	29205	35326	31650	30495	
4	18979	14929	20466	16329	19989	24113	16698	19231	22950	29004	26183	
5	12059	13519	11307	15618	13018	16135	19792	13074	15124	18850	24001	
6	8774	9160	10694	8969	12772	10728	13453	15858	10492	12569	15749	
7	4934	7347	7806	9141	7755	11083	9350	11607	13704	9156	10989	
8	4012	4183	6319	6735	7958	6771	9710	8139	10119	12028	8048	
9+	2908	4591	1951	3331	3179	5047	5146	15561	6778	14873	33437	

Table 6.7.3.5. Irish Sea plaice: Estimated fishing mortality-at-age.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.562	0.423	0.306	0.202	0.206	0.15	0.107	0.078	0.07	0.071	0.055	0.036
2	0.573	0.546	0.49	0.393	0.476	0.404	0.329	0.268	0.265	0.293	0.248	0.172
3	0.572	0.574	0.534	0.438	0.535	0.454	0.366	0.294	0.288	0.314	0.262	0.179
4	0.566	0.537	0.48	0.385	0.466	0.396	0.322	0.263	0.261	0.29	0.245	0.17
5	0.559	0.476	0.388	0.289	0.33	0.27	0.215	0.173	0.172	0.193	0.166	0.117
6	0.557	0.428	0.316	0.214	0.223	0.167	0.122	0.091	0.084	0.087	0.07	0.046
7	0.564	0.425	0.308	0.204	0.209	0.153	0.11	0.08	0.072	0.073	0.058	0.037
8	0.564	0.425	0.308	0.204	0.209	0.153	0.11	0.08	0.072	0.073	0.058	0.037
9+	0.564	0.425	0.308	0.204	0.209	0.153	0.11	0.08	0.072	0.073	0.058	0.037

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0.043	0.029	0.026	0.017	0.015	0.011	0.017	0.016	0.01	0.008	0.008
2	0.221	0.159	0.151	0.107	0.094	0.078	0.125	0.12	0.077	0.069	0.072
3	0.228	0.163	0.154	0.109	0.096	0.078	0.126	0.121	0.077	0.07	0.072
4	0.219	0.158	0.15	0.107	0.094	0.077	0.125	0.12	0.077	0.069	0.072
5	0.155	0.114	0.112	0.081	0.073	0.062	0.102	0.1	0.065	0.06	0.063
6	0.057	0.04	0.037	0.025	0.022	0.018	0.028	0.026	0.016	0.014	0.014
7	0.045	0.031	0.028	0.019	0.016	0.012	0.019	0.017	0.01	0.009	0.009
8	0.045	0.031	0.028	0.019	0.016	0.012	0.019	0.017	0.01	0.009	0.009
9+	0.045	0.031	0.028	0.019	0.016	0.012	0.019	0.017	0.01	0.009	0.009

Table 6.7.3.6. Irish Sea plaice: Update AP stock summary. Uncertainty analysis: modelled median values from 1000 bootstrap simulations (50th percentile) with 5th (lower) and 95th (upper) percentiles indicating the 90% CI for: spawning–stock biomass (SSB, tonnes), mean fishing mortality (F) for ages 3–6, discard tonnage (D) and recruitment (R, 000s).

Year	SSB (t) lower	SSB (t) med	SSB (t) upper	F(3-6) lower	F(3-6) med	F(3-6) upper	Discards (t) lower	Discards (t) med	Discards (t) upper	Recruits (000) lower	Recruits (000) med	Recruits (000) upper	Landings (t) lower	Landings (t) med	Landings (t) upper
1993	5438	8009	23794	0.392	0.513	0.625	2205	3586	6372	39621	52622	69228	1323	2122	5562
1994	6405	7857	20481	0.418	0.502	0.592	2121	3035	4534	31637	38614	47156	1850	2280	5436
1995	6723	7808	14817	0.369	0.433	0.505	1748	2308	3059	30607	36466	43233	1698	1983	3508
1996	7274	8435	13715	0.281	0.334	0.395	1463	1856	2358	38403	44477	52020	1517	1748	2552
1997	7479	8797	12152	0.327	0.391	0.464	2029	2485	3060	40501	46506	53643	1707	1937	2471
1998	8943	10787	13276	0.265	0.324	0.392	1829	2232	2740	30539	35348	40315	1627	1826	2067
1999	9221	11360	13536	0.203	0.255	0.323	1437	1779	2169	28367	32493	37057	1394	1560	1727
2000	9566	12184	14653	0.158	0.206	0.271	1220	1515	1856	38826	44249	50952	1197	1328	1473
2001	11110	14605	17879	0.153	0.199	0.269	1428	1765	2192	37359	43176	49179	1343	1486	1642
2002	12533	16793	20709	0.164	0.220	0.305	1724	2139	2640	38942	44914	51653	1524	1699	1875
2003	14436	19911	25079	0.133	0.185	0.264	1548	1937	2383	29175	33743	38863	1423	1586	1766

Year	SSB (t)	SSB (t)	SSB (t)	F(3-6)	F(3-6)	F(3-6)	Discards	Discards (t)	Discards	Recruits	Recruits	Recruits	Landings	Landings	Landings
	lower	med	upper	lower	med	upper	(t) lower	med	(t) upper	(000) lower	(000) med	(000) upper	(t) lower	(t) med	(t) upper
2004	12566	18107	23593	0.090	0.127	0.186	1065	1343	1658	38211	44721	51274	947	1052	1166
2005	13082	18751	24639	0.115	0.166	0.237	1510	1935	2376	28408	33489	39031	1184	1321	1462
2006	13280	19402	26036	0.084	0.119	0.170	1089	1352	1668	32297	38364	44916	837	931	1028
2007	11028	15976	21099	0.083	0.112	0.158	847	1031	1256	36473	43288	50931	738	814	901
2008	12444	17703	23179	0.059	0.079	0.110	729	894	1083	24395	28971	34120	515	570	627
2009	13297	18540	23802	0.053	0.071	0.096	612	744	897	28906	34259	39939	423	467	519
2010	13293	17928	22538	0.045	0.059	0.078	672	805	976	35825	42469	49709	354	391	431
2011	16511	21766	27181	0.074	0.095	0.121	961	1180	1432	42759	51660	61655	539	595	659
2012	14767	19266	24102	0.072	0.092	0.117	654	788	971	35978	44181	53554	515	558	607
2013	15638	20111	24836	0.046	0.059	0.076	544	676	854	33221	41598	52497	272	299	329
2014	16404	20780	25780	0.042	0.053	0.069	552	718	951	45851	58964	74565	305	332	361
2015	27080	35530	44834	0.043	0.055	0.074	475	630	852	18444	24798	33197	406	431	460

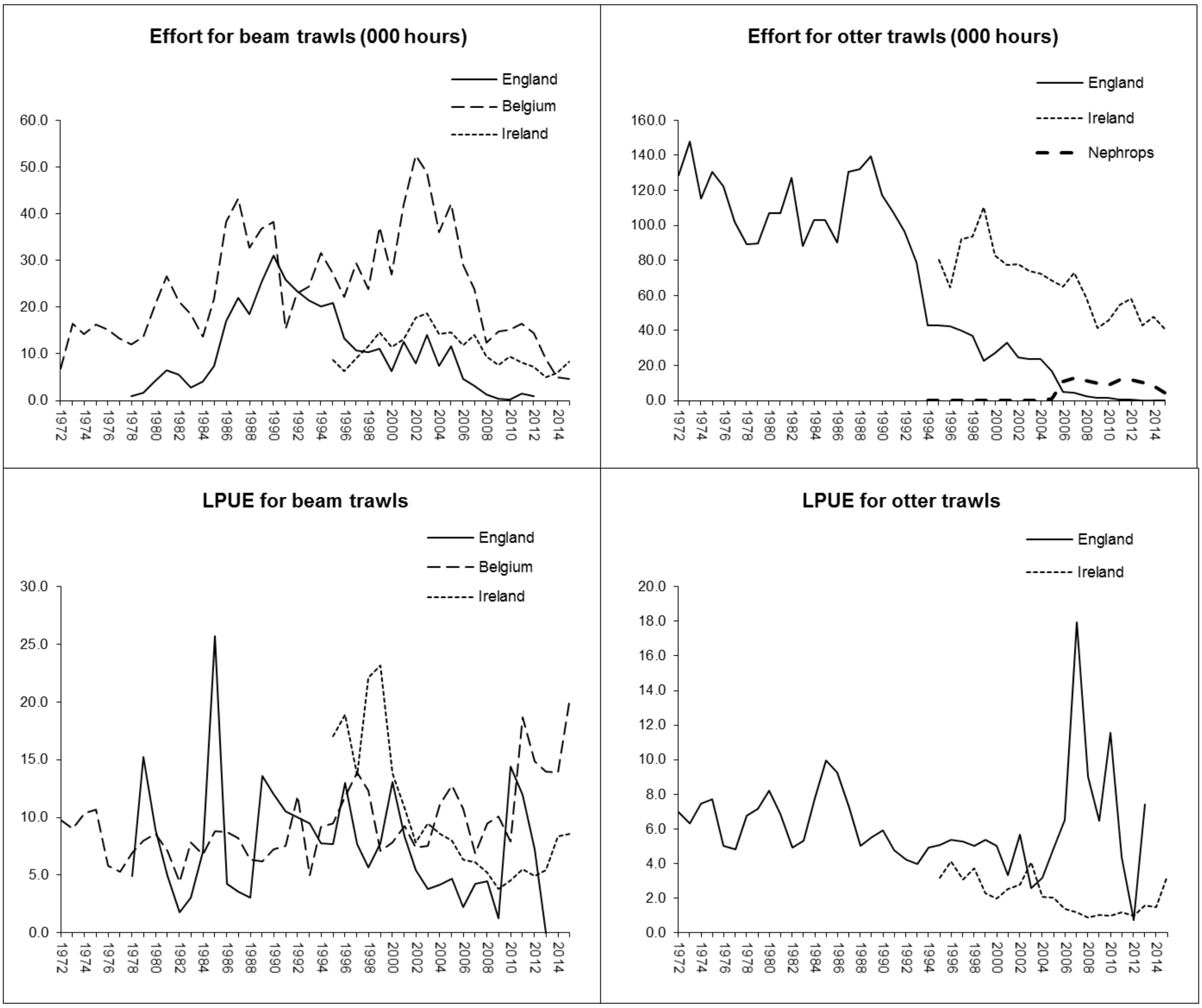


Figure 6.7.2.1. Irish Sea plaice: Effort and lpue for commercial fleets.

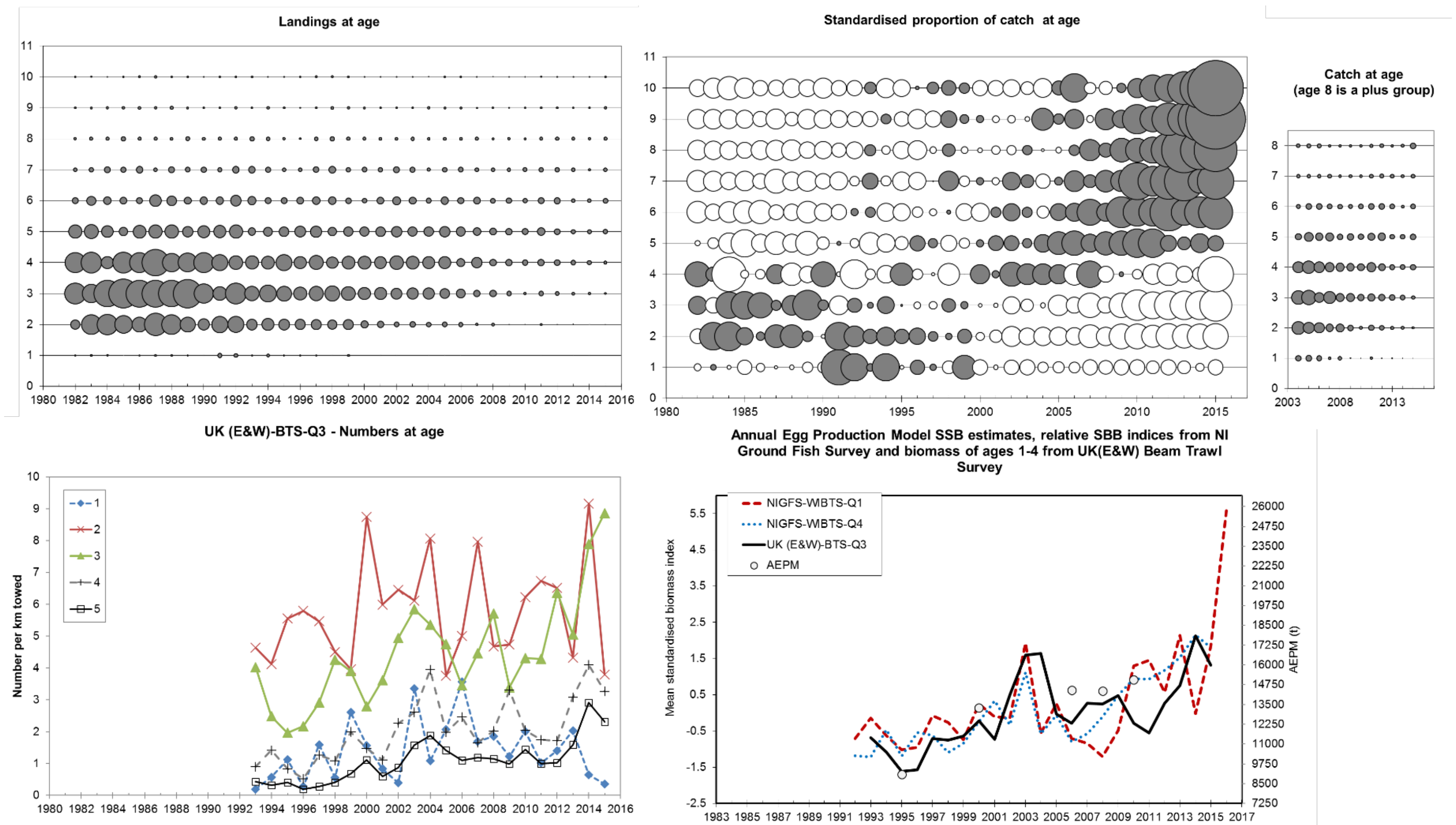


Figure 6.7.2.2. Catch and survey data: raw landings-at-age data (top left), mean standardised proportion-at-age (top centre, grey bubbles are positive values and white bubbles are negative); raw catch-at-age data (discards plus landings, top right); UK(E&W)-BTS-Q3 (extended area) cpue (bottom left); standardised indices of SBB (bottom right) derived from NIGFS-WIBTS and also shown biomass of ages 1–4 from UK(E&W)-BTS-Q3 (extended area) and the SSB estimates from the Annual Egg Production Methods (circles, bottom right). Mean standardised proportion-at-age = [(proportion-at-age in year) – mean(proportion-at-age over all years)] / STDEV(proportion-at-age over all years).

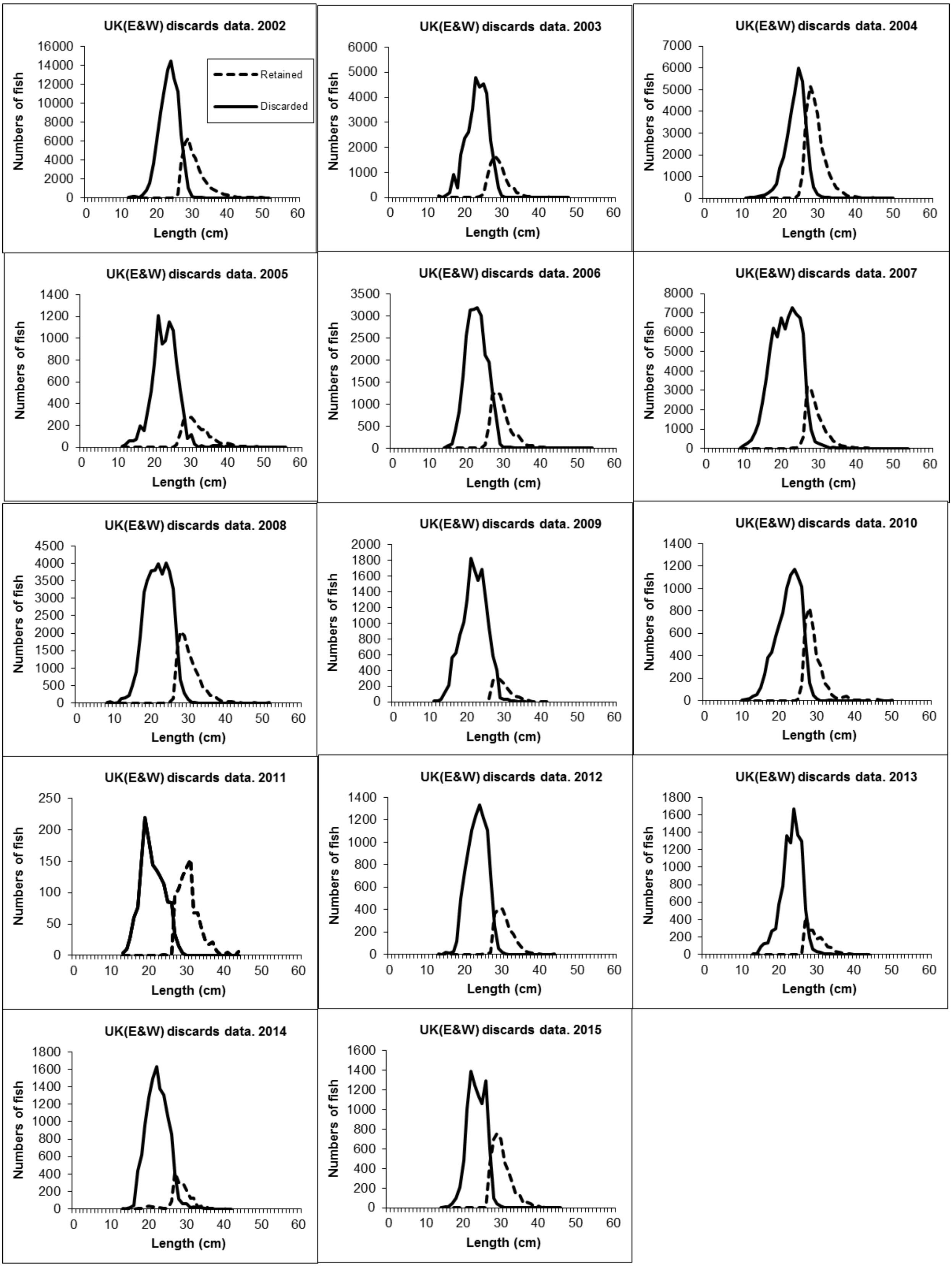


Figure 6.7.2.3. Length distributions of discarded and retained catches from UK(E&W).

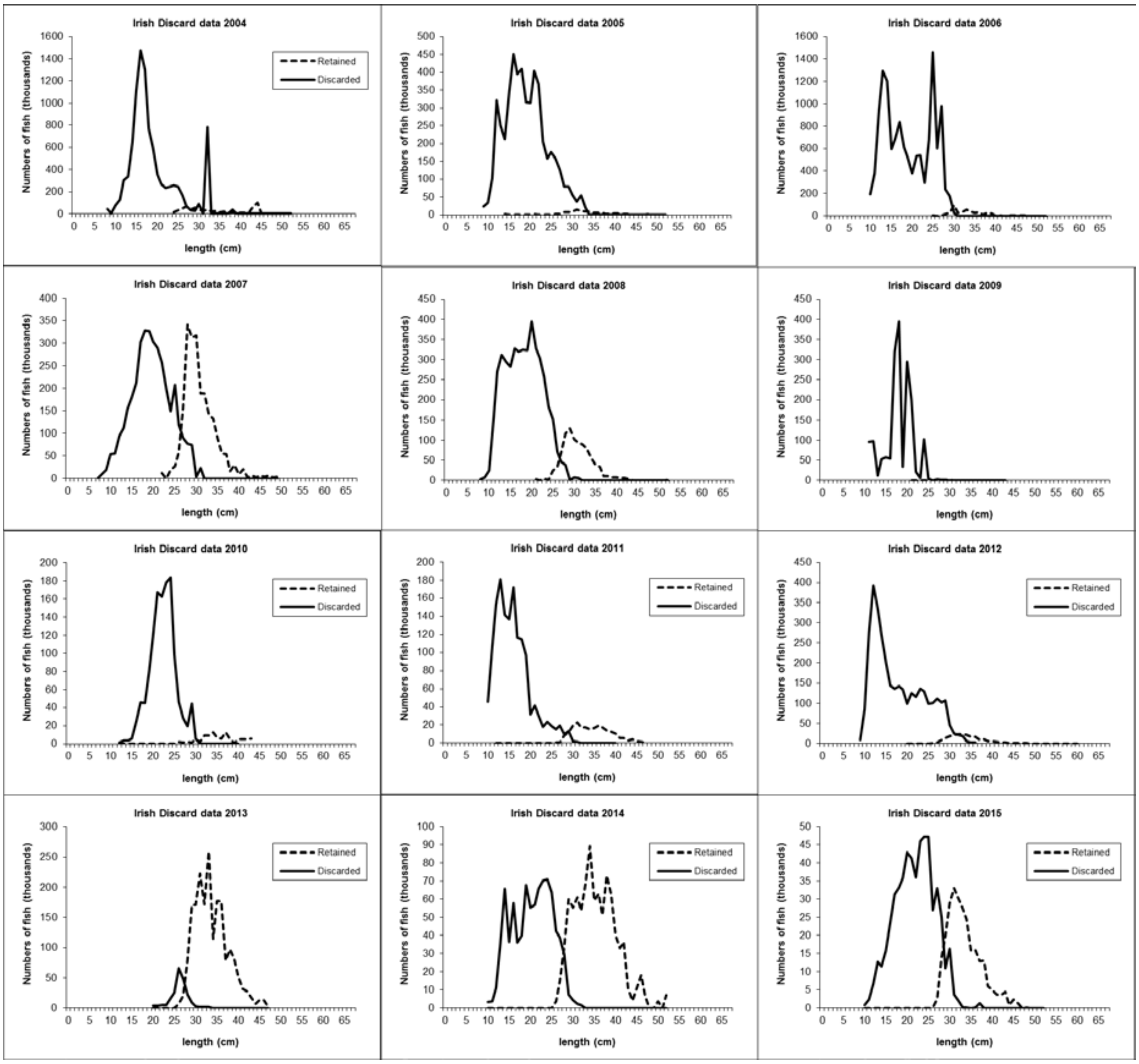


Figure 6.7.2.4. Length distributions of discarded and retained catches from Ireland.

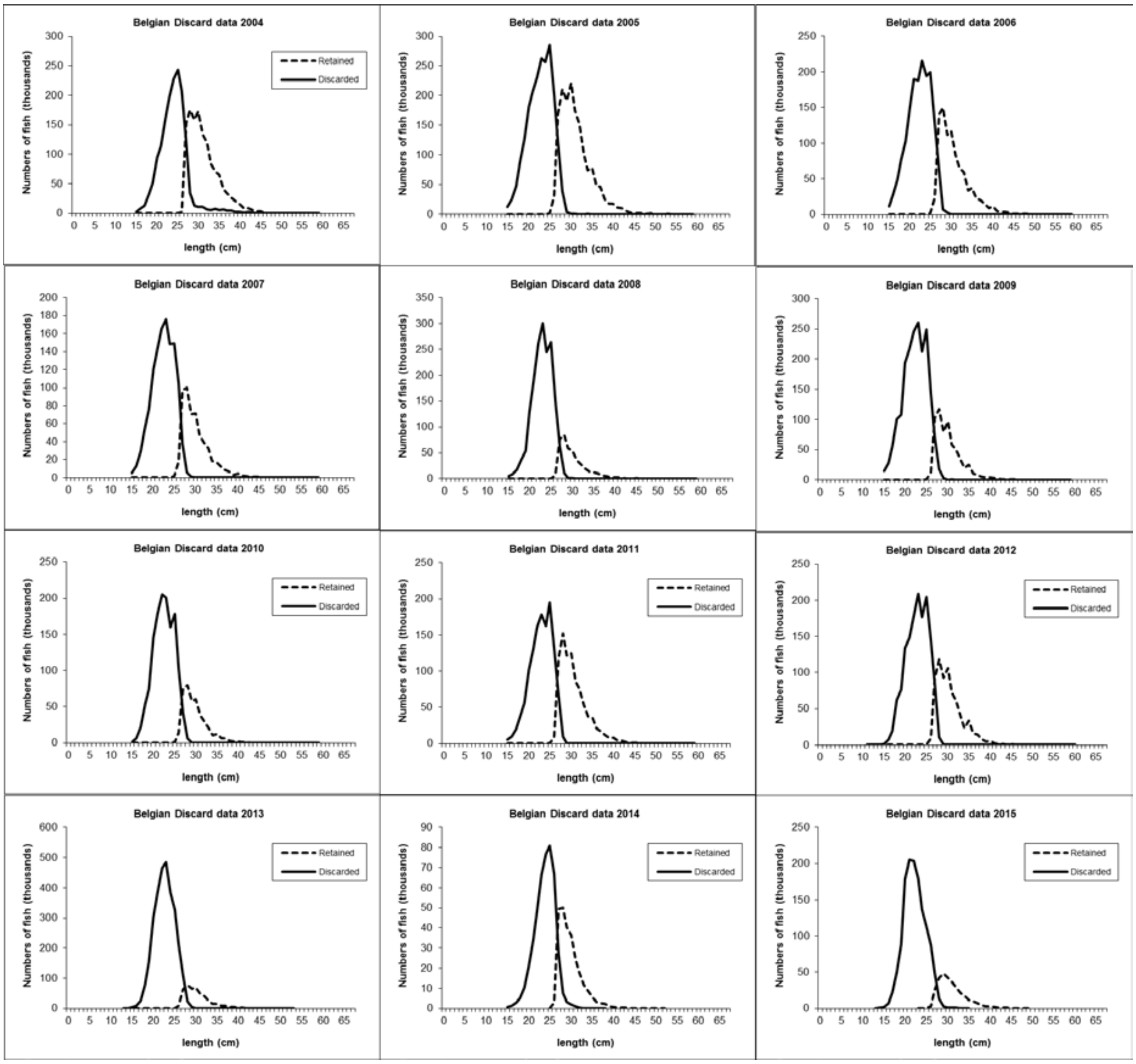


Figure 6.7.2.5. Length distributions of discarded and retained catches from Belgium.

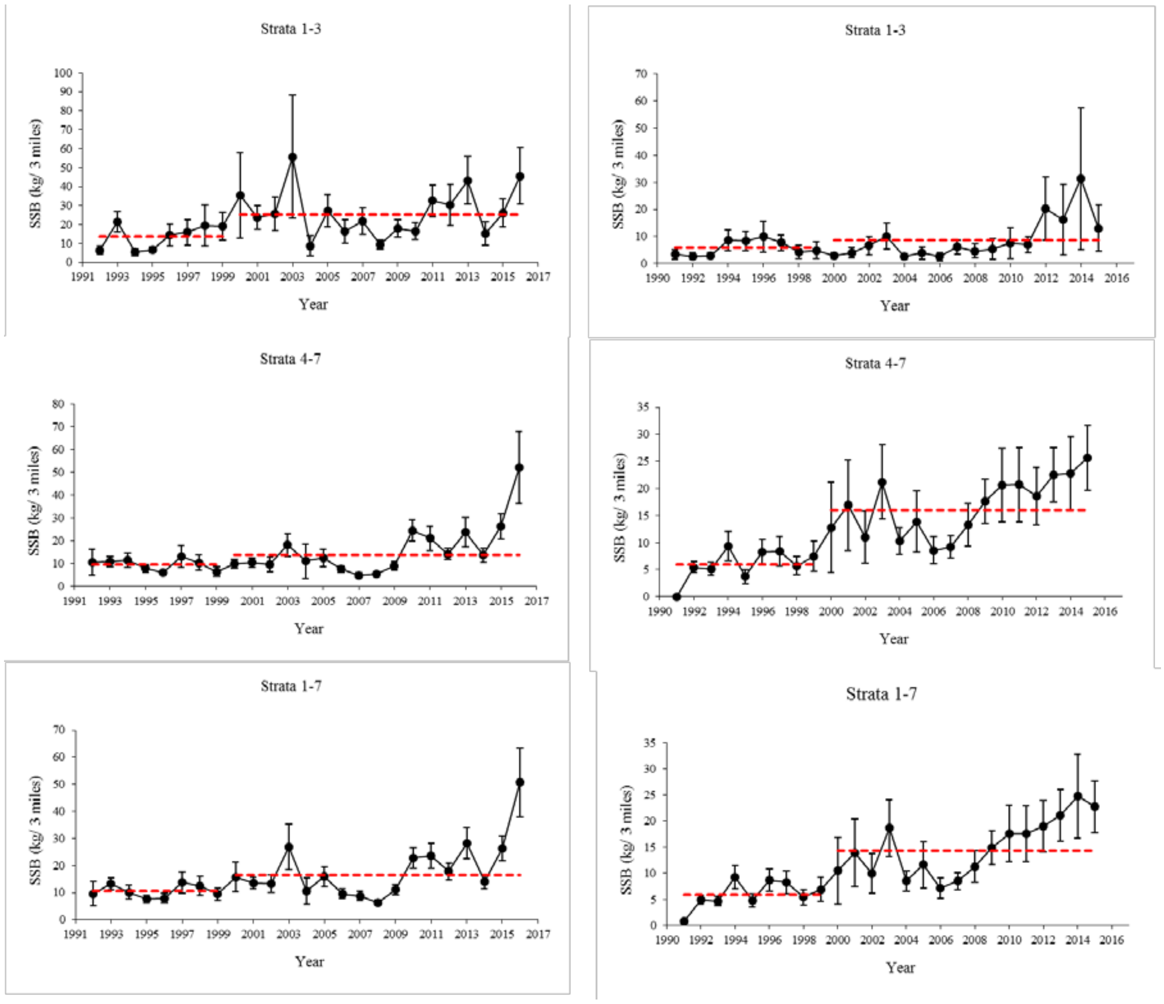


Figure 6.7.2.7. Northern Irish groundfish survey SSB indices split into spring (left hand panels) and autumn (right hand panels) sampling by western strata (1–3), eastern strata (4–7) and total survey area (strata 1–7) with confidence intervals (± 1 standard error, vertical lines) and mean biomass (kg/3 miles, dashed horizontal lines) for periods identified by statistical breakpoint analysis (see WGCSE 2010).

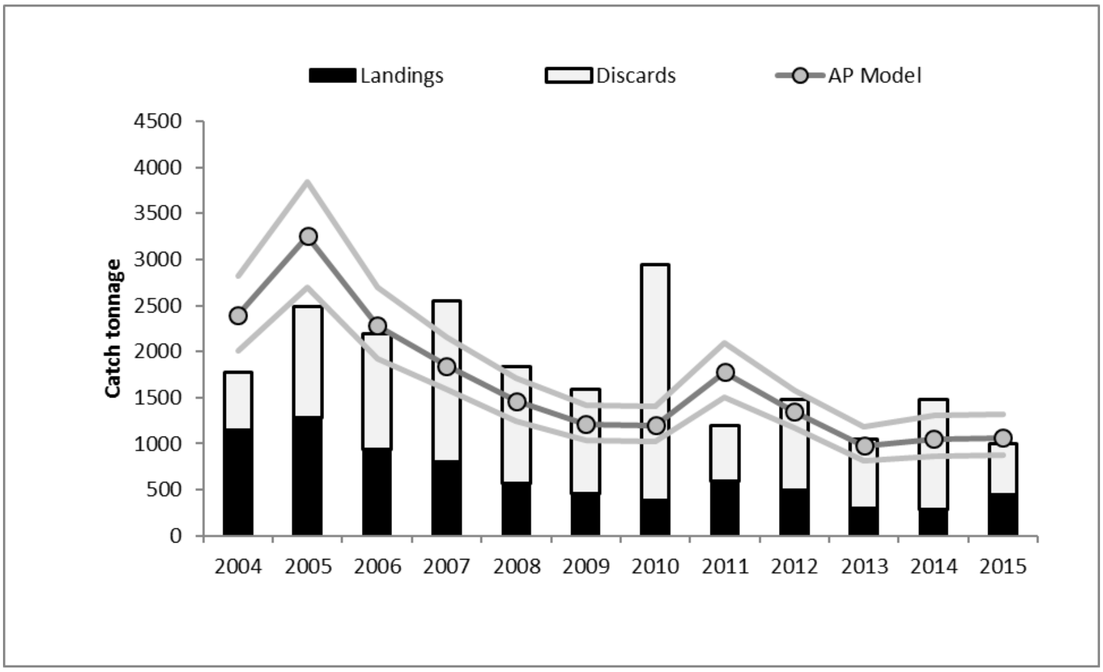


Figure 6.7.2.8. Plaice in 7.a: WG raised international catch tonnage vs. AP model estimates with uncertainty bounds.

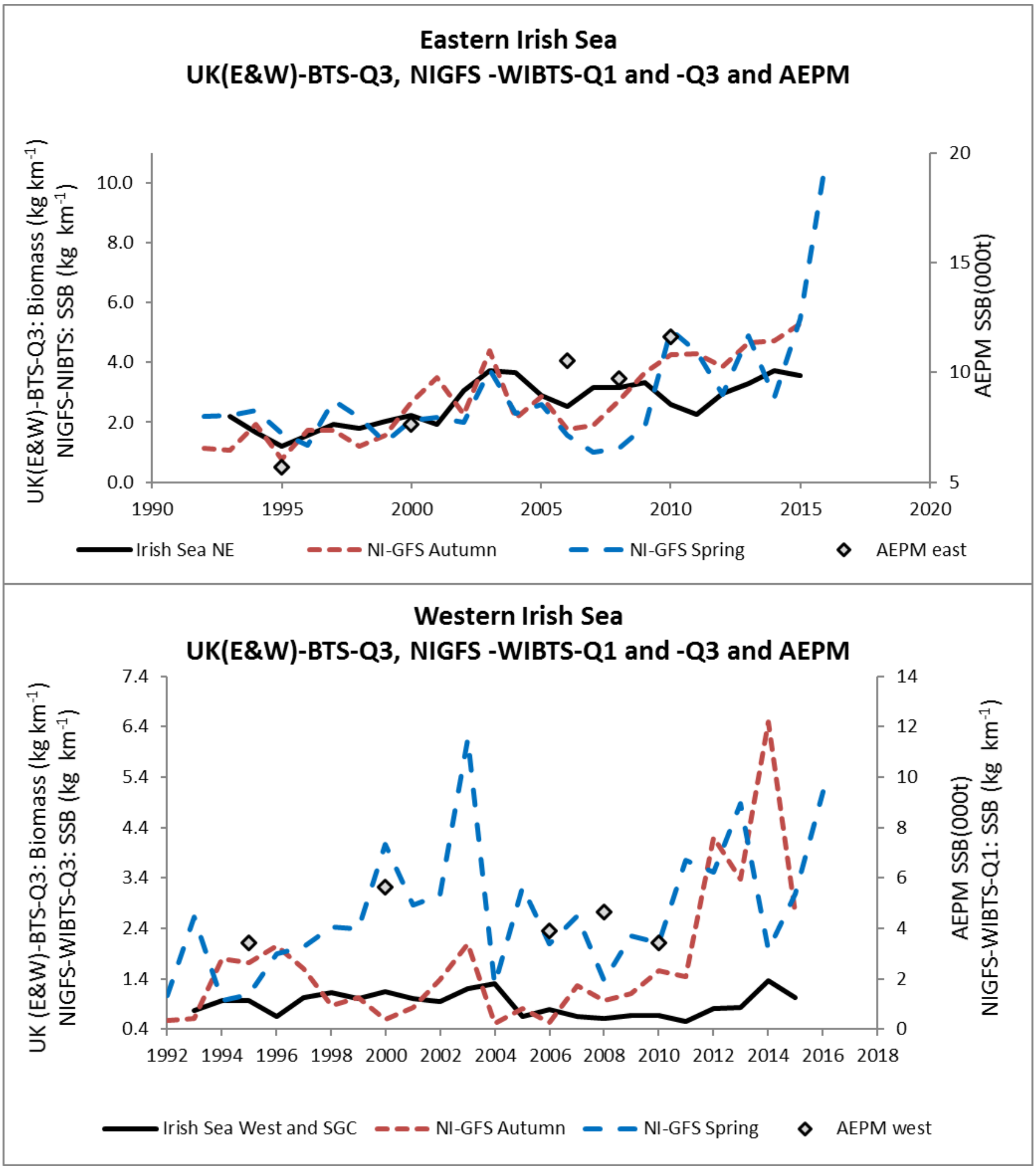


Figure 6.7.2.9. Trends in biomass indices (kg per km towed) from the UK(E&W)-BTS-Q3 (black line) and the NIGFS-WIBTS-Q1 and -Q3 (blue and red dashed lines respectively) in the eastern Irish Sea (top) and the western and southern Irish Sea (bottom). Also shown (grey diamonds, right axis) are the estimates of SSB from the Annual Egg Production Method (AEPM) from Armstrong *et al*. (2011).

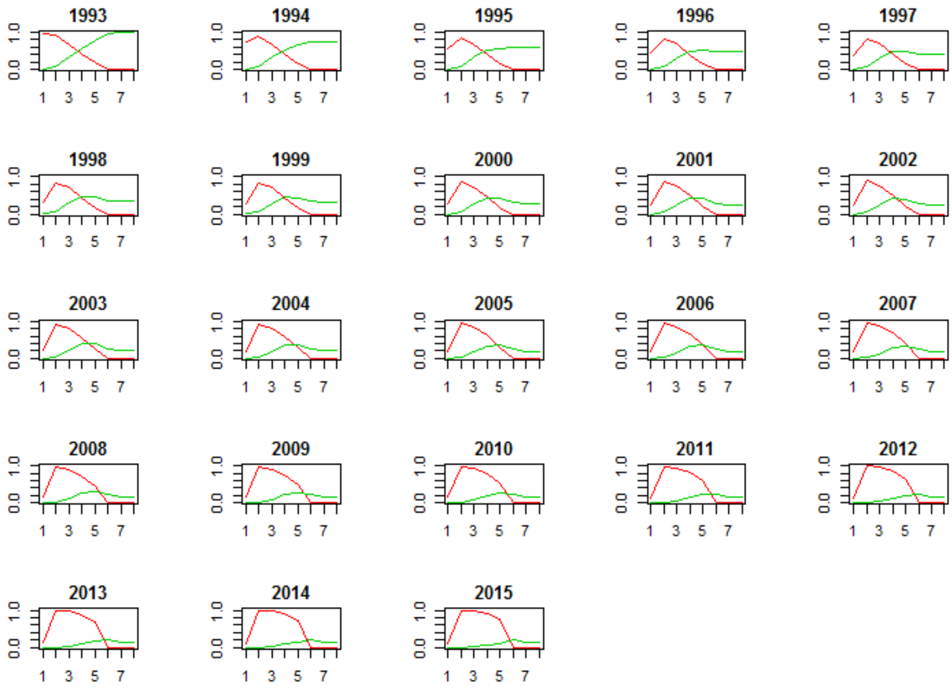


Figure 6.7.2.10. Selectivity of the fishery split into the landed (green) and discarded (red) components as estimated by the AP model, where the x-axis shows age and the y-axis gives the fishing mortality-at-age scaled so that the maximum value is 1 and split by the proportion of fish (by number) discarded and landed at-age.

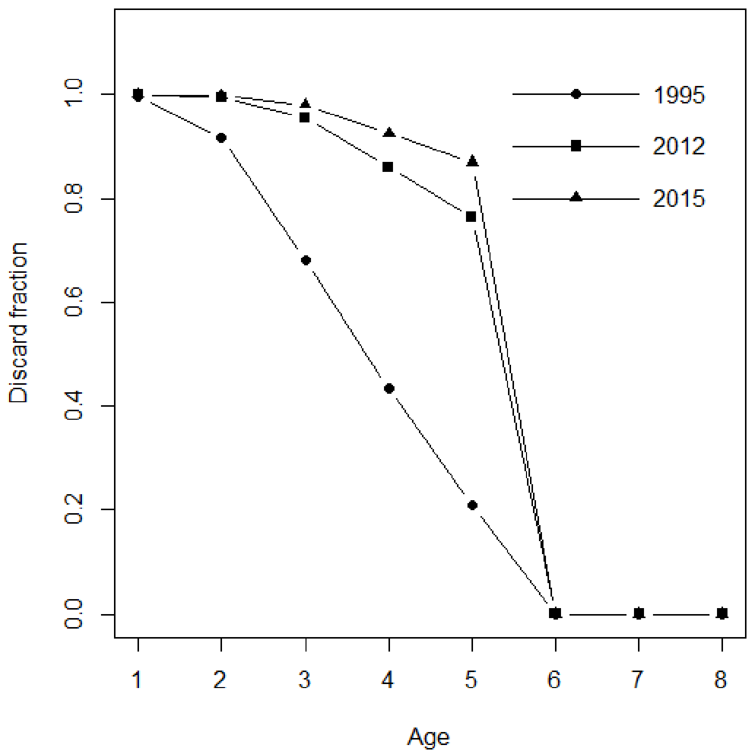


Figure 6.7.2.11. Change in the discard fraction at-age over time as estimated by the AP model.

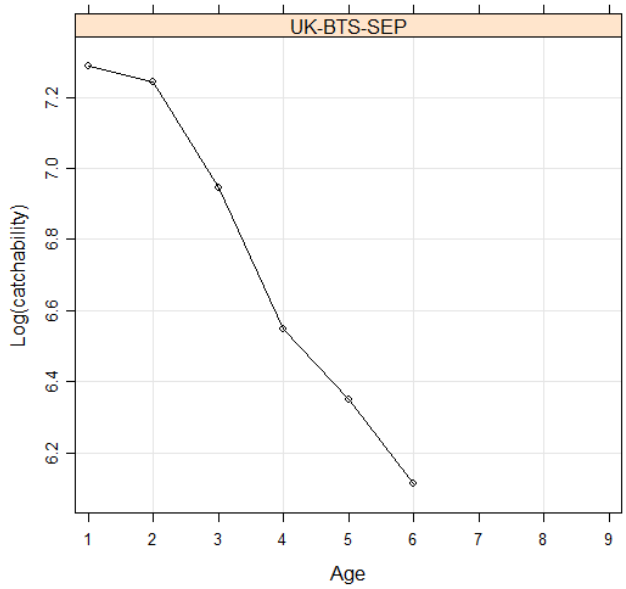


Figure 6.7.2.12. Log catchability for the UK(E&W)-BTS-Q3 extended index as estimated by the AP model.

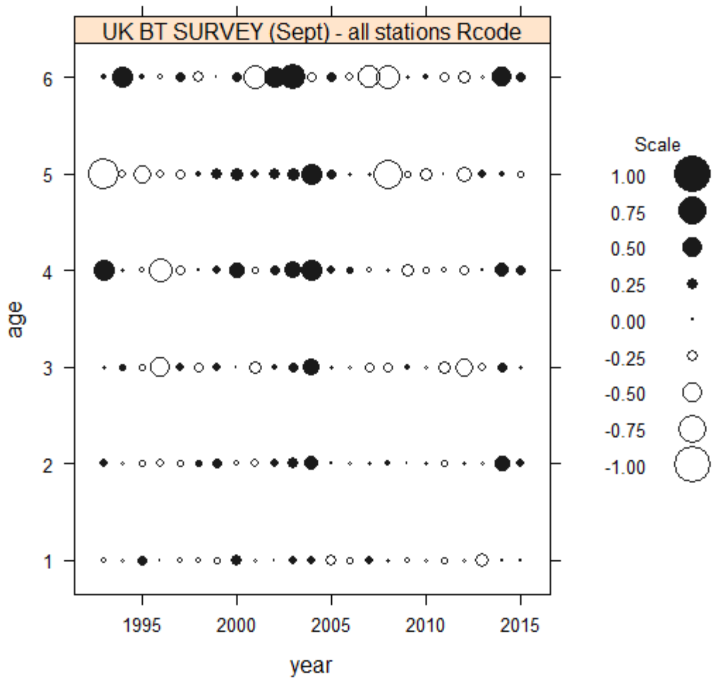


Figure 6.7.2.13. Residual plot (left) for the UK(E&W)-BTS-Q3extended area index. Bubbles are log(observed) – log(expected). Expected values were estimated by the AP model.

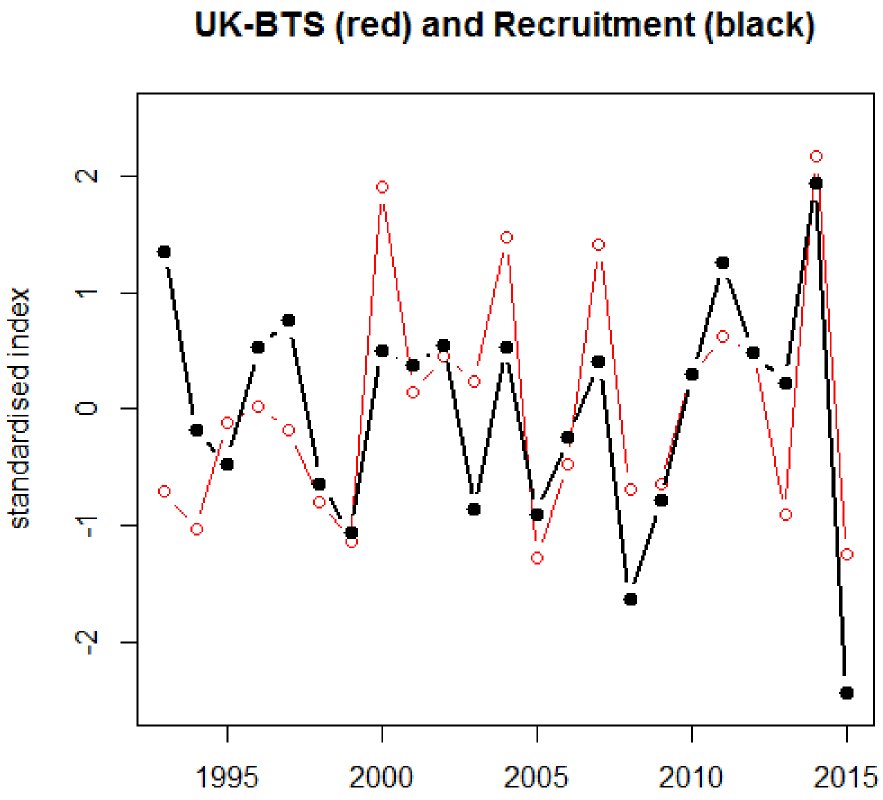


Figure 6.7.2.14. Age 1 index from the UK(E&W)-BTS-Q3 extended area index (red and crosses) and recruitment (black and circles) estimated by the AP model.

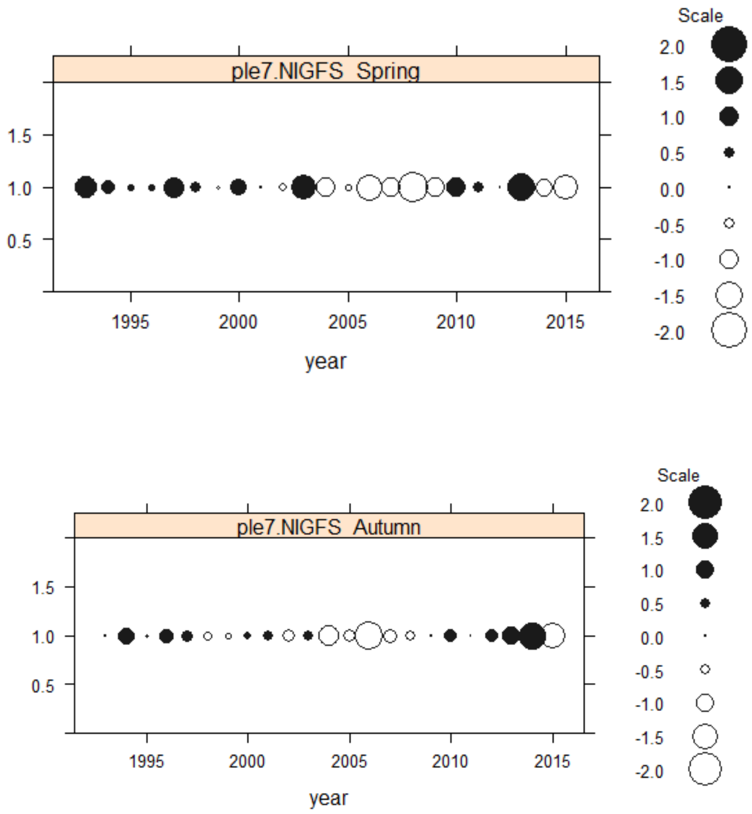


Figure 6.7.2.15. Residual plots for the NIGFS-WIBTS-Q1 (top) and –Q4 (bottom). Bubbles are (observed mean standardised SSB) (expected mean standardised SSB). Expected values were estimated by the AP model.

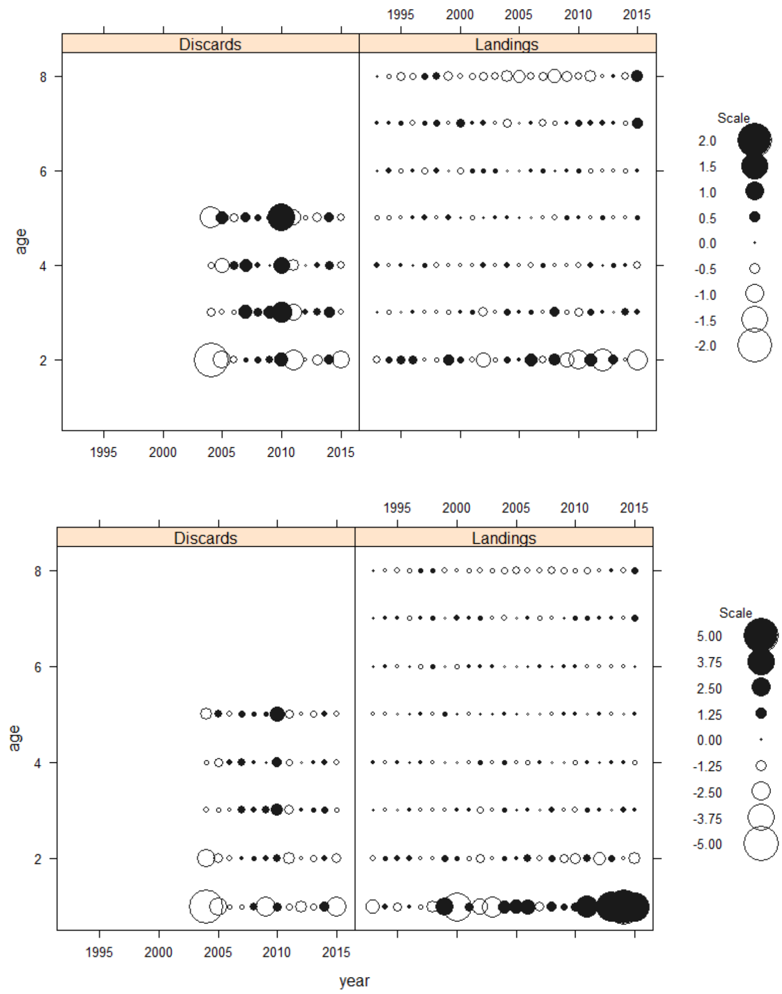


Figure 6.7.2.16. Residual plots for discards (left) and landings (right) with (bottom) and without (top) bubbles drawn for age 1. Bubbles are log(observed)–log(expected). Expected values were estimated by the AP model.

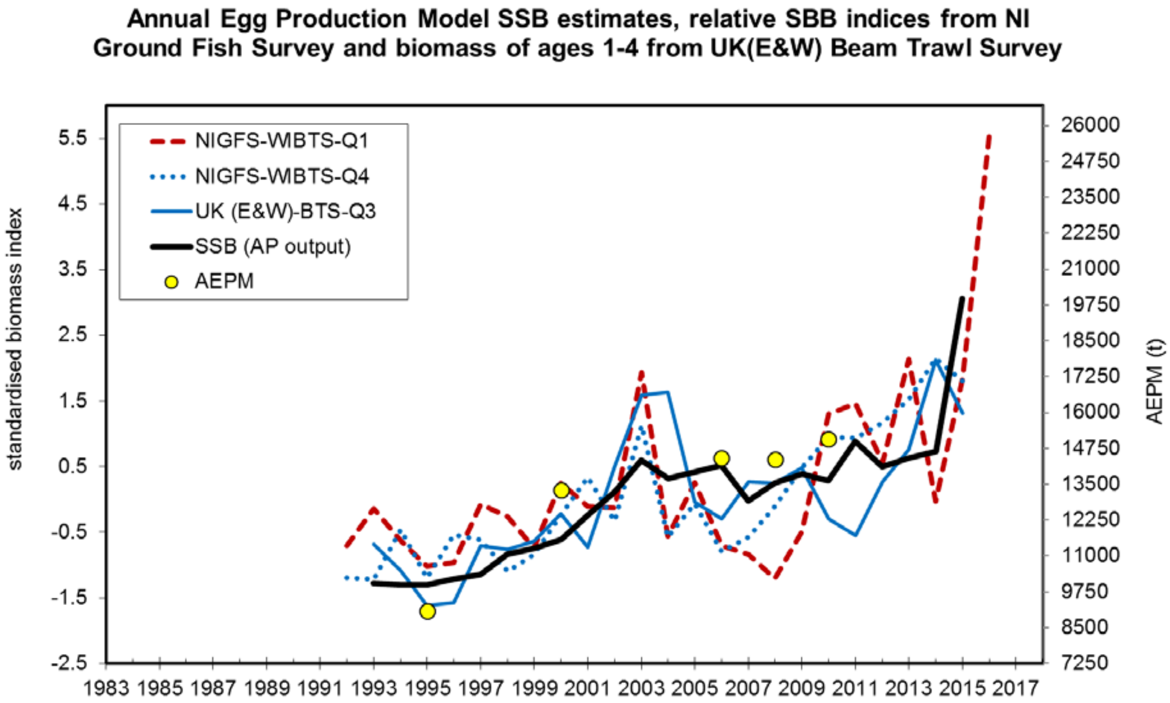


Figure 6.7.2.17. AP model estimates of mean standardised SSB (black line) overlain with standardised NI-GFS in spring (red dashed) and autumn (blue dashed) relative SSB indices, standardised (minus mean and divide by standard deviation) biomass (ages 1–4) from the UK(E&W)-BTS (blue solid line) and AEPM SSB index (circles, right axis).

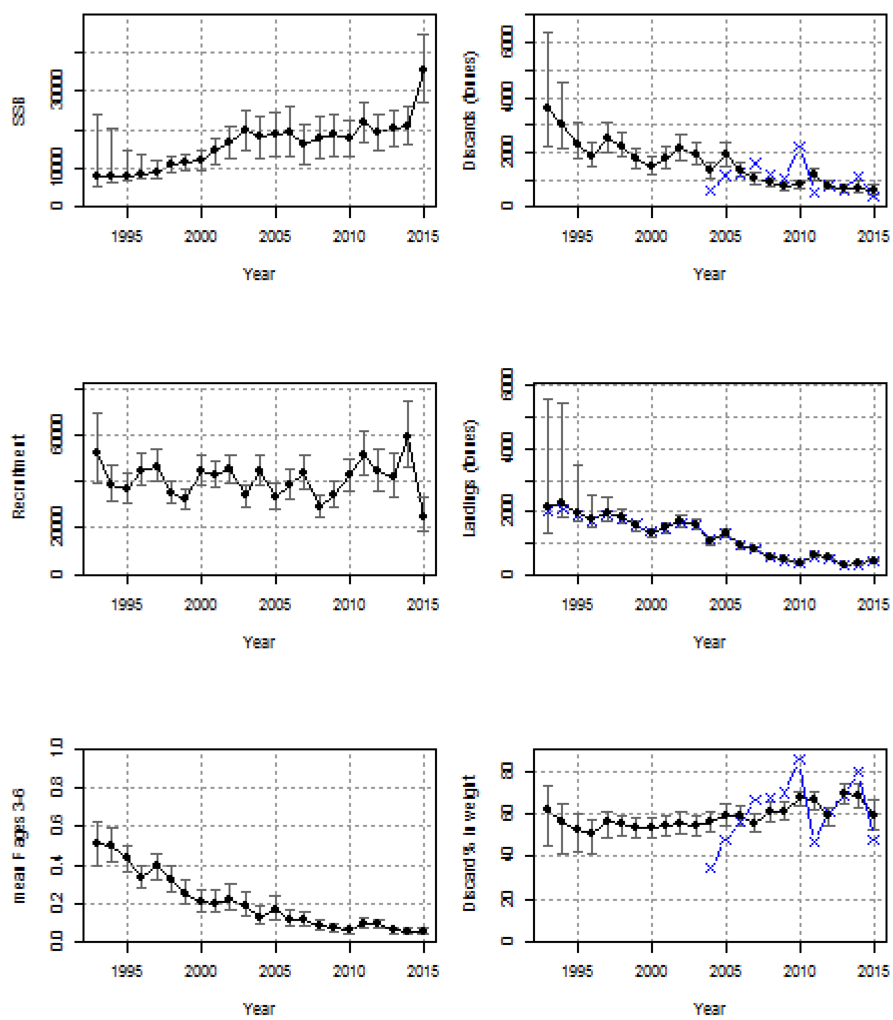


Figure 6.7.2.18. Modelled SSB (tonnes, top left), recruitment (thousands, centre left), FBAR (ages 3–6, bottom left) discard tonnage (top right), landed tonnage (centre right) and % discarded by weight (bottom right). Modelled using the AP model. Raw data shown in blue with crosses. Error bars indicate 5th–95th percentiles.

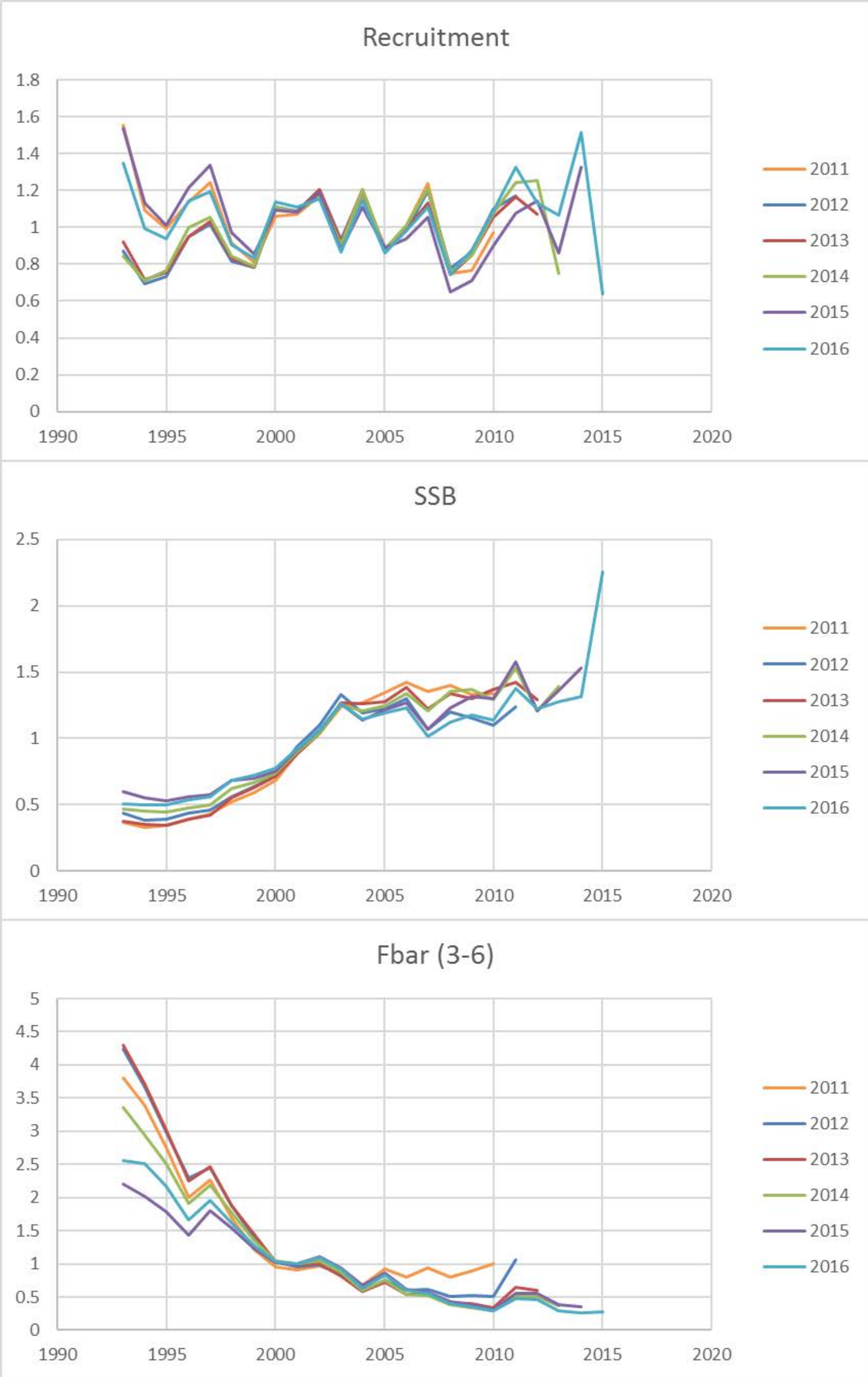


Figure 6.7.2.19. Comparison of recruitment (age 1), SSB and FBAR (ages 3–6) between the WGCSE 'AP model' assessments in 2011–2016. Series standardised to a common mean for the period 1998–2006.

6.8 Sole in Division 7.a (Irish Sea)

Type of assessment in 2016

This assessment is an Update Assessment.

ICES advice applicable to 2015

In 2015 the stock status was presented as follows:

Fishing pressure				
	2011	2012	2013	
MSY (F_{MSY})	✗	✗	✗	Above target
Precautionary approach (F_{pa},F_{lim})	O	O	✓	Harvested sustainably

Stock size				
	2012	2013	2014	
MSY ($B_{trigger}$)	✗	✗	✗	Below trigger
Precautionary approach (B_{pa},B_{lim})	✗	✗	✗	Reduced reproductive capacity

MSY approach

Following the ICES MSY approach implies fishing mortality to be reduced to 0.07 (lower than F_{MSY} because SSB in 2015 is 56% below MSY $B_{trigger}$). ICES cannot quantify the resulting catches. The implied landings should be no more than 90 t. Discards are known to take place in the order of an additional 5% of the landings in the last three years (2011–2013). This is expected to lead to a SSB of 1582 t in 2016.

However, considering the low SSB and low recruitment since 2000, it is not possible to identify any non-zero catch which would be compatible with the MSY approach.

Precautionary approach

It is not possible to identify any non-zero catch that would be compatible with the precautionary approach.

ICES advice applicable to 2016

In 2016 the stock status was presented as follows:

		Fishing pressure			
		2012	2013	2014	
Maximum Sustainable Yield	F_{MSY}	✗	✓	✓	Below
Precautionary approach	F_{pa}, F_{lim}	✓	✓	✓	Harvested sustainably
Management Plan	F_{MGT}	-	-	-	Not applicable

		Stock size			
		2013	2014	2015	
Maximum Sustainable Yield	MSY $B_{trigger}$	✗	✗	✗	Below trigger
Precautionary approach	B_{pa}, B_{lim}	✗	✗	✗	Reduced reproductive capacity
Management Plan	SSB_{MGT}	-	-	-	Not applicable

MSY approach

ICES advises that when the MSY approach is applied, there should be no directed fisheries and all catches should be minimized in 2016.

Comments made by the audit of last year's assessment

No major deficiencies for the sole assessment in the Irish Sea were reported.

6.8.1 General

Stock description and management units

The sole fisheries in the Irish Sea are managed by TAC (see text tables below) and technical measures, with the assessment area corresponding to the stock area. Technical measures in force are minimum mesh sizes and minimum landing size (24 cm). In addition beam trawlers, fishing with mesh sizes equal to or greater than 80 mm, are obliged to have 180 mm mesh sizes in the entire upper half of the anterior part of their net. More details can be found in Council Regulation (EC) N°254/2002 and the Stock Annex.

Since 2000, a spawning closure for cod has been in force. The first year of the regulation the closure covered the Western and Eastern Irish Sea. Since then, closure has been mainly in the western part whereas the sole fishery takes place mainly in the eastern part of the Irish Sea (Liverpool Bay and Cardigan Bay). No direct impact on the sole stock is expected from this closure.

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 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); gillnets excluding trammelnets: GN1; trammelnets: GT1 and Longlines: LL1.

For 2010–2016, Council Regulation (EC) N°53/2010, Council Regulation (EC) N°57/2011, Council Regulation (EC) N°43/2012, Council Regulation (EC) N°40/2013, Council Regulation (EC) N°43/2014, Council Regulation (EC) N°2015/104 and Council Regulation (EC) N°2016/72 were updates of the 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.

Management applicable to 2015 and 2016

TAC 2015

Species:	Common sole *Solea solea*	Zone:	VIIa (SOL/07A.)
Belgium	22		
France	0		
Ireland	38		
The Netherlands	7		
United Kingdom	23		
Union	90		
TAC	90		Analytical TAC Article 3 of Regulation (EC) No 847/96 shall not apply Article 4 of Regulation (EC) No 847/96 shall not apply

TAC 2016

Species:	Common sole *Solea solea*	Zone:	VIIa (SOL/07A.)
Belgium	10 (1)		
France	0 (1)		
Ireland	17 (1)		
The Netherlands	3 (1)		
United Kingdom	10 (1)		
Union	40 (1)		
TAC	40 (1)		Analytical TAC Article 3 of Regulation (EC) No 847/96 shall not apply Article 4 of Regulation (EC) No 847/96 shall not apply

(1) Exclusively for by-catches. No directed fisheries are permitted under this quota.

Fishery in 2015

A full description of the fishery is provided in the Stock Annex, Section A2.

The WG estimated the total international landings at 76 t in 2015 (Table 6.8.1), of which Belgium landed 48% (36 t), Ireland 42% (32 t), 5% (4 t) by the UK (England & Wales) and the remainder by Northern Ireland, the Netherlands, Scotland and France. These landing-figures are the lowest in the time-series, corresponding to an international uptake of 84% of the agreed TAC in 2015 (90 t).

Landings

An overview of the landings data provided and used by the WG is shown in Table 6.8.1. The landings reached a level of 2800 t in the mid-1980s due to good recruitments in 1982–1984, but then subsequently dropped to a lowest of 818 t in 2000 (Table 6.8.12). After a small increase to 1090 t in the beginning of the 2000s, the landings have fallen to under 350 t in 2008–2012. From 2013 onwards the landings continued to decrease as they dropped to under 150 t.

The Working Group estimate of the 2014 landings was not revised.

Data

Quarterly age compositions for 2015 were available from the countries that take the major part of the international landings (95%) (Belgium, UK (E&W) and Ireland). The raw age data were combined for the three countries without weighting. The combined ALK was applied to the raised length distribution of the national catches to obtain a combined age distribution. This distribution was applied to the landings from Northern Ireland, the Netherlands, Scotland and France to obtain the catch numbers-at-age for 2015 (Table 6.8.2). Annual length distributions of the three major countries involved are given in Table 6.8.3.

Catch weights-at-age for 2015 were taken from the combined age–weight key (Table 6.8.4).

Stock weights-at-age for 2015 were derived from the mean catch weights by cohort interpolation to the first of January (Rivard weight calculator) (Table 6.8.5).

Further details on raising methods are given in the stock annex.

As last year, the combined age data (calculated outside InterCatch) as well as the landings from Northern Ireland, the Netherlands, Scotland and France were uploaded to InterCatch. It should be noted that the international age distribution is uploaded as “BE” as no international country code is available in InterCatch at present.

Discards

The available discard information (Table 6.8.6a,b) suggests that discarding is not a major problem in the Irish Sea sole fishery. Belgian beam-trawl length distributions of retained and discarded catches of sole for 2015 (Figure 6.8.1a) indicate that predominantly 2–3-year old fish are discarded which amount to a maximum of 6.8% in weight. Observer information from UK and Irish beam-trawl and otter trawl fleets also suggest low discard rates. 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.

As an attempt, estimating an overall discard rate for the stock, individual discard estimates for 2013, 2014 and 2015 from the main métiers and countries were weighted according to their landed weights to arrive at an overall discard rate by year (Table 6.8.6b). The percent of the métiers with discard information covering the total international landings is 72%, 46% and 60% for 2013, 2014 and 2015 respectively. Assuming that discard rates do not change from the average of the last three years (2013–2015) and a fixed proportion of discards survive, a discard rate of around 0.08 (of the catch) could be assumed for this stock at the moment.

Biological

Natural mortality, maturity and proportions of natural mortality and fishing mortality before spawning were set as in previous years, details of which can be found in the Stock Annex Section B2.

Surveys

Lpue and effort series were available from the UK (E&W) September beam-trawl survey (UK(E&W)-BTS-Q3) (1988–2015) and the UK (E&W) March beam-trawl survey (UK(E&W)-BTS-Q1) (1993–1998) (Table 6.8.7b and Figure 6.8.2c). From 2006 until 2010 the two UK beam-trawl surveys have been used as tuning indices in the Irish Sea sole assessments. Following the outcome of WKFLAT 2011, the March survey (UK(E&W)-BTS-Q1) was omitted from the following assessments. The lpue from the UK(E&W)-BTS-Q3 has fluctuated since the beginning of the time-series (1988) between 90 and 200 kg/100 Km fished. Since 2000 it has dropped gradually to the lowest value in 2012 (27 kg/100 Km fished). In the last three years it slightly increased to 59 kg/100 Km fished in 2015.

Detailed information on the survey protocols and area coverage can be found in the Stock Annex.

Commercial lpue

Commercial lpue and effort data were available for Belgian beam trawlers, UK (E&W) beam and otter trawlers and Irish otter and beam trawlers. It should be noted that the most recent lpue values of the UK (E&W) beam trawlers (2013–2015) and the UK (E&W) otter trawlers (2014 and 2015) are not available as the effort values for those years are missing.

Trends in lpue and effort are given in Table 6.8.7 and Figure 6.8.2–6.8.3.

Effort from both Belgian and UK commercial beam-trawl fleets increased from the early seventies until the beginning of the nineties. Since then UK beam-trawl effort has shown a continuing declining trend. In contrast, the Belgian beam-trawl effort has shown a fluctuating pattern. After the decline in the early nineties, it reached its highest level in 2002 and decreased again afterwards. For the period 2008–2012, it remained stable at a very low level, but in 2013 it continued to decrease, and in 2015 it dropped to the lowest level in the time–series. The effort of the Irish beam trawlers shows a slow decline since 2004 and reached the lowest level in the time-series in 2013. In 2008 all beam-trawl fleets showed a substantial reduction in effort compared to 2007. The effort from the UK otter trawlers remained stable until the beginning of the nineties. Since then the UK otter trawl effort has continuously declined and is at the lowest level in 2013. The Irish otter trawlers have shown a striking reduction in effort since 2000, followed by a slight increase in the period 2010–2012. In 2015 the Irish otter trawl effort fell back to the level observed in 2009. Nearly all effort time-series show a substantial decrease in the last three years.

Lpue for both UK and Belgian beam trawlers was at a high level in the late seventies and early eighties, but since early 2000s, lpue for these fleets has fluctuated at a lower level. Since 2007–2009 there has been a small increase in the UK beam-trawl lpue. However, in 2012 the lpue has dropped to a remarkable low level in the time-series (4.3 kg/hour fished). An update for 2013–2015 was not available.

The Belgian beam trawlers hold on to a higher lpue value (18–20 kg/hour fished) for the period 2008–2012. However, in 2013 the lpue decreased (12.7 kg/hour fished) and in 2014 and 2015 it remained at the lowest level in the time-series (8.9 kg/hour fished). Irish beam-trawl lpue shows a gradually diminishing trend over the whole time-series. After the slight increase in 2012 and 2013, it fell back to a record low level in 2015. In the most recent years, the lpue of Irish otter trawlers are fluctuating at a lower level.

History of the assessment

In 2010, the Irish Sea sole assessment was based on XSA with two survey tuning indices (UK(E&W)-BTS-Q3 and UK(E&W)-BTS-Q1 (Table 6.8.8). The UK(E&W)-BTS-Q1 indices only provide information for the years 1993 up to 1999 and therefore no longer contribute to the final survivor estimates. At WKFLAT 2011, the exclusion of the UK(E&W)-BTS-Q1 from the assessment was investigated and it was found that there was little effect on the catchability residuals and that the retrospective pattern was slightly improved. WKFLAT 2011 therefore decided to omit this survey from the assessment.

6.8.2 Stock assessment

Data screening

The age range for the analysis was 2–8+.

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 (4–7) did not show any patterns or large residuals. The results of exploratory XSA runs, which are not included in this report, are available on SharePoint.

The screening of the tuning indices (UK(E&W)-BTS-Q3) showed good cohort tracking and consistency between ages for year-class strength. The plots with log-standardised indices, which are not included in this report, are available on SharePoint.

Final update assessment

The model settings for the final assessment are summarized below:

Assmnt Year	:2010	:2011–2016
Assmnt Model	: XSA	:XSA
Fleets :		:
Bel Beam Trwl	: omitted	:omitted
UK Trawl	: omitted	:omitted
UK Sept BTS	:1988–2009 2–7	:1988–2015 2–7
UK Mar BTS	:1993–1999 2–7	:omitted
Time-Ser. Wts	: linear 20 yrs	:no taper weighting
Power Model	: none	:none
Q plateau	: 7	:4
Shk se	:1.5	:1.5
Shk age-yr	: 5 yrs 3 ages	: 5 yrs 3 ages
Pop Shk se	: 0.3	: 0.3
Prior Wting	: none	: none
Plusgroup	: 8	: 8
F_{bar}	: 4–7	: 4–7

The final XSA output is given in Table 6.8.9 (diagnostics), Table 6.8.10 (fishing mortalities) and Table 6.8.11 (stock numbers). Log catchability residuals for the final assessment are given in Figure 6.8.4. A summary of the XSA results is given in Table 6.8.12 and trends in yield, fishing mortality, recruitment and spawning stock biomass are shown in Figure 6.8.5. Retrospective patterns for the final run are shown in Figure 6.8.6.

Adding the 2015 data to the time-series did not cause any additional anomalies compared to last year. The log catchability residual pattern showed no trends and no year effects for the UK(E&W)-BTS-Q3 fleet.

The survivor estimates and fishing mortality estimates are almost entirely determined by the UK(E&W)-BTS-Q3 survey as it gets a high weighting (>96%) at all ages.

This assessment shows no retrospective bias and a high consistency. There is a tendency in the last years to slightly underestimate fishing mortality and slightly overestimate SSB.

Comparison with previous assessments

A comparison of the estimates of this year's assessment with last year's is given in Figure 6.8.7.

Trends in fishing mortality, SSB and recruitment are very similar. In last year's assessment, F and SSB for 2014 were estimated to be 0.106 and 942 t respectively; this year's estimates for 2014 are 0.121 and 886 t; an upward revision of 14% for F and a downward revision of 6% for SSB. The estimated recruitment by XSA in 2014 (634 thousand fish) was revised upward by 23% in this year's assessment (781 thousand fish).

State of the stock

Estimated trends of Irish Sea sole landings, SSB, fishing mortality and recruitment are presented in Table 6.8.12 and Figure 6.8.5. Since the late eighties the landings of Irish Sea sole have been declining to the lowest level of the time-series (76 t) in 2015. SSB has been at a higher level until the late eighties. Since then SSB has been fluctuating between B_{pa} and B_{lim} and since 2004 it dropped below B_{lim}. In 2014 SSB declined to the lowest estimate of the time-series (886 t), but in 2015 SSB increased (1337 t) to the level of 2008. High fishing mortalities were observed during the late eighties until the mid-nineties. Thereafter fishing mortality declined to a level fluctuating just above F_{lim}. From 2013 onwards, fishing mortality has dropped under the level of F_{pa} and F_{MSY} (0.172 in 2013, 0.121 in 2014 and 0.075 in 2015). The decline in F is supported by a substantial reduction of the TAC in the last two years. Since 2001 recruitment has been well below the mean (5698 thousand fish) and the 2011 recruitment (year class 2009) is estimated to be the lowest in the time-series (603 thousand fish). The 2015 recruitment (2149 thousand fish, year class 2013) is estimated to be 3.5 times higher than the record low recruitment in 2011.

6.8.3 Short-term projections

Estimating year-class abundance

The 2013 year class is now estimated at 2149 thousand fish at age 2, which is 50% higher than the short-term GM (2005–2013 (1437 thousand fish) used in last year's forecast. The current estimate of the 2013 year class is solely coming from the UK(E&W)-BTS-Q3. From 2010 to 2014, the UK(E&W)-BTS-Q3 abundance for age 2 fluctuated around the level of the lowest abundance in 2011 (0.28). In 2015 the UK(E&W)-BTS-Q3 abundance for age 2 increased to the higher level of 2009 (1.2).

Given the consecutive low recruitments in recent years, the WG decided to assume the short-term GM for the 2014 year class instead of the RCT3 value (5725 thousand fish) or the long-term GM (1970–2013, 4314 thousand fish). The short-term GM (2006–2014, 1205 thousand fish) recruitment was also assumed for the 2015 and subsequent year classes.

The working group estimates of year-class strength used for prediction can be summarised as follows:

Year Class	XSA	GM 70-13	GM 06-14	RCT3
2013 (age 3 in 2016)	1930	3957	-	-
2014 (age 2 in 2016)	-	4314	1205	5725
2015 & 2016 (recruits)	-	4314	1205	-

Fishing mortality was calculated as the mean of 2013–2015, scaled by the $F_{bar}(4–7)$ to the level of 2015. Catch and stock weights-at-age were also averages for the years 2013–2015. Population numbers at the start of 2016 for ages 3 and older, were taken from the XSA output.

In line with last year's decision, the working group agreed to use a TAC constraint (40 t) for the intermediate year (2016). At the end of 2015 additional quota regulations were imposed by the Flemish government for the Belgian sole fishery in the Irish Sea. After a national closure of the Irish Sea in January 2016, the fleet is allocated a bycatch quota for sole from February until the end of October 2016 of 500 kg in the Irish Sea. Because of the restricted fishing opportunities by the main countries fishing for Irish Sea sole, it seemed reasonable that the landings in 2016 would be in line with the agreed TAC of 40 t.

An EU action plan for the Irish Sea fisheries has been set up, composed of a pilot industry–science beam-trawl survey and a comparative fishing study funded with scientific quota (7 t).

The short-term catch predictions were calculated using a TAC constraint of 40 t and 47 t for the intermediate year. The input for the short-term catch predictions and sensitivity analysis is given in Table 6.8.15a (40 t TAC constraint) and Table 6.8.15b (47 t TAC constraint). The short-term management option table is given in Table 6.8.16a (40 t TAC constraint) and Table 6.8.16b (47 t TAC constraint), a detailed output is presented in Table 6.8.17a (40 t TAC constraint) and Table 6.8.17b (47 t TAC constraint). A short-term forecast plot is shown in Figure 6.8.8a.

Assuming a TAC constraint for 2016 of 40 t, implies a fishing mortality in 2016 of 0.03. The assumed landings using a *status quo* fishing mortality in 2017 is 118 t. This results in a SSB of 1662 t in 2017 and 1766 t in 2018. The proportional contributions of recent year classes to the predicted landings and SSB are given in Table 6.8.18a. Given the low stock size, predictions become more dependent on the assumed incoming recruitment. The assumed short-term GM recruitment accounts for about 12% of the landings in 2017 and about 24% of the 2018 SSB.

Assuming a TAC constraint for 2016 of 47 t, implies a fishing mortality in 2016 of 0.04. The assumed landings using a *status quo* fishing mortality in 2017 is 117 t. This results in a SSB of 1655 t in 2017 and 1760 t in 2018. The proportional contributions of recent year classes to the predicted landings and SSB are given in Table 6.8.18b. Given the low stock size, predictions become more dependent on the assumed incoming recruitment. The assumed short-term GM recruitment accounts for about 12% of the landings in 2017 and about 25% of the 2018 SSB.

6.8.4 MSY explorations

ICES carried out and evaluation of MSY and PA reference points for this stock last year at WKMSYREF4 (ICES, 2016a). The results have been published earlier this year (ICES, 2016b) are summarized below:

STOCK CODE	MSY F_{LOWER}	F_{MSY}	MSY F_{UPPER} WITH AR	MSY F_{UPPER} WITH NO AR
Sol-iris	0.16	0.20	0.24	0.22

6.8.5 Biological reference points

Precautionary approach reference points

Previous and current biological reference points are given in the text table below:

REFERENCE POINTS	ACFM 2007 ONWARDS	2016 ONWARDS
F_{MSY}	0.16 (PLOTMSY, WG2010)	0.20 (Eqsim, WKMSYREF 4)
F_{lim}	0.4 (based on F_{loss})	0.29 (based on simulated recruitment to give median biomass = B_{lim})
F_{pa}	0.3 (high probability of avoiding F_{lim})	0.21 (F_{lim}*1.4)
B_{lim}	2200 t (B_{loss} estimated in 2007)	2500 t (lowest value with above average recruitment)
B_{pa}	3100 t (B_{pa}~B_{lim}*1.4)	3500 t (B_{lim} *1.4)
$B_{trigger}$	B_{pa}	3500 t

Yield per Recruit analysis

Yield-per-recruit results, long-term yield and SSB, conditional on the present exploitation pattern and assuming a *status quo* F in 2016, are given in Table 6.8.19 and Figure 6.8.8. Current fishing mortality (0.075) is well below F_{MSY} (0.20). F_{MAX} is estimated to be 0.51, but was considered to be not well defined given the flat yield per recruit curve.

6.8.6 Management plans

No management plan is currently in place for Irish Sea sole.

6.8.7 Uncertainties and bias in assessment and forecast

Sampling

The deteriorating quality of the historic catch numbers-at-age data was considered to be a consequence of the low biological sampling intensity, and in particular the limited sampling in the first quarter. Therefore the combined age distribution was introduced in 2000 as an alternative method for raising the international catch numbers-at-age. The mean catch weights from this combined key were taken and the stock weights-at-age were obtained using a cohort interpolation method from the catch weights-at-age.

Sampling is now considered to be at a reasonable level. Under the DCF there is an initiative to coordinate sampling across the three countries involved in the fishery.

Landings

There is no reliable information on the accuracy of the landing statistics. For the period 2005–2012, the total TAC uptake was only in the range of 50–98%. In this context, misreporting was not considered to be a major problem. However, in the most recent years, the TAC was substantially reduced and has become restrictive. In 2015, 84% of the TAC has been taken.

Discards

The absence of discard data is unlikely to affect the quality of the assessment as information from recent years indicates that the average discarding by weight is 8% of the catch.

Effort

There are no indications of Irish Sea sole fisheries misreporting effort. Effort in beam-trawl fisheries that target sole has declined substantially in the last few years in accordance with the significant reductions in TAC.

Surveys

The UK(E&W)-BTS-Q3 survey appears to track year-class strength well. As previously investigated, this tuning fleet is also consistent in estimating year-class strength of the same year class at different ages. Therefore the Working Group had confidence in using the UK(E&W)-BTS-Q3 survey as the only tuning fleet. The bias problem in the assessment maybe the result of the precise survey and less precise catch-at-age data.

Model formulation

At present XSA is used to assess Irish Sea sole setting have not changed since WKFLAT 2011. Model diagnostics a generally very good. However, the proportion of biomass in the plus group has increased significantly in the last few years. This is something that WGCSE will monitor since it has the potential to cause problems in the future.

6.8.8 Recommendations for next Benchmark

The assessment diagnostics indicate a good correlation between the catch data and the survey tuning series. Therefore, at present there are no recommendations for a single-stock Benchmark. However, in the recent years there has been great uncertainty from the fishing industry on the actual status of the sole stock in the Irish Sea. Fishermen are concerned that due to ecosystem changes and the changing fishing behaviour in the Irish Sea, science is no longer capturing the current situation. Because of this mismatch an EU action plan for the Irish Sea fisheries has been set up. First, a comparative fishing study is suggested to compare the catch efficiency between the UK-BTS-Q3 and a Belgian commercial vessel. Secondly, a pilot industry–science beam-trawl survey should reveal the spatial distribution of sole. The outcome of those work packages will indicate whether the data gathered by the UK-BTS-Q3 is still representative for the current situation or whether the implementation of an additional (annual) industry–science industry survey is needed. Thirdly, stock identification techniques (i.e. genetic and micro-chemical fingerprinting) will be performed to give insight on the origin and potential migration routes of sole that is caught in the Irish Sea. The WG agrees that it is reasonable to wait for the outcome of this action plan before proposing potential Benchmark recommendations.

Next year, an ecosystem benchmark for the Irish Sea (WKIrish) is planned that aims to integrate ecosystem information into the assessment.

6.8.9 Management considerations

There is a stock–recruitment relationship for this stock and evidence of reduced recruitment at low levels of SSB. However, the recruitment for higher levels of SSB is less well defined (Figure 6.8.9).

Recruitment-at-age 2 has been well below average since 2001. SSB is below B_{lim} since 2004. XSA indicates that fishing mortality has reduced to a very low level over the last couple of years (as did effort for most fleets fishing for Irish Sea sole), and is now well below F_{MSY}.

It is not possible for the stock to reach B_{pa} in one year. A management plan for effort reduction that can be phased in over a number of years and implemented in conjunction with technical conservation measures should be considered.

Sole is caught in a mixed fishery with other flatfish as well as gadoids. Information from observer trips indicates that discarding of sole is relatively low.

6.8.10 Ecosystem considerations

Sole and plaice are primarily targeted by beam-trawl fisheries. Beam trawling, is known to have an impact on the benthic communities, although less so on soft substrata and in areas which have been historically exploited by this fishing method. Some beam trawlers are using benthic drop-out panels that release about 75% of benthic invertebrates from the catches. Full square mesh codends are being tested in order to reduce the capture of benthos further and improve the selection profile of gadoids (Connolly, P.L. *et al*., 2009).

A complete ecosystem overview can be found in the stock annex Section A.3.

6.8.11 References

Connolly, P.L., Kelly, E., Dransfeld, L., Slattery, N., Paramor, O.A.L., and Frid, C.L.J. 2009. MEFEPO North Western Waters Atlas. Marine Institute.

ICES. 2016a. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 183 pp.

ICES. 2016b. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10, ICES special request advice. 5 February 2016 Version 2; 13 May 2016.

Table 6.8.1. Sole in 7.a. Nominal landings (tonnes) as officially reported by ICES, and working group estimates of the landings. Last year's landings are preliminary.

Year	Belgium	France	Ireland	Netherlands	UK (E+W)	UK (Isle of Man)	UK (N. Ireland)1	UK (Scotland)	Officially reported	Unallocated	Total used by WG	TAC
1973	793	12	27	281	258	-	46	11	1428	0	1428	
1974	664	54	28	320	218	-	23	-	1307	0	1307	
1975	805	59	24	234	281	-	24	15	1442	-1	1441	
1976	674	72	74	381	195	-	49	18	1463	0	1463	
1977	566	39	84	227	160	-	49	21	1146	1	1147	
1978	453	65	127	177	189	-	57	30	1098	8	1106	
1979	779	48	134	247	290	-	47	42	1587	27	1614	
1980	1002	41	229	169	367	-	44	68	1920	21	1941	
1981	884	13	167	186	311	-	41	45	1647	20	1667	
1982	669	9	161	138	277	-	31	44	1329	9	1338	
1983	544	3	203	224	219	-	33	29	1255	-86	1169	
1984	425	10	187	113	230	-	38	17	1020	38	1058	
1985	589	9	180	546	269	-	36	28	1657	-511	1146	
1986	930	17	235	-	637	1	50	46	1916	79	1995	
1987	987	5	312	-	599	3	72	63	2041	767	2808	2100
1988	915	11	366	-	507	1	47	38	1885	114	1999	1750
1989	1010	5	155	-	613	2	.	38	1823	10	1833	1480
1990	786	2	170	-	569	10	.	39	1576	7	1583	1500
1991	371	3	198	-	581	44	.	26	1223	-11	1212	1500
1992	531	11	164	-	477	14	.	37	1234	25	1259	1350
1993	495	8	98	-	338	4	.	28	971	52	1023	1000
1994	706	7	226	-	409	5	.	14	1367	7	1374	1500
1995	675	5	176	-	424	12	.	8	1300	-34	1266	1300
1996	533	5	133	149	194	4	.	5	1023	-21	1002	1000
1997	570	3	130	123	189	5	.	7	1027	-24	1003	1000
1998	525	3	134	60	161	3	.	9	895	16	911	900
1999	469	<1	120	46	165	1	.	8	810	53	863	900
2000	493	3	135	60	133	1	.	8	833	-15	818	1080
2001	674	4	135	-	195	+	.	4	1012	41	1053	1100
2002	817	4	96	-	165	+	.	3	1085	5	1090	1100
2003	687	4	103	-	217	+	.	3	1014	0	1014	1010
2004	527	1	77	-	106	+	.	1	712	-3	709	800
2005	662	3	85	-	103	+	.	1	854	1	855	960
2006	419	1	85	-	69	+	.	2	576	-7	569	960
2007	305	1	115	-	66	<1	.	4	491	1	492	820
2008	216	1	66	-	37	n/a	.	n/a	320	12	332	669
2009	257	n/a	47	-	19	1	.	1	325	0	325	502

Year	Belgium	France	Ireland	Netherlands	UK (E+W)	UK (Isle of Man)	UK (N. Ireland)1	UK (Scotland)	Officially reported	Unallocated	Total used by WG	TAC
2010	217	<1	47	-	12	<1	.	n/a	277	0	277	402
2011	250	<1	48	-	31	<1	.	n/a	330	0	330	390
2012	222	<1	51	-	23	<1	-	n/a	296	0	298	300
2013	96	<1	40	-	12	<1	-	n/a	148	0	148	140
2014	43	n/a	43	-	10	<1	-	n/a	96	0	99	95
2015	37	n/a	32	-	7	n/a	-	n/a	76	0	76	90

[1] 1989 onwards: N. Ireland included with England & Wales.

Table 6.8.2. Sole in 7.a. Catch numbers-at-age (in thousands).

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978
2	29	113	31	368	25	262	29	221	65
3	895	434	673	363	891	733	375	416	958
4	1009	2097	730	2195	576	2386	1332	1292	649
5	467	1130	1537	557	1713	539	2330	774	1009
6	1457	232	537	815	383	842	247	1066	442
7	289	878	172	267	422	157	544	150	638
+gp	2537	1887	1500	1143	971	1006	739	648	587
TOTALNUM	6683	6771	5180	5708	4981	5925	5596	4567	4348
TONSLAND	1785	1882	1450	1428	1307	1441	1463	1147	1106
SOPCOF %	100	100	100	100	100	100	100	100	100
Age/Year	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**
2	108	187	70	8	37	651	154	141	189
3	1027	939	580	346	165	786	1601	3336	3348
4	3433	1968	1668	1241	998	380	1086	3467	4105
5	829	3055	1480	1298	758	610	343	961	3185
6	637	521	1640	711	757	343	334	235	844
7	326	512	114	641	416	424	164	277	307
+gp	620	1145	865	397	709	557	739	848	808
TOTALNUM	6980	8327	6417	4642	3840	3751	4421	9265	12786
TONSLAND	1614	1941	1667	1338	1169	1058	1146	1995	2808
SOPCOF %	100	100	100	100	100	100	100	100	100
Age/Year	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
2	32	179	564	1317	363	83	122	132	60
3	444	771	1185	1270	2433	543	1342	920	469
4	4752	775	986	841	918	1966	1069	1444	1188
5	2102	3978	598	300	556	559	1578	737	741
6	1310	1178	2319	226	190	251	394	1010	430
7	203	552	592	1173	156	199	133	179	509
+gp	516	255	466	459	929	686	524	350	347
TOTALNUM	9359	7688	6710	5586	5545	4287	5162	4772	3744
TONSLAND	1999	1833	1583	1212	1259	1023	1374	1266	1002
SOPCOF %	100	100	100	100	100	100	100	100	100
Age/Year	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
2	789	167	301	178	240	148	436	295	536
3	713	1728	1069	908	1438	927	824	850	1052
4	474	466	1258	909	822	1618	965	337	626
5	710	256	297	601	717	738	794	363	271
6	408	315	115	150	511	573	302	300	314
7	258	191	136	55	80	253	217	137	279
+gp	531	423	232	258	272	216	344	178	368
TOTALNUM	3883	3546	3408	3059	4080	4473	3882	2460	3446
TONSLAND	1003	911	863	818	1053	1090	1014	709	855
SOPCOF %	100	100	100	100	100	100	100	101	100
Age/Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
2	111	171	99	92	22	17	17	23	12
3	666	356	354	414	336	225	148	99	49
4	645	348	191	333	233	401	311	75	59
5	202	243	196	146	177	176	274	106	37
6	112	86	157	132	65	97	116	78	38
7	150	41	56	127	72	54	52	34	51
+gp	377	298	210	162	158	122	115	82	56
TOTALNUM	2263	1543	1263	1406	1063	1092	1033	497	302
TONSLAND	569	492	332	325	277	330	298	148	99
SOPCOF %	101	100	100	100	100	100	100	100	100
Age/Year	**2015**								
2	15								
3	36								
4	37								
5	30								
6	17								
7	21								
+gp	74								
TOTALNUM	230								
TONSLAND	76								
SOPCOF %	101								

Table 6.8.3. Sole in 7.a. Annual length distributions by country (2015).

Length (cm)	UK (England & Wales) All gears	Belgium All gears	Ireland All gears
21		7	
22		62	23
23	19	984	47
24	95	9574	164
25	874	15866	1134
26	1103	15609	1228
27	1673	16506	703
28	1008	12317	3543
29	1084	9240	3155
30	1141	10467	5065
31	950	7842	6894
32	798	7563	9850
33	855	6142	7257
34	646	4340	9840
35	608	4291	3429
36	551	2629	2596
37	494	2527	4555
38	114	1791	5164
39	342	1328	4417
40	95	1051	463
41	171	738	2287
42	133	432	445
43	19	346	123
44	19	185	1050
45	19	105	25
46		59	170
47		32	25
48		16	25
49		20	0
50		0	25
51		8	0
52			0
53			23
Total	12811	132070	73725

Table 6.8.4. Sole in 7.a. Catch weights-at-age (kg).

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978
2	0.13	0.152	0.126	0.151	0.138	0.13	0.12	0.085	0.093
3	0.153	0.178	0.164	0.178	0.174	0.172	0.161	0.146	0.147
4	0.178	0.204	0.201	0.204	0.209	0.21	0.2	0.202	0.197
5	0.204	0.23	0.237	0.23	0.241	0.244	0.239	0.251	0.243
6	0.232	0.257	0.272	0.256	0.272	0.275	0.276	0.293	0.286
7	0.26	0.284	0.306	0.283	0.301	0.303	0.313	0.33	0.326
+gp	0.3769	0.4194	0.4169	0.3918	0.3956	0.3671	0.4574	0.387	0.4294
SOPCOF %	1	0.9997	1.0004	0.9999	1	0.9999	0.9996	0.9996	0.9997

Age/Year	1979	1980	1981	1982	1983	1984	1985	1986	1987
2	0.134	0.146	0.162	0.112	0.189	0.191	0.144	0.122	0.135
3	0.165	0.169	0.183	0.171	0.212	0.225	0.189	0.164	0.164
4	0.199	0.193	0.207	0.225	0.238	0.257	0.231	0.203	0.196
5	0.234	0.219	0.234	0.275	0.266	0.288	0.272	0.241	0.231
6	0.271	0.247	0.264	0.321	0.298	0.318	0.31	0.277	0.268
7	0.311	0.275	0.296	0.362	0.332	0.347	0.346	0.311	0.308
+gp	0.4507	0.3801	0.452	0.4564	0.4577	0.4085	0.4296	0.4071	0.4615
SOPCOF %	0.9997	1.0007	1.0002	1.0002	0.9997	0.9998	0.9994	0.9994	0.9998

Age/Year	1988	1989	1990	1991	1992	1993	1994	1995	1996
2	0.111	0.125	0.135	0.133	0.149	0.102	0.175	0.129	0.156
3	0.147	0.163	0.162	0.172	0.177	0.156	0.198	0.182	0.193
4	0.183	0.201	0.192	0.208	0.207	0.205	0.227	0.232	0.228
5	0.218	0.237	0.227	0.241	0.239	0.248	0.261	0.277	0.263
6	0.252	0.271	0.265	0.272	0.274	0.285	0.301	0.318	0.296
7	0.286	0.304	0.307	0.3	0.31	0.318	0.346	0.356	0.327
+gp	0.4188	0.3887	0.414	0.3452	0.3788	0.3701	0.5093	0.4507	0.4104
SOPCOF %	0.999	1.0001	1.0004	0.9995	0.9992	0.9994	1.0007	0.9998	1.0003

Age/Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	0.154	0.187	0.179	0.14	0.175	0.162	0.16	0.17	0.16
3	0.197	0.209	0.217	0.189	0.18	0.172	0.187	0.219	0.203
4	0.237	0.234	0.252	0.25	0.271	0.211	0.247	0.289	0.256
5	0.275	0.263	0.285	0.311	0.293	0.283	0.294	0.338	0.286
6	0.311	0.295	0.314	0.368	0.326	0.328	0.342	0.371	0.312
7	0.345	0.331	0.341	0.428	0.42	0.333	0.326	0.383	0.326
+gp	0.4068	0.4399	0.3992	0.5042	0.438	0.3746	0.415	0.4436	0.3515
SOPCOF %	1.0015	1	1.0005	0.9981	1	1.003	1.0015	1.0141	0.9996

Age/Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
2	0.179	0.172	0.148	0.141	0.166	0.215	0.187	0.17	0.17
3	0.194	0.224	0.189	0.195	0.193	0.213	0.22	0.213	0.196
4	0.224	0.296	0.248	0.229	0.266	0.276	0.26	0.278	0.269
5	0.297	0.36	0.279	0.279	0.285	0.362	0.311	0.32	0.328
6	0.293	0.38	0.291	0.277	0.321	0.413	0.331	0.347	0.369
7	0.318	0.429	0.386	0.261	0.308	0.368	0.368	0.353	0.397
+gp	0.3494	0.4785	0.3919	0.2767	0.3353	0.3635	0.3346	0.3544	0.4413
SOPCOF %	1.0057	0.9989	0.9963	0.9993	1.0002	0.9992	1.0006	1.0007	1.0037

Age/Year	2015
2	0.18
3	0.221
4	0.309
5	0.342
6	0.381
7	0.4
+gp	0.3835
SOPCOF %	1.0052

Table 6.8.5. Sole in 7.a. Stock weights-at-age (kg).

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978
2	0.13	0.152	0.126	0.151	0.138	0.13	0.12	0.085	0.093
3	0.153	0.178	0.164	0.178	0.174	0.172	0.161	0.146	0.147
4	0.178	0.204	0.201	0.204	0.209	0.21	0.2	0.202	0.197
5	0.204	0.23	0.237	0.23	0.241	0.244	0.239	0.251	0.243
6	0.232	0.257	0.272	0.256	0.272	0.275	0.276	0.293	0.286
7	0.26	0.284	0.306	0.283	0.301	0.303	0.313	0.33	0.326
+gp	0.377	0.419	0.417	0.392	0.396	0.367	0.457	0.387	0.429

Age/Year	1979	1980	1981	1982	1983	1984	1985	1986	1987
2	0.134	0.146	0.162	0.112	0.189	0.191	0.144	0.122	0.135
3	0.165	0.169	0.183	0.171	0.212	0.225	0.189	0.164	0.164
4	0.199	0.193	0.207	0.225	0.238	0.257	0.231	0.203	0.196
5	0.234	0.219	0.234	0.275	0.266	0.288	0.272	0.241	0.231
6	0.271	0.247	0.264	0.321	0.298	0.318	0.31	0.277	0.268
7	0.311	0.275	0.296	0.362	0.332	0.347	0.346	0.311	0.308
+gp	0.451	0.380	0.452	0.456	0.458	0.409	0.430	0.407	0.462

Age/Year	1988	1989	1990	1991	1992	1993	1994	1995	1996
2	0.111	0.125	0.135	0.133	0.149	0.102	0.175	0.129	0.156
3	0.147	0.163	0.162	0.172	0.177	0.156	0.198	0.182	0.193
4	0.183	0.201	0.192	0.208	0.207	0.205	0.227	0.232	0.228
5	0.218	0.237	0.227	0.241	0.239	0.248	0.261	0.277	0.263
6	0.252	0.271	0.265	0.272	0.274	0.285	0.301	0.318	0.296
7	0.286	0.304	0.307	0.3	0.31	0.318	0.346	0.356	0.327
+gp	0.419	0.389	0.414	0.345	0.379	0.370	0.509	0.451	0.410

Age/Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	0.154	0.187	0.179	0.124	0.151	0.145	0.144	0.15	0.144
3	0.197	0.209	0.217	0.158	0.159	0.174	0.174	0.187	0.186
4	0.237	0.234	0.252	0.23	0.226	0.195	0.207	0.232	0.237
5	0.275	0.263	0.285	0.303	0.271	0.277	0.249	0.289	0.288
6	0.311	0.295	0.314	0.345	0.318	0.31	0.311	0.331	0.325
7	0.345	0.331	0.341	0.41	0.393	0.33	0.327	0.362	0.348
+gp	0.407	0.440	0.399	0.530	0.450	0.397	0.383	0.419	0.383

Age/Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
2	0.152	0.156	0.134	0.129	0.158	0.167	0.156	0.149	0.111
3	0.177	0.2	0.181	0.17	0.165	0.188	0.218	0.2	0.183
4	0.213	0.24	0.236	0.208	0.228	0.231	0.235	0.248	0.24
5	0.276	0.284	0.288	0.263	0.256	0.31	0.293	0.288	0.302
6	0.289	0.336	0.324	0.278	0.3	0.343	0.346	0.329	0.343
7	0.315	0.354	0.383	0.276	0.292	0.344	0.39	0.342	0.371
+gp	0.348	0.419	0.424	0.319	0.305	0.340	0.345	0.358	0.399

Age/Year	2015
2	0.153
3	0.194
4	0.246
5	0.303
6	0.353
7	0.384
+gp	0.3974

Table 6.8.6a. Sole in 7.a. Discard rates for the main fleets operational in the Irish Sea (Belgian, UK and Irish beam trawl, UK and Irish otter trawl, UK and Irish *Nephrops* trawl).

	BEL	UK						IRL		
Gear	TBB	TBB	OTB	TWIN OTB	NEPH OTB	TWIN NEPH	Other	TBB	NEPH OTB	OTB DEF
Landings (t)	716	284	61	4	25	6	Na	427	/	/
Discard ratio	0.05	0.08	0.05	0.01	0.08	0.02	Na	0.02	/	/
years	2007–2009	2002, 2005–2007	2002–2009	2003,2004,2007	2003, 2006–2009	2002,2003,2008	Na	2003–2009	/	/
Landings (t) 2010	210.917	1.721	1.071	0.014	3.329	0.501	0.741	38.283	5.327	3.632
Discard ratio 2010	0.04	Na	0.00	Na	0.05	Na	Na	0.05	0.16*	0.39*
Landings (t) 2011	239.483	13.662	2.866	0.05	5.201	0.414	0.821	32.514	10.116	5.581
Discard ratio 2011	0.04	Na	0.02	Na	0.00	Na	Na	0.003	0.16*	0.00

*** It should be noted that the 16% discard rate for 2010-2011 of the Irish *Nephrops* fleet and the 39% discard rate for 2010 of the Irish otter trawl fleet only accounts for respectively 1.9%, 3.1% and 1.3% of the total international landings.**

Table 6.8.6b. Sole 7.a. Discard rates.

Country	Year	Landings (L) (t)			Discards (D) (t)
BE		TBB	OTB	other	
	2012	213.392	8.301	0	16.222
	2013	93.009	3.028	0	8.538
	2014	36.144	7.288	0	2.286
	2015	32.2	3.995	0	2.343
UK	2012	7.278	5.459	1.229	0
	2013	0.168	5.108	1.258	0
	2014	0.149	3.579	1.582	1.195
	2015	0.164	3.505	0.491	0
IR	2012	38.79	8.162	3.824	1
	2013	30.934	9.23	0.009	0
	2014	37.007	6.016	0.1613	0.4
	2015	24.306	7.19	0.031	1.394

	total L	L corresponding with discard info	% coverage of L	total D	rate
2012	286.44	227.01	0.79	17.22	0.071
2013	142.74	107.35	0.75	8.54	0.074
2014	91.93	45.74	0.50	3.88	0.078
2015	71.88	42.89	0.60	3.74	0.080
average			0.62	5.39	0.08

Table 6.8.7a. Sole in 7.a. Effort series.

	Belgium	UK(E+W)		Ireland	
	beam[1]	beam[2]	otter[2]	otter[3]	beam[3]
Year	Whole year	Whole year	Whole year	Whole year	Whole year
1972	-	-	128.4	-	-
1973	-	-	147.6	-	-
1974	-	-	115.2	-	-
1975	28.4	-	115.2	-	-
1976	24.9	-	122.3	-	-
1977	22.1	-	101.9	-	-
1978	17.5	0.9	89.1	-	-
1979	20.4	1.7	89.9	-	-
1980	32.0	4.3	107.0	-	-
1981	36.5	6.4	107.1	-	-
1982	26.5	5.5	127.2	-	-
1983	28.7	2.8	88.1	-	-
1984	17.5	4.1	103.1	-	-
1985	27.0	7.4	102.9	-	-
1986	44.5	17.0	90.3	-	-
1987	51.6	22.0	130.6	-	-
1988	38.2	18.6	132.0	-	-
1989	42.2	25.3	139.5	-	-
1990	42.4	31.0	117.1	-	-
1991	17.1	25.8	107.3	-	-
1992	25.1	23.4	96.8	-	-
1993	23.9	21.5	78.9	-	-
1994	32.5	20.1	43.0	-	-
1995	28.6	20.9	43.1	80.3	8.6
1996	23.2	13.3	42.2	64.8	6.3
1997	30.7	10.8	39.9	92.2	9.9
1998	24.7	10.4	36.9	93.5	11.6
1999	22.7	11.0	22.9	110.3	14.7
2000	26.0	6.3	27.0	82.7	11.4
2001	36.8	12.5	32.8	77.5	13.1
2002	47.0	8.0	24.8	77.9	17.7
2003	43.6	14.0	23.9	73.9	18.7
2004	32.0	7.4	23.5	72.5	14.2
2005	37.5	11.4	16.7	68.3	14.7
2006	24.6	4.6	5.2	66.2	12.2
2007	19.4	3.2	4.4	74.1	14.2
2008	9.6	1.3	2.7	58.8	9.5
2009	11.1	0.5	1.5	42.8	7.6
2010	11.1	0.2	1.4	45.8	9.4
2011	12.5	1.6	0.7	54.5	8.1
2012	10.9	0.9	0.4	58.3	7.2
2013	7.0	0.0	0.3	42.6	5.0
2014	3.9	-	-	47.7	6.0
2015*	3.5	-	-	41.0	8.3

[1]000'hours fishing
[2]000'hours fished (GRT corrected > 40' vessels)
[3]000'hours

*** Provisional.**

Table 6.8.7b. Sole in 7.a. Lpue series.

Year	Belgium	UK(E+W)		UK		Ireland	
	beam[1]	beam[2]	otter[2]	beam survey[3]		otter[4]	beam[4]
	Whole year	Whole year	Whole year	Sept	March	Whole year	Whole year
1972	-	-	1.1	-	-	-	-
1973	-	-	1.1	-	-	-	-
1974	-	-	1.1	-	-	-	-
1975	21.4	-	1.4	-	-	-	-
1976	23.1	-	0.9	-	-	-	-
1977	19.8	-	0.8	-	-	-	-
1978	18.1	34.3	1.0	-	-	-	-
1979	33.4	32.0	1.4	-	-	-	-
1980	28.2	31.7	1.0	-	-	-	-
1981	22.2	21.3	0.8	-	-	-	-
1982	22.0	29.9	0.5	-	-	-	-
1983	13.9	37.3	0.6	-	-	-	-
1984	22.5	16.2	0.7	-	-	-	-
1985	20.6	17.3	0.6	-	-	-	-
1986	19.1	19.2	0.8	-	-	-	-
1987	17.7	14.8	0.8	-	-	-	-
1988	21.3	11.8	0.5	158.7	-	-	-
1989	21.9	9.2	0.7	145.9	-	-	-
1990	17.5	9.5	0.6	190.1	-	-	-
1991	18.7	10.4	1.1	170.5	-	-	-
1992	19.2	9.5	1.0	158.3	-	-	-
1993	20.0	7.6	0.5	97.3	104.7	-	-
1994	19.1	11.8	0.7	107.7	91.9		-
1995	18.1	15.0	1.0	89.5	79.3	0.4	12.7
1996	17.7	9.4	0.5	86.8	-	0.3	14.9
1997	16.6	10.5	0.7	151.2	63.3	0.2	8.5
1998	19.0	8.4	0.5	140.8	89.3	0.4	7.8
1999	19.5	9.9	0.6	107.3	-	0.3	9.2
2000	15.5	12.9	0.4	122.6	-	0.3	8.5
2001	15.0	11.7	0.2	96.9	-	0.4	7.9
2002	15.0	16.7	1.5	76.0	-	0.3	4.7
2003	14.8	13.2	0.2	88.6	-	0.3	4.2
2004	15.4	13.9	0.2	98.9	-	0.1	4.3
2005	16.7	9.1	0.2	48.9	-	0.2	4.7
2006	15.2	7.8	0.5	52.6	-	0.2	6.0
2007	13.7	16.4	0.4	53.0	-	0.4	6.4
2008	19.5	15.3	0.3	50.7	-	0.2	6.1
2009	20.2	18.9	0.2	45.8	-	0.3	4.5
2010	18.0	13.9	0.4	27.8	-	0.2	4.1
2011	17.6	4.5	0.2	37.0	-	0.3	4.1
2012	18.9	4.3	0.1	26.5	-	0.1	5.4
2013	12.7	-	0.1	31.7	-	0.2	6.3
2014	8.9	-	-	41.1	-	0.1	5.4
2015*	8.9	-	-	58.9	-	0.2	3.1

[1]Kg/000'hr

[2]Kg/000'hr fished (GRT corrected > 40' vessels)

[3]Kg/100km fished

[4]Kg/hr

* Provisional

Table 6.8.8. Sole in 7.a. Tuning series (values in bold are used in the assessment).

BE-CBT		Belgium Commercial Beam trawl (Effort = Corrected formula)										
	1975	2005										
	1	1	0	1								
	4	14										
12.3		1045	275	393	69	105	94	61	72	11	15	64
11.8		568	1066	80	263	64	58	35	5	56	5	5
10.7		434	307	509	76	93	45	23	20	2	35	32
9.9		169	304	155	258	41	90	12	29	12	7	17
11.2		1455	510	323	193	162	37	36	9	41	0	0
16.7		958	1644	296	268	247	210	30	64	31	14	7
22.6		909	721	998	62	92	44	161	13	92	10	8
19.5		451	608	378	394	52	64	11	29	24	5	0
20.5		259	310	394	238	216	44	38	28	49	3	26
12		107	204	143	188	91	121	2	1	4	14	0
19.6		606	171	186	99	150	125	83	27	13	4	23
38		1531	468	138	135	90	104	69	69	20	8	21
43.2		1527	881	297	167	69	39	54	59	40	13	9
30.5		2027	1012	480	21	33	37	34	42	35	0	7
34		376	2423	751	250	59	15	9	2	14	0	1
36.1		307	223	1263	276	142	13	9	11	11	8	5
13.8		253	78	60	588	115	40	16	1	1	11	3
23.9		298	330	68	40	203	93	36	12	0	0	0
24.5		862	253	149	89	79	160	66	77	0	0	0
31		680	786	164	103	39	117	58	19	15	0	7
26.2		729	366	410	52	27	6	28	15	6	11	3
21.6		537	334	241	219	53	13	11	14	9	7	2
28.5		270	376	180	162	134	28	27	15	9	8	1
23.3		248	146	142	89	73	62	20	20	9	10	3
21.7		693	199	65	50	37	21	17	9	6	4	6
18.6		685	220	107	31	15	33	13	7	9	0.6	8
30.5		600	284	248	39	35	44	33	1	3	0.2	4
38.6		1138	814	349	109	30	9	2	1	1	1	0
24.45		724	436	196	84	20	7	2	1	0	2	1
25.58		313	197	159	47	12	11	6	3	0	0	0
32.15		505	342	156	71	87	9	7	1	13	2	1
UK(E&W)-BTS-Q3			September beam trawl survey									
	1988	2015										
	1	1	0.75	0.85								
	1	9										
100.062		118	**196**	**180**	**410**	**76**	**40**	**4**	0	4		
129.71		218	**304**	**180**	**74**	**284**	**56**	**32**	8	6		
128.969		1712	**534**	**122**	**42**	**88**	**194**	**40**	20	6		
123.78		148	**1286**	**122**	**26**	**16**	**14**	**55**	19	7		
129.525		220	**309**	**657**	**142**	**34**	**22**	**7**	75	17		
131.192		83	**330**	**143**	**211**	**40**	**17**	**7**	16	36		
124.892		60	**408**	**203**	**73**	**132**	**49**	**11**	13	6		
126.004		246	**154**	**253**	**110**	**30**	**67**	**12**	5	5		
126.004		886	**126**	**32**	**76**	**46**	**23**	**31**	8	2		
126.004		1158	**577**	**72**	**24**	**55**	**27**	**16**	30	7		
126.004		539	**716**	**292**	**18**	**6**	**24**	**23**	5	18		
126.004		385	**293**	**255**	**203**	**29**	**8**	**26**	5	6		
126.004		354	**464**	**147**	**219**	**91**	**13**	**2**	13	6		
126.004		91	**284**	**192**	**65**	**96**	**63**	**6**	3	12		
126.004		205	**61**	**121**	**126**	**42**	**79**	**49**	2	1		
126.004		242	**210**	**51**	**97**	**81**	**40**	**43**	26	1		
126.004		406	**240**	**119**	**27**	**77**	**45**	**41**	17	19		
122.298		53	**165**	**69**	**25**	**13**	**35**	**25**	4	6		
126.004		107	**110**	**90**	**45**	**36**	**9**	**16**	15	10		
126.004		125	**93**	**49**	**57**	**41**	**11**	**4**	6	12		
122.298		126	**126**	**60**	**21**	**43**	**23**	**6**	2	9		
126.004		60	**150**	**68**	**40**	**19**	**30**	**12**	7	1		
126.004		26	**60**	**74**	**37**	**17**	**5**	**9**	9	3		
122.298		88	**35**	**62**	**68**	**35**	**12**	**4**	13	6		
122.298		22	**49**	**16**	**46**	**25**	**12**	**11**	2	6		
126.004		75	**57**	**36**	**21**	**33**	**18**	**21**	9	1		
126.004		172	**43**	**22**	**35**	**14**	**26**	**21**	14	6		
126.004		421	**150**	**41**	**20**	**23**	**5**	**15**	29	8		

Table 6.8.8 - Sole in 7.a - Continued (values in bold are used in the assessment)

UK(E&W)-BTS-Q1 March beam trawl survey

	1993	1999								
	1	1	0.15	0.25						
	1	9								
126.931		18	337	147	332	73	15	17	10	41
115.442		8	354	208	69	151	51	14	11	9
126.189		24	96	186	140	30	104	27	10	8
134.343		651	114	49	110	78	32	54	10	12
121.742		130	417	33	17	69	23	11	46	17
130.081		47	421	330	39	19	48	27	12	37
130.822		45	227	284	177	14	4	34	12	7

UK(E&W)-CBT UK Commercial Beam trawl

	1991	2013												
	1	1	0	1										
	2	14												
25.838		267	426	212	84	58	218	53	34	4	1	2	1	0
23.399		36	460	176	68	37	32	121	34	38	3	1	0	0
21.503		11	74	355	98	36	48	25	34	13	22	5	2	4
20.145		24	228	150	234	87	17	25	19	42	10	17	1	0
20.392		47	239	231	130	199	55	11	22	5	34	10	11	3
13.32		0	13	109	98	49	100	37	9	8	6	14	8	3
10.76		0	111	50	81	58	24	46	34	12	12	0	8	1
10.386		43	219	40	28	49	31	12	22	11	9	2	1	0
11.016		53	115	134	12	15	25	10	9	14	9	0	1	2
6.275		16	90	84	82	9	6	10	5	5	7	2	1	1
12.495		33	184	100	145	107	12	4	17	12	10	6	4	2
8.017		4	63	152	50	79	47	5	4	6	3	1	1	1
13.996		28	63	178	149	78	52	72	7	5	8	3	7	14
7.396		54	61	29	43	25	12	10	5	1	1	4	0	1
11.406		10	81	44	16	45	37	17	10	17	3	0	3	3
4.649		7	28	33	11	5	10	12	7	9	5	2	0	1
3.197		22	20	34	17	6	1	7	7	6	3	2	1	1
1.302		1	11	5	7	12	1	2	4	3	4	0	3	1
0.462		0	0	0	0	0	0	0	0	0	0	0	0	0
0.186		0	0	0	0	0	0	0	0	0	0	0	0	0
1.564		0	3	6	3	3	1	1	1	0	0	0	0	0
0.849		0	0	0	0	0	0	0	0	0	0	0	0	0
0.003		0	0	0	0	0	0	0	0	0	0	0	0	0

Table 6.8.8 - Sole in VIIa. Continued (values in bold are used in the assessment)

UK(E&W)-C0T UK Commercial Otter trawl

1991 2013
1 1 0 1
2 14

107.3	265	155	63	29	19	71	20	11	2	0	1	1	1
96.8	16	224	69	22	16	10	36	10	10	1	0	0	0
78.9	9	27	77	19	3	7	4	5	1	2	0	0	0
43	4	66	34	50	20	3	4	4	7	1	2	0	0
43.1	17	50	34	15	24	7	1	2	0	2	1	1	0
42.2	2	5	18	12	7	12	4	1	1	1	1	1	1
39.9	14	15	7	14	9	3	7	3	1	1	0	1	0
36.9	5	24	5	3	5	3	2	2	1	1	0	0	0
22.8	5	15	12	2	0	2	1	1	1	1	0	0	0
27	2	12	9	8	1	0	1	1	0	0	0	0	0
32.9	3	10	6	8	5	0	0	0	0	0	0	0	0
24.8	0	8	16	3	5	3	1	0	1	0	0	0	0
23.9	1	2	6	4	2	1	2	0	0	0	0	0	0
23.5	3	5	3	4	3	2	1	1	0	0	0	0	0
16.7	2	4	2	1	2	2	1	1	1	0	0	0	0
5.2	1	2	4	1	1	1	1	1	1	1	0	0	0
4.4	1	1	2	2	0	0	1	1	1	0	0	0	0
2.7	0	1	1	1	1	0	0	0	0	0	0	0	0
1.54	0	0	0.2	0.3	0.1	0.2	0.2	0	0	0.1	0	0	0
1.42	0	0.1	0.2	0.3	0.1	0.1	0.2	0.1	0	0.1	0.1	0.1	0
0.686	0	0.1	0.1	0	0	0	0	0	0	0	0	0	0
0.241	0	0	0	0	0	0	0	0	0	0	0	0	0
0.272	0	0	0	0	0	0	0	0	0	0	0	0	0

IR-COT Irish Commercial Otter trawl

1995 2005
1 1 0 1
2 10

70682	6.8	17.7	25.5	9.2	25.8	3.6	0.8	1.5	1.9	1995
58166	0	5.7	12.9	12.7	4.7	4.7	2.2	0.2	0	1996
75029	27.8	10.2	4.1	9.2	6.4	3.5	3.9	1	0.2	1997
81073	5.5	40.7	14.7	6.6	12.3	5.4	2.7	4.1	1	1998
93221	26.6	36.8	30.9	5.1	3.8	5.3	2.4	0.5	1.2	1999
64320	1.6	13.2	13.4	11	3.4	1.1	1	0.4	0	2000
77541	0.2	6.1	18.6	18.6	10.8	2.1	4.1	1.3	0.3	2001
39996	20.3	20	30.2	16.4	8.2	2.9	2.4	1.4	0.5	2002
73854	0.9	35.9	21.7	9.8	3.3	0.5	0.8	0.2	0.2	2003
72507	9	15.1	4.1	3.2	1.9	1.6	0.3	0.2	0.1	2004

##

31142	4	1.7	1.6	1.6	0.6	0.1	0	0	0	2005

##

Please note the 2005 data is based only on Q3 and Q4 data and has not been raised to annual effort.
It should not be included as part of this time series.

Table 6.8.9. Sole in 7.a. Diagnostics.

2/05/2016 9:50

Extended Survivors Analysis

IRISH SEA SOLE 2016 WG COMBSEX PLUSGROUP.

CPUE data from file SOL7ATUN.TXT

Catch data for 46 years. 1970 to 2015. Ages 2 to 8.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
UK (E&W)-BTS-Q3	1988	2015	2	7	0.75	0.85

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 4

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 = 1.500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 19 iterations

1

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2	0.092	0.101	0.054	0.043	0.014	0.03	0.019	0.036	0.016	0.007
3	0.391	0.42	0.278	0.299	0.197	0.18	0.348	0.134	0.091	0.056
4	0.5	0.324	0.371	0.405	0.245	0.339	0.358	0.265	0.1	0.083
5	0.449	0.315	0.272	0.477	0.347	0.263	0.363	0.177	0.181	0.061
6	0.59	0.31	0.306	0.264	0.357	0.29	0.247	0.148	0.08	0.106
7	0.312	0.394	0.303	0.386	0.202	0.501	0.222	0.095	0.123	0.052

XSA population numbers (Thousands)

YEAR \ AGE	2	3	4	5	6	7
2006	1.32E+03	2.16E+03	1.72E+03	5.87E+02	2.64E+02	5.88E+02
2007	1.88E+03	1.09E+03	1.32E+03	9.47E+02	3.39E+02	1.32E+02
2008	1.96E+03	1.53E+03	6.48E+02	8.66E+02	6.25E+02	2.25E+02
2009	2.28E+03	1.68E+03	1.05E+03	4.05E+02	5.97E+02	4.17E+02
2010	1.61E+03	1.97E+03	1.13E+03	6.34E+02	2.27E+02	4.15E+02
2011	6.03E+02	1.44E+03	1.47E+03	8.00E+02	4.06E+02	1.44E+02
2012	9.33E+02	5.29E+02	1.09E+03	9.46E+02	5.56E+02	2.75E+02
2013	6.80E+02	8.28E+02	3.38E+02	6.88E+02	5.95E+02	3.93E+02
2014	7.81E+02	5.94E+02	6.55E+02	2.35E+02	5.21E+02	4.64E+02
2015	2.15E+03	6.95E+02	4.90E+02	5.36E+02	1.77E+02	4.36E+02

Estimated population abundance at 1st Jan 2016

0.00E+00	1.93E+03	5.95E+02	4.09E+02	4.57E+02	1.44E+02

Taper weighted geometric mean of the VPA populations:

4.09E+03	3.66E+03	2.74E+03	1.73E+03	1.05E+03	6.33E+02

Standard error of the weighted Log(VPA populations) :

0.8545	0.8642	0.8775	0.8407	0.8223	0.7744

1

Log catchability residuals.

Fleet : UK (E&W)-BTS-Q3

Age	1988	1989	1990	1991	1992	1993	1994	1995
2	0.06	0.04	0.43	0.52	-0.04	-0.26	0.18	0.19
3	0.59	0.37	-0.12	-0.29	0.48	-0.27	-0.04	0.3
4	0.01	0.07	-0.24	-0.93	0.45	-0.1	-0.29	0.05
5	-0.38	-0.02	0.97	-0.62	-0.02	-0.31	0.03	-0.58
6	-0.23	-0.24	0.3	-0.19	0.17	-0.08	0.54	-0.02
7	-0.12	0.09	0.19	-0.19	-0.19	-0.09	0.18	-0.34

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	-0.26	0.11	0.46	-0.14	0.02	-0.02	-0.88	0.16	0.06	0.02
3	-0.67	-0.07	0.12	0.01	-0.2	-0.21	-0.22	-0.16	0.43	-0.36
4	-0.25	-0.16	-0.77	0.32	0.33	-0.49	0.07	0.24	-0.1	-0.21
5	-0.22	0.03	-0.75	0.34	-0.12	-0.14	-0.39	0.21	0.45	-0.06
6	-0.18	-0.16	-0.28	0.36	0.15	-0.09	0.08	-0.01	0.04	0.18
7	-0.16	0.27	0.2	0.18	-0.13	-0.02	-0.01	-0.23	0.34	-0.03

Age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2	0.29	-0.22	0.03	0.02	-0.58	-0.09	-0.2	0.25	-0.18	0.05
3	0.16	0.26	0.03	0.05	-0.1	0.05	-0.17	-0.01	-0.2	0.24
4	-0.09	0.27	0.05	0.21	-0.07	0.38	0.31	0.59	0.31	0.02
5	0.72	0.27	0.4	0.48	-0.19	0.27	-0.16	0.26	0.48	0.05
6	0.25	-0.03	0.13	0.38	-0.38	-0.1	-0.45	-0.23	0.22	-0.33
7	-0.2	-0.03	-0.2	-0.08	-0.51	0	0.14	0.3	0.16	-0.17

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
Mean Log q	-7.4592	-7.7781	-7.9109	-7.9109	-7.9109	-7.9109
S.E(Log q)	0.2936	0.282	0.348	0.4075	0.2495	0.2069

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	0.89	1.739	7.51	0.91	28	0.25	-7.46
3	0.97	0.502	7.78	0.89	28	0.28	-7.78
4	1.07	-0.838	7.94	0.84	28	0.37	-7.91
5	1.17	-1.592	8	0.78	28	0.46	-7.88
6	0.99	0.234	7.9	0.92	28	0.25	-7.92
7	0.99	0.175	7.92	0.94	28	0.21	-7.93
1							

Terminal year survivor and F summaries :

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2013

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3	2022	0.3	0	0	1	0.961	0.007
F shrinkage mean	606	1.5				0.039	0.023

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1930	0.29	0.24	2	0.807	0.007

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2012

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3	612	0.212	0.21	0.99	2	0.979	0.054
F shrinkage mean	163	1.5				0.021	0.19

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
595	0.21	0.2	3	0.949	0.056

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2011

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3	418	0.182	0.135	0.74	3	0.983	0.081
F shrinkage mean	118	1.5				0.017	0.262

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
409	0.18	0.15	4	0.803	0.083

Age 5 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2010

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3	468	0.167	0.105	0.63	4	0.985	0.059
F shrinkage mean	93	1.5				0.015	0.267

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
457	0.17	0.13	5	0.808	0.061

1

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2009

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3	146	0.154	0.185	1.2	5	0.984	0.105
F shrinkage mean	64	1.5				0.016	0.225

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
144	0.15	0.17	6	1.111	0.106

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2008

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3	376	0.138	0.126	0.91	6	0.988	0.052
F shrinkage mean	230	1.5				0.012	0.083

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
374	0.14	0.12	7	0.845	0.052

1
1

Table 6.8.10. Sole in 7.a. Fishing mortality.

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	0.0083	0.0117	0.0103	0.0299	0.0045	0.0421	0.0079	0.0148	0.0076	0.0129	0.0395	0.0165
3	0.1196	0.148	0.0809	0.1436	0.0847	0.1575	0.0704	0.135	0.0743	0.1427	0.1334	0.1488
4	0.2956	0.3988	0.3518	0.3621	0.3157	0.3032	0.4193	0.3256	0.2867	0.3647	0.3929	0.3288
5	0.4445	0.5545	0.5058	0.4394	0.4722	0.4844	0.4817	0.4073	0.4037	0.6325	0.567	0.5108
6	0.4292	0.3671	0.493	0.4873	0.5435	0.3973	0.3793	0.3753	0.3817	0.4262	0.9488	0.6026
7	0.3909	0.4416	0.4517	0.431	0.4453	0.3962	0.4281	0.3705	0.3584	0.4761	0.6389	0.4824
+gp	0.3909	0.4416	0.4517	0.431	0.4453	0.3962	0.4281	0.3705	0.3584	0.4761	0.6389	0.4824
FBAR 4-7	0.39	0.4405	0.4506	0.43	0.4442	0.3953	0.4271	0.3696	0.3576	0.4749	0.6369	0.4811

Age/Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	0.0034	0.007	0.0452	0.01	0.0063	0.0591	0.0097	0.0439	0.1126	0.1154	0.08	0.0142
3	0.0952	0.0813	0.1807	0.1343	0.2754	0.18	0.1722	0.2987	0.3981	0.3519	0.2874	0.1482
4	0.4769	0.3834	0.2429	0.3603	0.4215	0.5641	0.37	0.4501	0.6773	0.4838	0.4108	0.3529
5	0.4076	0.532	0.3793	0.3205	0.5519	0.7598	0.5602	0.5349	0.6632	0.3941	0.6063	0.4184
6	0.4368	0.392	0.4326	0.3272	0.337	1.2551	0.7282	0.6257	0.6082	0.4993	0.4126	0.5377
7	0.4419	0.4372	0.3526	0.3369	0.4382	0.864	1.0987	0.691	0.6597	0.6311	0.6812	0.8945
+gp	0.4419	0.4372	0.3526	0.3369	0.4382	0.864	1.0987	0.691	0.6597	0.6311	0.6812	0.8945
FBAR 4-7	0.4408	0.4362	0.3518	0.3362	0.4372	0.8607	0.6893	0.5755	0.6521	0.5021	0.5277	0.5509

Age/Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	0.0247	0.0717	0.0256	0.1042	0.0258	0.0619	0.0273	0.0571	0.0693	0.1633	0.0891	0.2117
3	0.2948	0.2338	0.3451	0.4154	0.3089	0.2041	0.2394	0.2834	0.2888	0.5824	0.4815	0.4577
4	0.4271	0.5237	0.4714	0.6169	0.4651	0.3442	0.2393	0.3156	0.5232	0.4866	0.4419	0.6999
5	0.4707	0.5209	0.4948	0.5072	0.7119	0.5398	0.2445	0.2687	0.4592	0.4665	0.3018	0.681
6	0.5187	0.5537	0.5812	0.4936	0.3914	0.7241	0.51	0.3015	0.3179	0.306	0.2853	0.4107
7	0.5395	0.4176	0.531	0.7394	0.4007	0.2595	0.8252	0.4978	0.2138	0.1703	0.1978	0.4146
+gp	0.5395	0.4176	0.531	0.7394	0.4007	0.2595	0.8252	0.4978	0.2138	0.1703	0.1978	0.4146
FBAR 4-7	0.489	0.504	0.5196	0.5893	0.4923	0.4669	0.4547	0.3459	0.3785	0.3574	0.3067	0.5516

Age/Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	FBAR 13-15
2	0.0924	0.1008	0.0544	0.0434	0.0144	0.0301	0.0193	0.0362	0.0163	0.0074	0.0199
3	0.3913	0.4203	0.2779	0.2992	0.1971	0.1797	0.3481	0.1344	0.0908	0.0560	0.0937
4	0.4997	0.3237	0.3707	0.405	0.2445	0.3388	0.3578	0.2655	0.0995	0.0826	0.1492
5	0.4486	0.3145	0.2717	0.4765	0.3471	0.263	0.3632	0.1768	0.1813	0.0606	0.1395
6	0.5901	0.3097	0.3064	0.2645	0.3572	0.2895	0.2474	0.1482	0.0797	0.1064	0.1114
7	0.3122	0.3935	0.3028	0.3865	0.2015	0.5012	0.2218	0.0953	0.1227	0.0520	0.0900
+gp	0.3122	0.3935	0.3028	0.3865	0.2015	0.5012	0.2218	0.0953	0.1227	0.052	
FBAR 4-7	0.4626	0.3354	0.3129	0.3831	0.2876	0.3481	0.2975	0.1715	0.1208	0.0754	

Table 6.8.11. Sole in 7.a. Stock numbers-at-age (start of year, in thousands).

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	3695	10178	3186	13135	5871	6681	3857	15771	9040	8849	5071	4500	2463
3	8349	3316	9102	2853	11535	5289	5796	3462	14060	8118	7904	4411	4005
4	4145	6703	2587	7595	2236	9590	4088	4887	2737	11811	6368	6259	3439
5	1368	2791	4071	1647	4785	1476	6408	2432	3193	1859	7421	3890	4076
6	4389	794	1450	2221	960	2700	823	3582	1465	1930	894	3809	2112
7	939	2586	497	802	1235	505	1642	509	2227	905	1140	313	1887
+gp	8212	5534	4321	3418	2829	3221	2222	2193	2042	1713	2535	2366	1164
TOTAL	31098	31901	25214	31672	29452	29461	24835	32837	34763	35184	31334	25547	19146

Age/Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	5562	15488	16264	23766	3460	3503	4380	5567	12700	4961	6195	5255	2006
3	2221	4997	13395	14569	21370	2951	3139	3793	4501	10239	4144	5526	4639
4	3295	1853	3774	10597	10010	16152	2248	2107	2305	2865	6950	3233	3724
5	1932	2032	1315	2382	6291	5152	10095	1297	968	1286	1719	4419	1908
6	2454	1027	1258	864	1241	2663	2662	5350	604	591	634	1023	2497
7	1235	1500	603	821	558	320	1163	1289	2635	332	354	335	551
+gp	2096	1964	2707	2502	1457	806	534	1008	1025	1965	1210	1315	1074
TOTAL	18793	28861	39316	55501	44387	31546	24221	20411	24739	22238	21206	21106	16399

Age/Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
2	2500	8385	6902	5271	6958	4546	2324	3043	3638	2953	1322	1875	1964
3	1689	2205	6836	6087	4483	6126	3885	1962	2338	3012	2162	1091	1534
4	3323	1082	1317	4542	4491	3193	4175	2633	992	1307	1724	1323	648
5	1996	1876	528	748	2913	3199	2107	2239	1465	577	587	947	866
6	1026	1101	1022	235	395	2064	2212	1204	1271	980	264	339	625
7	1299	519	608	625	103	214	1382	1457	803	864	588	132	225
+gp	881	1061	1342	1064	479	726	1177	2305	1041	1136	1474	959	842
TOTAL	12713	16230	18556	18572	19821	20067	17262	14843	11547	10829	8122	6667	6705

Age/Year	2009	2010	2011	2012	2013	2014	2015	2016	GMST 70-13	AMST 70-13
2	2279	1612	603	933	680	781	2149	0	4314	5891
3	1683	1974	1438	529	828	594	695	1930	3957	5308
4	1051	1129	1467	1087	338	655	490	595	2946	4031
5	405	634	800	946	688	235	536	409	1856	2494
6	597	227	406	556	595	521	177	457	1110	1480
7	417	415	144	275	393	464	436	144	643	849
+gp	529	908	324	606	947	509	1534	1692		
TOTAL	6961	6900	5181	4932	4469	3759	6018	5227		

Table 6.8.12. Sole in 7.a. Summary.

	RECRUITS Age 2	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 7
1970	3695	7133	6437	1785	0.2773	0.39
1971	10178	7406	6222	1882	0.3025	0.4405
1972	3186	5727	5010	1450	0.2894	0.4506
1973	13135	6554	5123	1428	0.2787	0.43
1974	5871	6190	5068	1307	0.2579	0.4442
1975	6681	6230	5360	1441	0.2688	0.3953
1976	3857	5502	4890	1463	0.2992	0.4271
1977	15771	5510	4490	1147	0.2554	0.3696
1978	9040	6244	5092	1106	0.2172	0.3576
1979	8849	6887	5684	1614	0.2839	0.4749
1980	5071	6428	5513	1941	0.3521	0.6369
1981	4500	5909	5166	1667	0.3227	0.4811
1982	2463	4748	4332	1338	0.3088	0.4408
1983	5562	4920	4098	1169	0.2852	0.4362
1984	15488	6793	4607	1058	0.2296	0.3518
1985	16264	7865	5645	1146	0.203	0.3362
1986	23766	9527	6961	1995	0.2866	0.4372
1987	3460	8564	7170	2808	0.3916	0.8607
1988	3503	6002	5524	1999	0.3619	0.6893
1989	4380	5186	4637	1833	0.3953	0.5755
1990	5567	4296	3633	1583	0.4357	0.6521
1991	12700	4485	3194	1212	0.3794	0.5021
1992	4961	4461	3453	1259	0.3646	0.5277
1993	6195	3871	3240	1023	0.3157	0.5509
1994	5255	4995	4062	1374	0.3383	0.489
1995	2006	3970	3528	1266	0.3588	0.504
1996	2500	3088	2719	1002	0.3685	0.5196
1997	8385	3451	2507	1003	0.4001	0.5893
1998	6902	4260	3033	911	0.3003	0.4923
1999	5271	4334	3327	863	0.2594	0.4669
2000	6958	3919	3130	818	0.2613	0.4547
2001	4546	4316	3569	1053	0.295	0.3459
2002	2324	4020	3579	1090	0.3046	0.3785
2003	3043	3616	3218	1014	0.3151	0.3574
2004	3638	2783	2303	709	0.3079	0.3067
2005	2953	2516	2077	855	0.4116	0.5516
2006	1322	1888	1638	569	0.3473	0.4626
2007	1875	1660	1401	492	0.3513	0.3354
2008	1964	1590	1336	332	0.2484	0.3129
2009	2279	1355	1081	325	0.3006	0.3831
2010	1612	1466	1203	277	0.2302	0.2876
2011	603	1257	1101	330	0.2998	0.3481
2012	933	1302	1165	298	0.2557	0.2975
2013	680	1218	1101	148	0.1344	0.1715
2014	781	978	886	99	0.1117	0.1208
2015	2149	1586	1337	76	0.0569	0.0754
2016	1205 [1]	1664 [2]	1447 [2]			0.0307 [3]
Arith. Mean	5698	4478	3692	1121	0.2961	0.4328
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

[1] Geometric mean 2006-2014

[2] Forecast

[3] F corresponding to a TAC constraint in 2016 (40 t)

Table 6.8.13. Sole in 7.a. Input to RCT3.

XSA = XSA estimates at age 2
S2= abundance indices at age 2 from UK(E&W)-BTS-Q3
S1= abundance indices at age 1 from UK(E&W)-BTS-Q3
Irish Sea sole recruits - age 2

2	40	2	
1975	15771	-11	-11
1976	9040	-11	-11
1977	8849	-11	-11
1978	5071	-11	-11
1979	4500	-11	-11
1980	2463	-11	-11
1981	5562	-11	-11
1982	15488	-11	-11
1983	16264	-11	-11
1984	23766	-11	-11
1985	3460	-11	-11
1986	3503	196	-11
1987	4380	304	118
1988	5567	534	218
1989	12700	1286	1712
1990	4961	309	148
1991	6195	330	220
1992	5255	408	83
1993	2006	154	60
1994	2500	126	246
1995	8385	577	886
1996	6902	716	1158
1997	5271	293	539
1998	6958	464	385
1999	4546	284	354
2000	2324	61	91
2001	3043	210	205
2002	3638	240	242
2003	2953	165	406
2004	1322	110	53
2005	1875	93	107
2006	1964	126	125
2007	2279	150	126
2008	1612	60	60
2009	603	35	26
2010	933	49	88
2011	680	57	22
2012	-11	43	75
2013	-11	150	172
2014	-11	-11	421

S2
S1

Table 6.8.14. Sole in 7.a. RCT3 output.

Analysis by RCT3 ver3.1 of data from file :

S7ARCT3N.TXT

Irish Sea sole recruits - age 2

Data for 2 surveys over 40 years : 1975 - 2014

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 = 2013

Survey/ Series	I----- Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
S2	0.9	3.28	0.26	0.902	26	5.02	7.8	0.273	0.728
S1	0.85	3.66	0.49	0.725	25	5.15	8.02	0.522	0.199

VPA Mean = 8.31 .867 .072

Yearclass = 2014

Survey/ Series	I----- Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	0.85	3.66	0.49	0.725	25	6.05	8.78	0.529	0.728
S2									
S1									

VPA Mean = 8.31 .867 .272

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2013	2640	7.88	0.23	0.11	0.21		
2014	5725	8.65	0.45	0.21	0.21		

Table 6.8.15a. Sole in 7.a. Input for catch forecast and F_{MSY} analysis.

Input: TAC constraint for 2016 (40 t)
Catch and stock weights are mean 13-15
Recruits age 2 in 2016, 2017 and 2018 GM(06-14)

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N2	1205	0.53	WS2	0.138	0.17
N3	1930	0.29	WS3	0.192	0.04
N4	595	0.21	WS4	0.245	0.02
N5	409	0.18	WS5	0.298	0.03
N6	457	0.17	WS6	0.342	0.04
N7	144	0.17	WS7	0.366	0.06
N8	1692	0.14	WS8	0.385	0.06
H.cons selectivity			Weight in the HC catch		
sH2	0.012	1.20	WH2	0.173	0.03
sH3	0.058	0.68	WH3	0.210	0.06
sH4	0.092	1.10	WH4	0.285	0.07
sH5	0.086	0.80	WH5	0.330	0.03
sH6	0.069	0.50	WH6	0.366	0.05
sH7	0.055	0.64	WH7	0.383	0.07
sH8	0.055	0.64	WH8	0.393	0.11
Natural mortality			Proportion mature		
M2	0.1	0.1	MT2	0.38	0.1
M3	0.1	0.1	MT3	0.71	0.1
M4	0.1	0.1	MT4	0.97	0.1
M5	0.1	0.1	MT5	0.98	0.1
M6	0.1	0.1	MT6	1	0
M7	0.1	0.1	MT7	1	0
M8	0.1	0.1	MT8	1	0
Relative effort in HC fihery			Year effect for natural mortality		
HF16	1	0.1	K16	1	0.1
HF17	1	0.1	K17	1	0.1
HF18	1	0.1	K18	1	0.1
Recruitment in 2017 and 2018					
R17	1205	0.53			
R18	1205	0.53			

Table 6.8.15b. Sole in 7.a. Input for catch forecast and F_{MSY} analysis.

Input: TAC constraint for 2016 (47 t)
Catch and stock weights are mean 13-15
Recruits age 2 in 2016, 2017 and 2018 GM(06-14)

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N2	1205	0.53	WS2	0.138	0.17
N3	1930	0.29	WS3	0.192	0.04
N4	595	0.21	WS4	0.245	0.02
N5	409	0.18	WS5	0.298	0.03
N6	457	0.17	WS6	0.342	0.04
N7	144	0.17	WS7	0.366	0.06
N8	1692	0.14	WS8	0.385	0.06
H.cons selectivity			Weight in the HC catch		
sH2	0.012	1.20	WH2	0.173	0.03
sH3	0.058	0.68	WH3	0.210	0.06
sH4	0.092	1.10	WH4	0.285	0.07
sH5	0.086	0.80	WH5	0.330	0.03
sH6	0.069	0.50	WH6	0.366	0.05
sH7	0.055	0.64	WH7	0.383	0.07
sH8	0.055	0.64	WH8	0.393	0.11
Natural mortality			Proportion mature		
M2	0.1	0.1	MT2	0.38	0.1
M3	0.1	0.1	MT3	0.71	0.1
M4	0.1	0.1	MT4	0.97	0.1
M5	0.1	0.1	MT5	0.98	0.1
M6	0.1	0.1	MT6	1	0
M7	0.1	0.1	MT7	1	0
M8	0.1	0.1	MT8	1	0
Relative effort in HC fihery			Year effect for natural mortality		
HF16	1	0.1	K16	1	0.1
HF17	1	0.1	K17	1	0.1
HF18	1	0.1	K18	1	0.1
Recruitment in 2017 and 2018					
R17	1205	0.53			
R18	1205	0.53			

Table 6.8.16a. Sole in 7.a. Management option table.

MFDP version 1a
Run: S7A
IRISH SEA SOLE,2016 WG
Time and date: 15:02 06/05/2016
Fbar age range: 4-7

2016 Biomass	SSB	FMult	FBar	Landings
1664	1447	0.4076	0.0307	40

2017 Biomass	SSB	FMult	FBar	Landings	2018 Biomass	SSB
1841	1662	0.0000	0.0000	0	2059	1879
.	1662	0.1000	0.0075	12	2048	1868
.	1662	0.2000	0.0151	24	2036	1856
.	1662	0.3000	0.0226	36	2024	1844
.	1662	0.4000	0.0302	48	2012	1833
.	1662	0.5000	0.0377	60	2001	1822
.	1662	0.6000	0.0452	72	1989	1810
.	1662	0.7000	0.0528	83	1978	1799
.	1662	0.8000	0.0603	95	1966	1788
.	1662	0.9000	0.0679	106	1955	1777
.	1662	1.0000	0.0754	118	1944	1766
.	1662	1.1000	0.0829	129	1933	1755
.	1662	1.2000	0.0905	140	1922	1744
.	1662	1.3000	0.0980	151	1911	1734
.	1662	1.4000	0.1056	162	1900	1723
.	1662	1.5000	0.1131	173	1889	1712
.	1662	1.6000	0.1206	184	1879	1702
.	1662	1.7000	0.1282	195	1868	1691
.	1662	1.8000	0.1357	206	1858	1681
.	1662	1.9000	0.1433	216	1847	1671
.	1662	2.0000	0.1508	227	1837	1660

Input units are thousands and kg - output in tonnes

Fmult corresponding to FMSY = 2.652

.	1662	2.652	0.2	295	1771	1596

Fmult corresponding to FHCR-MSY = 1.26

.	1662	1.26	0.095	147	1915	1738

Bpa = 3500 t

Table 6.8.16b. Sole in 7.a. Management option table.

MFDP version 1a
Run: S7A
IRISH SEA SOLE,2016 WG
Time and date: 15:40 06/05/2016
Fbar age range: 4-7

2016 Biomass	SSB	FMult	FBar	Landings
1664	1447	0.4801	0.0362	47

2017 Biomass	SSB	FMult	FBar	Landings	2018 Biomass	SSB
1834	1655	0.0000	0.0000	0	2053	1873
.	1655	0.1000	0.0075	12	2041	1861
.	1655	0.2000	0.0151	24	2029	1849
.	1655	0.3000	0.0226	36	2017	1838
.	1655	0.4000	0.0302	48	2006	1826
.	1655	0.5000	0.0377	60	1994	1815
.	1655	0.6000	0.0452	71	1983	1804
.	1655	0.7000	0.0528	83	1971	1793
.	1655	0.8000	0.0603	94	1960	1782
.	1655	0.9000	0.0679	106	1949	1771
.	1655	1.0000	0.0754	117	1938	1760
.	1655	1.1000	0.0829	128	1927	1749
.	1655	1.2000	0.0905	139	1916	1738
.	1655	1.3000	0.0980	151	1905	1727
.	1655	1.4000	0.1056	162	1894	1717
.	1655	1.5000	0.1131	173	1883	1706
.	1655	1.6000	0.1206	183	1873	1696
.	1655	1.7000	0.1282	194	1862	1685
.	1655	1.8000	0.1357	205	1852	1675
.	1655	1.9000	0.1433	216	1841	1665
.	1655	2.0000	0.1508	226	1831	1655

Input units are thousands and kg - output in tonnes

Fmult corresponding to FMSY = 2.652						
.	1655	2.652	0.2	293	1765	1590
Fmult corresponding to FHCR-MSY = 1.26						
.	1655	1.26	0.095	146	1909	1732

Bpa = 3500 t

Table 6.8.17a. Sole in 7.a. Detailed results.

Year: 2016		F multiplier: 0.4076		Fbar:	0.0307				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
2	0.0050	6	1	1205	166	458	63	458	63
3	0.0235	43	9	1930	371	1370	264	1370	264
4	0.0374	21	6	595	146	577	141	577	141
5	0.0350	13	4	409	122	401	119	401	119
6	0.0279	12	4	457	156	457	156	457	156
7	0.0226	3	1	144	53	144	53	144	53
8	0.0226	36	14	1692	651	1692	651	1692	651
Total		134	40	6432	1664	5099	1447	5099	1447

Year: 2017		F multiplier: 1		Fbar:	0.0754				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
2	0.0123	14	2	1205	166	458	63	458	63
3	0.0577	58	12	1085	209	770	148	770	148
4	0.0918	142	41	1706	417	1655	405	1655	405
5	0.0859	41	13	519	154	508	151	508	151
6	0.0686	23	8	357	122	357	122	357	122
7	0.0554	21	8	402	147	402	147	402	147
8	0.0554	83	33	1624	625	1624	625	1624	625
Total		381	118	6898	1841	5775	1662	5775	1662

Year: 2018		F multiplier: 1		Fbar:	0.0754				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
2	0.0123	14	2	1205	166	458	63	458	63
3	0.0577	57	12	1077	207	765	147	765	147
4	0.0918	77	22	927	227	899	220	899	220
5	0.0859	110	36	1408	419	1380	411	1380	411
6	0.0686	27	10	431	147	431	147	431	147
7	0.0554	15	6	302	110	302	110	302	110
8	0.0554	89	35	1735	668	1735	668	1735	668
Total		391	124	7084	1944	5969	1766	5969	1766

Input units are thousands and kg - output in tonnes.

Table 6.8.17b. Sole in 7.a. Detailed results.

Year: 2016		F multiplier: 0.4801		Fbar:	0.0362				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
2	0.0059	7	1	1205	166	458	63	458	63
3	0.0277	50	11	1930	371	1370	264	1370	264
4	0.0441	24	7	595	146	577	141	577	141
5	0.0412	16	5	409	122	401	119	401	119
6	0.0329	14	5	457	156	457	156	457	156
7	0.0266	4	1	144	53	144	53	144	53
8	0.0266	42	17	1692	651	1692	651	1692	651
Total		157	47	6432	1664	5099	1447	5099	1447

Year: 2017		F multiplier: 1		Fbar:	0.0754				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
2	0.0123	14	2	1205	166	458	63	458	63
3	0.0577	58	12	1084	208	770	148	770	148
4	0.0918	142	40	1699	416	1648	403	1648	403
5	0.0859	40	13	515	153	505	150	505	150
6	0.0686	22	8	355	121	355	121	355	121
7	0.0554	21	8	400	146	400	146	400	146
8	0.0554	83	33	1618	623	1618	623	1618	623
Total		380	117	6876	1834	5753	1655	5753	1655

Year: 2018		F multiplier: 1		Fbar:	0.0754				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
2	0.0123	14	2	1205	166	458	63	458	63
3	0.0577	57	12	1077	207	765	147	765	147
4	0.0918	77	22	926	227	898	220	898	220
5	0.0859	110	36	1402	417	1374	409	1374	409
6	0.0686	27	10	428	146	428	146	428	146
7	0.0554	15	6	300	110	300	110	300	110
8	0.0554	89	35	1727	665	1727	665	1727	665
Total		390	123	7065	1938	5950	1760	5950	1760

Input units are thousands and kg - output in tonnes.

Table 6.8.18a. Sole 7.a. 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			2012	2013	2014	2015	2016	
Stock No. (thousands) of	2	year-olds	781	2149	1205	1205	1205	
Source			XSA	XSA	GM 06-14	GM 06-14	GM 06-14	
Status Quo F:								
% in	2016	landings	15.4	23.1	2.6	-	-	59.0
% in	2017	landings	11.1	35.0	10.3	1.7	-	41.9
								100.0
% in	2016	SSB	9.7	18.2	4.4	-	-	67.7
% in	2017	SSB	9.1	24.4	8.9	3.8	-	53.8
% in	2018	SSB	8.3	23.3	12.5	8.3	3.6	44.1

GM : geometric mean recruitment

Table 6.8.18b. Sole 7.a. 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			2012	2013	2014	2015	2016	
Stock No. (thousands) of	2 year-olds		781	2149	1205	1205	1205	
Source			XSA	XSA	GM 06-14	GM 06-14	GM 06-14	
Status Quo F:								
% in	2016	landings	14.9	23.4	2.1	-	-	59.6
% in	2017	landings	11.2	34.5	10.3	1.7	-	42.2
								100.0
% in	2016	SSB	9.7	18.2	4.4	-	-	67.7
% in	2017	SSB	9.1	24.4	8.9	3.8	-	53.8
% in	2018	SSB	8.3	23.2	12.5	8.4	3.6	44.0

GM : geometric mean recruitment

Table 6.8.19. Sole in 7.a. Yield per recruit summary table.

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	10.5083	3.4030	9.5866	3.2567	9.5866	3.2567
0.1000	0.0075	0.0542	0.0189	9.9668	3.1977	9.0458	3.0516	9.0458	3.0516
0.2000	0.0151	0.1028	0.0356	9.4810	3.0138	8.5607	2.8679	8.5607	2.8679
0.3000	0.0226	0.1467	0.0505	9.0431	2.8482	8.1235	2.7025	8.1235	2.7025
0.4000	0.0302	0.1864	0.0638	8.6463	2.6985	7.7274	2.5530	7.7274	2.5530
0.5000	0.0377	0.2225	0.0757	8.2854	2.5625	7.3672	2.4171	7.3672	2.4171
0.6000	0.0452	0.2556	0.0865	7.9558	2.4385	7.0383	2.2933	7.0383	2.2933
0.7000	0.0528	0.2858	0.0962	7.6537	2.3251	6.7369	2.1801	6.7369	2.1801
0.8000	0.0603	0.3136	0.1050	7.3760	2.2210	6.4599	2.0761	6.4599	2.0761
0.9000	0.0679	0.3393	0.1130	7.1198	2.1252	6.2044	1.9804	6.2044	1.9804
1.0000	0.0754	0.3630	0.1203	6.8830	2.0367	5.9683	1.8921	5.9683	1.8921
1.1000	0.0829	0.3851	0.1270	6.6633	1.9548	5.7493	1.8104	5.7493	1.8104
1.2000	0.0905	0.4055	0.1330	6.4592	1.8789	5.5459	1.7346	5.5459	1.7346
1.3000	0.0980	0.4246	0.1386	6.2691	1.8083	5.3564	1.6642	5.3564	1.6642
1.4000	0.1056	0.4424	0.1437	6.0916	1.7425	5.1795	1.5986	5.1795	1.5986
1.5000	0.1131	0.4590	0.1484	5.9255	1.6811	5.0142	1.5373	5.0142	1.5373
1.6000	0.1206	0.4747	0.1527	5.7700	1.6237	4.8593	1.4800	4.8593	1.4800
1.7000	0.1282	0.4893	0.1566	5.6239	1.5699	4.7139	1.4264	4.7139	1.4264
1.8000	0.1357	0.5031	0.1603	5.4866	1.5194	4.5772	1.3761	4.5772	1.3761
1.9000	0.1433	0.5161	0.1637	5.3572	1.4720	4.4485	1.3288	4.4485	1.3288
2.0000	0.1508	0.5283	0.1668	5.2353	1.4273	4.3271	1.2843	4.3271	1.2843

Reference point	F multiplier	Absolute F
Fbar(4-7)	1.0000	0.0754
FMax	6.7194	0.5066
F0.1	2.5237	0.1903
F35%SPR	2.372	0.1789

Weights in kilograms

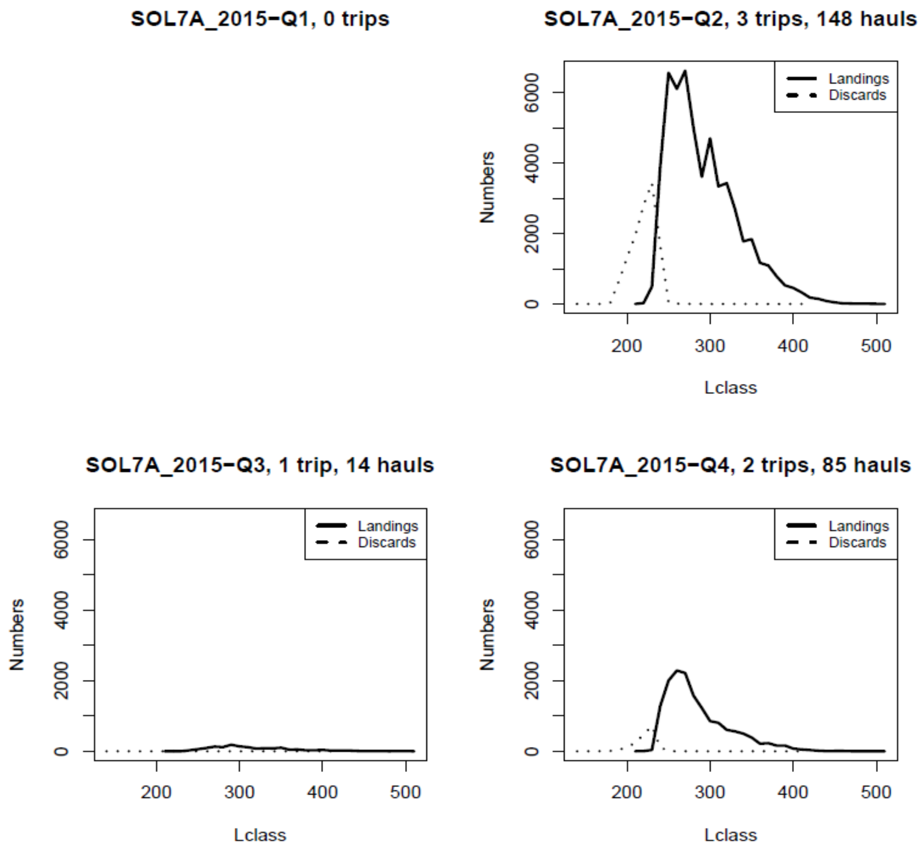


Figure 6.8.1a. Sole 7.a. BE Length distributions of discarded and retained fish from discard sampling studies (Beam trawl).

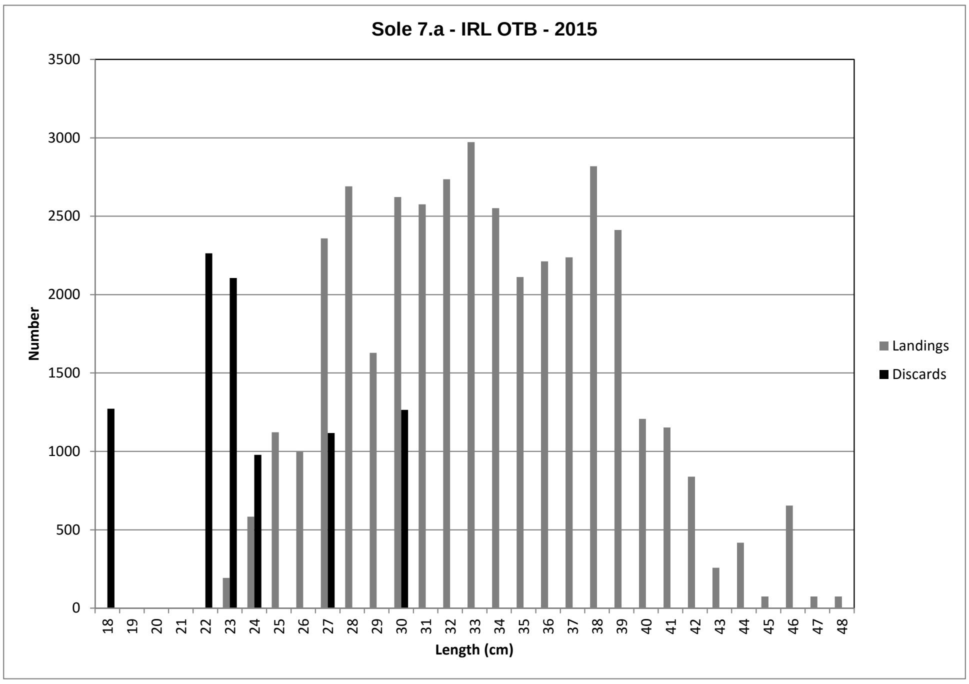


Figure 6.8.1b. Sole 7.a. IR Length distributions of discarded and retained fish from discard sampling studies (Otter trawl).

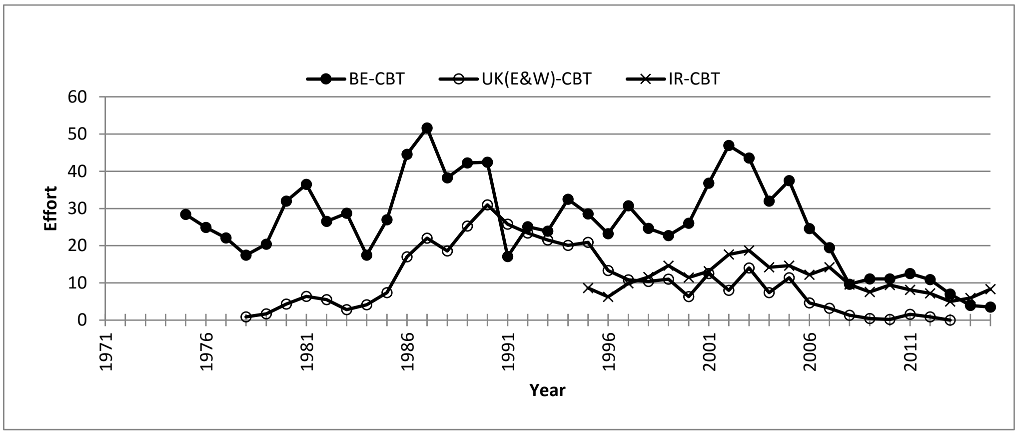


Figure 6.8.2a. Sole in 7.a. Effort series.

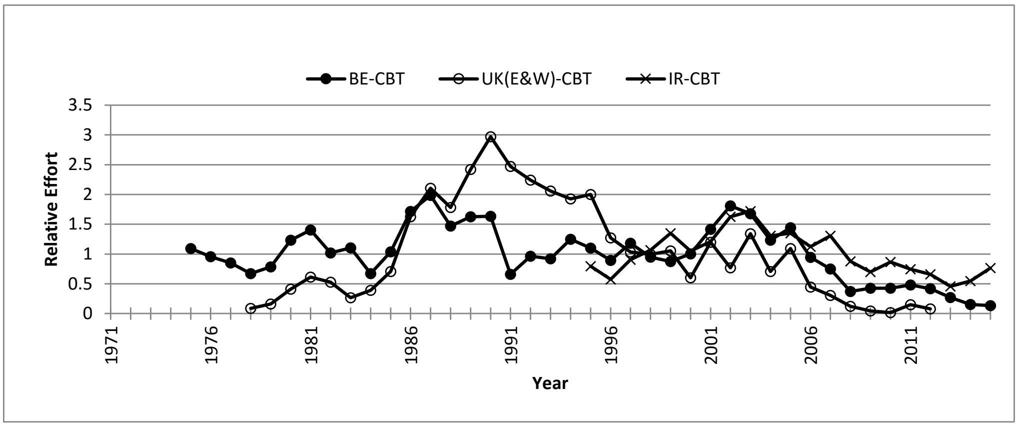


Figure 6.8.2b. Sole in 7.a. Relative effort series.

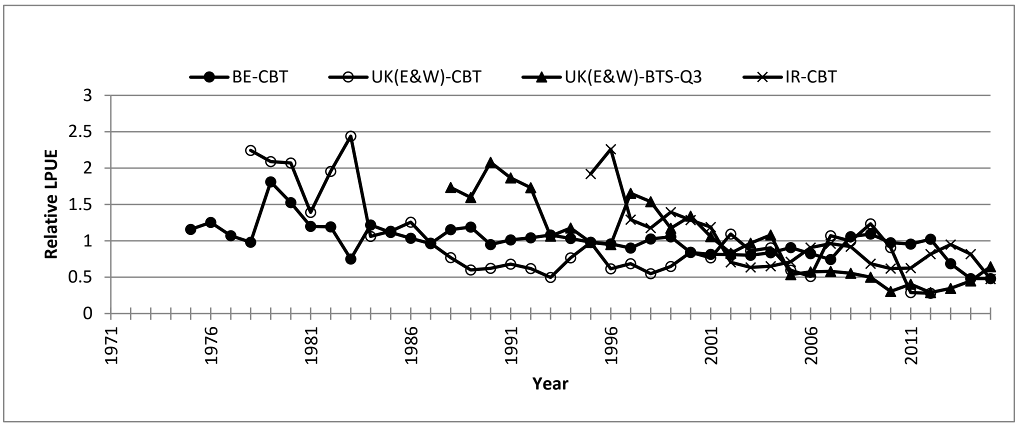


Figure 6.8.2c. Sole in 7.a. Relative lpue series.

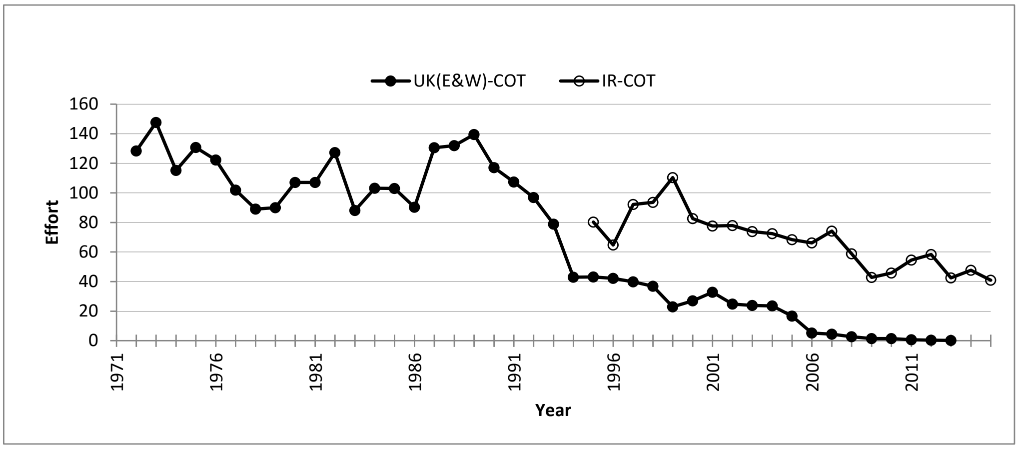


Figure 6.8.3a. Sole in 7.a. Effort series.

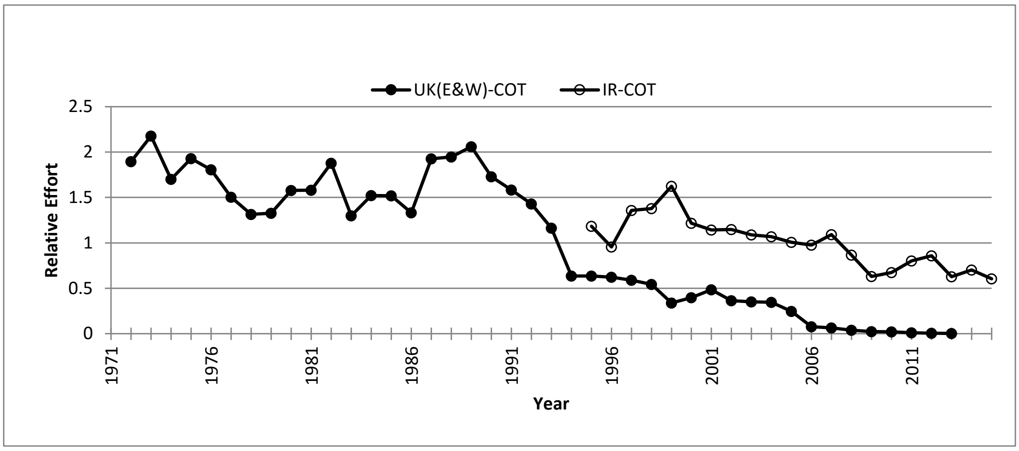


Figure 6.8.3b. Sole in 7.a. Relative effort series.

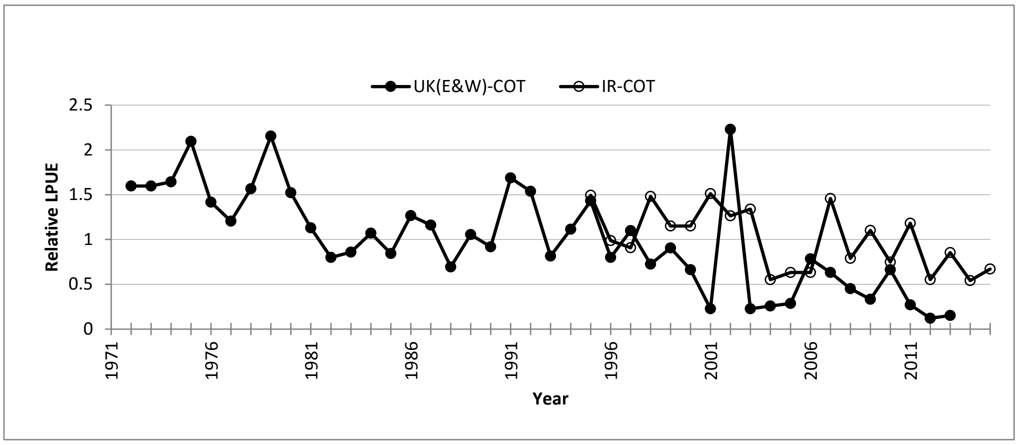
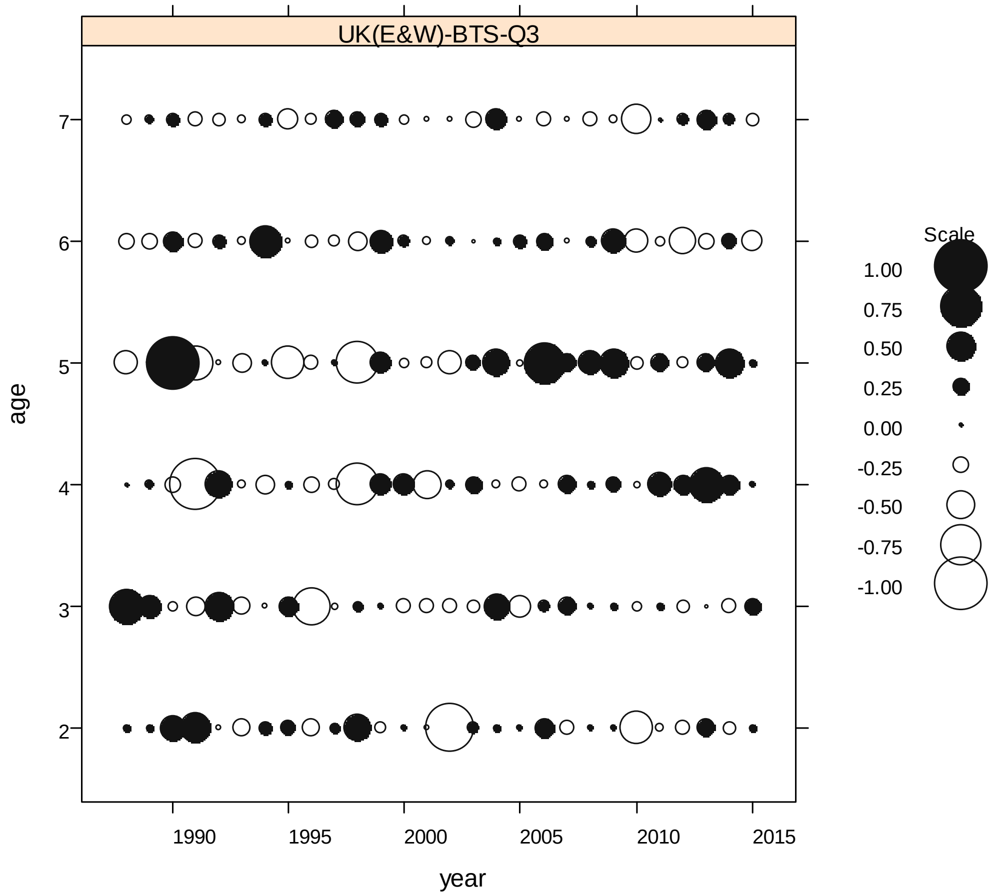


Figure 6.8.3c. Sole in 7.a. Relative lpue series.


UK(E&W)-BTS-Q3
age
year
7
6
5
4
3
2
1990
1995
2000
2005
2010
2015
Scale
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00

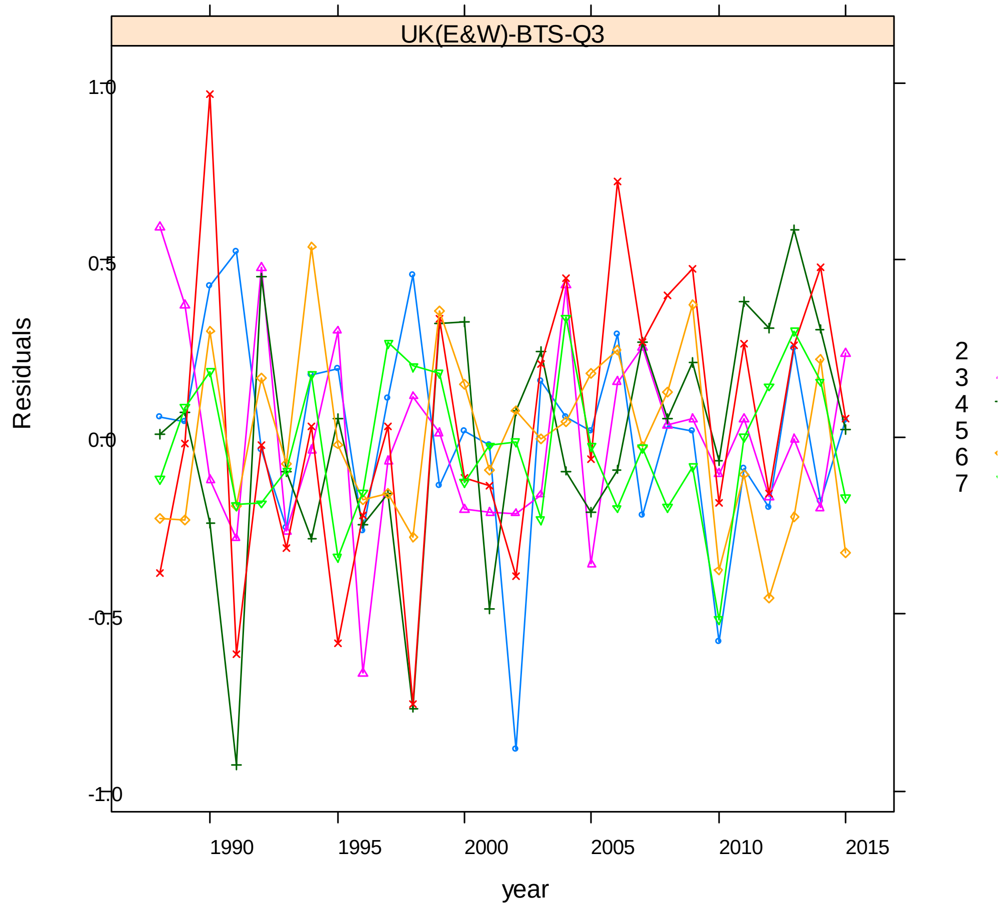


Figure 6.8.4. 7.a. SOLE LOG CATCHABILITY RESIDUAL PLOTS Final XSA.

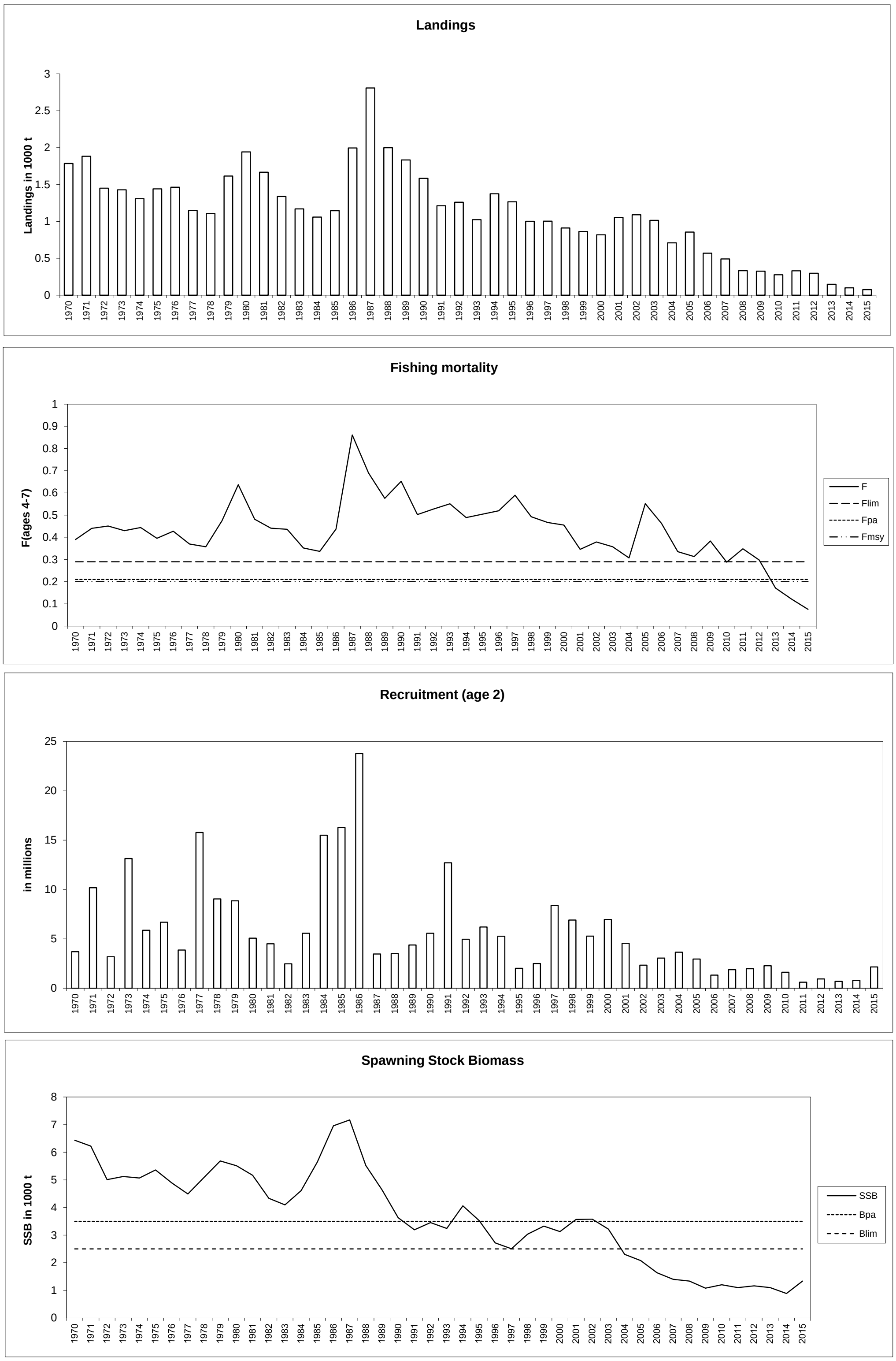


Figure 6.8.5. Sole in 7.a. Summary plots.

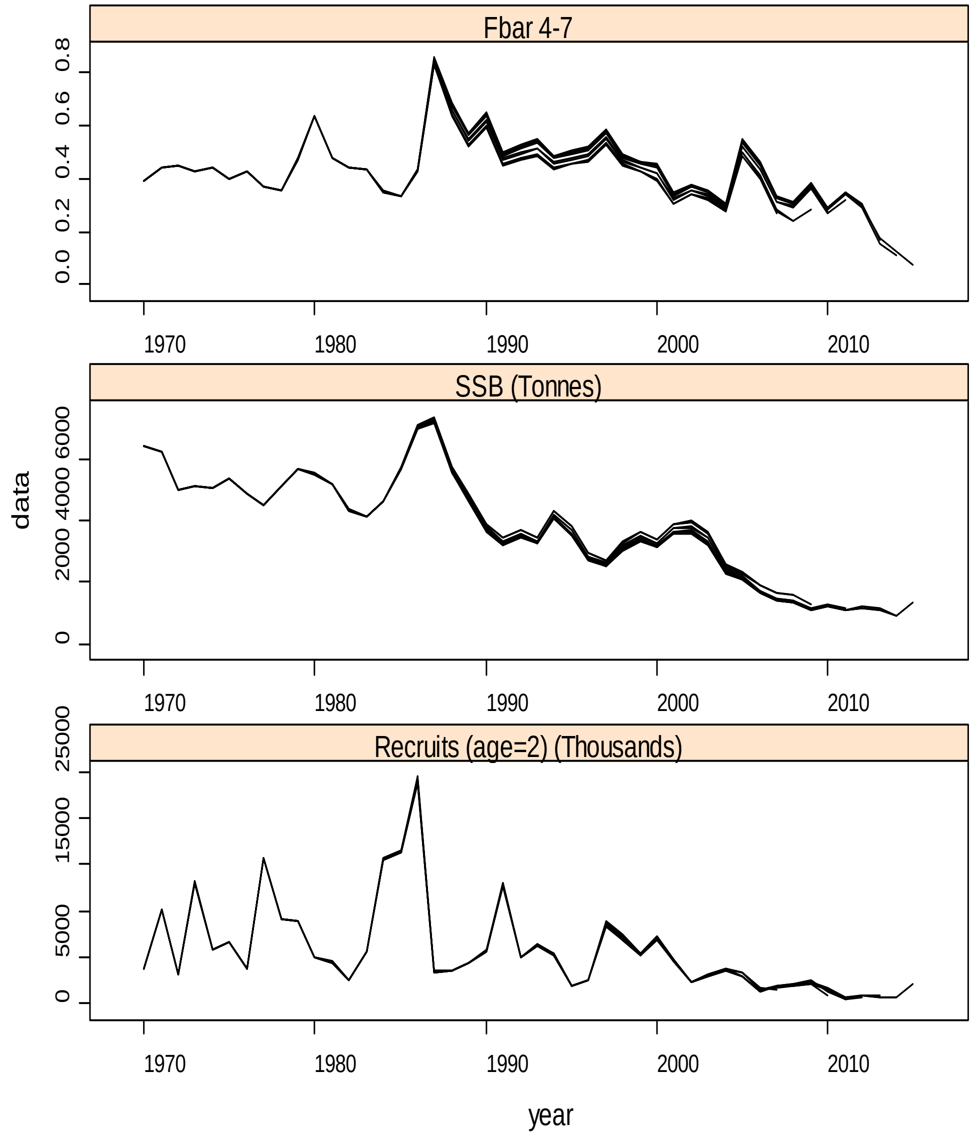


Figure 6.8.6. Sole 7.a. Retrospective XSA analysis (shrinkage SE=1.5).

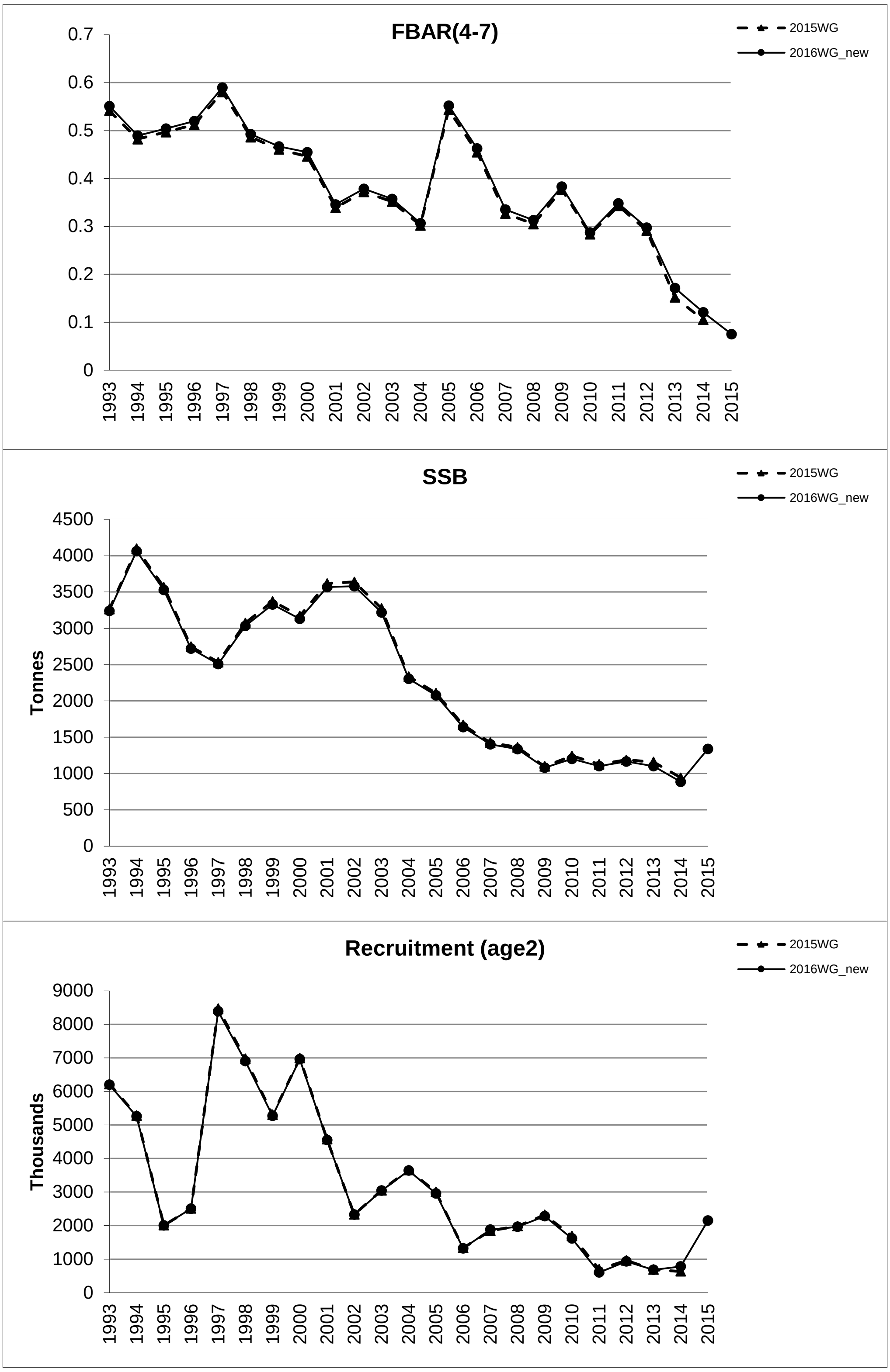
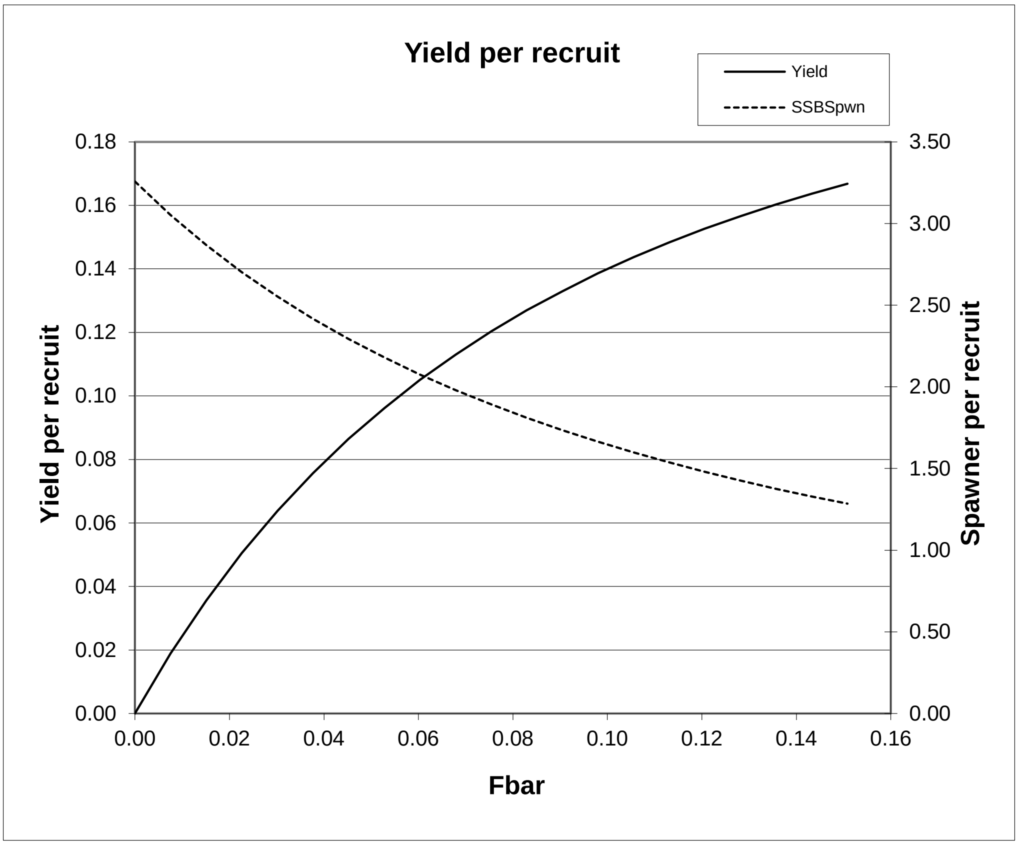


Figure 6.8.7. Sole 7.a. Comparison with last year's assessment.



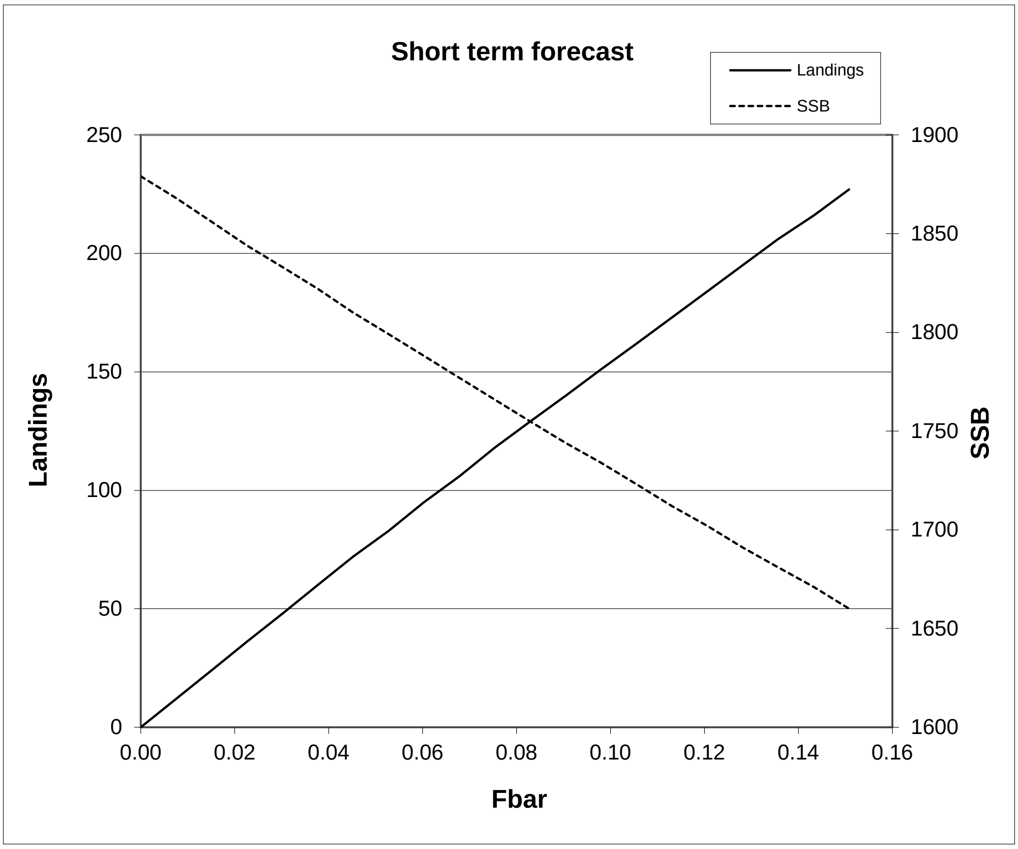


Figure 6.8.8. Sole in 7.a. Yield per recruit and short-term forecast plots.

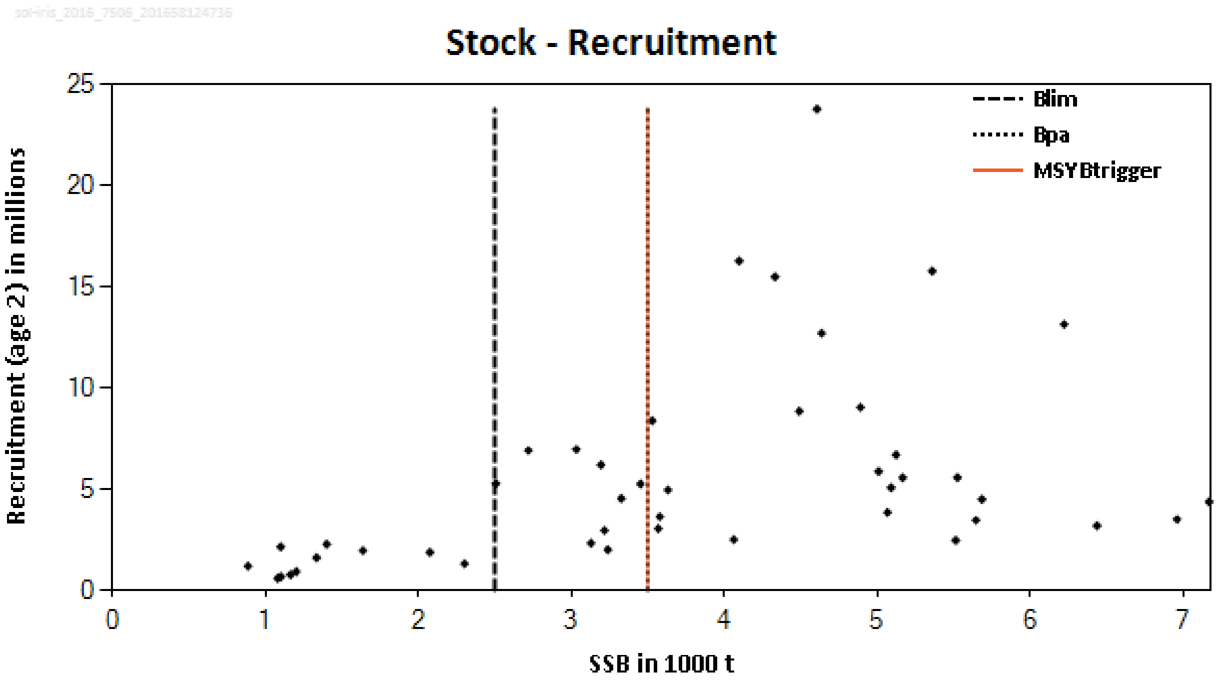


Figure 6.8.9. Sole 7.a. Stock–recruitment plot.

6.8.12 Audit of (sole-iris; sole in Irish Sea/7.a)

Date: 2016-05-12

Auditor: Simon Fischer

General

For single stock summary sheet advice

1) Assessment type: update

2) Assessment: analytical
reproduced in FLR (FLXSA), assuming the input data (numbers and weights-at-age are correct) and using the assessment parameters from the Stock Annex, the results can be reproduced.

3) Forecast: presented
replicated within FLR, using the input options provided in the advice sheet, the results could be reproduced. Forecast based on landings only assessment data, forecast is performed without discards, and final catch derived by topping up of calculated landings with discard ratio.

4) Assessment model: XSA with 1 Survey

5) Data issues: data available as described

6) Consistency: consistent

7) Stock status: F decreased in recent years, all time low, below all reference points, SSB still below all reference points.

8) Management Plan: According to advice sheet no management plan available. Ambiguous in Stock Annex (not clear if there is one or not): "A management plan for Irish Sea sole could be developed, also taking into account the dynamics of the plaice stock in that area."

General comments

Technical comments

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? **yes**
- Is the assessment according to the stock annex description? **yes**
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? **No management plan**
- Have the data been used as specified in the stock annex? **yes**
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? **yes**
- Is there any **major** reason to deviate from the standard procedure for this stock? **no**

- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? **yes**

7.1 Celtic Sea overview

There is no overview.

7.2 Cod in Division VIIe-k (Celtic Sea)

Type of assessment in 2014

Update XSA and forecast using the same settings agreed at WKROUND in February 2012. The only deviation from the stock annex is that a weak recruitment assumption is used in the Short-Term Forecast this is explained in Section 7.2.4.

ICES advice applicable to 2015

"ICES advises on the basis of the MSY approach that landings in 2015 should be no more than 4024 t."

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/cod-7e-k.pdf

ICES advice applicable to 2016

"ICES advises on the basis of the MSY approach that landings in 2015 should be no more than 3569 t."

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/cod-7e-k.pdf

7.2.1 General

Stock description and management units

The 2016 TAC was set for ICES Areas VIIb–c, VIIe–k, VIII, IX, X, and CECAF 34.1.1(1), excluding VIId. This is more representative of the stock area than in previous years as the cod population in VIId is more relevant to the North Sea population. However, landings from VIIbc are not included in the assessment area (see Section 7.3 for these).

Management applicable in 2015 and 2016

TAC 2015 (Council regulation 608/2013)

Species:	Cod *Gadus morhua*	**Zone:**	VIIb, VIIc, VIIe-k, VIII, IX and X; Union waters of CECAF 34.1.1 (COD/7XAD34)
Belgium	218		
France	3 568		
Ireland	901		
The Netherlands	1		
United Kingdom	384		
Union	5 072		
TAC	5 072		Analytical TAC Article 11 of this Regulation applies

TAC 2016 (Council regulation 608/2013)

L 22/46 EN Official Journal of the European Union 28.1.2016

Species:	Cod *Gadus morhua*	Zone:	VIIb, VIIc, VIIe-k, VIII, IX and X; Union waters of CECAF 34.1.1 (COD/7XAD34)
Belgium	193		
France	3 166		
Ireland	864		
The Netherlands	1		
United Kingdom	341		
Union	4 565		
TAC	4 565		Analytical TAC Article 12(1) of this Regulation applies

Since 2005, ICES rectangles 30E4, 31E4, and 32E3 have been closed during the first quarter (Council Regulations 27/2005, 51/2006, and 41/2007, 40/2008, and 43/2009).

Technical measures applied to this stock are a minimum mesh size (MMS) for beam and otter trawlers in Subarea VII and a minimum landing size (MLS) of 35 cm.

Fishery in 2015

Landings data used by the WG are shown in Table 7.2.1 and Figure 7.2.1. Landings in 2015 were 4157 t. The agreed TAC was not entirely taken (82% uptake). TAC uptake varies among countries. Belgium, France did not use their quotas fully whereas Ireland, Netherlands and United Kingdom overshot their national quota. The lower uptake rate for France is the consequence of the mixed nature of its fisheries, (the restricted TAC on haddock).

France is fishing in all area, whereas Ireland mostly fish in Area VIIg, UK in VIIe and Belgium in Area VIIf (Figure 7.2.2). At the stock level, 43% of the landings are taken from Area VIIg, 23% in VIIe, 18% in VIIh and 8% in VIIf and j respectively. No landings are reported in VIIk.

Landings and discards by countries.

Country	CatchCategory	CATON	TAC_C	TAC_Uptake
Belgium	Discards	6.6	NA	NA
France	Discards	309	NA	NA
Ireland	Discards	219.6	NA	NA
Netherlands	Discards	0	NA	NA
United Kingdom	Discards	33.4	NA	NA
Belgium	Landings	120.6	218	55
France	Landings	2485	3568	70
Ireland	Landings	1123	901	125
Netherlands	Landings	2	1	200
United Kingdom	Landings	422.1	384	110

Given the rapid growth of this species in this area, discards are mostly composed of one year fish. Since 2011 quotas were not restricted and the discards rate has stabilized around 10–15%. Discards in 2015 were 565 t; leading to a 12% discards in weight.

Cod 7ek are mainly caught by OTB_DEF_100-119, OTB_DEF_70-99 and OTT_DEF_100-119 métiers. Beam trawlers also constitute significantly to the catches. The discards rate in weight varies among fleets depending on mesh size range and targeted species.

The group advices to follow métier definition specified in the Appendix 2 of the ICES data call to reduce the number of métier upload in InterCatch. Métiers which contribute to less than 1% of the landings should be included in the MIS_MIS_0_0_0_HC métier.

Landings and discards by fleets.

Fleet	Landings_t	Discards_t	Discard_rate
OTB_DEF_100-119_0_0_all	1636	117	6.7
OTB_DEF_70-99_0_0_all	676	298	30.6
OTT_DEF_100-119_0_0_all	656	0	0
TBB_DEF_70-99_0_0_all	348	107	23.5
SSC_DEF_100-119_0_0_all	187	4	2.1
GNS_DEF_all_0_0_all	149	14	8.6
MIS_MIS_0_0_0_HC	142	3	2.1
OTT_CRU_100-119_0_0	142	3	2.1
GNS_DEF_120-219_0_0_all	73	5	6.4
OTB_DEF_>=120_0_0_all	71	0	0
GTR_DEF_>=220_0_0_all	23	3	11.5
LLS_FIF_0_0_0_all	17	0	0
OTB_CRU_70-99_0_0_all	16	4	20
GTR_DEF_all_0_0_all	10	1	9.1
C-Allgears	4	0	0
SSC_DEF_All_0_0_All	4	0	0
SSC_DEF_70-99_0_0_all	2	0	0
OTM_DEF_100-119_0_0_all	1	0	0
OTB_CRU_16-31_0_0_all	0	0	NA
SSC_DEF_70-99_0_0_all_FDF	0	0	NA
TBB_CRU_16-31_0_0_all	0	0	NA

Information from the industry

No specific information was reported to the group in 2015.

7.2.2 Data

InterCatch procedure

Since 2013, international landings and discards data are uploaded in InterCatch. Discards are raised for unreported strata to output a total estimate of discards in weight.

Unsampled strata of landings and discards (number-at-age) are filled in using a complex allocation procedure. Information on national and international assumptions made by data providers and submitters at the national level and allocation grouping used in IC are documented in the available on the SharePoint (/data/Cod7ek/Allocationscheme2016).

The data call based on métier level 6 is likely to have modified the way the data were historically processed at the national and at the international level. To ensure the consistency of data processing at international level, the same rules are applied each year for the allocation procedure: fill unsampled strata using as much as possible the same métier and quarter, regardless area and country.

For 2014 data (WGCSE 2015) given the diversity in the ways national data are provided, it was difficult to use the InterCatch database to inform on spatial pattern (ICES division). In 2015 (WGCSE 2016), national data were split by area, as such detailed analysis of spatial pattern in landing can be performed (see above and Figure 7.2.2).

One of the recommendations for the next benchmark is to streamlining data compilation procedures for fishery-dependent date of the three main gadoids species. General raising protocol would then be added to the stock annex.

Landings

Length distributions of 2015 landings provided by countries for sampled strata and quarter are shown Figure 7.2.3a–d.

Age distribution of 2015 landings is shown in Figure 7.2.4. It is noticeable that this stock has always been composed of a few age classes, even if Celtic sea cod can live up to ten years. While the catch was mainly composed of age 2 over the period 2005–2008, the strong 2009 year class has contributed strongly to the catch at older ages in recent years: 63% in number in 2012 at age 3, 36% at age 4 in 2013 (Table 7.2.2). In 2014, high recruitment has been observed resulting in an increasing proportion of age 1 fish in the landings (53%), age 2 accounts for 22% of the landings. In 2015, landings are dominated by fish of Age 2, with small proportion of old fish.

Discards

The landings/discards pattern is known to be strongly variable between fleets and years due to metier, recruitment intensity, TACs constraints and mixed fisheries concerns. In 2009, age 1 individuals (30–45 cm) were mainly discarded. In 2010, most of them were landed. In 2011, ages 1 and 2 represents respectively 51% and 46% of the total discards in numbers for all fleets. Due to the low TAC relative to the high magnitude of recruitment in 2009 and 2010, all countries had unusually high discards rates in 2011, generally 70% by weight was made up of fish above the MLS. The high-graded fish from the French fishery have been added to the landings in 2003–2011. In 2014, total amount of discards is 740 t (639 t imported + 101 t raised), giving a discard rate of

19%. This discards rate is higher than the normal 10% situation and mostly results of undersized fish coming from the strong 2013 year class (fish of age 1 in 2014).

Length distributions of 2015 discards provided by countries for sampled strata and quarter are shown Figure 7.2.3a–d. The total amount of discard is 565 tons (250 t sampled and uploaded in InterCatch and 309 t resulting from the raising procedure), giving a discard rate by weight of 12%, which is considered as a usual discard rate for this species in the mixed fisheries. Highgrading in 2015 (discards of fish above Minimum conservation size) is low. Due to quota constraint at vessels levels, length distribution of discards for the UK fleet show highgrading pattern (cod being a non-target species). However, this fleet have a little contribution to both landings and discards quantities.

Raised age distribution of landings and discards are shown in Figure 7.2.4. Discards are composed of age 1 and age 2 fish.

Biological

Catch (landings) in numbers-at-age, catch and stock weights are given respectively in Tables 7.2.2, 7.2.3, 7.2.4.

Biological parameters are described in the stock Annex and are unchanged since the 2012 WKROUND benchmark. Celtic Sea cod are very fast growing and early maturing compared with more northern cod stocks.

Commercial lpue

Tables 7.2.5 show the series of landings, fishing effort and lpue dataseries for French fleets (a), Irish fleets (b) and UK fleets (c). Figure 7.2.5 (a,b,c) shows their trends.

A general decrease in the lpue trend is observed in almost all series between 1990 and 2004, where the TAC began to be constraining. From that point, the lpues seemed to stabilize, or even to increase if highgrading is taken into account. In 2011, the strong recruitment of year class 2009 has resulted in an increase of lpue for all fleets between 2010 and 2012. Different features are observed in the effort time-series. The métiers showing the highest levels of cod directed effort have decreased significantly in the last 5–10 years until 2010.Since then, effort has gone up again following the increased of TACs possibilities.

Since 2013 effort for French tuning fleet decreased and lpue has stabilized. Effort of Irish fleet targeting gadoids (otter trawlers VIIg) remains at high level and lpue is decreasing. Effort of the UK trawl fleet in VIIe shows on a decreasing trend while beam-trawl effort in VIIe–k is stable.

Surveys and commercial tuning fleet

Table 7.2.6 presents the survey dataseries. Two ongoing surveys, both part of the DCF, IBTS Q4 (FR-EVHOE & IR-GFS7gj combined) are used to assess this stock (see details in the stock annex and modification based on 2014 WKCELT benchmark).

The historical time-series of age structure of the commercial tuning index (OTDEF French fleet for quarter 2,3 and 4) and the survey index are shown in Figure 2.2.6.

In order to overcome the difficulty of constructing survey-series with generally low number of cod, WKROUND 2012 tested and agreed on a combination of the two surveys into a single abundance index. Both surveys reflect the strong 2009 and 2010 year class. French survey (FR-EVOHOE) generally picks up older fish in central and southern Celtic Sea whereas the Irish survey provides more juvenile information from VIIg and along the Irish coast. As part of constructing a combined index for whiting during the 2014 WKCELT benchmark process a review of methods was made to speed up and simplify the spatial aggregation process. Updated indices were then recalculated for both Celtic Sea whiting and cod. In 2013 good correlation were found between the two indices calculation and the uses of the updated indices was validated by the WGCSE (see stock annex).

Data issues

Minor revision of 2013 discard estimates (597 t to 530 t) was made. Ireland annual discards of OTB_DEF_100-119 and TBB_DEF-70-99 strata were not manually matched to quarterly landings of the same strata in InterCatch, leading to a slight overestimation of discards for these strata (duplication : quarterly estimated and annual imported data for the same strata).

7.2.3 Stock assessment

Model used: XSA.

Final update assessment (XSA)

The final assessment was run with the same settings as established by WKROUND 2012 and described in the stock annex. Discards are not included in the assessment.

VPA.95 software was run in parallel to the FLRXSA R script to fully validate the assessment.

Xsa diagnostics is shown in Tables 7.27. Residuals (Figure 7.2.7) and diagnostics do not highlight any problem regarding the input data and model fit. Outputs from the assessment are shown are in Tables 7.2.8–7.2.10 and in Figures 7.2.8–7.2.10.

Last year's assessment shows strong upward revision in F and downward revision in SSB in recent years. The upward revision in F is likely due to strong recruitment dynamics (strong 2009 year class still included in F_{bar} range).

This year's assessment shows again substantial upward revision in F and downward revision in SSB in recent years (7.2.11). The fishery is mainly based on the 2013 year class because other year classes in the fishery are very weak (year class 2011 and 2012).

The comparison of run with and without tuning indices indicates that both tuning indices contain little information and that the majority of the information comes from the catch-at-age matrix (Figure 7.2.12). The low numbers of old fish in the 2015 catch data (Table 7.2.2 and Figure 7.2.9) results in this upward revision of F for the last few years.

Other issues might increase retrospectives bias: The non-inclusion of undersized discards (and highgrading in recent years) in the assessment. Potential problems in the commercial tuning index could not be excluded.

State of the stock

Table 7.4.8 shows the estimated fishing mortality-at-age and Table 7.4.9 shows the stock numbers-at-age. The stock summary is given in Table 7.4.10 and Figure 7.4.10.

Catches are around 5000 t since 2000 (Figure 7.2.1), with some higher catch following strong recruitments. Reliable discards estimates are only available since 2011 and ranges between 500 and 1000 t depending on the interplay between recruitment dynamics and TAC constraints.

Recruitment has been highly variable over time with occasional very high recruitment followed by period of low recruitments. The 2011, 2012 year classes are estimated well below the average of the time-series, but the 2013 year class is above average. The 2014 year class is the lowest observed in the time-series.

Spawning–stock biomass (SSB) is well below $MSYB_{trigger}$ since 2000 and often below B_{lim}, with the exception of 2012 as the consequence of very good recruitments.

Fishing mortality (F) has declined between 2005 and 2011 and fluctuated in recent years with high increase in 2012 and 2013 and a decrease in 2014 and 2015. Fishing mortality remains well above reference points F_{MSY}, and in recent year above F_{pa}.

7.2.4 Short-term projections

Because catches of Celtic sea cod are often composed by a high proportion of age 2 fish (due to their fast growth rate, age 2 fish range between 30 and 60 cm) and recruitment of cod is characterised by period of low recruitment and sporadic events, the assumed geometric mean for recruitment introduces significant uncertainty in the short-term projections. Recruitment (age 1) in 2016 and thereafter, is assumed as the 25th quantile of the time-series to account for recruitment dynamics of the stock (successive weak recruitments have often been observed).

Three year averages were used for F (age range 2 to 5) and weights-at-age. No TAC constraint was applied.

Input to the short-term predictions are presented in Table 7.2.11. The detailed results are presented in Table 7.2.12.

Variable	Value	Notes
F ages 2–5 (2016)	0.73	F(2013–2015)
SSB (2017)	6202	
R age1(2016/2017)	2740	The 25th quantile of the recruitment time-series (1971–2015)
Catch (2016)		Unknown
Landings (2016)	4865	Assuming F = F(2013–2015)
Discards (2016)		Not quantified because of variable discard rates in the recent past

Slower growth rate for the 2014 year class was observed when preparing national data, leading for smaller fish of age 2 compared to average. This do not impact mean weight assumptions in the forecast that seems reliable.

Under the forecast assumption, landings in 2016 are predicted to be 4865 t (higher than the TAC set at 4565 t), and the spawning–stock biomass of 6202 t in 2017which is well below B_{lim} (7300 t) (Table 7.2.15).

The detailed management option table is presented in Table 7.2.13 and various special management options are presented in Table 7.2.14. Note the values in this table are based on an interpolation.

The forecast are sensitive to the recruitment assumption that contributes to 38% of the landings in 2016 and the half of the projected SSB in 2018 (Figure 7.2.13 and Table

7.2.12). The relatively strong 2013 year class (compared to the other years) accounts for most of the remainder of the projected landings in 2017.

7.2.5 Medium-term projection

No medium-term projections were carried out.

7.2.6 MSY and Biological reference points

New value of F_{MSY} has been estimated using the agreed ICES guidelines (ICES, 2016, WKMSYref4).

The advice and forecasts are based on the following reference points:

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	10 300 t	B_{pa}	ICES (2016)
	F_{MSY}	0.35	Range (0.23–0.55)	ICES (2016)
Precautionary approach	B_{lim}	7300 t	B_{loss} estimated in 2015	ICES (2016)
	B_{pa}	10 300 t	B_{lim} × 1.4.	ICES (2016)
	F_{lim}	0.80	Based on segmented regression with B_{lim} as breakpoint	ICES (2016)
	F_{pa}	0.58	F_{lim}/1.4	ICES (2016)
Management plan	SSB_{MGT}	Undefined.		
	F_{MGT}	Undefined.		

7.2.7 Management plans

There are no specific management objectives or a management plan for this stock.

There was some discussion at the WG about the recent past history of Cod7e–k management. After the next benchmark in 2018, MSE which accounts for recruitment dynamics should be discussed.

7.2.8 Uncertainties and bias in assessment and forecast

Issues that might increase retrospectives bias are:

i) the non-inclusion of undersized discards (and highgrading in recent years) in the assessment. However, highgrading is estimated at a very low level in recent year because the TACs were not constraining (undershoot TACs).

ii) Potential problems in the commercial tuning index could not be excluded. Sensitivity analysis to commercial tuning index calculation should be undertaken to try improving the quality of the assessment. A clear description on the how the French commercial tuning index is calculated should be added to the stock annex.

The strong retrospective patterns observed imply that the 2015 estimates of SSB and F might be uncertain as well.

Discards normally constitute about 10% of the total catch, but discard rates in recent years have fluctuated substantially due to variable recruitment and TACs constraints. This prevents the forecast of a discard rate for 2016 with any certainty.

Benchmark recommendations

WGCSE recommend that cod, haddock and whiting in the Celtic Sea should be benchmarked together in 2018. The focus of the benchmark would be on streamlining data compilation procedures for fishery-dependent and survey data. This we give improved transparency and diagnostics surrounding commercial tuning fleets and surveys. The benchmark should also relook at the assessment methods and diagnostics given the potential for changes in selectivity in the commercial fishery. The benchmark should also investigate mixed fisheries and multispecies interactions as well as environmental drivers that may be impacting on growth and recruitment of all three species.

7.2.9 Management considerations

None of the catch option will bring the SSB in 2018 above MSY $B_{trigger}$ due to the weak 2014 year class. The 25% quantile assumption chosen for forecasting recruitment is more precautionary that the geometric mean that is normally used.

Several management options (F lower than F_{MSY}) can bring SBB above B_{lim}. The upward revision in F compared to last year assessment implies that the current F estimates might be uncertain.

The recent technical measures introduced in the Celtic Sea (square mesh panels) are not expected to significantly reduce catches of Celtic Sea cod or improved the selection pattern. This is because of the fast growth rate of Celtic sea cod (age 2 fish range between 30 and 50 cm).

Mixed fisheries issues can also be responsible for maintaining F at high level, as the other gadoids fishing opportunities are higher. In this context, cod has is no longer a target species but can be considered as bycatch in the fleet targeting haddock whiting and *Nephrophs*.

Historical information on management consideration can be found in the stock annex.

7.2.10 References

Bendall, V., O Cuaig, M, Schön, P-J., Hetherington, S., Armstrong, M., Graham, N., and Righton, D. 2009. Spatiotemporal dynamics of Atlantic cod (*Gadus morhua*) in the Irish and Celtic Seas: results from a collaborative tagging programme ICES CM 2009/J:06.

Cochran, W.G. 1977. Sampling Technics. J. Wiley & Sons. 428 p.

STECF. 2014. European Commission Request for services - Celtic Sea.

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

Table 7.2.1.Nominal landings of Cod in Divisions VII e–k used by the Working Group.

Year	Belgium	France	Ireland	UK	Others	Landings taken or reported in 33E2 and33E3***	Total	Highgraded discard estimates	Discard estimates
1971	NA	NA	NA	NA	NA	NA	5782		
1972	NA	NA	NA	NA	NA	NA	4737		
1973	NA	NA	NA	NA	NA	NA	4015		
1974	NA	NA	NA	NA	NA	NA	2898		
1975	NA	NA	NA	NA	NA	NA	3993		
1976	NA	NA	NA	NA	NA	NA	4818		
1977	NA	NA	NA	NA	NA	NA	3059		
1978	NA	NA	NA	NA	NA	NA	3647		
1979	NA	NA	NA	NA	NA	NA	4650		
1980	NA	NA	NA	NA	NA	NA	7243		
1981	NA	NA	NA	NA	NA	NA	10597		
1982	NA	NA	NA	NA	NA	NA	8766		
1983	NA	NA	NA	NA	NA	NA	9641		
1984	NA	NA	NA	NA	NA	NA	6631		
1985	NA	NA	NA	NA	NA	NA	8317		
1986	NA	NA	NA	NA	NA	NA	10475		
1987	NA	NA	NA	NA	NA	NA	10228		
1988	554	13863	1480	1292	2	NA	17191		
1989	910	15801	1860	1223	15	NA	19809		
1990	621	9383	1241	1346	158	NA	12749		
1991	303	6260	1659	1094	20	NA	9336		
1992	195	7120	1212	1207	13	NA	9747		

Year	Belgium	France	Ireland	UK	Others	Landings taken or reported in 33E2 and33E3***	Total	Highgraded discard estimates	Discard estimates
1993	391	8317	766	945	6	NA	10425		
1994	398	7692	1616	906	8	NA	10620		
1995	400	8321	1946	1034	8	NA	11709		
1996	552	8981	1982	1166	0	NA	12681		
1997	694	8662	1513	1166	0	NA	12035		
1998	528	8096	1718	1089	0	NA	11431		
1999	326	5488	1883	897	0	NA	8594		
2000	208	4281	1302	744	0	NA	6535		
2001	347	6033	1091	838	0	NA	8309		
2002	555	7368	694	618	0	NA	9235		
2003	136	5222	517	346	0	NA	6221	210*	na
2004	153	2425	663	282	0	108	3523	148*	na
2005	186	1623	870	309	0	54	2988	74*	na
2006	103	1896	959	368	0	103	3326	432*	na
2007	108	2509	1210	412	0	527	4239	592*	na
2008	65	2064	1221	289	0	558	3639	322*	na
2009	49	2080	870	264	0	193	3263	25*	na
2010	51	1853	1034	289	2	143	3229	7*	na
2011	124	3171	1011	414	17	147	4737	1828**	696
2012	290	5166	1536	701	0	85	7693	na	952
2013	202	4064	1478	546	0	76	6290	na	530
2014	141	2080	1159	464	1	24	3845	na	741
2015	120	2487	1126	422	2	39	4157	na	565

***French highgrading estimates from self-sampling programme.**

****International highgrading estimate.**

*****Already included in the Ireland estimates.**

Table 7.2.2a. Cod in Divisions VIIe–k. Landings number-at-age (in thousands) (note: 2011 values represent actual catch) - InterCatch outputs.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
1971	725	461	557	96	35	17	5	5	1	0
1972	4	774	110	205	45	26	11	5	1	0
1973	332	239	346	60	74	17	6	4	1	0
1974	1	224	40	118	38	37	18	4	14	0
1975	673	136	185	61	105	20	20	12	1	0
1976	51	1456	61	107	11	22	2	4	1	0
1977	25	416	236	15	60	2	2	5	10	0
1978	197	497	129	116	20	34	6	8	4	2
1979	438	357	263	68	104	19	24	5	2	1
1980	609	1213	285	175	52	55	14	0	0	0
1981	315	3086	811	153	41	20	10	2	0	0
1982	76	1157	888	169	36	19	4	1	0	0
1983	1285	529	540	424	77	21	5	5	1	0
1984	737	1210	134	97	94	22	3	2	0	0
1985	726	1245	465	61	40	47	12	2	1	0
1986	651	1303	673	254	30	31	17	0	0	0
1987	2741	946	448	250	62	20	11	4	0	0
1988	1830	5443	320	133	46	21	4	2	2	0
1989	666	2639	2483	149	77	18	8	2	1	0
1990	360	846	1006	663	79	21	8	6	2	0
1991	1377	1034	229	330	203	48	11	3	0	0
1992	1434	2601	329	64	70	53	16	1	0	0
1993	274	2371	928	79	24	19	14	2	0	0
1994	1340	692	1199	258	27	10	11	6	0	0
1995	823	3320	310	284	73	13	2	3	0	0
1996	617	2248	1199	134	95	43	3	1	0	0
1997	1184	1870	951	297	48	22	6	0	0	0
1998	639	2545	641	254	99	36	6	2	0	0
1999	496	1141	756	158	59	36	9	5	0	0
2000	1693	464	419	169	44	17	12	2	0	0
2001	1091	2373	136	98	70	19	12	6	1	0
2002	210	2069	883	64	33	12	6	4	1	0
2003	103	556	827	217	15	9	6	1	0	0
2004	341	298	175	168	59	8	4	3	0	0
2005	295	664	138	52	45	11	2	0	0	0
2006	368	994	249	25	14	13	4	1	0	0
2007	491	1245	409	60	9	4	3	1	0	0
2008	123	769	312	101	24	4	3	1	0	0
2009	161	281	324	96	37	10	2	0	0	0
2010	532	434	122	91	42	9	2	0	0	0
2011	1516	3158	232	52	32	9	2	0	0	0
2012	35	489	1346	219	26	14	4	0	3	0

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
2013	110	195	433	451	65	21	6	0	0	0
2014	762	327	82	113	134	9	1	0	0	0
2015	37	1576	119	21	34	27	8	1	0	0

Table 7.2.2b. Cod in Divisions VIIe–k. Landings number-at-age (in thousands) used in the assessment (note: 2011 values represents actual catch) - after sop correction.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
1971	725	461	557	96	35	17	11
1972	4	772	110	204	45	26	17
1973	331	239	345	60	74	17	11
1974	1	223	40	118	38	37	36
1975	674	136	185	61	105	20	33
1976	51	1460	61	107	11	22	7
1977	25	416	236	15	60	2	17
1978	196	496	129	116	20	34	20
1979	438	357	263	68	104	19	32
1980	609	1213	285	175	52	55	14
1981	315	3087	811	153	41	20	12
1982	77	1174	901	171	37	19	5
1983	1286	529	540	424	77	21	11
1984	736	1208	134	97	94	22	5
1985	733	1256	469	62	40	47	15
1986	651	1303	673	254	30	31	17
1987	2698	931	441	246	61	20	15
1988	1829	5441	320	133	46	21	8
1989	666	2640	2484	149	77	18	11
1990	356	838	996	656	78	21	16
1991	1377	1034	229	330	203	48	14
1992	1434	2601	329	64	70	53	17
1993	274	2373	929	79	24	19	16
1994	1340	692	1199	258	27	10	17
1995	823	3320	310	284	73	13	5
1996	617	2248	1199	134	95	43	4
1997	1185	1871	952	297	48	22	6
1998	640	2548	642	254	99	36	8
1999	497	1143	757	158	59	36	14
2000	1692	464	419	169	44	17	14
2001	1090	2371	136	98	70	19	19
2002	210	2068	883	64	33	12	11
2003	103	556	826	217	15	9	7
2004	341	298	175	168	59	8	7
2005	296	665	138	52	45	11	2
2006	368	995	249	25	14	13	5
2007	492	1246	409	60	9	4	4
2008	123	771	313	101	24	4	4
2009	161	281	324	96	37	10	2
2010	534	435	122	91	42	9	2
2011	1515	3156	232	52	32	9	2
2012	35	490	1349	219	26	14	7

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
2013	110	195	434	452	65	21	6
2014	747	320	80	111	131	9	1
2015	36	1518	115	20	33	26	9

Table 7.2.3. Cod in Divisions VIIe–k. Catch (landings) weight-at-age.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
1971	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1972	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1973	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1974	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1975	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1976	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1977	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1978	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1979	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1980	0.908	2.193	4.831	7.464	9.669	11.784	13.862	15.494	16.195	16.315
1981	0.945	1.549	4.385	7.565	9.060	12.750	13.822	19.232	19.232	19.232
1982	0.945	2.242	4.474	7.797	10.250	12.465	15.074	16.908	18.538	20.949
1983	0.979	2.525	4.961	7.457	9.965	12.010	14.767	17.643	19.131	19.131
1984	0.981	2.645	5.284	7.828	9.758	11.672	14.548	16.527	16.527	16.527
1985	1.001	2.637	5.521	8.082	10.407	11.469	13.448	16.658	20.853	20.853
1986	1.054	2.554	5.398	7.440	10.782	12.396	13.558	13.558	13.558	13.558
1987	0.909	2.504	5.264	8.089	10.447	13.574	15.029	16.229	16.229	16.229
1988	0.906	2.187	5.318	7.997	10.649	12.486	13.805	14.285	16.592	16.592
1989	0.844	2.013	4.706	7.638	9.438	12.917	12.479	15.407	16.683	16.683
1990	0.880	2.300	4.624	7.188	9.045	11.713	13.769	16.786	13.081	13.081
1991	0.905	2.135	4.987	6.738	8.865	10.809	13.768	15.478	15.478	15.478
1992	0.815	1.916	4.916	7.359	9.744	11.498	12.474	15.117	15.117	15.117
1993	0.871	2.043	4.508	6.866	8.431	10.942	12.147	13.646	16.530	16.530
1994	0.874	2.000	4.492	7.926	10.092	12.212	13.072	15.865	15.865	15.865
1995	0.806	1.973	4.589	7.560	9.750	11.152	13.983	14.147	14.147	14.147
1996	0.787	1.877	4.639	6.997	9.854	11.407	13.040	10.363	10.363	10.363
1997	0.771	2.039	4.516	7.389	9.719	11.820	14.367	13.687	13.687	13.687
1998	0.853	1.896	4.461	6.881	9.329	11.216	13.904	14.573	17.161	14.020
1999	0.993	2.098	4.495	7.326	8.945	11.255	13.877	15.988	15.988	17.159
2000	0.863	2.541	4.629	7.042	9.502	10.660	11.746	14.476	14.720	14.720
2001	0.794	2.029	5.112	7.858	9.832	11.423	13.206	14.879	16.311	16.311
2002	0.757	1.880	4.728	6.764	9.360	10.774	12.876	13.463	13.719	14.300
2003	0.889	1.844	4.274	6.667	9.506	11.064	12.040	12.762	11.139	11.139
2004	0.884	2.177	4.543	7.073	9.435	10.802	11.985	14.115	14.115	12.468
2005	0.776	2.118	3.907	6.168	9.194	11.544	10.037	12.657	13.835	13.835
2006	0.789	1.793	4.716	7.404	9.186	11.646	12.313	12.699	12.699	12.699
2007	0.772	1.657	4.276	7.463	9.697	11.863	12.441	13.953	15.046	15.046
2008	0.847	1.804	4.541	7.164	9.229	11.095	13.470	12.807	15.178	16.086
2009	0.923	2.384	4.248	6.721	8.895	10.584	10.342	10.497	16.169	14.560
2010	0.853	2.226	4.789	7.285	9.975	11.948	12.188	14.489	15.119	15.119
2011	0.532	1.449	4.551	7.745	9.524	10.597	12.749	10.595	10.595	10.595
2012	1.093	1.712	3.510	7.077	10.196	12.232	14.106	13.929	11.214	16.248

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
2013	0.982	2.159	4.087	6.977	8.363	10.479	11.904	16.384	12.989	12.989
2014	0.811	2.454	4.726	7.228	9.114	11.080	12.014	16.659	16.659	16.659
2015	0.915	1.838	4.144	7.980	9.539	10.719	11.891	12.416	16.165	16.165

Table 7.2.4. Cod in Divisions VIIe–k. Stock weight-at-age =1st quarter values.

year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
1971	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1972	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1973	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1974	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1975	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1976	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1977	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1978	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1979	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1980	0.662	1.709	4.444	7.321	9.529	11.605	13.513	15.327	15.744	15.744
1981	0.460	1.549	2.284	7.806	10.544	11.439	14.464	15.354	15.354	15.354
1982	0.704	1.488	3.876	7.407	9.624	12.316	15.032	18.569	18.569	18.569
1983	0.446	1.945	4.467	7.353	9.752	11.223	15.908	18.089	21.977	21.977
1984	0.512	1.951	4.928	7.433	9.552	12.180	14.181	16.733	16.733	16.733
1985	0.581	2.070	5.333	8.376	10.851	11.585	14.247	16.399	20.853	20.853
1986	0.528	1.902	5.286	7.382	10.689	12.393	14.482	14.482	14.482	14.482
1987	0.522	1.947	4.877	7.946	10.308	14.419	15.171	16.201	16.201	16.201
1988	0.906	1.621	4.887	7.777	10.302	11.786	12.416	13.889	15.119	15.119
1989	0.844	1.463	4.514	7.615	9.438	12.692	12.788	17.794	17.794	17.794
1990	0.613	1.774	4.390	7.186	8.486	10.703	13.305	16.987	13.081	13.081
1991	0.539	1.538	4.791	6.524	8.631	10.672	13.512	14.898	14.898	14.898
1992	0.663	1.318	4.600	6.558	9.342	11.285	12.322	14.770	14.770	14.770
1993	0.703	1.385	4.278	6.574	8.066	10.815	11.945	13.421	16.530	16.530
1994	0.605	1.754	4.189	7.720	9.722	12.101	12.844	15.859	15.859	15.859
1995	0.612	1.444	4.346	7.452	9.140	10.646	13.908	14.147	14.147	14.147
1996	0.673	1.283	4.471	6.747	9.877	11.424	12.848	12.848	12.848	12.848
1997	0.470	1.410	4.079	7.112	9.044	11.156	13.730	13.623	13.623	13.623
1998	0.421	1.314	4.340	6.676	9.303	11.172	12.369	14.205	17.161	14.020
1999	0.778	1.542	4.252	7.126	8.700	11.142	13.978	17.463	17.159	17.159
2000	0.561	1.696	4.223	6.627	9.326	10.505	11.115	13.566	13.566	13.566
2001	0.630	1.455	4.904	7.872	10.192	11.613	13.174	14.715	16.311	16.311
2002	0.352	1.257	4.452	7.046	9.400	10.614	12.637	14.949	14.949	14.949
2003	0.482	1.327	4.111	6.601	9.183	10.635	12.047	15.832	15.832	15.832
2004	0.591	1.258	4.053	6.759	9.372	10.158	11.680	13.850	13.850	13.850
2005	0.588	1.688	4.075	5.945	9.018	11.333	11.487	13.772	13.772	13.772
2006	0.703	1.216	4.233	6.819	8.895	11.487	11.411	12.703	12.703	12.703
2007	0.722	1.399	3.794	6.990	9.809	12.273	15.042	14.465	14.795	14.795
2008	0.869	1.449	4.188	6.896	8.881	11.543	13.624	10.045	13.763	13.763
2009	0.938	1.629	3.865	6.557	8.985	10.567	12.981	12.981	12.981	12.981
2010	0.819	1.424	4.373	6.984	9.891	11.663	12.575	13.085	13.085	13.085
2011	0.374	1.214	4.198	7.239	9.404	11.039	12.785	12.785	12.785	12.785
2012	1.005	1.224	3.534	7.333	10.404	11.702	13.727	12.663	16.045	16.174

year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
2013	0.497	1.377	3.747	6.805	8.491	9.945	9.897	17.158	17.158	17.158
2014	0.464	1.654	3.788	6.530	9.074	10.584	11.611	12.285	12.285	12.285
2015	1.161	1.309	4.079	8.517	10.105	10.661	12.288	13.134	13.134	13.134

Table 7.2.5a. Cod in Divisions VIIe–k. Time-series of landings, effort, lpue for French OT-DEF fleets. Units in tonnes, Effort in 000s hours fished, lpue in Kg/hour fished.

Year	Effort	Landings	LPUE
2000	217480.1	1360798.3	6.26
2001	223428.0	2297415.3	10.28
2002	191161.1	2521943.2	13.19
2003	184878.5	1594331.4	8.62
2004	164606.5	693554.3	4.21
2005	132471.5	589933.2	4.45
2006	117258.8	571191.5	4.87
2007	115878.4	816210.8	7.04
2008	113485.2	652235.7	5.75
2009	113347.6	550405.7	4.86
2010	100331.9	635001.8	6.33
2011	101251.0	925372.7	9.14
2012	124404.4	2518809.6	20.25
2013	155301.2	1513472.3	9.75
2014	147142.9	1097602.2	7.46
2015	135732.0	1202081.0	8.86

Table 7.2.5b. Cod in Divisions VIIe–k. Time-series of landings, effort, lpue for the Irish fleets. Units in tonnes live weight, Effort in 000s hours fished, lpue in Kg/hour fished.

	Otter.trawlers.VIIj			Beam.trawlers.VIIj			Ir.Scottish.seiners.VIIj			Gillnet VIIj		
year	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue
1995	339.3	93.2	3.6	0	0.2	0.2	75.5	5.3	14.4	178.8	21.3	8.4
1996	326.4	70.2	4.6	8.7	1.4	6.3	124.5	8.2	15.3	65	5.2	12.4
1997	352.7	82.7	4.3	3.4	1.7	2	115.8	10.7	10.8	45.5	8.3	5.5
1998	262.7	89.1	2.9	19.1	5.2	3.7	103.4	6.6	15.6	59.1	16	3.7
1999	76.7	40.5	1.9	27.5	7.4	3.7	9.6	1.4	6.8	24.6	8.7	2.8
2000	95.5	63.9	1.5	21.2	6.9	3.1	24.4	3.5	7	13.8	7	2
2001	148.5	67.4	2.2	10.7	3	3.6	31.3	4.4	7.1	14.8	6.6	2.3
2002	150	90.4	1.7	5.4	3.1	1.7	24.6	8.9	2.8	12.3	8.1	1.5
2003	73.6	107.4	0.7	8.8	9	1	12	7.9	1.5	6.3	11.2	0.6
2004	36.1	88.3	0.4	2.5	2.2	1.2	10.3	8.1	1.3	4.2	6.1	0.7
2005	37.8	71.3	0.5	4.7	2.4	2	17.5	5.8	3	3.4	6.1	0.6
2006	39.6	64.5	0.6	2	1.5	1.3	15.6	5.3	2.9	7.2	7.3	1
2007	35.9	78.3	0.5	7.8	2.4	3.3	9.8	3.5	2.8	6.5	10.5	0.6
2008	33.1	66.7	0.5	2.6	1.1	2.3	9.5	2.8	3.3	6.5	7.9	0.8
2009	26.6	73	0.4	4.7	2.8	1.7	8.9	3.3	2.7	8	10.9	0.7
2010	52.5	85.7	0.6	1.7	1	1.7	17	4.4	3.9	8.4	9.4	0.9
2011	57.7	62.8	0.9	1.7	0.6	2.7	21.6	4.6	4.7	16.8	8	2.1
2012	62.8	65.6	1	0.4	0.3	1.5	29.8	5.4	5.6	25.2	8.3	3
2013	66.1	61.3	1.1	1.8	0.6	3.3	32.5	6.6	4.9	15.4	9.8	1.6
2014	51.6	53.9	1	1.2	0.6	1.9	52.6	7.4	7.1	9.7	12.2	0.8
2015	63.6	46.9	1.4	0.6	0.1	6.3	38.2	5.3	7.2	18.1	14.1	1.3

	Otter.trawlers VIIg			Beam.trawlers VIIg			Scottish.seiners.VIIg			Gillnet.VIIg		
Year	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue
1995	429.8	63.3	6.8	85.8	20.7	4.1	111.3	6.4	17.3	114.9	6.3	18.1
1996	569.2	60.0	9.5	112.5	26.7	4.2	164.9	9.7	16.9	338.9	6.2	54.8
1997	401.9	65.0	6.2	131.5	28.1	4.7	215.2	16.1	13.4	52.8	1.9	27.7
1998	450.5	72.3	6.2	166.8	35.2	4.7	264.1	14.9	17.7	87.3	3.4	25.4
1999	300.7	51.5	5.8	190.6	40.8	4.7	64.6	8.0	8.1	200.4	8.4	23.9
2000	279.4	60.6	4.6	180.6	36.8	4.9	106.0	9.9	10.8	151.7	10.1	15.0
2001	358.5	69.4	5.2	101.2	39.5	2.6	115.0	16.3	7.0	115.8	8.8	13.2
2002	212.9	77.2	2.8	57.9	31.5	1.8	71.0	20.9	3.4	31.0	6.4	4.8
2003	167.2	86.8	1.9	56.8	49.2	1.2	35.6	20.1	1.8	31.3	11.1	2.8
2004	190.2	97.1	2.0	74.3	54.9	1.4	54.4	18.4	3.0	62.0	13.5	4.6
2005	292.5	124.7	2.3	118.9	49.6	2.4	64.4	14.6	4.4	77.9	10.9	7.2
2006	379.4	118.0	3.2	128.6	60.5	2.1	91.0	14.8	6.2	63.7	7.8	8.1
2007	316.1	135.4	2.3	96.2	55.8	1.7	58.5	15.8	3.7	85.4	9.4	9.1
2008	344.9	125.4	2.7	85.4	37.2	2.3	55.6	11.6	4.8	88.0	14.1	6.2
2009	405.9	137.1	3.0	74.4	37.9	2.0	34.6	8.2	4.2	81.1	13.8	5.9
2010	524.8	140.8	3.7	94.7	40.2	2.4	54.3	9.7	5.6	76.0	14.0	5.4
2011	438.4	120.3	3.6	82.5	35.3	2.3	46.7	11.0	4.2	76.6	11.3	6.7
2012	780.7	127.7	6.1	161.9	40.3	4.0	111.5	14.1	7.9	129.1	15.4	8.4
2013	721.4	118.2	6.1	195.8	38.5	5.1	111.3	13.2	8.5	92.5	14.4	6.4
2014	600.1	127.3	4.7	142.9	37.8	3.8	110.5	12.5	8.9	59.2	14.1	4.2
2015	528.5	133.2	4.0	160.1	37.8	4.2	59.2	9.3	6.4	48.3	12.5	3.9

Table 7.2.5c. Cod in Divisions VIIe–k. Time-series of landings, effort, lpue for the UK fleets. Units: landings in tonnes, Effort in days fished and lpue in Kg/day.

	BEAM.TRAWL.VIIe.k		TRAWL..VIIe.k		TRAWL.VIIe..only	
YEAR	Lands.t.	Effort.Days.	Lands.t..1	Effort.Days..1	Lands.t..2	Effort.Days..2
1983	25.55	2853	40.93	2573	20.60	1871
1984	128.75	8427	235.68	8092	76.42	5618
1985	145.39	7706	250.67	7186	63.97	5411
1986	165.76	6651	232.19	6174	78.31	4425
1987	248.91	8060	210.36	5446	88.49	3701
1988	249.21	9487	262.68	5645	151.35	4265
1989	231.24	10071	177.12	5997	96.00	4607
1990	309.07	10477	305.78	6661	119.41	4423
1991	256.19	9017	242.33	5938	83.60	4004
1992	256.33	8183	231.85	6494	80.76	4108
1993	221.79	9511	183.05	5055	42.88	3761
1994	179.13	13925	78.23	4426	41.25	3423
1995	241.35	15076	115.05	4405	55.09	3294
1996	304.22	15748	120.46	4476	59.21	2589
1997	303.67	16373	150.01	5088	79.81	3011
1998	266.15	15574	119.56	4729	62.50	2699
1999	257.43	15614	90.68	6638	46.81	2486
2000	188.07	16456	110.79	7054	52.59	2681
2001	257.24	17335	109.75	5875	59.05	2732
2002	132.13	16503	82.70	5657	34.11	2448
2003	108.77	18285	58.80	5120	24.48	2273
2004	96.93	18250	44.06	5273	15.05	2334
2005	103.60	17157	41.13	5047	17.38	1762
2006	91.88	15412	55.43	5314	13.54	1699
2007	111.28	15085	49.65	5679	21.61	1917
2008	71.38	13734	49.34	4686	24.26	1750
2009	67.27	12170	27.56	4928	12.56	1847
2010	65.62	12150	31.13	5185	15.27	2213
2011	99.03	13205	47.73	4354	26.00	1931
2012	165.63	13411	79.03	4312	30.95	2068
2013	114.49	12950	37.30	2014	22.94	1587
2014	87.55	12802	17.07	1606	14.06	1440
2015	89.38	12764	16.68	1061	14.40	978

Table 7.2.6. Cod in Divisions VIIe–k. Time-series of survey indices scrutinized at WGCSE and used in the assessment.

Cod	in	Divisions	VIIe–k,	tuning							
102											
FR-OTDEF	Q2+3+4	trawlers	in	VIIe–k							
2000	2015										
1	1	0.25	1								
1	10										
Year	Effort	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8	Age_9	Age_10
2000	217479	200742	93804	59384	35784	11253	5683	3988	545	356	0
2001	223427	119879	383175	45401	44844	34907	11427	5256	2109	0	0
2002	191161	188306	472476	144332	38748	16046	9760	4317	4212	252	0
2003	184878	22380	134512	138065	59698	7928	7313	4455	847	424	0
2004	164606	12412	54908	41644	21032	13420	1720	208	0	0	208
2005	132472	13489	132632	10525	6207	8814	2861	367	54	237	0
2006	117259	24447	148506	27730	3716	1912	1282	845	0	0	0
2007	115878	265362	409573	76766	13367	2099	684	818	235	60	0
2008	113485	77385	252690	44372	16057	4178	624	236	447	0	8
2009	113348	106600	58211	46807	14017	5042	1939	894	353	0	19
2010	100332	206831	103580	15881	8766	4600	678	102	0	17	0
2011	101251	6870	1145981	92577	22801	17131	3074	551	0	0	0
2012	124404	2709	108920	463339	109825	12257	6173	1939	176	1329	0
2013	155301	41174	66032	126952	129554	21809	5676	1921	0	0	0
2014	147143	160520	70506	23843	29394	48405	2958	191	0	0	0
2015	135732	3473	409342	36700	6263	11629	7460	4640	0	0	0
IR-GFS	FR-EVHOE	Q4	combined	indices	new						
2003	2015										
1	1	0.79	0.92								
0	6										
Year	Effort	Age_0	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6			
2003	1	0.14	0.61	0.75	0.50	0.17	0.00	0.00			
2004	1	0.24	0.88	0.24	0.15	0.14	0.07	0.00			
2005	1	0.06	1.81	0.26	0.09	0.00	0.00	0.00			
2006	1	0.04	1.39	0.67	0.08	0.00	0.00	0.02			
2007	1	0.00	1.93	0.64	0.19	0.05	0.00	0.00			
2008	1	0.00	0.55	0.88	0.24	0.12	0.00	0.00			
2009	1	0.10	1.38	0.17	0.26	0.12	0.00	0.01			
2010	1	0.12	7.34	0.76	0.04	0.06	0.07	0.00			
2011	1	0.02	4.09	3.54	0.22	0.04	0.03	0.00			
2012	1	0.00	0.39	1.32	0.80	0.19	0.04	0.00			
2013	1	0.08	0.42	0.05	0.21	0.23	0.00	0.00			
2014	1	0.00	3.64	0.27	0.12	0.15	0.20	0.00			
2015	1	0.00	0.31	1.36	0.12	0.00	0.05	0.06			

Table 7.2.7. Cod in Divisions VIIe–k. Final XSA diagnostics (from FLR XSA).

FLR XSA Diagnostics 2016-05-11 12:26:46

CPUE data from indices

Catch data for 45 years. 1971 to 2015. Ages 1 to 7.

	fleet	first age	last age	first year	last year	alpha	beta
1	FR-OTDEF	1	6	2000	2015	<NA>	<NA>
2	IR-FR COMBINED SURVEY	1	4	2003	2015	<NA>	<NA>

Time-series weights:

Tapered time weighting not applied

Catchability analysis:

Catchability independent of size for all ages

Catchability independent of age for ages > 3

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	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

year										
age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0.109	0.179	0.104	0.072	0.052	0.493	0.054	0.101	0.127	0.084
2	0.749	0.936	0.650	0.489	0.374	0.678	0.386	0.660	0.658	0.557
3	0.928	1.027	0.786	0.771	0.486	0.412	0.867	0.876	0.772	0.628
4	0.727	0.675	0.893	0.670	0.574	0.437	1.029	0.955	0.648	0.495
5	0.916	0.689	0.694	1.145	0.782	0.434	0.440	1.173	0.921	0.429
6	1.106	0.787	0.824	0.751	1.096	0.388	0.361	0.837	0.485	0.479
7	1.106	0.787	0.824	0.751	1.096	0.388	0.361	0.837	0.485	0.479

XSA population number (NA)

year \ age	1	2	3	4	5	6	7
2006	4588	2268	480	55	26	22	8
2007	3871	2464	742	140	20	8	8
2008	1614	1939	669	196	54	8	8
2009	3008	872	701	225	61	21	4
2010	13548	1678	370	239	88	15	3
2011	5025	7706	799	168	103	31	7
2012	856	1839	2708	391	83	52	26
2013	1475	486	865	840	107	42	12
2014	8098	799	174	266	247	26	3
2015	570	4275	286	59	106	77	25

Estimated population abundance at 1st January 2016

year \ age	1	2	3	4	5	6	7
2016	0	314	1696	113	28	54	38

Fleet: FR-OTDEF

Log catchability residuals.

age \ year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	-0.012	-0.401	1.580	-0.012	-1.266	-1.357	-0.728	1.879	1.498	1.178	0.446	-1.717	-1.342	0.642	0.369	-0.755
2	-0.395	-0.592	-0.100	0.066	-0.308	0.061	-0.132	0.918	0.532	-0.229	-0.254	0.794	-0.502	0.265	-0.113	-0.010
3	-0.579	-0.151	-0.156	0.026	0.206	-0.504	-0.245	0.404	-0.156	-0.156	-0.642	0.297	0.746	0.376	0.302	0.232
4	-0.516	0.210	0.941	0.356	-0.327	-0.214	-0.232	0.104	0.096	-0.304	-0.769	0.451	1.315	0.451	-0.004	-0.060
5	-0.575	0.460	0.227	0.379	0.317	0.321	-0.060	0.170	-0.096	0.231	-0.305	0.640	0.319	0.843	0.713	-0.075
6	0.001	0.208	0.105	0.143	-0.059	0.061	-0.169	0.004	-0.016	0.103	-0.297	0.072	0.042	0.238	-0.084	-0.173

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	-8.8912	-6.6891	-6.6350	-6.6350	-6.6350	-6.6350
S.E_Logq	1.1506	0.4355	0.3913	0.5311	0.3737	0.1434

Fleet: IR-FR COMBINED SURVEY

Log catchability residuals.

age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0.052	-0.347	-0.035	-0.384	0.174	-0.271	-0.001	0.149	0.932	-0.023	-0.453	0.026	0.181
2	0.889	0.112	-0.524	-0.012	0.019	0.333	-0.649	0.095	0.369	0.567	-1.143	0.046	-0.102
3	0.506	0.486	0.478	-0.535	-0.022	0.111	0.131	-1.345	-0.474	-0.015	-0.203	0.752	0.131
4	0.537	0.584	NA	NA	-0.018	0.706	0.379	-0.458	-0.627	0.592	-0.045	0.416	NA

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	-7.1871	-7.1614	-7.1118	-7.1118
S.E_Logq	0.3542	0.5318	0.5549	0.4681

Terminal year survivor and F summaries:

Age 1 Year class = 2014

source	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in VIIe-k	147	1	0.077
IR-GFS FR-EVHOE Q4 combined indices new	376	1	0.804
fshk	150	1	0.118

Age 2 Year class = 2013

source	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in VIIe-k	1752	2	0.326
IR-GFS FR-EVHOE Q4 combined indices new	1667	2	0.572
fshk	1680	1	0.102

Age 3 Year class = 2012

source	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in VIIe-k	131	3	0.474
IR-GFS FR-EVHOE Q4 combined indices new	99	3	0.428
fshk	98	1	0.098

Age 4 Year class = 2011

source

	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in VIIe-k	31	4	0.575
IR-GFS FR-EVHOE Q4 combined indices new	28	3	0.298
fshk	16	1	0.127

Age 5 Year class = 2010

source

	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in VIIe-k	52	5	0.630
IR-GFS FR-EVHOE Q4 combined indices new	82	4	0.259
fshk	25	1	0.111

Age 6 Year class = 2009

source

	survivors	N	scaledWts
FR-OTDEF Q2+3+4 trawlers in VIIe-k	38	6	0.841
IR-GFS FR-EVHOE Q4 combined indices new	39	4	0.063
fshk	34	1	0.096

Table 7.2.8. Cod in Divisions VIIe–k. Final XSA fishing mortality-at-age.

Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7+	F_{bar}(mean2-5)
1971	0.219	0.685	0.635	0.550	0.359	0.519	0.519	0.557
1972	0.006	0.518	0.397	0.567	0.585	0.521	0.521	0.517
1973	0.165	0.731	0.553	0.437	0.442	0.481	0.481	0.541
1974	0.001	0.208	0.290	0.407	0.595	0.435	0.435	0.375
1975	0.156	0.367	0.313	1.160	0.871	0.791	0.791	0.678
1976	0.034	0.838	0.327	0.333	0.717	0.463	0.463	0.554
1977	0.011	0.570	0.352	0.135	0.338	0.277	0.277	0.349
1978	0.097	0.431	0.405	0.322	0.287	0.340	0.340	0.361
1979	0.089	0.340	0.512	0.433	0.585	0.515	0.515	0.468
1980	0.066	0.513	0.601	0.896	0.767	0.764	0.764	0.694
1981	0.082	0.776	0.987	0.890	0.580	0.829	0.829	0.808
1982	0.048	0.680	0.653	0.642	0.586	0.633	0.633	0.640
1983	0.274	0.747	0.987	0.861	0.741	0.874	0.874	0.834
1984	0.153	0.617	0.499	0.514	0.496	0.507	0.507	0.532
1985	0.175	0.577	0.624	0.505	0.450	0.531	0.531	0.539
1986	0.184	0.752	0.881	0.978	0.536	0.808	0.808	0.787
1987	0.148	0.596	0.757	1.165	0.726	0.894	0.894	0.811
1988	0.215	0.691	0.497	0.606	0.763	0.629	0.629	0.639
1989	0.269	0.768	1.010	0.510	0.978	0.843	0.843	0.816
1990	0.121	0.923	0.942	0.954	0.602	0.843	0.843	0.855
1991	0.170	0.865	0.869	1.173	1.018	1.034	1.034	0.981
1992	0.172	0.786	0.948	0.724	0.948	0.884	0.884	0.851
1993	0.101	0.656	0.908	0.705	0.726	0.789	0.789	0.749
1994	0.135	0.536	1.067	0.792	0.602	0.831	0.831	0.749
1995	0.116	0.811	0.587	0.919	0.584	0.705	0.705	0.725
1996	0.113	0.741	0.999	0.616	1.057	0.902	0.902	0.853
1997	0.166	0.834	1.052	0.835	0.503	0.806	0.806	0.806
1998	0.180	0.924	0.980	1.088	0.828	0.978	0.978	0.955
1999	0.319	0.791	0.999	0.791	0.896	0.907	0.907	0.869
2000	0.230	0.785	0.963	0.713	0.569	0.755	0.755	0.758
2001	0.173	0.824	0.671	0.701	0.815	0.545	0.545	0.753
2002	0.133	0.816	1.098	0.914	0.585	0.321	0.321	0.853
2003	0.108	0.873	1.224	1.060	0.604	0.322	0.322	0.940
2004	0.163	0.719	0.955	1.052	1.096	0.829	0.829	0.956
2005	0.096	0.767	1.145	1.002	1.038	0.640	0.640	0.988
2006	0.109	0.749	0.928	0.727	0.916	1.106	1.106	0.830
2007	0.179	0.936	1.027	0.675	0.689	0.787	0.787	0.832
2008	0.104	0.650	0.786	0.893	0.694	0.824	0.824	0.756
2009	0.072	0.489	0.771	0.670	1.145	0.751	0.751	0.769
2010	0.052	0.374	0.486	0.574	0.782	1.096	1.096	0.554
2011	0.493	0.678	0.412	0.437	0.434	0.388	0.388	0.490
2012	0.054	0.386	0.867	1.029	0.440	0.361	0.361	0.680
2013	0.101	0.660	0.876	0.955	1.173	0.837	0.837	0.916
2014	0.127	0.658	0.772	0.648	0.921	0.485	0.485	0.750
2015	0.084	0.557	0.628	0.495	0.429	0.479	0.479	0.527

Table 7.2.9. Cod in Divisions VIIe–k. Final XSA stock number-at-age.

Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7+
1971	4769	1118	1381	260	131	47	30
1972	928	2296	390	540	115	72	46
1973	2810	553	947	194	234	50	32
1974	889	1428	184	402	96	118	113
1975	6031	532	802	102	204	41	67
1976	1986	3093	255	433	24	67	21
1977	2871	1151	926	136	237	9	78
1978	2741	1701	450	480	91	132	77
1979	6630	1491	765	222	266	53	88
1980	12254	3634	734	338	110	116	29
1981	5179	6872	1506	297	105	40	24
1982	2117	2860	2189	414	93	46	12
1983	6923	1209	1003	841	167	41	21
1984	6696	3153	396	276	272	62	14
1985	5892	3443	1177	178	126	129	41
1986	5000	2964	1338	466	82	63	34
1987	25361	2493	967	409	134	37	28
1988	12239	13110	950	335	97	51	19
1989	3648	5919	4547	427	140	36	21
1990	4042	1670	1900	1221	196	41	31
1991	11365	2146	459	547	360	84	24
1992	11743	5745	625	142	129	101	32
1993	3701	5927	1812	179	53	39	32
1994	13717	2006	2128	539	68	20	33
1995	9676	7183	812	540	187	29	11
1996	7433	5162	2210	333	165	81	7
1997	10005	3977	1702	601	137	45	12
1998	5020	5079	1196	439	199	65	14
1999	2352	2513	1395	331	113	68	26
2000	10658	1025	789	379	115	36	29
2001	8842	5077	324	222	142	51	50
2002	2185	4455	1542	122	84	49	45
2003	1301	1147	1363	379	37	37	28
2004	2932	700	332	296	100	16	14
2005	4167	1493	236	94	79	26	5
2006	4588	2268	480	55	26	22	8
2007	3871	2464	742	140	20	8	8
2008	1614	1939	669	196	54	8	8
2009	3008	872	701	225	61	21	4
2010	13548	1678	370	239	88	15	3
2011	5025	7706	799	168	103	31	7
2012	856	1839	2708	391	83	52	26
2013	1475	486	865	840	107	42	12
2014	8098	799	174	266	247	26	3
2015	570	4275	286	59	106	77	25
GMST_71_2013	4457	2339	866	297	107	42	22
AMST_71_2013	6002	3106	1095	357	126	51	29

Table 7.2.10. Cod in Divisions VIIe–k. Final XSA summary table.

Year	Recruitment	SSB	Catch	Landings	TSB	F_{bar}_2_5	Y/SSB
1971	4769	10093	5782	5782	15346	0.557	0.57
1972	928	9298	4737	4737	12808	0.517	0.51
1973	2810	8617	4015	4015	11700	0.541	0.47
1974	889	8327	2898	2898	10717	0.375	0.35
1975	6031	7526	3993	3993	12589	0.678	0.53
1976	1986	7316	4818	4818	12224	0.554	0.66
1977	2871	8841	3059	3059	12545	0.349	0.35
1978	2741	9689	3647	3647	13783	0.361	0.38
1979	6630	9848	4650	4650	16346	0.467	0.47
1980	12254	10347	7243	7243	22845	0.694	0.7
1981	5179	11212	10597	10597	20697	0.808	0.95
1982	2117	13547	8766	8766	18951	0.64	0.65
1983	6923	13008	9641	9641	18545	0.834	0.74
1984	6696	9568	6631	6631	17147	0.531	0.69
1985	5892	13103	8317	8317	21794	0.539	0.63
1986	5000	13692	10475	10475	20931	0.787	0.77
1987	25361	11364	10228	10228	28403	0.811	0.9
1988	12239	16607	17191	17191	41445	0.639	1.04
1989	3648	26324	19809	19809	37580	0.817	0.75
1990	4042	19126	12749	12749	25110	0.855	0.67
1991	11365	10846	9336	9336	19521	0.981	0.86
1992	11743	9074	9747	9747	21918	0.851	1.07
1993	3701	12282	10425	10425	20981	0.749	0.85
1994	13717	14361	10620	10620	26255	0.749	0.74
1995	9676	13029	11709	11709	26018	0.725	0.9
1996	7433	15919	12681	12681	26403	0.853	0.8
1997	10005	14106	12035	12035	23431	0.806	0.85
1998	5020	12601	11431	11431	19665	0.955	0.91
1999	2352	11002	8594	8594	16133	0.869	0.78
2000	10658	7695	6536	6536	15344	0.757	0.85
2001	8842	8618	8308	8308	19024	0.753	0.96
2002	2185	10881	9236	9236	16018	0.854	0.85
2003	1301	8886	6420	6420	11345	0.94	0.72
2004	2932	4648	3672	3672	7233	0.955	0.79
2005	4167	3403	3062	3062	7555	0.988	0.9
2006	4588	3775	3776	3776	8973	0.83	1
2007	3871	5128	4830	4830	10460	0.832	0.94
2008	1614	5466	3961	3961	9042	0.756	0.72
2009	3008	5110	3292	3292	9254	0.769	0.64
2010	13548	4981	3229	3229	17862	0.554	0.65
2011	5025	9100	7261	7261	17207	0.49	0.8
2012	856	13719	7692	7692	17397	0.681	0.56
2013	1475	9830	6290	6290	11793	0.916	0.64
2014	8098	5247	3879	3879	10017	0.75	0.74
2015	570	5872	4154	4154	10134	0.527	0.71
2016	2741	8035					
Average_71_2014	5928	10290	7587	7587	17566	0.717	0.734

Table 7.2.11. Cod Division VIIe–k. Short-term forecast. Input table.

year	age	stock.n	stock.wt	catch.wt	mat	M	F
2016	1	2741	0.707	0.903	0.00	0.512	0.10
	2	314	1.447	2.150	0.39	0.368	0.62
	3	1696	3.871	4.319	0.87	0.304	0.76
	4	113	7.284	7.395	0.93	0.269	0.70
	5	28	9.223	9.005	1.00	0.247	0.84
	6	54	10.397	10.759	1.00	0.233	0.60
	7	50	11.297	11.956	1.00	0.223	0.60
2017	1	2741	0.707	0.903	0.00	0.512	0.10
	2	1480	1.447	2.150	0.39	0.368	0.62
	3	116	3.871	4.319	0.87	0.304	0.76
	4	586	7.284	7.395	0.93	0.269	0.70
	5	43	9.223	9.005	1.00	0.247	0.84
	6	9	10.397	10.759	1.00	0.233	0.60
	7	45	11.297	11.956	1.00	0.223	0.60
2018	1	2741	0.707	0.903	0.00	0.512	0.10
	2	1480	1.447	2.150	0.39	0.368	0.62
	3	548	3.871	4.319	0.87	0.304	0.76
	4	40	7.284	7.395	0.93	0.269	0.70
	5	222	9.223	9.005	1.00	0.247	0.84
	6	14	10.397	10.759	1.00	0.233	0.60
	7	24	11.297	11.956	1.00	0.223	0.60

Table 7.2.12. Cod Division VIIe–k. Short-term forecast. Single option output table.

	Year :2016	F multiplier 1	F_{bar}=0.73				
Age	F	CacthNos	CacthTons	StockNos	StockTons	SSBNos	SSBTons
1	0.1041894	213	192	2741	1939	0	0
2	0.6248637	124	267	314	454	122	177
3	0.7587698	792	3422	1696	6565	1475	5712
4	0.6994432	51	374	113	821	105	764
5	0.8413182	14	128	28	255	28	255
6	0.6006232	22	237	54	561	54	561
7	0.6006232	21	245	50	567	50	567
Total	1237		4865	4996	11 162	1834	8036

	Year :2017	F multiplier 1	Fbar=0.73				
Age	F	CacthNos	CacthTons	StockNos	StockTons	SSBNos	SSBTons
1	0.1041894	213	192	2741	1939	0	0
2	0.6248637	586	1261	1480	2141	577	835
3	0.7587698	54	235	116	450	101	392
4	0.6994432	262	1941	586	4268	545	3969
5	0.8413182	22	198	43	395	43	395
6	0.6006232	4	41	9	97	9	97
7	0.6006232	19	222	45	514	45	514
	Total	1160	4090	5020	9804	1320	6202

	Year :2018	F multiplier 1	Fbar=0.73				
Age	F	CacthNos	CacthTons	StockNos	StockTons	SSBNos	SSBTons
1	0.1041894	213	192	2741	1939	0	0
2	0.6248637	586	1261	1480	2141	577	835
3	0.7587698	256	1107	548	2123	477	1847
4	0.6994432	18	133	40	293	37	272
5	0.8413182	114	1027	222	2052	222	2052
6	0.6006232	6	63	14	150	14	150
7	0.6006232	10	117	24	271	24	271
	Total	1203	3900	5069	8969	1351	5427

Table 7.2.13. Cod Division VIIe–k. Short-term forecast. Management options output.

2016						
Biomasse	ssb	fmult	f2_5	landings		
11162	8035	1	0.731	4865		
2017					2018	
Biomasse	ssb	fmult	f2_5	landings	Biomasse.1	ssb.1
9803	6201	0.0	0.000	0	13877	9929
9803	6201	0.1	0.073	532	13231	9333
9803	6201	0.2	0.146	1031	12625	8774
9803	6201	0.4	0.292	1942	11527	7764
9803	6201	0.5	0.366	2356	11029	7307
9803	6201	0.7	0.512	3114	10124	6479
9803	6201	0.8	0.585	3459	9714	6105
9803	6201	0.9	0.658	3784	9329	5755
9803	6201	1.0	0.731	4090	8968	5427
9803	6201	1.1	0.804	4378	8630	5120
9803	6201	1.3	0.950	4906	8014	4564
9803	6201	1.4	1.024	5148	7733	4312
9803	6201	1.5	1.097	5375	7470	4076
9803	6201	1.6	1.170	5590	7223	3855
9803	6201	1.8	1.316	5985	6773	3454
9803	6201	1.9	1.389	6166	6567	3272
9803	6201	2.0	1.462	6337	6374	3101

Table 7.2.14. Catch option table.

Rationale	Wanted catch 2017	Basis	F wanted catch2017	SSB 2018	% SSB change	% TAC change
MSY Approach	2276	FMSY	0.351	7396	19	-50
MSY Approach	1546	FMSY Min	0.227	8202	32	-66
MSY Approach	3289	FMSY Max	0.548	6289	1	-28
Precautionary Buffer	1455	FBuff	0.212	8303	34	-68
Zero catch	0	F=0	0.000	9929	60	-100
Other options	4090	F2016	0.731	5427	-12	-10
	3878	TAC2016-15% (F2016*0.93)	0.680	5654	-9	-15
	4570	TAC2016	0.855	4917	-21	0
	5240	TAC2016+15% (F2016*1.44)	1.053	4215	-32	15
	4350	Flim	0.80	5150	-17	-5
	2356	Blim	0.366	7307	18	-48
	0	Bpa	0.000	9929	60	-100

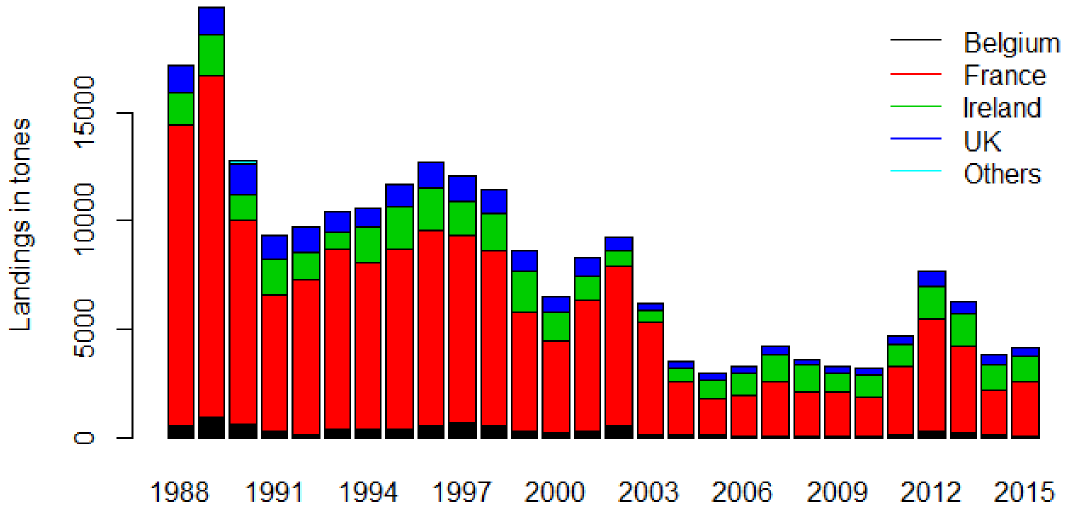


Figure 7.2.1. Cod in Divisions VIIe–k 2015. Historical landings.

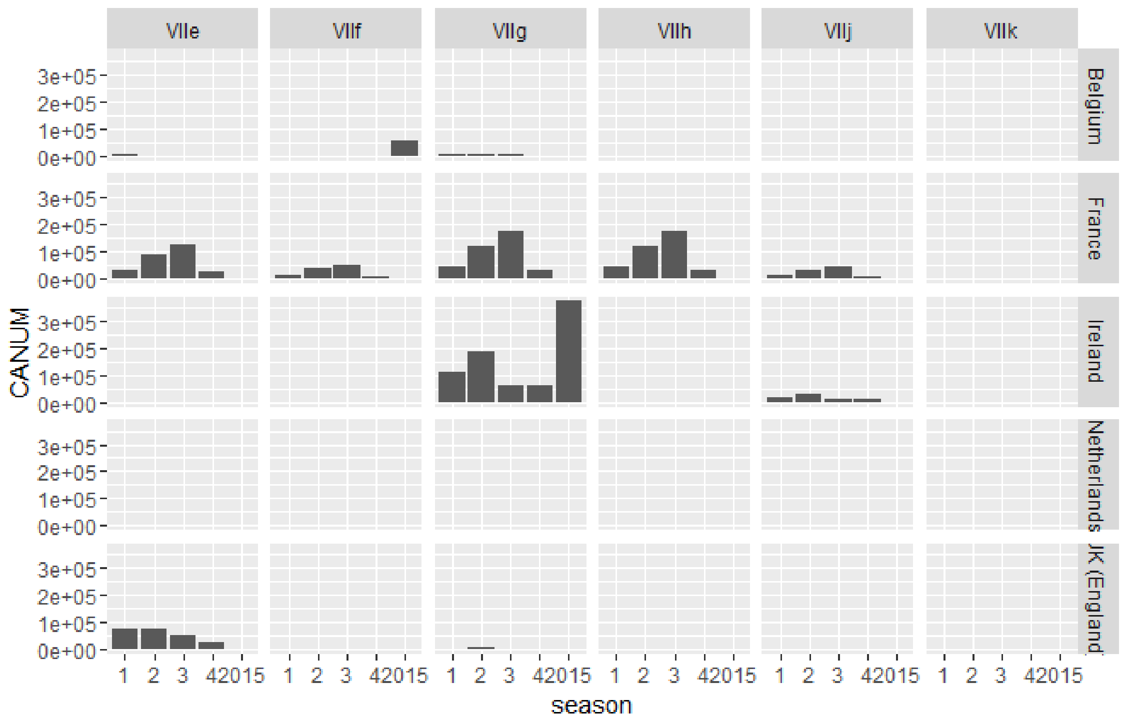


Figure 7.2.2. Cod in Divisions VIIe–k 2015. 2015 catch numbers by area, season and country.

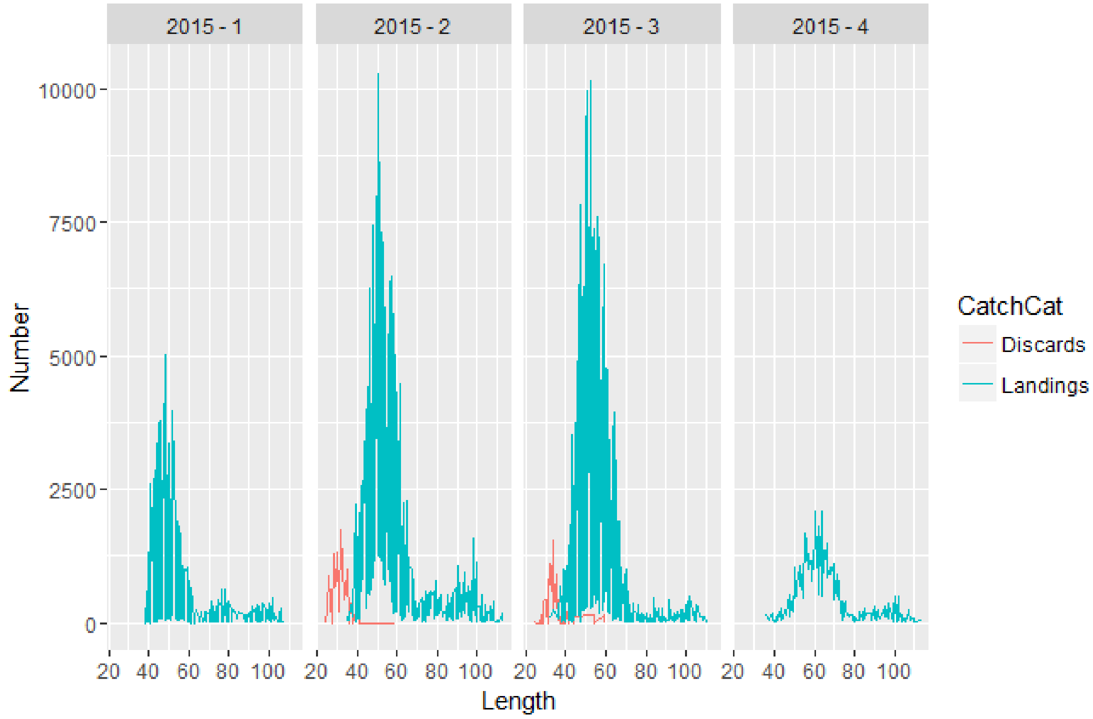
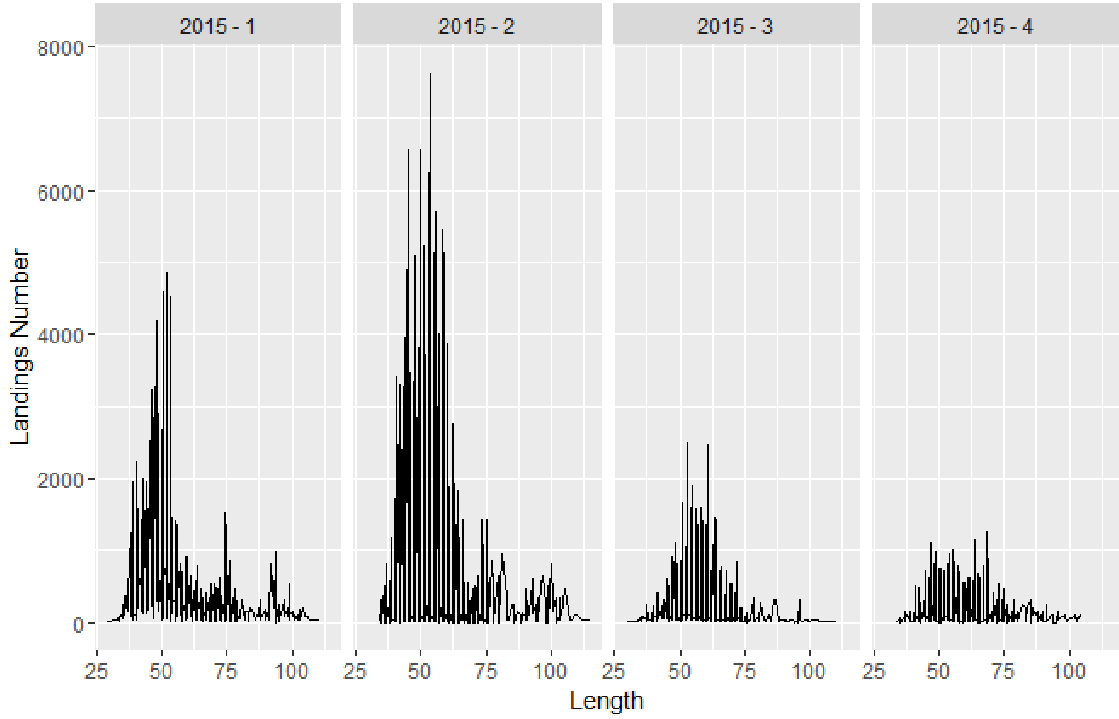


Figure 7.2.3.a. Cod in Divisions VIIe–k 2015. Raised French 2015 landings and discards length distribution - Sampled strata only (e.g.Q1–Q4 unsampled, or number of sampled to low).



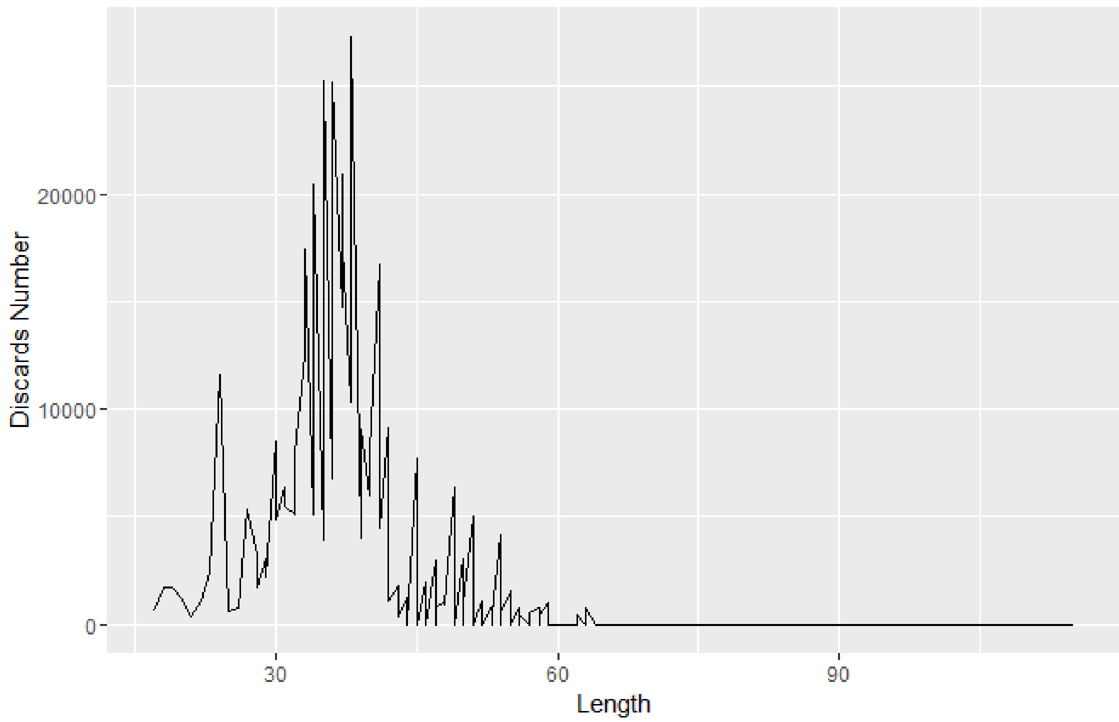


Figure 7.2.3.b. Cod in Divisions VIIe–k 2015. Raised Irish 2015 landings and discards length distribution- sampled strata only.

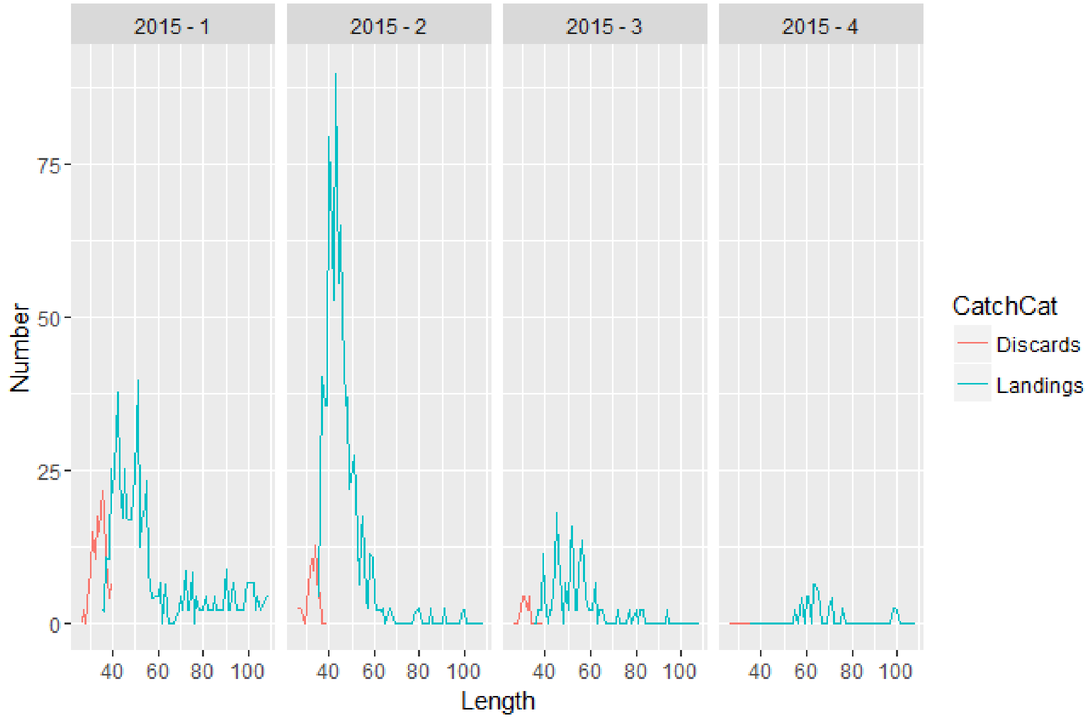


Figure 7.2.3.c. Cod in Divisions VIIe–k 2015. Belgium 2015 landings length distribution. Raised to trips level only.

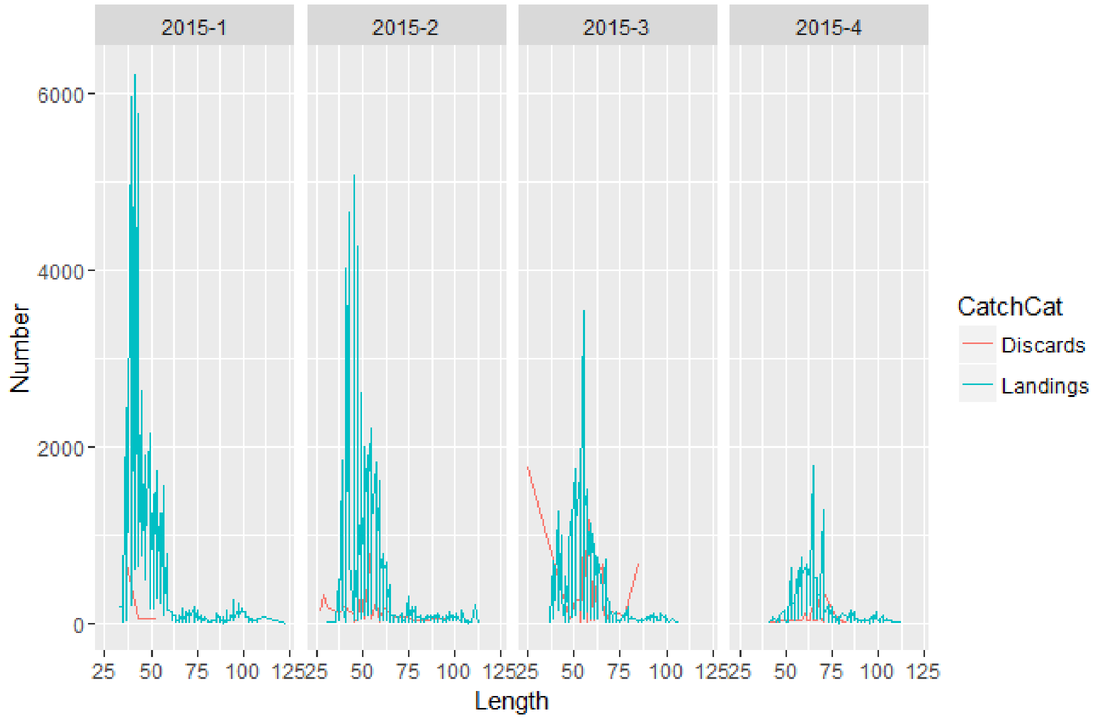


Figure 7.2.3.d. Cod in Divisions VIIe–k 2015. Raised UK 2015 landings and discards length distribution - Sampled strata only.

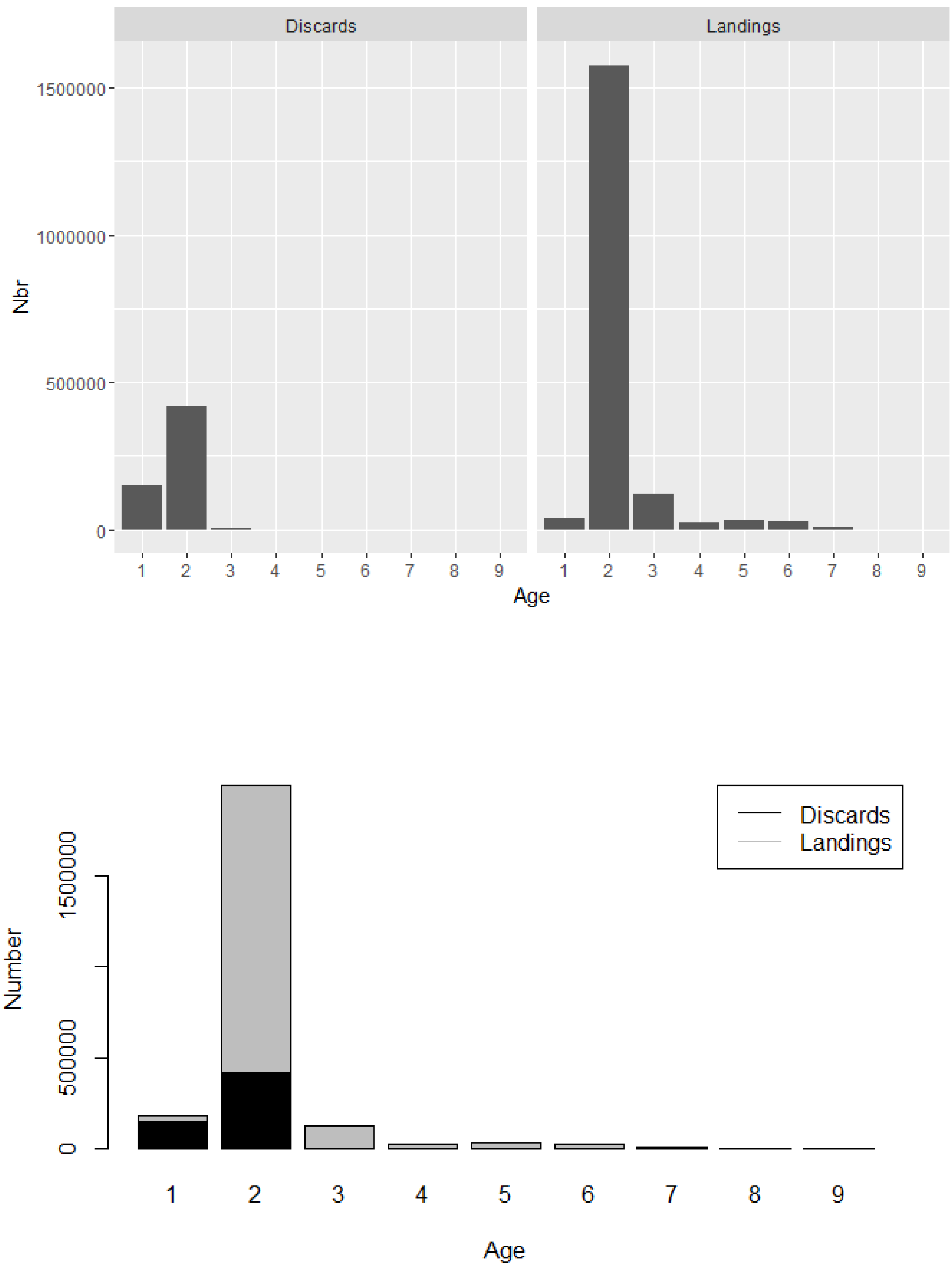


Figure 7.2.4. Cod in Divisions VIIe–k 2015. Raised age distribution of the catches (landings and discards).

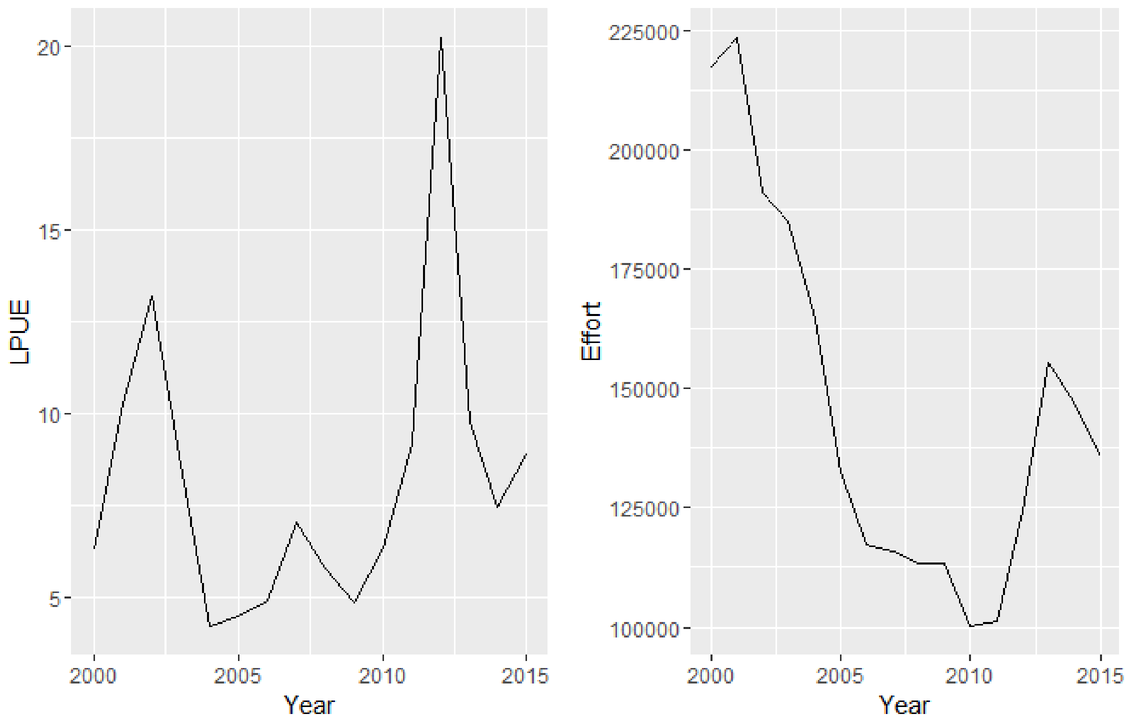
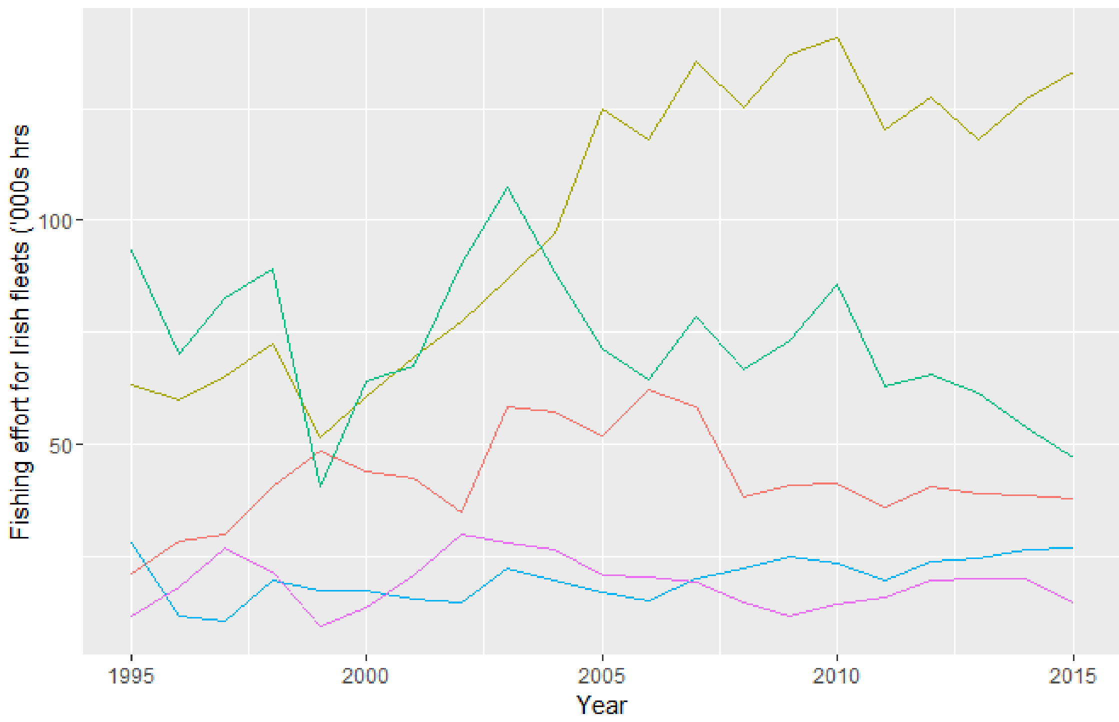


Figure 7.2.5a. Cod in Divisions VIIe–k. Time-series of landings, effort, lpue for the French fleets. Units: landings in tonnes, Effort in days fished and lpue in Kg/day.

Figure 7.2.5b. Cod in Divisions VIIe–k. Time-series of landings, effort, lpue for the UK fleets. Units: landings in tonnes, Effort in days fished and lpue in Kg/day.



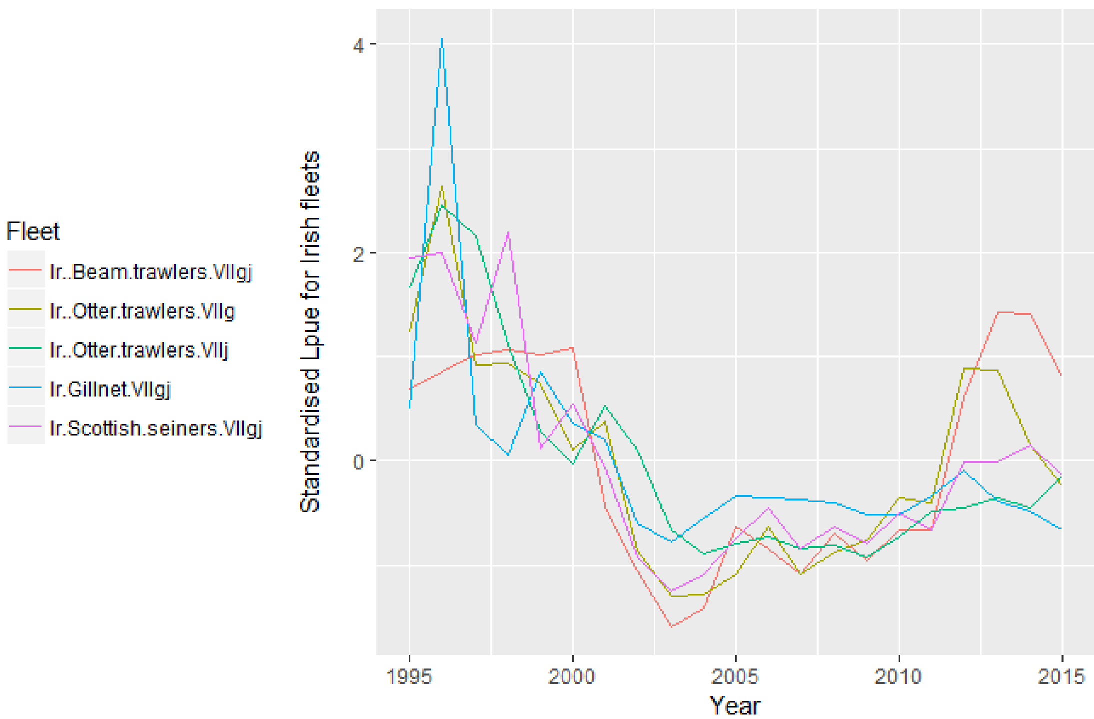


Figure 7.2.5c. Cod in Divisions VIIe–k. Time-series of landings, effort, lpue for the Irish fleets. Units in tonnes live weight, Effort in 000s hours fished, lpue in Kg/hour fished.

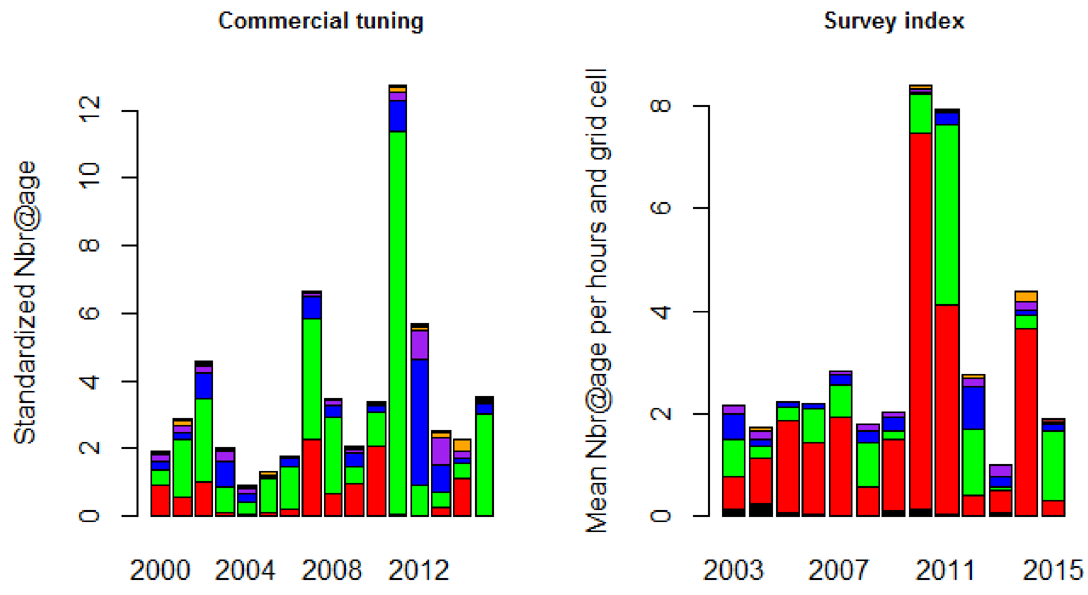


Figure 7.2.6. Cod in Divisions VIIe–k. Tuning indices used in the assessment. Commercial tuning fleet corresponds to French OTDEF Q2+3+4 where standardized number-at-age are plotted. The survey index is a combined index based on both French IR-GFS and FR-Evhoe Q4 data, where mean number-at-age per hour and grid cell are plotted. Legends: Age0=black, Age1=red, Age2=green, Age3=blue, Age4=purple, Age5=orange, Age6=brown, Age7=pink, Age8=yellow, Age9=light blue, Age10=grey.

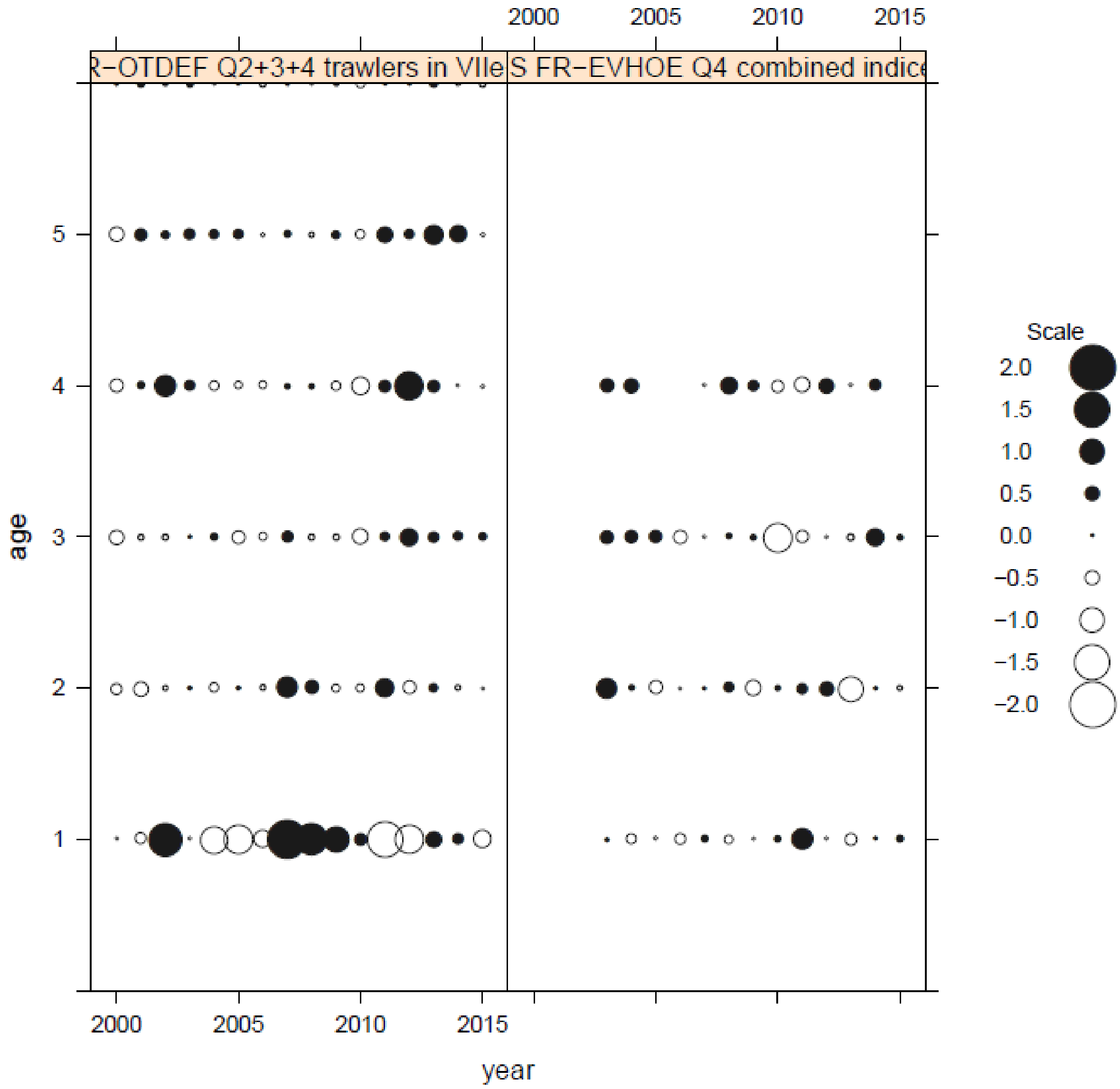


Figure 7.2.7. Cod in Divisions VIIe–k. Final assessment. Residuals (Left panel: French OTDEF demersal tuning fleet; Right Panel: Combined survey indices).

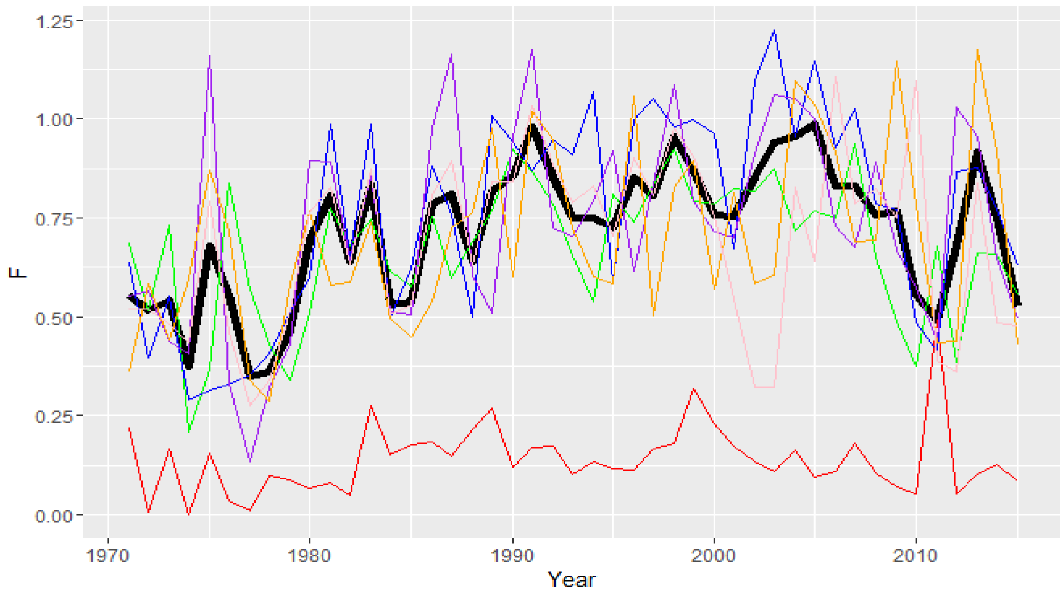


Figure 7.2.8. Cod in Divisions VIIe–k. Final XSA outputs. Fishing mortality. Fbar=Thick black line. Age1=red, Age2=green, Age3=blue, Age4=purple, Age5=orange, Age6=brown, Age7=pink. Age 0 are not included in the assessment.

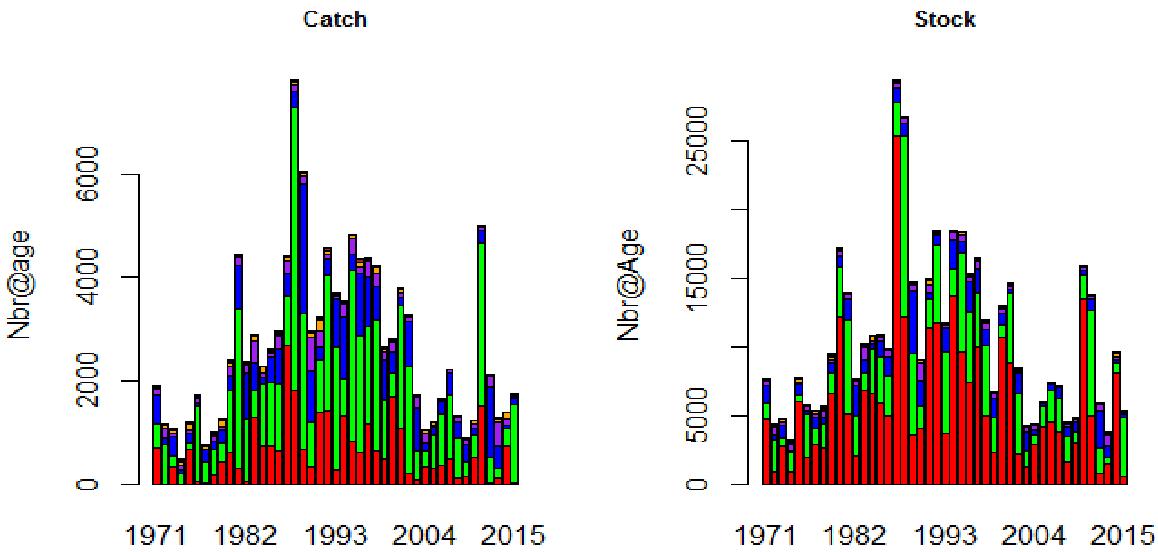


Figure 7.2.9. Cod in Divisions VIIe–k. Final XSA outputs. Catch and Stock number-at-age. Age1=red, Age2=green, Age3=blue, Age4=purple, Age5=orange, Age6=brown, Age7=pink. Age 0 are not included in the assessment.

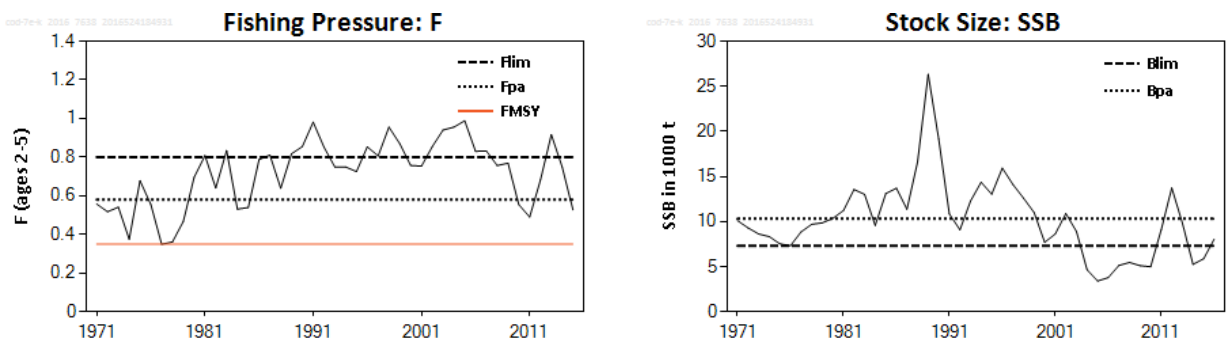
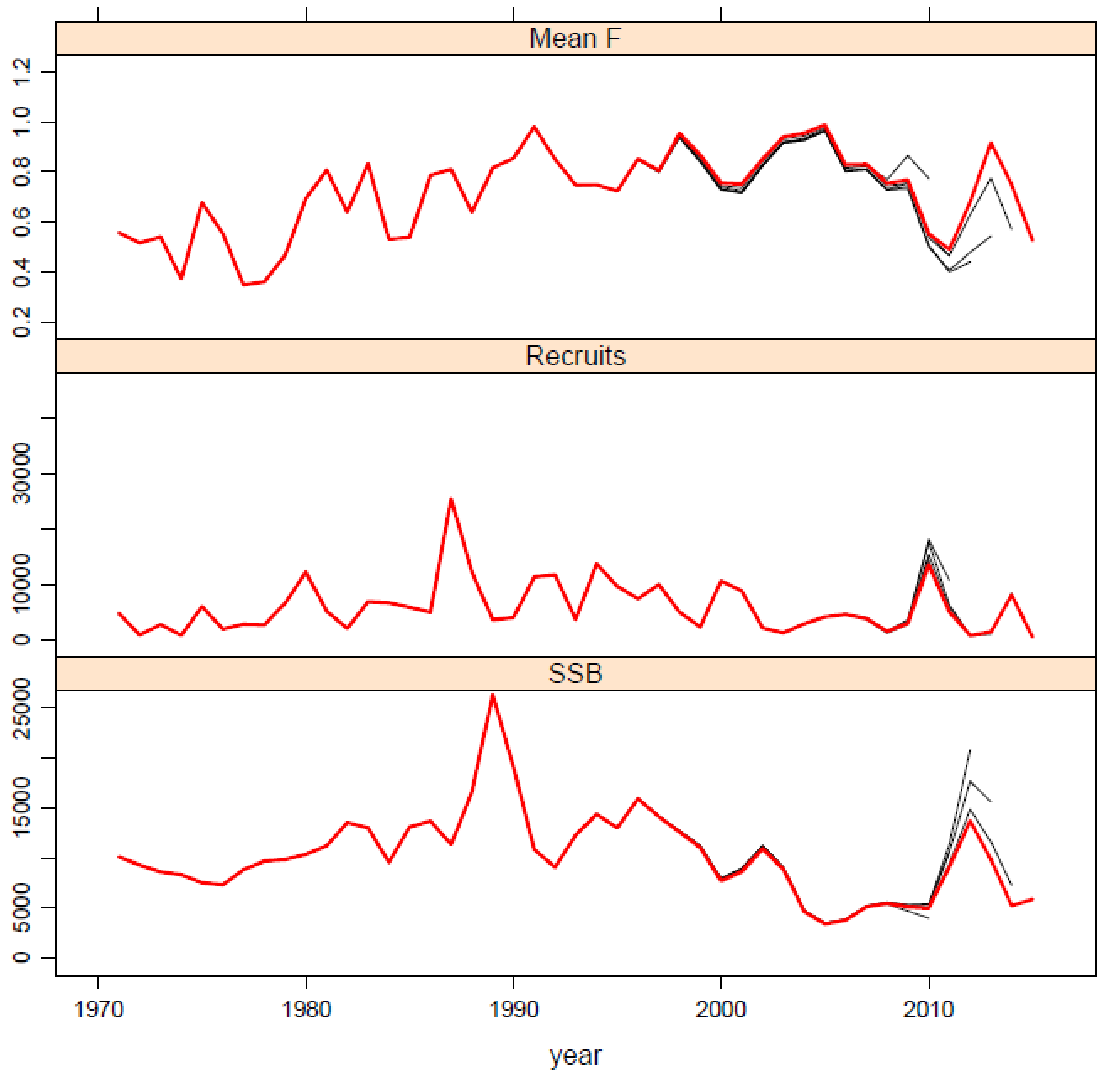


Figure 7.2.10. Cod in Divisions VIIe–k. Final XSA outputs. Summary plots.



7.2.11a.Cod in Divisions VIIe–k. Final XSA. Retrospective plots.

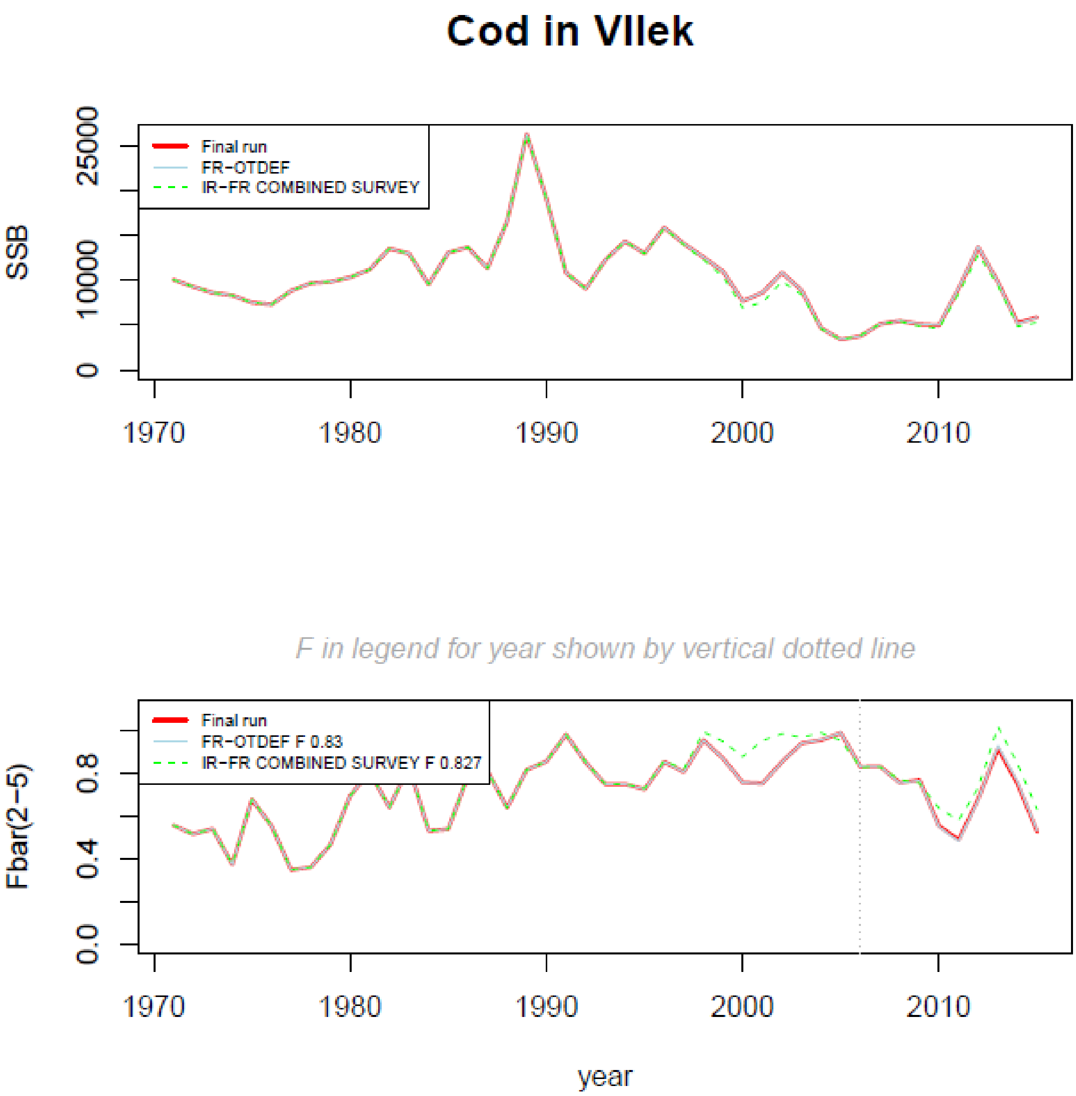


Figure 7.2.11b.Cod in Divisions VIIe–k. Final XSA. Comparison between runs (runs with the two tuning indices, with only the survey index and with only the commercial tuning index).

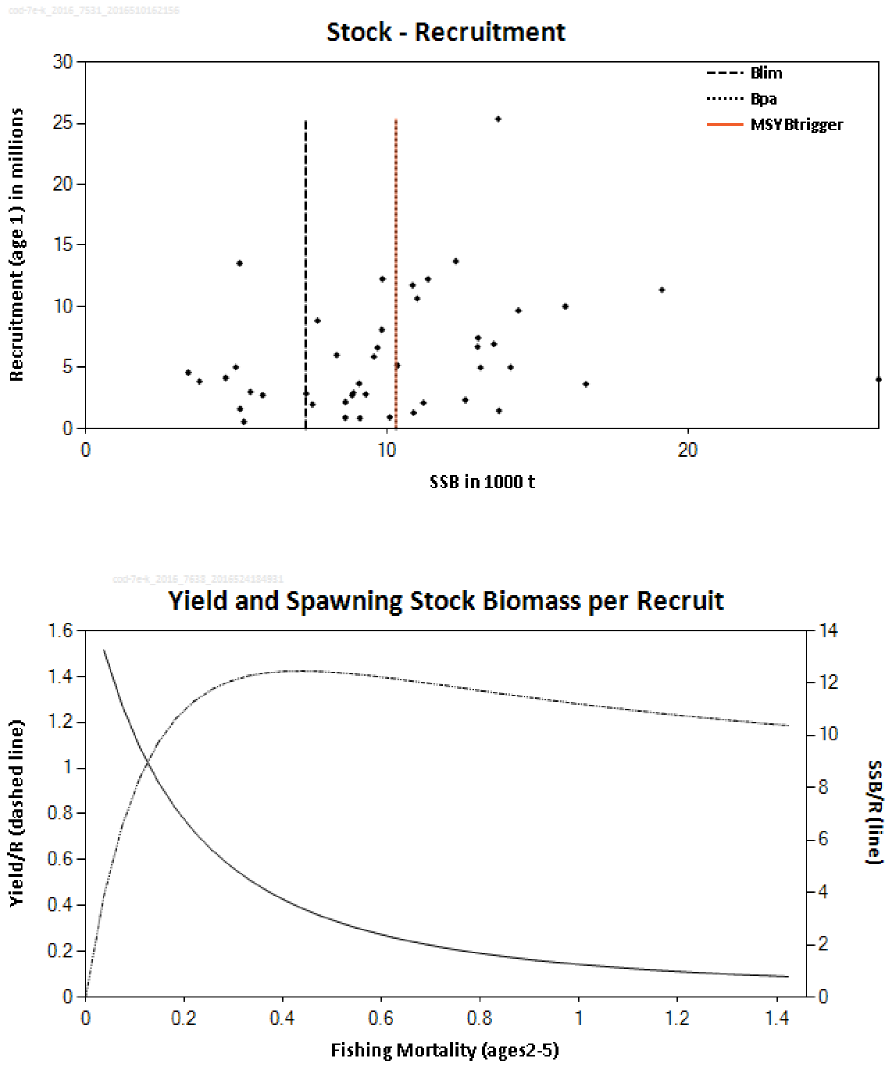


Figure 7.2.12. Cod in Divisions VIIe–k. Stock–recruitment plots and yield per recruit information.

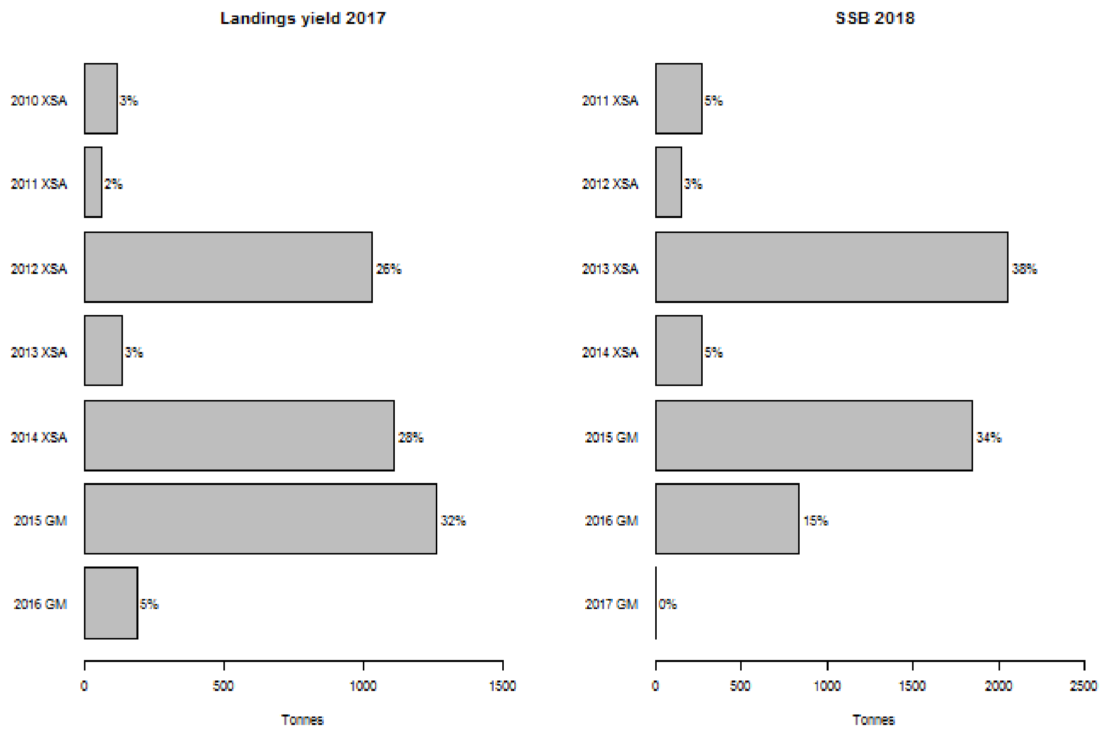


Figure 7.2.13. Cod in Divisions VIIe–k. Forecast yield in 2017 and SSB 2018.

7.2.11 Audit of Cod 7e-k

Date: 23/05/2016

Auditor: Helen Dobby

General

ICES provides annual landings (wanted catch) advice for this stock based on the MSY approach. Advice not topped up because of variable discard rates (big increase when TAC restrictive) and also discards not included in the F_{MSY} estimate.

Last benchmarked at WKROUND in 2012.

For single stock summary sheet advice:

1) Assessment type: update/SALY XSA

2) **Assessment**: FLXSA using two tuning series – French commercial fleet (OTDef Q2, 3 & 4) and trawl survey index (combined IRGFS and FR-Evhoe). The age ranges in the tuning fleets used in the assessment appear to differ from those stated in the stock annex although they are the same as in last year's assessment (need to be corrected in the stock annex?)

3) **Forecast**: Short-term forecast is presented. Conducted in R. Differs from the stock annex in that 25th percentile of recruitment time-series was used for R in 2016 and onwards due to a succession of weak year classes – this is explained in the WG report. (Long-term GM omitting last two years likely to be an overestimate). F2016=mean F(2013–2015). There are no catch options for 2017 which take the stock above B_{pa} in 2018.

4) Assessment model: FLXSA

5) **Data issues:** No major issues affecting the assessment. The non-inclusion of discards could potentially increase retrospective bias. Raised discards account for over 50% of the total which may mean the total is not sufficiently reliable for use in top-up procedure. There was a problem with the calculation of the French commercial tuning fleet which was resolved at the meeting, but a clear description of how this is calculated is required for the Stock Annex.

6) **Consistency:** The assessment shows substantial retrospective bias with big upward revisions in F (and corresponding downward revisions to SSB) when compared to previous year's assessment.

7) **Stock status**: The stock is characterised by occasional strong year classes which disappear rapidly from the stock which has a very truncated age distribution. SSB estimated to be below B_{lim} in 2013 and 2014 and just above in 2016. The 2011 and 2012 year classes were weak and recruitment in 2015 is estimated to be the lowest of the time-series. F is above F_{MSY} and has been so for the full time-series.

8) Management Plan:

There is no long-term management plan for cod in 7e–k. There was some discussion at the WG about the appropriateness of F_{MSY} management and that a more appropriate F target could be derived from a MSE which accounts for the frequency of large year classes.

9) General comments

Report was clear and generally well written. Some suggestions for improvements are given below.

Technical comments

- There does not appear to be a table of official landings either in the WG or advice sheet.
- Table 7.2.1 is confusing – need to explain that the column 'Total' already includes the 'Landings taken or reported in 33E2 & 33E3', but that the actual assessment uses 'Total' plus 'Highgrading' columns.(Also need to explain the asterisks in the table).
- The fishery description section refers to total discards and breakdown by fleet of landings and discards – given that some of these discards are estimates based on the InterCatch raising assumptions, they probably ought not to be part of the fishery description.
- It would be more logical to have the description of the InterCatch procedure at the start of the Data section rather than the end. Should also include the general raising protocols in the Stock Annex.
- Table 7.2.7 – the age ranges in the tuning fleets differ to those in the stock annex – however, they are the same as in last year's report so probably the stock annex is wrong.
- The F reference points need to be checked – they look like the cod-scow ones. The values that appear in the MSYREF report for cod-7e–k are 0.8 and 0.58. These should be updated in the report, advice sheet and stock annex.
- Table 7.2.11 – Age 7 in 2016 only includes survivors from age 6 in 2015 (and not age 7) i.e. it is different to the number in Table 7.2.12.

- Last paragraph in 7.2.4 – talks about GM assumptions – there are no GM assumptions – Recruitment is 25th percentile. Figure 7.2.13 shows yield and SSB in 2018, probably should show yield in 2017 instead. (Labelling is all wrong).
- Figure 7.2.12 – only shows SSB/R and not Y/R
- Figure 7.2.3a – are the discards zero or unsampled in Q1 and Q4?
- Figure 7.2.6 – Might be better if the commercial fleet was plotted as standardized number-at-age rather than total.

Conclusions

The assessment and forecast have been performed correctly. The catch options inputs and table in the advice sheet are consistent with the tables and description in the WG report.

Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? Yes
- Is the assessment according to the stock annex description? Yes
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? yes
- Have the data been used as specified in the stock annex? yes
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex?
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes

7.2.12 Second WGCSE 2016 Celtic Sea Cod Audit

Dr. Colm Lordan

May 19, 2016

This an r-Markdown document to check and validate the assessment and STF for Celtic Sea cod at WGCSE 2016.

General

1) Assessment type: update of SPALY.

2) Assessment: analytical - settings consistent with last year.

3) Forecast: presented - settings consistent with last.

4) Assessment model: XSA - tuning by 1 comm + two surveys combined.

5) Data issues: There was problems with the derivation of the French commercial tuning fleet but this was sorted out during the WG.

6) Consistency: The assessment shows a large increase in F and reduction in SSB for the last three years relative to last year's assessment.

7) Stock status: The retrospective revision means that the stock is now estimated to have been below B_{lim} for the last two years, whereas last year's assessment had the stock above B_{lim} and the previous year's assessment had the stock well above B_{pa} (==MSY $B_{trigger}$).

Install the FLR libraries

First we install the necessary library and check the global environment. Normally, the following should work for R version 3.2.2:

```
#install.packages("FLCore", repos="http://flr-project.org/R")
#install.packages("FLXSA", repos="http://flr-project.org/R")
#install.packages("FLAssess", repos="http://flr-project.org/R"
)

library(FLCore)
library(FLAssess)
library(FLXSA)
library(knitr)
library(tidyr)
library(ggplotFL)
library(ggplot2)
rm(list=ls())

sessionInfo()
```

```
## R version 3.2.2 (2015-08-14)
## Platform: i386-w64-mingw32/i386 (32-bit)
## Running under: Windows 7 x64 (build 7601) Service Pack 1
##
## locale:
## [1] LC_COLLATE=English_Ireland.1252  LC_CTYPE=English_Ireland.1252
## [3] LC_MONETARY=English_Ireland.1252 LC_NUMERIC=C
## [5] LC_TIME=English_Ireland.1252
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] ggplotFL_2.5.20141027 reshape2_1.4.1        gridExtra_2.0.0
##  [4] ggplot2_2.0.0         tidyr_0.2.0           knitr_1.11
##  [7] FLXSA_2.5.20140808    FLAssess_2.5.20130716 FLash_2.5.2
## [10] FLCore_2.5.20150513   MASS_7.3-43           lattice_0.20-33
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_0.12.4      magrittr_1.5     munsell_0.4.2    colorspace_1.2-6
##  [5] stringr_1.0.0    plyr_1.8.3       tools_3.2.2      grid_3.2.2
##  [9] gtable_0.1.2     htmltools_0.3.5  yaml_2.1.13      digest_0.6.9
## [13] formatR_1.3      evaluate_0.7.2   rmarkdown_0.9.5  stringi_1.0-1
## [17] scales_0.3.0     stats4_3.2.2
```

Read the stock object

Then we set the main directory and data and output directories.

```
maindir <- 'L:/Data for ICESWG/2016/WGCSE/cod 7e-k/Audit/'
datadir <- paste0(maindir,'Data/')
```

We read in the Lowestoft input files for this stock.

```
la<-readVPAFile(file.path(datadir,"cod7eklafin.txt"))
ln<-readVPAFile(file.path(datadir,"cod7ekcnfin.txt"))
lw<-readVPAFile(file.path(datadir,"cod7ekcwfin.txt"))
sw<-readVPAFile(file.path(datadir,"cod7ekswfin.txt"))
nm<-readVPAFile(file.path(datadir,"cod7eknm.txt"))
mo<-readVPAFile(file.path(datadir,"cod7ekmo.txt"))
pf<-readVPAFile(file.path(datadir,"cod7ekpf.txt"))
pm<-readVPAFile(file.path(datadir,"cod7ekpm.txt"))

tun <- readFLIndices(file.path(datadir,"fleetsxsafinal.txt"))
```

Next we have to create the FLStock object. For Celtic Sea Cod discards are not included in the assessment currently, so I have not included a discard slot in the stock object. Ideally we should make a discard slot object for the years when raised discards are included in the assessment. Note some discards; French High Grading estimates and other discards in 2011 have been included in the landings-at-age matrix in the Lowestoft file.

```
stock <- FLStock(ln)
landings(stock) <- la
#discards(stock) <- di
catch(stock) <- la#+di
landings.n(stock) <- ln
#discards.n(stock)<- dn
catch.n(stock) <- ln #+dn
landings.wt(stock) <- lw
#discards.wt(stock) <- dw
#catch.wt(stock) <- (lw*ln+dw*dn)/(ln+dn)
#catch.wt(stock)[(ln+dn)==0] <- 0 # fix divide by zero
catch.wt(stock) <- lw
stock.wt(stock) <- sw
m(stock) <- nm
mat(stock) <- mo
harvest.spwn(stock) <- pf
m.spwn(stock) <- pm
```

We save the stock object in case we need to load it independently later.

```
save(stock,tun,file=file.path(datadir,'cod7ek_stock.Rdata'))
```

Some housekeeping for this stock

Here we set some of the parameters for this stock i.e. F_{bar} range, plusgroup, recruit age, F_{MSY}, MSY range, F_{lim}, F_{pa}, B_{lim}, B_{pa}, $MSYB_{trigger}$, interim year TAC. For Celtic Sea cod the standard practice has been to apply a SoP correction to the lanum==canum before running the XSA.

```
stock@range[c("minfbar","maxfbar")] = c(2,5)
fbarage <- 2:5
stock <- setPlusGroup(stock,plusgroup=7)
rage <- 1 #Recruitment age
years<-stock@range['minyear']:stock@range['maxyear']
nyears <-length(years)
ages <- stock@range['min']:stock@range['max']
```

```
nages <- length(ages)

fmsy <- 0.35
fmsy.max <- 0.55
fmsy.min <- 0.23
flim <- 0.80
fpa <- 0.58
Blim <- 7300 # Blim= B76
Bpa <- 10300
msybtrig <- 10300
TAC <- 4565

## SoP correction
soplan <- sop(stock,"landings")
stock@landings.n <- sweep(stock@landings.n,2,soplan,"/")
stock@catch.n<- sweep(stock@catch.n,2,soplan,"/")
```

Next we select tuning fleets. Fleet 1 is a French commercial otter trawl fleet in Q2,3,4 used since 1999 for ages 1–6. Fleet 2 is a combined index based on the Irish and French IBTS groundfish survey 2003–2014 for ages 1–4.

Note although these are the tuning selections used in previous assessments the stock annex states the age ranges as 1-7+ for the FR-OTBDEF and 0-4+ for the FR-IR-WIBTS

```
tun.sel <- FLIndices(
 trim(tun[[1]],age=1:6),
 trim(tun[[2]],age=1:4)
)
```

run XSA

These XSA settings are as stated in the stock annex. It would be clearer to include this control file in the stock annex.

Once the XSA is run I output the F-at-age matrix to compare with the final assessment.

The Final XSA output is saved in case I need to check something in later.

I also generate a stock summary table which will be outputed later.

```
xsa.control <- FLXSA.control(tol = 1e-09, maxit = 30, min.nse = 0.3, fse = 1.0,
               rage = -1, qage = 3, shk.n = TRUE, shk.f = TRUE,
               shk.yrs = 5, shk.ages= 3, window = 100, tsrange = 99,
               tspower = 0)

xsa<-FLXSA(stock=stock, indices=tun.sel, control=xsa.control)
fout <- as.data.frame(xsa@harvest)
fout <-fout[,c(1,2,7)]
names(fout)[3] <- 'f'
fout <- tidyr::spread(fout,age,f)

save(xsa,file=file.path(datadir,'cod7ek_xsa.Rdata'))
stock@stock.n <- xsa@stock.n; stock@harvest <- xsa@harvest

GM <- round(exp(mean(log(c(stock@stock.n[as.character(rage)])[1:(nyears-2
```

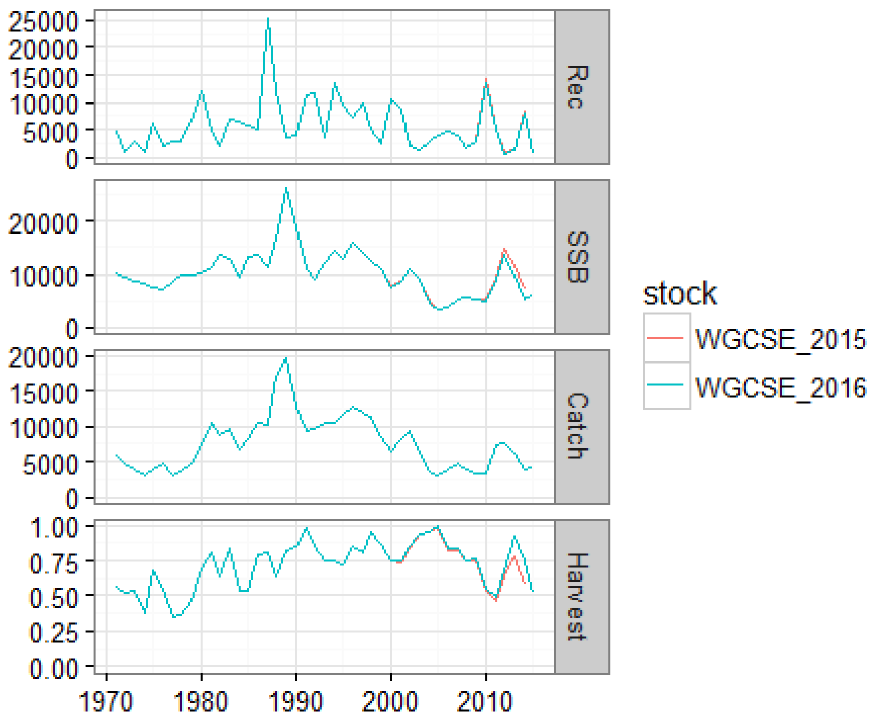
```
)]))),0)

summary<-data.frame(year=stock@range['minyear']:stock@range['maxyear'
]
            #,catch=c(stock@catch)
            ,land=c(stock@landings)
            ,recruit=c(stock@stock.n[as.character(rage)])
            ,tsb=c(tsb(stock))
            ,ssb=c(ssb(stock))
            ,fbar=c(apply(stock@harvest[as.character(fbarage)],2,mean))
            )

knitr::kable(subset(fout,year>2000),row.names=F, digits=3)
```

Fishing mortality-at-age table is shown below:

year	1	2	3	4	5	6	7
2001	0.173	0.824	0.671	0.701	0.815	0.545	0.545
2002	0.133	0.816	1.098	0.914	0.585	0.321	0.321
2003	0.108	0.873	1.224	1.060	0.604	0.322	0.322
2004	0.163	0.719	0.955	1.052	1.096	0.829	0.829
2005	0.096	0.767	1.145	1.002	1.038	0.640	0.640
2006	0.109	0.749	0.928	0.727	0.916	1.106	1.106
2007	0.179	0.936	1.027	0.675	0.689	0.787	0.787
2008	0.104	0.650	0.786	0.893	0.694	0.824	0.824
2009	0.072	0.489	0.771	0.670	1.145	0.751	0.751
2010	0.052	0.374	0.486	0.574	0.782	1.096	1.096
2011	0.493	0.678	0.412	0.437	0.434	0.388	0.388
2012	0.054	0.386	0.867	1.029	0.440	0.361	0.361
2013	0.101	0.660	0.876	0.955	1.173	0.837	0.837
2014	0.127	0.658	0.772	0.648	0.921	0.485	0.485
2015	0.084	0.557	0.628	0.495	0.429	0.479	0.479

Comparison with previous assessment

The comparison with last year's assessment is shown below.



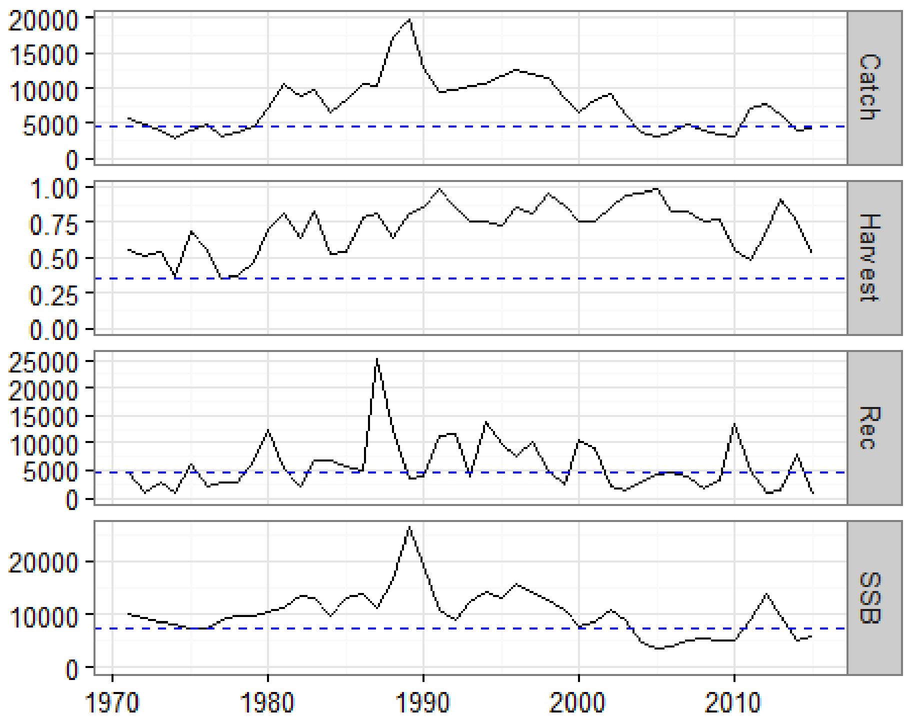
The percentage change in recruitment, total stock biomass, spawning–stock biomass in this year's assessment relative to the estimates last year are given below in a table.

Year	recruit	tsb	ssb	fbar
2011	-4	-4	-4	5
2012	-8	-8	-8	8
2013	8	-14	-15	18
2014	-4	-18	-28	31

Spawning–stock biomass has been revised down by 28% for 2014 and 15% for 2013. Fishing mortality has been revised upwards by 31% in 2014 and 18% in 2013.

Stock status in relation to reference points

The stock summary plot for the 2016 assessment below shows the time-series of Landings (Catch), Fishing Mortality (Harvest), Recruitment (Rec) and Spawning–Stock Biomass (SSB). The horizontal lines show the following reference points; the 2016 TAC, F_{MSY}, GM recruitment and B_{lim}.



Running the STF

First set up the year and age ranges for the forecast period. The catch options function produces a forecast table including landings and discards. In the case of Celtic Sea Cod we are only using landings.

The STF settings follow the standard procedure in the stock annex. GM at-age 1 - last two years and average F pattern of the last three years. However the text in the stock annex is very ambiguous on scaling the F vector.

A standard detailed catch option table is generated using a loop. A number of other catch options are also made.

Outputs

The 25%ile of recruitment is used in the STF instead of GM it is 2741, 11.

A standard assessment summary table is made but the landing forecast, recruitment assumption, SSB and TSB estimates and the F assumption in the forecast are appended on for convenience.

The detailed catch option table and other stock-specific catch options are also listed.

Note these values are calculated exactly in the script below rather than by interpolation as in Table 7.2.14. The exact values here should be used in the summary sheet because these will match with the STF carried out by WGMIXFISH.

year	land	recruit	tsb	ssb	f_{bar}
1971	5782	4769	15346	10093	0.56
1972	4737	928	12808	9298	0.52
1973	4015	2810	11700	8617	0.54
1974	2898	889	10717	8327	0.38
1975	3993	6031	12589	7526	0.68
1976	4818	1986	12224	7316	0.55
1977	3059	2871	12545	8841	0.35
1978	3647	2741	13783	9689	0.36
1979	4650	6630	16346	9848	0.47
1980	7243	12254	22845	10347	0.69
1981	10597	5179	20697	11212	0.81
1982	8766	2117	18951	13547	0.64
1983	9641	6923	18545	13008	0.83
1984	6631	6696	17147	9568	0.53
1985	8317	5892	21794	13103	0.54
1986	10475	5000	20931	13692	0.79
1987	10228	25361	28403	11364	0.81
1988	17191	12239	41445	16607	0.64
1989	19809	3648	37580	26324	0.82
1990	12749	4042	25110	19126	0.86
1991	9336	11365	19521	10846	0.98
1992	9747	11743	21918	9074	0.85
1993	10425	3701	20981	12282	0.75
1994	10620	13717	26255	14361	0.75
1995	11709	9676	26018	13029	0.73
1996	12681	7433	26403	15919	0.85
1997	12035	10005	23431	14106	0.81
1998	11431	5020	19665	12601	0.95
1999	8594	2352	16133	11002	0.87
2000	6536	10658	15344	7695	0.76
2001	8308	8842	19024	8618	0.75
2002	9236	2185	16018	10881	0.85
2003	6420	1301	11345	8886	0.94
2004	3672	2932	7233	4648	0.96
2005	3062	4167	7555	3403	0.99
2006	3776	4588	8973	3775	0.83
2007	4830	3871	10460	5128	0.83
2008	3961	1614	9042	5466	0.76
2009	3292	3008	9254	5110	0.77
2010	3229	13548	17862	4981	0.55
2011	7261	5025	17207	9100	0.49
2012	7692	856	17397	13719	0.68
2013	6290	1475	11793	9830	0.92
2014	3879	8098	10017	5247	0.75
2015	4154	570	10134	5872	0.53
2016	4865	4457	9803	6201	0.73

```
other <- rbind(msyapproach, msy, msymax, msymin, flim, fpa, TACstable,T
ACplus15, TACminus15)
other$Fmult <- other$FLand17/fsq
out <- rbind(out,other[, c(10,1:9)])
out$basis <- c(paste0('Fsq*',seq(0,2,by=0.1)),'msyapproach', 'msy', 'msymax', 'ms
ymin', "flim", "fpa", 'TACstable','TACplus15', 'TACminus15')
knitr::kable(out,row.names=F, digits= c(2,0,0,0,2,2,2,0,0,0,0))
```

Catch Option Table is shown below.

Fmult	Catch17	Land17	Dis17	FCatch17	FLand17	FDis17	SSB18	SSB.change17	TAC.chanage16	basis
0.00	NA	0	NA	0.00	NaN	NaN	9929	60	-100	Fsq*0
0.10	NA	532	NA	0.07	0.07	0	9333	51	-88	Fsq*0.1
0.20	NA	1031	NA	0.15	0.15	0	8774	42	-77	Fsq*0.2
0.30	NA	1501	NA	0.22	0.22	0	8252	33	-67	Fsq*0.3
0.40	NA	1942	NA	0.29	0.29	0	7764	25	-57	Fsq*0.4
0.50	NA	2356	NA	0.37	0.37	0	7307	18	-48	Fsq*0.5
0.60	NA	2747	NA	0.44	0.44	0	6879	11	-40	Fsq*0.6
0.70	NA	3114	NA	0.51	0.51	0	6479	4	-32	Fsq*0.7
0.80	NA	3459	NA	0.58	0.58	0	6105	-2	-24	Fsq*0.8
0.90	NA	3784	NA	0.66	0.66	0	5755	-7	-17	Fsq*0.9
1.00	NA	4090	NA	0.73	0.73	0	5427	-12	-10	Fsq*1
1.10	NA	4378	NA	0.80	0.80	0	5120	-17	-4	Fsq*1.1
1.20	NA	4650	NA	0.88	0.88	0	4833	-22	2	Fsq*1.2
1.30	NA	4906	NA	0.95	0.95	0	4564	-26	7	Fsq*1.3
1.40	NA	5148	NA	1.02	1.02	0	4312	-30	13	Fsq*1.4
1.50	NA	5375	NA	1.10	1.10	0	4076	-34	18	Fsq*1.5
1.60	NA	5590	NA	1.17	1.17	0	3855	-38	22	Fsq*1.6
1.70	NA	5793	NA	1.24	1.24	0	3648	-41	27	Fsq*1.7
1.80	NA	5985	NA	1.32	1.32	0	3454	-44	31	Fsq*1.8
1.90	NA	6166	NA	1.39	1.39	0	3272	-47	35	Fsq*1.9
2.00	NA	6337	NA	1.46	1.46	0	3101	-50	39	Fsq*2

Fmult	Catch17	Land17	Dis17	FCatch17	FLand17	FDis17	SSB18	SSB.change17	TAC.chanage16	basis
0.29	NA	1447	NA	0.21	0.21	0	8312	34	-68	msyapproach
0.48	NA	2270	NA	0.35	0.35	0	7402	19	-50	msy
0.75	NA	3297	NA	0.55	0.55	0	6281	1	-28	msymax
0.31	NA	1567	NA	0.23	0.23	0	8179	32	-66	msymin
1.09	NA	4362	NA	0.80	0.80	0	5137	-17	-4	flim
0.79	NA	3436	NA	0.58	0.58	0	6129	-1	-25	fpa
1.16	NA	4565	NA	0.85	0.85	0	4922	-21	0	TACstable
1.45	NA	5250	NA	1.06	1.06	0	4206	-32	15	TACplus15
0.93	NA	3880	NA	0.68	0.68	0	5651	-9	-15	TACminus15

7.3 Cod in Divisions 7.bc

Type of assessment: No assessment

The nominal landings are given in Table 7.3.1.

Table 7.3.1. Landings (t) of cod in Division 7.bc for 1995–2015 as officially reported to ICES.

YEAR	FR	IE	ES	UK	OTHERS	TOTAL
1970	1889	158	0	0	2	2049
1971	1188	114	0	0	0	1302
1972	589	77	15	4	50	735
1973	453	253	28	19	256	1009
1974	284	77	22	16	6	405
1975	365	215	42	14	56	692
1976	331	290	120	0	15	756
1977	143	132	14	3	0	292
1978	256	173	4	2	0	435
1979	203	286	0	2	20	511
1980	585	320	9	13	5	932
1981	841	765	15	11	0	1632
1982	587	1234	11	9	0	1841
1983	645	579	16	0	1	1241
1984	435	524	24	288	1	1272
1985	381	494	17	115	22	1029
1986	1012	619	0	142	104	1877
1987	591	758	0	104	1	1454
1988	591	388	0	28	2	1009
1989	na	915	0	41	10	966
1990	na	795	0	312	29	1136
1991	na	612	0	210	11	833
1992	223	507	0	210	39	979
1993	118	357	0	90	0	565
1994	155	289	0	122	6	572
1995	91	282	6	91	3	473
1996	115	353	3	47	1	519
1997	71	177	0	44	9	301
1998	44	234	6	34	0	318
1999	na	154	2	5	11	172
2000	44	141	3	4	0	192
2001	38	107	1	2	1	149
2002	54	59	1	2	5	121
2003	33	59	0	9	1	102
2004	13	60	0	10	0	83
2005	13	32	0	0	0	45
2006	10	16	0	1	1	28
2007	18	11	0	2	1	32

YEAR	FR	IE	ES	UK	OTHERS	TOTAL
2008	14	18	0	1	0	33
2009	5	29	0	1	0	35
2010	17	37	0	1	0	55
2011	43	36	0	0	0	79
2012	47	39	0	1	1	88
2013	32	51	0	2	0	85
2014	29	45	0	2	0	76
2015*	38	41	0	3	0	82

*** Preliminary, na = not available.**

7.4 Haddock in Divisions 7.b,c,e–k

Type of assessment in 2016

Update assessment procedure.

ICES advice applicable to 2016

Last year's full advice is available in the ICES Advice 2015, Book 5. The headline advice was as follows:

"ICES advises that when the MSY approach is applied, catches in 2016 should be no more than 8590 tonnes. If this stock is not under the EU landing obligation in 2016 and discard rates do not change from the average of the full time-series (1993–2014), this implies landings of no more than 6078 tonnes."

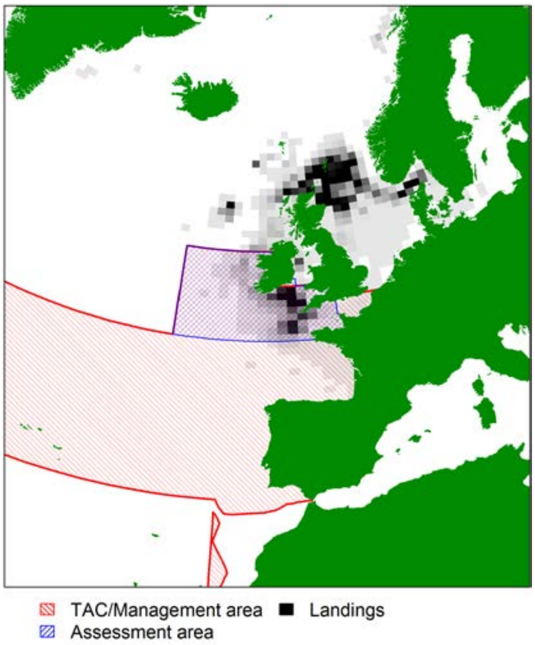
7.4.1 General

Stock description and management units

The basis for the stock assessment area 7.b,c,e–k is described in detail in the stock annex.

Figure 7.4.1 shows the spatial distribution of international haddock landings in the NE Atlantic for 2013. It is clear from the figure that the stock extends into Area 8 and it could be argued that landings from 8 should be included in the stock area. In recent years these landings varied between 20 and 300 t which is up to 4% of the total landings in the stock area.

The TAC for haddock is set for the combined Areas 7.b–k, 8, 10 and 10 and EU waters of CECAF 34.1.1. This does not correspond to the stock assessment area (7.b–k).



2015 management (Council Regulation (EU) 2015/104)

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	VIIb-k, VIII, IX and X; Union waters of CECAF 34.1.1 (HAD/7X7A34)
Belgium	93 (1)		
France	5 561 (1)		
Ireland	1 854 (1)		
United Kingdom	834 (1)		
Union	8 342 (1)		
TAC	8 342		Analytical TAC Article 11 of this Regulation applies

(1) In addition to this quota, a Member State may grant to vessels flying its flag and participating in trials on fully documented fisheries an additional allocation within an overall limit of 5 % of the quota allocated to that Member State, under the conditions set out in Chapter II of Title II of this Regulation.

2016 management (Council Regulation (EU) 2016/72)

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	VIIb-k, VIII, IX and X; Union waters of CECAF 34.1.1 (HAD/7X7A34)
Belgium	81		
France	4 838		
Ireland	1 613		
United Kingdom	726		
Union	7 258		
TAC	7 258		Analytical TAC Article 12(1) of this Regulation applies

Since 2009, a separate TAC is set for 7.a haddock; previously a separate allocation for 7.a existed within the TAC for 7, 8, 9 and 10.

During the 2011 December fisheries council meeting, Ireland, UK and France agreed to introduce additional technical measures to reduce the high levels of gadoids discards recently observed in the Celtic Seas. In consultation with national governments and the NWWRAC it was agreed to introduce the mandatory use of a 110 mm square mesh panel in *Nephrops* trawls and a 100 mm panel in gadoid fisheries. While the regulation was not introduced until 14th August 2012 (EC Regulation 737/2012), it is understood that for both French and Irish fleets, the technical measures were in practice introduced much earlier in the year by the national administrations.

The fishery

The official landings reported to ICES and Working Group estimates of the landings and discards are given in Table 7.4.1. The historic landings are also shown in Figure 7.4.2. No revisions to the landings or discard figures for 2014 were provided.

Before 2002, the TAC was well in excess of the landings in the TAC area (Table 7.4.1a). The TAC appeared to become restrictive for France in 2003–2004 and Ireland in 2002–2003 and perhaps after (Table 7.4.1a and Figure 7.4.2b). (WGSSDS05 provided some qualitative evidence that misreporting was now a problem). During 2005–2008 the landings were well below the TAC again. In 2009 and 2010 the total landings were still below the TAC but the quota appeared to become restrictive again for Ireland and Belgium. Since 2011 the TAC has been close to the total landings and can be assumed to be restrictive for all countries.

Figure 7.4.2a gives a long-term overview of the landings of haddock. The time-series is characterized by a number of peaks with rapid increases in the landings, mostly followed by rapid decreases within a few years, suggesting the fishery was taking advantage of sporadic events of very high recruitment. During the 1960s and 1970s three such peaks in landings occurred: the landings increased from less than 4000 t to 10 000 t or more. During the 1980s and early 1990s, landings were relatively stable around 2000–4000 t. During the mid-1990s the haddock landings increased again to over 10 000 t, mirroring increased landings in the Irish Sea in that period. Since the late 1990s the landings have varied between 7000 and 10 000 t and in 2012 the landings were the highest on record at more than 18 000 t.

The discard estimate for 2010 was the highest on record at 16 547 tonnes (Table 7.4.1b), this was mainly a consequence of the 2009 cohort entering the fishery.

Table 7.4.2 and Figure 7.4.3 show that Irish commercial lpue was relatively low between 2003 and 2007 after which it increased. Effort in the French gadoid fleet has declined considerably since the early 2000s as the result of a decommissioning scheme. The French and Irish VIIfgh fleets both showed an increase in lpue as the strong 2009 cohort entered the fishery. These data are presented for auxiliary information only; these fleets are not used directly in the assessment.

7.4.2 Information from the industry

The French and Irish fishing industry have reported that the abundance and distribution of haddock has increased a lot in 2016. Due to the restrictive TAC the industry have reported to national scientists that there is increased discarding of haddock.

7.4.3 Data

Numbers-at-length

Discard and retained catch–length distributions for 2015 are shown in Figure 7.4.4. Significant numbers of discarded fish were above the MLS, which is likely to be the result of restrictive quota.

Figure 7.4.5a shows the available time-series of catch (discards and retained catch) length distributions. The Irish fleet in VIIb generally catches smaller fish than the other fleets although the retained catches appear similar to the Irish VIIgj fleets. The French fleets tend to catch fewer small fish and discard larger fish than the Irish fleets although this was not the case in 2014. Figure 7.4.5b shows the time-series of discard ogives. Discarding of fish over the minimum landing size of 30 cm has occurred in all years although nearly all fish >35 cm were landed up to 2010. Since then increasing proportions of large fish have been discarded.

Landings and discard numbers-at-age

The historic approach to raising the catch numbers-at-age is given in the stock annex. France and Ireland had allocated age distributions to most unsampled catches before uploading to InterCatch. The remaining unsampled catches were minor (Figure 7.4.6). For métiers where discards were not provided, the discards were estimated from the discard rate of métiers that had both landings and discards. The allocation rules were simple and slightly different from those described in the stock annex: any unsampled catches were allocated age compositions from the combined annual landings or discards of all countries using the same gear type (otter trawl, beam trawl, seine, gillnet or miscellaneous). An alternative allocation rule that merged all sampled landings/discards and applied to the unsampled landings/discards resulted in nearly identical estimates.

Landings numbers-at-age are given in Table 7.4.3a and discard numbers-at-age are given in Table 7.4.3b. Despite some uncertainty about the quality of the discard data, it is possible to track strong year classes in both the discards and the landings-at-age matrices. Discards account for a large proportion of the catch numbers up to age 3. Figure 7.4.7 shows the proportions-at-age that are discarded; over the last ten years 96% of one year-olds, 78% of two year-olds and 36% of three year-olds have been discarded. By number, 78% of the total catch was discarded (45% by weight; average last ten years). There is a trend for increasing proportions of 2 and 3-year-olds to be discarded, in the mid-nineties around half of the 2-year-olds were discarded and around 10% of 3-year-olds while in recent years around 80% of 2-year-olds and 30% of 3-year-olds were being discarded.

Catch and stock weights-at-age are given in the ASAP input file (Table 7.4.4). Figure 7.4.8 shows that the raw stock weights-at-age which are fairly noisy, a 3-year running average was applied to the stock weights used in the assessment. There appear to be cyclical trends in the weights-at-age that follow cohorts (rather than year-effects).

Biological

The assumptions of natural mortality and maturity are described in the stock annex. The maturity ogive used in the assessment is knife-edged at-age 2. Recent Irish maturity data from 2004–2014 (working document to WGCSE15) suggested a similar maturity ogive for females but also indicated that a significant number of males mature before the age of two.

Surveys and commercial tuning fleets

The available surveys and commercial tuning fleets are described in detail in the stock annex. One survey index is used in the assessment: the FR-IRL-IBTS index, which is a combined index from the French EVHOE Q4 WIBTS and Irish IGFS Q4 WIBTS surveys. Additionally one commercial tuning fleet is used: the IR-GAD index, which is the Irish gadoid fleet in selected rectangles of VIIgj. The index data are given in the ASAP input file (Table 7.4.4). The standardised indices are given by year in Figure 7.4.9a and by cohort in Figure 7.4.9b. Figure 7.4.10 shows the scatterplot matrices of the log indices. These plots suggest that the internal consistency of the indices is quite good. The IR-GAD index (Figure 7.4.9.a) shows an increasing trend over time, mainly as a result of the relatively strong 2002 and 2009 cohorts.

7.4.4 Historical stock development

Model used: ASAP; (XSA is also used for quality control purposes)

Software used: ASAP V3.0.17 NOAA Fisheries toolbox (http://nft.nefsc.noaa.gov)

FLR with R version 3.1.2 with packages FLCore 2.5.20150309, FLAssess _2.5.20130716, FLXSA 2.5.20140808 and FLEDA 2.5 (http://flr-project.org)

Data screening

The general approach to data screening and analysis was followed in addition to the data exploration tools available in the FLR package FLEDA. The results of the data screening are fully documented using R markdown and are available in the folder 'Data\Stock\had-7bce–k' on SharePoint.

Final update assessment

The final assessment was run with the same settings as established by WKROUND 2012 and described in the stock annex. Discards were combined with the landings and not supplied separately to the model.

Figure 7.4.11 shows the residuals of that catch proportions-at-age. For age classes where discards dominate, the residuals are relatively large. There is no obvious pattern in the younger ages but the residuals in the older ages at the start of the time-series are mostly positive. The observed and predicted catches are shown in Figure 7.4.12. The predicted catches were slightly lower than observed in most recent years while they were generally higher than observed from 2002–2006.

The residuals of the index proportions-at-age are shown in Figure 7.4.13a. The 2009 year class consistently has positive residuals in the survey index while the 2010 year class has negative residuals, indicating that the model does not 'believe' that the 2009 cohort is as strong as the index suggests. However, right-hand panel of the figures shows that the difference between observed and predicted values for this cohort are minor. The observed and predicted index cpue values are shown in Figure 7.4.14. The model closely follows the survey index but in there is a bias in the last few years for the IRL-GAD fleet that shows up in Figures 7.4.14 and 7.4.11 as a strong positive residual on the 2009 year class at ages 4 to 6. There catches of this year class may be under-estimated, which could cause the retrospective bias in F (see below).

The selectivity of the catch data was freely estimated for ages 1 and 2 by the model. For the other ages, selectivity was fixed. Table 7.4.5 shows the model estimates for ages 1 and 2. Selectivity of the FR-IR-IBTS index was fixed at 1 for all ages that were included and selectivity (exploratory data analysis shows that log catch numbers of those ages decline in straight lines) of the IRL-GAD index was freely estimated for age 3 and fixed at one for older ages. (Discards are not included in this commercial fleet therefore selectivity was not assumed to be the same as that of the catch data).

Figure 7.4.15 shows the retrospective analysis. The predicted catch shows no obvious retrospective pattern, neither does the recruitment estimate. However, the SSB has a tendency to be revised upwards as another year of data was added. F has been over-estimated recently and revised downwards with the addition of another year. It is likely that this retrospective bias appears to have been caused by the strong 2009 cohort for which caused a conflict between the catch data and the IRL_GAD index: the index (Figure 7.4.11) shows large negative residuals for the young ages and positive residuals for this cohort at ages 5 and 6.

Comparison with previous assessments

Figure 7.4.16 shows the comparison of the current assessment with previous ASAP and XSA assessments. The 2016 assessment has revised F down for the last couple of years. The plot also shows the intermediate-year assumptions for the short-term forecast (for SSB the assumption is for the intermediate year + 1). These assumptions appear to have been reasonable.

State of the stock

Table 7.4.6 shows the estimated fishing mortality-at-age and Table 7.4.7 shows the stock numbers-at-age. The stock summary is given in Table 7.4.8 and Figure 7.4.17.

The spawning–stock biomass (SSB) peaked in 2011 as the very strong 2009 year class matured; this cohort was followed by three years of below-average recruitment which led to a rapid decline in SSB after 2011. Recent recruitment has varied around the average and SSB appears to have stabilised. Fishing mortality (F) has been above F_{MSY} for the entire time-series but shows a declining trend.

7.4.5 Short-term projections

Because recruitment of haddock is characterised by sporadic events, the assumed geometric mean recruitment for the intermediate year introduces significant uncertainty for the SSB estimate in 2017. However, the short-term predictions are expected to give a reasonably reliable estimate of landings in 2017 (assuming average F 2012–2014), which are largely based on the estimates of the 2013 and 2015 recruitments. In the past, recruitment has generally be accurately estimated.

Short-term projections were performed using FLR libraries. Recruitment for 2016–2018 was estimated at 266 437 (GM 1993–2013; thousands). Three year averages were used for F (unscaled) and weights-at-age. Catches were split into landings and discards using the proportions of the catch that were discarded over the full time-series. This was done because the discard pattern over the last three years are unlikely to persist: the proportion of discards in the 2013–2014 was considerably lower than the historic proportion of discards.

Input data for the short-term forecast are given in Table 7.4.9. The single-option output is given in Tables 7.4.10 and 7.4.11 gives the management options.

Estimates of the relative contribution of recent year classes to the 2017 landings and 2018 SSB are shown in Figure 7.4.18. The relatively high recruitment in 2015 accounts for nearly half of the projected landings in 2017. The GM assumption only accounts for 3% of the landings in 2017. The 2015 cohort also contributes considerably to the estimated SSB in 2018 but much of this estimate also results from the 2016 GM assumption. At GM recruitment and *status quo* F, SSB will remain well above $B_{trigger}$.

7.4.6 MSY evaluations and Biological reference points

ICES carried out and evaluation of MSY and PA reference points for this stock last year at WKMSYREF4 (ICES, 2016a). The results have been published earlier this year (ICES, 2016b) are summarized below:

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	10 000 t	B_{pa}.	ICES (2016b)
	F_{MSY}	0.40	Median point estimates of EqSim with segmented regression S–R relationship (landings: 0.36 + discards: 0.04).	ICES (2016b)
Precautionary approach	B_{lim}	6700 t	Lowest observed SSB	ICES (2016a)
	B_{pa}	10 000 t	B_{lim} combined with the assessment error; $B_{lim} \times \exp(1.645 \times \sigma)$, $\sigma = 0.26$	ICES (2016)
	F_{lim}	1.41	F with 50% probability of SSB< B_{lim}	ICES (2016a)
	F_{pa}	0.89	F_{lim} combined with the assessment error; $F_{lim} \times \exp(-1.645 \times \sigma)$, $\sigma = 0.28$	ICES (2016a)
Management plan	SSB_{MGT}	Undefined		
	F_{MGT}	Undefined		

7.4.7 Management plans

No management plan for VIIb,c,e–k haddock has been agreed or proposed.

7.4.8 Uncertainties and bias in assessment and forecast

Landings

Sampling levels of the landed catch for recent years are considered to be sufficient to support current assessment approaches, although the assessment is contingent on the accuracy of the landings statistics.

Discards

Irish discards have been monitored since 1995. The number of trips sampled has varied considerably over time (between three and 62 trips per year). Sample numbers were particularly low in 1995, 1999–2002 and 2006. During the remaining years, the number of sampled trips was considered sufficient to give reliable estimates of discards.

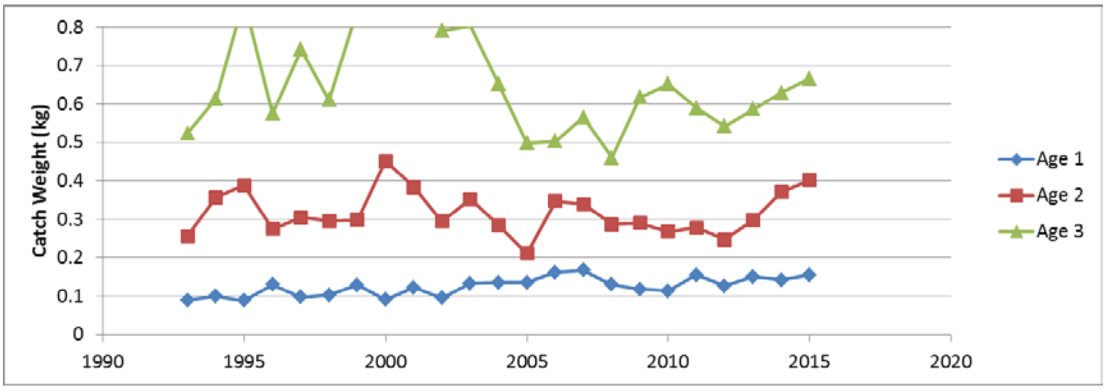
French discard data exist from 2004 onwards but the data are not considered to be reliable before 2008. The time-series of French discards was reconstructed by assuming that 90% of one-year olds, 50% of two-year olds and 10% of three year olds were discarded throughout the time-series. These proportions were estimated from the available discard and retained catch data provided by France. Because French discards are estimated to account for 80–86% of the international discards (by weight; 2008–2012), there is considerable uncertainty around the historic discard estimates. However WKROUND (2012) concluded that the ASAP assessment is relatively robust to the uncertainty in the discard estimates.

Although recent discard estimates are considered to be more reliable, the problem remains that the number of observer trips is very small compared to the total number of trips (typically <1% of all trips are sampled). The level of uncertainty due to the small sample sizes is likely to be high but the cost of increasing discard coverage would be considerable.

Selectivity

As a consequence of the introduction of square-mesh panels in the Celtic Sea, the selectivity of the fleet might be expected to change. The regulations were introduced in the second half of 2012 (although many vessels had already voluntarily fitted panels earlier that year). STECF (PLEN-13-03) investigated the efficiency of the introduction of the square-mesh panel in the Celtic Sea and did not find evidence for a change in selectivity in 2012 or 2013. A possible change in selectivity was investigated using a number of different approaches:

- There is no evidence of a 'block' of negative residuals of young fish in recent years from the catch proportions-at-age residuals (Figure 7.4.11).
- An exploratory ASAP run with two selectivity blocks (1993–2011 and 2012–2015) estimated slightly higher lower selectivity for 1-year olds but slightly higher selectivity for 2-year olds since the introduction of the panels. The assessment results were otherwise nearly identical.
- The XSA assessment (which does not have a fixed selectivity pattern) does not show clear reductions in F for younger ages relative to the older ages since 2012.
- A change in selectivity may also be detected from a change in mean weight-at-age for young fish (within an age class the smaller, lighter fish should escape). The catch weight of 1-year olds has not changed since 2012 (Figure below). The catch weights of 2-year-olds have increased in recent years, but are still within the variability observed previously. Three-year-olds also show an increasing trend, and this age class is not expected to be affected by square-mesh panels.



Therefore there is no clear evidence that selectivity has changed significantly and the assumption of constant selectivity in ASAP appears to be valid. In future assessments a separate selectivity block for the last three years should continue to be considered.

Surveys

The combined French/Irish survey has nearly full spatial coverage of the assessment area. The survey has good internal consistency. The commercial tuning fleet only covers a small part of the stock area but WKROUND (2012) decided to include this fleet due to the short time-series of the survey.

Forecast

The 2015 cohort accounts for nearly half the projected landings in 2017, the recruitment of this cohort was estimated with a CV of 23% which is not very precise. However, recruitment estimates have tended to be accurate in the past with little retrospective bias. The strong cohort was picked up in all divisions covered by the survey and by both the French and Irish component of the survey index.

The GM recruitment assumption does not contribute much to the forecasted landings in 2017 (3% contribution); however it contributes 39% to the 2018 SSB estimate; this adds considerable uncertainty to the 2018 SSB forecast.

7.4.9 Recommendation for next benchmark

Stock audit

The audit of the 2015 report did not raise any concerns.

Recommendations for future work

WGCSE recommend that cod, haddock and whiting in the Celtic Sea should be benchmarked together in 2018. The focus of the benchmark would be on streamlining data compilation procedures for fishery-dependent and survey data. This will give improved transparency and diagnostics surrounding commercial tuning fleets and surveys. The benchmark should also relook at the assessment methods and diagnostics given the potential for changes in selectivity in the commercial fishery. The benchmark should also investigate mixed fisheries and multispecies interactions as well as environmental drivers that may be impacting on growth and recruitment of all three species.

The catch data should be monitored for indirect evidence of improved selection patterns due to the augmented TCMs in the Celtic Sea. Direct monitoring of escapement through SMPs would also be useful.

It would be desirable to include discard separately in the assessment model in order to specify a lower precision for the discard numbers-at-age than for the landings numbers-at-age. However WKROUND (2012) concluded that this resulted in undesirable residual patterns. The benchmark workshop did not have sufficient time to fully evaluate this problem.

It would be worth investigating if there is any worth in retaining the commercial tuning fleet. If this fleet is to be retained it would be useful to apply some sort of standardisation to account for possible changes in the fleet.

7.4.10 Management considerations

The stock size fluctuates strongly over the time. The size of the stock is determined to a large extent by recruitment, which is erratic. There is no discernible relationship between stock size and recruitment, as is the case with most haddock stocks.

Fishing mortality has been consistently above F_{MSY}, but this has not led to a decreasing trend in stock size, which suggests that the stock is very robust to over-fishing. On the other hand, at current levels of F the SSB could quickly fall below B_{loss} if recruitment is low for three or four years (B_{loss} has been proposed as $B_{trigger}$). Current SSB is well above B_{loss}.

The variable recruitment has also resulted in substantial short-term variability in TACs and high discards have occurred when a strong year class occurs. Discarding of under-size as well as marketable fish is a serious problem for this stock: over the last ten years 78% of the catch numbers and 45% of the catch weight has been discarded. Alternative or complimentary approaches to managing such strong, recruit-driven fluctuations are required, especially with regard to the upcoming discard ban.

The minimum landing size of haddock is 30 cm, which is about the same as the mean length of two-year old haddock in the Celtic sea. Because gadoids are caught in a mixed fishery, restrictive quota in recent years have led to increased discarding of marketable fish as well as already considerable discarding of undersized fish. Technical measures have been introduced to reduce discards of undersize gadoids (110 mm square-mesh panel in the *Nephrops* fisheries and 100 mm in the gadoid fisheries). It is not clear whether this is sufficient to reduce discard mortality of future cohorts. It is important that technical measures are fully implemented and their effectiveness in reducing discards and impact on commercial catches are monitored and evaluated.

7.4.11 References

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

ICES. 2016b. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. ICES Advice 2016 Book 5, ICES Special Request Advice, Published 5 February 2016.

Tables

Table 7.4.1.a. Haddock in 7bc–ek. Official landings (quota uptake in brackets).

YEAR	BEL	ESP	FRA	IRL	UK*	OTHERS	TOTAL	TAC**
1994	123	0	2788	908	240	17	4076	
1995	189 (28%)	19	2964 (74%)	966 (72%)	266 (44%)	64	4468	6000
1996	133 (9%)	48	4527 (49%)	1468 (47%)	439 (31%)	38	6653	14000
1997	246 (16%)	54	6581 (71%)	2789 (90%)	569 (41%)	31	10270	14000
1998	142 (6%)	260	3674 (28%)	2788 (63%)	445 (22%)	52	7361	20000
1999	51 (2%)	88	2725 (19%)	2034 (42%)	278 (13%)	71	5247	22000
2000	90 (5%)	110	3088 (28%)	3066 (83%)	289 (17%)	13	6656	16600
2001	165 (12%)	646	4842 (61%)	3608 (135%)	422 (35%)	19	9702	12000
2002	132 (128%)	85	4348 (70%)	2188 (106%)	315 (34%)	21	7089	9300
2003	118 (130%)	82	5781 (106%)	1867 (103%)	393 (48%)	0	8241	8185
2004	136 (127%)	143	6130 (96%)	1715 (80%)	313 (33%)	16	8453	9600
2005	167 (130%)	197	4166 (54%)	2037 (80%)	292 (25%)	0	6859	11520
2006	99 (77%)	185	3190 (42%)	1875 (73%)	274 (24%)	24	5647	11520
2007	119 (93%)	49	4142 (54%)	1930 (75%)	386 (34%)	3	6629	11520
2008	108 (84%)	121	3639 (47%)	1800 (70%)	566 (49%)	0	6234	11579
2009	131 (102%)	47	5429 (70%)	2983 (116%)	716 (62%)	1	9307	11579
2010	170 (132%)	127	6240 (81%)	2609 (101%)	852 (74%)	1	9999	11579
2011	211 (143%)	94	8388 (94%)	3322 (112%)	1659 (125%)	35	13709	13316
2012	231 (125%)	105	11793 (106%)	4130 (112%)	1901 (114%)	62	18222	16645
2013	173 (110%)	3	8748 (93%)	2699 (86%)	1455 (103%)	20	13098	14148
2014	99 (94%)	3	6374 (101%)	2092 (99%)	785 (83%)	18	9371	9479
2015	117 (126%)	0	5681 (102%)	1656 (89%)	759 (91%)	4	8217	8342

*** UK Includes Channel Islands.**

**** TAC Applied to Subareas 7–10 from 1995 to 2008 and to 7b–k, 8, 9 and 10 from 2009 onwards.**

Table 7.4.1.b. Haddock in 7.bc–ek. ICES estimate of the landings (lan) and discards (dis).

Year	BEL Lan	ESP Lan	FRA Lan	IRL Lan	UK Lan	Others Lan	Total Lan	FRA Dis*	IRL Dis**	Others Dis***	Total Dis
1993							3348	505	594	109	1208
1994							4131	1116	594	176	1886
1995							4470	730	1221	267	2218
1996							6756	3170	713	426	4309
1997							10827	2129	502	253	2883
1998							7928	680	140	114	934
1999							4970	477	54	55	586
2000							7499	1587	727	189	2503
2001							9278	2234	743	441	3418
2002	134	85	3878	2070	301	21	6488	871	5651	552	7073
2003	116	82	5960	1731	362	41	8292	1835	6941	680	9456
2004	137	143	6336	1785	303	73	8777	1108	5156	486	6750
2005	165	197	4096	2026	282	21	6787	762	3933	496	5191
2006	98	185	3151	1883	262	14	5593	1061	1167	256	2484
2007	118	49	4073	2135	383	23	6781	1268	1241	230	2739
2008	109	121	4587	2032	545	61	7455	7608	2153	1427	11187
2009	131	47	5455	3271	703	1	9608	6064	2143	873	9080
2010	170	127	6267	2876	789	34	10262	11396	3246	1905	16547
2011	212	94	7365	3697	1511	0	12879	9320	2913	2145	14378
2012	232	105	11793	4608	1637	0	18376	7221	1678	1293	10191
2013	174	40	8622	3109	1480	0	13424	1103	727	255	2085
2014	99	3	6376	2529	848	0	9855	1793	992	392	3177
2015	118	0	5679	1978	766	4	8545	2798	2785	1110	6693

*** For 1993–2007 fixed discard ratios were used to estimate French discards.**

**** For 1993–1994, the mean Irish discards over 1995–1999 were used.**

***** Estimated from the proportion of the landings of `Others' between 1993 and 2012.**

Table 7.4.2. Haddock in 7bc–ek. Lpue (kg/hour fishing) of haddock and effort (hours fishing x 1000) for Irish Otter trawls in 7bc, 7fgh and 7jk, the French demersal fleet in 7bc–ek and effort only for the UK trawl fleets (excluding beam trawls) in 7e–k (effort in fishing days).

	FR GAD 7EK EFFORT	FR GAD 7EK LPUE	IRL OTB 7BC EFFORT	IRL OTB 7BC LPUE	IRL OTB 7FGH EFFORT	IRL OTB 7FGH LPUE	IRL OTB 7JK EFFORT	IRL OTB 7JK LPUE	UK TRAWL 7E-K EFFORT
1983	NA	NA	NA	NA	NA	NA	NA	NA	51.5
1984	NA	NA	NA	NA	NA	NA	NA	NA	161.8
1985	NA	NA	NA	NA	NA	NA	NA	NA	143.7
1986	NA	NA	NA	NA	NA	NA	NA	NA	123.5
1987	NA	NA	NA	NA	NA	NA	NA	NA	108.9
1988	NA	NA	NA	NA	NA	NA	NA	NA	112.9
1989	NA	NA	NA	NA	NA	NA	NA	NA	119.9
1990	NA	NA	NA	NA	NA	NA	NA	NA	133.2
1991	NA	NA	NA	NA	NA	NA	NA	NA	118.8
1992	NA	NA	NA	NA	NA	NA	NA	NA	129.9
1993	NA	NA	NA	NA	NA	NA	NA	NA	101.1
1994	NA	NA	NA	NA	NA	NA	NA	NA	88.5
1995	NA	NA	78	5.77	64	1.48	106	2.20	88.1
1996	NA	NA	47	4.16	60	5.35	73	3.24	89.5
1997	NA	NA	63	4.36	65	5.83	92	8.23	101.8
1998	NA	NA	79	5.71	72	4.09	99	5.88	94.6
1999	NA	NA	77	5.27	51	2.35	52	3.53	132.8
2000	306	6.12	74	4.73	61	10.43	72	4.25	141.1
2001	333	10.57	78	4.30	69	8.69	81	7.41	117.5
2002	289	10.63	63	2.81	79	3.22	108	5.50	113.1
2003	264	15.15	81	2.09	87	3.26	123	3.88	102.4
2004	217	19.39	82	2.51	97	3.49	108	3.35	105.5
2005	175	14.67	69	2.45	127	4.53	93	3.70	100.9
2006	167	10.64	60	2.56	119	4.19	89	3.59	106.3
2007	160	14.97	60	3.31	136	4.01	103	3.66	113.6
2008	148	19.60	48	4.36	127	4.56	84	4.60	93.7
2009	150	22.65	48	5.47	141	9.25	82	7.09	98.6
2010	131	30.83	54	4.36	144	7.33	101	5.15	103.7
2011	216	22.90	40	6.39	129	10.51	84	5.58	87.1
2012	188	45.03	44	4.93	135	13.17	84	6.58	86.2
2013	215	27.40	42	5.38	126	8.69	80	4.92	40.3
2014	203	19.81	46	5.22	142	5.11	77	3.91	32.1
2015	NA	NA	30	4.77	151	4.34	78	2.91	21.2

Table 7.4.3a. Haddock in 7bc–ek. Landings numbers-at-age.

	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1993	0	491	3291	948	810	255	129	129	45
1994	0	1277	5223	674	302	94	24	35	16
1995	0	4275	1622	1327	270	245	46	0	0
1996	0	3693	15998	818	313	93	32	10	9
1997	0	1353	9645	5553	716	354	139	144	110
1998	0	167	3184	7403	1443	307	178	86	61
1999	0	476	654	1464	2425	307	18	19	6
2000	0	2197	2996	784	741	1250	205	35	28
2001	0	4297	8638	1131	303	317	321	54	39
2002	0	879	4274	3400	765	39	89	74	26
2003	0	703	8791	2160	1226	116	43	49	51
2004	0	125	5948	4663	928	589	51	12	20
2005	0	786	863	4366	1983	450	115	4	17
2006	0	852	3393	1500	2219	400	67	7	1
2007	0	707	6404	2687	532	864	155	29	5
2008	0	1637	4034	4422	987	235	382	70	13
2009	0	795	7010	3394	1939	489	145	110	27
2010	0	1291	4814	6091	901	494	162	68	62
2011	0	170	11164	3359	3249	606	200	55	43
2012	0	61	787	18587	2352	1319	212	60	54
2013	0	24	244	2071	11007	764	444	87	47
2014	0	284	719	309	1632	5587	272	108	19
2015	0	111	4775	552	215	946	1896	165	23

Table 7.4.3b. Haddock in 7bc–ek. Discard numbers-at-age.

	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1993	0	7617	2816	160	6	0	0	0	0
1994	0	15120	3069	170	5	0	0	0	0
1995	0	32830	1977	91	4	0	0	0	0
1996	0	20734	8976	187	9	0	0	0	0
1997	0	12613	10022	493	5	0	0	0	0
1998	0	3580	2348	445	5	0	0	0	0
1999	0	3742	1562	100	10	0	0	0	0
2000	0	29015	2521	64	3	0	0	0	0
2001	0	25234	6772	219	2	0	0	0	0
2002	0	21624	20729	249	7	0	0	0	0
2003	0	52412	11075	352	8	0	0	0	0
2004	0	11733	21598	1395	61	0	0	0	0
2005	0	15904	10766	4315	149	0	0	0	0
2006	0	9377	4130	381	33	0	0	0	0
2007	0	6387	7066	662	34	0	0	0	0
2008	0	48764	15658	5492	330	0	0	0	0
2009	0	23561	27015	873	581	0	0	0	0
2010	0	98400	23292	2133	131	0	0	0	0
2011	0	16081	47971	1831	665	0	0	0	0
2012	0	7056	22315	12250	115	0	0	0	0
2013	0	1645	1187	1339	1899	0	0	0	0
2014	0	13089	3385	449	176	155	0	0	0
2015	0	2806	17841	550	14	103	134	15	1

Table 7.4.4. Haddock in 7bc–ek. ASAP input data.

```
# ASAP VERSION 3.0
# Had7b-k
#
# ASAP GUI 15 AUG 2012
#
# Number of Years
23
# First Year
1993
# Number of Ages
9
# Number of Fleets
1
# Number of Sensitivity Blocks
1
# Number of Available Survey Indices
2
# Natural Mortality
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
0.99 0.72 0.6 0.5 0.43 0.4 0.37 0.36 0.34
# Fecundity Option
0
# Fraction of year that elapses prior to SSB calculation (0=Jan-1)
0
# Maturity
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
0 0 1 1 1 1 1 1 1
```

```
0 0 1 1 1 1 1 1 1
# Number of Weights at Age Matrices
2
# Weight Matrix - 1
0 0.09 0.257 0.524 0.848 1.402 1.693 2.13 2.573
0 0.1 0.358 0.614 0.987 1.456 1.745 2.014 2.536
0 0.089 0.388 0.875 1.321 1.188 1.746 0 0
0 0.13 0.275 0.576 0.799 1.181 1.369 1.828 1.827
0 0.097 0.305 0.743 1.205 1.362 1.268 1.412 1.176
0 0.103 0.296 0.611 0.938 0.956 1.086 1.292 1.453
0 0.129 0.299 0.848 1.072 1.186 1.223 0.908 1.708
0 0.091 0.452 1.19 1.463 1.719 1.627 1.163 1.459
0 0.122 0.384 0.971 1.857 1.783 1.705 2.297 1.612
0 0.095 0.295 0.791 1.03 1.733 1.678 1.505 1.569
0 0.133 0.353 0.804 1.238 1.441 1.818 1.704 1.709
0 0.136 0.285 0.654 1.135 1.378 1.876 1.84 2.084
0 0.136 0.211 0.499 0.971 1.252 1.942 2.667 1.949
0 0.162 0.348 0.504 0.925 1.47 2.091 2.59 4.022
0 0.168 0.34 0.566 0.855 1.2 1.642 1.507 2.837
0 0.13 0.287 0.461 0.74 1.159 1.282 1.685 1.926
0 0.118 0.291 0.618 0.846 1.311 1.547 1.653 2.441
0 0.114 0.268 0.653 1.072 1.754 1.845 1.738 1.673
0 0.155 0.278 0.59 0.928 1.623 2.116 1.888 1.478
0 0.127 0.248 0.543 1.041 1.443 2.022 2.278 2.203
0 0.151 0.298 0.587 0.832 1.422 1.611 2.209 1.86
0 0.142 0.372 0.63 0.911 1.179 1.654 1.965 2.576
0 0.155 0.403 0.667 1.02 1.233 1.478 1.859 2.462
# Weight Matrix - 2
0.041 0.093 0.277 0.641 0.824 1.804 2.089 2.407 2.647
0.042 0.093 0.29 0.756 1.138 2.36 2.163 2.407 2.647
0.045 0.102 0.295 0.715 1.232 2.174 1.972 2.169 2.386
0.046 0.1 0.313 0.719 1.246 2.046 1.773 1.95 2.145
0.043 0.098 0.287 0.579 0.904 1.144 1.261 1.631 1.794
0.037 0.096 0.274 0.655 0.87 1.005 1.016 1.251 1.376
0.028 0.103 0.265 0.791 0.962 1.148 1.203 1.348 1.483
0.027 0.109 0.306 0.93 1.326 1.548 1.605 1.765 1.942
0.022 0.102 0.312 0.926 1.33 1.634 1.672 1.84 2.024
0.021 0.11 0.312 0.841 1.399 1.676 1.888 2.076 2.284
0.023 0.119 0.275 0.725 1.189 1.601 1.938 2.132 2.345
0.032 0.133 0.248 0.623 1.207 1.662 2.308 2.538 2.792
0.037 0.139 0.252 0.523 1.056 1.587 2.159 2.409 2.65
0.043 0.148 0.265 0.49 0.922 1.417 2.062 2.537 2.79
0.041 0.145 0.282 0.481 0.799 1.313 1.763 2.168 2.385
0.048 0.135 0.267 0.505 0.759 1.148 1.611 1.838 2.022
0.048 0.119 0.252 0.522 0.804 1.252 1.519 1.775 1.952
0.041 0.128 0.256 0.55 0.861 1.331 1.732 2.036 2.24
0.043 0.13 0.251 0.52 0.913 1.439 1.896 2.268 2.495
0.044 0.142 0.263 0.512 0.87 1.445 1.95 2.514 2.765
0.054 0.138 0.281 0.539 0.848 1.348 1.846 2.166 2.383
0.055 0.148 0.315 0.572 0.824 1.251 1.617 1.922 2.115
0.055 0.147 0.331 0.578 0.831 1.095 1.561 1.718 1.889
# Weights at Age Pointers
1
1
1
1
2
2
# Selectivity Block Assignment
# Fleet 1 Selectivity Block Assignment
1
1
1
1
1
1
1
1
1
1
1
1
```

```
1
1
1
1
1
1
1
1
1
1
1
# Selectivity Options for each block 1=by age, 2=logisitic, 3=double
logistic
1
# Selectivity Block #1 Data
0 -1 0 1
0.5 1 0 1
1 1 0 1
1 -1 0 1
1 -1 0 1
1 -1 0 1
1 -1 0 1
1 -1 0 1
1 -1 0 1
1 1 0 1
1 1 0 1
1 1 0 1
1 1 0 1
1 1 0 1
1 1 0 1
# Fleet Start Age
1
# Fleet End Age
9
# Age Range for Average F
4 6
# Average F report option (1=unweighted, 2=Nweighted, 3=Bweighted)
1
# Use Likelihood constants? (1=yes)
0
# Release Mortality by Fleet
1
# Catch Data
# Fleet-1 Catch Data
0 8107 6107 1108 816 255 129 129 45 4556
0 16396 8292 844 307 94 24 35 16 6017
0 37105 3599 1419 273 245 46 0 0 6688
0 24428 24973 1005 321 93 32 10 9 11065
0 13965 19667 6046 722 354 139 144 110 13710
0 3747 5531 7848 1448 307 178 86 61 8862
0 4218 2217 1564 2435 307 18 19 6 5556
0 31212 5517 848 744 1250 205 35 28 10002
0 29531 15409 1350 304 317 321 54 39 12696
0 22503 25003 3650 772 39 89 74 26 13561
0 53115 19866 2512 1234 116 43 49 51 17748
0 11858 27546 6058 989 589 51 12 20 15527
0 16690 11629 8681 2133 450 115 4 17 11978
0 10229 7524 1881 2252 400 67 7 1 8077
0 7094 13470 3350 566 864 155 29 5 9520
0 50401 19692 9913 1317 235 382 70 13 18642
0 24356 34025 4267 2519 489 145 110 27 18688
0 99691 28106 8225 1033 494 162 68 62 26809
0 16252 59134 5190 3914 606 200 55 43 27257
0 7116 23102 30837 2467 1319 212 60 54 28567
0 1669 1431 3410 12906 764 444 87 47 15509
0 13372 4103 758 1808 5741 272 108 19 13031
0 2918 22616 1102 229 1049 2029 180 24 15239
# Discards
# Fleet-1 Discards Data
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
```

```
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
# Release Proportion
# Fleet-1 Release Data
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
# Survey Index Data
# Aggregate Index Units
2 2
# Age Proportion Index Units
2 2
# Weight at Age Matrix
2 2
# Index Month
11 7
# Index Selectivity Link to Fleet
-1 -1
# Index Selectivity Options 1=by age, 2=logisitic, 3=double logistic
1 1
# Index Start Age
1 4
# Index End Age
6 8
# Estimate Proportion (Yes=1)
1 1
# Use Index (Yes=1)
1 1
# Index-1 Selectivity Data
1 1 1 1e-04
1 -1 0 1
1 -1 0 1
1 -1 0 1
1 -1 0 1
```

```
1 -1 0 1
-1 -1 0 1
-1 -1 0 1
-1 -1 0 1
1 1 0 1
1 1 0 1
0 -1 0 1
0.001 -1 0 1
1 1 0 1
1 1 0 1
# Index-2 Selectivity Data
-1 -1 0 1
-1 -1 0 1
-1 -1 0 1
0.8 1 0 1
1 -1 0 1
1 -1 0 1
1 -1 0 1
1 -1 0 1
-1 -1 0 1
1 1 0 1
1 1 0 1
3 -1 0 1
1 -1 0 1
8 -1 0 1
1 -1 0 1
# Index-1 Data
1993 0 0 0 0 0 0 0 0 0 0 0 0
1994 0 0 0 0 0 0 0 0 0 0 0 0
1995 0 0 0 0 0 0 0 0 0 0 0 0
1996 0 0 0 0 0 0 0 0 0 0 0 0
1997 0 0 0 0 0 0 0 0 0 0 0 0
1998 0 0 0 0 0 0 0 0 0 0 0 0
1999 0 0 0 0 0 0 0 0 0 0 0 0
2000 0 0 0 0 0 0 0 0 0 0 0 0
2001 0 0 0 0 0 0 0 0 0 0 0 0
2002 0 0 0 0 0 0 0 0 0 0 0 0
2003 707.4 0.2 157 508.3 32.6 7 2.4 0.1 0 0 0 40
2004 517.7 0.2 385.7 49.1 70.9 7.9 2.7 1.4 0 0 0 40
2005 310.7 0.2 193.5 85.7 9.9 19.4 1.9 0.3 0 0 0 40
2006 176.9 0.2 110.2 39.7 19 4.5 3.2 0.4 0 0 0 40
2007 670.6 0.2 610.8 38.6 9.9 5.8 2.8 2.7 0 0 0 40
2008 424 0.2 271.5 143.3 5.6 1.6 1.3 0.7 0 0 0 40
2009 1562.4 0.2 1428.4 67.1 62 2.1 1.9 0.8 0 0 0 40
2010 823.4 0.2 89.7 686 33 13.6 0.4 0.8 0 0 0 40
2011 317.8 0.2 69.2 45.3 193.9 7.2 2.1 0.2 0 0 0 40
2012 113.9 0.2 21.4 23.1 13.4 52.4 2.2 1.3 0 0 0 40
2013 705.9 0.2 666 10.5 8.9 5.2 14.3 0.8 0 0 0 40
2014 279.9 0.2 91.3 177.2 2.4 1.9 2.1 5.1 0 0 0 40
2015 476.7 0.2 355.6 74.1 42.7 0.9 1.2 2.2 0 0 0 40
# Index-2 Data
1993 0 0 0 0 0 0 0 0 0 0 0 0
1994 0 0 0 0 0 0 0 0 0 0 0 0
1995 0.826 0.3 0 0 0 0.751 0.06 0.015 0 0 0 40
1996 1.031 0.3 0 0 0 0.675 0.226 0.096 0.035 0 0 40
1997 3.578 0.3 0 0 0 3.086 0.339 0.115 0.019 0.019 0 40
1998 6.695 0.3 0 0 0 5.811 0.824 0.033 0.008 0.018 0 40
1999 3.047 0.3 0 0 0 1.147 1.735 0.149 0.005 0.011 0 40
2000 4.103 0.3 0 0 0 1.618 1.077 1.204 0.204 0 0 40
2001 3.47 0.3 0 0 0 2.926 0.293 0.148 0.093 0.009 0 40
2002 3.996 0.3 0 0 0 3.657 0.266 0.02 0.021 0.034 0 40
2003 2.075 0.3 0 0 0 1.267 0.703 0.082 0.009 0.015 0 40
2004 4.594 0.3 0 0 0 3.368 0.858 0.351 0.01 0.008 0 40
2005 7.108 0.3 0 0 0 4.707 2.085 0.268 0.048 0 0 40
2006 7.058 0.3 0 0 0 2.976 3.523 0.484 0.062 0.012 0 40
2007 4.706 0.3 0 0 0 2.664 0.674 1.219 0.136 0.012 0 40
2008 5.48 0.3 0 0 0 3.56 1.17 0.258 0.404 0.088 0 40
2009 5.872 0.3 0 0 0 2.952 1.822 0.569 0.307 0.223 0 40
2010 9.978 0.3 0 0 0 8.297 0.964 0.506 0.154 0.057 0 40
2011 9.597 0.3 0 0 0 3.939 4.592 0.705 0.301 0.06 0 40
2012 17.739 0.3 0 0 0 13.829 1.746 1.787 0.285 0.092 0 40
2013 9.851 0.3 0 0 0 0.796 7.03 0.989 0.891 0.145 0 40
```

```
2014 4.997 0.3 0 0 0 0.225 0.972 3.584 0.155 0.061 0 40
2015 3.057 0.3 0 0 0 0.378 0.166 0.521 1.902 0.089 0 40
# Phase Control
# Phase for F mult in 1st Year
1
# Phase for F mult Deviations
2
# Phase for Recruitment Deviations
3
# Phase for N in 1st Year
1
# Phase for Catchability in 1st Year
3
# Phase for Catchability Deviations
-5
# Phase for Stock Recruitment Relationship
1
# Phase for Steepness
-5
# Recruitment CV by Year
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
# Lambdas by Index
1 1
# Lambda for Total Catch in Weight by Fleet
1
# Lambda for Total Discards at Age by Fleet
1
# Catch Total CV by Year and Fleet
0.2
0.3
0.3
0.3
0.3
0.3
0.3
0.3
0.3
0.3
0.3
0.3
0.3
0.3
0.3
0.2
0.2
0.2
0.2
0.2
0.2
0.2
```

```
0.2
# Discard Total CV by Year and Fleet
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
# Catch Effective Sample Size by Year and Fleet
25
25
25
25
25
25
25
25
25
50
50
50
50
50
50
50
50
50
50
50
50
50
50
# Discard Effective Sample Size by Year and Fleet
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
```

```
0
# Lambda for F Mult in First year by Fleet
0
# CV for F Mult in First year by Fleet
0.5
# Lambda for F Mult Deviations by Fleet
0
# CV for F Mult Deviations by Fleet
0.5
# Lambda for N in 1st Year Deviations
0
# CV for N in 1st Year Deviations
1
# Lambda for Recruitment Deviations
0
# Lambda for Catchability in First year by Index
0 0
# CV for Catchability in First year by Index
1 1
# Lambda for Catchability Deviations by Index
0 0
# CV for Catchability Deviations by Index
1 1
# Lambda for Deviation from Initial Steepness
0
# CV for Deviation from Initial Steepness
1
# Lambda for Deviation from Unexploited Stock Size
0
# CV for Deviation from Unexploited Stock Size
1
# NAA Deviations Flag
1
# Initial Numbers at Age in 1st Year
40000 20000 10000 4000 2000 1000 500 250 100
# Initial F Mult in 1st Year by Fleet
0.7
# Initial Catchabilty by Index
1 1
# Stock Recruitment Flag
0
# Initial Unexploited Stock
1000
# Initial Steepness
1
# Maximum F
2.5
# Ignore Guesses (Yes=1)
0
# Projection Control
# Do Projections (Yes=1)
0
# Fleet Directed Flag
1
# Final Year in Projection
2016
# Projection Data by Year
2016 -1 3 -99 1
# Do MCMC (Yes=1)
0
# MCMC Year Option
0
# MCMC Iterations
1000
# MCMC Thinning Factor
200
# MCMC Random Seed
1415963
# Agepro R Option
0
# Agepro R Option Start Year
1993
```

```
# Agepro R Option End Year
2005
# Export R Flag
1
# Test Value
-23456
######
###### FINIS ######
# Fleet Names
#$LAND+DIS
# Survey Names
#$FR-IRL-IBTS
#$IR-GAD
#
```

Table 7.4.5. Haddock in 7bc–ek. Selectivity of the catches and indices. Catch selectivity was fixed at zero for age 0 and at one for ages 3–8; it was freely estimated for ages 1–2. For the FR_IR_IBTS survey the selectivity was fixed at 1 for all ages and for the IR_GAD commercial fleet selectivity was freely estimated for age 3 and fixed at 1 for the older ages. Catch and index selectivity were not allowed to vary over time.

Age	Catch	FRA.IRL.IBTS	IRL.GAD
0	0.000	1	NA
1	0.371	1	NA
2	1.000	1	NA
3	1.000	1	0.791
4	1.000	1	1.000
5	1.000	1	1.000
6	1.000	NA	1.000
7	1.000	NA	1.000
8	1.000	NA	NA

Table 7.4.6. Haddock in 7bc–ek. Fishing mortality- (F) at-age.

	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1993	0	0.402	1.083	1.083	1.083	1.083	1.083	1.083	1.083
1994	0	0.388	1.045	1.045	1.045	1.045	1.045	1.045	1.045
1995	0	0.316	0.851	0.851	0.851	0.851	0.851	0.851	0.851
1996	0	0.307	0.827	0.827	0.827	0.827	0.827	0.827	0.827
1997	0	0.252	0.680	0.680	0.680	0.680	0.680	0.680	0.680
1998	0	0.279	0.753	0.753	0.753	0.753	0.753	0.753	0.753
1999	0	0.194	0.523	0.523	0.523	0.523	0.523	0.523	0.523
2000	0	0.241	0.649	0.649	0.649	0.649	0.649	0.649	0.649
2001	0	0.254	0.685	0.685	0.685	0.685	0.685	0.685	0.685
2002	0	0.462	1.246	1.246	1.246	1.246	1.246	1.246	1.246
2003	0	0.234	0.632	0.632	0.632	0.632	0.632	0.632	0.632
2004	0	0.285	0.770	0.770	0.770	0.770	0.770	0.770	0.770
2005	0	0.298	0.802	0.802	0.802	0.802	0.802	0.802	0.802
2006	0	0.190	0.513	0.513	0.513	0.513	0.513	0.513	0.513
2007	0	0.149	0.403	0.403	0.403	0.403	0.403	0.403	0.403
2008	0	0.267	0.721	0.721	0.721	0.721	0.721	0.721	0.721
2009	0	0.209	0.562	0.562	0.562	0.562	0.562	0.562	0.562
2010	0	0.219	0.591	0.591	0.591	0.591	0.591	0.591	0.591
2011	0	0.166	0.448	0.448	0.448	0.448	0.448	0.448	0.448
2012	0	0.214	0.577	0.577	0.577	0.577	0.577	0.577	0.577
2013	0	0.187	0.504	0.504	0.504	0.504	0.504	0.504	0.504
2014	0	0.197	0.531	0.531	0.531	0.531	0.531	0.531	0.531
2015	0	0.192	0.519	0.519	0.519	0.519	0.519	0.519	0.519

Table 7.4.7. Haddock in 7bc–ek. Stock numbers-at-age (start of year) (`1000).

	Age0	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8
1993	110096	49785	11913	2761	785	250	257	227	75
1994	379440	40909	16219	2214	567	173	57	60	72
1995	525427	140991	13513	3130	472	130	41	14	33
1996	148671	195236	50053	3167	810	131	37	12	14
1997	74881	55243	69937	12017	840	231	38	11	8
1998	156252	27824	20896	19446	3693	277	78	13	7
1999	415616	58060	10245	5403	5557	1132	87	25	7
2000	397128	154433	23282	3334	1943	2144	450	36	13
2001	447315	147564	59098	6679	1057	661	751	162	18
2002	794001	166212	55713	16350	2042	347	223	262	64
2003	217180	295032	50962	8794	2852	382	67	44	66
2004	279376	80699	113611	14870	2836	986	136	25	41
2005	268300	103809	29526	28879	4177	854	306	44	22
2006	199004	99694	37526	7265	7853	1218	257	95	20
2007	703067	73945	40112	12325	2637	3057	489	106	48
2008	367665	261243	30998	14715	4997	1147	1370	226	72
2009	1744006	136616	97329	8273	4340	1581	374	460	102
2010	213086	648032	53979	30439	2860	1609	604	147	224
2011	57276	79178	253335	16404	10223	1030	597	231	145
2012	40855	21282	32637	88806	6355	4248	441	263	169
2013	531250	15181	8365	10062	30259	2322	1600	171	171
2014	112602	197400	6129	2772	3686	11887	940	667	146
2015	426645	41840	78908	1978	989	1410	4685	382	335
2016	266437	158531	16802	25779	714	383	563	1926	300

Table 7.4.8. Haddock in 7bc–ek. Stock Summary: weights in tonnes; CatchPred is prediced catch from ASAP; recruitment at age zero (`1000); F_{bar} ages 3–5.

Year	Lan	Dis	Cat	CatPred	Tsb	Ssb	SsbCv	Recr	RecrCv	Fbar	FbarCv
1993	3348	1208	4556	4678	16594	7450	0.211	110096	0.213	1.083	0.243
1994	4131	1886	6017	5331	27630	7889	0.220	379440	0.185	1.045	0.223
1995	4470	2218	6688	6508	45301	7276	0.196	525427	0.161	0.851	0.255
1996	6756	4309	11065	12187	45704	19341	0.184	148671	0.199	0.827	0.251
1997	10827	2883	13710	13187	36768	28135	0.157	74881	0.222	0.680	0.240
1998	7928	934	8862	9854	30512	22059	0.160	156252	0.194	0.753	0.241
1999	4970	586	5556	5927	31401	13784	0.162	415616	0.182	0.523	0.286
2000	7499	2503	10002	10533	44488	16932	0.169	397128	0.206	0.649	0.268
2001	9278	3418	12696	16292	53594	28701	0.168	447315	0.175	0.685	0.293
2002	6488	7073	13561	23419	70638	35681	0.203	794001	0.140	1.246	0.230
2003	8292	9456	17748	16848	64874	24770	0.165	217180	0.157	0.632	0.254
2004	8777	6750	15527	22023	62666	42993	0.142	279376	0.133	0.770	0.238
2005	6787	5191	11978	14512	53491	29134	0.154	268300	0.126	0.802	0.225
2006	5593	2484	8077	10558	46611	23299	0.139	199004	0.141	0.513	0.281
2007	6781	2739	9520	8501	64116	24568	0.133	703067	0.107	0.403	0.259
2008	7455	11187	18642	15313	76500	23584	0.133	367665	0.131	0.721	0.170
2009	9608	9080	18688	16020	135867	35897	0.111	1744006	0.091	0.562	0.176
2010	10262	16547	26809	25510	128696	37011	0.122	213086	0.142	0.591	0.179
2011	12879	14378	27257	27638	97707	84951	0.094	57276	0.196	0.448	0.174
2012	18376	10191	28567	25506	72528	67709	0.104	40855	0.214	0.577	0.160
2013	13424	2085	15509	13372	71077	40295	0.118	531250	0.142	0.504	0.186
2014	9854	3177	13031	12044	59942	24534	0.151	112602	0.243	0.531	0.213
2015	8545	6694	15239	15015	67845	38229	0.149	426645	0.233	0.519	0.273
2016*	NA	NA	NA	NA	NA	26082	NA	266437	NA	0.518	NA

*** GM recruitment and mean F last over the three years.**

Table 7.4.9. Haddock in 7bc–ek. Input values for short-term forecast. Note that Sel and CWt refer to the landings and DSel and DCWt refer to the discards. Numbers in thousands; Weights in kg.

2016

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	266437	0.99	0	0	0	0.055	0.000	0.000	0.000	0.055
1	158531	0.72	0	0	0	0.144	0.011	0.345	0.181	0.145
2	16802	0.60	1	0	0	0.309	0.178	0.628	0.340	0.295
3	25779	0.50	1	0	0	0.563	0.391	0.810	0.127	0.440
4	714	0.43	1	0	0	0.834	0.486	0.964	0.033	0.530
5	383	0.40	1	0	0	1.231	0.515	1.297	0.003	0.466
6	563	0.37	1	0	0	1.675	0.517	1.591	0.001	0.346
7	1926	0.36	1	0	0	1.935	0.516	1.966	0.002	1.102
8	300	0.34	1	0	0	2.129	0.517	2.316	0.001	0.421

2017

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	266437	0.99	0	0	0	0.055	0.000	0.000	0.000	0.055
1	99002	0.72	0	0	0	0.144	0.011	0.345	0.181	0.145
2	63677	0.60	1	0	0	0.309	0.178	0.628	0.340	0.295
3	5493	0.50	1	0	0	0.563	0.391	0.810	0.127	0.440
4	9314	0.43	1	0	0	0.834	0.486	0.964	0.033	0.530
5	277	0.40	1	0	0	1.231	0.515	1.297	0.003	0.466
6	153	0.37	1	0	0	1.675	0.517	1.591	0.001	0.346
7	231	0.36	1	0	0	1.935	0.516	1.966	0.002	1.102
8	928	0.34	1	0	0	2.129	0.517	2.316	0.001	0.421

2018

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	266437	0.99	0	0	0	0.055	0.000	0.000	0.000	0.055
1	99002	0.72	0	0	0	0.144	0.011	0.345	0.181	0.145
2	39766	0.60	1	0	0	0.309	0.178	0.628	0.340	0.295
3	20817	0.50	1	0	0	0.563	0.391	0.810	0.127	0.440
4	1985	0.43	1	0	0	0.834	0.486	0.964	0.033	0.530
5	3609	0.40	1	0	0	1.231	0.515	1.297	0.003	0.466
6	110	0.37	1	0	0	1.675	0.517	1.591	0.001	0.346
7	63	0.36	1	0	0	1.935	0.516	1.966	0.002	1.102
8	490	0.34	1	0	0	2.129	0.517	2.316	0.001	0.421

Table 7.4.10. Haddock in 7bc–ek. Single-option output of the short-term forecast (F = mean F2013–2015). Numbers in thousands, weights in tonnes.

2016

Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0.000	0	0	0.000	0	0	266437	14565	0	0
1	0.011	1163	401	0.181	18817	2722	158531	22881	0	0
2	0.178	1804	1133	0.340	3436	1014	16802	5192	16802	5192
3	0.391	6330	5127	0.127	2049	901	25779	14513	25779	14513
4	0.486	224	216	0.033	15	8	714	596	714	596
5	0.515	129	167	0.003	1	0	383	471	383	471
6	0.517	193	306	0.001	1	0	563	942	563	942
7	0.516	662	1301	0.002	3	3	1926	3728	1926	3728
8	0.517	104	241	0.001	0	0	300	639	300	639
Total	0.464	10609	8892	0.054	24322	4648	471435	63527	46467	26081

2017

Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0.000	0	0	0.000	0	0	266437	14565	0	0
1	0.011	726	251	0.181	11751	1700	99002	14289	0	0
2	0.178	6835	4295	0.340	13023	3842	63677	19676	63677	19676
3	0.391	1349	1092	0.127	437	192	5493	3092	5493	3092
4	0.486	2922	2816	0.033	196	104	9314	7771	9314	7771
5	0.515	93	121	0.003	1	0	277	341	277	341
6	0.517	52	83	0.001	0	0	153	256	153	256
7	0.516	80	156	0.002	0	0	231	448	231	448
8	0.517	322	746	0.001	1	0	928	1976	928	1976
Total	0.464	12379	9560	0.054	25409	5838	445512	62414	80073	33560

2018

Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0.000	0	0	0.000	0	0	266437	14565	0	0
1	0.011	726	251	0.181	11751	1700	99002	14289	0	0
2	0.178	4269	2682	0.340	8133	2399	39766	12288	39766	12288
3	0.391	5111	4140	0.127	1654	728	20817	11720	20817	11720
4	0.486	623	600	0.033	42	22	1985	1656	1985	1656
5	0.515	1217	1578	0.003	7	3	3609	4444	3609	4444
6	0.517	38	60	0.001	0	0	110	185	110	185
7	0.516	22	42	0.002	0	0	63	122	63	122
8	0.517	170	394	0.001	0	0	490	1042	490	1042
Total	0.464	12176	9747	0.054	21587	4852	432279	60311	66840	31457

Table 7.4.11. Haddock in 7bc–ek. Management options table. Weights in tonnes.

Fmult	Catch17	Land17	Dis17	Basis	FCatch17	FLand17	FDis17	SSB18	dSSB	dTac
0.0	0	0	0	NA	0.00	NA	NA	47070	40%	-100%
0.1	1856	1167	688	NA	0.05	0.05	0	45162	35%	-84%
0.2	3632	2281	1351	NA	0.10	0.09	0	43342	29%	-69%
0.3	5333	3344	1988	NA	0.16	0.14	0	41604	24%	-54%
0.4	6961	4359	2602	NA	0.21	0.19	0	39946	19%	-40%
0.5	8521	5329	3193	NA	0.26	0.23	0	38363	14%	-27%
0.6	10016	6254	3762	NA	0.31	0.28	0	36852	10%	-14%
0.7	11448	7138	4310	NA	0.36	0.32	0	35409	6%	-2%
0.8	12821	7983	4838	NA	0.41	0.37	0	34031	1%	10%
0.9	14137	8789	5347	NA	0.47	0.42	0	32714	-3%	21%
1.0	15398	9560	5838	NA	0.52	0.46	0	31457	-6%	32%
1.1	16608	10296	6312	NA	0.57	0.51	0	30255	-10%	42%
1.2	17769	11000	6769	NA	0.62	0.56	0	29107	-13%	52%
1.3	18883	11673	7210	NA	0.67	0.60	0	28009	-17%	61%
1.4	19952	12316	7636	NA	0.73	0.65	0	26960	-20%	70%
1.5	20978	12931	8047	NA	0.78	0.70	0	25957	-23%	78%
1.6	21963	13520	8444	NA	0.83	0.74	0	24998	-26%	86%
1.7	22909	14082	8827	NA	0.88	0.79	0	24080	-28%	94%
1.8	23818	14620	9198	NA	0.93	0.84	0	23202	-31%	101%
1.9	24692	15136	9556	NA	0.98	0.88	0	22362	-33%	109%
2.0	25531	15628	9903	NA	1.04	0.93	0	21559	-36%	115%

Figures

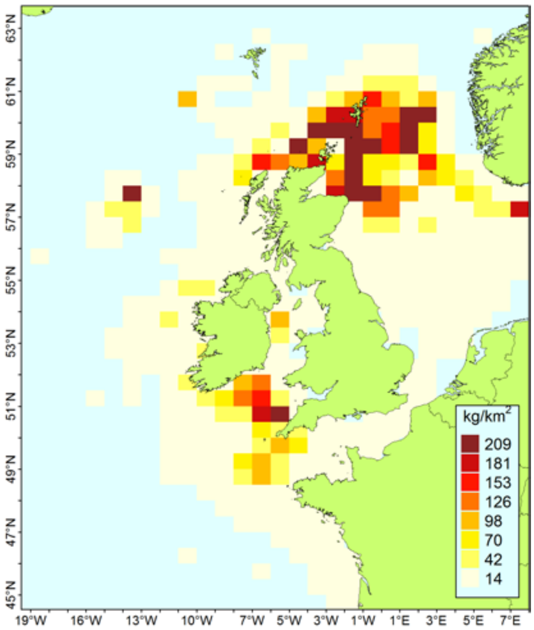


Figure 7.4.1. International haddock landings by ICES rectangle (all gears; 2014; data from https://datacollection.jrc.ec.europa.eu/data-dissemination).

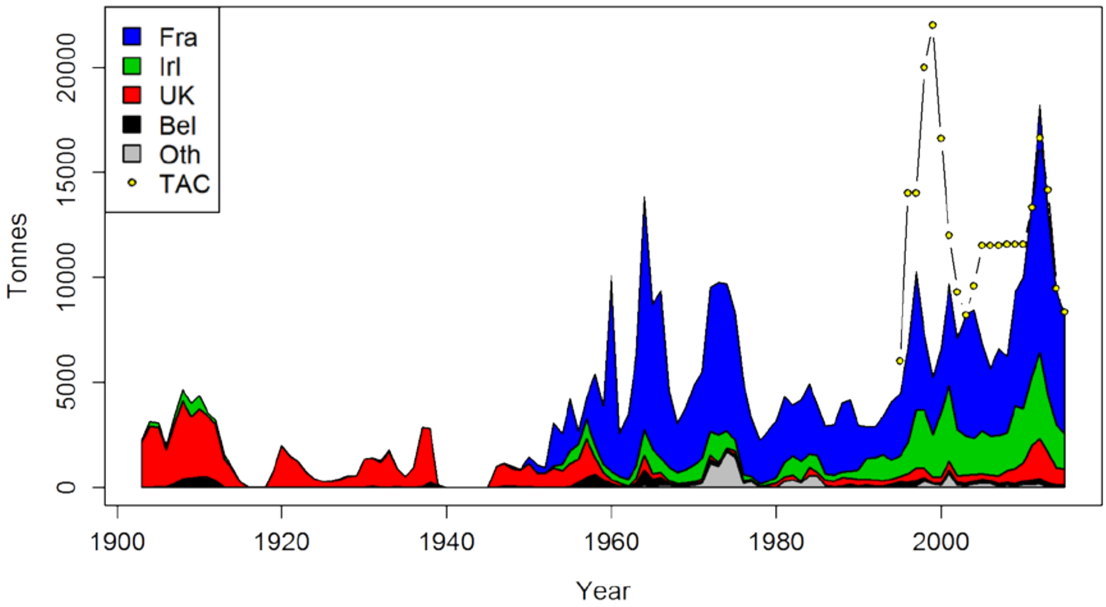


Figure 7.4.2. a) Haddock in 7bc–ek. Official Ices landings and TAC of haddock in 7b–k.

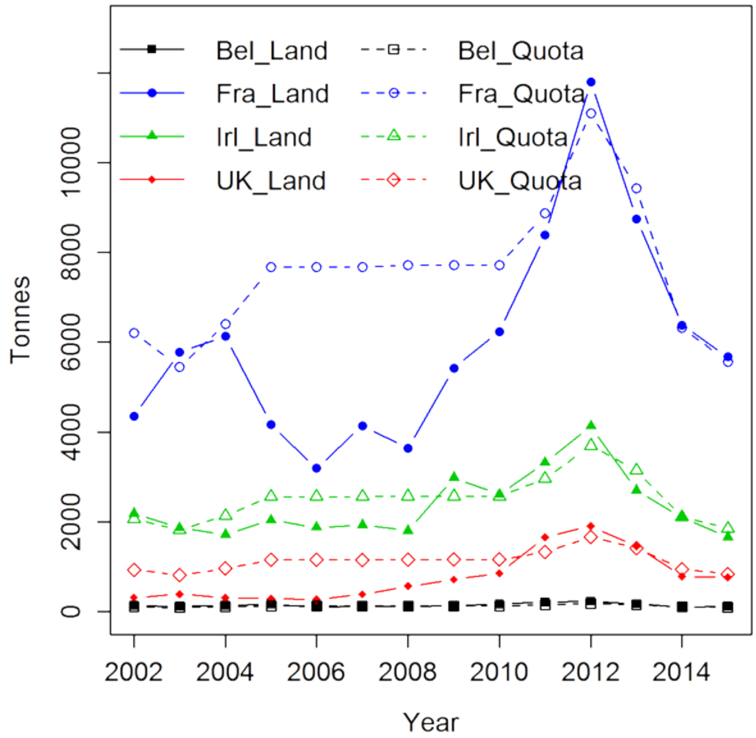


Figure 7.4.2 b) Haddock in 7bc–ek. Recent working group landings and quota by country.

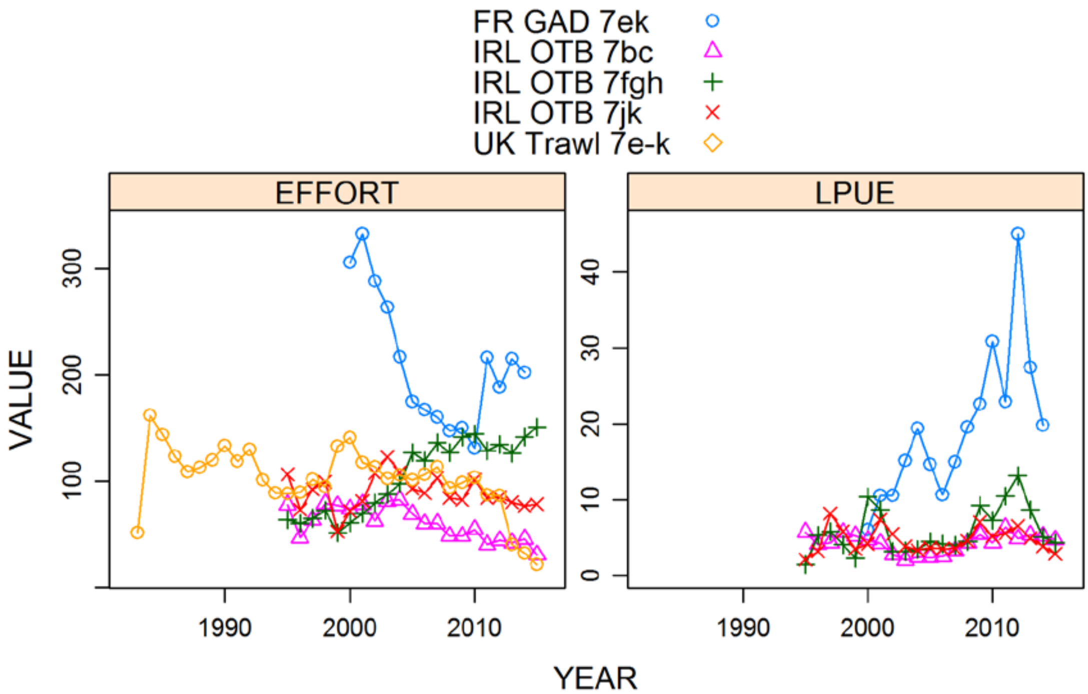


Figure 7.4.3. Haddock in 7bc–ek. Effort ('1000h) of the Irish Otter trawl fleets, the French demersal otter trawl fleet and for UK trawl fleet (effort in fishing days, rescaled to other fleets) and lpue (kg/h) for the Irish and French fleets.

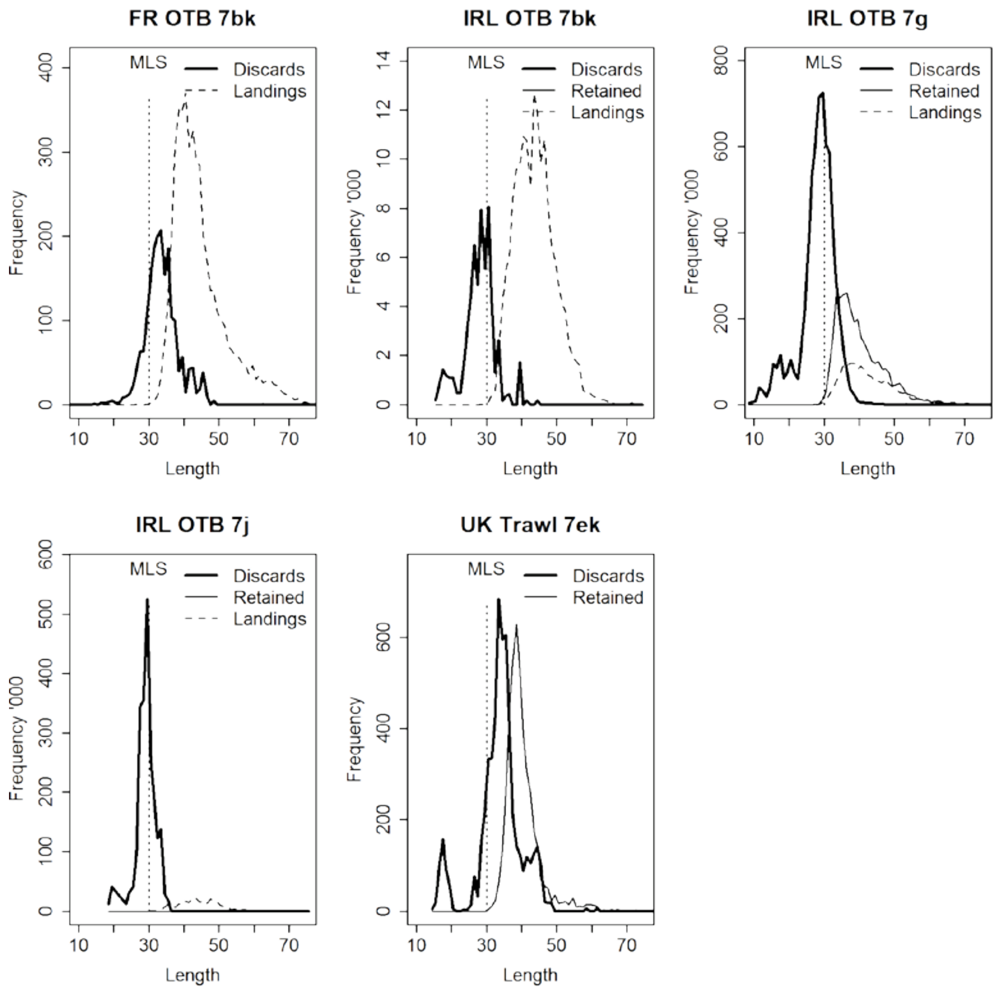


Figure 7.4.4. Haddock in 7bc–ek. Length distributions of discards and the retained catch of haddock in 7b–k in 2015. FR OTB is the French otter trawl fleet (demersal fish and *Nephrops* combined); IRL OTB is the Irish otter trawl fleet; UK trawl consists of all UK trawls except beam trawls. Irish and French data were raised to total numbers, the raised length distributions of the landings (from port sampling) is given for comparison.

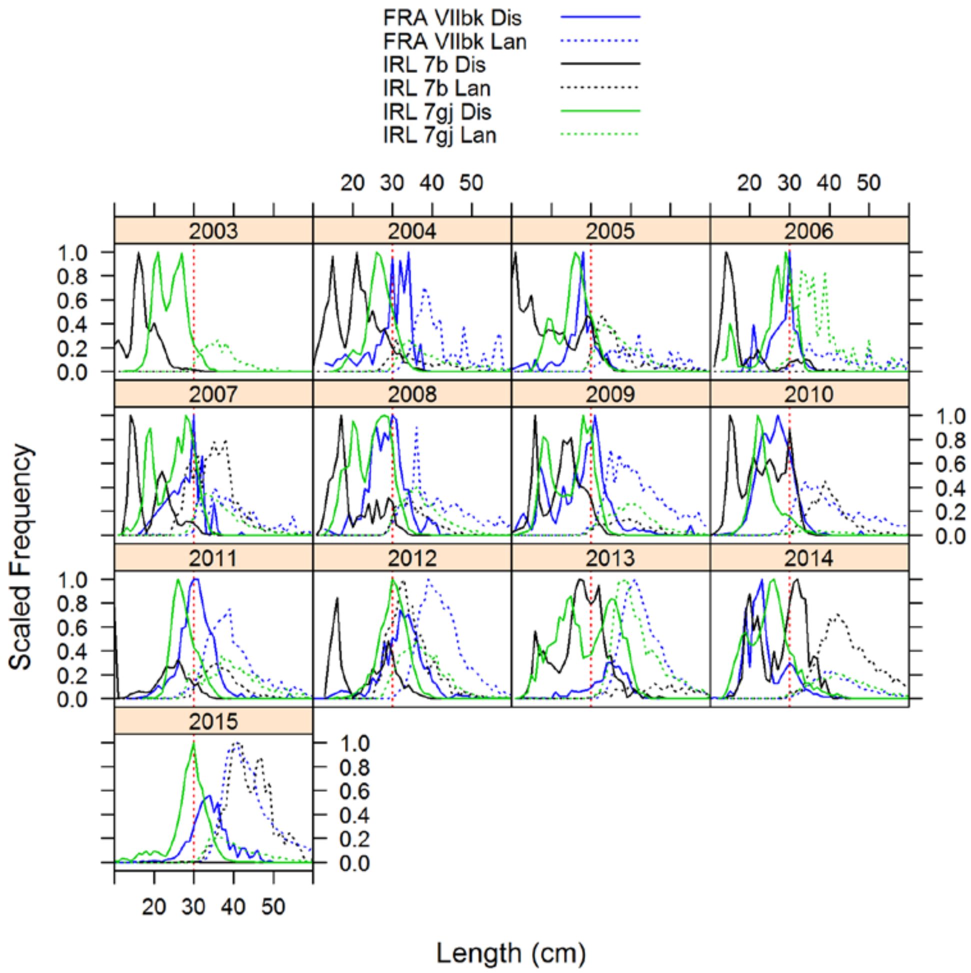


Figure 7.4.5a. Haddock in 7bc–ek. Time-series of the cumulative scaled length distributions of total catch and the retained catch of haddock in 7b–k. The minimum landing size (30 cm) is indicated by the dotted red line.

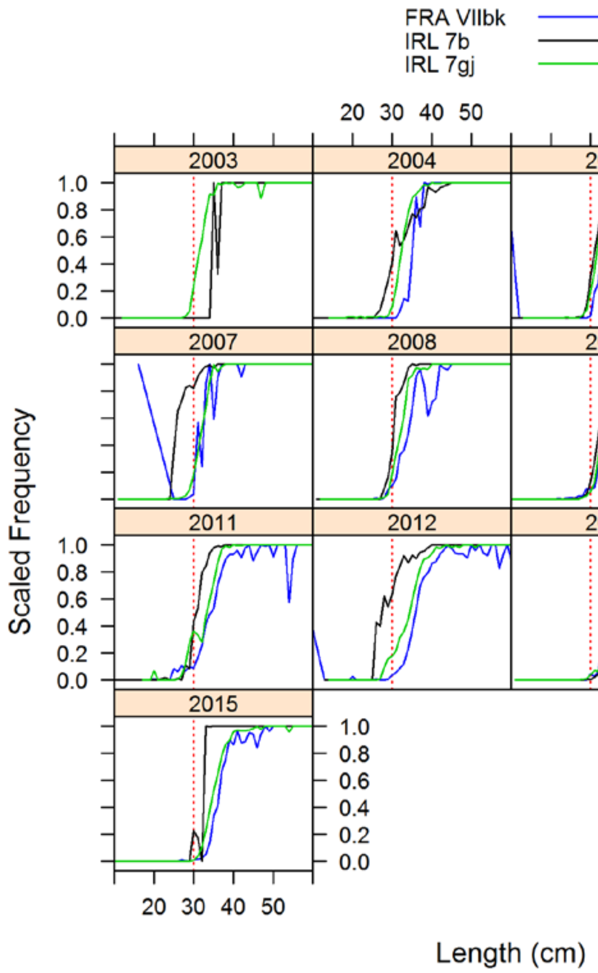


Figure 7.4.5b. Haddock in 7bc–ek. Time-series of the discard ogives of haddock in 7bc–ek. The minimum landing size (30 cm) is indicated by the dotted red line.

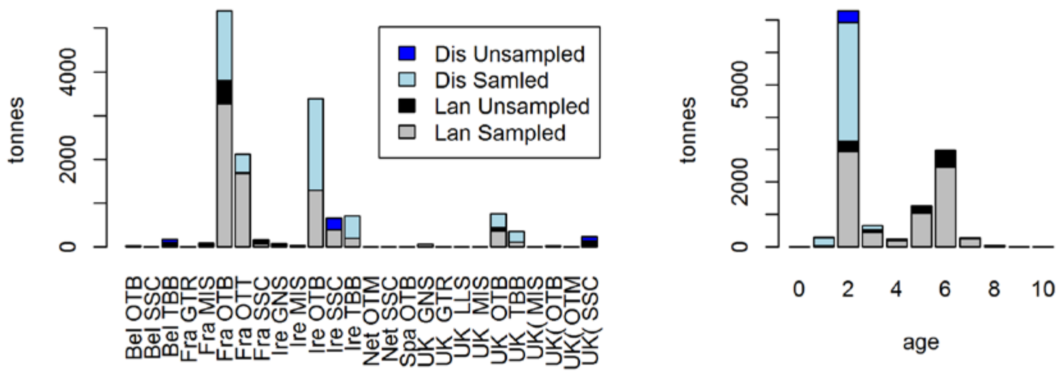


Figure7.4.6. Haddock in 7bc–ek. Distribution sampled and unsampled the catches by country and gear (left) and by age (right). Note that both France and Ireland allocated age data to most unsampled strata before uploading to InterCatch.

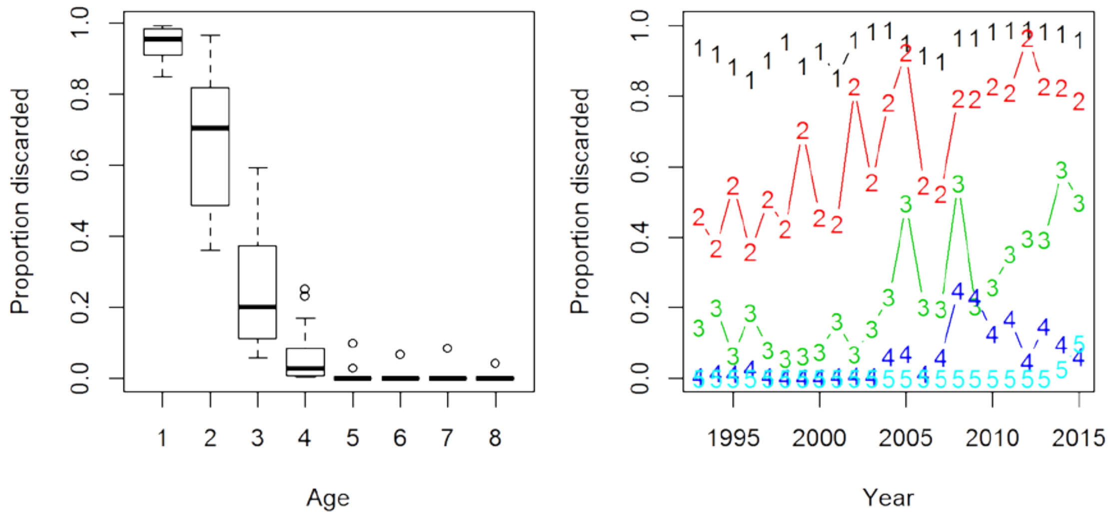


Figure7.4.7. Haddock in 7bc–ek. Proportion of discards by age (left) and year (right).

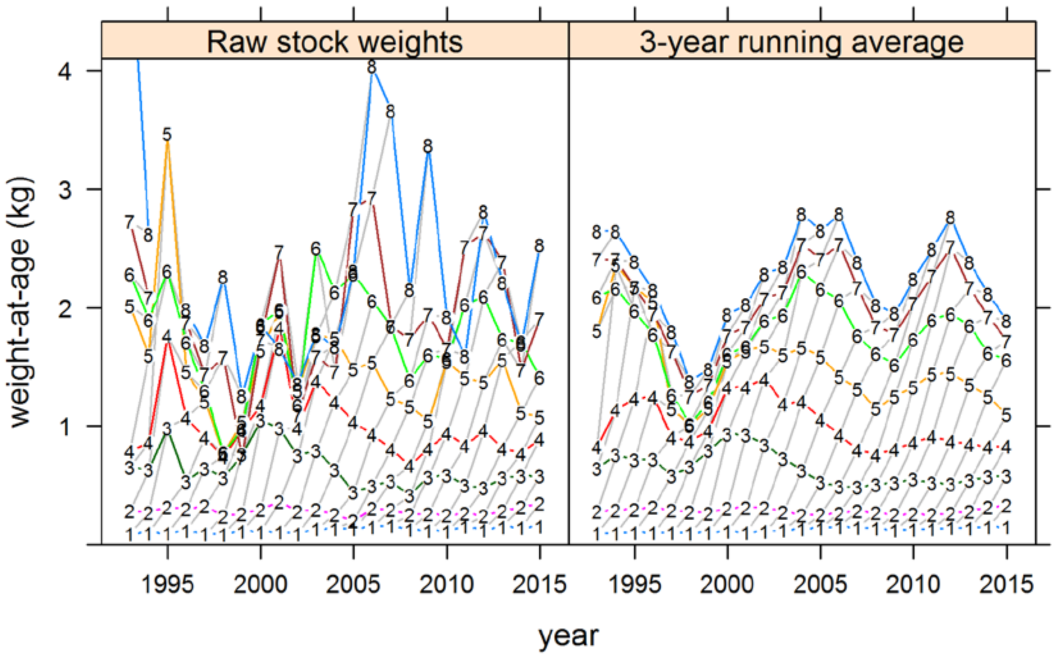


Figure7.4.8. Haddock in 7bc–ek. Raw stock weights-at-age (left) and the three-year running average stock weights (right).

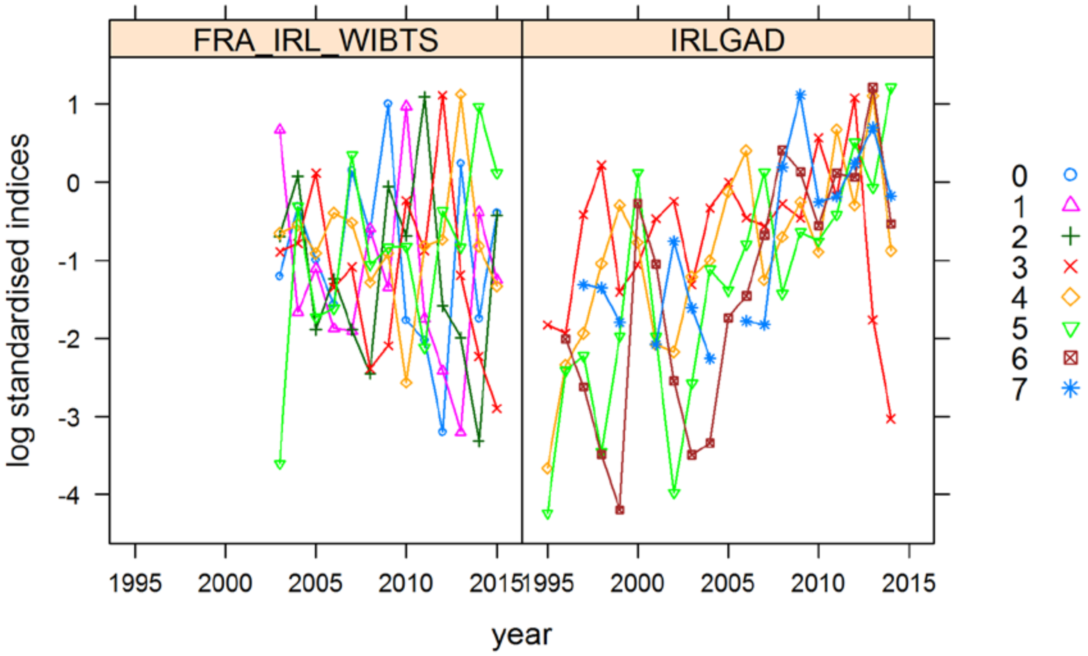


Figure 7.4.9a. Haddock in 7bc–ek. Log standardised indices of tuning fleets by year. The FRA-IRL-IBTS survey is the combined French EVHOE Q4 WIBTS and Irish IGFS Q4 WIBTS survey. The IRL-GAD commercial tuning fleet is the Irish gadoid fleet in 7gj.

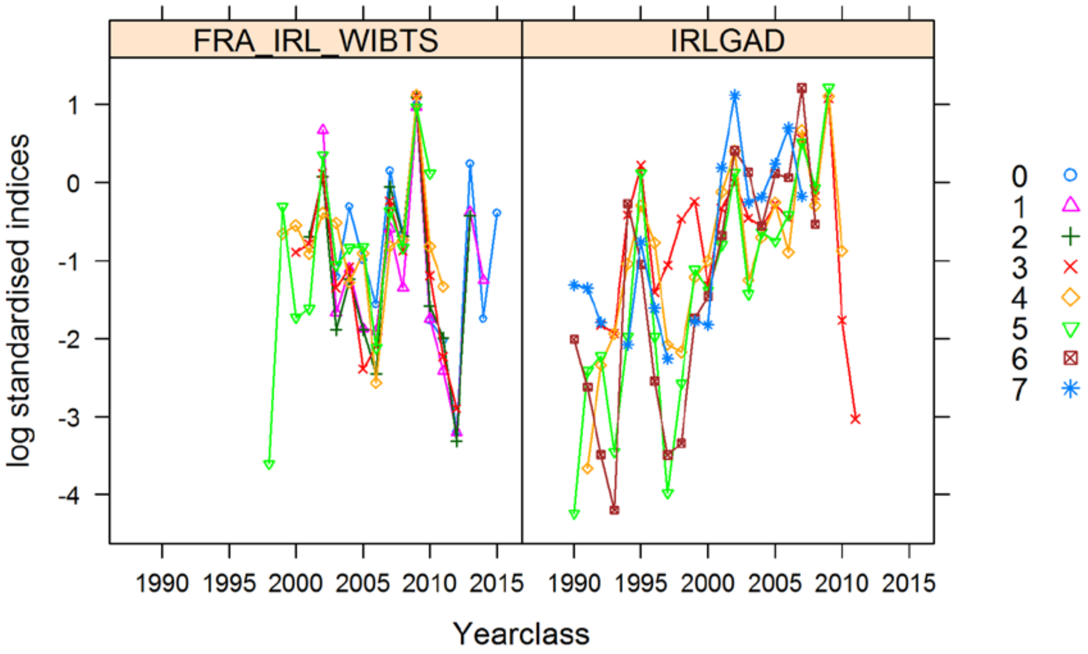


Figure 7.4.9b. Haddock in 7bc–ek. Log standardised indices of tuning fleets by cohort.

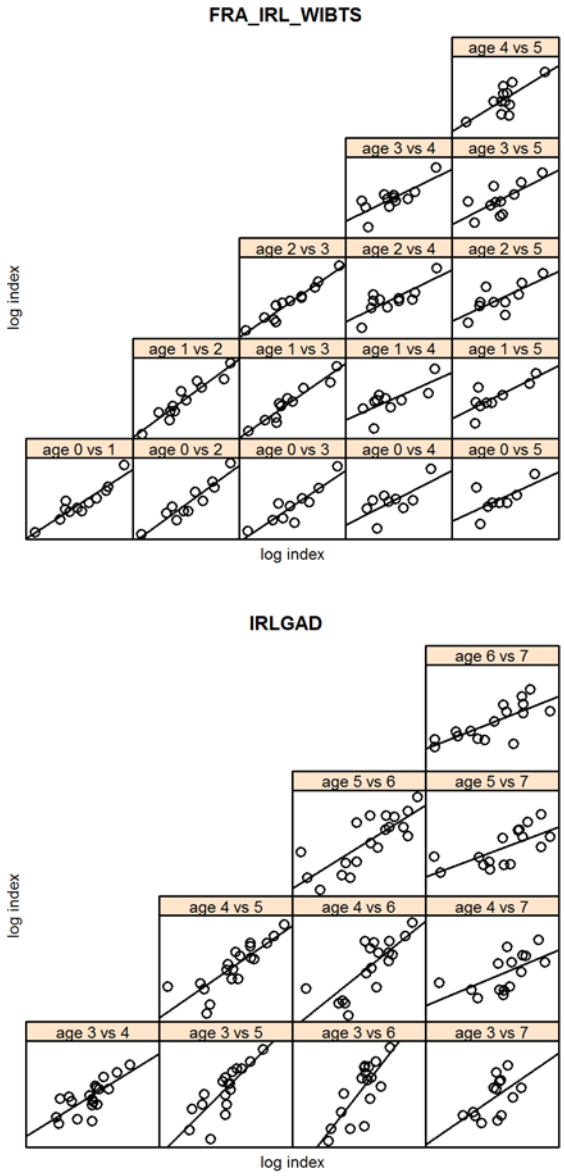


Figure 7.4.10. Haddock in 7bc–ek. Scatterplot matrix of log indices of cohorts at different ages.

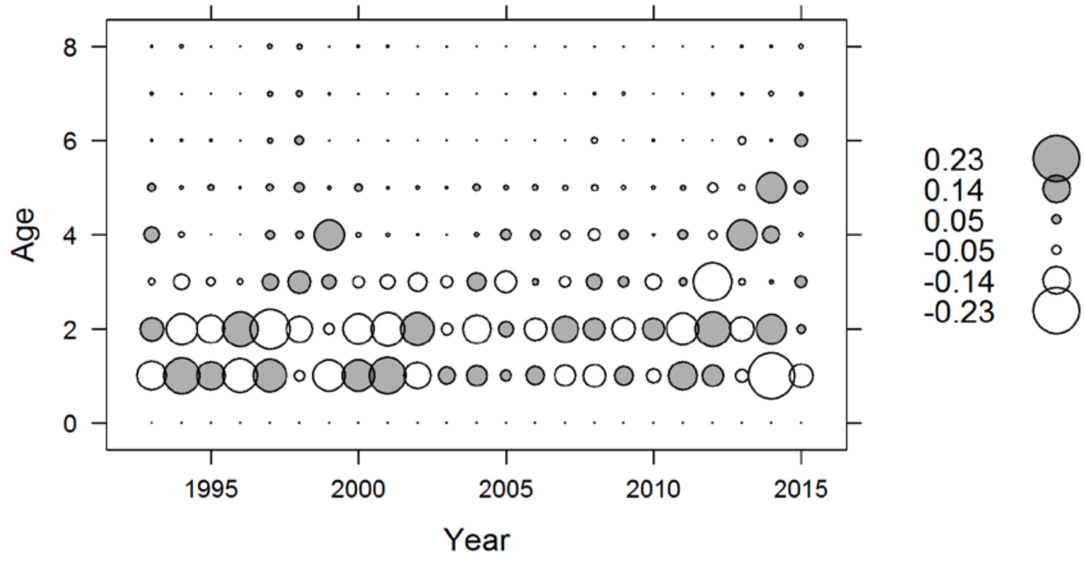


Figure 7.4.11. Haddock in 7bc–ek. Catch proportions-at-age residuals (observed-predicted).

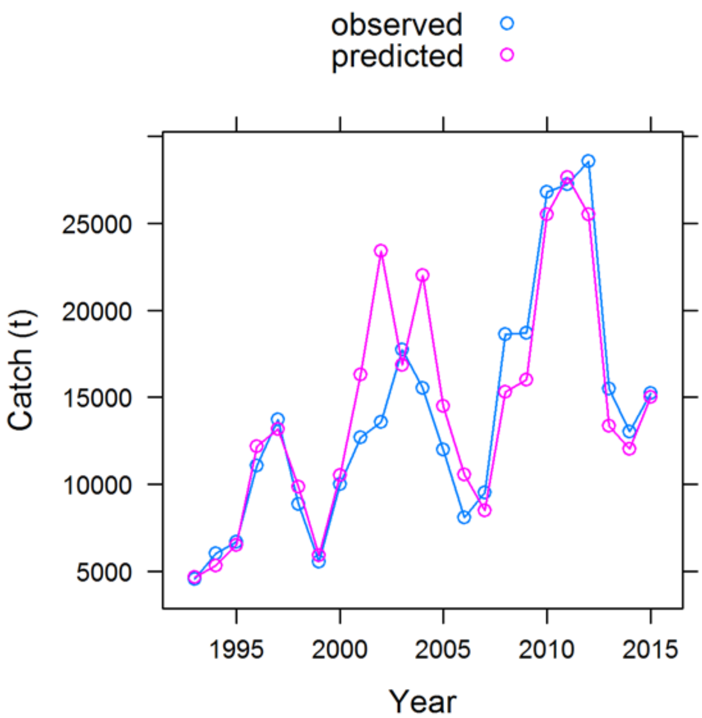


Figure 7.4.12. Haddock in 7bc–ek. Observed and predicted catches.

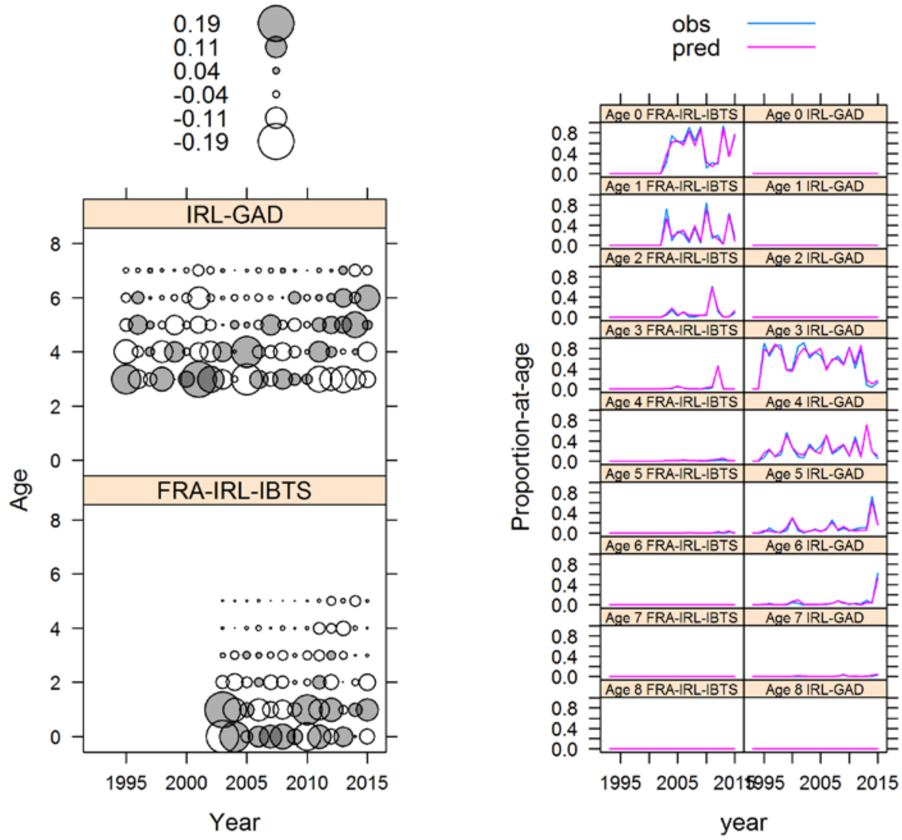


Figure 7.4.13. Haddock in 7bc–ek. Index proportions-at-age residuals (observed - predicted).

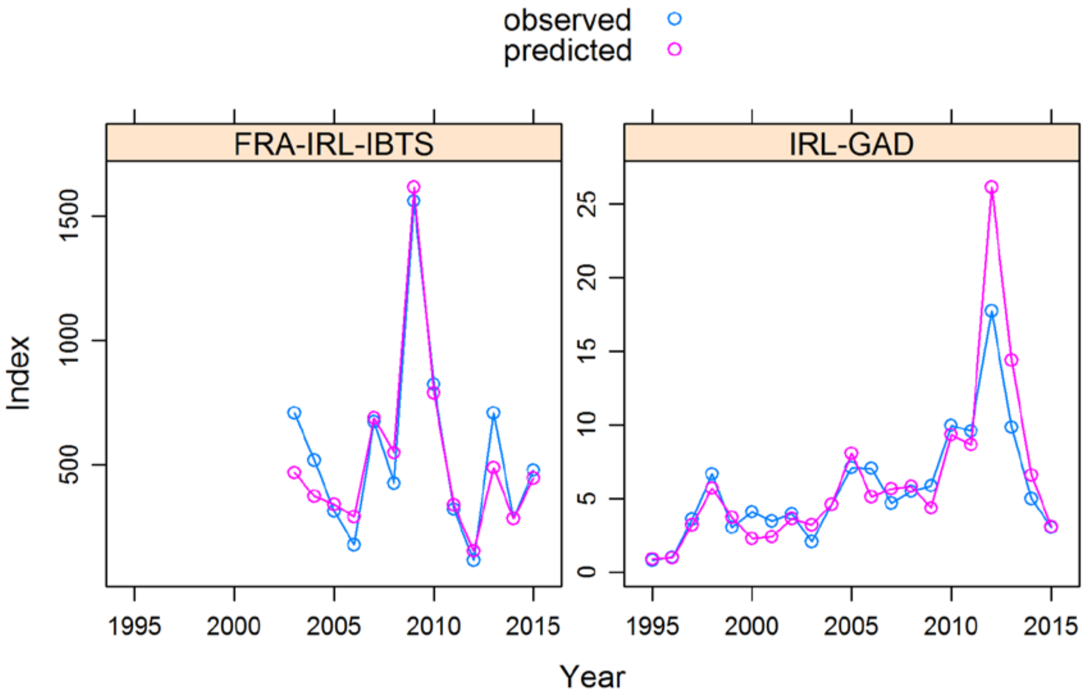


Figure 7.4.14. Haddock in 7bc–ek. Observed and predicted index cpue.

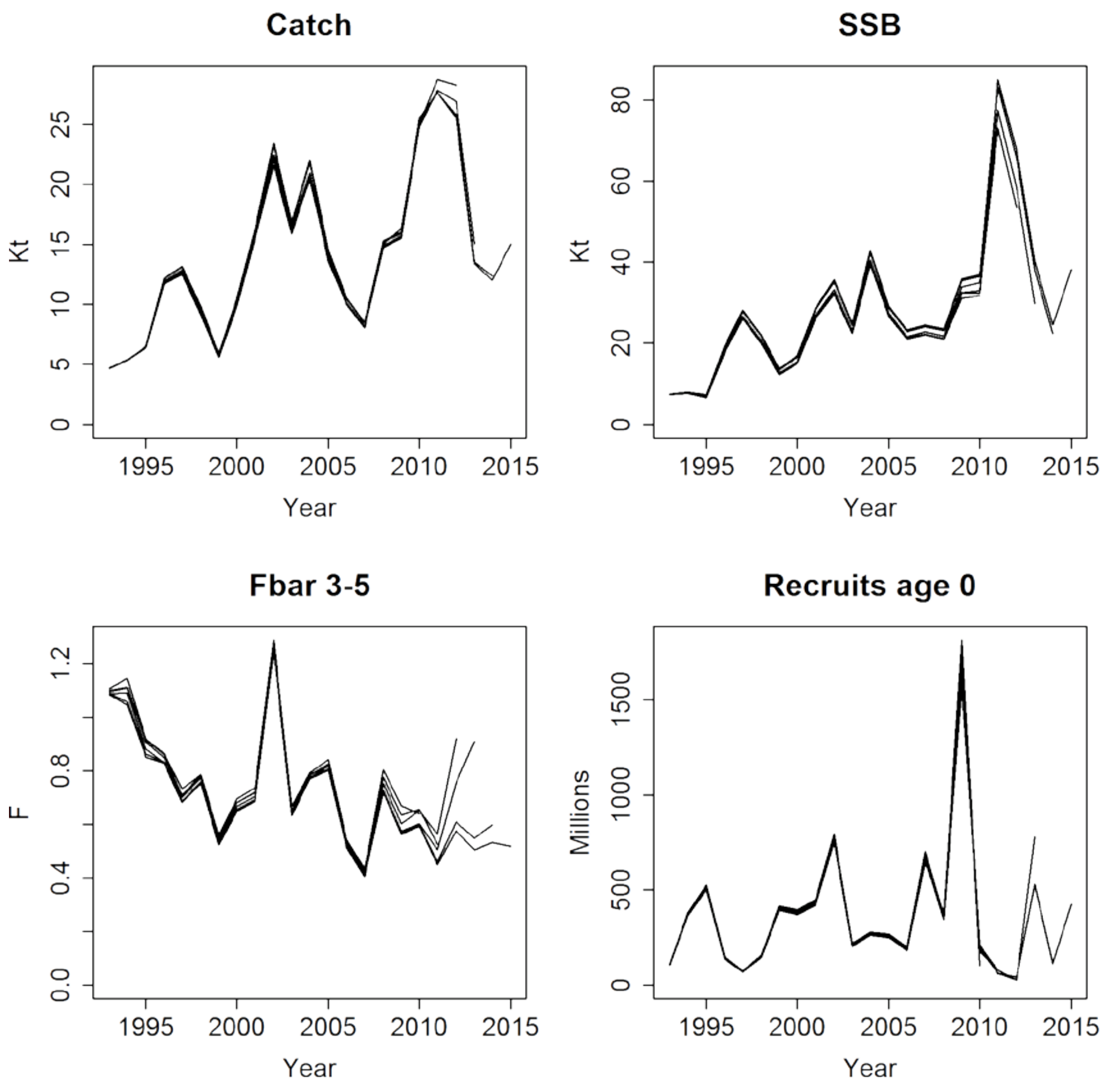


Figure 7.4.15. Haddock in 7bc–ek. Retrospective analysis of the final ASAP run. Note that the survey index only started in 2003.

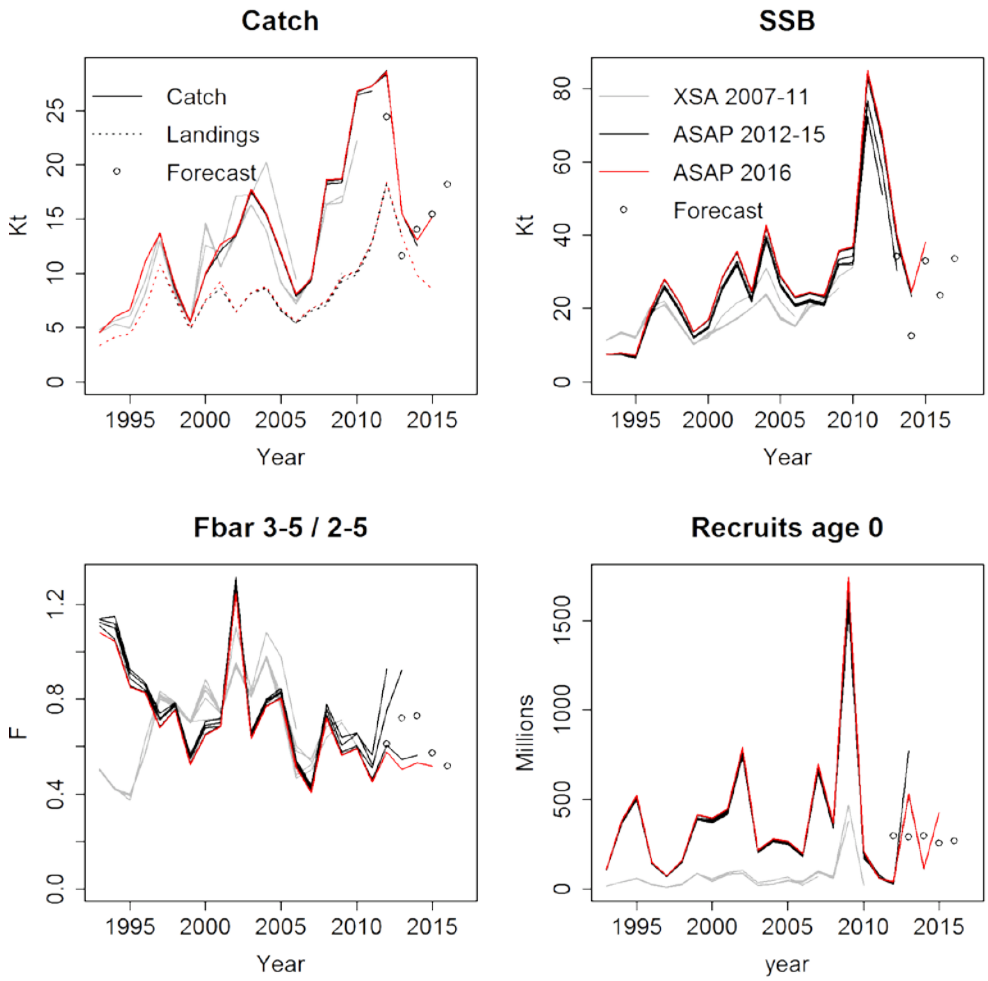


Figure 7.4.16. Haddock in 7bc–ek. Comparison of the latest ASAP assessment (red) with historic assessments (ASAP in black; XSA in grey). The FBAR range was 3-5 for the ASAP assessments and 2–5 for the XSAs. The natural mortality assumption for the ASAP is much higher for young ages than the assumed M for the historic XSAs, resulting in a higher estimate of recruitment. The intermediate-year assumptions for the short-term forecast are also shown (for SSB the assumption is for the intermediate year + 1).

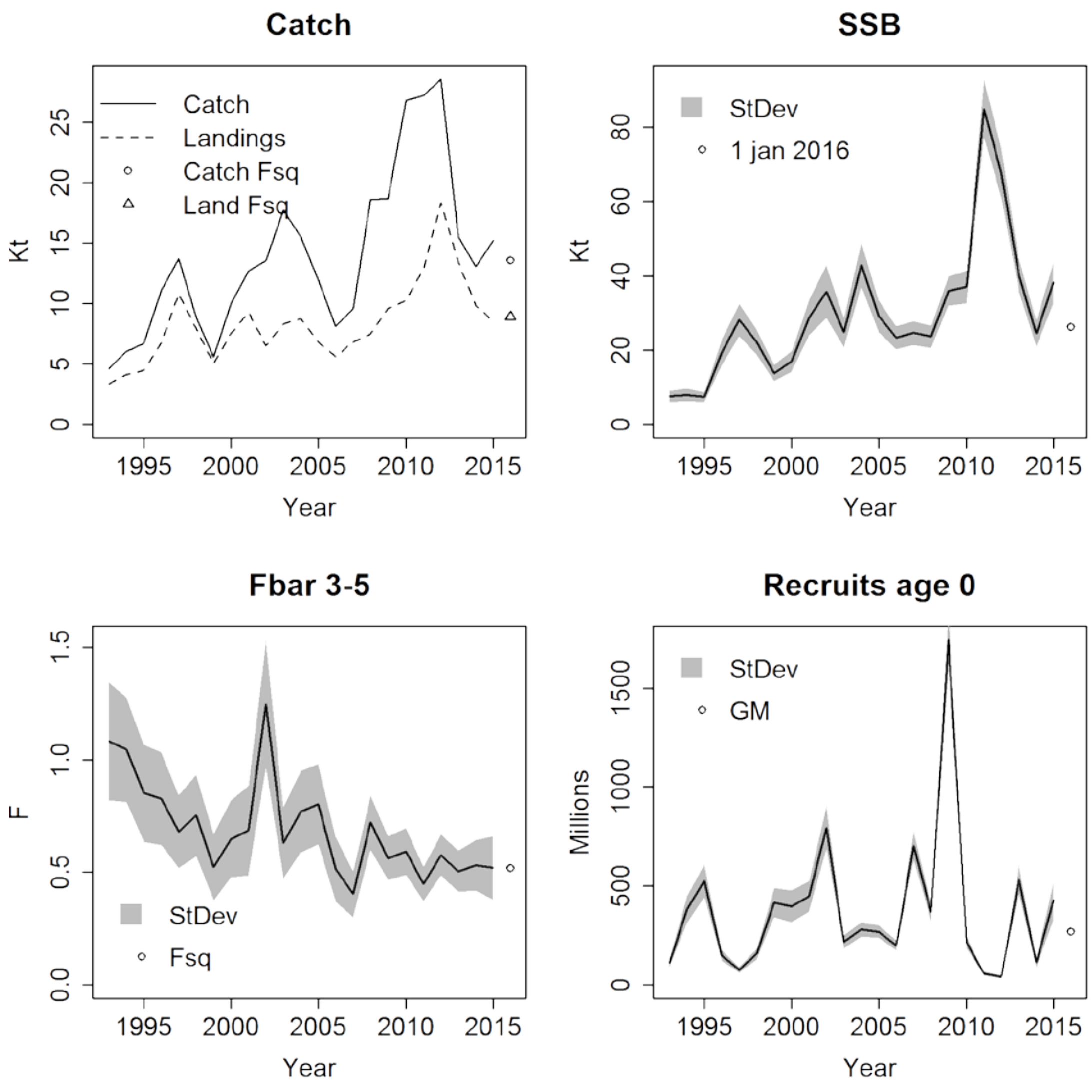


Figure 7.4.17. Haddock in 7bc–ek. Stock summary plot. The thick black line represents the ASAP assessment standard deviations from ASAP are shaded grey. The forecast/ assumed values are given by open circles. The thick black line in the catch plot represents the predicted catch from ASAP. The dotted line in the SSSB, F_{bar} and recruitment plots represents the XSA assessment with the same input data.

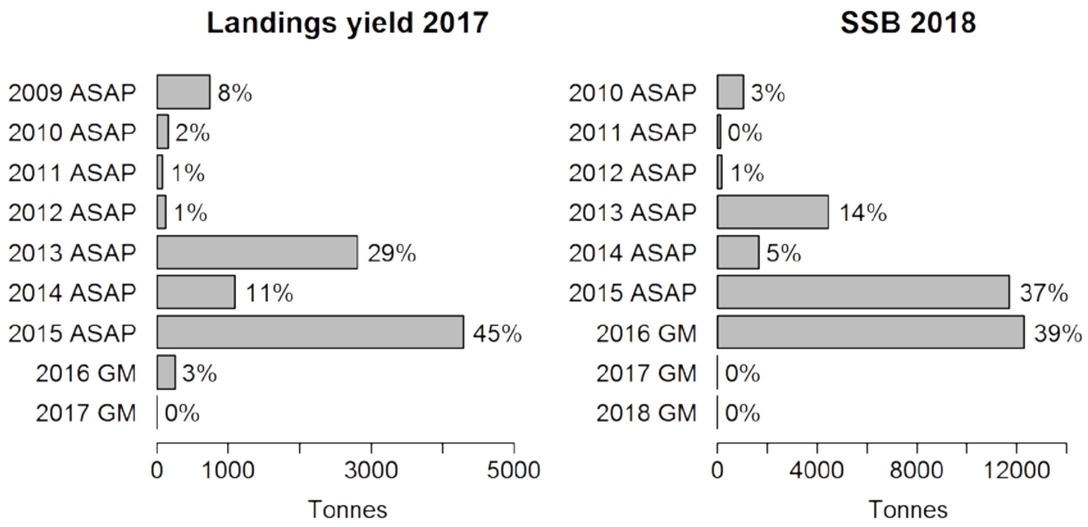


Figure 7.4.18. Haddock in 7bc–ek. Haddock 7bc–ek. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

7.5 *Nephrops* in Division 7.b (Aran Grounds, FU17)

Type of assessment in 2016

This stock was inter-benchmarked in September 2015 by correspondence (ICES, 2015). The assessment and catch options follow the agreed proceedures set out in the stock annex.

ICES advice applicable to 2015

"ICES advises that, on the basis of the MSY approach and considering that no discard ban is in place in 2015, landings should be no more than 524 tonnes. Assuming that discard rates do not change from the average of the last three years (2011–2013) the resulting catch would be no more than 584 tonnes.

In order to ensure the stock in this FU is exploited sustainably, management should be implemented at the functional unit level."

ICES advice applicable to 2016

"ICES advises that when the MSY approach is applied, catches in 2016 (assuming zero discards) should be no more than 991 tonnes. If instead discard rates continue at recent values (average of 2012–2014) and there is no change in assumed discard survival rate, this implies landings of no more than 948 tonnes.

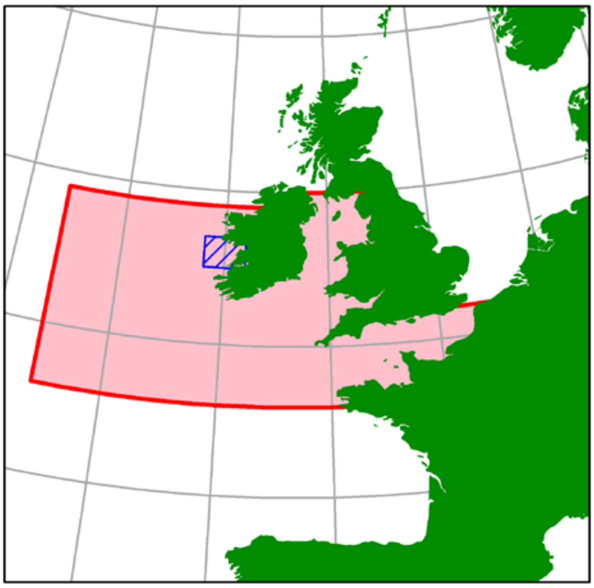
In order to ensure the stock in this FU is exploited sustainably, management should be implemented at the functional unit level."

7.5.1 General

Stock description and management units

The Aran Grounds *Nephrops* stock (FU17) covers ICES rectangles 34–35 D9–E0 within 7.b. This stock is included as part of the TAC Area 7 *Nephrops* which includes the following stocks: Irish Sea East and West (FU14, FU15), Porcupine Bank (FU16), northwestern Irish Coast (FU18), southeastern and southwestern Irish Coast (FU19) and the Celtic Sea (FU20–22).

Map below shows FU17 assessment area (blue) and TAC area (red). See Section 6.4 for details on *Nephrops* Subarea 7 general section.



Ecosystem aspects

Details of the ecosystem on the Aran grounds are provided in the stock annex updated by WKIBPNeph (ICES, 2015).

Fishery description

A description of the fleet is given in the stock annex. The time-series of numbers of vessels is updated in Figure 7.5.1. The numbers of vessels has been relatively stable since 1995. The time-series of vessel power is shown as a box and kite plot in Figure 7.5.2.

The majority of the landings are made with 80 mm mesh.

The majority of the landings come from the grounds to the west and southwest of the Aran Islands known as the 'back of the Aran ground' (See stock annex). The fishery on the Aran Grounds operates throughout the year, weather permitting with a seasonal trend (See stock annex).

Fishery in 2015

In recent years several newer vessels specializing in *Nephrops* fishing have participated periodically in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates. There has been a trend for Irish vessels to switch to multi (quad) rig trawls since 2012. These vessels are more efficient at catching *Nephrops* (BIM, 2015).

Information from stakeholders

Voluntary effort restriction were put in place by the Irish fishing industry in April and May 2015. These measures reduced catches and effort significantly on the stock in advance of the 2015 UWTV survey.

7.5.2 Data

Intercatch

Data were available in Intercatch and used on a trial basis.

Landings

The reported landings time-series is shown in Figure 7.5.3 and Table 7.5.1. The 2015 landings decreased by about 50% from those made in 2014 and amounted to 370 t.

Effort

The IBPNeph 2015 reviewed Irish commercial landings and effort data in detail. They concluded that effort should be reported in the WGCSE report in KWdays and lpue should be reported in KG/kwdays in the knowledge that the trend is likely to be a biased underestimate because it is not adjusted for efficiency or behavioural changes. The time-series of effort and lpue is updated in Figure 7.5.4 and Table 7.5.2. There was a significant decline in lpue and effort in 2015 which is due to the local management efforts put in place in April and May.

Sampling levels

Sampling levels, data aggregating and raising procedures were reviewed by IBPNeph 2015 and are documented in the stock annex. The time-series of samples is shown in Figure 7.5.5. and Table 7.5.3. Sampling levels in 2015 were good and are comparable to 2014 levels.

Commercial length-frequency distributions

The raised catch length distributions are shown in Figure 7.5.6. The mean size for both sexes from 2008 fluctuate considerably.

Sex ratio

The sex ratio by year is shown in Figure 7.5.7. This shows some fluctuations over time. The sex ratio has a distinct seasonal pattern (Figure 7.5.8) with lowest males proportions in the samples in May and June. Males dominate the catches in the autumn and winter.

Mean weight explorations

Explorations of the mean weight in the catch samples by sex shows a strong cyclical pattern (Figure 7.5.8). This corresponds with the emergence of mature females from the burrows to mate in summer. The annual mean weight estimate for landings and discards is shown in Figure 7.5.9. The mean weight estimates from 2008 fluctuate considerably.

Discarding

Table 7.5.4 gives weights, numbers and mean weights of the landings and discard raised internationally according to the stock annex. There is no information on discard survival rate in this fishery but a 25% discard survival rate is assumed in line with other *Nephrops* stocks in the Celtic sea (see stock annex).

Abundance indices from UWTV surveys

The spatial extent of the *Nephrops* grounds in FU17 has been re-defined by IBPNeph 2015 and the total abundance estimates have been revised using a new procedure (ICES, 2015). The redefinition of the polygons in FU17 resulted in ~30% increase in overall area from 1007 km^2 to 1320 km^2 (stock annex).Operational details of the 2015 UWTV survey are available (Doyle *et al*., 2015).

The spatial distributions of burrow densities are shown in Figure 7.5.10. The densities have fluctuated considerably over the time-series and throughout the Aran grounds. In general the densities are higher towards the western side of the ground and there is a notable trend towards lower densities towards the east. On the southwestern boundary there are often high densities close to the boundary. In this area there is a sharp transition from mud to rocky substrate. The increase in densities in 2015 was mainly towards the middle of the ground.

On average the Aran Grounds account for ~88% of the total estimated burrow abundance from FU17 .Galway Bay and Slyne Head account for ~8% and ~2% respectively. The Galway Bay estimates fluctuate widely but appear to be highly correlated with the Aran ground (except 2004). Estimates for the Slyne Head ground also fluctuate considerably but show no significant correlation with the other areas (Figure 7.5.11).

Table 7.5.5 shows the Aran ground abundance estimates and CV (or relative standard error) which is well below (<6%) the recommendation of 20% by SGNEPS (ICES, 2012). The CVs on the abundance estimates for Galway Bay and Slyne Head are also well within the recommendation showing the surveys are precise (Table 7.5.6) Figure 7.5.12 and Table 7.5.7 shows the total abundance estimate for FU17 with the IBPNeph proposed MSY $B_{trigger.}$ The 2015 combined abundance estimate was 42% higher than in 2014 and at 556 million and is just above the MSY $B_{trigger}$ (540 million).

7.5.3 Assessment

Comparison with previous assessments

The WGCSE 2016 carried out an UWTV based assessment for this stock. The methods used were very much in line with WKNEPH (ICES, 2009) and the approach taken for other *Nephrops* stocks in 6 and 7 by WGCSE. This approach was inter-benchmarked at IBPNeph (ICES, 2015).

State of the stock

UWTV abundance estimates suggest that the stock size has fluctuated widely with an overall declining trend. The 2015 estimate is an increase on the lowest observed in 2014 and is above the MSY $B_{trigger}$. The 2015 abundance remains below the average of the series (geomean: 727 million). Table 7.5.8 and Figure 7.5.13 summarize recent harvest ratios which have been above the $F_{MSYproxy}$ for the last three years.

7.5.4 Catch option table

Catch option table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 7.5.8 and summarised below. The calculation of catch options for the Aran Grounds follows the procedure outlined in the stock annex.

The basis for the catch options.

VARIABLE	VALUE	NOTES
Stock abundance	Available October 2016	UWTV Survey 2016
Mean weight in landings	22.3 g	Average 2008–2015.
Mean weight in discards	11.3 g	Average 2008–2015.
Discard rate	12.7%	Average (proportion by number) 2013–2015. Calculated as discards/(landings + discards).
Discard survival rate	25%	Only applies in scenarios where discarding is allowed.
Dead discard rate	9.8%	Average 2013–2015 (proportion by number). Calculated as dead discards divided by dead removals (landings + dead discards). Only applies in scenarios where discarding is allowed.

Given the fluctuations observed in mean weights for landings and discards (Figure 7.5.8) an average from 2008 to the most recent year is used in the calculation of catch options as set out in the stock annex. The discard rates and proportions for the last three years are used to account for recent onboard retention practices (this is also according to the stock annex).

7.5.5 Reference points

New reference points were defined for this stock at the IBPNeph (ICES, 2015) and no new proposals were made by WKMSYRef4 (ICES, 2016XX, ICESYY). For *Nephrops* stocks MSY $B_{trigger}$ has been defined as the lowest stock size from which the abundance has increased. This corresponds to the abundance observed in 2008 rounded to the nearest 10 = 540 million individuals (Figure 7.5.12).

The F_{MSY} proxy was revised during the benchmark in 2015. The observed burrow density has declined, from high (> 0.8 individuals m^{-2}) at the start of the series to medium density (~0.3 individuals m^{-2}) towards the end of the time-series. The nature of the fishery has also changed, from a continuous fishery throughout the year to a fishery which is more concentrated on periods of high catch rates. For these reasons a harvest rate consistent with a combined sex $F_{0.1}$ = 8.5% is considered an appropriate proxy for F_{MSY}.

These should remain under review by WGCSE and may be revised should improved data become available.

7.5.6 Management strategies

As yet there are no explicit management strategies for this stock but there have been some discussions among the fishing industry and scientists about developing a long-term plan for the management of the Aran fishery. Sustainable utilization of the *Nephrops* stock will form the cornerstone of any management strategy for this fishery.

7.5.7 Quality of assessment and forecast

Biological sampling for this stock is adequate. Since 2002 a dedicated annual UWTV survey has provided abundance estimates for the Aran Grounds with high precision. The area of the Aran Grounds was revised in 2015, resulting in a recalculation of the abundance time-series which now also includes Galway Bay and Slyne Head. A number of other biological parameters such as mean weights and length distributions have also been revised. The revisions were made as part of an interbenchmark process and have improved the quality of the assessment.

In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. Fisheries catching *Nephrops* in Subarea VII will be covered by the EU landing obligation in 2016 (EC, 2015). It is not yet clear how the landing obligation will be implemented, there is a possibility for a *De minimis* exemption consisting of a 7% discard rate by weight. The average discard rate by weight for FU17 over the last three years is 6%. Three different catch options at F_{MSY} have been provided to give some information on the impact of different LO scenarios on catches.

There are several key uncertainties and bias sources in the method used here (these are discussed further in WK*NEPH* 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007; WKNEPHBID 2008; SGNEPS 2009; WGNEPS 2014). Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates (Marrs *et al.*, 1996). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that is more accurate, although no more precise WK*NEPH* (ICES, 2009).

Landings data are adjusted to take into account landings that have been mis-reported from FU16 since 2011. This adjustment is thought to be reasonably accurate (See Section 7.6).

7.5.8 Recommendation for next benchmark

This stock was last benchmarked by IBPNeph (ICES, 2015). WGCSE will keep the stock under close review and recommend future benchmark as required.

7.5.9 Management considerations

A meeting was held with stakeholders in March 2015 to discuss the state of the Aran *Nephrops* stock. In response to this meeting voluntary effort limits were put in place for April, May and June. These voluntary measures have significantly reduced effort and catches on the Aran grounds in 2015 before the UWTV survey.

The *Nephrops* trawl fleet operating in VIIb discards around 47% by weight (Table 7.5.4). Small whole *Nephrops* are the main species comprising the discards. The main fish species discarded are haddock, hake, whiting, megrim and dogfish (Anon, 2011).

The ICES 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 controls to ensure effort and catch were in line with resources available.

7.5.10 References

Anon. 2011. Atlas of Demersal Discarding, Scientific Observations and Potential Solutions, Marine Institute, Bord Iascaigh Mhara, September 2011. ISBN 978-1-902895-50-5. 82 pp.

BIM. 2015. Report on catch comparison of Quad and Twin-rig trawls in the Celtic Sea *Nephrops* fishery. Bord Iascaigh Mhara, 29 August 2014.

Doyle, J., Lordan, C., Fitzgerald, R., O'Connor, S., Fee, D., Butler, R., Stokes, D., Ni Chonchuir, G., Sheridan, M. and Simpson, S. 2015. Aran, Galway Bay and Slyne Head *Nephrops* Grounds (FU17) 2015 UWTV Survey Report and catch options for 2016. Marine Institute UWTV Survey report. http://oar.marine.ie/handle/10793/1095.

ICES. 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM:14.

ICES. 2008. Report of the Workshop and training course on *Nephrops* burrow identification (WKNEPHBID). ICES CM 2008/LRC:03.

ICES. 2009. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2009/LRC: 15, pp 52.

ICES. 2009. Report of the Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM 2009/ACOM:33.

ICES. 2010. Report of the Working Group on the Celtic Seas Region (WGCSE) ICES CM 2009/ACOM:09.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2012/SSGESST:19.

ICES. 2014. Report of the Working Group on *Nephrops* Surveys (WGNEPS). ICES CM 2014/SSGESST:20. 57 pp.

ICES. 2015. Report of the Inter-Benchmark Protocol of *Nephrops* in FU 17 and 14 (IBPNeph). ICES CM 2015/ACOM:38.

ICES. 2016. EU request to ICES to provide FMSY ranges for selected stocks in ICES subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

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

Table 7.5.1. *Nephrops* in FU17 (Aran Grounds). Landings in tonnes by country.

Year	France	Rep. of Ireland	UK	Total
1974	477			477
1975	822			822
1976	131			131
1977	272			272
1978	481			481
1979	452			452
1980	442			442
1981	414			414
1982	210			210
1983	131			131
1984	324			324
1985	207			207
1986	147		1	148
1987	62		0	62
1988	14	814		828
1989	27	317	3	347
1990	30	489		519
1991	11	399		410
1992	11	361	2	374
1993	11	361	0	372
1994	18	707	4	729
1995	91	774	2	867
1996	2	519	7	528
1997	2	839	0	841
1998	9	1401	0	1410
1999	0	1140	0	1140
2000	1	879	0	880
2001	1	912	0	913
2002	2	1152	0	1154
2003	0	933	0	933
2004	0	525	0	525
2005	0	778	0	778
2006	0	637	0	637
2007	0	913	0	913
2008	0	1050	7	1057
2009	0	625	0	625
2010	0	930	9	939
2011	0	659	0	659
2012	0	1246	0	1246
2013	0	1295	0	1295
2014	0	766	0	766
2015	0	370	0	370

Table 7.5.2. *Nephrops* in FU17 (Aran Grounds). Effort data for the Irish otter trawl *Nephrops* directed fleet.

YEAR	EFFORT (KW DAYS)	LANDINGS (KGS)
1995	286,939	522,007
1996	174,030	312,421
1997	260,676	442,218
1998	445,308	940,902
1999	366,839	782,407
2000	293,684	561,244
2001	362,754	586,462
2002	350,346	798,744
2003	492,284	801,813
2004	355,673	420,652
2005	396,202	708,540
2006	337,503	618,515
2007	460,396	905,282
2008	512,245	1,052,077
2009	319,873	613,220
2010	441,080	910,346
2011	332,300	667,564
2012	488,721	1,139,413
2013	571,916	1,239,469
2014	460,818	774,097
2015	232,190	461,409

Table 7.5.3. *Nephrops* in FU17 (Aran Grounds). Sampling levels.

Year	Quarter	Number of samples		Numbers Measured	
		Catch	Discards	Catch	Discards
2008	1	2	3	565	1376
2008	2	9	8	2224	3758
2008	3	5	4	1266	1834
2008	4	3	3	889	1733
2009	1	3	3	800	1184
2009	2	6	6	1685	1978
2009	3	6	6	2260	2726
2009	4	2	2	1491	1149
2010	1	4	4	3322	2322
2010	2	8	7	3577	2957
2010	3	2	2	951	742
2010	4	6	4	3209	1802
2011	1	7	7	3755	3537
2011	2	7	7	7399	6617
2011	3	4	2	3531	2386
2011	4	5	5	2440	2271
2012	1	3	3	1538	1250
2012	2	17	15	6481	5113
2012	3	0	0	-	-
2012	4	5	5	2333	1945
2013	1	10	9	3108	2983
2013	2	11	11	3733	3733
2013	2	3	3	1163	1263
2013	4	7	7	2956	1779
2014	1	3	3	1208	1223
2014	2	12	12	5365	3563
2014	3	2	2	786	499
2014	4	8	8	3542	2760
2015	1	2	2	827	611
2015	2	2	2	961	664
2015	3	0	0	-	-
2015	4	2	2	1047	1388

Table 7.5.4. *Nephrops* in FU17 (Aran Grounds). Raised landings and discard weight and numbers by year.

Year	Landings (t)	Discards (t)	Discards by weight (%)	Landings in number ('000s)	Discards in number ('000s)	Discards by number (%)
2008	1057	248	19%	48,162	22,074	31%
2009	626	129	17%	24,935	9,487	28%
2010	939	224	19%	37,341	15,246	29%
2011	659	92	12%	31,950	8,542	21%
2012	1246	86	6%	61,076	8,292	12%
2013	1295	129	9%	60,016	12,034	17%
2014	766	48	6%	33,882	5,038	13%
2015	370	15	4%	17,693	1,622	8%

Table 7.5.5. *Nephrops* in FU17 (Aran Grounds). Results summary table for geostatistical analysis of UWTV survey.

Ground	Year	Number of stations	Mean Density adjusted (burrow/m²)	Domain Area (km²)	Geostatistical Abundance Estimate adjusted (millions burrows)	CV on Burrow estimate
Aran Grounds	2002	49	0.79	1196	947	3%
	2003	41	0.94	1196	1118	6%
	2004	64	1.08	1196	1297	3%
	2005	70	0.81	1196	972	2%
	2006	67	0.46	1196	556	3%
	2007	71	0.69	1196	828	2%
	2008	63	0.41	1196	494	3%
	2009	82	0.52	1196	627	2%
	2010	87	0.63	1196	752	2%
	2011	76	0.51	1196	609	2%
	2012	31*	0.33	1196	397	3%
	2013	31*	0.33	1196	390	4%
	2014	33*	0.28	1196	332	4%
	2015	34*	0.4	1197	480	4%

***reduced isometric grid.**

Table 7.5.6. *Nephrops* in FU17 (Galway Bay and Slyne Head). Results summary table for analysis of UWTV survey.

Ground	Year	Number of stations	Mean Density adjusted (burrow/m²)	Domain Area (km²)	Raised Abundance Estimate adjusted (millions burrows)*	CV on Burrow estimate
Galway Bay	2002	7	1.18	79.0	93.1	7%
	2003	3	1.30	79.0	102.6	16%
	2004	8	1.17	79.0	92.2	14%
	2005	4	1.30	79.0	103.0	11%
	2006	3	0.74	79.0	58.8	9%
	2007	5	0.91	79.0	71.8	8%
	2008	5	0.40	79.0	31.6	4%
	2009	8	0.71	79.0	56.3	4%
	2010	10	1.24	79.0	97.6	11%
	2011	6	0.55	79.0	43.2	12%
	2012	4	0.64	79.0	50.9	10%
	2013	5	0.37	79.0	29.6	10%
	2014	3	0.50	79.0	39.8	6%
	2015	5	0.71	79.0	55.8	15%
Slyne Head	2002	5	0.76	39.1	29.8	8%
	2003**	0	0.65	39.1	25.3	0%
	2004	3	0.53	39.1	20.8	10%
	2005	3	0.44	39.1	17.4	1%
	2006	3	0.30	39.1	11.8	9%
	2007	4	0.51	39.1	19.8	12%
	2008**	0	0.41	39.1	16.0	0%
	2009	6	0.31	39.1	12.2	7%
	2010	7	0.73	39.1	28.7	4%
	2011	7	0.51	39.1	20.0	5%
	2012	3	0.52	39.1	20.5	2%
	2013	4	0.54	39.1	21.1	10%
	2014	4	0.28	39.1	11.0	6%
	2015	5	0.50	39.1	19.6	4%

***random stratified estimates are given for the Slyne Head and Galway Bay grounds.**

****estimated as no survey data available for these years.**

Table 7.5.7. ***Nephrops*** **in FU17. Results summary table for analysis of UWTV survey for the combined grounds.**

Year	Abundance (Millions)	Upper bound	Lower bound
2002	1069.796	1139.209	1000.383
2003	1246.37	1432.821	1059.92
2004	1409.782	1523.114	1296.45
2005	1091.971	1148.121	1035.822
2006	626.7601	686.7448	566.7755
2007	919.7013	972.1887	867.214
2008	541.1782	572.2073	510.1491
2009	695.6454	724.5324	666.7583
2010	878.5592	916.5185	840.5999
2011	672.1959	710.8391	633.5526
2012	468.2692	504.6183	431.92
2013	441.0297	486.5642	395.4952
2014	383.0244	419.5843	346.4646
2015	555.5154	605.8891	505.1418

Table 7.5.8. ***Nephrops*** **in FU17 (Aran Grounds). Forecast inputs (bold) and historical estimates of mean weight in landings and harvest rate. Removals estimated in years with no sampling (shaded) using ratio of removals to landings in adjacent years. na= not available due to non-cooperation with sampling programmes.**

Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	UWTV abundance estimate	95% Confidence Interval	Harvest rate	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	**millions**	**millions**	%	%	**millions**		%	**tonnes**	**tonnes**	**gramme**	**gramme**
2001	48.7	25.4	67.8	28.2	34.3				912			
2002	54.5	17.7	67.8	19.6	24.5	1070	69	6.30%	1152	192	21.2	10.8
2003	44.1	18.3	57.8	23.7	29.3	1246	186	4.60%	933	183	21.2	10
2004	29	11.4	37.6	22.9	28.2	1410	113	2.70%	525	112	18.1	9.9
2005	42.4	19.7	57.2	25.9	31.7	1092	56	5.20%	778	182	18.4	9.2
2006	na	na	49.5*	na	na	627	60	7.90%	636	na	na	na
2007	na	na	57.3*	na	na	920	52	6.20%	913	na	na	na
2008	48.2	22.1	64.7	25.6	31.4	541	31	12.00%	1057	248	21.9	11.2
2009	24.9	9.5	32	22.2	27.6	696	29	4.60%	626	129	25.1	13.6
2010	37.3	15.2	48.8	23.4	29.0	879	38	5.60%	939	224	25.2	14.7
2011	31.9	8.5	38.4	16.7	21.1	672	39	5.70%	659	92	20.6	10.8
2012	61.1	8.3	67.3	9.2	12.0	468	36	14.40%	1246	86	20.4	10.4

Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	UWTV abundance estimate	95% Confidence Interval	Harvest rate	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	**millions**	**millions**	%	%	**millions**		%	**tonnes**	**tonnes**	**gramme**	**gramme**
2013	60	12	69	13.1	16.7	441	46	15.70%	1295	129	21.6	10.7
2014	33.9	5	37.7	10.0	12.9	383	37	9.80%	766	48	22.6	9.6
2015	17.7	1.6	18.9	6.4	8.4	556	50	3.40%	370	15	20.9	9.1
			Avg 13-15	**9.8**	**12.7**					**Avg 08–15**	**22.3**	**11.3**

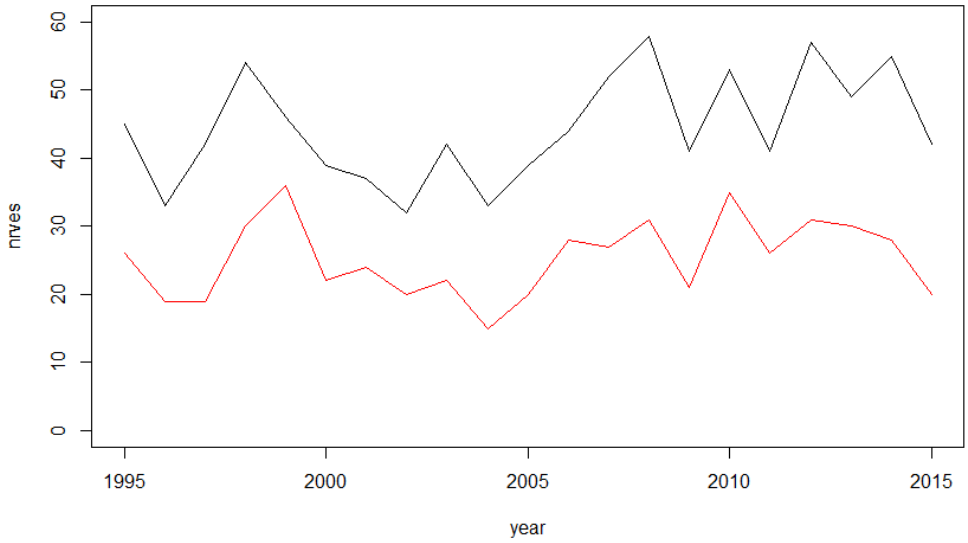


Figure 7.5.1. ***Nephrops*** **in FU17 (Aran Grounds). Time-series of the number of Irish vessels reporting landings of** ***Nephrops*** **from FU17 (red line landings >10 t threshold, black line all vessels).**

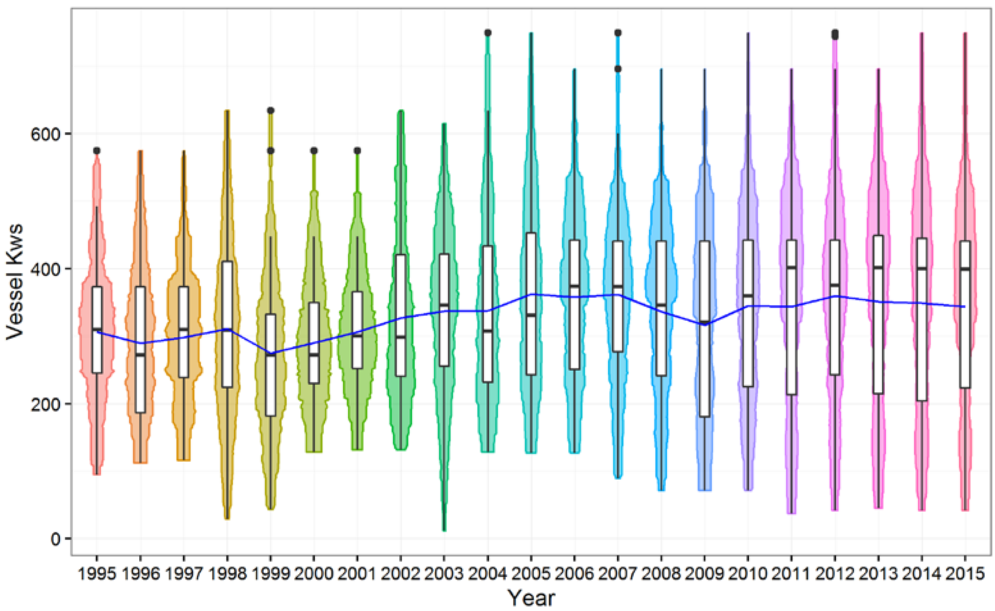


Figure 7.5.2. ***Nephrops*** **in FU17 (Aran Grounds). Combined box and kite plot of vessel power on the Aran Grounds by year. The blue line indicates the mean.**

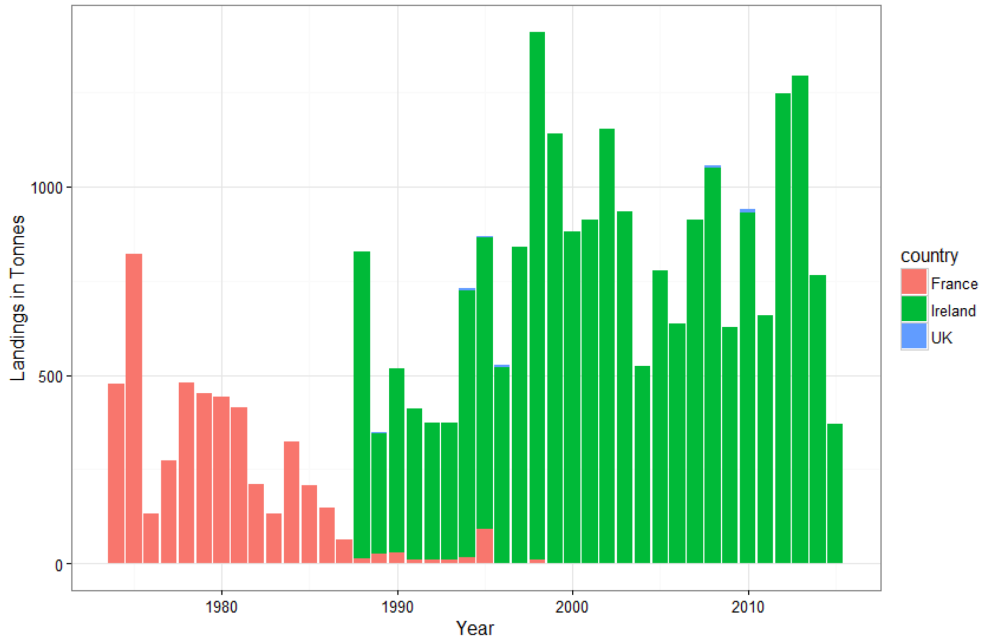


Figure 7.5.3. *Nephrops* in FU17 (Aran Grounds). Landings in tonnes by country.

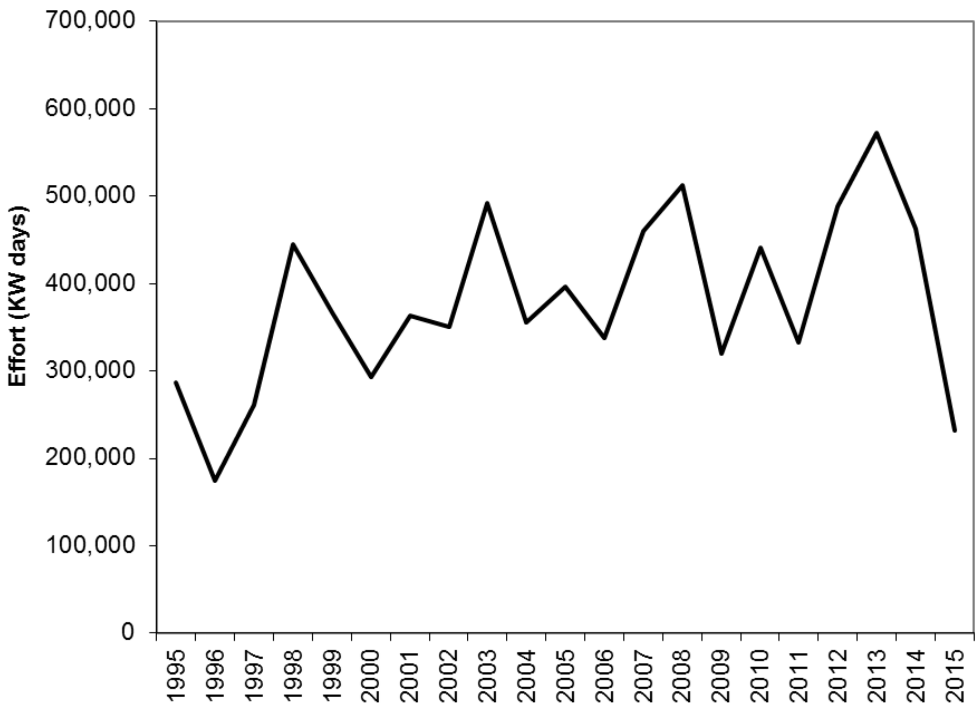


Figure 7.5.4. *Nephrops* in FU17 (Aran Grounds). Effort data (KW days) for Irish directed *Nephrops* fleet.

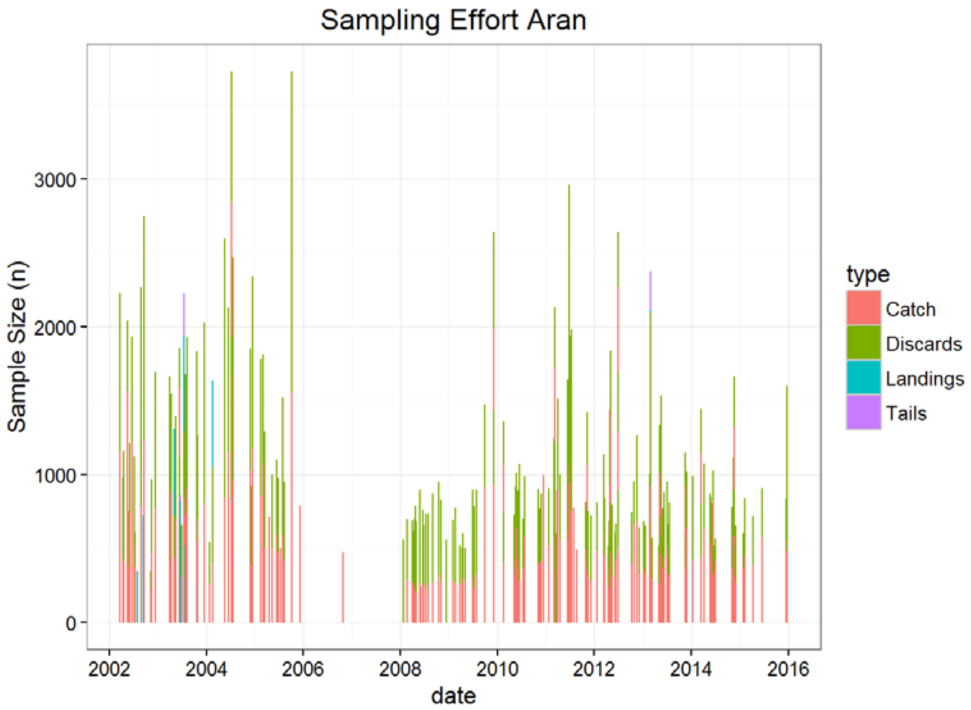


Figure 7.5.5. ***Nephrops*** **FU17 (Aran Grounds).Sampling levels for the Aran grounds.**

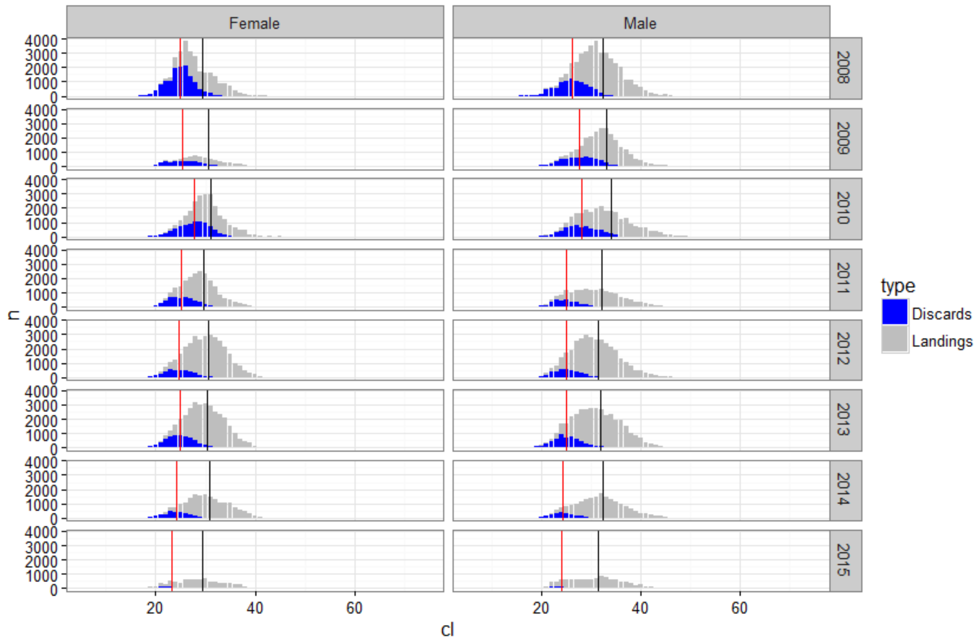


Figure 7.5.6. ***Nephrops*** **FU17 Aran Grounds. Annual length composition of landings (grey) and discards (blue) for males (right) and females (left) from 1995 (bottom) to 2015 (top). Mean sizes of landings (black vertical line) and discards (red vertical line) are also shown.**

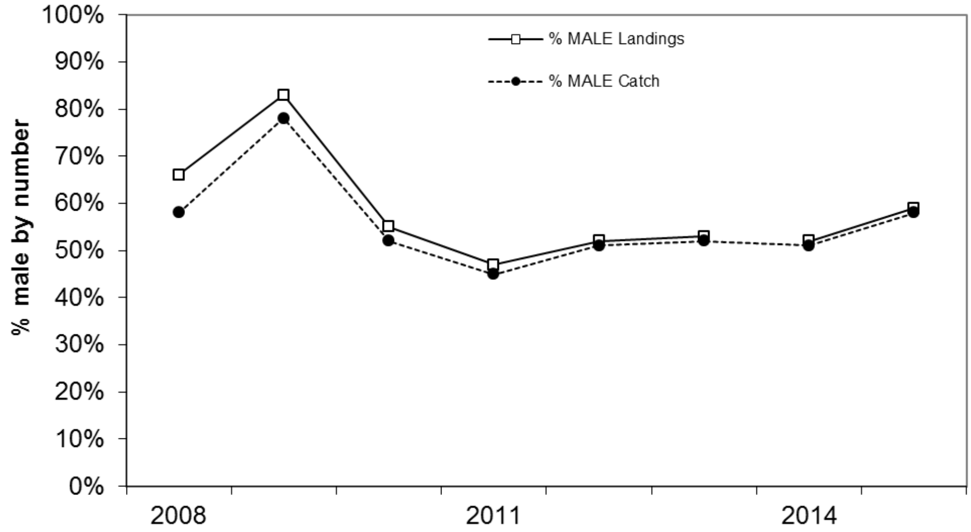


Figure 7.5.7. *Nephrops* FU17 (Aran Grounds). Annual sex ratio of whole landings (1995–2000), landings (2001–2015) and catch (2001–2015).

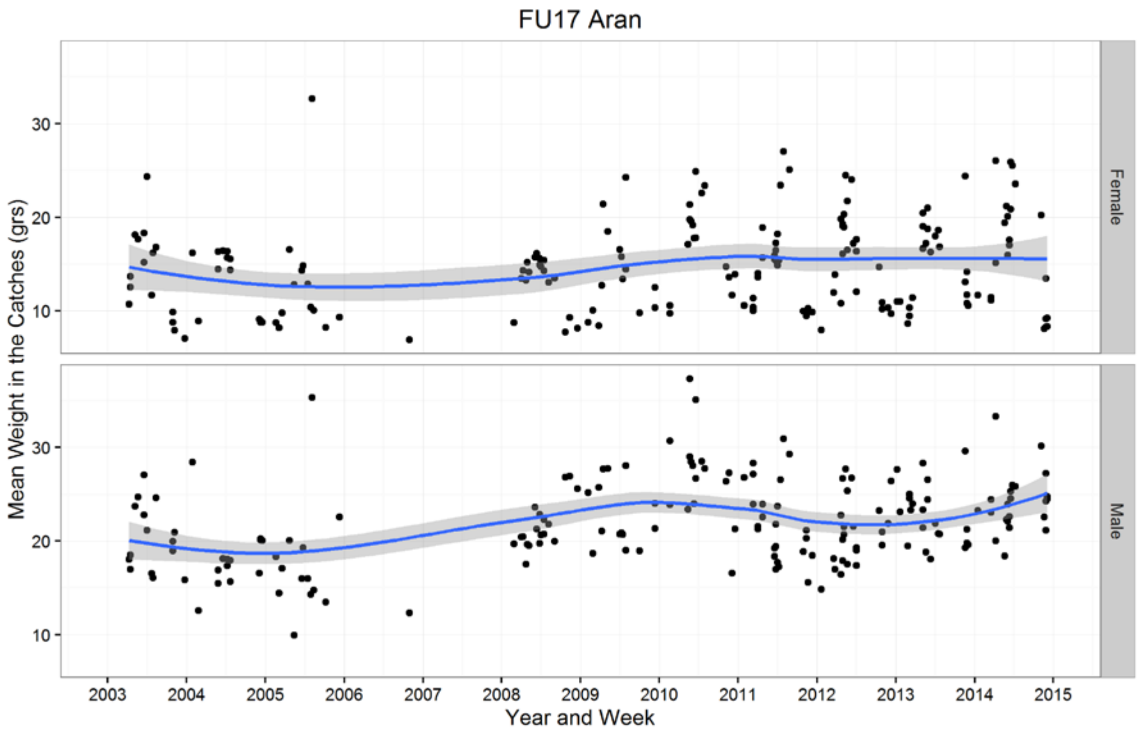


Figure 7.5.8. *Nephrops* FU17 (Aran Grounds). Mean weight in catch samples by sex showing cyclical trends.

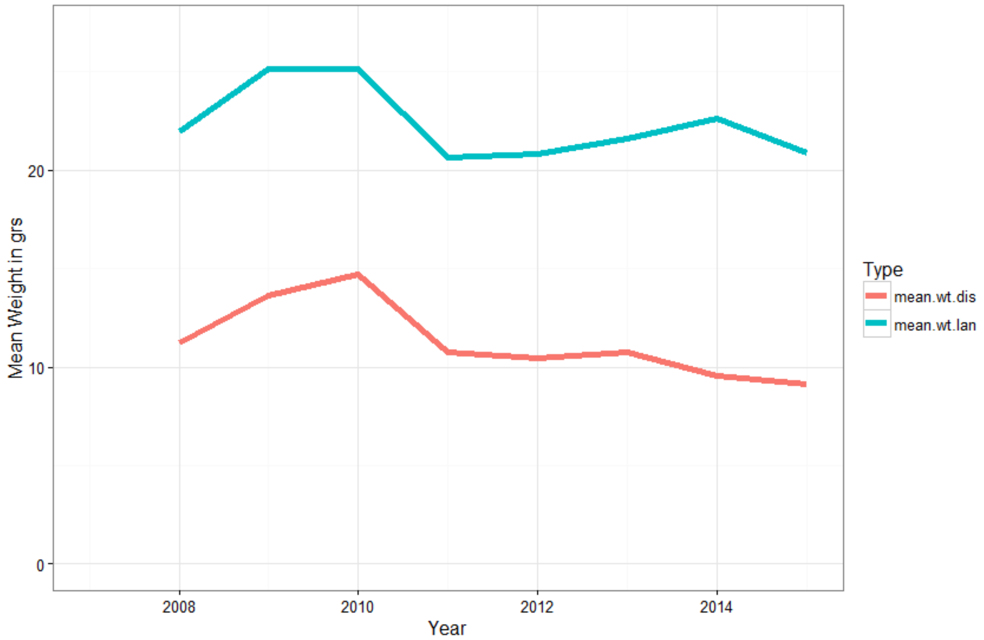


Figure 7.5.9. ***Nephrops*** **FU17 (Aran Grounds). Annual mean weight (gr) estimates of landings and discards.**

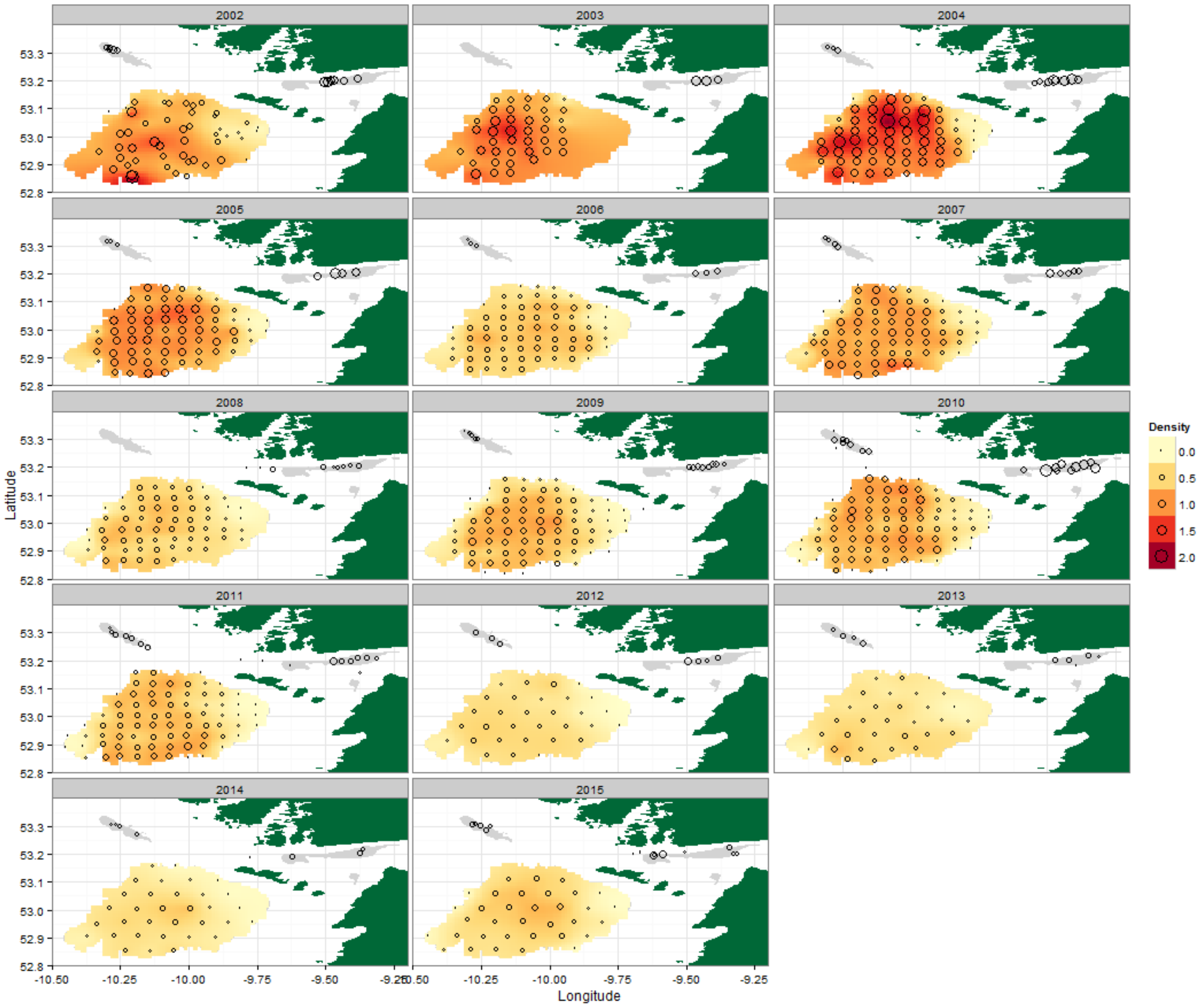


Figure 7.5.10. ***Nephrops*** **in FU17 (Aran Grounds). Contour plots of the krigged density estimates for the Aran Ground UWTV surveys from 2002 (top left) to 2015 (bottom right).**

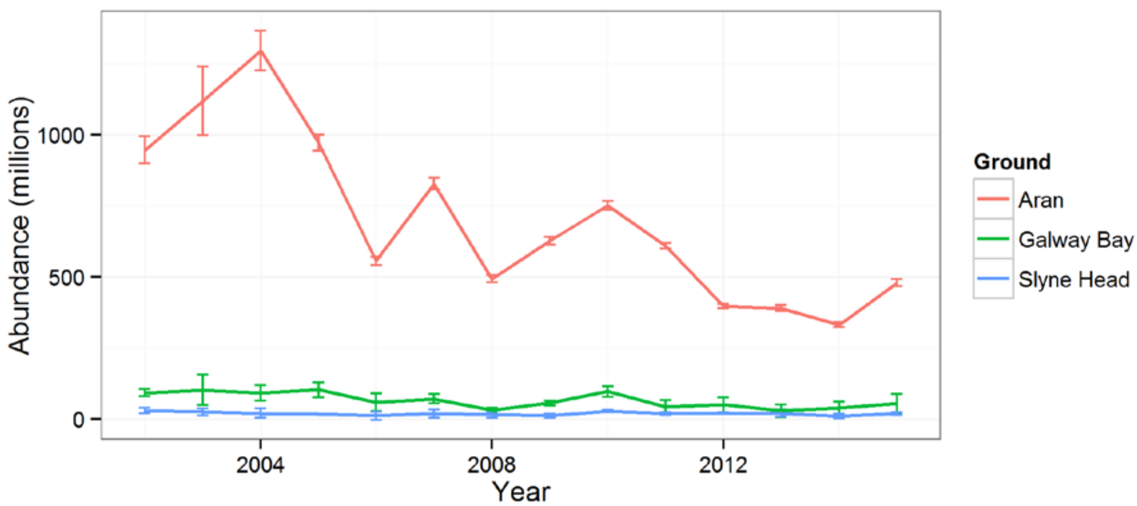


Figure 7.5.11. ***Nephrops*** **FU17 Aran Grounds.** ***Nephrops*** **burrow estimates in FU17 Aran, Galway Bay and Slyne Head grounds 2002–2015.**

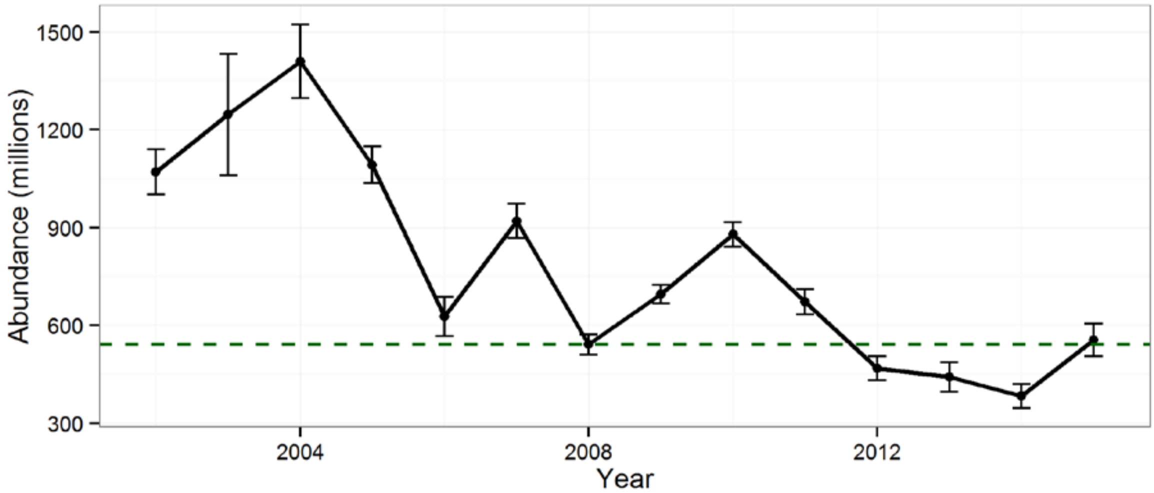


Figure 7.5.12. Time-series of total abundance estimates for FU17 (error bars indicate 95% confidence intervals) and $B_{trigger}$ is dashed green line.

Figure 7.5.13. *Nephrops* FU17 Aran Grounds. Harvest Rate (% dead removed/UWTV abundance). The dashed and solid lines are the MSY proxy and the harvest rate respectively.

7.5.11 Audit of *Nephrops* FU17 (Aran grounds)

An audit is not available.

7.6 *Nephrops* in Division 7.b,c,j,k (Porcupine Bank, FU16)

Type of assessment in 2016

Available data on the fishery for 2015 and other stock indicators have been updated here according to the stock annex (*Nephrops* FU16). The assessment and catch options follow the agreed procedures set out in the stock annex.

ICES advice applicable to 2015

ICES advises on the basis of the MSY approach that catches from FU 16 in 2015 should be no more than 1850 tonnes. All catches are assumed to be landed.

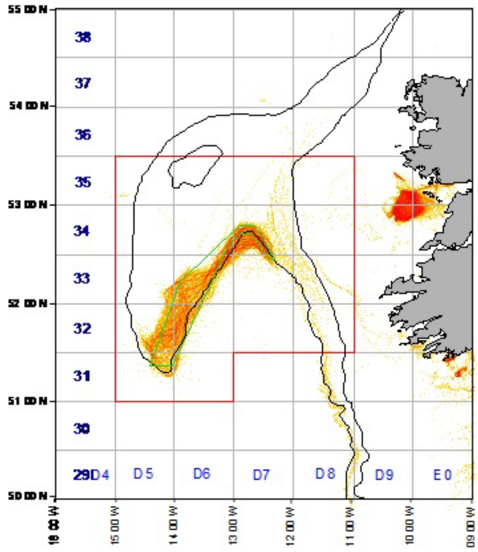
ICES advice applicable to 2016

ICES advises on the basis of the MSY approach that catches from FU 16 in 2015 should be no more than 1850 tonnes. All catches are assumed to be landed.

7.6.1 General

Stock description and management units

The TAC area is Subarea 7, since 2011 an 'of which' clause was introduced specifically for the Porcupine Bank (FU16) see Table 7.6.1. The Functional Unit for assessment includes some parts of the following ICES Divisions 7.b, c, j, and k. The exact stock area is shown on the map below and includes the following ICES Statistical rectangles: 31–35 D5–D6; 32–35 D7–D8.



The FU16 outlined by the red line. The closed area is shown with a green line. Irish *Nephrops* directed fishing effort between 2006–2009 derived from integrated VMS and logbook information is shown as a heat map.

Management applicable to 2015 and 2016

COUNCIL REGULATION (EU) No 43/2014 of 19 January 2015 fixing for 2015 the fishing opportunities available to EU vessels for certain fish stocks and groups of fish stocks which are not subject to international negotiations or agreements.

TAC in 2015

Species:	Norway lobster *Nephrops norvegicus*	**Zone:**	VII (NEP/07.)
Spain	1 297		
France	5 257		
Ireland	7 973		
United Kingdom	7 092		
Union	21 619		
TAC	21 619		Analytical TAC Article 11 of this Regulation applies

Special condition:

within the limits of the abovementioned quotas, no more than the quantities given below may be taken in the following zone:

	Functional Unit 16 of ICES Sub-area VII (NEP/*07U16):
Spain	558
France	349
Ireland	671
United Kingdom	272
Union	1 850

TAC in 2016

COUNCIL REGULATION (EU) 2016/72 of 22 January 2016 fixing for 2016 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, and amending Regulation (EU) 2015/104

Species:	Norway lobster *Nephrops norvegicus*	**Zone:**	VII (NEP/07.)
Spain	1 401		
France	5 678		
Ireland	8 610		
United Kingdom	7 659		
Union	23 348		
TAC	23 348		Analytical TAC Article 12(1) of this Regulation applies

Special condition:

within the limits of the abovementioned quotas, no more than the quantities given below may be taken in the following zone:

	Functional Unit 16 of ICES Subarea VII (NEP/*07U16):
Spain	558
France	349
Ireland	671
United Kingdom	272
Union	1 850

Closed area restrictions

A seasonal closed area has been in place for three months May 1–July 31 between 2010–2012 (shown in the map above and co-ordinates below). The period of the closure was been reduce to only one month (May) after 2013. Article 12 of COUNCIL REGULATION (EU) 2016/72 of 22 January 2016 is given below:

Article 12

Closed fishing seasons

1. It shall be prohibited to fish or retain on board any of the following species in the Porcupine Bank during the period from 1 May to 31 May 2016: cod, megrims, anglerfish, haddock, whiting, hake, Norway lobster, plaice, pollack, saithe, skates and rays, common sole, tusk, blue ling, ling and spurdog.

For the purposes of this paragraph, the Porcupine Bank shall comprise the geographical area bounded by rhumb lines sequentially joining the following positions:

Point	Latitude	Longitude
1	52° 27′ N	12° 19′ W
2	52° 40′ N	12° 30′ W
3	52° 47′ N	12° 39,600′ W
4	52° 47′ N	12° 56′ W
5	52° 13,5′ N	13° 53,830′ W
6	51° 22′ N	14° 24′ W
7	51° 22′ N	14° 03′ W
8	52° 10′ N	13° 25′ W
9	52° 32′ N	13° 07,500′ W
10	52° 43′ N	12° 55′ W
11	52° 43′ N	12° 43′ W
12	52° 38,800′ N	12° 37′ W
13	52° 27′ N	12° 23′ W
14	52° 27′ N	12° 19′ W

By way of derogation from the first subparagraph, transit through the Porcupine Bank while carrying on board the species referred to in that paragraph, shall be permitted in accordance with Article 50(3), (4) and (5) of Regulation (EC) No 1224/2009.

The following TCMs are in place for *Nephrops* in VII (excluding VIIa) after EC 850/9 in operation since 2000:

Minimum Landing Sizes (MLS); total length >85 mm, carapace length >25 mm, tail length >46 mm.

The mesh size restrictions apply to towed gears in 7.b–k targeting *Nephrops and* are given in Section 7.1. Vessels mainly used 80–99 mm mesh to target *Nephrops* on the Porcupine Bank.

Fishery in 2015

There has been a trend for Irish vessels to switch to multi (quad) rig trawls since 2012. These vessels are more efficient at catching *Nephrops* (BIM, 2015).

Effect of regulations

Prior to 2011 TACs and quotas were applied to the whole of 7 so the FU16 fishery was not been restricted by quotas. Since 2011 the "of which clause" was implemented in the TAC regulation specifically for the Porcupine Bank. Quotas have been very restrictive for Irish vessels and this has led to various changes in fishing patterns. Vessels have tried to optimise the economic value of the catch by targeting larger higher value *Nephrops*. The FU16 specific quota has also increased the risk of area misreporting, discarding and of highgrading landings. The implementation of the quota in Ireland has had the perverse consequence of increasing effort and participation in the fishery as vessels try to establish 'track record' in the fishery.

Previously WGCSE have carried out an analysis of VMS effort data by month which illustrated that the spatio-temporal closed area has been respected by the fleet but effort was displaced to the parts of the *Nephrops* ground not fully covered by the closure.

Information from stakeholders

The provision of grade information by individual fishermen and Co-ops remains a highly important assessment input. In 2015 the percentage of landings where grade data was provided increased.

Year	% of Irish landings where grade data was provided
2011	60%
2012	45%
2013	57%
2014	33%
2015	44%

The industry has also collaborated with the development of the IFSRP survey since 2010 (Stokes and Lordan, 2011).

The Irish industry considers that the stock has increased significantly and no longer requires the Functional Unit "*of which*" clause.

7.6.2 Data

InterCatch

Data were available in InterCatch and used on a trial basis.

Landings

Total international landings increased by ~15% in 2015 to 1394 t (Figure 7.6.1 and Table 7.6.2). The total landings include the WGCSE best estimate of "unallocated landings" for the area ~454 t. The "unallocated" landings include an estimate of area-misreported catches for Irish vessels. This was derived in the following way: If an FU16 trip had reported catches in rectangles outside the defined FUs this was assumed to be take in FU16. If an FU16 trip had a daily lpue for FUs outside FU16 that was beyond the 90th percentile of the lpue distribution for that other FU then the daily catch was estimated using daily effort * average annual lpue for that other FU. Any residual catch was assumed to be taken in FU16. The "unallocated" landings prior to 2013 included a component derived for differences between Spanish "official" landings and IEO estimates for FU16.

Sampling levels

Sampling levels, data aggregating and raising procedures were reviewed by WKNEPH 2013 and are documented in the stock annex. Recent sampling rate is provided in Table 7.6.3.

Since 2010 landings length distributions have been reconstructed using the methods outlined in the stock annex. This involves using samples of the grade length structure from Irish sampling and estimates of the volume of each commercial size grade provided by the fishing industry. This was used to reconstruct Irish LFDs, landings by other fleets which accounted for 14% of the landings were unsampled.

Commercial length-frequency distributions

The time-series of raised international length–frequency distributions of the sampled landings by sex are given in Figure 7.6.2. This also shows significant shift towards larger individuals in the landings between 2002–2009 when few individuals at smaller sizes were observed. The 2009 data for males show a recruiting year class entering the landings at ~35 mm CL. This year class was also apparent in the data for subsequent years.

Sex ratio

Previous *Nephrops* working groups have highlighted stability in sex ratio as an important indicator for *Nephrops* stocks. The landings and fishery-independent survey catches show a dramatic switch in the sex ratio for this stock with larger proportions of females in the catches between 2007 and 2009 (Figure 7.6.3). Both the commercial and survey data indicate that sex ratio switched back to a more usual situation since 2010 with males accounting for larger proportions of the catch/landings.

Nephrops moult once a year shortly after hatching of eggs in April or May. There is a 24 hour period after moulting when the male *Nephrops* can mate with the female (Farmer, 1974). If there are insufficient males in the population to mate with the recently moulted females this can result in a change in female behaviour whereby unmated females concentrate on feeding and growth instead of reproduction. This so called "sperm limitation" hypothesis could explain the sex ratio changes observed in the Porcupine *Nephrops*. WKNEPH 2013 examined the available scientific data on proportions of females mated observed on the Spanish survey. These results showed high proportions of unmated females and a high L_{50} for mated females in catches in 2009. Simulations were also carried out to investigate the densities at which sperm limitation may become an issue given a range of plausible ranges of stock density, sex ratios, search radii. The conclusion was that at the densities recently observed on the Porcupine Bank that sperm limitation was a real possibility.

Mean weight explorations

The mean weights in in the landings are shown for the full time-series in Figure 7.6.4 and Table 7.6.4.

Discards

There are few historical estimates of discards for this stock. Irish sampling up to 2015 observed very minimal discarding (mainly limited to small and damaged individuals <5% by number). Three Irish trips were sampled in 2015. Discards were not recorded on one of the these trips. However on the other two trips discards were estimated to be around 8% and 9% by number (2 and 3% by weight). In 2016, discards have also been recorded on observer trips and the numbers of *Nephrops* discards also appears to have increased.

A detailed examination of discard estimates was provided in Spain last year. No estimate of was provided in InterCatch by Spain in 2015.

Abundance indices from UWTV surveys

The latest survey report is available at http://oar.marine.ie/handle/10793/59 (Doyle, *et al*., 2016). These surveys use the standard UWTV methodology and conform to WGNEPS best practice and guidelines. WKNEPH 2013 recommended that these surveys could be used for assessment and provision of catch options. The results are given in Table 7.6.5. Further detail of the survey are provided in the annex and annual survey reports available at http://oar.marine.ie/handle/10793/59.

Trawl surveys

The longest time-series of fishery-independent data is from the Spanish Porcupine trawl survey 2001–2015 (SpPGFS-WIBTS-Q4). This survey is carried out in September when *Nephrops* catchability is quite low, particularly of adults. Further information on this survey is provided in the IBTS report (ICES, 2015) and in previous IBTS reports.

Distribution of *Nephrops* catches and biomass in Porcupine surveys between 2001 and 2015 are shown in Figure 7.6.5. There was a year effect in 2008 when unusual gear parameters were observed. Catch rates in 2011 may also have been reduced due to exceptionally poor weather and gear performance issues. The stratified abundance estimate and biomass increased significantly in 2010 (Figure 7.6.6).

The size structure of the catches in the survey shows two things: a much lower mean size than in the commercial fleets and an increasing trend in mean size for both sexes up to 2008 (Figure 7.6.7). In 2009 there is large reduction of mean size in both sexes due to a recruiting year class with a modal length at around 27 mm (possibly the 2006 year class). Tracking of cohorts was carried out at WKNEPH 2013 but the results are inconclusive (ICES, 2013). There appears to be increased recruitment in the last three years on the survey with increased catch rates of individuals <20 mm (Figure 7.6.8).

An Irish Fisheries Science Research Partnership (IFSRP) survey was developed in collaboration the Irish fishing industry to obtain data from the closed area in 2010–2012. Details of the design and methodology are presented in Stokes and Lordan (2011). The survey uses both commercial gear (Comm) and a baca trawl similar to the SpPGFS-WIBTS-Q4. WKNEPH concluded that the IFSRP trawl survey is too short (with changes in coverage, gears and vessels) to draw an inference about cpue changes reflecting changing stock abundance (ICES, 2013). The surveys carried out between 2010–2012 provided very useful data on population structure across the ground as well as data on grade structure and maturity-at-length.

Commercial cpue

In the past the *Nephrops* fishery on the Porcupine Bank was both seasonal and opportunistic with increased targeting during periods of high *Nephrops* emergence and good weather. Freezing of catches at sea has become increasingly prevalent since 2006 and the fishery now operates throughout the year, mainly targeting larger more valuable *Nephrops* in lower volumes. Fishing effort has fluctuated considerably in the recent past in response to availability of *Nephrops*.

Effort and lpue/cpue data are generally not standardized, and hence do not take into account vessel capacity, efficiency, seasonality or other factors that may bias perception of abundance trends over the longer term. WKNEPH concluded that effort and lpue series should be maintain in the WGCSE report for information purposes (ICES, 2013a). Any inferences about changes in stock abundance from these data should take account of the quality and bias concerns raised above.

These data are presented by country in Table 7.6.6.

7.6.3 Stock assessment

Comparison with previous assessments

This assessment is based on UWTV approach outlined in WKNEPH 2013 and using parameter in the stock annex (ICES, 2013). No survey was possible in 2015 so this year's assessment has been updated based on the results of the June 2016 UWTV survey.

State of the stock

The UWTV results are shown in Table 7.6.5. These indicate that recent harvest ratios have been below the F_{MSY} proxy and the estimated abundance in 2014 was similar to 2013.

7.6.4 Catch options table

The inputs to the catch options are given below. WGCSE concluded that the mean weights for the full time-series should be used for the catch options because recent mean weights in the landings have fluctuated considerably. At this point it is not possible to estimate the numbers and mean weights of discards in the fishery although there are indications that discards have increased in 2015 and 2016.

Variable	Value	Source	Notes
Stock abundance	958	ICES (2016a)	UWTV survey 2016.
Mean weight in landings	52.2	ICES (2016a)	Average 1986–2015.
Mean weight in discards		ICES (2016a)	Not relevant.
Discard proportion		ICES (2016a)	Discarding is negligible.
Discard survival rate		ICES (2016a)	Not relevant.
Dead discard rate		ICES (2016a)	Discarding is negligible.

7.6.5 Reference points

New reference points were evaluated by WKMSYREF4 (ICES, 2016a) and advised by ICES (2016b). The F_{MSY} for this stock was increased from 5.0% to 6.2%. The F_{MSY} for this stock is based on $F_{0.1}$ for both sexes combined given the low density of *Nephrops* on the Porcupine Bank.

Stock code	MSY Flower*	FMSY*	MSY Fupper* with AR	MSY Btrigger	MSY Fupper* with no AR
nep-16	5.0%	6.2%	6.2%	Not defined	6.2%

*** Harvest rate (HR).**

7.6.6 Management strategies

There is no management plan for this stock.

7.6.7 Quality of assessment and forecast

The main quality considerations for this stock is related to mean weight and discarding. The mean weight for this stock have been fluctuating, the most recent estimates maybe over estimate due to the non-inclusion of discards. A long-term mean weight has been used in the calculation of catch options. There is some evidence from surveys and length structure that recruitment has improved and this may result in a reduction in mean weight in the stock. Currently there is no methodology to take this into account in the calculation of catch options. In 2015 and 2016 some discards have been observed on catch sampling trips. Estimates remain relatively small 2–3% by weight and 8–9% by number. This will result is a small underestimate of recent harvest rates of similar magnitude to the numbers which will not change the status evaluation.

The UWTV survey provides abundance since 2012 (except 2015) with high precision. The time-series is short and the $MSY_{trigger}$ has yet to be defined. The landings are considered fairly well estimated (an unallocated component related to area misreporting has been included since 2011).

7.6.8 Recommendation for next benchmark

This stock was benchmark in 2013 at WK*NEPH*. WGCSE will keep the stock under close review and recommend future benchmark as required.

7.6.9 Management considerations

The introduction of the "of which limit" with the TAC regulations since 2011 has increased the risk of high-grading and area misreporting in this fishery.

A seasonal closed area (May 1–July 31) has been in place since 2010. The period of the closure was reduced to one month, May, since 2013. There hasn't been an evaluation of the impact of this closure and whether is provides a conservation benefit over and above catch limits.

Productivity of deep-water *Nephrops* stocks is generally lower than that in shelf waters, though individual *Nephrops* grow to relatively large sizes and attain high market prices. Other deep-water *Nephrops* stocks off the Spanish and Portuguese coast have collapsed and have been subject to recovery measures for many years e.g. FU25, 26, 27 and 31. Recruitment in *Nephrops* populations in deep water may be more sporadic than for shelf stocks where strong larval retention mechanisms exist (O'Sullivan *et al*., 2015). This makes these stocks more vulnerable to over exploitation and potential recruitment failure as has been observed on the Porcupine Bank in the early 2000s.

Discarding by the *Nephrops* trawl fishery is around 50% of the total catch by weight. The main species that are discarded by weight are blue mouth-red fish, blue whiting and argentines (Marine Institute & Bord Iascaigh Mhara, 2011).

7.6.10 References

Doyle, J., Lordan, C., Fitzgerald, R., O'Brien, S., Allsop, C., Kelly C., and McArdle J. 2016. Porcupine Bank *Nephrops* Grounds (FU16) 2016 UWTV Survey Report and catch options for 2017. Marine Institute UWTV Survey report.

ICES. 2015. Report of the International Bottom Trawl Survey Working Group (IBTSWG), 23–27 March 2015, Bergen, Norway. ICES CM 2015/SSGIEOM:24. 278 pp.

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

ICES. 2016b. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. In Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

Marine Institute and Bord Iascaigh Mhara. 2011. Atlas of Demersal Discarding, Scientific Observations and Potential Solutions, Marine Institute, Bord Iascaigh Mhara, September 2011. ISBN 978-1-902895-50-5. 82 pp. http://hdl.handle.net/10793/666

O'Sullivan D., Lordan C., Doyle J., Berry A., Lyons K. 2015. Metapopulation connectivity via larval transport of the Norway lobster *Nephrops norvegicus* in waters around Ireland: a modelled approach. Marine Ecology Progress Series 534:95–106.

Stokes, D. and Lordan, C. 2011. "Irish fisheries–science research partnership trawl survey of the Porcupine Bank *Nephrops* Grounds July 2010", Irish Fisheries Bulletin No. 39, Marine Institute 2011. http://hdl.handle.net/10793/712.

Table 7.6.1. ***Nephrops*** **Porcupine Bank (FU 16): Of which catch limit.**

Year	France	Ireland	Spain	UK	Total
2011	241	454	377	188	1260
2012	238	457	380	185	1260
2013	340	653	543	264	1800
2014	349	671	557	271	1848
2015	349	671	558	272	1850
2016	349	671	558	272	1850

Table 7.6.2. *Nephrops* Porcupine Bank (FU 16): Landings (tonnes) by country.

Year	France	Ireland	Spain	UK E& W	UK Scotland	Unallocated	Total
1965	514						514
1966	0						0
1967	441						441
1968	441						441
1969	609						609
1970	256						256
1971	500		1444				1944
1972	0		1738				1738
1973	811		2135				2946
1974	900		1894				2794
1975	0		2150				2150
1976	6		1321				1327
1977	0		1545				1545
1978	2		1742				1744
1979	14		2255				2269
1980	21		2904				2925
1981	66		3315				3381
1982	358		3931				4289
1983	615		2811				3426
1984	1067		2504				3571
1985	1181		2738				3919
1986	1060		1462	69			2591
1987	609		1677	213			2499
1988	600		1555	220			2375
1989	324	350	1417	24			2115
1990	336	169	1349	41			1895
1991	348	170	1021	101			1640
1992	665	311	822	217			2015
1993	799	206	752	100			1857
1994	1088	512	809	103			2512
1995	1234	971	579	152			2936
1996	1069	508	471	182			2230
1997	1028	653	473	255			2409
1998	879	598	405	273			2155
1999	1047	609	448	185			2290
2000	351	227	213	120			910
2001	425	369	270	158			1222
2002	369	543	276	139			1327
2003	131	307	489	108	29		1064
2004	289	494	468	126	28		1406
2005	397	754	681	208	156		2197
2006	462	731	636	201	155		2185
2007	302	1060	384	146	183		2074
2008	26	562	234	41	138		1000
2009	4	356	348	13	159		879
2010	4	579	240	10	90		922
2011	8	643	182	23	122	301	1278
2012	0.46	605	198	0	134	320	1258
2013	5.8	651	132	1	118	234	1141
2014	3	813	129	0	96	148	1189
2015	3	744	84	0	109	454	1394

Table 7.6.3. *Nephrops* Porcupine Bank (FU 16): Recent sampling used in the assessment.

Year	Spain		France		Ireland	
	Number of Trips	Type	Number of Trips	Type	Number of Trips	Type
2015					3	Graded Landings
2014					3	Graded Landings
2013					3	Graded Landings
2012	0		0		3	Graded Landings
2011	0		0		2	Graded Landings
2010	0		0		3	Graded Landings

Table 7.6.4. *Nephrops* Porcupine Bank (FU 16): Time series of numbers landed and mean weight in the landings.

year	Numbers (millions)	Weight Landed (Tonnes)	Mean Weight in landings (gr)
1986	55.7	2591.0	46.5
1987	60.3	2499.1	41.4
1988	48.1	2374.5	49.3
1989	45.6	2115.0	46.4
1990	38.9	1894.8	48.7
1991	37.3	1640.4	44.0
1992	47.0	2014.8	42.8
1993	38.5	1857.4	48.3
1994	54.4	2511.7	46.1
1995	65.5	2936.3	44.8
1996	52.9	2230.1	42.2
1997	59.1	2408.9	40.7
1998	49.9	2155.1	43.2
1999	52.3	2289.5	43.8
2000	15.1	910.4	60.1
2001	24.6	1222.0	49.6
2002	32.0	1327.1	41.5
2003	18.4	1063.5	57.8
2004	21.5	1405.7	65.3
2005	31.5	2196.6	69.8
2006	28.7	2184.9	76.2
2007	29.2	2074.3	71.1
2008	17.9	1000.4	55.9
2009	16.5	879.5	53.2
2010	14.1	922.0	65.3
2011	27.9	1278.0	45.8
2012	25.0	1257.6	50.4
2013	19.8	1141.3	57.5
2014	17.3	1189.0	68.5
2015	27.4	1393.8	50.9

Table 7.6.5. ***Nephrops*** **Porcupine Bank (FU 16): Assessment summary.**

Year	Landings in number	Total discards in number *	Removals in number	UWTV abundance estimates	95% conf. intervals	Harvest rate	Mean weight in landings	Mean weight in discards	Discard rate	Dead discard rate
	millions	millions	millions	millions	millions	%	grammes	grammes	%	%
2012	25	0	25	787	78.7	3.2	50.4	NA	0	0
2013	19.8	0	19.8	768	61.4	2.6	57.5	NA	0	0
2014	17.4	0	17.4	722	35.4	2.4	68.4	NA	0	0
2015	27.4	0	27.4	NA	NA	3.3**	50.9	NA	0	0
2016				958	68.1					

***Discards are considered negligible and are not included in the assessment.**

**** The harvest rate is estimated based on a linear extrapolation of abundance for 2015 when no survey was carried out.**

Table 7.6.6. ***Nephrops*** **Porcupine Bank (FU 16): Effort and lpue for the various different fleets exploiting the stock 1971–2014.**

Year	Spain[1]		France[2]		Ireland[3]	
	Effort ('000's Hrs)	lpue (kg/hr)	Effort[2] ('000's Hrs)	lpue (>10%) (kg/hr)	Effort[3] ('000's Hrs)	lpue (kg/hr)
1980	318	9				
1981	272	12				
1982	237	17				
1983	196	14	18	35		
1984	194	13	30	35		
1985	200	14	33	36		
1986	162	9	28	38		
1987	174	10	24	26		
1988	180	9	22	27		
1989	173	8	14	23		
1990	159	9	15	23		
1991	138	7	19	18		
1992	96	9	32	21		
1993	80	9	36	22		
1994	80	10	38	28		
1995	67	9	42	30	15	41
1996	58	8	41	26	8	42
1997	57	8	41	25	11	35
1998	56	7	40	22	10	42
1999	53	8	43	21	9	35
2000	47	5	23	14	2	31
2001	44	6	24	15	8	30
2002	54	5	18	18	10	38
2003	66	5	7	19	7	26
2004	59	10	9	25	17	22
2005	60	13	15	26	24	30
2006	65	9	22	21	28	25
2007	58	8	17	18	36	27
2008	42	6	4	7	20	26
2009	44	7			12	27
2010	42	6			19	29
2011	na	na			26	33
2012	15	na			22	41
2013	na	na			20	44
2014	na	na			25	37
2015	na	na			30	40

[1] = Effort and lpue between 1980 and 2010 was estimated based on fishing days in 7. Effort in 2012 was based on logbooks for FU16.

[2] = Effort and lpue for vessels where <10% of landed value was *Nephrops*.

[3] = Effort and lpue for vessels where 30% of the landed weight was *Nephrops*.

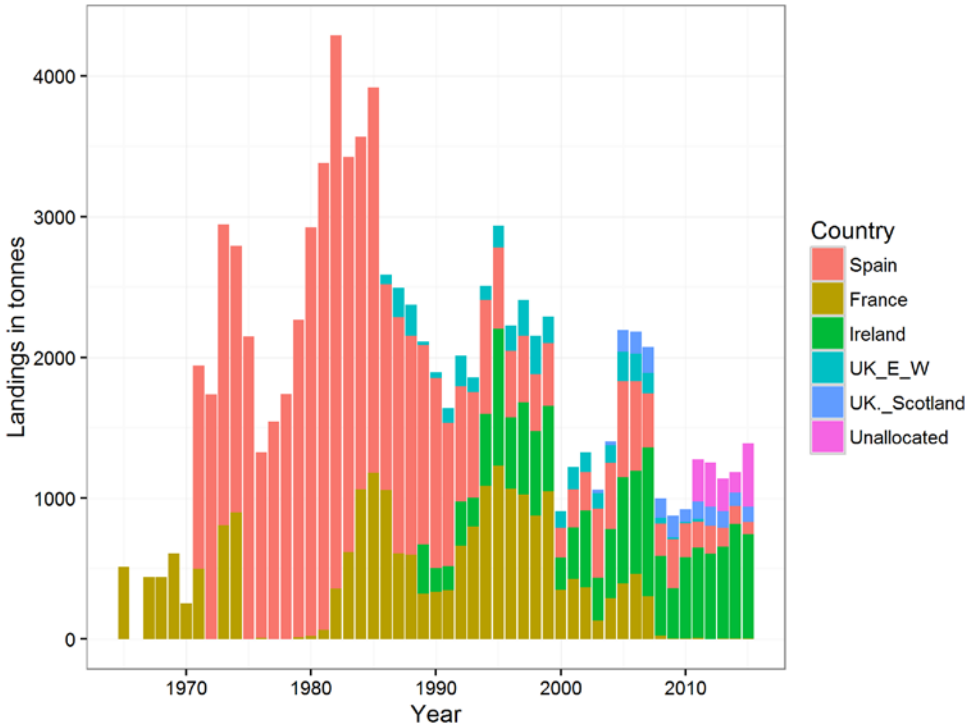


Figure 7.6.1. ***Nephrops*** **in FU16 (Porcupine Bank). WGs best estimates of landings in tonnes by country.**

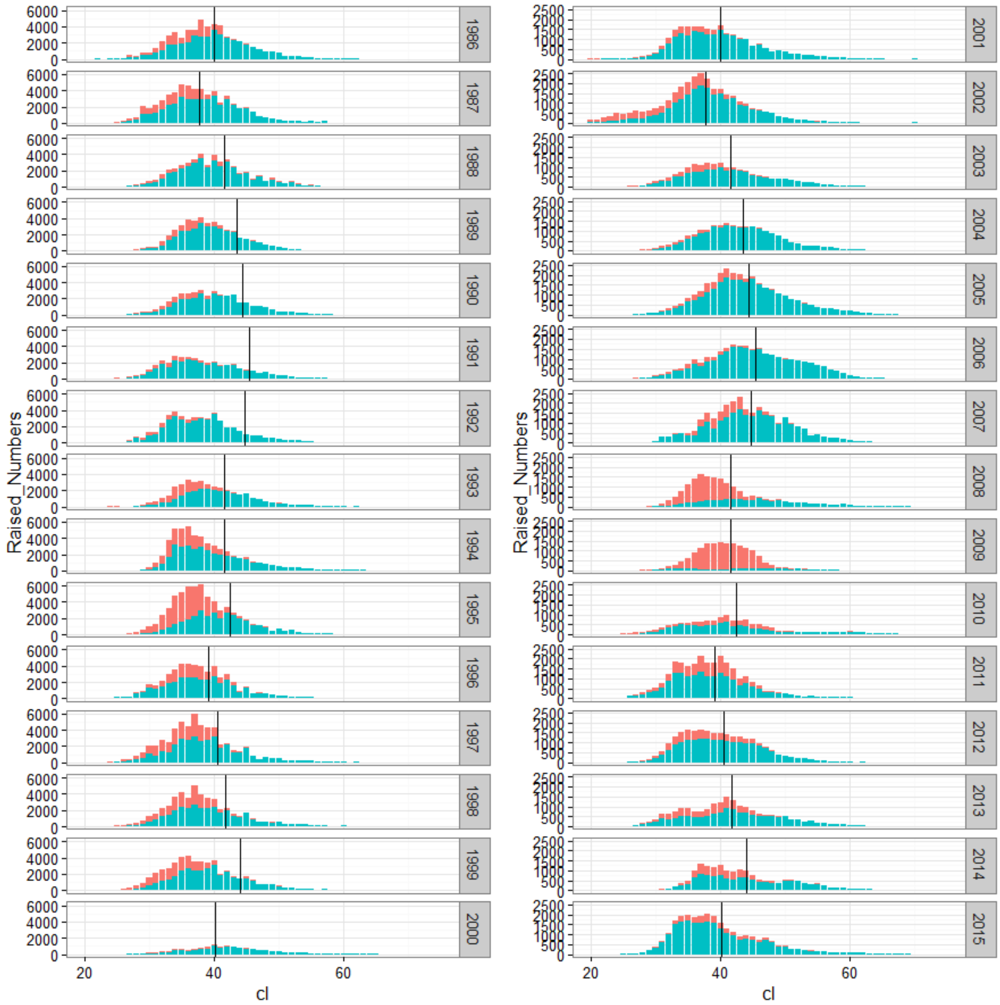


Figure 7.6.2. ***Nephrops*** **in FU16 (Porcupine Bank). Female and male landings length distributions. (Vertical line is the mean length in the landings).**

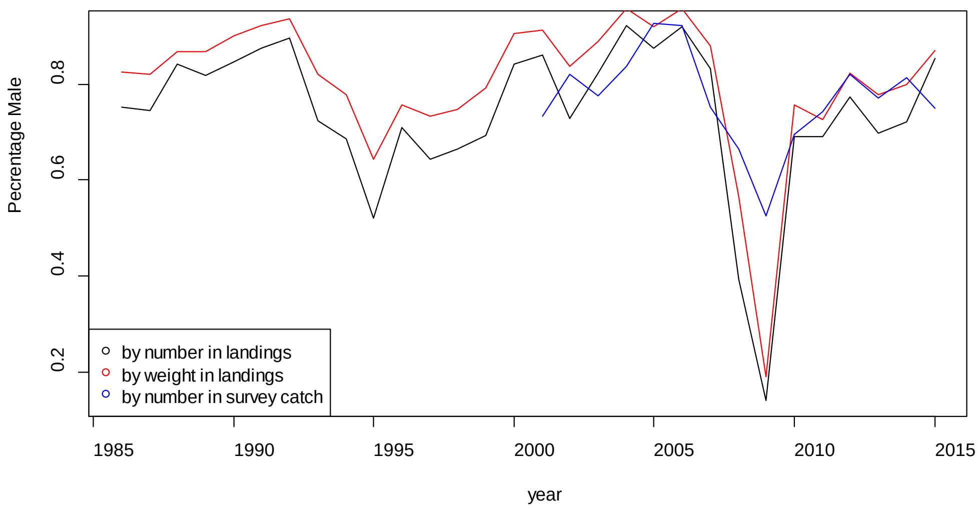


Figure 7.6.3. ***Nephrops*** **in FU16 (Porcupine Bank). The percentage males in the landings and survey over time.**

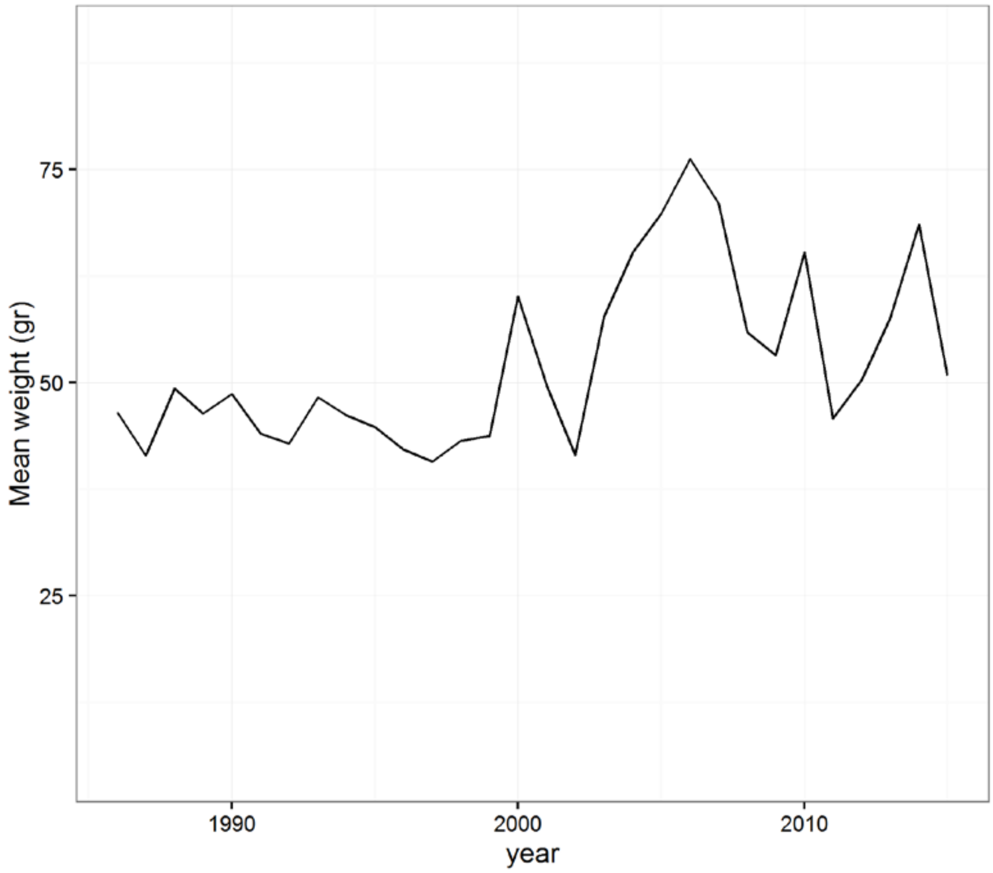


Figure 7.6.4. ***Nephrops*** **in FU16 (Porcupine Bank). Mean weight in the commercial landings.**

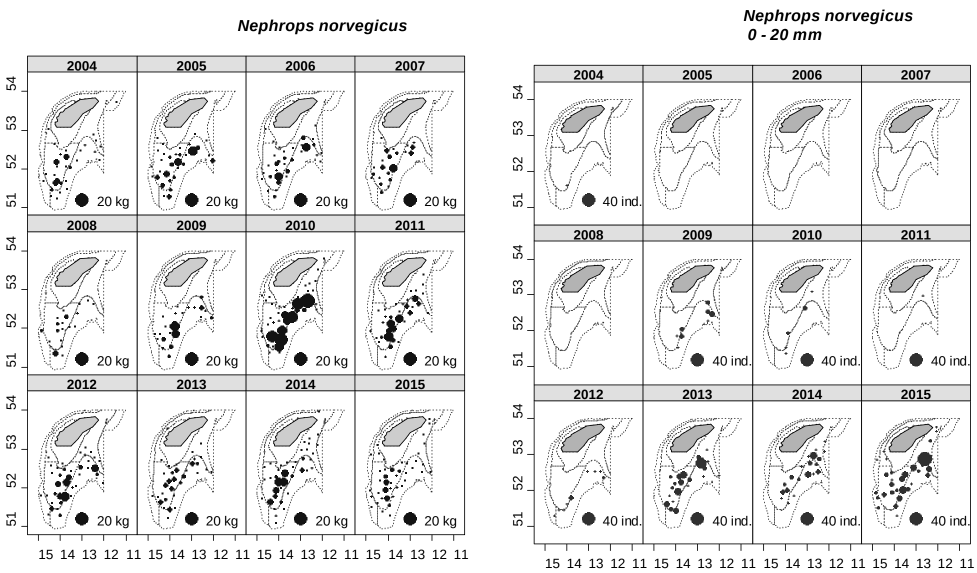


Figure 7.6.5. ***Nephrops*** **in FU16 (Porcupine Bank). Distribution of** ***Nephrops norvegicus*** **in Porcupine surveys left biomass, right No. juveniles (<20 mm carapace length.)**

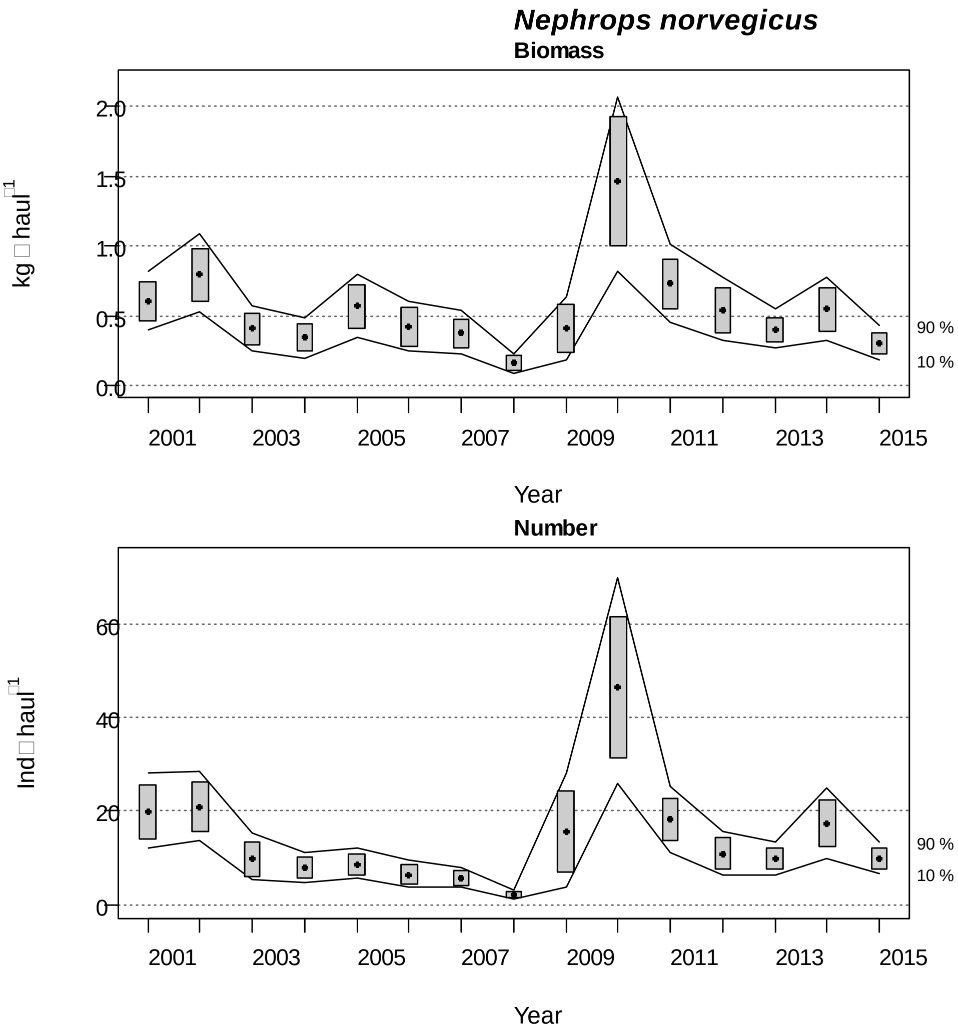


Figure 7.6.6. ***Nephrops*** **in FU16 (Porcupine Bank). Changes in** ***Nephrops norvegicus*** **biomass and number stratified indices during Porcupine Survey time-series (2001–2014). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (**α**=0.80, bootstrap iterations=1000).**

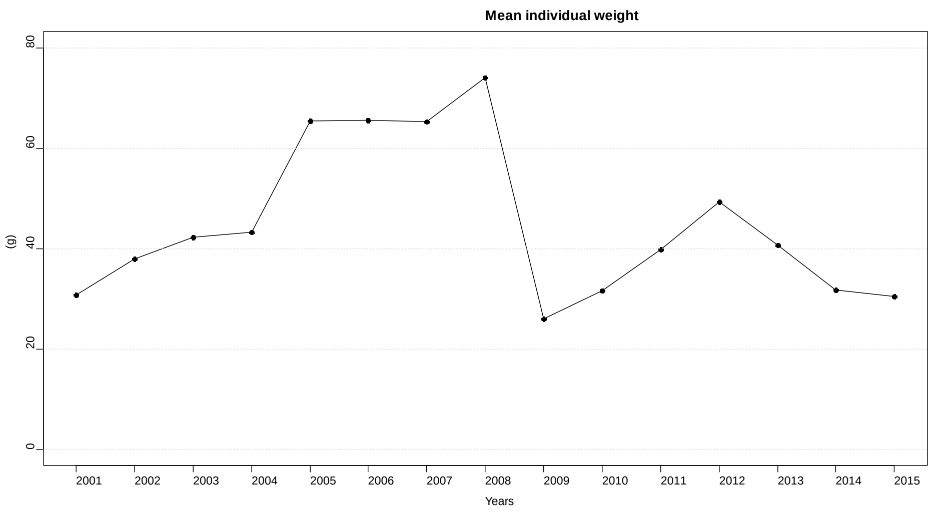


Figure 7.6.7. Nephrops in FU16 (Porcupine Bank). Mean weight per individual along the Porcupine Bank surveys carried out between 2001 and 2015.

7.7 *Nephrops* in Division 7.f.g (Smalls Grounds, FU22)

Type of assessment in 2016

UWTV based assessment using WK*NEPH* 2009 protocol as described in the stock annex. The TV survey is due to be repeated in the summer 2016 and the new survey will form the basis of advice for this stock in the autumn.

ICES advice applicable to 2015

"ICES advises that, on the basis of the MSY approach and considering that no discard ban is in place in 2015, landings should be no more than 3409 tonnes. Assuming that discard rates do not change from the average of the last three years (2011–2013) the resulting catch would be no more than 3797 tonnes."

In order to ensure the stock in this FU is exploited sustainably, management should be implemented at the functional unit level.

ICES advice applicable to 2016

"ICES advises that when the MSY approach is applied, catches in 2016 (assuming zero discards) should be no more than 3027 tonnes. If instead discard rates continue at recent values (average of 2012–2014) and there is no change in assumed discard survival rate, this implies landings of no more than 2778 tonnes."

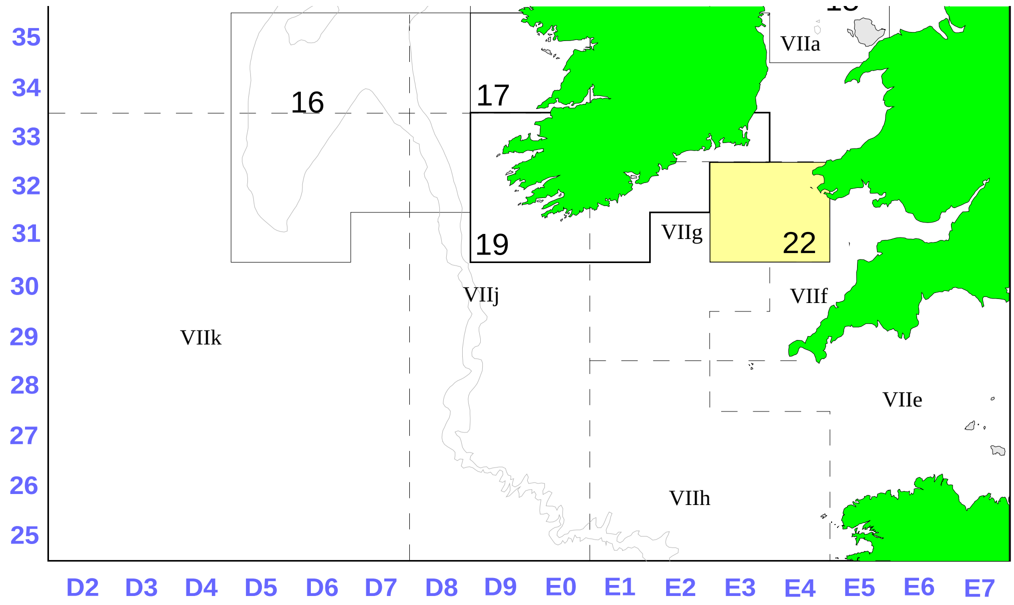
To ensure that the stock in functional unit (FU) 22 is exploited sustainably, management should be implemented at the functional unit level.

7.7.1 General

Stock description and management units

The Smalls *Nephrops* stock (FU22) covers ICES rectangles 31–32E3, 31–32E4 within 7.f.g. It is included in the whole ICES Area 7 together with Irish Sea East and West [FU14, FU15], Porcupine Bank [FU16], Aran Grounds [FU17], northwest Irish Coast [FU18], southeast and southwest Irish Coast [FU19], NW Labadie, Baltimore and Galley [FU20–21], Jones and Cockburn [FU21].

Historically FU20–22 has covered an amalgamation of several spatially distinct mud patches; FU 20 NW Labadie, Baltimore and Galley, FU 21 Jones and Cockburn and FU22 the Smalls. There is no evidence that the whole exploited area belongs to the same stock or that there are several patches linked in meta-population sense. WGCSE 2013 recommended that FU20–22 should be split into FU20–21 and FU22 for the purposes of assessment and advice provision.



See Section 6.4 for details on *Nephrops* in ICES Area 7.

Ecosystem aspects

This section is detailed in stock annex.

Fishery description

Ireland, France and the UK are the main countries involved in the FU22 *Nephrops* fishery. In the early 2000s the Republic of Ireland fleet had on average over 70% of the landings and this has increased to over 90% from this FU in recent times. A description of this fleet is given in the stock annex. Irish landings from this FU come mainly from ICES statistical rectangle 31E3. The fishery on the Smalls grounds operates throughout the year, weather permitting with a seasonal trend.

French trawlers targeting *Nephrops* in the Celtic Sea operate mainly in the FU20–21 component of the stock, thus the contribution of the FU22 (Smalls grounds) became minor during recent years: in 2000, 1186 t coming from FU22 were landed by French vessels (out of a total of 2848 t for the whole Celtic Sea) whereas in 2015 only 9 t were harvested in the same area (in a total of 371 t for the whole Celtic Sea). 80–90% of the FU22 French landings come from ICES statistical rectangle 31E3.

Fishery in 2015

In 2015, 85 Irish vessels reported landings from FU22. Of these, 66 vessels reported landings in excess of 10 t. Vessels >18 m account for 90% of the landings in 2015. In recent years several newer vessels specializing in *Nephrops* fishing have participated periodically in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates. In 2015, 18 French trawlers reported landings for FU22. French vessels switch between FU20–21 and FU22. In 2015, seven Northern Ireland vessels reported landings for this FU.

The French minimum mesh size of codend was set at 100 mm since January 2000 the majority of Irish landings are from vessels with 80–99 mm codend mesh.

Information from stakeholders

None presented.

7.7.2 Data

InterCatch

Data were available in InterCatch and use on a trial basis.

Landings

The reported landings time-series by country is shown in Figure 7.7.1 and Table 7.7.1. The reported Irish landings from FU22 have increased since 2000 to the present fluctuating around 1800 t recently. French landings have gradually decreased since the early 2000s to the present to the lowest level (9 t). Reported landings from the UK have fluctuated with no obvious trend. Northern Irelandhad highest landings at 75 t followed by Scotland reporting 20 t and minor landings from England >0.5 t. In 2015 Belgium reported 8 t from this FU due to quota swap.

Effort

Effort data are available for the Irish *Nephrops* directed fleet in FU22 from 1995–2015. The effort series is based on the same criteria for FU15, 16, 17, 22 and 20–21 (30% landings threshold) and will be contingent on the accuracy of landings data reported in logbooks. Effort data are not standardized, and hence do not take into account vessel capabilities, efficiency, seasonality or other factors that may bias perception of lpue as an abundance trend over the longer term. These data are not used in the assessment.

WGCSE 2015 recommended that effort data in Kw days should be presented as these data are more informative that uncorrected effort data. Effort data are available from 1995 for the Irish otter trawl *Nephrops* directed fleet. In 2015 this fleet accounted for ~95% of the landings compared with an average of 70% over the time period. Effort shows an increasing trend since the early 2000s (Table 7.7.2. and Figure 7.7.2).

Effort data for France are not available for FU22 and are only available for the combined area FU20–22.

Sampling levels

A dedicated sampling of landings and discards began in 2003 by Ireland. Sampling levels in 2015 were good and comparable to levels in 2014.

Commercial length-frequency distributions

The Irish sampling programme started in 2003 and since then coverage and intensity have been very good covering the seasonal trend of the fishery. The mean size of *Nephrops* in Irish landings has remained stable for both sexes. The mean size of *Nephrops* in the catch has remained relatively stable since 2005 (Figure 7.7.3) with a slight decrease observed in 2015. There is an increase in mean size in the catches in 2007 to 2009 for both sexes which is linked to the recruitment signal picked up by both the UWTV and Irish groundfish survey.

Sex ratio

The sex ratio by year is shown in Figure 7.7.4. This shows some fluctuations over time. The sex ratio has a distinct seasonal pattern (Figure 7.7.5) with lowest males proportions in the samples in May and June. Males dominate the catches in the autumn and winter.

Mean weight explorations

Explorations of the mean weight in the catch samples by sex shows a strong cyclical pattern in the females (Figure 7.7.5). This corresponds with the emergence of mature females from the burrows to mate in summer. There is an increase in mean weight in 2007 to 2009 for both sexes which is linked to the recruitment signal picked up by both the UWTV and Irish groundfish survey (Figure 7.7.6).

Discarding

Since 2003 discard rates have been estimated using unsorted catch and discards sampling. This involves unsorted catch and discard samples being provided by vessels or collected by observers at sea on discard trips. The catch sample is partitioned into landings and discards using an on-board discard selection ogive derived for the discard samples. Sampling effort is stratified monthly, but quarterly aggregations are used to derive length distributions and selection ogives. The length–weight regression parameters given in the stock annex are used to calculate sampled weights and appropriate quarterly raising factors. The sampling intensity and coverage has varied over the time-series, but in recent years has been good.

Discard rates range between 6–34% of total catch by weight and 10–48% of total catch by number (Table 7.7.3). Discard rate of females tends to be higher due to the smaller average size and market reasons. There is no information on discard survival rate in this fishery. 25% is assumed in line with other *Nephrops* stocks in the Celtic Sea (Charuau *et al*., 1982). Highest discard rates were observed in 2007 as a result of the recruitment into the fishery in 2006.

Surveys

Abundance indices from UWTV surveys

The methods used during the survey were similar to those employed for UWTV surveys of *Nephrops* stocks around Ireland and elsewhere and are documented by WKNEPHTV (ICES, 2007), SGNEPS (ICES, 2009, 2010, 2012) and WGNEPS (ICES, 2013, 2014). SGNEPS 2012 (ICES, 2012) recommended that a CV (or relative standard error) of <20% is an acceptable precision level for UWTV survey estimates of abundance. This allowed sampling intensity to be reduced from around 90 stations in the past to 40 on the Smalls grounds in 2015 which allowed survey coverage of other FUs. A randomised isometric grid design was employed with UWTV stations at 5.5 nmi intervals, whereas previously a 3.0 nmi square grid was used. Operational details of the 2015 UWTV survey are available (Lordan *et al*., 2015).

Seven stations were not surveyed successfully in 2015 due to very poor visibility conditions encountered as a result of strong tides These conditions produced a heavy sediment loading in the water column and practically nil visibility at the seabed. In line with standard operating procedures these seven stations were only abandoned completely after two attempts were made at each station. The following fill-in procedure was used: Two buffer zones of 1 nmi and 2 nmi distance were generated around the missing stations. The counts and mean of historic density estimates within the 1 and 2 nmi buffers were calculated. The standard kriging procedure was carried out and summary results were computed for the 1 and 2 nmi “fill-ins”. Finally the mean of historic densities within 2 nmi buffer of the planned stations were used in the calculation of the 2015 abundance Operational details of the 2015 UWTV survey are available (Lordan *et al.*, 2015).The 2015 krigged burrow abundance estimate decreased by about 15% relative to 2014 with a CV (or relative standard error) of 7%.

The blanked krigged contour plot and posted point density data are shown in Figure 7.7.7a and 7.7.7.b. The krigged contours correspond very well to the observed data. In general the densities are higher in the central area of the ground with a localised hotspot centrally and also in the southwestern leg. Densities and abundance have remained stable in the time-series with the exception of the first year which was the highest in the series. The mean density in 2015 is approximately 15% decrease on 2014 and is the fourth highest observed in the series. The summary statistics from this geostatistical analysis are given in Table 7.7.4 and plotted in Figure 7.7.7a–b. The statistical analysis follows these steps documented in Lordan *et al.*, 2015): annual variograms were used to create krigged grid files and the resulting cross-validation data were plotted. If the results looked reasonable then surface plots of the grids were made using a standardised scale. The final part of the process was to limit the calculation to a fixed ground boundary using a blanking file. The resulting blanked grid was used to estimate the mean, variance, standard deviation, coefficient of variation, domain area and total burrow abundance estimate.

The 2015 estimate of 1363 million burrows are the fourth highest observed, and the estimates have remained fairly stable since the survey commenced. The estimation variance of the survey as calculated by EVA is very low (CVs in the order <8%).

Groundfish survey data

The Irish groundfish survey (IGFS-WIBTS-Q4) has been carried out since 2003 (Stokes *et al.*, 2014). This provides information on length–frequency compositions, mean size in the catches, cpue of *Nephrops* in FU22. The mean size of the catches is stable over the time-series except in 2006 and 2008 which signals recruitment into the fishery in 2006 and 2007 (Figure 7.7.8). This signal of recruitment was also picked up during the 2006 UWTV survey (Doyle *et al.*, 2012). The groundfish survey provides a useful indicator of recruitment in this FU.

7.7.3 Assessment

Comparison with previous assessments

The assessment is based on the same methods and similar data as used in 2015. The stock size is estimated to be stable and harvest ratio has increased to 10.1% based on the 2015 UWTV survey.

The WGCSE decided to use a series average (2003–2015) for mean weight to account for the variability in the mean weights linked to recent recruitment (Figure 7.7.6). For proportion removals retained recent three year average was used as is standard procedure.

State of the stock

UWTV abundance estimates suggest that the stock size is stable and the 2015 estimate (1363 million) is above the average of the series (geomean [2006–2015]: 1285 million). Table 7.7.7 summarizes recent harvest ratios for the stock along with other stock parameters. Recent harvest rates have fluctuated due to recruitment pulses into the fishery in 2006 and 2010 and landings have fluctuated around 2300 t.

7.7.4 Catch options table

Catch option table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 7.7.7 and summarised below.

Catch option table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 7.7.5. Since 2003 mean weight in the landings has varied between 18–26 gr (Figure 7.7.6). In line with previous practice an average (2003–2015) of mean weights is used to account for this variability. Three year average (2013–2015) of proportion of removals retained was used as is standard for other *Nephrops* stocks. The estimate harvest ratio has also varied a lot, 5–24% with 2007 being the highest observed (Figure 7.7.10). This is a result of recruitment into the fishery in 2006 and 2007.

The basis for the catch options.

VARIABLE	VALUE	SOURCE	NOTES
Stock abundance	Available October 2016	ICES (2016a)	UWTV survey 2016
Mean weight in landings	22.2 g	ICES (2016a)	Average 2003–2015
Mean weight in discards	12.3 g	ICES (2016a)	Average 2003–2015
Discard rate	20%	ICES (2016a)	Average 2013–2015 (by number). Calculated as discards divided by landings + discards.
Discard survival rate	25%	ICES (2016a)	Only applies in scenarios where discarding is allowed.
Dead discard rate	16%	ICES (2016a)	Average 2013–2015 (by number). Calculated as dead discards divided by removals (landings + dead discards). Only applies in scenarios where discarding is allowed.

A prediction of landings for the FU22 using the approach agreed procedure proposed at WK*NEPH* 2009 and outlined in the stock annex will be made on the basis of the 2016 UWTV survey. This will be presented in October 2016 for the provision of advice.

7.7.5 Reference points

New reference points were derived by WKMSYRef4 (ICES, 2016XX, 2016YY) for FU22. These were updated on the basis of an average of estimated F_{MSY} proxy harvest rates over a period of years, this corresponds more closely to the methodology for finfish. In cases where there is a clear trend in the values a five year average was chosen. Similarly, the five year average of the F at 95% of the YPR obtained at the F_{MSY} proxy reference point was proposed as the F_{MSY} lower bound and the five year average of the F above F_{max} that leads to YPR of 95% of the maximum as the upper bound. Using an average value also has the advantage of reducing the effect of any unusually high or low estimates of the F_{MSY} proxy which occasionally appear.

This stock previously did not have MSY $B_{trigger}$ specified ,the time-series and range of indicator biomass is also limited such that direct use of B_{loss} is considered too close to equilibrium biomass. The workshop proposed to use the 5% interval on the probability distribution of indicator biomass assuming a normal distribution, which is analogous to the 5% on B_{MSY} proposed for finfish stocks assuming these *Nephrops* FU have been exploited at a rate close to near HR_{MSY}. The MSY $B_{trigger}$ for FU22 is 990 million individuals.

STOCK CODE	MSY FLOWER*	FMSY*	MSY FUPPER* WITH AR	MSY BTRIGGER	MSY FUPPER* WITH NO AR
nep-22	10.2%	12.8%	12.8%	990***	12.8%

*** Harvest rate (HR).**

***** Abundance in millions.**

7.7.6 Management strategies

No management strategies exist for this stock.

7.7.7 Quality of assessment and forecast

There are several key uncertainties and bias sources in the method used here (these are discussed further in WK*NEPH* 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007; WKNEPHBID 2008; SGNEPS 2009, WGNEPS 2014). Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates (Marrs *et al.*, 1996). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that is more accurate, although no more precise (WK*NEPH*, 2009). The survey estimates themselves are very precisely estimated (CVs 2–8%) given the homogeneous distribution of burrow density and the modelling of spatial structuring. The cumulative bias estimates for FU22 are largely based on expert opinion. The precision of these bias corrections cannot yet be characterised, but is likely to be lower than that observed in the survey.

In 2015 there is added uncertainty, not accounted for in the model or CV estimate, because 17% of the planned TV stations could not be successfully surveyed due to poor visibility on the seabed. However, the spatial distributions of densities have been fairly consistent over time and the overall density has also been relatively stable. The fill in procedure used to generate density estimates for the seven missing stations should be a good approximation.

In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. For FU22 deterministic estimates of the mean weight in the landings and discard rates for 2003–2015 are used by the WG to account for the variability in these over time. This variability has occurred when large recruitments are observed in the stock as was the case in 2006 and 2007.

The quality of landings data is thought to be good and sampling and discard estimates have improved over the time-series.

7.7.8 Recommendation for next benchmark

This stock has not been formally benchmarked by ICES although the approach used has.

There is no major urgency to benchmark this stock. When it is benchmarked the following issues should be considered:

- The biological parameters used as inputs to the SCA should be reconsidered; growth parameters, length-at-maturity and natural mortality.
- The methodology for aggregating length–distributions and calculating landings and discard LFDs and mean weights should be thoroughly investigated.
- The historical time-series of landings and effort by rectangle should be disaggregated and options for standardisation of lpue investigated.
- Historical sampling and groundfish survey data in this FU should also be disaggregated as far as possible back in time and investigated for useful trends and signals.

7.7.9 Management considerations

The trends from the fishery (landings, effort, mean size, etc.) appear to be relatively stable. The UWTV abundance and mean density estimates show some fluctuations in burrow abundance although it is stable over the time-series. There are fluctuations in the harvest rates which are related to the signals of recruitment into the fishery in 2006 and 2007 picked up by the UWTV and IGFS-WIBTS-Q4. Recent harvest rates for the FU22 Smalls suggest the stock is exploited below F_{MSY}.

A new survey point should be available after July 2016 which will provide a more up to date prognosis of stock status. This up to date survey information will be used to generate catch options and the provision of advice in October 2016.

In recent years several newer vessels specializing in *Nephrops* fishing have participated in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates. There have been concerns that effort could be displaced towards the Smalls and other *Nephrops* grounds due to effort controls in 7.a and 6.a. This has not happened to date and the 2014 effort was just below the recent average in the time-series.

There has been a trend for Irish vessels (>18 m) to switch to multi (quad) rig trawls. Provisional data suggest a ~30% increase in *Nephrops* catch rates and a reduction in fish bycatch of ~30% due to the lower headline height.

Nephrops fisheries in the Smalls have non-*Nephrops* bycatch composition. Cod, whiting and to a lesser extent haddock are the main bycatch species (Davie and Lordan, 2011). A target whiting fishery also overlaps with the *Nephrops* fishery in this area but this has negligible bycatch of *Nephrops*.

7.7.10 References

Anon. 2011. Atlas of Demersal Discarding, Scientific Observations and Potential Solutions, Marine Institute, Bord Iascaigh Mhara, September 2011. ISBN 978-1-902895-50-5. 82 pp.

Charuau A., Morizur Y., Rivoalen J.J. 1982. Survival of discarded *Nephrops norvegicus* in the Bay of Biscay and in the Celtic Sea. *ICES CM 1982/B:13.*

Davie S., Lordan C. 2011. Definition, dynamics and stability of métiers in the Irish otter trawl fleet. Fish. Res. 111, 145–158. http://dx.doi.org/10.1016/j.fishres.2011.07.005 or http://hdl.handle.net/10793/673.

Doyle, J., Lordan, C., Hehir, I., Fee, D., O'Connor, S., Browne, P. and Casserly, J. 2012. The "Smalls" *Nephrops* Grounds (FU22) 2012 UWTV Survey Report and catch options for 2013. Marine Institute UWTV Survey report. http://hdl.handle.net/10793/833.

Gerritsen H.D. and Lordan C. 2011. Integrating Vessel Monitoring Systems (VMS) data with daily catch data from logbooks to explore the spatial distribution of catch and effort at high resolution. *ICES Journal of Marine Science, 68(1)*: 245–453.

ICES. 2006. Report of the Workshop on *Nephrops* Stocks (WK*NEPH*), 24–27 January 2006, ICES Headquarters. ICES CM 2006/ACFM:12. 85 pp.

ICES. 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM: 14.

ICES. 2008. Report of the Workshop and training course on *Nephrops* burrow identification (WKNEPHBID). ICES CM 2008/LRC:03.

ICES. 2009. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2009/LRC: 15, pp 52.

ICES. 2009. Report of the Benchmark Workshop on *Nephrops* assessment (WK*NEPH*). ICES CM 2009/ACOM:33.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 012/SSGESST:19.

ICES. 2014. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 4–6 November 2014, Lisbon, Portugal. ICES CM 2014/SSGESST:20. 57 pp.

ICES. 2016XX. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

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

Lordan, C., Doyle, J., Fitzgerald, R., O'Connor, S., Blaszkowski, M., and Butler, R. 2015.The "Smalls" *Nephrops* Grounds (FU22) 2015 UWTV Survey Report and catch options for 2016. Marine Institute UWTV Survey report. http://hdl.handle.net/10793/1138.

Marrs S.J., Atkinson R.J.A., Smith C.J., Hills J.M. 1996. Calibration of the towed underwater TV technique for use in stock assessment of *Nephrops norvegicus*. Reference no. 94/069 (Study Project in support of the Common Fisheries Policy XIV/1810/C1/94, call for proposals 94/C 144/04).

Trenkel V.M., Rochet M.J. 2003. Performance of indicators derived from abundance estimates for detecting the impact of fishing on a fish community. Can. J. Fish. Aquat. Sci./J. Can. Sci. Halieut. Aquat. Vol. 60, no. 1, pp. 67–85.

Stokes, D., Gerritsen. H., O'Hea, B., Moore, S.J. and Dransfeld, L. 2014. "Irish Groundfish Survey Cruise Report, 24 September–17 December 2014", FEAS Survey Series;2014/01. http://hdl.handle.net/10793/1064.

Table 7.7.1. *Nephrops* in FU22 (Smalls Grounds). Landings in tonnes by country.

FU 22 Landings (t)					
Year	France	Rep. of Ireland	UK	Belgium	Total
1999	1,027	741	20		1,788
2000	1,186	1,687	34		2,907
2001	876	2,054	5		2,935
2002	595	1,392	3		1,990
2003	799	1,241	10		2,050
2004	465	1,330	33		1,827
2005	494	1,931	0		2,425
2006	302	1,398	52		1,752
2007	218	2,614	48		2,881
2008	312	2,474	328		3,114
2009	235	1,642	368		2,245
2010	136	2,220	351		2,708
2011	54	1,548	15		1,617
2012	65	2,509	59		2,633
2013	83	2,079	86	7	2,633
2014	29	2,443	134	8	2,615
2015	9	2258	97	5	2,368

Table 7.7.2. *Nephrops* in FU22 (Smalls Grounds). Effort data for the Irish otter trawl *Nephrops* directed fleet.

Year	Effort (Kw Days)	Landings (tonnes)
1995	551,930	1,226
1996	411,724	1,010
1997	473,822	1,096
1998	524,420	1,353
1999	292,419	620
2000	585,809	1,335
2001	788,999	1,964
2002	614,958	1,298
2003	638,990	1,000
2004	619,862	981
2005	986,292	1,882
2006	855,110	1,374
2007	1,130,765	2,677
2008	1,047,430	2,501
2009	702,412	1,605
2010	962,427	2,198
2011	723,924	1,497
2012	970,255	2,260
2013	902,073	1,849
2014	915,180	2,182
2015	970,561	2,076

Table 7.7.3. *Nephrops* in FU22 (Smalls Grounds). Landings and discards weight and numbers by year and sex.

	Female		Male		Both sexes
Year	**Landings (t)**	**Discards (t)**	**Landings (t)**	**Discards (t)**	**% Discard**
2003	504	193	886	170	21%
2004	803	60	796	44	6%
2005	1,075	692	1,289	428	32%
2006	758	307	1,080	300	25%
2007	1,041	903	2,137	738	34%
2008	976	448	2,408	358	19%
2009	645	200	2,181	249	14%
2010	1,066	245	2,015	191	12%
2011	402	34	1,129	78	7%
2012	645	114	1,864	130	9%
2013	567	160	1,514	174	14%
2014	951	219	1,493	169	14%
2015	737	94	1,522	77	7%

	Female Numbers '000s		Male Numbers '000s		Both sexes
Year	**Landings**	**Discards**	**Landings**	**Discards**	**% Discard**
2003	29,116	20,427	35,772	16,335	36%
2004	35,081	4,417	27,612	3,047	11%
2005	56,023	55,037	55,817	33,507	44%
2006	48,589	30,199	53,375	27,165	36%
2007	74,047	98,994	107,834	66,434	48%
2008	54,518	39,354	88,841	26,430	31%
2009	38,239	19,316	78,474	19,796	25%
2010	60,796	17,201	79,957	13,571	18%
2011	19,377	2,003	38,878	4,288	10%
2012	38,211	11,779	79,779	11,088	16%
2013	30,197	14,471	58,890	13,813	24%
2014	45,619	16,564	52,032	11,809	23%
2015	47,225	11,207	69,748	8,139	14%

Table 7.7.4. ***Nephrops*** **in FU22 (Smalls Grounds). Results summary table for geostatistical analysis of UWTV survey.**

Ground	Year	Number of stations	Mean Density adjusted (burrows/m²)	Area Surveyed (km²)	Domain Area (km²)	Burrow Count	Geostatistical Abundance Estimate adjusted (millions burrows)	CV on Burrow estimate
Smalls	2006	100	0.49	15	2962	10,498	1503	2%
	2007	107	0.37	16	2955	8,571	1136	6%
	2008	76	0.36	15	2698	9,411	1114	6%
	2009	67	0.36	10	2824	6,362	1093	5%
	2010	90	0.37	15	2861	8,195	1141	4%
	2011	107	0.41	15	2881	8,191	1256	3%
	2012*	47	0.49	6	2934	4,327	1498	8%
	2013*	41	0.41	7	2975	3,719	1254	7%
	2014*	52	0.53	9	2970	5,715	1622	8%
	2015*	40	0.49	4.69	3064	2,897	1363	7%

*** reduced isometric grid 4.5 nmi.**

Table 7.7.5. ***Nephrops*** **in FU22 (Smalls Grounds). Short-term catch option prediction inputs (Bold) and recent estimates of mean weight in landings and harvest rate (cells in bold indicates inputs to catch option calculations).**

Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	UWTV abundance estimate	95% Confidence Interval	Harvest rate	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	millions		%	tonnes	tonnes	gramme	gramme
2003	95.7	54.2	136.4	0.3	0.36	Na			2,050	535	21.4	9.9
2004	71.7	8.5	78.1	0.08	0.11	Na			1,828	76	25.5	8.9
2005	114.7	90.8	182.8	0.37	0.44	Na			2,425	647	21.1	7.1
2006	97.2	54.7	138.2	0.3	0.36	1503	70	9.2%	1,752	593	18	10.8
2007	164.8	149.9	277.2	0.41	0.48	1136	126	24.4%	2,880	1513	17.5	10.1
2008	131.9	60.5	177.3	0.26	0.31	1114	123	15.9%	3,114	764	23.6	12.6
2009	92.8	31.1	116.1	0.2	0.25	1093	108	10.6%	2,245	589	24.2	19
2010	129.7	28.4	151	0.14	0.18	1141	88	13.2%	2,840	439	21.9	15.5
2011	61.6	6.7	66.5	0.07	0.1	1256	72	5.3%	1,617	144	26.3	21.7
2012	123.8	24	141.8	0.13	0.16	1498	239	9.5%	2,633	256	21.3	10.7
2013	96.6	30.7	119.6	0.19	0.24	1254	177	9.5%	2,255	362	23.3	11.8
2014	104.5	30.4	127.3	0.18	0.23	1622	268	7.8%	2,615	415	25	13.7

Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	UWTV abundance estimate	95% Confidence Interval	Harvest rate	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	**millions**	**millions**	**%**	**%**	**millions**		**%**	**tonnes**	**tonnes**	**gramme**	**gramme**
2015	122.6	20.3	137.8	0.11	0.14	1363	179	10.1%	2,368	179.39732	19.3	8.8
			Avg 13–15	**16.1**	**20.3**					**Avg 03–15**	**22.2**	**12.3**

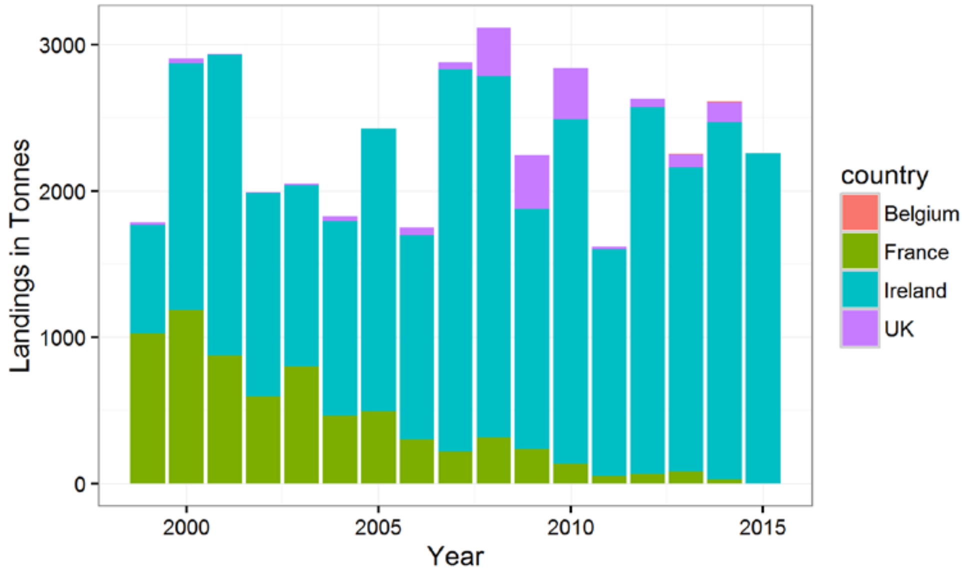


Figure 7.7.1. ***Nephrops*** **in FU22 (Smalls Grounds). Landings in tonnes by country.**

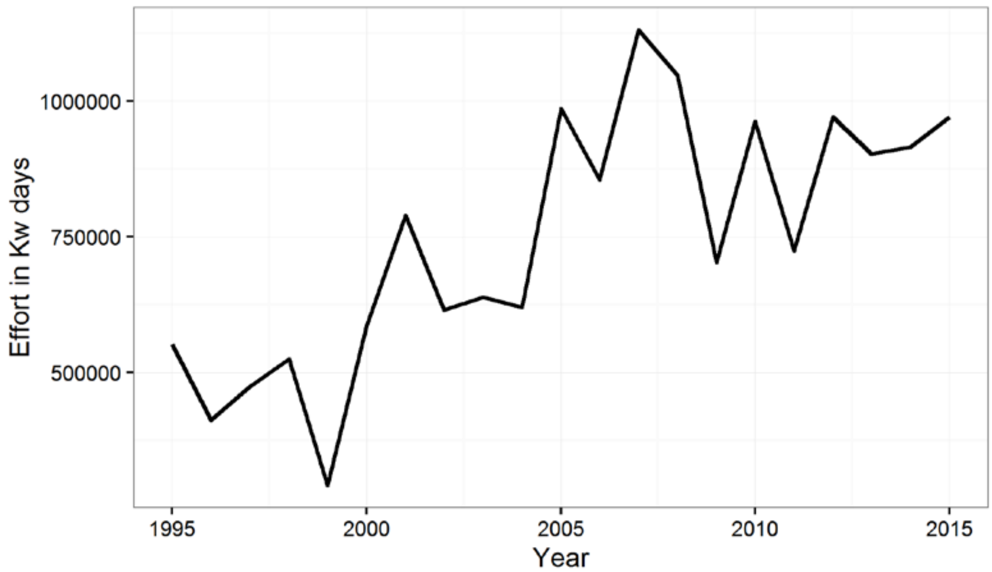


Figure 7.7.2. ***Nephrops*** **in FU22 (Smalls Grounds). Fishing effort Kw days for the Irish otter trawl** ***Nephrops*** **directed fleet (30% of** ***Nephrops*** **weight in total landings).**

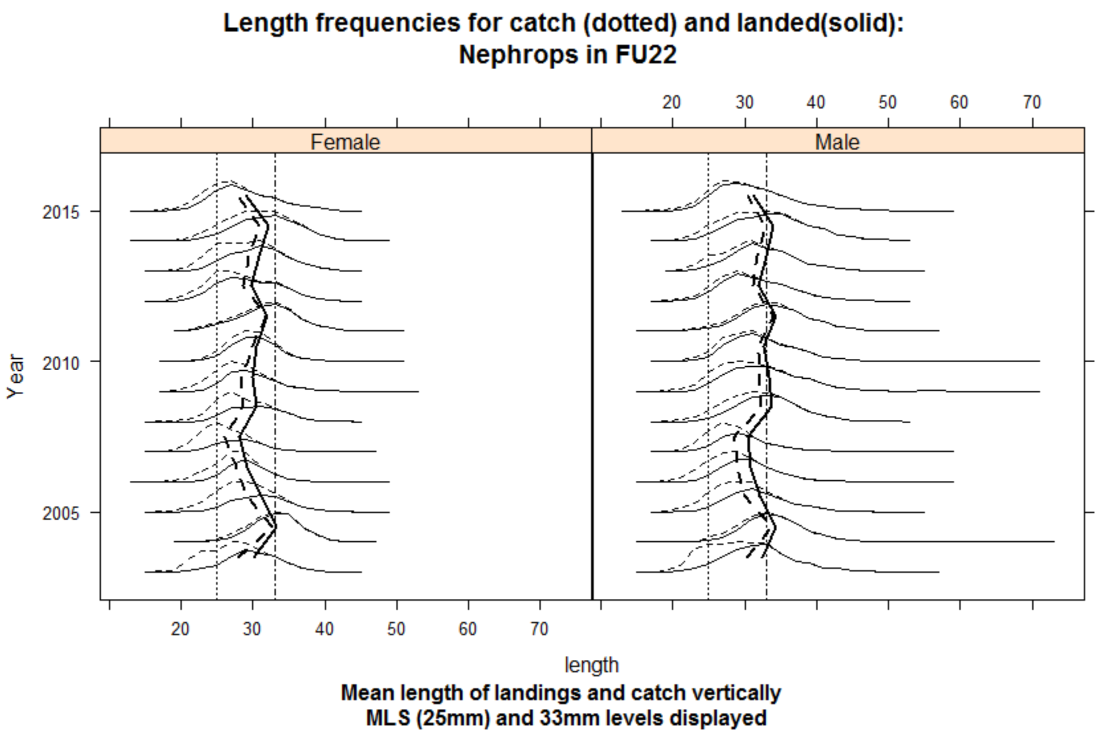


Figure 7.7.3. *Nephrops* in FU22 (Smalls Grounds). Mean size trends for catches and whole landings by sex 2003–2015.

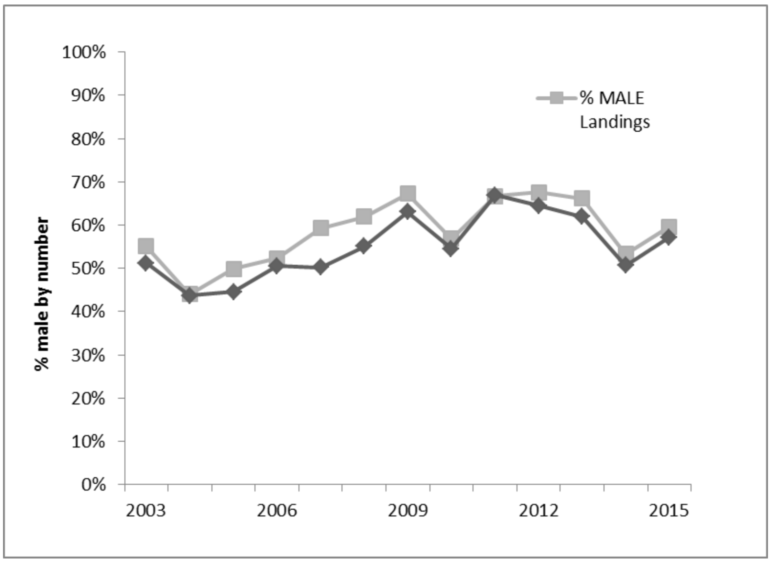


Figure 7.7.4. *Nephrops* in FU22 (Smalls Grounds). Sex ratio of landings (2003–2015) and catch (2003–2015).

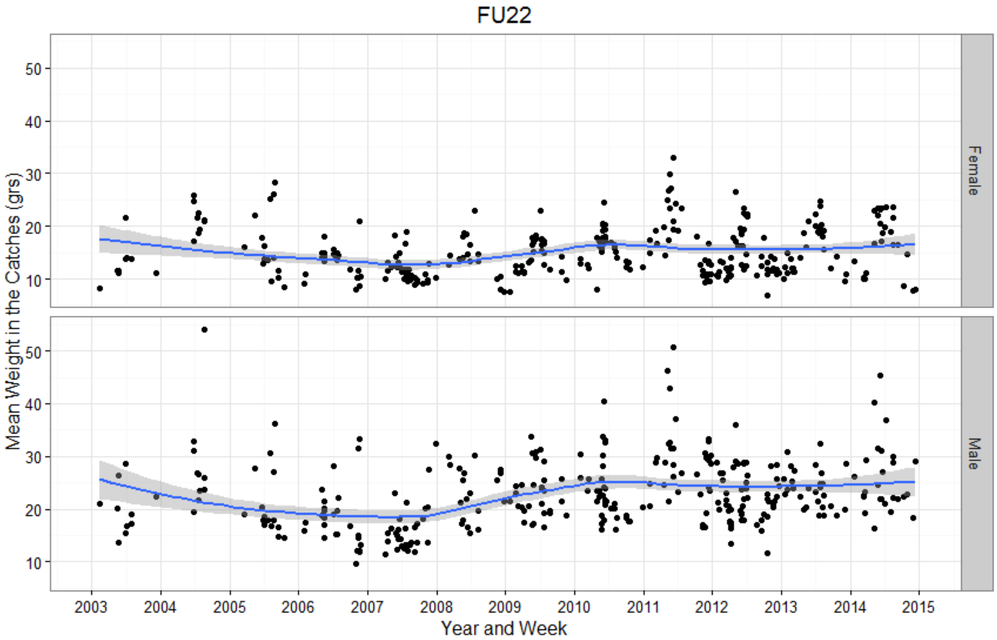


Figure 7.7.5. ***Nephrops*** **in FU22 (Smalls Grounds). Mean weight in catch samples by sex with loess smoother and showing cyclical trends.**

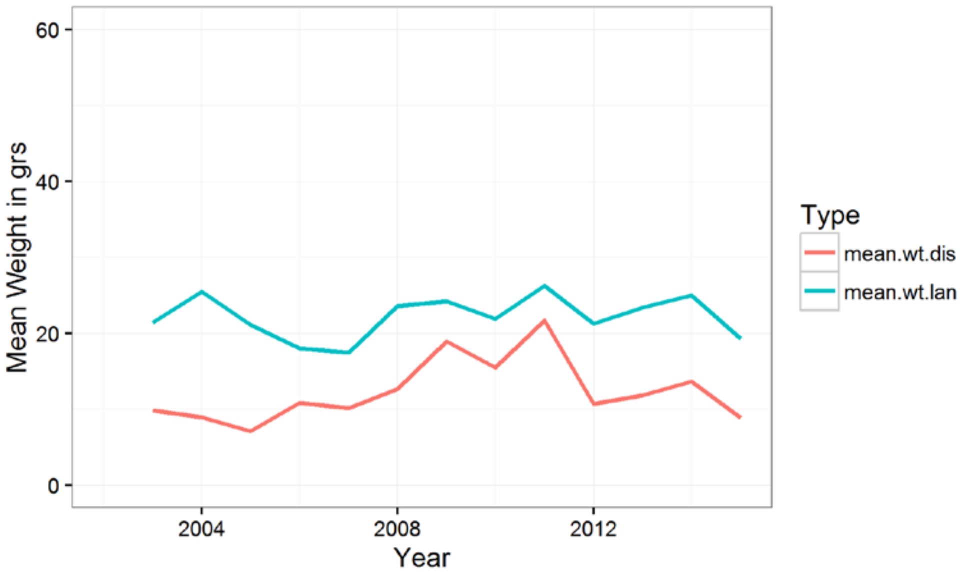


Figure 7.7.6. ***Nephrops*** **in FU22 (Smalls Grounds). Annual mean weights (gr) in the landings and discards.**

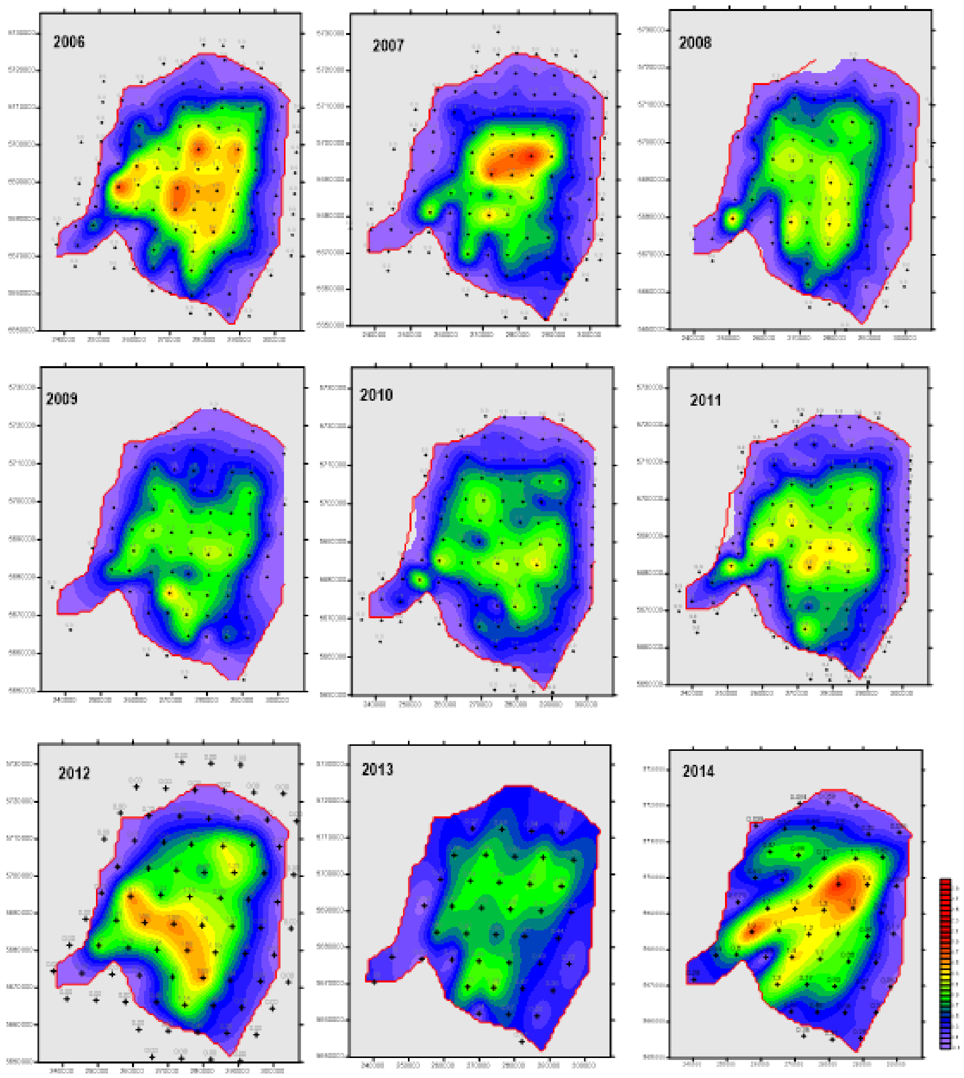


Figure 7.7.7.a. ***Nephrops*** **in FU22 (Smalls Grounds). Contour plots of the krigged density estimates for the UWTV surveys from 2006–2014.**

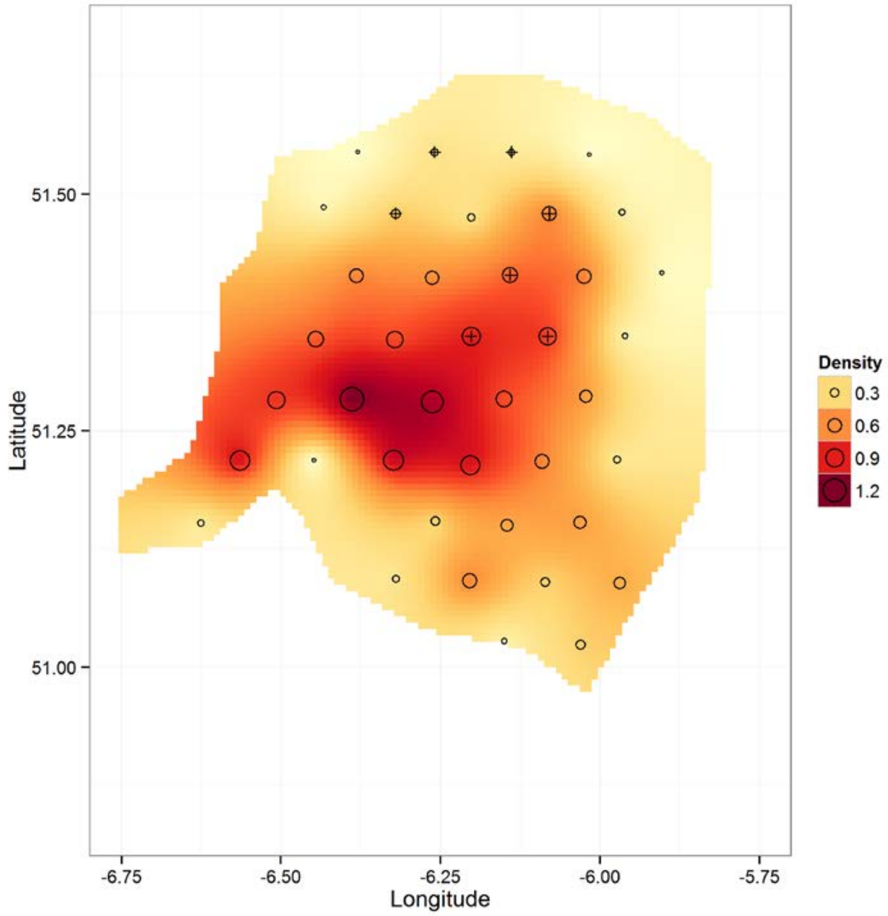


Figure 7.7.7.b. ***Nephrops* in FU22 (Smalls Grounds). Contour plots of the krigged density estimates for the 2015 UWTV survey. Stations with (+) are filled in estimates.**

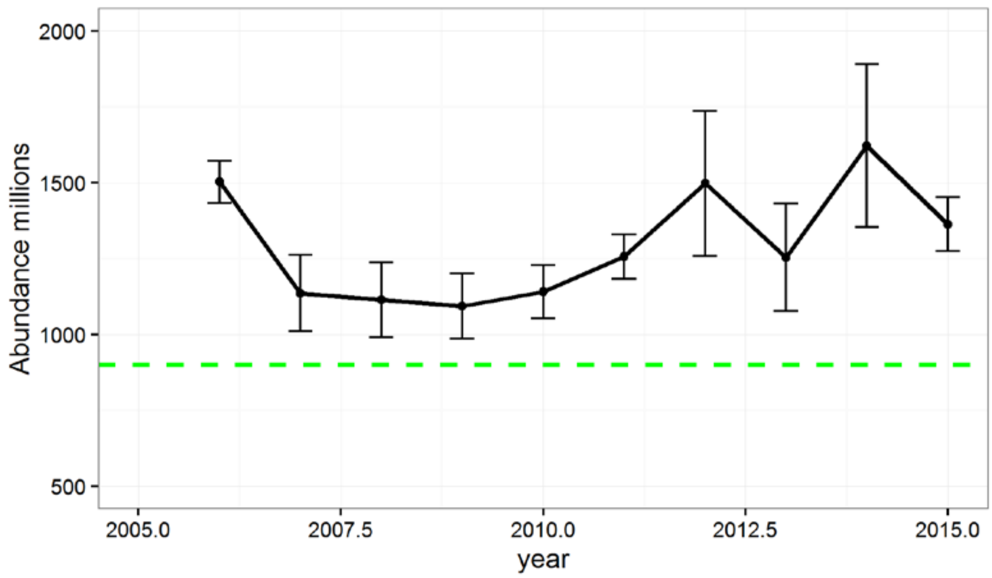


Figure 7.7.8. ***Nephrops* in FU22 (Smalls Grounds). Time-series of abundance estimates for FU22 (error bars indicate 95% confidence intervals) and $B_{trigger}$ is dashed green line.**

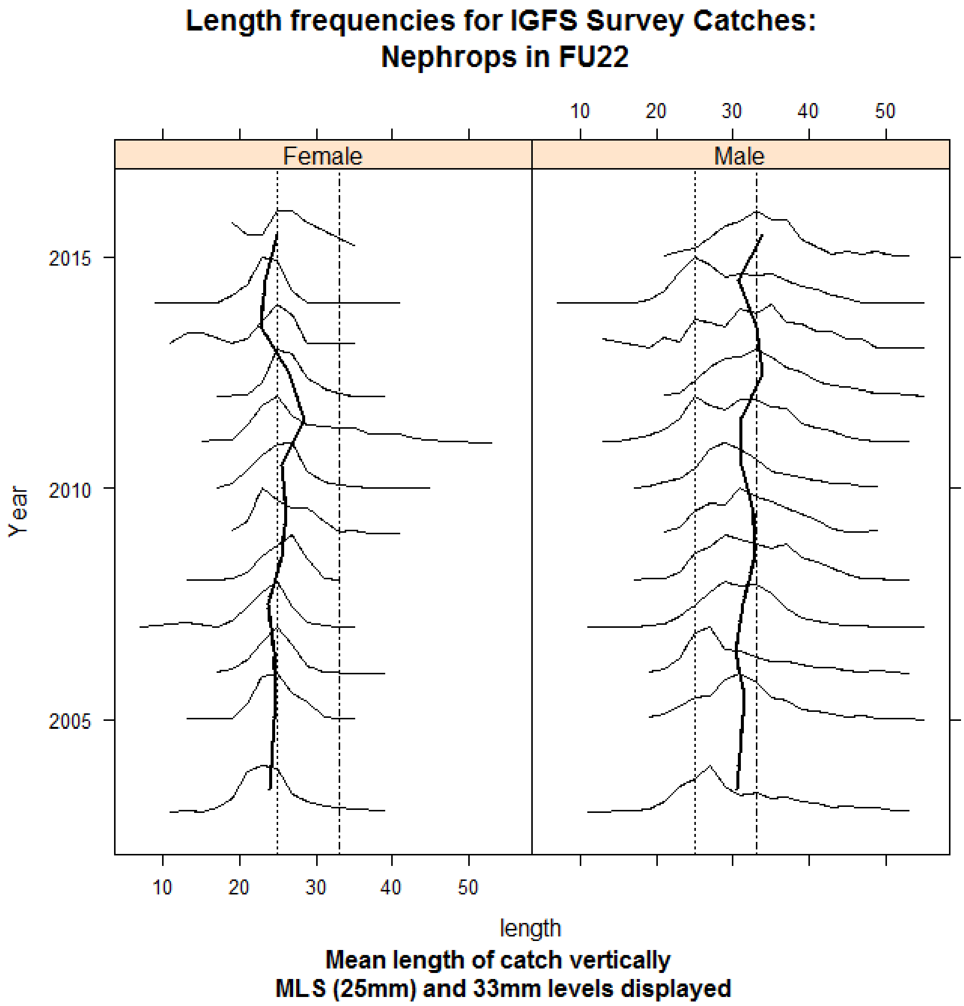


Figure 7.7.8. ***Nephrops*** **in FU22 (Smalls Grounds). Mean size trends for catches by sex from Irish Groundfish Survey 2003–2015.**

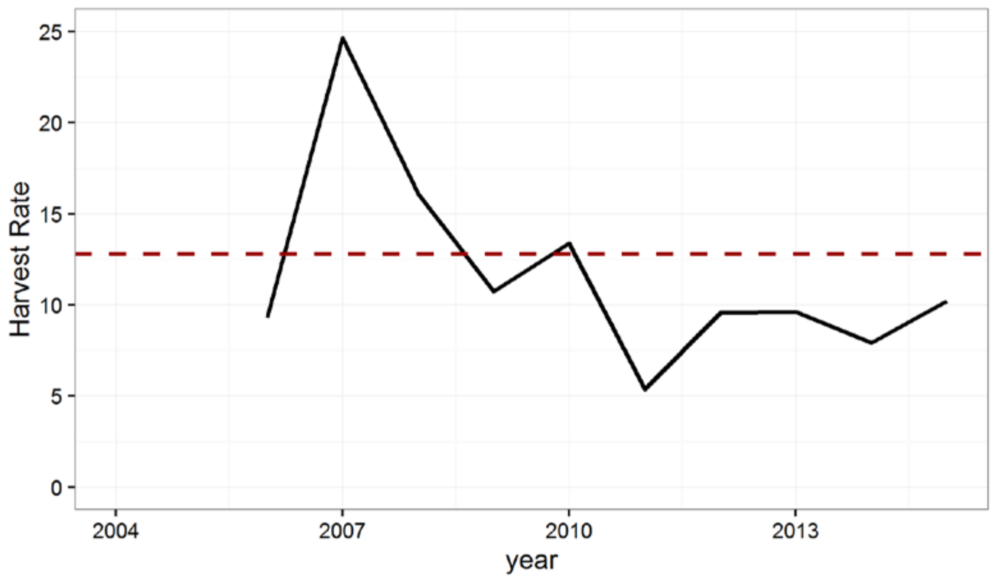


Figure 7.7.9. ***Nephrops*** **in FU22 (Smalls Grounds). Harvest Ratio (% dead removed/UWTV abundance). The dashed and solid lines are the MSY proxy and the harvest rate respectively.**

7.7.11 Audit of *Nephrops* FU22 (Smalls Grounds)

Date: 23/06/2016 Auditor: Lynda Blackadder

General

ICES provides annual landings (wanted catch) advice for this stock based on the MSY approach and advises management at the functional unit level. This stock has not been formally benchmarked by ICES. Reference points for this stock were updated at WKMSYREF4 and MSY $B_{trigger}$ was specified for the first time. Note there seems to be some discrepancy between the value in the WGCSE report and that specified in the WKMSYREF and advice? I have highlighted this to the stock assessor and chair.

For single stock summary sheet advice

1) Assessment type: Update

2) Assessment: Underwater television (UWTV) survey

3) Forecast: Not presented. Inputs for the catch options table were provided and advice will be issued in October on the basis of the 2016 UWTV survey.

4) Assessment model: Underwater television (UWTV) survey in combination with examining trends in fishery indicators to generate catch options.

5) Data issues: No

6) Consistency: The assessment is based on the same methods and similar data to last year.

7) Stock status:

- Landings in 2015 decreased by approximately 9% to 2368 tonnes.
- The survey abundance is estimated to have decreased in 2015 to 1363 million individuals but is well above the newly defined MSY $B_{trigger}$ (check for correct value, see comments below).
- The harvest rate increased in 2015 to 10.1% but is below the updated F_{MSY} of 12.8%.

8) Man. Plan.: There is no specific management plan for FU22, although ICES has repeatedly advised that management should be at the functional unit level. The 2016 UWTV survey information will be used to generate catch options and advice will be issued in October 2016.

General comments

The assessment report was well written and fully documented. All sections were clear, concise and easy to interpret.

Technical comments

The assessment report contains some minor editorial discrepancies.

- Page 4 Section 7.7.2. Recent Irish landings are closer to 2000 t than 1800 t? Belgium reported 5 t in 2015 (not 8?). It might be useful to state what the sampling levels are? Or show them in a table; they are in the stock annex so you could just reference to that table?
- In the report it states that the "MSY $B_{trigger}$ for FU22 is 937 individuals rounded to 900 million." This contrasts to The WKMSYREF4 report states

that the figure is 987 million but the advice document from that workshop states 990 million? Which is correct?

- There are two Figure 7.7.8 causing confusion. Check text for which ones should be referenced where.
- Change roman numerals to numeric for ICES areas and subareas.
- There are a few references listed which are not referenced in the report (Anon, 2011; Gerritsen and Lordan, 2011; ICES, 2006). A few references are missing from the reference list (ICES, 2010; ICES, 2013).

Stock annex

- The stock annex needs a read over as a few paragraphs mention FU17 and FU19 and it's not clear if this is simply a typo or if these paragraphs do not relate to FU22.
- Change roman numerals to numeric form ICES areas and subareas.
- Some of the links in the stock annex did not work?
- In the fishery description for the UK, it says the landings are minor but they are a lot higher than France? Maybe another sentence or two about this fleet?
- Check MSY $B_{trigger}$ value.
- The historical overview of previous assessment methods is quite long; do we need all of this detail?
- Pope and Thomas (1955) missing from reference list.

Conclusions

The assessment has been performed correctly with no deviations from the standard procedure for this stock. Advice will be issued in October 2016. There is no benchmark planned for this stock.

Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? **YES**
- Is the assessment according to the stock annex description? **YES**
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? **NA**
- Have the data been used as specified in the stock annex? **YES**
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? **YES**
- Is there any **major** reason to deviate from the standard procedure for this stock? **NO**
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? **Advice will be issued in October**.

7.8 *Nephrops* in Divisions VIIjg (South and SW Ireland, FU19)

Type of assessment in 2016

This stock was benchmarked in February 2014 and 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 (ICES, 2014). The survey is due to be repeated in the summer 2016 and the new survey will form the basis of advice for this stock in the autumn.

ICES advice applicable to 2015

"ICES advises that, on the basis of the MSY approach and considering that no discard ban is in place in 2015, landings should be no more than 715 tonnes. Assuming that discard rates do not change from the average of the last three years (2011–2013) the resulting catch would be no more than 1119 tonnes."

In order to ensure the stock in this FU is exploited sustainably, management should be implemented at the functional unit level.

ICES advice applicable to 2016

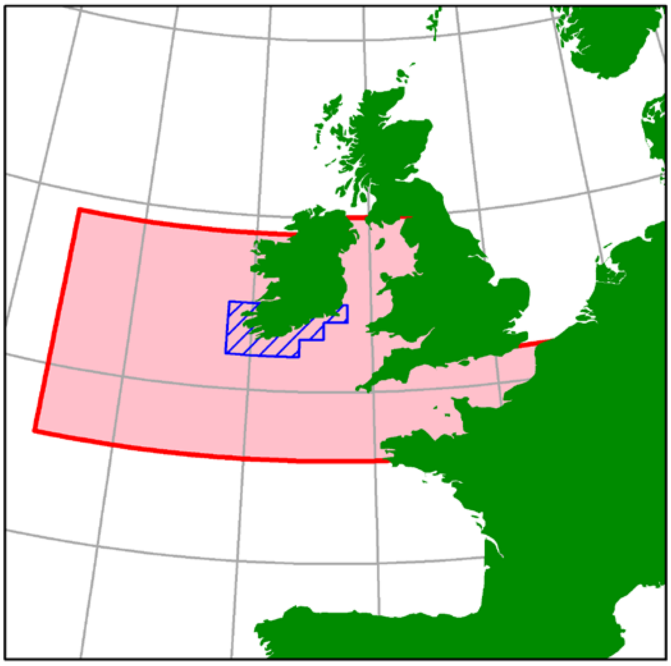
"ICES advises that when the MSY approach is applied, catches in 2016 (assuming zero discards) should be no more than 793 tonnes. If instead discard rates continue at recent values (average of 2012–2014) and there is no change in assumed discard survival rate, this implies landings of no more than 618 tonnes."

To ensure that the stock in functional unit (FU) 19 is exploited sustainably, management should be implemented at the functional unit level.

7.8.1 General

Stock description and management units

In FU19 *Nephrops* are caught on a large number of spatially discrete small inshore grounds and on some larger grounds further offshore and of these the 'Galley ground 4' and around Cork channels appear to be the most important (see Figure 7.8.8). The TAC is set for Subarea 7 (red area) which does not correspond to the stock area (FU19 in blue). There is no evidence that the individual functional units belong to the same stock. A map of the spatial distribution of FU19 is given in the Figure 7.8.7 and includes *Nephrops* within the following ICES statistical rectangles; 31–33 D9–E0; 31E1; 32E1–E2; 33E2–E3.



Ecosystem aspects

This section is detailed in stock annex. There are no updates.

Fishery description

A description of the fleet is given in the stock annex. For the Irish fleet vessels <18 m total length operate out of many local ports and fish the inshore *Nephrops* patches in periods of good emergence and weather. Irish vessels >18 m tend to fish the offshore *Nephrops* patches and target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates. The minimum mesh size in use is 80 mm. French trawlers harvesting *Nephrops* on this area fish also in the Celtic Sea (FU22 and FU20–21) and switch to the FU19 according to meteorological conditions. They have used mesh size 100 mm for codend since January 2000 (in order to not be constrained by bycatch composition) and they apply MLS of 11.5 cm (i.e. 35 mm CL) adopted by French Producers' Organizations larger than the European one (8.5 cm i.e. 25 mm CL).

Fishery in 2015

The number of Irish vessels reporting landings in this area has increased from 28 in 2000 to 102 in 2015. Of these, 28 vessels (<18 m) reported landings in excess of 10 t. There has been a trend for Irish vessels (>18 m) to switch to multi (quad) rig trawls. Provisional data suggests a ~30% increase in *Nephrops* catch rates and a reduction in fish bycatch of ~30% due to the lower headline height. The number of French vessels reporting landings in FU19 has decreased from 35 vessels in 2005 to six vessels in 2015.

Information from stakeholders

None available.

7.8.2 Data

InterCatch

All data were available in InterCatch and used on a trial basis.

Landings

Landings data for FU19 are summarized in Table 7.8.1. The Republic of Ireland, France and the UK report landings for FU19. The Republic of Ireland landings have fluctuated considerably throughout the time-series, with a marked dip in 1994 (Table 7.8.1; Figure 7.8.1). The highest landings in the time-series were observed in 2002–2004 (>1000 t). Landings in 2005 and 2006 have been below average for the series. In 2015 landings increased by approximately 8% for the Irish fleet and were below the series average. This can be explained due to the poor weather conditions in quarter 1 which hampered fishing activities of smaller vessels and the larger vessels maximising effort in other FUs. Landings by the French fleet have fluctuated with a declining trend throughout the time-series from the highest value in 1989 of 245 t to 5 t in 2015. Landings from the UK are minor at less than 0.25 t.

Effort

In line with WGCSE 2015 recommendation effort is reported in KWdays and lpue reported in KG/kwdays in the knowledge that the trend is likely to be a biased underestimate because it is not adjusted for efficiency or behavioural changes. The effort series is based on the same criteria for FU15, 16, 17, 22 and 20–21 (30% landings threshold) and will be contingent on the accuracy of landings data reported in logbooks.

Disaggregated effort and landings data are available for the Irish *Nephrops* directed fleet in FU19 from 1995–2015 for all vessels and vessels >18 metres total length. (Table 7.8.2; Figure 7.8.2). For vessels >18 effort (since early 2000s) has fluctuated with an overall decreasing trend in recent three years. This can be explained by fleet mobility where vessels target *Nephrops* in this area in periods of good emergence. For vessels <18 effort has decreased in 2015 due to weather conditions.

A time-series of landings by all FUs in ICES Subarea 7 together with the overall TAC is shown in Table 7.8.9. (Note that national quotas for Ireland and the UK are restrictive in most of the recent years).

Sampling levels

The sampling levels in 2015 were good for this FU are given in the stock annex.

Commercial length–frequency distributions

Length–frequency data of the landings were collected on a regular basis 2002 to 2015. Spatial and temporal coverage is problematic with landings from FU19 coming from several discrete grounds (see stock annex.) The sampling intensity and coverage has varied over the time-series (see stock annex). Since 2008 sampling has been good although the majority of the samples come from Bantry Bay recently. Also sampling of the discards has quite sparse over the time-series and are difficult to obtain due to the spatial coverage of the grounds. The catch samples from 2008 to 2015 were split using the discard selection ogive agreed at the benchmark. The length–weight regression parameters given in the stock annex are used to calculate sampled weights and appropriate quarterly raising factors. The length distributions are shown in Figure 7.5.3.

Trends in the mean size (revised since 2008) shows no significant difference to previous values. The catches of males varies from 30 to 36 mm CL, and for females between 28 and 33 mm CL and the mean size has remained relatively stable and the trend in mean size is stable in recent years.

Sex ratio

The sex ratio in the landings is male biased in most years but there is a trend towards increased percentage of females in the landings (Figure 7.8.4). The proportion of females was higher in 2013 and this was confirmed by the industry.

Mean weight explorations

Explorations of the mean weight in the catch samples by sex shows a strong cyclical pattern in the females (Figures 7.8.5 and 7.8.6). This corresponds with the emergence of mature females from the burrows to mate in summer. Figure 7.8.7 shows there is an increase in mean weights for both sexes. The annual mean weight estimate for landings and discards is shown in Figure 7.5.9. The mean weight estimates show a slight increase.

Discarding

Sampling of the discards has quite sparse over the time-series and are difficult to obtain due to the spatial coverage of the grounds (see stock annex). Since 2002 discard rates have been estimated using unsorted catch and discards sampling (as described in the stock annex). WKCELT 2014 examined the available discard data observations for FU19. An average discard selection ogive using data from Bantry Bay in years 2008 and 2013 was generated and deemed appropriate given the variable sampling intensity and coverage. The catch data from 2008 to 2013 was then revised and split into landings and discards. Catch data sampling for years previous to 2008 was not revised as was considered to be not of good enough quality. The 2015 catch data were split using this selection ogive.

Discard rates range between 26–86% of total catch by weight and 41–80% of total catch by number (Table 7.8.3). These high discard rates are very high compared with other FUs. This is because the fleet is mainly smaller inshore vessels with limited space for extra crew. On-board "tailing" of the smaller *Nephrops* is not usually practiced and the bigger *Nephrops* are picked from catches. There is no information on discard survival rate in this fishery but a 25% discard survival rate is assumed in line with other *Nephrops* stocks in the Celtic sea.

Abundance indices from UWTV surveys

The methods used during the survey were similar to those employed for UWTV surveys of *Nephrops* stocks around Ireland and elsewhere and are documented by WKNEPHTV (ICES, 2007), SGNEPS (ICES, 2009, 2010, 2012) and WGNEPS (ICES, 2013, 2014). Given the scale of the area and the number of distinct patches it is unrealistic to expect sufficient stations (~10) in each individual patch to estimate densities separately. The random stratified approach may cause problems in years where the planned survey coverage is not achieved. WKCELT 2014 concluded that WGCSE or WGNEPS should make recommendations on the most appropriate fill in procedure to be adopted in these cases.

The spatial extent of the *Nephrops* grounds in FU19 has been re-defined by WKCELT 2014 and the abundance estimates are calculated using these areas. The redefinition of the polygons in FU19 resulted in ~16% increase in overall area from 1653 km² to 1973 km² (see stock annex). The discrete grounds have been named as: Bantry Bay, Galley Ground 1–4, Cork Channels and Helvick 1–2 and are shown in Figure 7.8.8. In terms of area the Galley Grounds (1–4) account for 61% of the total grounds in FU19 and Galley Ground 4 is the largest of these representing 47% of the total area (Table 7.8.4). Helvick patches 2 and 3 were also amalgamated and renamed Helvick 2 based on the information from the VMS data.

From 2011 to 2015 an average of 38 stations have been completed annually. The survey design is based on randomly picked stations from the ground polygons and the sampling effort on each ground was determined by relative area.

All grounds except Galley Ground 4 in 2011 and Galley Ground 1 in 2012 were covered by the TV survey. In 2015 a new patch Kenmare Bay was surveyed, Operational details of the 2015 UWTV survey are available (Lordan *et al*., 2015).

Detailed summary statistics for the various *Nephrops* patches in FU19 over the time-series are presented in Table 7.8.5. The mean density varies across the different patches but there is some consistency to the estimates over time. The UWTV coverage has improved. In 2015 all discrete grounds were covered by the TV survey and also one station on a new patch Kenmare Bay (Lordan *et al.,* 2015). The 2015 mean density estimates adjusted vary between patches from 0.08 (no./m²) observed at Cork Channels to 0.53 (no./m²) at Galley ground 2 (Table 7.8.5, Figure 7.8.9) whereas in 2014 the lowest density was also observed at Helvick 2 (0.03 no./m²) and the highest at Galley ground 2 (0.82 no./m²). The overall mean density for FU19 in 2015 is 0.24 (no./m²) (Figure 7.8.10). The 2015 abundance estimate adjusted is 482 million individuals with a RSE of 13% which is below the 20% limit recommended by SGNEPs (2012).

Information from Irish Groundfish survey

Length–frequency data of the *Nephrops* catches on the Irish groundfish survey (IGFS-WIBTS-Q4) from 2003–2015 are available (Stokes *et al.,* 2014). These data were investigated for trends in indicators such as possible recruitment signals(Figure 7.8.11). The mean size of males and females in from the survey was fairly stable over time at 33 mm for males and 25 mm for females.

7.8.3 Assessment

The WGCSE 2016 carried out an UWTV based assessment for this stock. The methods used were very much in line with WK*NEPH* (ICES, 2009) and the approach taken for other *Nephrops* stocks in VI and VII by WGCSE. This approach was benchmarked at WKCELT 2014 (ICES, 2014).

Comparison with previous assessments

The assessment is based on the same methods and similar data as used in 2015 and outlined in stock annex. This approach was benchmarked at WKCELT (ICES, 2014).

State of the stock

UWTV abundance estimates suggest that the stock size has fluctuated although the series is quite short. The 2015 estimate is the lowest observed and is above the MSY $B_{trigger}$. The 2015 abundance remains below the average of the series (geomean: 567 million).

Table 7.8.8 summarizes recent abundance estimates, harvest rates for the stock along with other stock parameters. Harvest rate is calculated as (landings + dead discards)/(abundance estimate). The abundance is estimated to have decreased in 2015 and the harvest rate is below the F_{MSY} harvest rate of 9.3% which was defined by WKMSYRef4 see Section 7.8.5 and Figure 7.8.12.

7.8.4 Catch option table

Catch option table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 7.8.8 and summarised below.

The basis for the catch options.

VARIABLE	VALUE	SOURCE	NOTES
Stock abundance	Available October 2016	ICES (2016a)	UWTV survey 2016
Mean weight in landings	28.6 g	ICES (2016a)	Average 2013–2015
Mean weight in discards	13.3 g	ICES (2016a)	Average 2013–2015
Discard rate	46%	ICES (2016a)	Average 2013–2015 (by number). Calculated as discards divided by landings + discards.
Discard survival rate	25%	ICES (2016a)	Only applies in scenarios where discarding is allowed.
Dead discard rate	39.1%	ICES (2016a)	Average 2013–2015 (by number). Calculated as dead discards divided by removals (landings + dead discards). Only applies in scenarios where discarding is allowed.

A prediction of landings for the FU19 using the approach agreed procedure proposed at WK*NEPH* 2009 and outlined in the stock annex will be made on the basis of the 2016 UWTV survey. This will be presented in October 2016 for the provision of advice.

7.8.5 Reference points

WKMSYRef4 updated the F_{MSY} reference points for FU19 (ICES, 2016XX, 2016YY) on the basis of an average of estimated F_{MSY} proxy harvest rates over a period of years, this corresponds more closely to the methodology for finfish. The updated harvest rate calculated at 9.3% is expected to deliver high long-term yield with a low probability of recruitment overfishing. This is close to the harvest rate of 8.1% calculated by WKCELT (ICES, 2014)

This stock previously did not have MSY $B_{trigger}$ specified, the time-series and range of indicator biomass is also limited such that direct use of B_{loss} is considered too close to equilibrium biomass. The workshop proposed to use the 5% interval on the probability distribution of indicator biomass assuming a normal distribution, which is analogous to the 5% on B_{MSY} proposed for finfish stocks assuming these *Nephrops* FU have been exploited at a rate close to near HR_{MSY}. The MSY $B_{trigger}$ for FU 19 is 434 million individuals rounded to 430 million.

These reference points shown in text table below should remain under review by WGCSE.

STOCK CODE	MSY FLOWER*	FMSY*	MSY FUPPER* WITH AR	MSY BTRIGGER	MSY FUPPER* WITH NO AR
nep-19	8.3%	9.3%	9.3%	430***	9.3%

*** Harvest rate (HR).**

***** Abundance in millions.**

7.8.6 Management strategies

No specific management plan exists for this stock.

7.8.7 Quality of assessment and forecast

There are several key uncertainties and bias sources in the method used here (these are discussed further in WK*NEPH* 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007; WKNEPHBID 2008; SGNEPS 2009, WGNEPS 2014). Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates (Marrs *et al.*, 1996). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that is more accurate, although no more precise WK*NEPH* (ICES, 2009). Different densities are apparent on the various different grounds within this FU. For the 2015 survey the number of observations on each individual patch is relatively low making the relative standard error (RSE) estimates not that relevant. Aggregating all areas together gives a mean burrow density of 0.24 with a RSE of around 13% which is below the 20% threshold recommended by SGNEPS (ICES, 2012). The cumulative bias estimates for FU19 are largely based on expert opinion. The precision of these bias corrections cannot yet be characterized, but is likely to be lower than that observed in the survey.

In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. For FU19 deterministic estimates of the mean weight in the landings and discard rates for 2013–2015 are used although there is some variability of these over time.

The quality of landings data is thought to be good and sampling and discard estimates have improved over the time-series.

7.8.8 Recommendations for next benchmark

This stock was benchmarked by ICES in February 2014 (ICES, 2014). WGCSE will keep the stock under close review and recommend future benchmark as required.

7.8.9 Management considerations

The trends from the fishery (landings, effort, mean size, etc.) appear to be relatively stable. The UWTV abundance and mean density estimates vary between the discrete patches and population dynamics between these are not fully understood. A new survey point should be available by September 2016 which will provide a more up to date prognosis of stock status. This up to date survey information will be used to generate catch options and the provision of advice in October 2016.

In recent years several newer vessels specializing in *Nephrops* fishing have participated in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates. Since the introduction of effort management associated with the cod long-term plan (EC 1342/2008) there have been concerns that effort will be displaced towards FU19 and other *Nephrops* grounds where effort control has not been put in place.

Nephrops fisheries in this area are fairly mixed also catching megrim, anglerfish and other demersal species. There are also some catches of hake, and in the offshore parts of the area. The *Nephrops* grounds in FU19 coincide with an important nursery area for juvenile hake and anglerfish among other species (ICES, 2009).

7.8.10 References

Anon. 2011. Atlas of Demersal Discarding, Scientific Observations and Potential Solutions, Marine Institute, Bord Iascaigh Mhara, September 2011. ISBN 978-1-902895-50-5. 82 pp.

Gerritsen, H.D. and Lordan, C. 2011. Integrating Vessel Monitoring Systems (VMS) data with daily catch data from logbooks to explore the spatial distribution of catch and effort at high resolution. ICES Journal of Marine Science, 68(1): 245–453.

ICES. 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM:14.

ICES. 2008. Report of the Workshop and training course on *Nephrops* burrow identification (WKNEPHBID). ICES CM 2008/LRC:03.

ICES. 2009. Report of the Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM 2009/ACOM:33.

ICES. 2012. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 012/SSGESST:19.

ICES. 2013. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 5–8 November 2013, Barcelona, Spain. ICES CM 2013/SSGESST:21. 27 pp.

ICES. 2014. Report of the Benchmark Workshop on Celtic Sea stocks (WKCELT), 3–7 February 2014, ICES Headquarters, Copenhagen, Denmark. ICES CM 2014\ACOM:42. 194 pp.

ICES. 2014. Report of the Working Group on *Nephrops* Surveys (WGNEPS), 4–6 November 2014, Lisbon, Portugal. ICES CM 2014/SSGESST:20. 57 pp.

ICES. 2016XX. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

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

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

Lordan, C., Doyle, J., Fitzgerald, R., O'Connor, S., Blaszkowski, M., Stokes, D., Ni Chonchuir, G., Gallagher, J., Butler, R., Sheridan, M. and Simpson, S. 2015. FU19 *Nephrops* grounds 2015 UWTV Survey report and catch options for 2016. Marine Institute UWTV Survey report. http://hdl.handle.net/10793/1096.

Marrs S.J., Atkinson R.J.A., Smith C.J., Hills J.M. 1996. Calibration of the towed underwater TV technique for use in stock assessment of *Nephrops norvegicus*. Reference no. 94/069 (Study Project in support of the Common Fisheries Policy XIV/1810/C1/94, call for proposals 94/C 144/04).

Stokes, D., Gerritsen. H., O'Hea, B., Moore, S.J. and Dransfeld, L. 2014. "Irish Groundfish Survey Cruise Report, 24 September–17 December 2014", FEAS Survey Series; 2014/01. http://hdl.handle.net/10793/1064 Table 7.8.1. *Nephrops* in FU19 (NW, SW and SE Ireland). Landings in tonnes by country.

Table 7.8.1. *Nephrops* in FU19 (SW and SE Ireland). Landings in tonnes by country.

Year	FU 19			
	France	Rep. of Ireland	UK	Total
1989	245	652	2	899
1990	181	569	4	754
1991	212	860	5	1077
1992	233	640	15	888
1993	229	672	4	905
1994	216	153	21	390
1995	175	507	12	695
1996	145	736	7	888
1997	93	656	7	756
1998	92	733	2	827
1999	77	499	3	579
2000	144	541	11	696
2001	111	702	2	815
2002	188	1130	0	1318
2003	165	1075	0	1239
2004	76	997	1	1074
2005	62	648	2	711
2006	65	675	1	741
2007	63	894	0	957
2008	46	805	15	866
2009	55	764	15	833
2010	14	694	13	722
2011	23	585	1	608
2012	11	758	1	770
2013	4	771	6	781
2014	6	459	3	468
2015	5	502	0	507

Table 7.8.2. *Nephrops* in FU19 (SW and SE Ireland). Irish *Nephrops* directed effort (Kw Days) and landings 1995–2015.

YEAR	IRISH FLEET - *NEPHROPS* TRAWLERS (>30% LANDINGS WEIGHT)			
	All Vessels		Vessels >18 m	
	Effort Kw Days	Landings Tonnes	Effort Kw Days	Landings Tonnes
1995	221,983	380	80,747	121
1996	178,640	355	55,593	86
1997	160,996	306	53,874	101
1998	329,624	498	144,552	189
1999	182,895	236	42,316	47
2000	141,987	217	56,157	86
2001	193,345	397	89,138	139
2002	506,728	883	323,726	446
2003	555,871	693	318,793	364
2004	488,143	558	303,025	311
2005	404,965	471	220,589	219
2006	424,189	478	208,822	186
2007	558,838	713	287,410	262
2008	534,101	643	288,083	319
2009	471,984	613	224,503	243
2010	382,164	494	103,654	114
2011	337,328	449	142,898	167
2012	355,468	541	91,897	126
2013	336,133	571	88,553	133
2014	213,561	332	52,124	74
2015	244,554	393	85,536	118

Table 7.8.3. *Nephrops* in FU19 (SW and SE Ireland). Landings and discard weight and numbers by year and sex.

	Female		Male		Both sexes
Year	Landings (t)	Discards (t)	Landings (t)	Discards (t)	% Discard
2008	99	29	691	68	86%
2009	117	106	681	141	79%
2010	138	98	522	148	74%
2011	155	135	425	235	69%
2012	180	183	579	232	69%
2013	272	203	500	197	59%
2014	106	71	354	86	26%
2015	78	69	424	107	26%

	Female Numbers '000s		Male Numbers '000s		Both sexes
Year	Landings	Discards	Landings	Discards	% Discard
2008	3892	1777	19 520	3254	80%
2009	5816	8248	20 324	8793	39%
2010	6271	8144	15 996	10 116	45%
2011	7273	12 161	15 935	17 167	56%
2012	8670	15 869	20 129	16 654	53%
2013	12 087	17 833	16 118	15 191	54%
2014	4,862	5,647	11,183	5,572	41%
2015	3,697	5,738	13,187	7,012	43%

Table 7.8.4. *Nephrops* in FU19 (SW and SE Ireland). Area (Km²) of discrete patches and percentage contribution to overall area.

Ground	Area (Km²)	% Contribution
Bantry	121.5	6%
Cork Channels	562.0	28%
Galley Grounds 1	60.9	3%
Galley Grounds 2	76.7	4%
Galley Grounds 3	133.9	7%
Galley Grounds 4	925.1	47%
Helvick 1	33.1	2%
Helvick 2	59.5	3%
Total	1972.8	

Table 7.8.5. *Nephrops* in FU19 (SW and SE Ireland). Detailed summary statistics for the various *Nephrops* patches in FU19 over the time-series. (N = number of stations, Mean Density (no/m²) is adjusted for the bias correction factor in Table 3, sd, se and ci are the standard deviation, standard error and 95% confidence intervals on the mean density).

YEAR	GROUND	N	MEAN DENSITY (NO/M²)	SD	SE	CI
2006	Galley Grounds 4	6	0.21	0.18	0.08	0.19
2011	Bantry	5	0.33	0.23	0.1	0.28
2011	Cork Channels	12	0.35	0.32	0.09	0.2
2011	Galley Grounds 1	3	0.52	0.41	0.24	1.02
2011	Galley Grounds 2	3	0.59	0.43	0.25	1.07
2011	Galley Grounds 3	4	0.58	0.22	0.11	0.35
2011	Helvick 1	3	0.6	0.01	0.01	0.04
2011	Helvick 2	5	0.12	0.21	0.09	0.26
2012	Bantry	1	0.2	NA	NA	NA
2012	Cork Channels	9	0.27	0.17	0.06	0.13
2012	Galley Grounds 2	4	0.59	0.12	0.06	0.19
2012	Galley Grounds 3	1	0.51	NA	NA	NA
2012	Galley Grounds 4	16	0.39	0.16	0.04	0.09
2012	Helvick 1	3	0.33	0.13	0.08	0.33
2012	Helvick 2	6	0.33	0.41	0.17	0.43
2013	Bantry	4	0.38	0.2	0.1	0.31
2013	Cork Channels	11	0.12	0.1	0.03	0.07
2013	Galley Grounds 1	2	0.23	0.18	0.13	1.59
2013	Galley Grounds 2	3	0.48	0.44	0.25	1.09
2013	Galley Grounds 3	4	0.59	0.24	0.12	0.38
2013	Galley Grounds 4	13	0.19	0.27	0.07	0.16
2013	Helvick 1	1	0.09	NA	NA	NA
2013	Helvick 2	2	0.06	0.05	0.04	0.48
2014	Bantry	4	0.25	0.05	0.03	0.09
2014	Cork Channels	10	0.1	0.06	0.02	0.04
2014	Galley Grounds 1	2	0.61	0.41	0.29	3.69
2014	Galley Grounds 2	2	0.82	0.14	0.1	1.23
2014	Galley Grounds 3	4	0.66	0.23	0.12	0.37
2014	Galley Grounds 4	14	0.29	0.29	0.08	0.17
2014	Helvick 1	2	0.67	0.28	0.2	2.53
2014	Helvick 2	2	0.03	0.04	0.03	0.39
2015	Bantry	2	0.32	0.11	0.08	1.02
2015	Cork Channels	10	0.08	0.11	0.03	0.08
2015	Galley Grounds 1	2	0.32	0.46	0.32	4.12
2015	Galley Grounds 2	2	0.53	0.08	0.06	0.74
2015	Galley Grounds 3	4	0.40	0.14	0.07	0.23
2015	Galley Grounds 4	14	0.27	0.19	0.05	0.11
2015	Helvick 1	2	0.30	0.23	0.16	2.08
2015	Helvick 2	2	0.09	0.09	0.06	0.79
2015	Kenmare Bay	1	0.30	NA	NA	NA

Table 7.8.6. *Nephrops* in FU19 (SW and SE Ireland). Forecast inputs (bold) and historical estimates of mean weight in landings and harvest rate (landings + dead discards)/(abundance estimate), discard rate (discards divided by landings + discards) and dead discard rate as dead discards divided by removals (landings + dead discards).

Year	Landings in number	Total discards* in number	Removals in number	Discard Rate number	Dead discard rate number	UWTV abundance estimate	95% Conf. intervals	Harvest rate	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	millions	millions	%	tonnes	tonnes	grammes	grammes
2006	26.2	2.6	28.1	9%	7%	na	na	na	741	37	28.3	14.4
2007	30.8	1.5	31.9	5%	4%	na	na	na	957	26	31.1	17
2008	25.7	5.5	29.8	18%	14%	na	na	na	866	107	33.7	19.3
2009	27.3	17.8	40.6	39%	33%	na	na	na	833	258	30.5	14.5
2010	24.4	20	39.3	45%	38%	na	na	na	722	269	29.6	13.5
2011	24.3	30.7	47.3	56%	49%	665	171	7.10%	608	387	25	12.6
2012	29.2	33	54	53%	46%	594	111	9.10%	770	420	26.4	12.7
2013	28.5	33.4	53.6	54%	47%	487	161	11.00%	781	404	27.4	12.1
2014	16.4	11.4	24.9	41%	34%	636	188	3.90%	468	161	28.6	14.1
2015	17.0	12.9	26.7	43%	36%	482	126	5.5%	507	177	29.8	13.8
			Avg 13–15	**46%**	**39%**					**Avg 13–15**	**28.6**	**13.3**

Table 7.8.7. *Nephrops* in VII summary table of landings by Function Unit and outside FU for TAC Area 7.

Year	FU 14 Irish Sea East	FU 15 Irish Sea West	FU 16 Porcupine Bank	FU 17 Aran Grounds	FU 18 Ireland NorthWest Coast	FU 19 Ireland SouthWest and SouthEast coast	FU 20-21 Labadie, Jones, Cockburn	FU 22 Smalls Grounds	FUs 20+21+22 All Celtic Sea FUs combined	Other statistical rectangles Outside FUs	Total Landings ICES Subarea VII	TAC for VII
1978	961	7,296	1,744	481						249	10,730	
1979	900	8,948	2,269	452						237	12,807	
1980	730	4,578	2,925	442						205	8,880	
1981	829	7,249	3,381	414						382	12,255	
1982	869	9,315	4,289	210						234	14,917	
1983	763	9,448	3,426	131					3,667	174	17,609	
1984	602	7,760	3,571	324					3,653	187	16,097	
1985	498	6,901	3,919	207					3,599	194	15,317	
1986	671	9,978	2,591	147					2,638	113	16,138	
1987	449	9,753	2,499	62					3,409	107	16,279	24,700
1988	462	8,586	2,375	828					3,165	140	15,557	24,700
1989	401	8,128	2,115	344		899			4,005	134	16,026	26,000
1990	563	8,300	1,895	519		754			4,290	102	16,423	26,000
1991	747	9,554	1,640	410		1,077			3,295	169	16,892	26,000
1992	427	7,541	2,015	372		888			4,165	409	15,816	20,000
1993	515	8,102	1,857	372	10	905			4,648	455	16,863	20,000
1994	447	7,606	2,512	729	126	390			5,143	570	17,523	20,000
1995	584	7,796	2,936	866	26	695			5,505	397	18,805	23,000
1996	475	7,247	2,230	525	46	888			4,828	623	16,862	23,000
1997	566	9,971	2,409	841	15	756			4,240	340	19,138	23,000

YEAR	FU 14 IRISH SEA EAST	FU 15 IRISH SEA WEST	FU 16 PORCUPINE BANK	FU 17 ARAN GROUNDS	FU 18 IRELAND NORTHWEST COAST	FU 19 IRELAND SOUTHWEST AND SOUTHEAST COAST	FU 20-21 LABADIE, JONES, COCKBURN	FU 22 SMALLS GROUNDS	FUS 20+21+22 ALL CELTIC SEA FUS COMBINED	OTHER STATISTICAL RECTANGLES OUTSIDE FUS	TOTAL LANDINGS ICES SUBAREA VII	TAC FOR VII
1998	388	9,128	2,155	1,410	78	827			3,925	514	18,426	23,000
1999	624	10,786	2,289	1,140	16	579	1,152	1,788		322	18,699	23,000
2000	567	8,370	910	880	9	696	1,778	2,907		243	16,361	21,000
2001	532	7,441	1,222	913	2	815	1,833	2,935		368	16,062	18,900
2002	577	6,793	1,327	1,154	14	1,318	2,674	1,990		243	16,090	17,790
2003	376	7,065	908	933	16	1,239	2,953	2,050		186	15,726	17,790
2004	472	7,270	1,526	525	22	1,074	2,443	1,827		161	15,320	17,450
2005	570	6,554	2,315	778	15	711	2,469	2,425		180	16,017	19,544
2006	628	7,561	2,120	637	14	741	2,523	1,752		270	16,246	21,498
2007	959	8,491	2,186	913	3	957	2,419	2,881		206	19,015	25,153
2008	681	10,508	1,000	1,057	1	866	2,980	3,114		322	20,529	25,153
2009	708	9,198	825	625	10	833	3,145	2,245		316	17,905	24,650
2010	583	8,963	917	1,000	7	722	1,793	2,708		359	17,052	22,432
2011	561	10,162	1,205	600	13	608	1,237	1,617		149	16,152	21,759
2012	530	10,529	1,260	1,135	35	770	1,189	2,633		325	18,406	21,759
2013	495	8,672	1,142	1,295	10	781	1,387	2,255		140	16,177	23,065
2014	679	8,613	1,189	766	0	468	1,840	2,614		174	16,343	20,989
2015	378	8,635	1,394	370	0	507	2,116	2,359	na	80*	15,839	23,348
Average												

***preliminary (landings outside FUs need to be updated when available).**

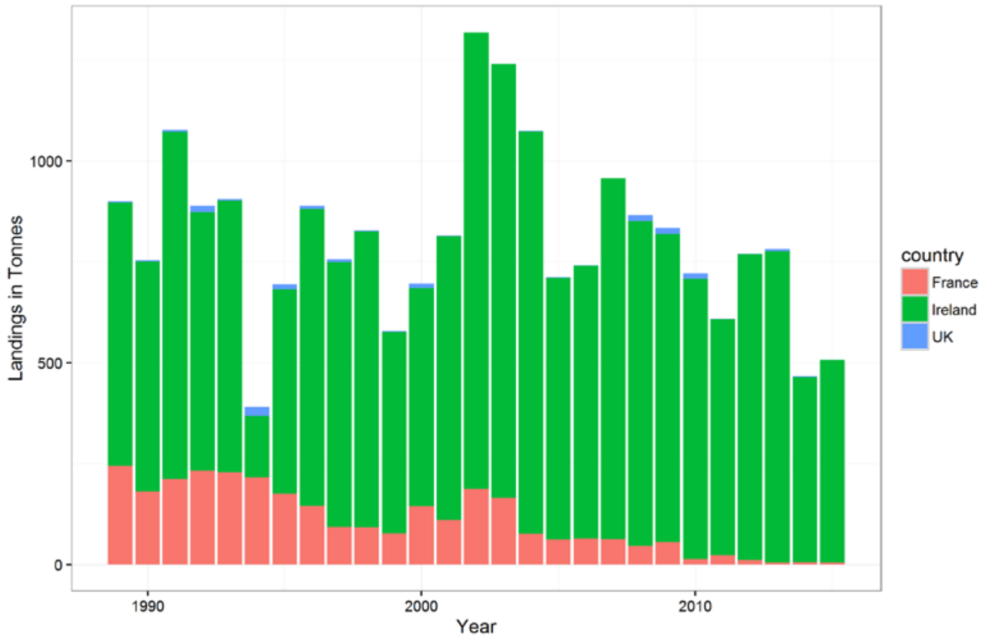


Figure 7.8.1. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Landings in tonnes by country.**

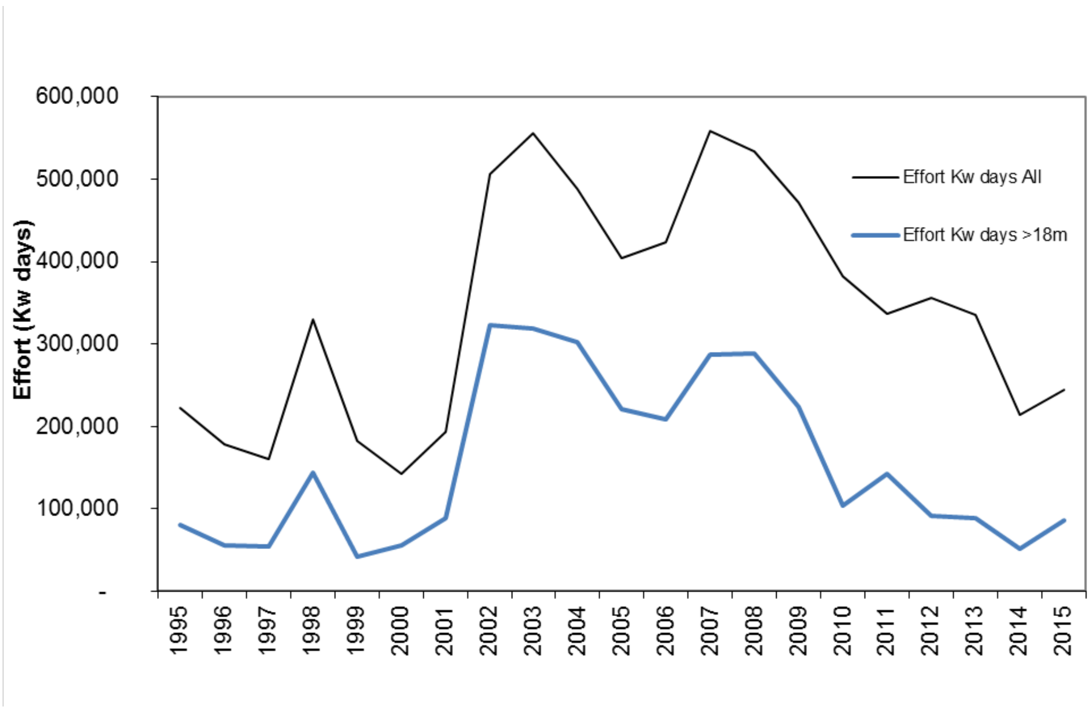


Figure 7.8.2. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Trawl effort for Irish OTB vessels where >30% of landed weight was** ***Nephrops*****.**

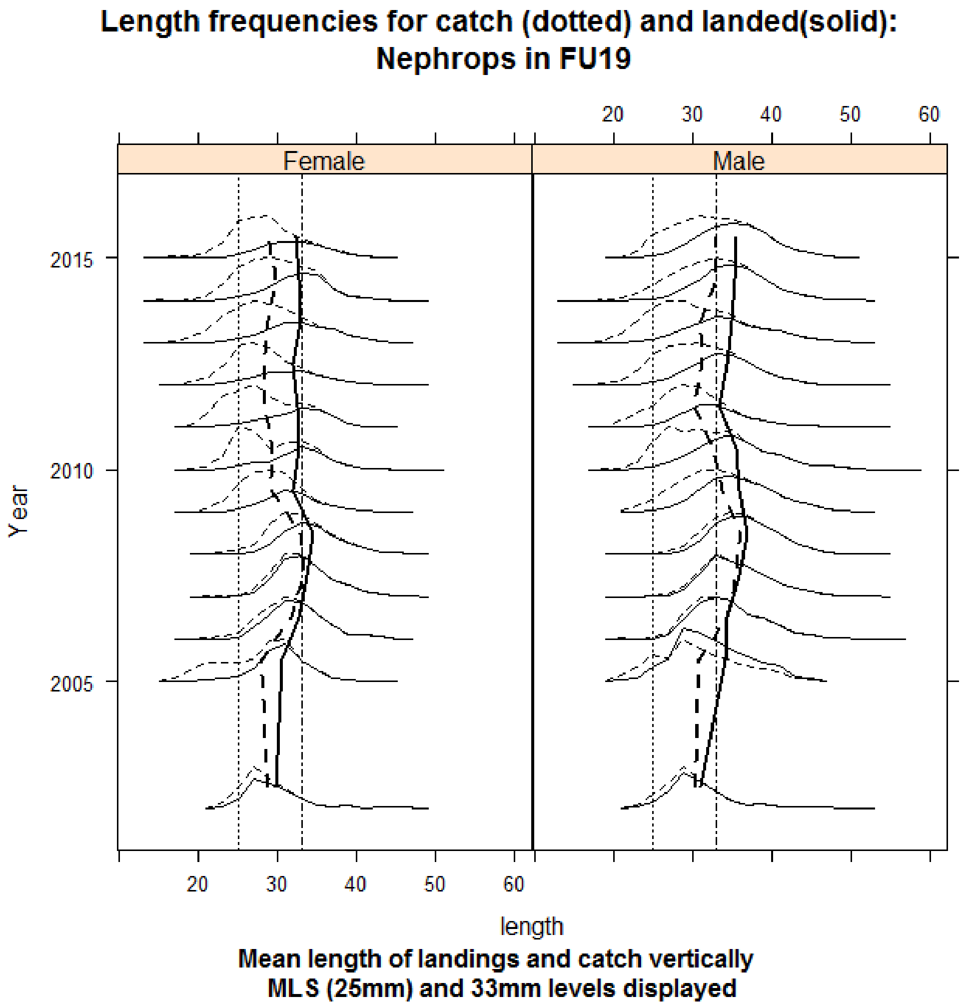


Figure 7.8.3. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean size trends for catches and whole landings by sex 2002–2015.**

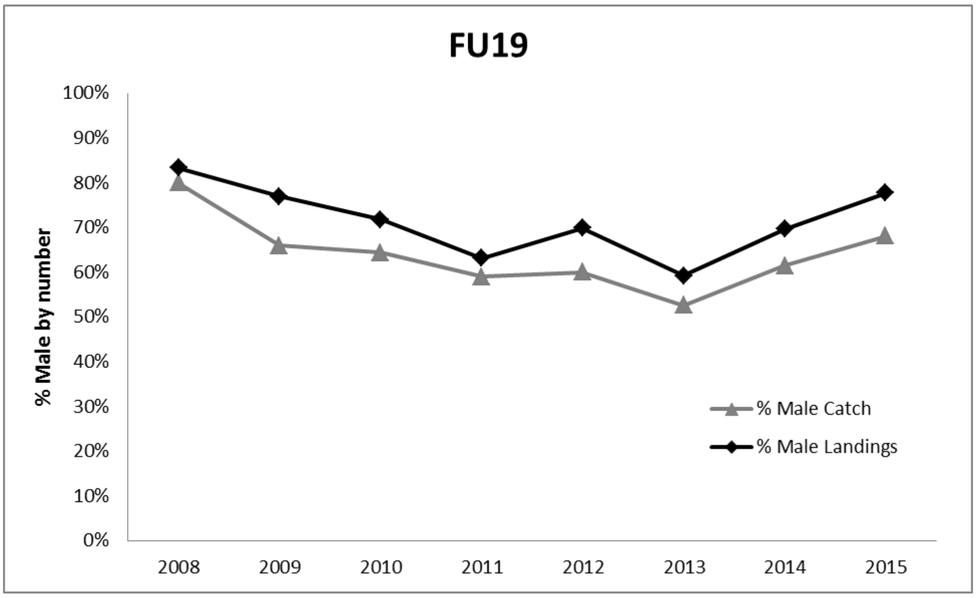


Figure 7.8.4. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Sex ratio of landings (2008–2015) and catch (2008–2015).**

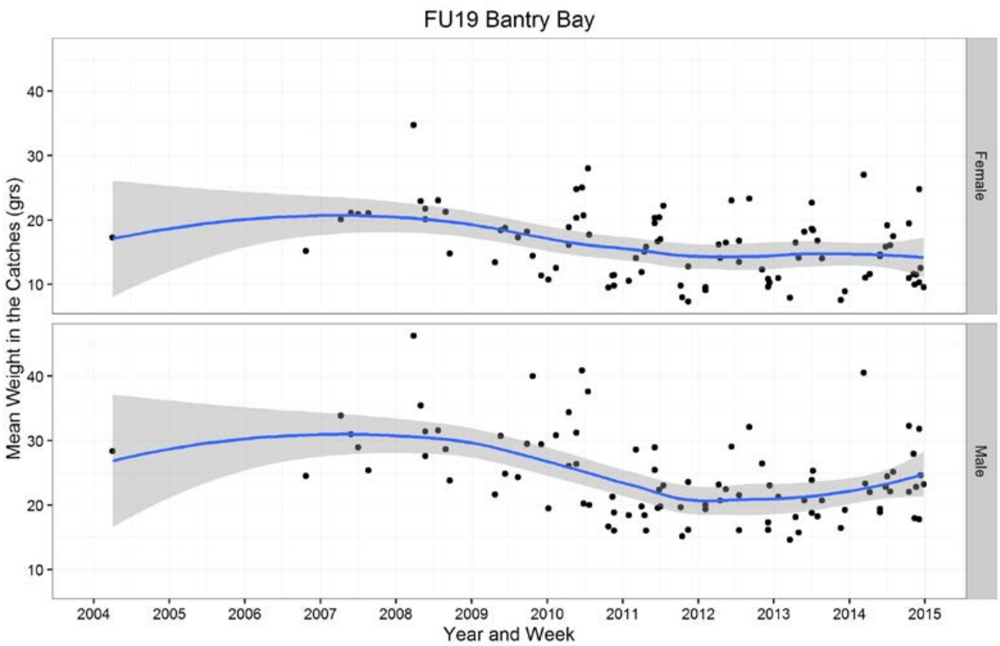


Figure 7.8.5. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean weight in Bantry Bay catch samples by sex with loess smoother and showing cyclical trends.**

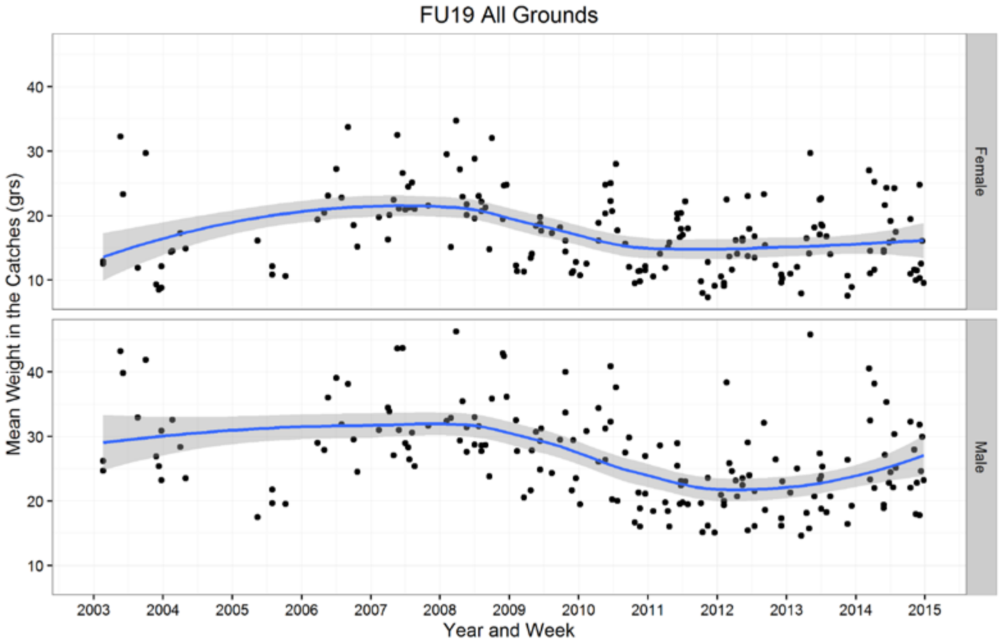


Figure 7.8.6. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean weight in catch data for all grounds in FU19 by sex with loess smoother and showing cyclical trends.**

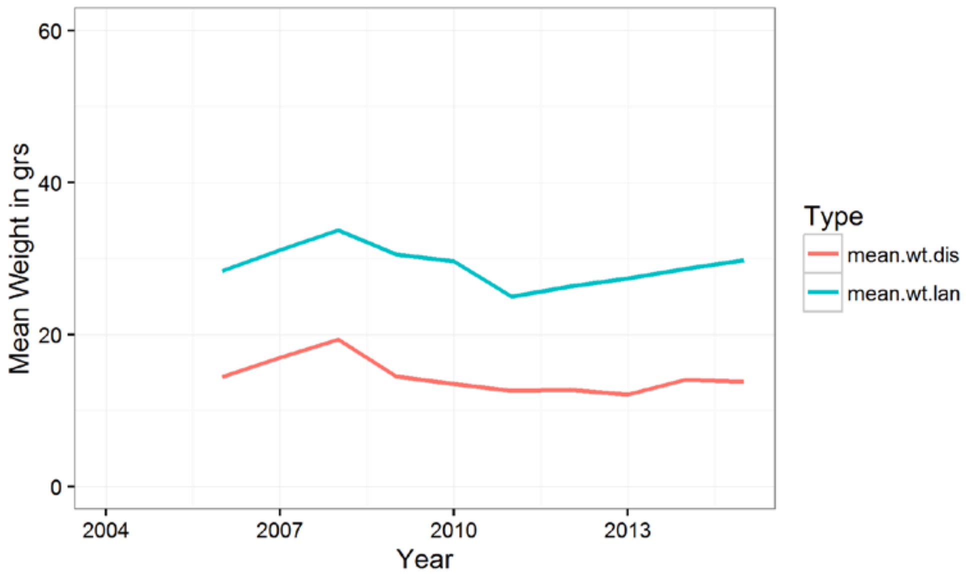


Figure 7.8.7. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Annual mean weights (gr) in the landings and discards.**

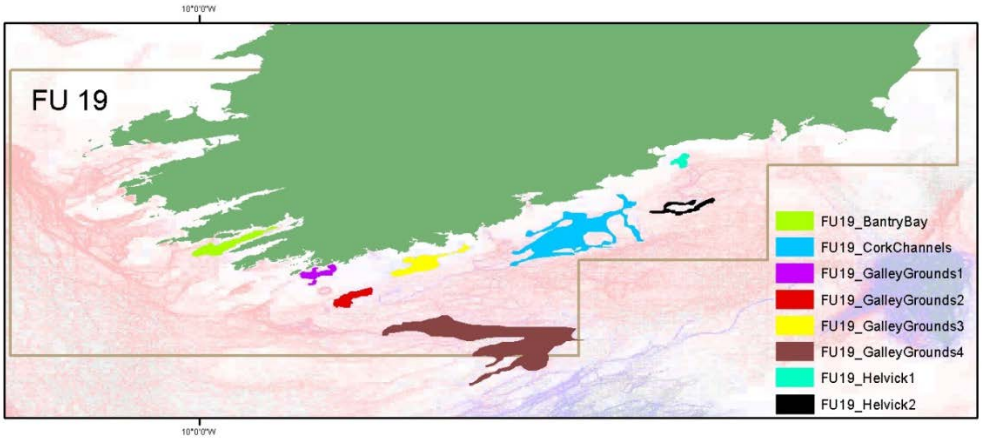


Figure 7.8.8. *Nephrops* in FU19 (Ireland SW and SE Coast). Revised discrete patches overlaid on overlaid on proportion of *Nephrops* in the Irish landings overlaid on international OTB effort (red=0% *Nephrops*; blue=50–60% *Nephrops*; grey=unknown (no Irish landings).

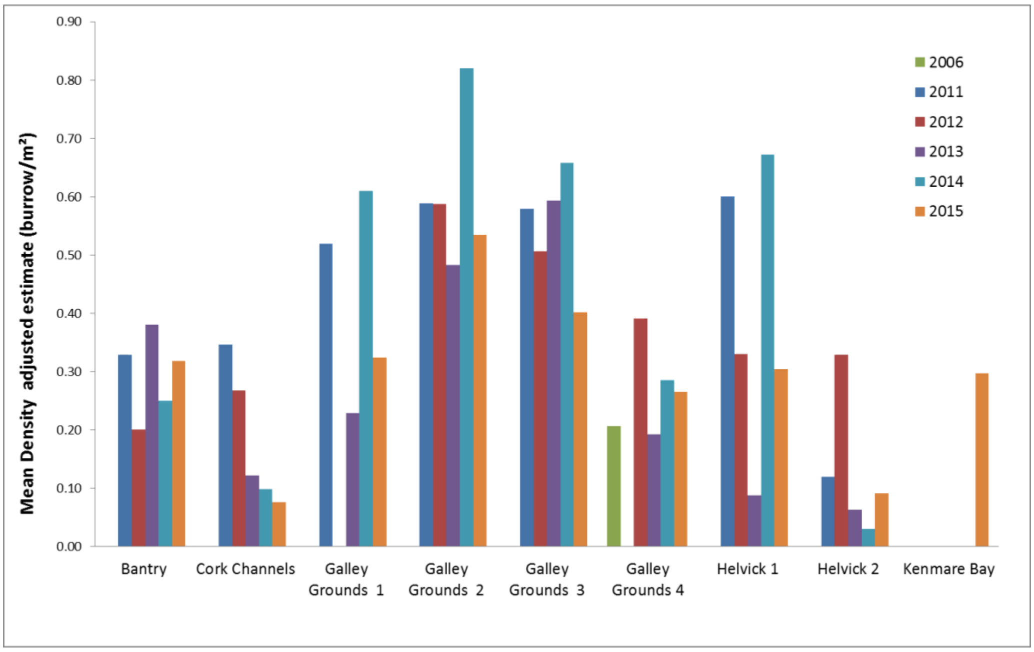


Figure 7.8.9. *Nephrops* in FU19 (Ireland SW and SE Coast). Mean density estimates adjusted (burrow/m²). No estimate available for Galley Ground 4 in 2011, Galley Ground 1 in 2012.

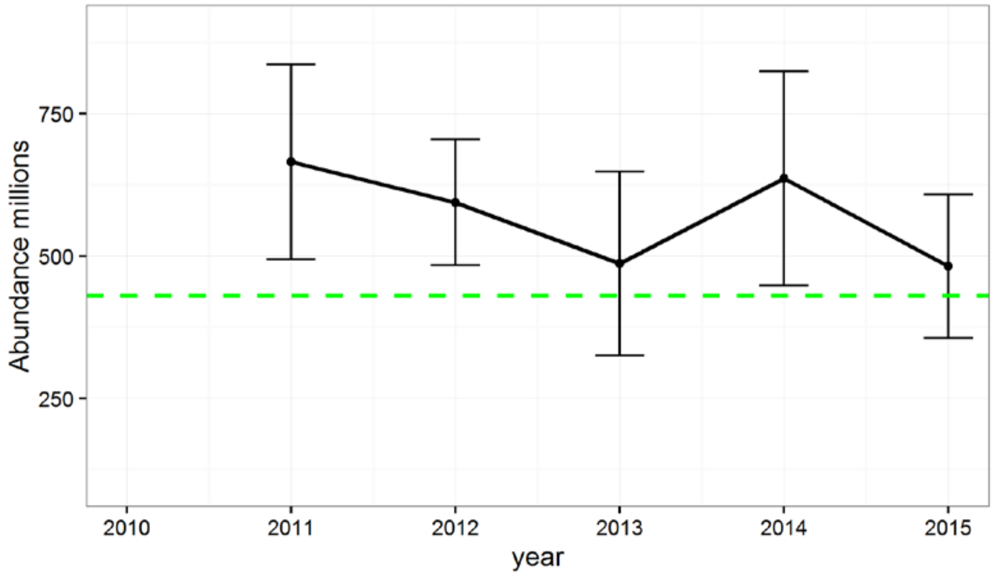


Figure 7.8.10. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Time-series of total abundance estimates for FU17 (error bars indicate 95% confidence intervals) and $B_{trigger}$ is dashed green line.**

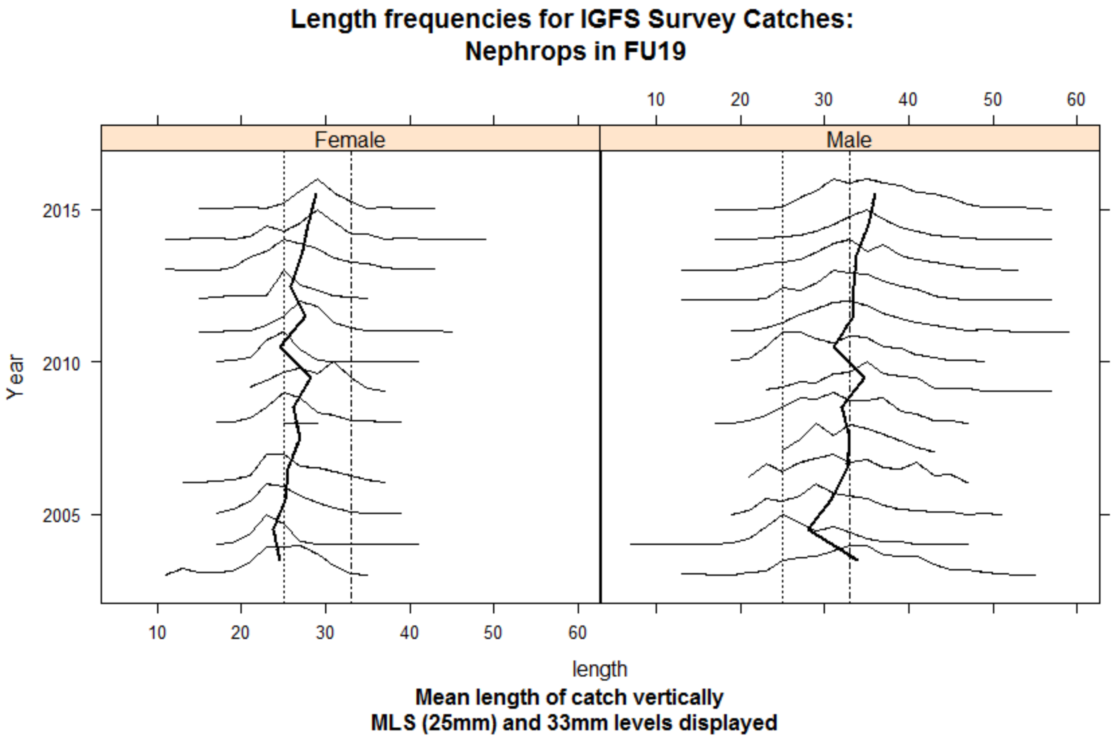


Figure 7.8.11. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean size trends for catches by sex from Irish Groundfish Survey 2003–2015.**

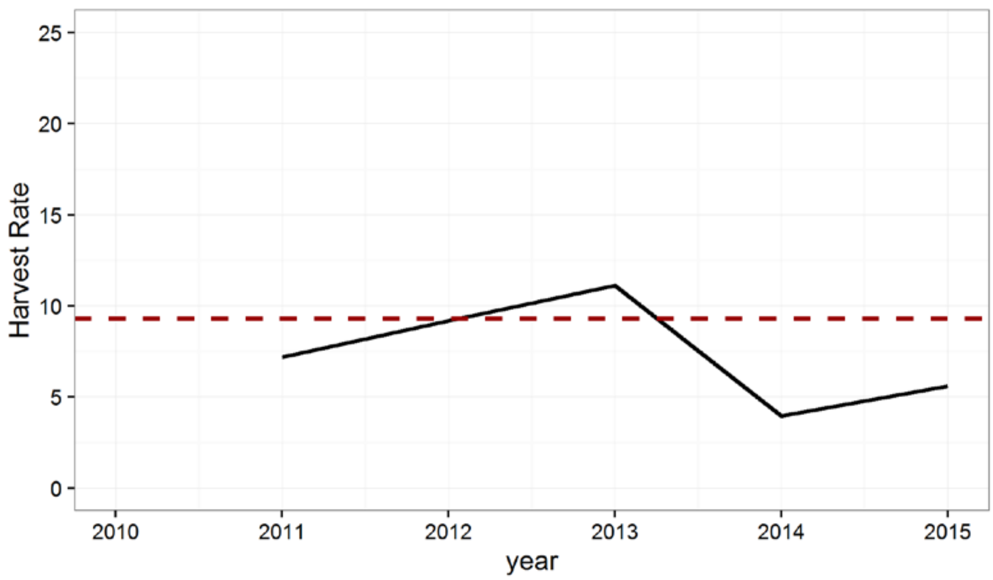


Figure 7.8.12. *Nephrops* in FU19 (Ireland SW and SE Coast). Harvest Rate (% dead removed/UWTV abundance). The dashed and solid lines are the MSY proxy and the harvest rate respectively.

7.9 Plaice in West of Ireland Division 7bc

Type of assessment in 2016

No assessment was performed.

7.9.1 General

Stock Identity

Plaice in 7.b are mainly caught by Irish vessels on sandy grounds in coastal areas. Plaice catches in 7.c are negligible. There are two distinct areas in which plaice are caught by Irish vessels in 7.b: an area around Galway Bay and an area in the north of 7.b which extends into 6.a (the Stags and Broadhaven Ground). During 1995–2000 a large proportion of the 7.bc plaice landings were taken from the Stags Grounds (Rectangles 37D8, 37D9, 37E0 and 37E1). The landings and lpue in this area have dropped sharply since 2000, in line with a general decrease of lpue in Division 6.a. Plaice in this area appear to be more linked with VIa than populations further south. The landings and lpue on the Aran grounds appear to have been more or less stable since the start of the logbooks' time-series in 1995 (WD 1, WGCSE 2009). It is not known how much exchange there is between plaice on the Aran grounds and those on the Stags ground. The commercial lpue time-series may not be reflective of overall stock abundance due to changing fishing practices.

7.9.2 Data

The time-series of official landings is presented in Table 7.9.1 and Figure 7.9.1.

Table 7.9.1. Landings of plaice in 7.bc as officially reported to ICES.

Year	BEL	FRA	UK	IRL	OTH	TOT	Year	BEL	FRA	UK	IRL	OTH	TOT	Unalloc	WG est
1908	0	0	0	135	0	135	1962	0	239	0	42	0	281		
1909	0	0	0	49	0	49	1963	0	471	2	67	0	540		
1910	0	0	0	36	0	36	1964	0	427	2	66	0	495		
1911	0	0	2	54	0	56	1965	0	417	2	99	0	518		
1912	0	0	1	40	0	41	1966	0	0	1	127	0	128		
1913	0	0	0	54	0	54	1967	0	182	2	112	0	296		
1914	0	0	0	85	0	85	1968	0	403	0	89	0	492		
1915	0	0	1	23	0	24	1969	0	281	2	99	0	382		
1916	0	0	0	22	0	22	1970	0	124	0	110	0	234		
1917	0	0	0	36	0	36	1971	0	0	1	89	0	90		
1918	0	0	0	29	0	29	1972	0	110	0	124	0	234		
1919	0	0	1	32	0	33	1973	0	60	1	124	0	185		
1920	0	0	25	15	0	40	1974	0	45	1	106	0	152		
1921	0	0	9	34	0	43	1975	0	10	0	153	0	163		
1922	0	0	1	37	0	38	1976	0	9	0	133	0	142		
1923	0	0	1	30	0	31	1977	0	4	0	135	0	139		
1924	0	0	4	166	0	170	1978	0	16	0	122	0	138		
1925	0	0	5	28	0	33	1979	0	6	0	117	2	125		
1926	0	13	10	42	0	65	1980	0	12	0	142	65	219		
1927	0	126	14	45	0	185	1981	0	9	4	135	58	206		
1928	0	40	7	35	0	82	1982	0	8	4	122	22	156		
1929	0	262	25	31	0	318	1983	0	37	0	108	7	152		
1930	0	96	6	44	0	146	1984	0	2	6	110	0	118		
1931	0	238	8	58	0	304	1985	0	10	7	150	0	167		
1932	0	411	19	76	0	506	1986	0	11	5	114	0	130		
1933	0	595	29	29	0	653	1987	0	13	1	153	0	167		
1934	0	406	31	33	0	470	1988	0	9	2	157	0	168		
1935	0	249	18	33	0	300	1989	0	1	14	159	0	174		
1936	0	265	47	37	0	349	1990	0	11	92	130	0	233		
1937	0	242	59	25	0	326	1991	0	9	3	179	0	191		
1938	0	359	25	20	0	404	1992	0	3	9	180	0	192		
1939	0	0	0	24	0	24	1993	0	2	3	191	0	196		
1940	0	0	0	47	0	47	1994	0	1	5	200	0	206		
1941	0	0	0	43	0	43	1995	0	5	2	239	0	246		
1942	0	0	0	41	0	41	1996	0	1	2	248	0	251	-11	240
1943	0	0	0	29	0	29	1997	0	3	0	206	0	209	4	213
1944	0	0	0	42	0	42	1998	0	0	1	160	0	161	22	183
1945	0	0	0	30	0	30	1999	0	0	2	157	0	159	13	172
1946	0	0	5	32	0	37	2000	0	31	0	99	0	130	-22	108
1947	5	0	9	36	0	50	2001	0	8	0	70	0	78	9	87
1948	0	0	8	47	0	55	2002	0	17	2	51	0	70	1	71
1949	0	0	20	63	0	83	2003	0	7	0	56	2	65	7	72
1950	0	289	16	42	0	347	2004	0	14	0	39	1	54	1	55

Year	BEL	FRA	UK	IRL	OTH	TOT	Year	BEL	FRA	UK	IRL	OTH	TOT	Unalloc	WG est
1951	0	100	12	31	0	143	2005	0	12	0	25	0	37	1	38
1952	0	120	18	46	0	184	2006	0	11	0	20	1	32	-2	30
1953	0	340	8	48	0	396	2007	0	12	0	23	0	35	-1	34
1954	0	273	5	72	0	350	2008	0	9	0	21	1	31	4	35
1955	0	111	3	96	0	210	2009	0	7	0	45	0	52	1	53
1956	0	174	1	64	0	239	2010	0	6	0	27	0	33	0	33
1957	0	80	1	60	0	141	2011	0	2	0	16	0	18	-2	16
1958	0	204	0	71	0	275	2012	0	9	0	20	0	29	-3	26
1959	0	392	5	54	0	451	2013	0	3	0	15	0	18	0	18
1960	0	197	3	46	0	246	2014	0	6	0	17	0	23	0	23
1961	0	182	0	30	0	212	2015	0	7	0	15	0	22	0	22

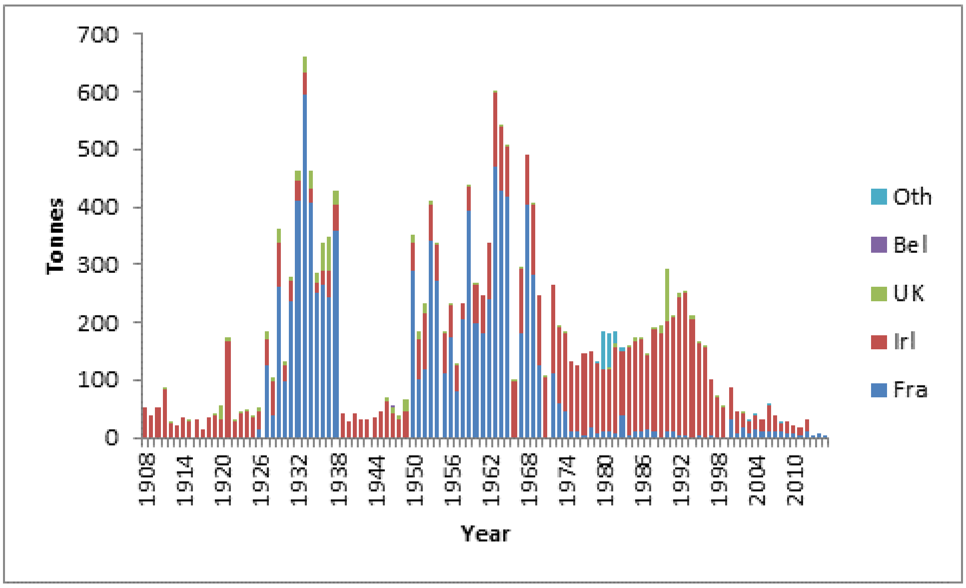


Figure 7.9.1. Landings of plaice in 7.bc as officially reported to ICES (1908–2015).

7.10 Plaice in Divisions 7.f–g (Celtic Sea)

Type of assessment in 2016

Update of survey trends which were the basis of the advice since 2015.

The analytic assessment by Aarts and Poos (2009) model continues to have difficulty in interpreting the data due to conflicting trends between survey time-series and commercial time-series.

ICES advice applicable to 2015

Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 1500 tonnes. If discard rates remain unchanged from the average of the last three years, this implies landings of no more than 405 tonnes.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/ple-celt.pdf

ICES advice applicable to 2016

Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 1500 tonnes. If discard rates remain unchanged from the average of the last three years, this implies landings of no more than 405 tonnes.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/ple-celt.pdf

7.10.1 General

Stock description and management units

A TAC is allocated to ICES areas 7.f–g which corresponds to the stock area.

Management applicable to 2015 and 2016

TACs and quotas set for 2015 (source COUNCIL REGULATION (EU) No 104/2015).

Species: Plaice *Pleuronectes platessa*, Zone: 7.f and 7.g (PLE/7FG.)

Belgium 69

France 125

Ireland 202

United Kingdom 65

Total EU 461

Total TAC 461

TACs and quotas set for 2016 (source COUNCIL REGULATION (EU) No 72/2016).

Species: Plaice *Pleuronectes platessa*, Zone: 7.f and 7.g (PLE/7FG.)

Belgium 59

France 106

Ireland 200

United Kingdom 55

Total EU 420

Total TAC 420

Fishery in 2015

The main fishery, as usual, was concentrated on the Trevose Head ground off the north Cornish coast and around Land's End. Despite plaice being harvested throughout the year, the bulk of landings are taken in the second and third quarters with an extended peak from June to August. The fisheries harvesting plaice in the Celtic Sea primarily involve vessels from Belgium, France, Ireland, England and Wales. In 2015 Belgium reported 48.7% of the landings, France 29.2%, Ireland 15.6% and the UK 6.5%. The contribution of individual countries to total landings was similar to 2013–2014. The Working Group estimated that total international landings for 2015 were 381 t, ~17.4% below the TAC of 461 t. Discards were a significant component of catch (~70% in 2015), with the available time-series extending from 2004 to 2014. Discards have exceeded landings since 2006. Most of the landings (57%) were taken by beam trawlers, and some 32% by bottom otter trawlers. Other gears accounted for 11% the most important being seines (6% of the total).

7.10.2 Data

Landings

National landings data and estimates of total landings and discards used by the WG are given in Table 7.10.1.

Discards

Prior to 2010 indications were that discard rates, although variable, were substantial in some fleets/periods. At the ICES WKFLAT (2010) meeting discard data from the countries participating in the fishery were raised and collated to the total international catch level for first time, a process that has continued annually. Discard information was available for Belgium, UK(E+W) and Ireland. The UK estimates were raised to incorporate equivalent levels of discards for that of France, Ireland and N Ireland (on the basis of similar gear types and quarter of the year). The total estimates (Table 7.10.1) confirm the perception of the significant level of discarding; discards have therefore been included within the assessment since 2010. WG estimates of the level of discards are available from 2004, they have shown a steady increase in time to levels higher than landings since 2006. In 2007 a substantial increase occurred in the discarding by all fleets followed by a return to previously low levels until 2011 from which until now discards exceeded landings by a factor 2.5–3.1. Length distributions of landings and discards national discard sampling programmes are summarized in Figures 7.10.4a and b.

Biological information

Quarterly or annual age compositions for 2015 were available for Belgium, Ireland, UK(E+W) and one French metier. Samples data accounted for approximately 80% of the total landings. International landings and discard numbers-at-age in years for which both are available (2004–2015) are plotted in Figure 7.10.5; in recent years discards considerably exceed landing numbers at the majority of ages. A strong 2010 year class can be tracked through the age structure and is age 5 in 2015.

Landings weight-at-age

Historically, landings weights-at-age were constructed by fitting a quadratic smoother through the aggregated catch weights for each year. WKFLAT (2011) decided not to continue with this approach following concerns raised by WGCSE that poor fits of the quadratic smoothing curve were resulting in the youngest ages being estimated to have heavier weights than adjacent older ages. WKFLAT (2011) rejected the use of the polynomial smoother for weights-at-age and suggested that raw landings weights are used in future (Figure 7.10.1). Raw data back to 1995 were obtained by WKFLAT (2011) and used to update the catch weights and stock weights files (Table 7.10.6). Data on landings weight-at-age (as well as those of discards weight-at-age) seem to be subjected to strong interannual variation, with one of possible reasons being insufficient sampling.

Discard weight-at-age

Discard weight-at-age raw data were available for UK(E+W), Belgium and Ireland. The three national weight-at-age matrices were averaged to a total international estimate by weighting the individual weights-at-age for each year, by the catch numbers-at-age from the three countries for each year and age (Figure 7.10.1; Table 7.10.8).

Stock weight-at-age

Where discard estimates were available from 2004 onwards, a revised set of stock weights-at-age were calculated. The stock weights were derived from the total international landings weights-at-age and the discard weights-at-age averaged by numbers-at-age from the respective datasets. Prior to 2004, a revised set of stock weights-at-age based on international landings data were produced. These new values were based on collected weight data with a SOP correction (Table 7.10.9). Numbers- and weights-at-age for landings, discards and the stock used in the assessment are presented in Tables 7.10.5–7.10.9. The separable assessment model fitted to estimate discards and landings mortality does not handle zero values efficiently (log zero), therefore zero numbers-at-age 1 were replaced by the value 0.001. This replacement affected age 1 for discards and landings. Sensitivity to the replacement value used was explored as the model was developed and did not reveal any visible impact between 0.1 and 0.0001.

Natural mortality and maturity

Estimates of natural mortality (0.12 for all years and all ages from tagging studies) were based on the value estimated for Irish Sea plaice. The maturity ogive is based on UK(E&W) 7.f–g survey data for March 1993 and March 1994 (Pawson and Harley, 1997). This maturity ogive was produced in 1997 and applied to all years in the assessment.

Age	1	2	3	4	5+
Maturity	0	0.26	0.52	0.86	1.00

Surveys

Indices of abundance from the UK(E&W)-BTS-Q3 beam trawl survey in 7.f and the Irish Celtic Explorer IBTS survey (IGFS-WIBTS-Q4) are presented in Table 7.10.10. The UK(E&W)-BTS-Q3 data indicate relatively strong 2009–2010 and 2013–2014 year classes. The IGFS-WIBTS-Q4 data indicates that 2008–2010 are all strong year classes. Both surveys indicate weak year class of 2012 and 2015. The Irish Celtic Explorer IBTS survey (IGFS-WIBTS-Q4) time-series started in 2003, but is not yet included in the assessment by the AP model. WKFLAT (2011) noted that year effects in the survey catch rates dominate the abundance indices; year class and catch curve plots illustrated that the consistency of plaice year-class abundance estimates between ages is relatively poor. The survey was not fitted during preliminary runs of the assessment model in 2013, 2014, and 2015 but will be monitored for inclusion as the time-series progresses. Its tentative inclusion in assessment 2016 did not improve the model performance. Figure 7.10.7 presents the log UK (BTS-Q3) catch per unit of effort (cpue) indices by year and year class, the log catch curves for each cohort and the gradient of the catch curves used as an indication of total mortality trends. The plots illustrate the historical consistency of year-class estimates from the survey, with less agreement in more recent (2014–2015) years.

Commercial landings per unit of effort

Commercial tuning indices of abundance from the UK(E&W) beam-trawl and otter trawl data are presented in Table 7.10.11. Figures 7.10.8 and 7.10.9 present the log commercial cpue indices by year and year class, the log catch curves for each cohort and the gradient of the catch curves used as an indication of total mortality trends. Data for UK beam trawl are used now as lpue expressed in landings per fishing day as information on lpue expressed in catches per fishing hour is not reliable since 2013 due to reporting issues. The plots illustrate the historical consistency of year-class estimates from the commercial data throughout the time-series for the beam trawls with noise resulting from two major year effects (2010 and 2012–2014) whereas the otter trawl data seem to be inconsistent since 2013. Effort, landings per unit of effort (lpue) and cpue data were available for the UK(E&W) beam trawl, the UK(E&W) otter trawl, the Irish otter trawl, beam trawl and seine fleets, the Belgian beam trawl and the UK September beam-trawl survey (Tables 7.10.2, 3, 4 and Figures 7.10.2, 7.10.3).

In contrast to survey data illustrating recent increase (or at least stability) in adult abundance between 2011 and 2015, lpue of commercial vessels (Figures 7.10.2, 7.10.3 and 7.10.16) show very different and contradictory picture with lpues of many métiers declining, possibly as result of increased discarding.

Commercial lpue data illustrate a general pattern of steep decline since the high levels in the early 1990s, followed by a further more gradual decline in the late 1990s. Since 2000, lpue has been relatively stable at a low level with small and short-term increases in 2015 for most (but not all) métiers. Overall, the lpue rates remain at a relatively low level compared to historic catch rates.

Other relevant data

There were no early closures of the fishery for plaice in 2015. There is relatively little information on the level of landings misreporting on this stock, although it is not considered to be a problem. Recent research on discard survival in the English Channel revealed that discard mortality of adult plaice (mean TL 33–40 cm) captured by beam trawl varied with season between 20 and 60% (Revill *et al*., 2013), so some 40–80% percent of commercial fish might survive discarding, bringing some noise into results of modelling. However, surviving fish would likely be weakened and more vulnerable to predators, so might be eaten instead of more resilient and faster fish. Smaller undersized plaice that represent bulk of discards are likely to have much higher mortality as in other flatfish species (review: Hendrikson, Nies, 2007). Because the impact of discard survival on the model performance is unknown it might not be properly accounted for and possibly is not important as represent a constant “noise”.

7.10.3 Stock assessment

Section 1.4.1 outlines the general approach adopted at this year's Working Group meeting.

Assessment model

WKFLAT (2011) agreed that the model that will be used as a temporary basis for the assessment and provision of advice for the Celtic Sea plaice is AP model (Aarts and Poos, 2009). This was selected on the basis that it was the only model available to WKFLAT which reconstructs the historic discarding rates (derived from the survey dataseries).

WKFLAT (2011) concluded that:

1) Due to the change in estimated fishing mortality when discards are included within the model fit, that discards should be retained within the assessment model structure.

2) Given that the time-series of discard data to which the models are fitted is short and that, consequently, there are likely to be changes in the management estimates as discard data are added in subsequent years, no definitive model structure can be recommended at this stage in the development process.

3) The most flexible of the models TVS_PTVS should be used as the basis for advice; in terms of relative changes in estimated total fishing mortality and biomass.

4) The other two models which provide similar structures should continue to be fitted at the WG to provide sensitivity comparisons.

5) As the dataseries are extended, a final model selection can be then determined.

In 2013, no assessment was presented for this stock given that the "preferred" Aarts and Poos (2009) model failed to converge and other model variants could not provide realistic representations of observed landings and discards. Consequently, WGCSE 2013 decided to avoid the use of the "preferred" TV_PTVS AP model variant and instead focus on assessing the stock using trends derived from the fishery-independent UK(E&W) beam-trawl survey. Trends derived from the UK(E&W) beam-trawl survey were selected for the basis of advice given that this survey most appropriately covered the spatial extent of the stock and well represented the mean age (2–5) landed in the fishery. The UK(E&W) beam-trawl survey was used to infer trends in recruitment, stock size (spawning–stock biomass) and fishing mortality.

In 2014 corrected TV_PTVS Aarts and Poos (2009) model converged and produced realistic results and confirmed conclusions derived in 2013 from the fishery-independent UK(E&W) beam-trawl survey. In 2015 all three model variants converged but only of the "preferred" TV_PTVS AP variant provided estimations consistent with the previous run, observed catches and landings. However, trends of both UK(E&W)-BTS-Q3 beam trawl and IGFS-WIBTS-Q4 surveys on one hand and data on lpues of commercial fleet produced conflicting signal that resulted in asymmetrical distribution of residuals. Because of this the ICES stock advice was based on surveys' cpue trends.

Comparative model runs

The recommended and the most flexible of the models TVS_PTVS converged in 2016, providing realistic looking results though predicting stability of the spawning stock in 2009–2015 to have a weak trend to decline rather than to increase as was observed in survey data (Figure 7.10.16). The TI_PTVS converged and predicted a decline in SSB in recent years that was going against existing knowledge. The TI_TVS converged and resulted in estimated values of landings and discards far off those reported and estimated with enormous credibility limits. Therefore, the last two versions were not taken into consideration. Results of the model are presented on Figure 7.10.10. The model again did not fit well the large increase in the discard data in 2007; producing a very strong year effect in the discard residuals in that year. It also does not fit very well prediction of discards in future years. The model prediction of very low recruitment in 2015 was in agreement with survey data.

Final assessment

The settings and data for the model fits are set out in the table below:

ASSESSMENT YEAR		2015
Assessment model		AP
Catch data		Including discards 1990–2014
Tuning fleets	UK(E&W)-BTS-Q3	1995–2015 ages 1–5
	UK commercial beam trawl	1990–2015 ages 4–8
	UK commercial otter trawl	1989–2015 ages 4–8
	IGFS-WIBTS-Q4	Series omitted
Selectivity model		Linear Time Varying Spline at-age (TV)
Discard fraction		Polynomial Time Varying Spline at-age (PTVS)
Landings number-at-age, range		1–9+
Discards number-at-age, year range, age range		2004–2015, ages 1–7

Figure 7.10.10 presents the output and diagnostic plots for the "preferred" TV_PTVS model fit: the estimated time-series of SSB, recruitment, fishing mortality, total discard and landings weight and the proportion of discards by weight; the estimated relative selection pattern, the log residuals for the discard-at-age data, the log survey and commercial fleet catchability residuals and the log residuals for the landings and discards-at-age data. Selectivity was estimated as being stable in recent years (Figure 7.10.11). Tables 7.10.13 and 7.10.14 present the total fishing mortality-at-age and estimated numbers-at-age. Table 7.10.15 presents the time-series of estimates of SSB, landings, discards, total fishing mortality, landings and discard fishing mortality and recruitment.

State of the stock

WKFLAT (2011) concluded that the TV_PTVS model estimates should be used as the basis for advice only in terms of relative changes in estimated total fishing mortality and biomass, until the discard time-series is longer and a definitive model structure can be recommended. WGCSE (2015) taking into account difficulties of the model that were due to increased discarding with unknown (and possibly important) survival rates as well as contrasting trends between both surveys cpues and lpues of most of métiers.

On the relative scale SSB is estimated to have increased between 2005 and 2009 and then either stabilised with some fluctuations (as predicted by the model) or went on to increase as follows from surveys' data, but the stock is still at a low level well below historical abundance. Total fishing mortality after initial increase in 2008–2012 stabilised from 2013 onwards generally following trends in discard rate. Landings from the fishery have been decreasing while at the same time discarding has increased; in recent years discarding is estimated to comprise the majority of the catch of plaice in 7.f–g (~70–75% by weight). During the time-series recruitment was fluctuating without an obvious trend in 2010–2014 years being very low in 2015. However, a week generation of 2014 might be compensated in future fisheries by a strong generation of 2013.

7.10.4 Short-term projections

No short-term projections are presented for this stock. Catches are dominated by discards which might decrease or increase depending on recruitment strength.

7.10.5 Maximum sustainable yield evaluation

On the basis of the revision of the assessment data structures and the AP model no MSY reference points are recommended for this stock, but will be evaluated when the assessment model is developed further. Meanwhile, using the SPiCT model at ICES WKProxy (ICES, 2015) resulted in estimation of $B_{trigger}$ as 3800 t (50% of B_{MSY}) and F_{MSY} = 0.27.

7.10.6 Precautionary approach reference points

On the basis of the revision of the assessment data structures and the AP model no precautionary reference levels are suggested at this stage in the model development.

7.10.7 Management plans

There is no management plan for Celtic Sea plaice.

7.10.8 Uncertainties in assessment and forecast

Sampling

Sampling levels of landed catch in recent years, and of some national catch-at-age datasets are available in the Stock Annex. The sampling levels for those countries supplying information are given in Section 2.1.2. Taking into account big variability of annual weights-at-age of both discards and landings, the sample level might be insufficient.

Discards

Estimates of discarding are now included in the assessment. The composition of the fleets and the gear types employed in the fishery have fluctuated over time, consequently it is likely that the discard rates observed in the fishery now are not applicable to periods earlier than 2004 in the time-series and this variability in fleet operations has been incorporated within the assessment model estimation. From 2003 onwards, discard sampling for Ireland, Belgium, France and the UK(E&W) has been improved under the Data Collection Regulation. Nevertheless, only discard data from the UK, Ireland, Belgium and recently some information from France were available in a suitable format required to raise the data to international level. Unknown level of partial discard survival varying with fishing gear and season also bring uncertainty into the assessment, which assumes that all discarded fish die. Discarding remains too high (>two landings) in this fishery, thereby compromising the effectiveness of quota management.

Consistency

In 2015 the advice for this stock was provided on the basis of research surveys trends due to unreliability of the model results and conflicting trends between commercial lpues (due to increasing discarding) and cpues of research surveys. In 2016 the WGCSE decided to follow the same approach as 2015. Meanwhile, the trends in SSB as predicted by the model were more or less consistent with trends in survey abundance of commercial-sized fish aged 3+ as represented by data of research surveys (Figure 7.10.16). However, the model results demonstrated the stability of the stock whereas surveys results favoured rather an increase in adult abundance.

7.10.9 References

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

Hendrikson, L., Nies, T. 2009. Discard and gear escapement survival rates of some Northeast groundfish species. NOAA Draft Working Paper. Data Meeting GARM 2008, October 29, 2007, 12 pp. (http://www.nefsc.noaa.gov/GARM-Public/1.DataMeeting/B.3%20Disc_survival_GARM2008.pdf).

ICES. 2015. Report of the Workshop to consider MSY proxies for stocks in ICES category 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015. ICES CM 2015/ACOM:61.

Revill, A.S., Broadhurst, M.K., Millar, R.B. 2013. Mortality of adult plaice, *Pleuronectes platessa* and sole, *Solea solea* discarded from English Channel beam trawlers. Fisheries Research, 147: 320–326.

7.10.10 Audit of (Plaice 7.f-g)

Date: 26/05/2016

Auditor: Dave Stokes

General

Annual catch advice is provided by ICES for this stock based on the approach recommended for data-limited stocks. In accordance with benchmark recommendations (WKFLAT 2011) an Arts and Poos model was tested again in 2016, but as per WGCSE 2015 advice is based on survey data due to model reliability and also conflicting trends between survey and commercial data.

For single stock summary sheet advice

1) **Assessment type**: Update assessment. Benchmarked WKFLAT (2011).
2) **Assessment**: Arts and Poos rejected – Survey trends based
3) **Forecast**: none
4) **Assessment model**: NA
5) **Data issues**: Two surveys available, one used for advice, the other being quite variable. Landings and discards available for main fleets. There is no direct comparison between commercial cpue and survey cpue in the Figures, so Figure 7.10.1 of survey cpue vs commercial lpue suggests a large

and increasing disparity between survey and commercial trends. Discarding is estimated to be high, but constant in recent years so doesn't account for the increasing difference in trends. Data on survival rate for the significant discard component are mentioned as a data gap, but this should probably be a constant proportion of discarding over time, so not address the increasing divergence in trends between commercial and survey data. WGCSE 2016 discussed availability of UK Q1 beam-trawl time-series being relevant, but not currently available to the working group.

6) **Consistency**: Last year's assess rejected; this year's advice is also based on survey trend with AAP model being rejected.

7) **Stock status**: No MSY or precautionary reference points are available at this point, but MSYREF4 used a SPiCT model to produce a $B_{trigger}$ point = 3800 t.

8) Management Plan: No management plan.

General comments

Document was well written and easy to follow.

Technical comments

There is a default return to survey trend advice when the AAP model conflicts with the survey data or seems unreliable. Survey and commercial cpue aren't currently presented on a single figure, but if trends are significantly divergent, and increasing, sources of potential error might be expanded upon in the text (e.g. high variability in stock weights, survey catchability and migration?).

Conclusions

The assessment has been performed correctly, is in accordance with the annex. Survey trends are only used for the advice.

For a benchmark inclusion/comparison of further survey series would be a useful confirmation of significant survey trends vs catchability.

In terms of variable stock weights, a review of national ageing methods, spatial variability in growth rates and sampling levels across métiers prior to raising may be useful.

Table 7.10.1. Plaice in Divisions 7.f–g. Nominal landings (t) as reported to ICES, and total landings as used by the working group.

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Belgium	214	196	171	372	365	341	314	283	357	665
UK (Engl. & Wales)	150	152	176	227	251	196	279	366	466	529
France	365	527	467	706	697	568	532	558	493	878
Ireland	28	0	49	61	64	198	48	72	91	302
N. Ireland										
Netherlands										9
Scotland	0	0	0	7	0	0	0	0	0	1
Total reported	757	875	863	1373	1377	1303	1173	1279	1407	2384
Discards	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Unallocated	0	0	0	0	0	0	-27	-69	345	-693
Landings used by WG	757	875	863	1373	1377	1303	1146	1210	1752	1691
Catch as used by WG	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	1987	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Belgium	581	617	843	794	836	371	542	350	346	410
UK (Engl. & Wales)	496	629	471	497	392	302	290	251	284	239
France	708	721	1089	767	444	504	373	298	254	246
Ireland	127	226	180	160	155	180	89	82	70	83
N. Ireland		1								
Scotland				1		5	9	1	2	
Total reported	1912	2194	2583	2219	1827	1362	1303	982	956	978
Discards	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Unallocated	-11	-78	-432	-137	-326	-174	-189	88	72	-26
Landings used by WG	1901	2116	2151	2082	1501	1188	1114	1070	1028	952
Catch as used by WG	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Belgium	594	540	371	224	241	248	221	212	168	172
UK (Engl. & Wales)	258	176	170	134	136	105	127	87	55	88
France	329	298		287	262	186	165	145	132	106
Ireland	78	135	115	76	45	79	51	45	44	48
Total reported	1259	1149	656	721	684	618	564	489	399	414
Discards	N/A	N/A	N/A	N/A	N/A	N/A	N/A	274	321	453
Unallocated	-42	-82	312	-3	30	24	30	21	-13	-10
Landings used by WG	1217	1067	968	718	714	642	594	510	386	404
Catch as used by WG	N/A	N/A	N/A	N/A	N/A	N/A	N/A	784	707	857
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	
Belgium	194	187	216	188	210	203	185	182	185	
UK (Engl. & Wales)	61	63	55	54	45	44	41	25	25	
France	104	62	N/A	136	98	126	106	155	111	
Ireland	58	63	63	63	67	76	80	49	59	
Total reported	417	375	N/A	442	420	450	412	411	381	
Discards	1288	583	608	670	1107	1123	1274	1158	870	
Unallocated	-7	62	N/A	-9	7	-8	-2	-1	0	
Landings used by WG	410	437	481	442	427	450	414	410	381	
Catch as used by WG	1698	1020	1089	1112	1534	1565	1688	1568	1251	

Table 7.10.2. Plaice in Divisions 7.f–g: lpue and cpue for UK(E&W) fleets.

	RECT. GROUP		RECT. GROUP		VIIg EAST (grp 2)		RECT. GROUP		VIIg WEST (grp 3)		RECT. GROUP		RECT. GROUP			
	VIIf (grp 1)		VIIg EAST (grp 2)		Effort		VIIg WEST (grp 3)		Effort		VIIf (grp 1)		VIIf (grp 1)		TRAWL	BEAM
	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM	LANDINGS	EFFORT	LANDINGS	EFFORT	(000	(000
YEAR		TRAWL		TRAWL	(Days fished)	(Days fished)		TRAWL	(Days fished	Days fished	(t)	Days fished	(t)	Days fished	Days fished	Days fished
1983	86.39	30.33	71.84	54.85	82	149	0.00	75.69	0	8	53.96	620	5.62	195	702	353
1984	79.67	99.69	94.50	106.65	316	298	0.00	66.96	0	129	156.33	1723	99.01	901	2039	1328
1985	115.93	122.91	119.63	174.39	206	285	67.62	233.25	23	92	188.60	1493	146.71	1101	1722	1478
1986	119.81	113.62	103.37	183.72	334	180	49.93	380.20	35	29	138.48	1125	91.16	973	1494	1182
1987	131.27	114.34	223.13	291.30	364	187	33.68	446.46	26	26	196.01	1211	148.39	1681	1601	1894
1988	232.51	247.91	217.11	356.02	351	77	48.43	670.38	20	36	200.68	838	205.01	1102	1210	1215
1989	130.84	138.62	137.76	293.89	327	125	86.54	575.30	15	7	129.65	966	96.15	861	1309	994
1990	75.55	88.83	59.00	166.69	435	165	78.13	147.13	24	194	97.39	1229	155.84	1256	1689	1615
1991	48.20	93.83	44.90	73.40	306	483	42.22	109.40	45	104	55.72	1066	190.79	1667	1417	2254
1992	49.33	57.20	41.29	69.80	303	633	45.00	70.04	435	90	44.92	898	91.34	1420	1636	2143
1993	43.85	69.98	23.83	65.14	251	694	56.64	32.85	30	135	38.41	836	109.37	1669	1117	2497
1994	39.67	40.41	31.76	49.39	225	610	10.70	70.61	19	116	23.21	623	86.14	2219	866	2945
1995	41.81	43.01	30.91	54.05	196	694	61.67	37.12	30	128	26.39	580	96.10	2303	807	3125
1996	38.80	33.67	26.25	27.49	341	560	6.15	11.82	105	220	23.68	593	81.19	2391	1038	3170
1997	34.61	31.01	21.37	33.42	370	770	17.47	7.50	122	146	20.76	577	85.13	2661	1069	3578
1998	21.86	26.07	15.53	15.33	385	591	5.12	12.65	94	159	10.97	517	85.15	2846	995	3597
1999	35.60	26.62	20.65	12.00	176	1461	5.14	11.96	235	312	12.06	395	85.55	3058	806	4831
2000	32.09	16.10	40.58	11.64	187	1007	3.35	10.10	160	200	10.99	284	53.59	3133	630	4341
2001	34.02	16.69	32.30	15.26	187	1155	4.66	11.04	179	91	9.82	309	53.47	3172	675	4418
2002	19.78	15.64	48.80	20.81	123	463	7.43	4.81	170	60	6.91	416	38.85	2652	709	3174
2003	23.45	18.24	8.19	20.78	51	772	4.48	1.49	124	158	15.85	696	50.94	2669	871	3599
2004	18.77	15.54	8.66	7.81	198	923	3.09	3.39	125	178	12.45	641	40.72	2503	965	3604
2005	11.20	11.00	2.14	8.25	21	618	0.25	1.33	154	116	9.55	876	23.25	1968	1051	2702
2006	21.21	12.77	5.91	15.19	23	630	0.64	0.58	233	70	19.94	924	14.31	1330	1181	2030
2007	14.79	17.93	20.42	10.58	31	518	1.71	5.90	219	12	12.09	798	18.18	1407	1048	1937
2008	18.01	21.20	21.10	10.22	109	290	0.08	1.72	229	5	13.23	711	18.85	1202	1049	1497
2009	14.40	15.66	11.58	14.77	244	266	1.63	0.76	296	48	8.33	656	24.33	1105	1197	1419
2010	14.09	27.93	12.88	11.82	84	327	0.31	1.06	469	78	7.79	565	19.63	1162	1117	1567
2011	11.11	32.98	5.43	17.11	8	180	2.09	0.76	353	111	6.32	525	18.79	868	887	1158
2012	10.96	17.70	3.11	9.38	138	275	0.67	0.51	487	102	6.11	543	22.18	1408	1168	1785
2013	6.40	12.29	0.89	8.18	72	265	0.44	0.61	37	77	1.47	280	20.68	1611	389	1947
2014	5.76	15.52	7.43	10.61	10	131	0.00	2.50	0	24	0.90	156	10.25	959	165	1114
2015	18.82	11.87	37.87	14.58	3	245	0.00	3.65	0	56	1.39	79	7.80	726	82	1027

Table 7.10.3. Plaice in Divisions 7.f–g: lpue and effort for Belgian fleets in 7.f–g.

Year	Landings (t)	Effort (000 hr)	Lpue (kg/h)	Year	Landings (t)	Effort (000 hr)	Lpue (kg/h)
1996	356.89	53.27	6.70	2006	134.44	50.28	2.67
1997	474.71	57.36	8.28	2007	139.39	45.72	3.05
1998	443.38	57.79	7.67	2008	106.29	28.71	3.70
1999	410.22	55.11	7.44	2009	140.76	30.84	4.56
2000	230.63	51.34	4.49	2010	127.15	32.74	3.88
2001	274.84	54.90	5.01	2011	159.03	41.41	3.84
2002	259.80	49.60	5.24	2012	165.725	46.249	3.583
2003	215.95	62.73	3.44	2013	155.973	45.159	3.454
2004	207.27	78.73	2.63	2014	155.317	31.271	4.967
2005	153.73	64.50	2.38	2015	165.17	31.792	5.195

Table 7.10.4. Plaice in Divisions 7.f–g: lpue and effort for Irish otter trawl, beam and seine fleets in 7.g and Belgian fleet in 7.fg.

	IR-OTB-7G			IR-SCC-7G		
Year	Landings (t)	Effort (000 hr)	lpue (kg/h)	Landings (t)	Effort (000 hr)	lpue (kg/h)
1995	94.23	63.56	1.48	9.55	6.43	1.49
1996	133.66	60.04	2.23	14.20	9.73	1.46
1997	119.84	65.10	1.84	38.79	16.13	2.40
1998	96.72	72.30	1.34	21.38	14.94	1.43
1999	60.05	51.66	1.16	10.40	8.01	1.30
2000	28.78	60.60	0.47	11.40	9.90	1.15
2001	23.82	69.43	0.34	10.93	16.33	0.67
2002	42.30	77.69	0.54	16.42	20.86	0.79
2003	26.35	86.79	0.30	13.80	20.91	0.66
2004	26.62	96.99	0.27	5.04	19.38	0.26
2005	22.78	124.40	0.18	6.47	14.81	0.44
2006	25.17	119.23	0.21	5.10	14.79	0.34
2007	30.99	136.52	0.23	4.76	15.82	0.30
2008	39.17	125.81	0.31	8.38	11.65	0.72
2009	43.81	137.11	0.32	7.98	8.19	0.98
2010	44.29	140.65	0.31	10.71	9.69	1.11
2011	44.68	120.33	0.37	11.12	11.01	1.01
2012	43.21	121.08	0.35	18.41	14.15	1.30
2013	31.91	118.13	0.28	11.10	12.06	0.84
2014	28.00	127.40	0.22	7.60	12.00	0.61
2015	33.34	133.20	0.25	8.36	9.28	0.90

	BELGIAN Beam Trawl VIIfg		
Year	Landings (t)	Effort (000 hr)	lpue (kg/h)
1996	356.89	53.27	6.70
1997	474.71	57.36	8.28
1998	443.38	57.79	7.67
1999	410.22	55.11	7.44
2000	230.63	51.34	4.49
2001	274.84	54.90	5.01
2002	259.80	49.60	5.24
2003	215.95	62.73	3.44
2004	207.27	78.73	2.63
2005	153.73	64.50	2.38
2006	134.44	50.28	2.67
2007	139.39	45.72	3.05
2008	106.29	28.71	3.70
2009	140.76	30.84	4.56
2010	127.15	32.74	3.88
2011	159.03	41.41	3.84
2012	165.73	46.25	3.58
2013	155.973	45.159	3.454
2014	155.317	31.271	4.967
2015	165.17	31.792	5.195

		IR-TBB-7G					
Year	Landings (t)	Effort (000 hr)	lpue (kg/h)	Year	Landings (t)	Effort (000 hr)	lpue (kg/h)
1995	37.92	20.78	1.83	2006	14.46	60.48	0.24
1996	53.02	26.76	1.98	2007	21.18	55.86	0.38
1997	94.59	28.25	3.35	2008	14.18	37.22	0.38
1998	122.13	35.25	3.46	2009	6.96	37.96	0.18
1999	25.80	40.87	0.63	2010	6.56	40.22	0.16
2000	12.62	37.03	0.34	2011	6.71	35.33	0.19
2001	4.80	39.71	0.12	2012	33.63	40.33	0.83
2002	7.08	31.62	0.22	2013	32.32	38.48	0.84
2003	9.37	49.26	0.19	2014	12.50	37.80	0.33
2004	6.17	54.86	0.11	2015	12.10	37.79	0.32
2005	9.49	49.65	0.19				

Table 7.10.5. Plaice in Divisions 7.f–g. Landings numbers-at-age.

LANDINGS NUMBERS-AT-AGE				NUMBERS*10**-3						
AGE\YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0	0	0	0	0	0	0	0	0	0
2	989	851	877	1921	822	300	750	704	1461	703
3	426	903	673	1207	2111	1180	560	918	2503	2595
4	411	291	638	658	681	955	827	343	393	1332
5	105	136	72	146	109	443	372	373	102	156
6	72	76	70	21	54	86	92	209	177	59
7	37	47	34	16	53	51	44	70	62	48
8	59	23	8	16	11	14	27	41	25	32
+gp	75	98	46	32	44	60	23	42	38	24
TOTALNUM	2175	2426	2419	4018	3886	3090	2696	2701	4762	4950
AGE\YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0	0	0	0	0	0	25	100	43	0
2	434	967	797	164	279	800	1019	428	488	812
3	1883	2099	3550	2078	1072	526	1179	936	572	734
4	1812	1568	1807	2427	1193	357	284	730	743	515
5	772	612	741	655	578	471	139	164	334	219
6	156	413	160	242	179	275	185	117	117	137
7	22	65	98	86	94	80	115	86	57	59
8	125	16	24	70	78	21	62	92	48	37
+gp	76	73	23	46	79	96	59	65	132	96
TOTALNUM	5281	5814	7201	5769	3553	2627	3066	2716	2534	2609
AGE\YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	8	17	22	19	75	3	15	6	24	12
2	420	426	243	320	651	170	239	126	201	331
3	1318	921	982	606	371	661	571	578	327	458
4	929	849	802	482	323	543	465	428	265	140
5	272	287	372	203	199	183	150	261	134	134
6	121	96	116	145	108	113	85	46	73	76
7	60	82	45	53	62	65	34	27	24	50
8	20	39	27	22	23	24	26	15	14	12
+gp	82	56	69	32	28	28	24	17	16	15
TOTALNUM	3231	2773	2678	1881	1838	1789	1608	1504	1078	1229
AGE\YEAR	2007	2008	2009	2010	2011	2012	2013	2014	2015	
1	8	15	2	3	1	2	3	0	0	
2	130	270	127	135	135	106	64	24	55	
3	513	341	626	223	326	488	326	123	122	
4	340	443	345	430	208	290	379	452	231	
5	104	145	273	191	248	165	191	247	410	
6	76	47	68	152	130	164	67	109	127	
7	46	29	20	44	69	65	70	33	43	
8	26	11	10	8	28	33	29	36	17	
+gp	13	15	12	8	17	23	31	30	26	
TOTALNUM	1257	1315	1485	1187	1161	1336	1160	1054	1052	

Table 7.10.6. Plaice in Divisions 7.f–g. Landings weights-at-age.

Landings weights-at-age (kg)										
AGE\YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.078	0.194	0.076	0.118	0.19	0.151	0.178	0.276	0.135	0
2	0.205	0.258	0.203	0.238	0.26	0.245	0.274	0.324	0.251	0.16
3	0.323	0.323	0.325	0.354	0.33	0.339	0.369	0.384	0.363	0.301
4	0.43	0.389	0.44	0.467	0.41	0.433	0.464	0.455	0.47	0.434
5	0.528	0.457	0.55	0.576	0.5	0.526	0.559	0.538	0.572	0.559
6	0.615	0.525	0.652	0.682	0.6	0.62	0.654	0.633	0.67	0.677
7	0.693	0.595	0.749	0.784	0.7	0.714	0.749	0.739	0.763	0.787
8	0.76	0.666	0.839	0.882	0.8	0.808	0.844	0.857	0.851	0.889
+gp	0.876	0.844	1.065	1.181	1.18	1.095	1.158	1.266	1.004	1.103
SOPCOFAC	1.005	1.026	1.023	1.014	1	1.013	1	1	1.005	1
AGE\YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.129	0.26	0.102	0.24	0.2	0.148	0.171	0.236	0.219	0
2	0.208	0.288	0.176	0.27	0.26	0.257	0.263	0.296	0.254	0.247
3	0.288	0.325	0.255	0.309	0.33	0.362	0.314	0.308	0.304	0.295
4	0.368	0.37	0.337	0.358	0.4	0.464	0.405	0.397	0.364	0.349
5	0.449	0.423	0.423	0.416	0.48	0.563	0.5	0.455	0.485	0.512
6	0.53	0.484	0.514	0.483	0.57	0.658	0.598	0.598	0.603	0.553
7	0.612	0.554	0.608	0.56	0.66	0.75	0.643	0.801	0.714	0.523
8	0.694	0.633	0.706	0.646	0.76	0.839	0.728	0.728	0.752	0.947
+gp	0.863	0.889	0.993	0.91	1.05	1.04	0.989	0.959	1.066	1.067
SOPCOFAC	1.003	1.002	1.001	1.001	1.01	1.002	1	1	1	1
AGE\YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.249	0.213	0.213	0.245	0.27	0.246	0.205	0.221	0.237	0.238
2	0.291	0.256	0.268	0.26	0.31	0.284	0.295	0.258	0.26	0.246
3	0.304	0.317	0.278	0.302	0.34	0.281	0.321	0.287	0.295	0.291
4	0.357	0.38	0.332	0.37	0.4	0.343	0.353	0.33	0.356	0.339
5	0.466	0.463	0.44	0.479	0.47	0.433	0.439	0.382	0.425	0.385
6	0.663	0.604	0.538	0.539	0.56	0.484	0.502	0.514	0.525	0.513
7	0.745	0.661	0.618	0.672	0.68	0.541	0.651	0.649	0.631	0.549
8	0.877	0.69	0.839	0.875	0.7	0.859	0.681	0.75	0.714	0.638
+gp	1.101	1.189	1.191	1.202	1.09	1.126	1.039	0.992	1.016	0.837
SOPCOFAC	1	1.001	1	1.001	1	1	0.999	1.001	1.001	1.001
AGE\YEAR	2007	2008	2009	2010	2011	2012	2013	2014	2015	
1	0.278	0.26	0.279	0.233	0.228	0.235	0.273	0.156	0.150	
2	0.271	0.273	0.267	0.292	0.242	0.246	0.285	0.280	0.240	
3	0.277	0.298	0.275	0.331	0.283	0.280	0.286	0.312	0.275	
4	0.303	0.329	0.329	0.328	0.335	0.307	0.32	0.346	0.300	
5	0.389	0.386	0.376	0.376	0.378	0.345	0.37	0.386	0.365	
6	0.457	0.433	0.469	0.458	0.465	0.418	0.465	0.504	0.467	
7	0.537	0.511	0.499	0.598	0.600	0.498	0.517	0.473	0.514	
8	0.547	0.719	0.605	0.469	0.690	0.570	0.602	0.599	0.609	
+gp	0.986	0.904	0.72	1.0433	1.1810	0.6750	0.655	0.735	0.946	
SOPCOFAC	1.001	1	0.999	1	1	1	1	1.001	1.002	

Table 7.10.7. Plaice in Divisions 7.f–g. Discards numbers-at-age.

DISCARD NUMBERS–AT–AGE			NUMBERS*10**-3											
AGE\YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	0	0	0	455	572	542	1829	73	671	385	960	142	614	83
2	0	0	0	360	1211	2584	3331	3595	985	2719	2656	2496	1283	987
3	0	0	0	641	441	750	3408	632	2041	1017	1429	1950	3581	1672
4	0	0	0	171	118	74	814	393	761	550	1019	502	1004	3195
5	0	0	0	68	41	47	81	69	399	345	501	179	231	454
6	0	0	0	3	12	12	32	4	44	54	45	163	32	173
7	0	0	0	4	4	1	11	1	4	8	99	58	44	77
8	0	0	0	1	22	1	9	1	5	0	56	25	11	27
+gp	0	0	0	0	0	0	0	0	0	0	0	8	8	36
TOTALNUM	0	0	0	1703	2421	4011	9515	4768	4910	5078	6765	5523	6808	6704
TONSLAND	0	0	0	274	321	453	1288	583	608	670	1107	852	1260	1158
SOPCOF %	0	0	0	100	100	100	100	100	100	100	100	100	100	100
AGE\YEAR	2015													
1	38													
2	1527													
3	1253													
4	753													
5	1106													
6	303													
7	54													
8	33													
+gp	80													
TOTALNUM	5145													
TONSLAND	870													
SOPCOF %	103													

Table 7.10.8. Plaice in Divisions 7.f–g. Discards weights-at-age.

	DISCARD WEIGHTS–AT–AGE (KG)													
AGE\YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	0	0	0	0.123	0.095	0.064	0.088	0.092	0.088	0.085	0.118	0.104	0.097	0.040
2	0	0	0	0.152	0.127	0.107	0.126	0.11	0.127	0.125	0.148	0.124	0.129	0.112
3	0	0	0	0.177	0.154	0.154	0.159	0.154	0.127	0.143	0.173	0.167	0.180	0.160
4	0	0	0	0.194	0.188	0.176	0.163	0.172	0.127	0.149	0.168	0.192	0.233	0.181
5	0	0	0	0.212	0.202	0.201	0.204	0.211	0.143	0.163	0.225	0.239	0.277	0.214
6	0	0	0	0.337	0.344	0.242	0.249	0.282	0.194	0.189	0.304	0.247	0.459	0.227
7	0	0	0	0.23	0.403	0.395	0.368	0.365	0.2	0.445	0.339	0.238	0.380	0.300
8	0	0	0	0.455	0.419	0.349	0.425	0.283	0.257	0.523	0.389	0.337	0.312	0.470
+gp	0	0	0	0	0	0	0	0	0	0	0	0	0	0.713
Discard weights-at-age (kg)														
AGE\YEAR	2015													
1	0.12													
2	0.124													
3	0.143													
4	0.171													
5	0.219													
6	0.315													
7	0.208													
8	0.204													
+gp	0.529													

Table 7.10.9. Plaice in Divisions 7.f–g. Stock weights-at-age.

Stock weights-at-age (kg)

AGE\YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.112	0.086	0.107	0.109	0.082	0.096	0.103	0.256	0.075	0.000
2	0.216	0.170	0.212	0.217	0.167	0.192	0.206	0.298	0.193	0.087
3	0.315	0.252	0.313	0.322	0.257	0.288	0.307	0.352	0.307	0.232
4	0.406	0.334	0.412	0.426	0.350	0.383	0.408	0.418	0.417	0.369
5	0.492	0.414	0.507	0.528	0.447	0.479	0.507	0.495	0.521	0.498
6	0.570	0.493	0.599	0.628	0.548	0.574	0.606	0.584	0.621	0.619
7	0.642	0.570	0.689	0.727	0.653	0.668	0.704	0.685	0.717	0.733
8	0.707	0.646	0.775	0.823	0.762	0.763	0.801	0.797	0.808	0.839
+gp	0.839	0.822	1.015	1.132	1.129	1.049	1.114	1.190	0.965	1.064

AGE\YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.089	0.249	0.066	0.228	0.173	0.092	0.171	0.236	0.219	0.000
2	0.168	0.273	0.139	0.254	0.229	0.203	0.263	0.296	0.254	0.247
3	0.248	0.305	0.215	0.288	0.293	0.310	0.314	0.308	0.304	0.295
4	0.328	0.346	0.295	0.332	0.363	0.414	0.405	0.397	0.364	0.349
5	0.408	0.395	0.380	0.386	0.440	0.514	0.500	0.455	0.485	0.512
6	0.489	0.453	0.468	0.448	0.523	0.611	0.598	0.598	0.603	0.553
7	0.571	0.518	0.560	0.520	0.613	0.705	0.643	0.801	0.714	0.523
8	0.653	0.593	0.657	0.602	0.710	0.795	0.728	0.728	0.752	0.947
+gp	0.822	0.837	0.938	0.854	0.987	1.000	0.989	0.959	1.066	1.067

AGE\YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.249	0.213	0.213	0.245	0.268	0.246	0.205	0.221	0.237	0.238
2	0.291	0.256	0.268	0.260	0.305	0.284	0.295	0.258	0.260	0.246
3	0.304	0.317	0.278	0.302	0.340	0.281	0.321	0.287	0.295	0.291
4	0.357	0.380	0.332	0.370	0.398	0.343	0.353	0.330	0.356	0.339
5	0.466	0.463	0.440	0.479	0.466	0.433	0.439	0.382	0.425	0.385
6	0.663	0.604	0.538	0.539	0.556	0.484	0.502	0.514	0.525	0.513
7	0.745	0.661	0.618	0.672	0.675	0.541	0.651	0.649	0.631	0.549
8	0.877	0.690	0.839	0.875	0.695	0.859	0.681	0.750	0.714	0.638
+gp	1.101	1.189	1.191	1.202	1.091	1.126	1.039	0.992	1.016	0.837

AGE\YEAR	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0.278	0.260	0.279	0.233	0.228	0.106	0.098	0.095	0.129
2	0.271	0.273	0.267	0.292	0.242	0.129	0.136	0.116	0.128
3	0.277	0.298	0.275	0.331	0.283	0.190	0.188	0.171	0.155
4	0.303	0.329	0.329	0.328	0.335	0.234	0.257	0.202	0.202
5	0.389	0.386	0.376	0.376	0.378	0.290	0.319	0.275	0.259
6	0.457	0.433	0.469	0.458	0.465	0.332	0.463	0.334	0.36
7	0.537	0.511	0.499	0.598	0.600	0.375	0.465	0.353	0.343
8	0.547	0.719	0.605	0.469	0.690	0.470	0.525	0.543	0.339
+gp	0.986	0.904	0.720	1.043	1.181	0.549	0.654	0.594	0.563

Table 7.10.10. Plaice in Divisions 7.f–g: Survey abundance indices (values used in the assessment highlighted in bold).

IRGFS							
2003	2015						
1	1	0.79	0.92				
1	7						
1	0.000	0.054	0.101	0.045	0.009	0.003	0.001
1	0.002	0.006	0.031	0.052	0.021	0.013	0.001
1	0.046	0.074	0.098	0.022	0.011	0.003	0.004
1	0.003	0.100	0.077	0.021	0.017	0.010	0.011
1	0.002	0.043	0.142	0.058	0.019	0.008	0.007
1	0.006	0.099	0.093	0.064	0.017	0.007	0.004
1	0.209	0.196	0.538	0.243	0.098	0.020	0.015
1	0.169	0.631	0.220	0.347	0.143	0.061	0.017
1	0.180	0.826	0.504	0.140	0.151	0.060	0.077
1	0.244	0.675	0.613	0.188	0.034	0.033	0.048
1	0.026	0.268	0.621	0.328	0.120	0.032	0.103
1	0.006	0.131	0.238	0.226	0.101	0.056	0.037
1	0.013	0.630	0.470	0.216	0.253	0.049	0.083
UK (E+W) BEAM TRAWL 7.F.							
1990 2015							
1 1 0 1							
4 8							
1	12.6	3.656	2.103		0.868	0.725	
1	8.372	5.158	1.715		0.894	0.834	
1	2.254	3.289	1.93		0.528	0.162	
1	1.528	0.947	1.498		0.923	0.443	
1	2.245	0.424	0.415		0.347	0.446	
1	1.715	1.289	0.43		0.252	0.278	
1	0.569	0.569	0.535		0.159	0.184	
1	0.909	0.319	0.256		0.169	0.026	
1	2.221	0.618	0.127		0.151	0.095	
1	1.72	0.844	0.252		0.078	0.062	
1	0.858	0.568	0.405		0.156	0.057	
1	0.867	0.558	0.318		0.186	0.076	
1	0.637	0.294	0.279		0.143	0.079	
1	1.349	0.393	0.199		0.135	0.094	
1	1.051	0.711	0.136		0.104	0.08	
1	0.671	0.396	0.269		0.102	0.061	
1	0.353	0.338	0.233		0.12	0.03	
1	0.853	0.227	0.142		0.099	0.043	
1	1.506	0.433	0.158		0.117	0.075	
1	1.375	0.968	0.271		0.09	0.054	
1	1.601	0.62	0.508		0.146	0.009	
1	0.841	1.002	0.357		0.3	0.092	

UK E+W OTTER TRAWL 7.F						
1	1.03	0.497	0.398		0.192	0.085
1	0.759	0.342	0.112		0.162	0.062
1	1.564	0.688	0.125		0.073	0.063
1	0.468	0.964	0.358		0.096	0.055

UK E+W OTTER TRAWL 7.F					
1989			2015		
1 1 0 1					
4 8					
1	6.366	2.37	0.766	0.518	0.041
1	10.452	2.774	1.074	0.333	0.35
1	7.29	3.415	1.529	0.413	0.46
1	1.391	2.059	0.946	0.156	0.045
1	1.065	0.479	0.754	0.491	0.335
1	2.407	0.433	0.498	0.225	0.273
1	2.5	0.948	0.276	0.138	0.121
1	0.725	0.574	0.422	0.169	0.186
1	0.953	0.208	0.121	0.069	0.017
1	1.664	0.387	0.097	0.135	0.039
1	1.997	0.961	0.228	0.051	0.025
1	2.327	0.882	0.458	0.141	0.035
1	1.326	0.809	0.42	0.194	0.065
1	0.696	0.36	0.264	0.12	0.048
1	1.335	0.302	0.187	0.129	0.086
1	1.622	0.905	0.14	0.078	0.047
1	0.628	0.331	0.171	0.057	0.034
1	0.736	0.703	0.487	0.26	0.065
1	0.939	0.276	0.175	0.125	0.063
1	1.645	0.52	0.197	0.098	0.056
1	0.731	0.472	0.122	0.046	0.03
1	1.311	0.496	0.407	0.089	0.018
1	0.171	0.229	0.114	0.076	0.057
1	0.847	0.368	0.276	0.111	0.037
1	0.107	0.143	0.071	0.036	0.036
1	0.514	0.193	0.129	0.001	0.001
1	0.759	1.266	0.506	0.253	0.001

E+W BT Survey					
1995 2015					
1 1 0.75 0.85					
1 5					
1	239.590	90.480	17.230	2.960	6.840
1	223.690	288.110	30.780	0.990	2.620
1	225.370	102.140	34.540	4.250	1.770
1	237.200	126.220	46.990	8.920	2.000
1	152.590	79.620	29.030	19.670	7.000
1	339.630	63.170	31.250	6.560	5.500
1	211.440	156.140	15.810	8.740	4.230
1	136.740	175.120	80.450	5.930	6.130
1	98.370	80.480	60.950	21.830	2.720
1	258.510	33.410	27.080	13.420	2.190
1	192.500	75.220	20.870	8.060	10.930
1	85.780	101.970	34.160	9.570	1.790
1	150.400	92.250	47.260	15.110	1.670
1	140.690	217.040	46.790	15.700	4.820
1	161.810	55.960	78.580	21.450	10.890
1	331.760	88.540	26.410	39.940	6.680
1	362.260	300.140	55.040	21.860	21.370
1	142.130	430.790	100.570	22.360	9.020
1	329.790	139.060	185.390	46.850	5.770
1	371.760	202.300	64.650	105.700	23.800
1	28.360	454.080	162.340	52.370	76.660

Table 7.10.12. Plaice in Divisions 7.f–g: AP Model Diagnostics (TV – PTVS).

Fri May 06 16:45:11 2016	
SEL_MODEL	TV
DISC_MODEL	PTVS
firstoptMETHOD	SANN
mainMETHOD	BFGS
BFGS_MAXIT	5000
BFGS_RELTOL	1.00E-30
n.tries for uncertainty	1000
eigenvalues Hessian positive?	FALSE
negative log.likelihood	352.358
AIC	910.716
Nparameters	103
Nobservations	615
Final parameter values	
Ftrend 1	0.638346
Ftrend 2	0.743099
Ftrend 3	0.882164
Ftrend 4	0.830481
Ftrend 5	0.892222
Ftrend 6	0.91307
Ftrend 7	0.955778
Ftrend 8	0.849179
Ftrend 9	0.765398
Ftrend 10	0.993279
Ftrend 11	0.918566
Ftrend 12	0.888324
Ftrend 13	0.752335
Ftrend 14	0.757653
Ftrend 15	0.913443
Ftrend 16	0.718101
Ftrend 17	0.753022
Ftrend 18	0.766037
Ftrend 19	0.842151
Ftrend 20	0.996215
Ftrend 21	0.950318
Ftrend 22	0.954402
Ftrend 23	1.1278
sel.C 1	-0.80675
sel.C 2	-0.30411
sel.C 3	5.295411
sel.C 4	-0.21896
sel.C 5	-0.26303
sel.C 6	0.510491

sel.C 7	-0.50729
sel.C 8	0.498101
logrecruitment 1	20.26152
logrecruitment 2	19.74485
logrecruitment 3	17.52638
logrecruitment 4	15.10814
logrecruitment 5	13.39841
logrecruitment 6	12.81914
logrecruitment 7	11.53269
logrecruitment 8	9.211119
logrecruitment 9	9.664773
logrecruitment 10	9.978558
logrecruitment 11	9.652323
logrecruitment 12	9.401153
logrecruitment 13	9.081755
logrecruitment 14	8.857108
logrecruitment 15	9.24781
logrecruitment 16	8.91604
logrecruitment 17	8.65246
logrecruitment 18	8.108444
logrecruitment 19	8.681788
logrecruitment 20	9.120739
logrecruitment 21	8.827452
logrecruitment 22	9.094763
logrecruitment 23	8.438779
logrecruitment 24	8.854533
logrecruitment 25	9.311828
logrecruitment 26	9.729803
logrecruitment 27	8.885989
logrecruitment 28	9.058251
logrecruitment 29	9.464907
logrecruitment 30	7.035695
Catchability1	-6.04173
Catchability2	-5.25927
Catchability3	-3.45354
sel.U 1	-0.4289
sel.U 2	0.211157
sel.U 3	0.505078
sel.U 4	3.918795
sel.U 5	-1.64417
sel.U 6	-1.36413
sel.U 7	-0.68337
sel.U 8	-1.27504
sel.U 9	19.84145
sel.U 10	-4.36072
sel.U 11	0.688687

sel.U 12	0.237487
b1	4.825097
b2	-4.84279
b3	2.802962
b4	-2.7583
b5	-0.16986
b6	0.6516
b7	-0.47982
b8	0.190352
b9	0.02053
b10	-0.00594
b11	0.018301
b12	-0.00479
sds.land1	-2.37109
sds.land2	-3.48871
sds.land3	3.772204
sds.disc1	-0.54077
sds.disc2	0.612232
sds.disc3	0.821269
sds.tun1	-1.6195
sds.tun2	0.29584
sds.tun3	0.623708
sds.tun4	-0.38748
sds.tun5	0.460195
sds.tun6	0.473479
sds.tun7	-0.84311
sds.tun8	
sds.tun9	-0.17237
Initial parameter values	
Ftrend 1	0.638346
Ftrend 2	0.743099
Ftrend 3	0.882164
Ftrend 4	0.830481
Ftrend 5	0.892222
Ftrend 6	0.91307
Ftrend 7	0.955778
Ftrend 8	0.849179
Ftrend 9	0.765398
Ftrend 10	0.993279
Ftrend 11	0.918566
Ftrend 12	0.888324
Ftrend 13	0.752335
Ftrend 14	0.757653
Ftrend 15	0.913443
Ftrend 16	0.718101

Ftrend 17	0.753022
Ftrend 18	0.766037
Ftrend 19	0.842151
Ftrend 20	0.996215
Ftrend 21	0.950318
Ftrend 22	0.954402
Ftrend 23	1.1278
sel.C 1	-0.80675
sel.C 2	-0.30411
sel.C 3	5.295411
sel.C 4	-0.21896
sel.C 5	-0.26303
sel.C 6	0.510491
sel.C 7	-0.50729
sel.C 8	0.498101
logrecruitment 1	20.26152
logrecruitment 2	19.74485
logrecruitment 3	17.52638
logrecruitment 4	15.10814
logrecruitment 5	13.39841
logrecruitment 6	12.81914
logrecruitment 7	11.53269
logrecruitment 8	9.211119
logrecruitment 9	9.664773
logrecruitment 10	9.978558
logrecruitment 11	9.652323
logrecruitment 12	9.401153
logrecruitment 13	9.081755
logrecruitment 14	8.857108
logrecruitment 15	9.24781
logrecruitment 16	8.91604
logrecruitment 17	8.65246
logrecruitment 18	8.108444
logrecruitment 19	8.681788
logrecruitment 20	9.120739
logrecruitment 21	8.827452
logrecruitment 22	9.094763
logrecruitment 23	8.438779
logrecruitment 24	8.854533
logrecruitment 25	9.311828
logrecruitment 26	9.729803
logrecruitment 27	8.885989
logrecruitment 28	9.058251
logrecruitment 29	9.464907
logrecruitment 30	7.035695
Catchability1	-6.04173

Catchability2	-5.25927
Catchability3	-3.45354
sel.U 1	-0.4289
sel.U 2	0.211157
sel.U 3	0.505078
sel.U 4	3.918795
sel.U 5	-1.64417
sel.U 6	-1.36413
sel.U 7	-0.68337
sel.U 8	-1.27504
sel.U 9	19.84145
sel.U 10	-4.36072
sel.U 11	0.688687
sel.U 12	0.237487
b1	4.825097
b2	-4.84279
b3	2.802962
b4	-2.7583
b5	-0.16986
b6	0.6516
b7	-0.47982
b8	0.190352
b9	0.02053
b10	-0.00594
b11	0.018301
b12	-0.00479
sds.land1	-2.37109
sds.land2	-3.48871
sds.land3	3.772204
sds.disc1	-0.54077
sds.disc2	0.612232
sds.disc3	0.821269
sds.tun1	-1.6195

Table 7.10.13 Plaice in divisions VIIf&g: Fishing mortalities

Total Fishing mortality at age

AGE\YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average(1
1	0.186	0.157	0.165	0.148	0.142	0.112	0.091	0.108	0.088	0.079	0.06	0.054	0.058	0.041	0.04	0.037	0.037	0.04	0.034	0.031	0.031	0.032
2	0.803	0.742	0.853	0.829	0.871	0.743	0.654	0.829	0.72	0.677	0.536	0.492	0.532	0.371	0.35	0.303	0.279	0.275	0.213	0.171	0.149	0.178
3	0.814	0.755	0.874	0.857	0.91	0.788	0.707	0.92	0.826	0.81	0.676	0.66	0.77	0.588	0.612	0.591	0.611	0.681	0.596	0.54	0.525	0.554
4	0.793	0.735	0.849	0.833	0.885	0.767	0.69	0.901	0.813	0.805	0.68	0.676	0.806	0.634	0.685	0.694	0.761	0.909	0.865	0.863	0.938	0.889
5	0.668	0.627	0.733	0.728	0.784	0.688	0.627	0.831	0.76	0.763	0.655	0.661	0.802	0.641	0.706	0.729	0.815	0.995	0.968	0.99	1.103	1.020
6	0.591	0.566	0.674	0.679	0.742	0.66	0.608	0.814	0.752	0.761	0.657	0.668	0.814	0.654	0.723	0.749	0.839	1.027	1.001	1.025	1.144	1.057
7	0.799	0.742	0.861	0.846	0.903	0.786	0.711	0.933	0.847	0.844	0.719	0.721	0.867	0.689	0.753	0.773	0.858	1.041	1.007	1.023	1.134	1.055
8	0.799	0.742	0.861	0.846	0.903	0.786	0.711	0.933	0.847	0.844	0.719	0.721	0.867	0.689	0.753	0.773	0.858	1.041	1.007	1.023	1.134	1.055
+gp	0.799	0.742	0.861	0.846	0.903	0.786	0.711	0.933	0.847	0.844	0.719	0.721	0.867	0.689	0.753	0.773	0.858	1.041	1.007	1.023	1.134	1.055
FBAR 3- 6	0.717	0.671	0.783	0.774	0.830	0.726	0.658	0.867	0.788	0.785	0.667	0.666	0.798	0.629	0.682	0.691	0.757	0.903	0.858	0.855	0.928	0.880

Discard Fishing mortality at age

AGE\YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average(1
1	0.172	0.148	0.158	0.143	0.138	0.109	0.089	0.106	0.087	0.078	0.059	0.053	0.057	0.041	0.040	0.037	0.037	0.040	0.034	0.031	0.031	0.032
2	0.750	0.687	0.782	0.754	0.787	0.668	0.585	0.741	0.644	0.607	0.483	0.446	0.486	0.342	0.326	0.285	0.264	0.263	0.205	0.166	0.146	0.172
3	0.485	0.437	0.496	0.479	0.507	0.441	0.400	0.532	0.492	0.500	0.435	0.443	0.542	0.434	0.473	0.477	0.514	0.594	0.536	0.498	0.495	0.510
4	0.051	0.058	0.081	0.097	0.125	0.130	0.140	0.216	0.229	0.265	0.257	0.291	0.389	0.341	0.405	0.445	0.525	0.667	0.669	0.697	0.787	0.718
5	0.004	0.007	0.013	0.019	0.030	0.039	0.049	0.088	0.109	0.140	0.151	0.188	0.267	0.248	0.308	0.351	0.425	0.554	0.567	0.604	0.693	0.622
6	0.005	0.004	0.010	0.015	0.023	0.028	0.039	0.066	0.073	0.098	0.102	0.129	0.185	0.164	0.210	0.237	0.288	0.372	0.381	0.398	0.453	0.411
7	0.188	0.155	0.157	0.137	0.129	0.110	0.093	0.118	0.102	0.091	0.077	0.085	0.104	0.081	0.112	0.117	0.137	0.187	0.204	0.242	0.289	0.245
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
FBAR 3- 6	0.136	0.127	0.150	0.153	0.171	0.159	0.157	0.226	0.226	0.251	0.236	0.263	0.346	0.297	0.349	0.378	0.438	0.547	0.538	0.549	0.607	0.565

Landings Fishing mortality at age

AGE\YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average(1
1	0.014	0.009	0.007	0.005	0.004	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.053	0.055	0.071	0.075	0.084	0.075	0.069	0.088	0.076	0.070	0.053	0.046	0.046	0.029	0.024	0.018	0.015	0.012	0.008	0.005	0.003	0.005
3	0.329	0.318	0.378	0.378	0.403	0.347	0.307	0.388	0.334	0.310	0.241	0.217	0.228	0.154	0.139	0.114	0.097	0.087	0.060	0.042	0.030	0.044
4	0.742	0.677	0.768	0.736	0.760	0.637	0.550	0.685	0.584	0.540	0.423	0.385	0.417	0.293	0.280	0.249	0.236	0.242	0.196	0.166	0.151	0.171
5	0.664	0.620	0.720	0.709	0.754	0.649	0.578	0.743	0.651	0.623	0.504	0.473	0.535	0.393	0.398	0.378	0.390	0.441	0.401	0.386	0.410	0.399
6	0.586	0.562	0.664	0.664	0.719	0.632	0.569	0.748	0.679	0.663	0.555	0.539	0.629	0.491	0.513	0.512	0.551	0.655	0.620	0.627	0.691	0.646
7	0.611	0.587	0.704	0.709	0.774	0.676	0.618	0.815	0.745	0.753	0.642	0.636	0.763	0.608	0.641	0.656	0.721	0.854	0.803	0.781	0.845	0.810
8	0.799	0.742	0.861	0.846	0.903	0.786	0.711	0.933	0.847	0.844	0.719	0.721	0.867	0.689	0.753	0.773	0.858	1.041	1.007	1.023	1.134	1.055
+gp	0.799	0.742	0.861	0.846	0.903	0.786	0.711	0.933	0.847	0.844	0.719	0.721	0.867	0.689	0.753	0.773	0.858	1.041	1.007	1.023	1.134	1.055
FBAR 3- 6	0.580	0.544	0.633	0.621	0.659	0.566	0.501	0.641	0.562	0.534	0.431	0.403	0.452	0.333	0.332	0.313	0.319	0.356	0.319	0.305	0.321	0.315

Table 7.10.14. Plaice in Divisions 7.f–g: Population numbers.

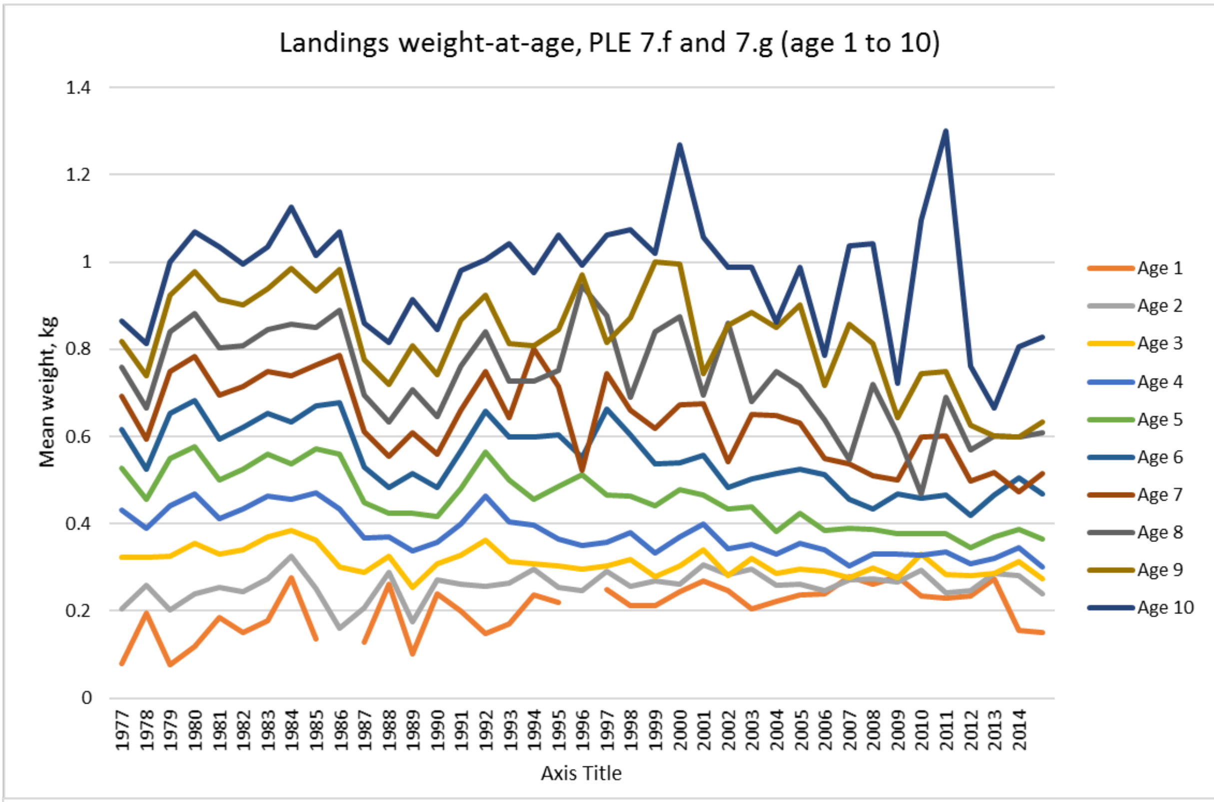
Stock number at age (start of year) Numbers*10**-3

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	10008	15753	21559	15558	12102	8793	7024	10382	7451	5724	3322	5895	9143
2	5969	4818	7119	9034	7187	5680	4357	3647	6104	4823	3607	2271	4259
3	4035	3696	2833	3912	5149	4005	3163	2399	2137	3756	2689	2102	1354
4	1363	2453	2092	1458	2057	2580	1960	1491	1203	1124	1675	1251	990
5	774	707	1159	873	632	842	1032	752	626	542	412	654	500
6	612	363	298	425	337	230	301	355	288	261	181	148	243
7	435	288	154	110	164	123	82	103	135	119	86	64	54
8	226	272	164	77	55	75	53	33	44	61	43	32	24
+gp	211	190	319	230	179	116	133	65	60	49	44	31	33
TOTAL	25626	30534	37692	33673	29859	24442	20104	21227	20049	18461	14062	14452	18605

AGE\YEAR	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	6819	8909	4623	7006	11068	16811	7230	8589	12899	1136
2	7052	5407	7103	3842	5894	9417	14393	6209	7440	11234
3	2718	4523	3275	4713	2536	3905	6113	8911	3942	4756
4	697	1385	2042	1707	2388	1269	1838	2550	3828	1679
5	446	312	537	949	771	1068	531	671	969	1448
6	212	189	114	239	411	331	429	185	245	354
7	101	88	67	50	101	173	130	146	66	87
8	23	42	31	29	21	42	66	43	50	23
+gp	30	22	30	24	16	32	52	68	113	197
TOTAL	20104	22884	19830	20568	25216	35059	32794	29385	31566	22929

Table 7.10.15. Plaice in Divisions 7.f–g: Summary table.

	SSB (t)			Recruitment (000's)			Landings (t)			Discards (t)			Total Fbar(3-6)			Partial Fbar	
Percentile	0.05	0.5	0.95	0.05	0.5	0.95	0.05	0.5	0.95	0.05	0.5	0.95	0.05	0.5	0.95	Landings	Discards
1993	3381	2834	2411	7391	10059	13674	700	807	928	453	750	1218	0.463	0.546	0.643	0.325	0.221
1994	3368	2859	2439	12072	15766	20805	843	956	1083	690	1017	1540	0.556	0.638	0.735	0.392	0.249
1995	3028	2608	2252	17055	21634	27509	861	972	1096	1027	1456	2015	0.679	0.763	0.858	0.478	0.287
1996	2804	2473	2176	12680	15554	19192	806	916	1039	839	1134	1537	0.645	0.721	0.804	0.460	0.265
1997	3057	2714	2402	10020	12066	14619	995	1124	1269	725	964	1279	0.705	0.778	0.858	0.501	0.280
1998	2870	2569	2305	7358	8819	10446	947	1064	1190	575	757	981	0.730	0.801	0.874	0.518	0.285
1999	2286	2049	1849	5915	7035	8392	774	856	946	483	618	789	0.772	0.841	0.921	0.546	0.298
2000	1941	1763	1598	8714	10407	12268	609	675	749	456	578	723	0.684	0.750	0.817	0.485	0.267
2001	2056	1863	1677	6310	7461	8772	566	636	710	379	480	601	0.618	0.681	0.742	0.436	0.244
2002	1908	1717	1546	4884	5714	6752	648	717	802	414	521	645	0.816	0.884	0.963	0.561	0.325
2003	1756	1591	1447	2885	3336	3837	541	604	669	299	368	452	0.751	0.821	0.900	0.512	0.310
2004	1325	1212	1111	5139	5870	6825	396	435	483	322	392	478	0.734	0.797	0.865	0.487	0.311
2005	1287	1186	1095	7951	9190	10497	308	341	382	281	345	419	0.617	0.674	0.739	0.402	0.275
2006	1546	1415	1286	5989	6814	7810	327	366	410	302	373	453	0.619	0.681	0.745	0.394	0.291
2007	1840	1669	1521	7812	8894	10066	421	473	527	467	563	673	0.736	0.820	0.917	0.456	0.369
2008	2078	1904	1719	4061	4631	5299	359	397	441	382	449	526	0.577	0.649	0.721	0.341	0.303
2009	2104	1924	1724	6151	7016	8018	376	417	462	356	420	495	0.612	0.680	0.746	0.339	0.334
2010	2289	2088	1871	9531	11077	12868	368	410	451	401	473	556	0.627	0.689	0.757	0.325	0.356
2011	2429	2199	1973	14291	16841	19701	367	404	445	677	815	973	0.689	0.759	0.829	0.336	0.412
2012	1933	1736	1542	5982	7248	8934	368	411	456	991	1165	1408	0.814	0.893	0.978	0.373	0.511
2013	2280	2019	1768	6506	8638	11315	352	391	432	1048	1256	1502	0.773	0.852	0.944	0.331	0.512
2014	1838	1597	1394	8932	12875	18375	336	379	417	741	885	1082	0.767	0.857	0.958	0.310	0.537
2015	1856	1559	1310	723	1154	1780	287	326	362	836	1057	1346	0.813	1.017	1.243	0.339	0.664



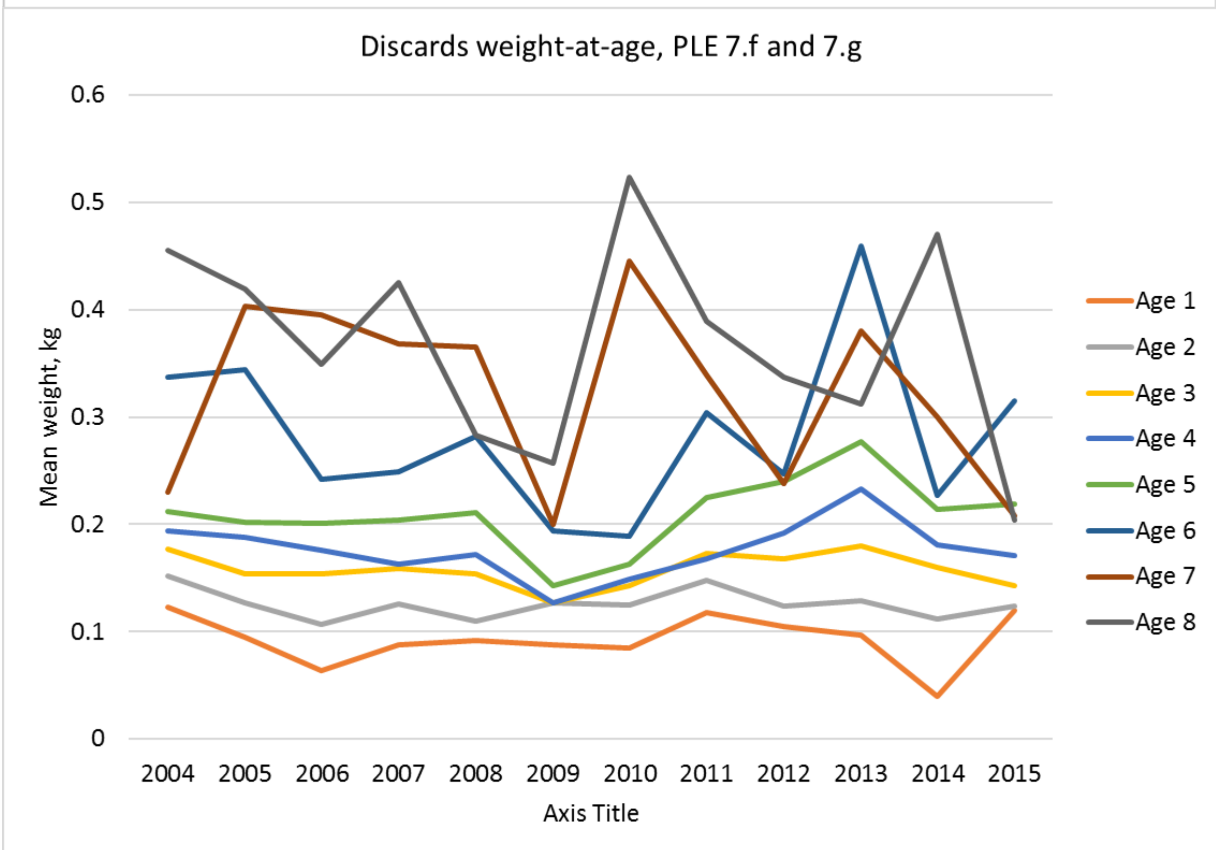


Figure 7.10.1. Plaice in Divisions 7.f–g: Landings and discards weights-at-age.

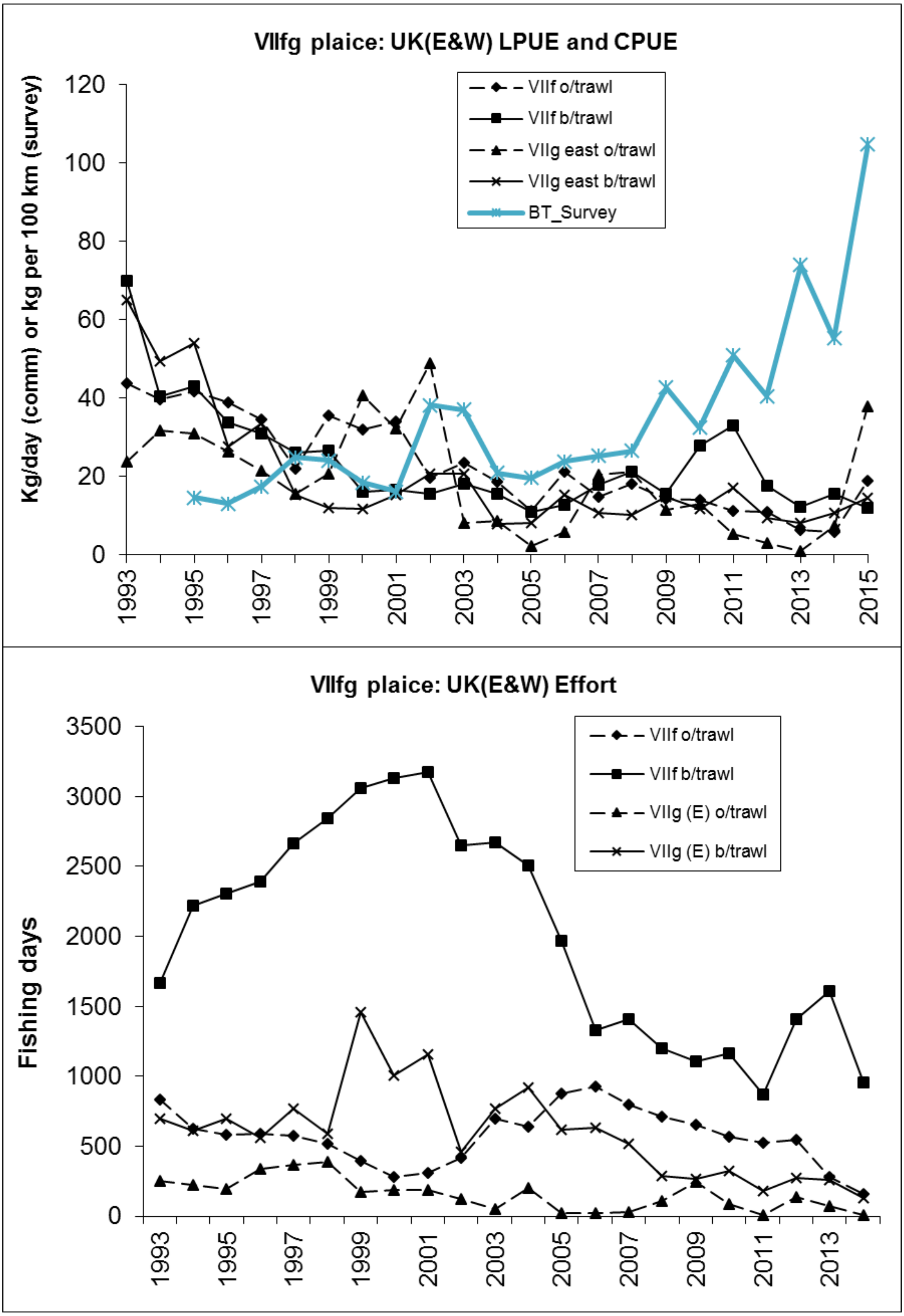


Figure 7.10.2. Plaice in Divisions 7.f–g: UK(E&W) lpue and effort by commercial fleet and survey cpue of commercial plaice (3+).

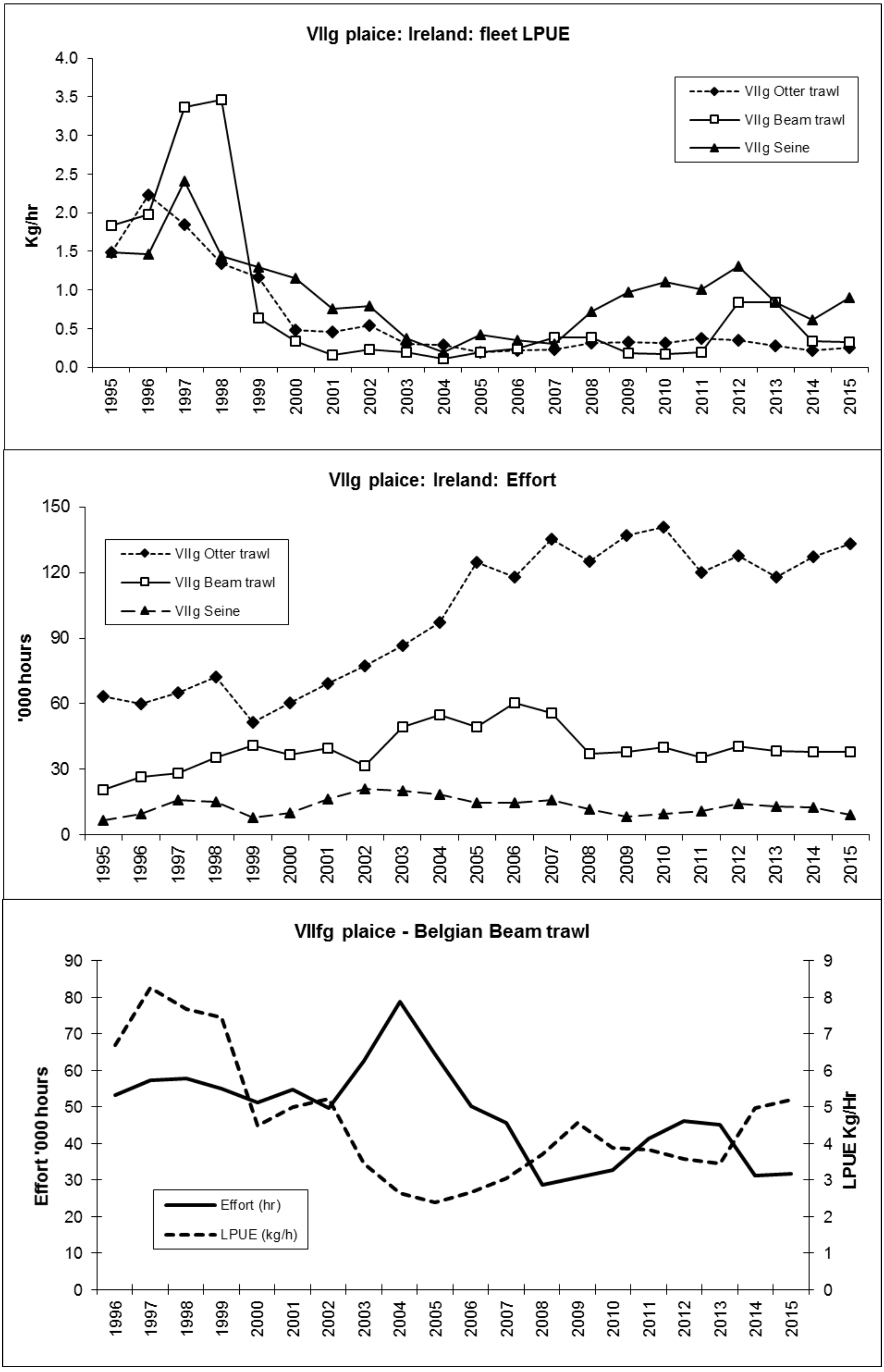


Figure 7.10.3. Plaice in Divisions 7.f–g: Ireland and Belgium: lpue and effort by fleet.

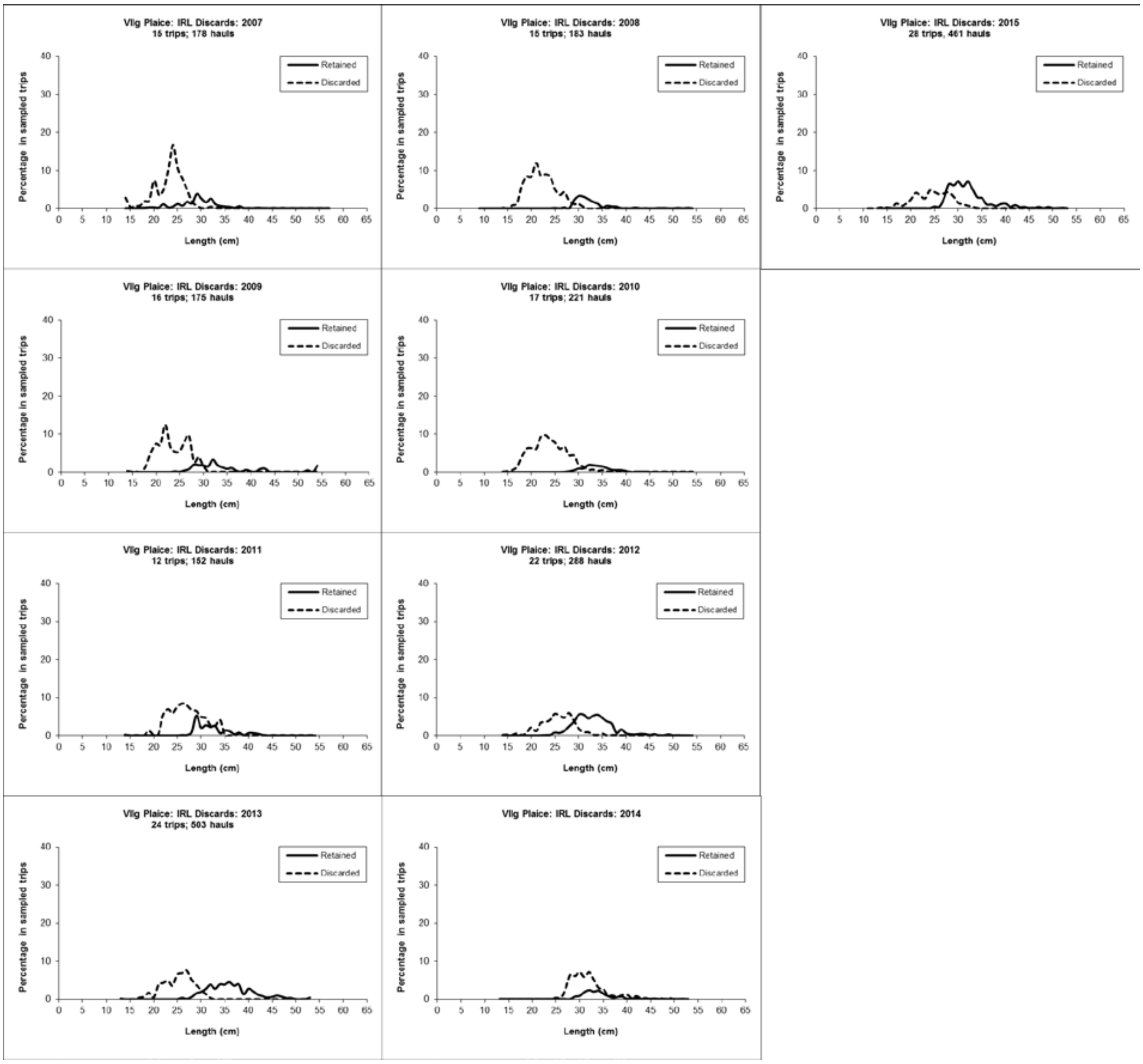


Figure 7.10.4a. Plaice in Divisions 7.f–g: Ireland otter trawl discard sampling results in 2007–2015; raised to sampled trips.

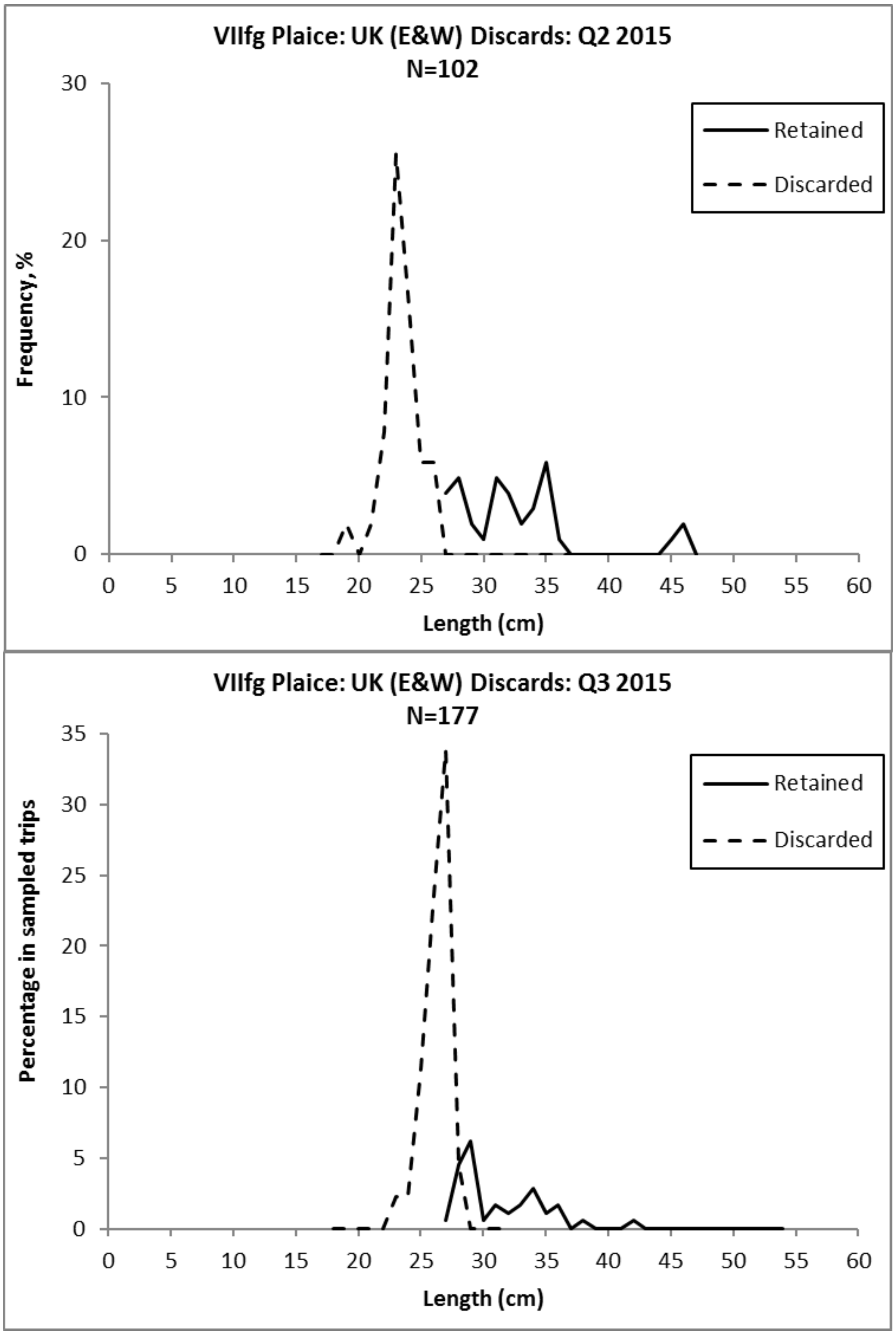


Figure 7.10.4b. Plaice in Divisions 7.f–g: UK(E&W) Discard sampling results in 2014 (only restricted data for Q2 and Q3 available); raised to sampled trips. All gears bar beam.

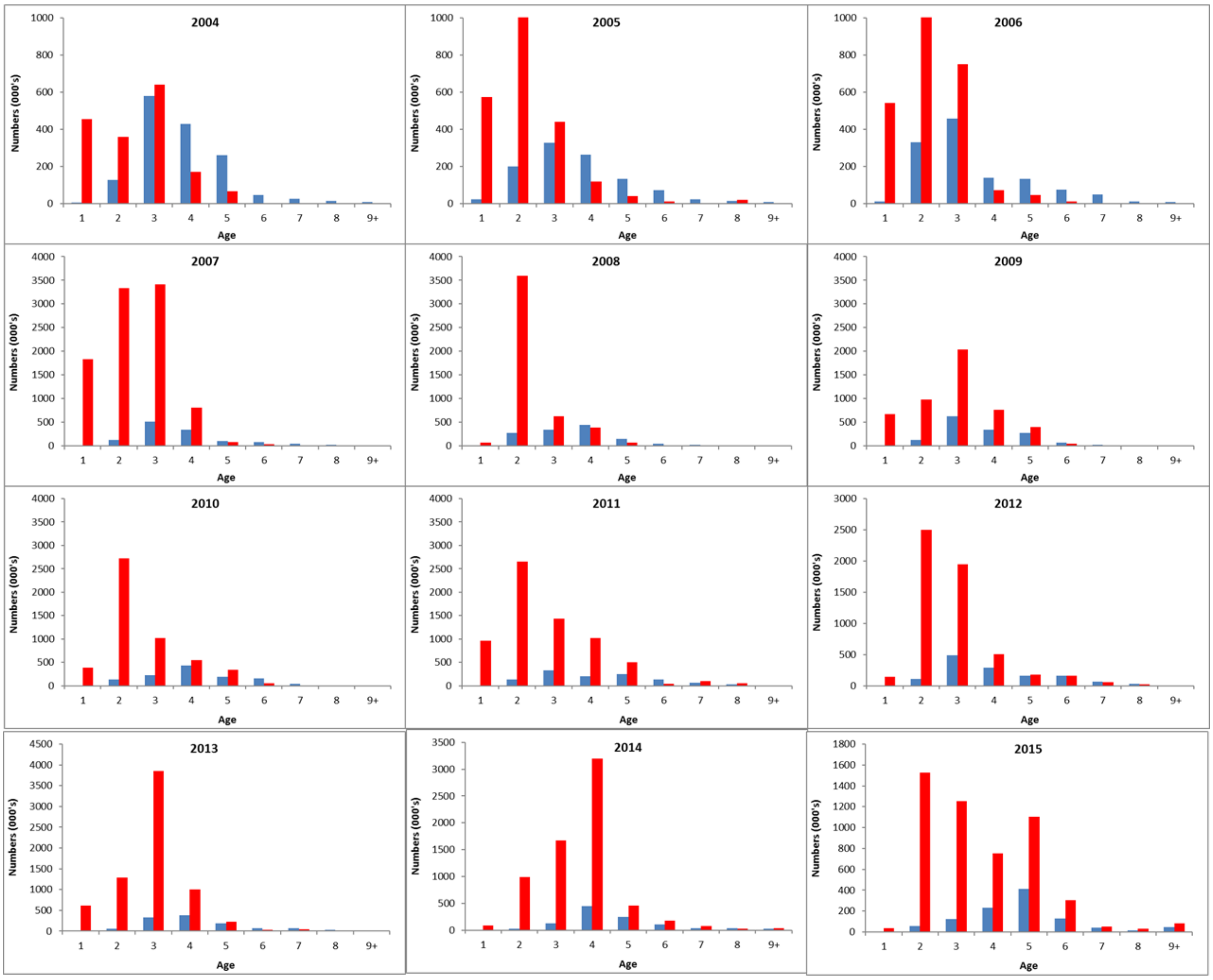


Figure. 7.10.5. Plaice in Divisions 7.f–g: Age composition of international landings and discards from 2004 to 2015 (blue = landings, red = discards).

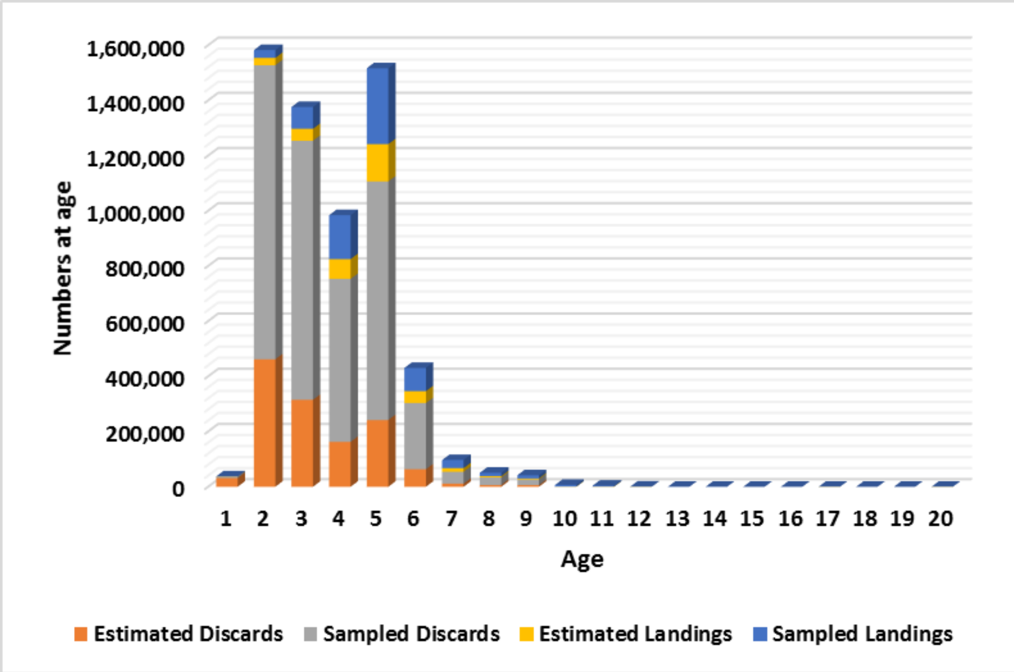


Figure 7.10.6. Plaice in Division 7.f–g: Contribution of sampled and unsampled landings and discards to final assessment catch numbers-at-age in 2015.

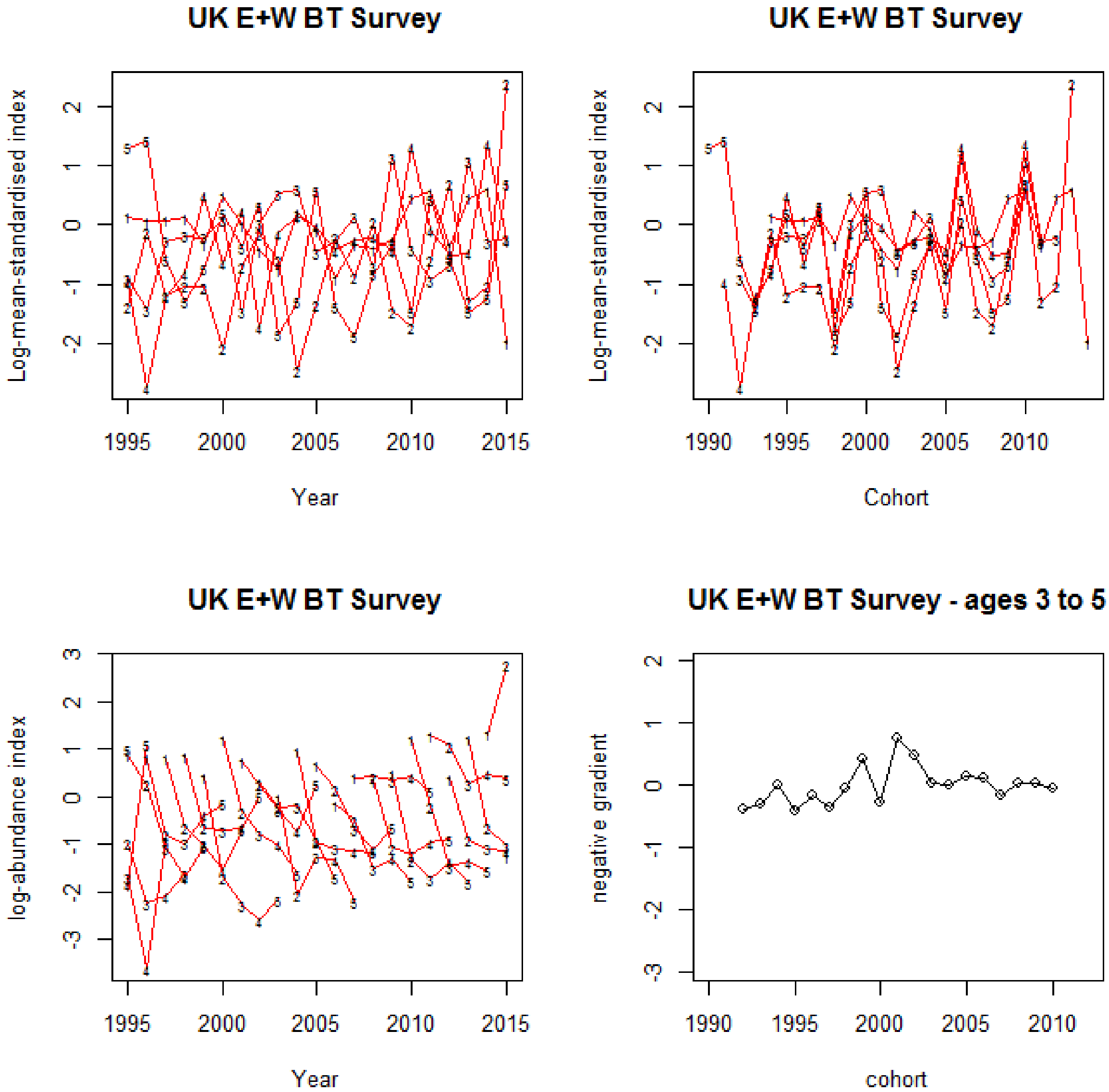


Figure 7.10.7. Plaice in Divisions 7.f–g: UK beam-trawl survey (UK(E&W)-BTS-Q3) log cpue by year, year class, log catch curves and the negative slopes of the catch curves (~Z).

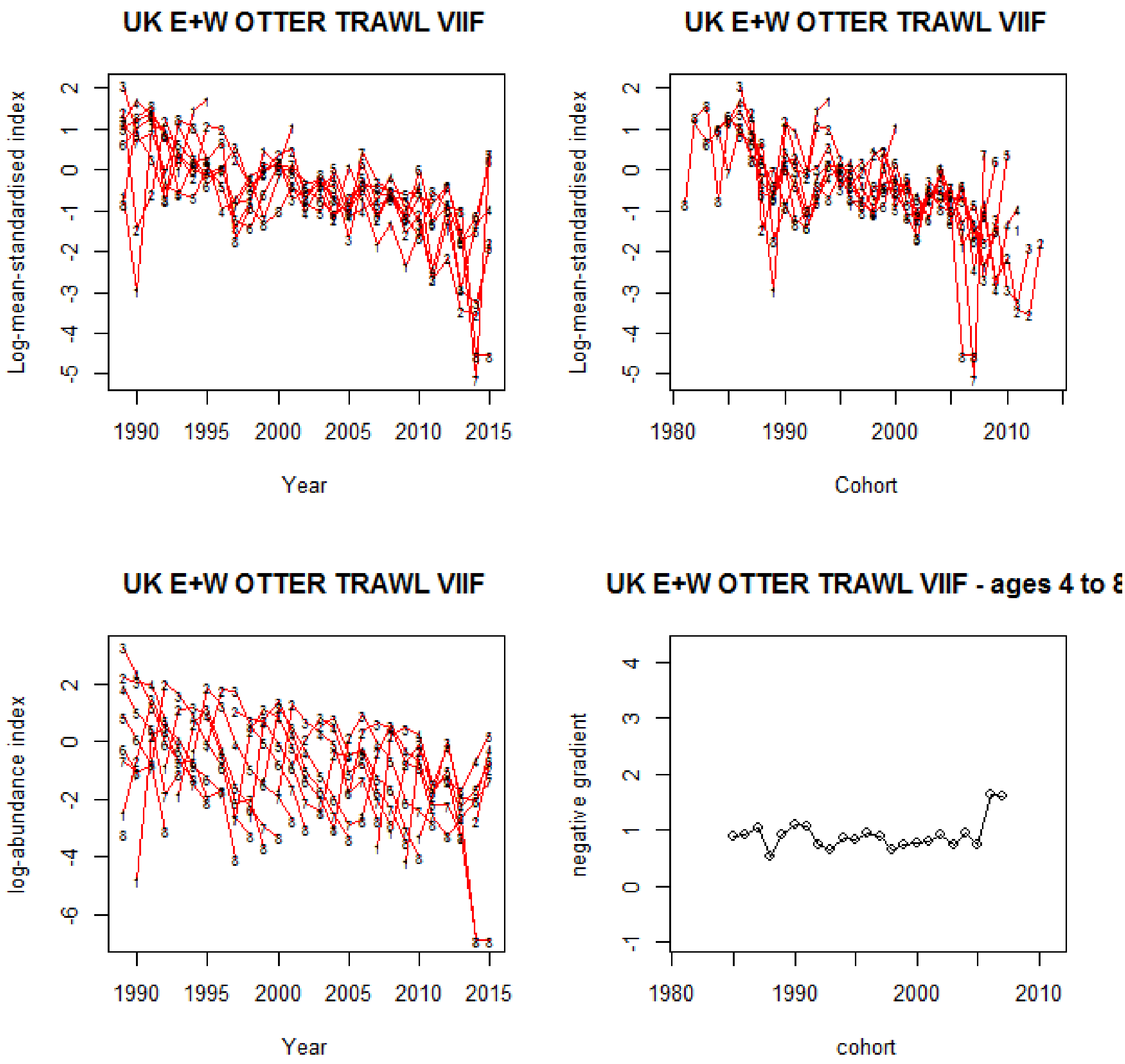


Figure 7.10.8. Plaice in Divisions 7.f–g: UK(E&W) otter trawl fleet log cpue by year, year class, log catch curves and the negative slopes of the catch curves (~Z).

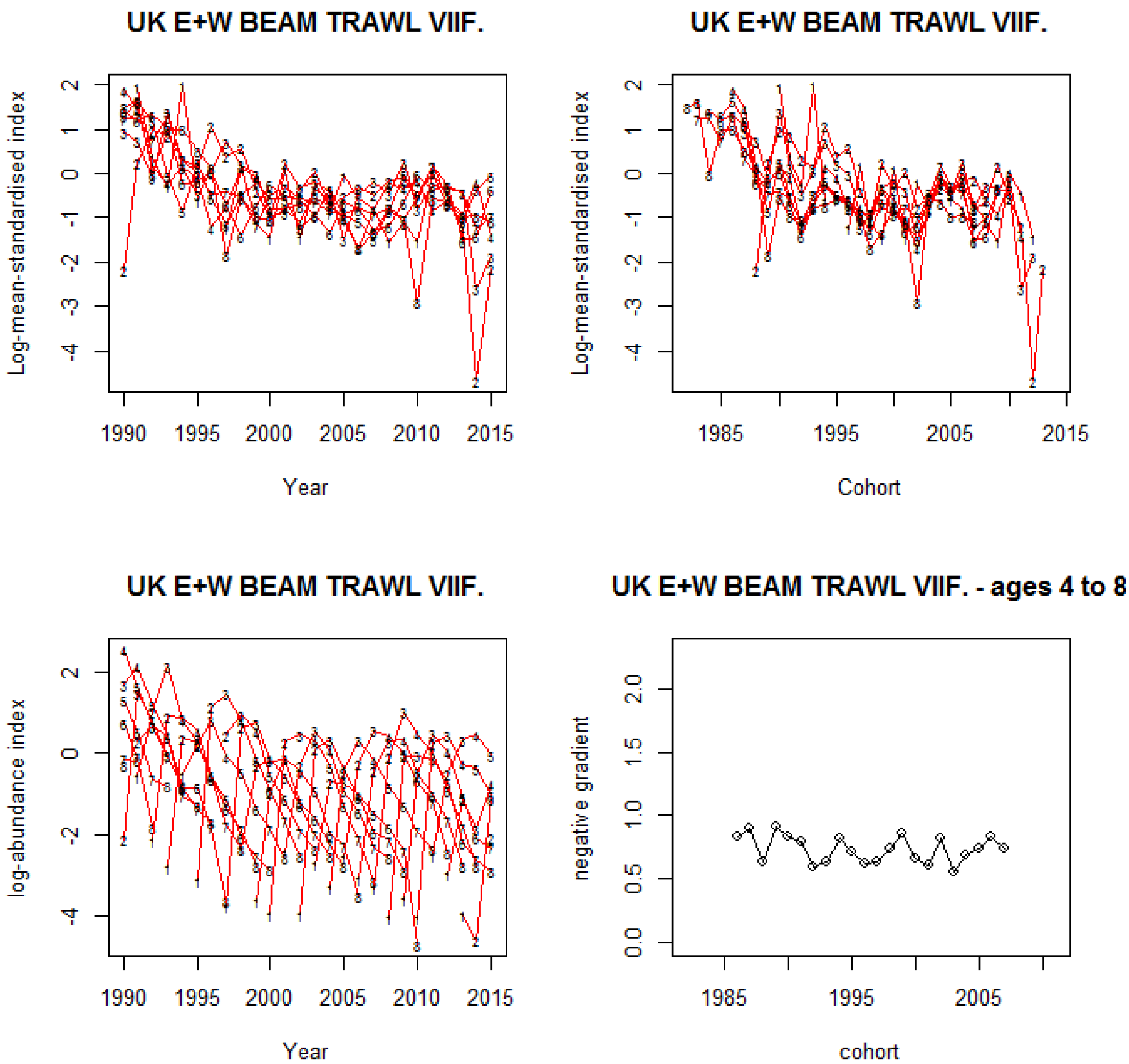


Figure 7.10.9. Plaice in Divisions 7.f–g: UK(E&W) beam-trawl fleet log cpue by year, year class, log catch curves and the negative slopes of the catch curves (~Z). Data up to 2012 only because of insufficient data of fishing effort in 2013.

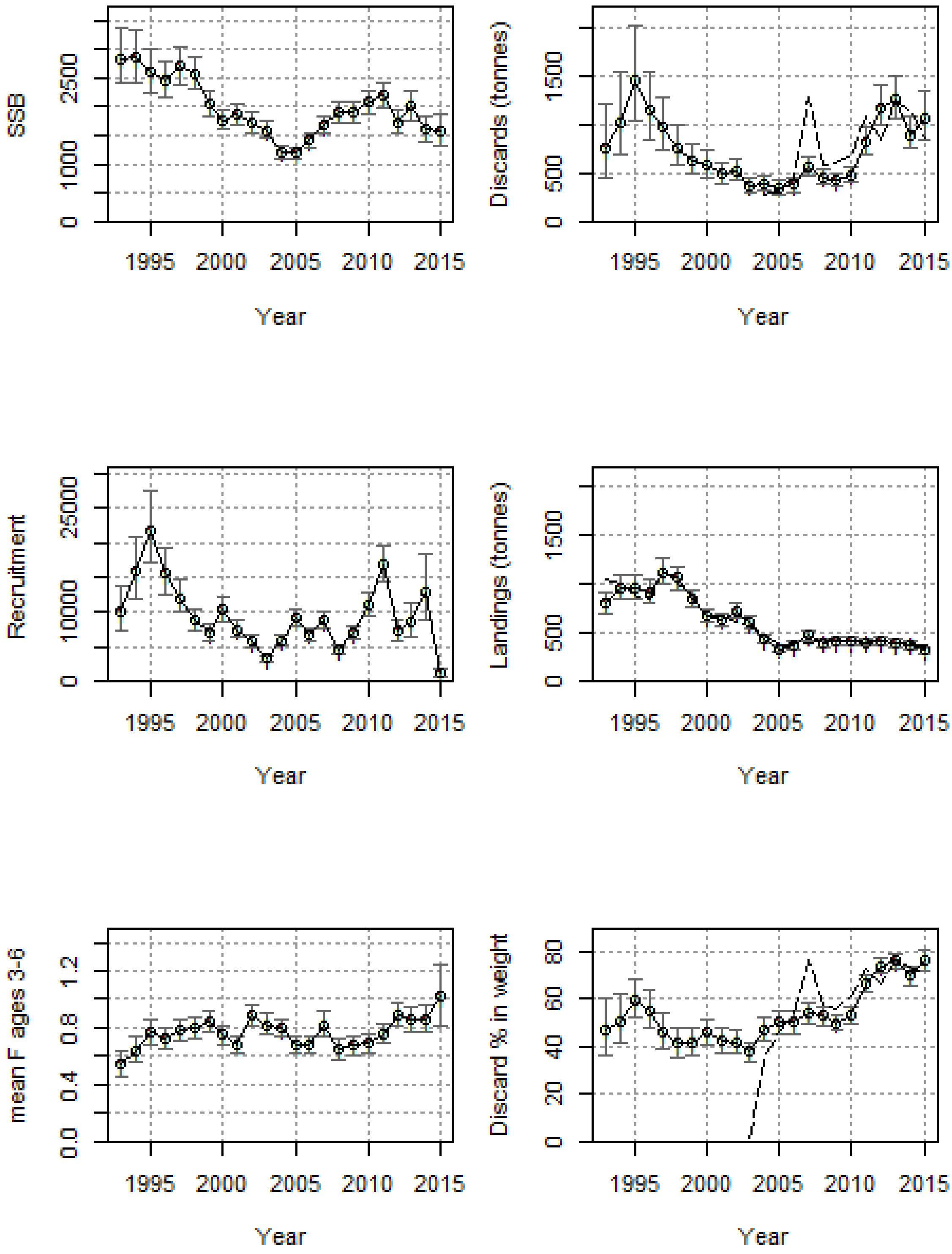


Figure 7.10.10. Plaice in Division 7.f–g: The estimated time-series of spawning–stock biomass, recruitment, average fishing mortality-at-ages 3–6, total discard weight, total landings weight and the discard percentage in weight with standard error bars derived from bootstrapping the hessian matrix, for the fit of the TV_PTVS model for the data to 2015. Dashed line = actual discards.

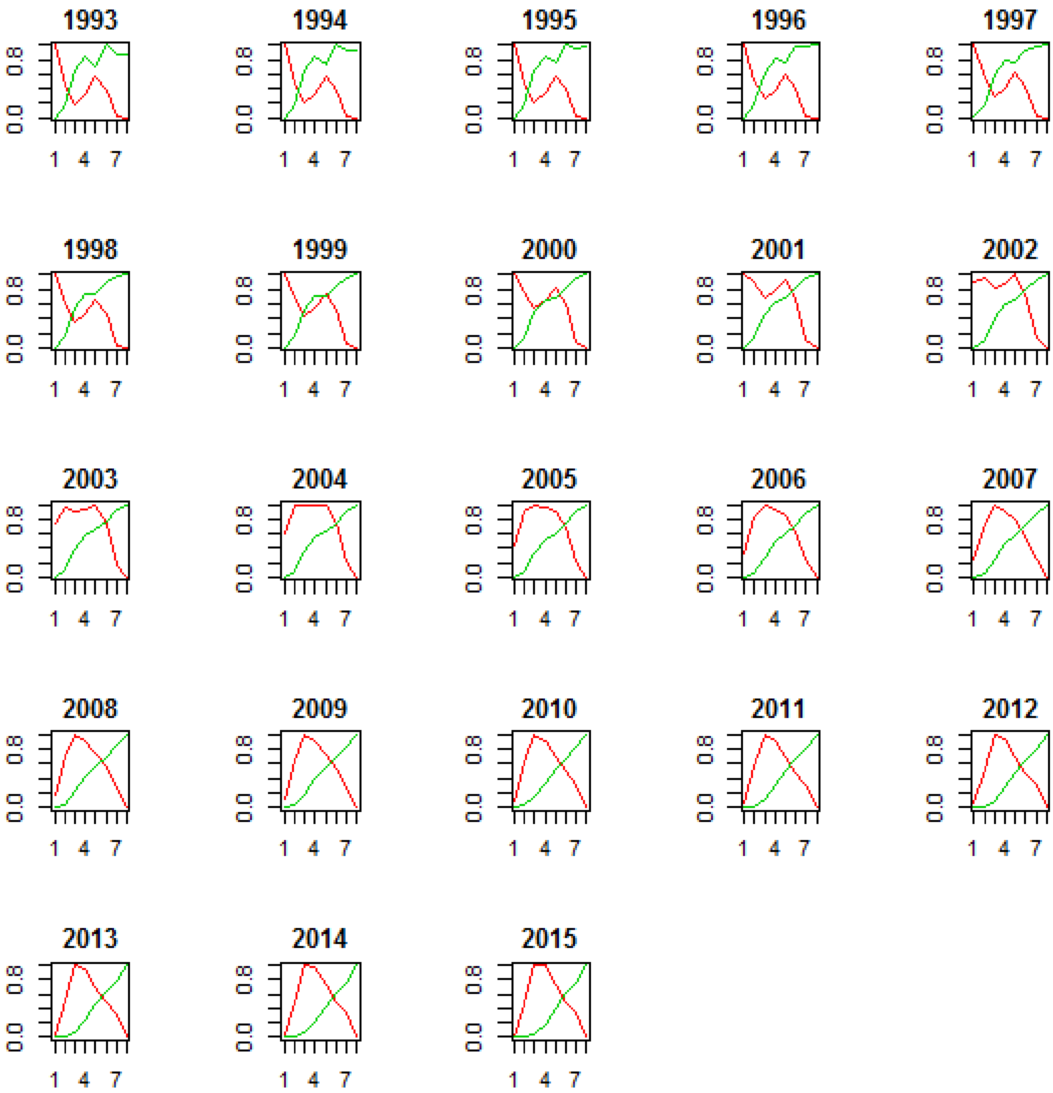


Figure 7.10.11. Plaice in Division 7.f–g: Estimated selection pattern at-age for landings (green) and discards (red) scaled to the highest value (1.0 for the TV_PTVS model). The TV_PTVS model fits a time variant selection pattern to the landings and a polynomial time variant spline for the discard selection.

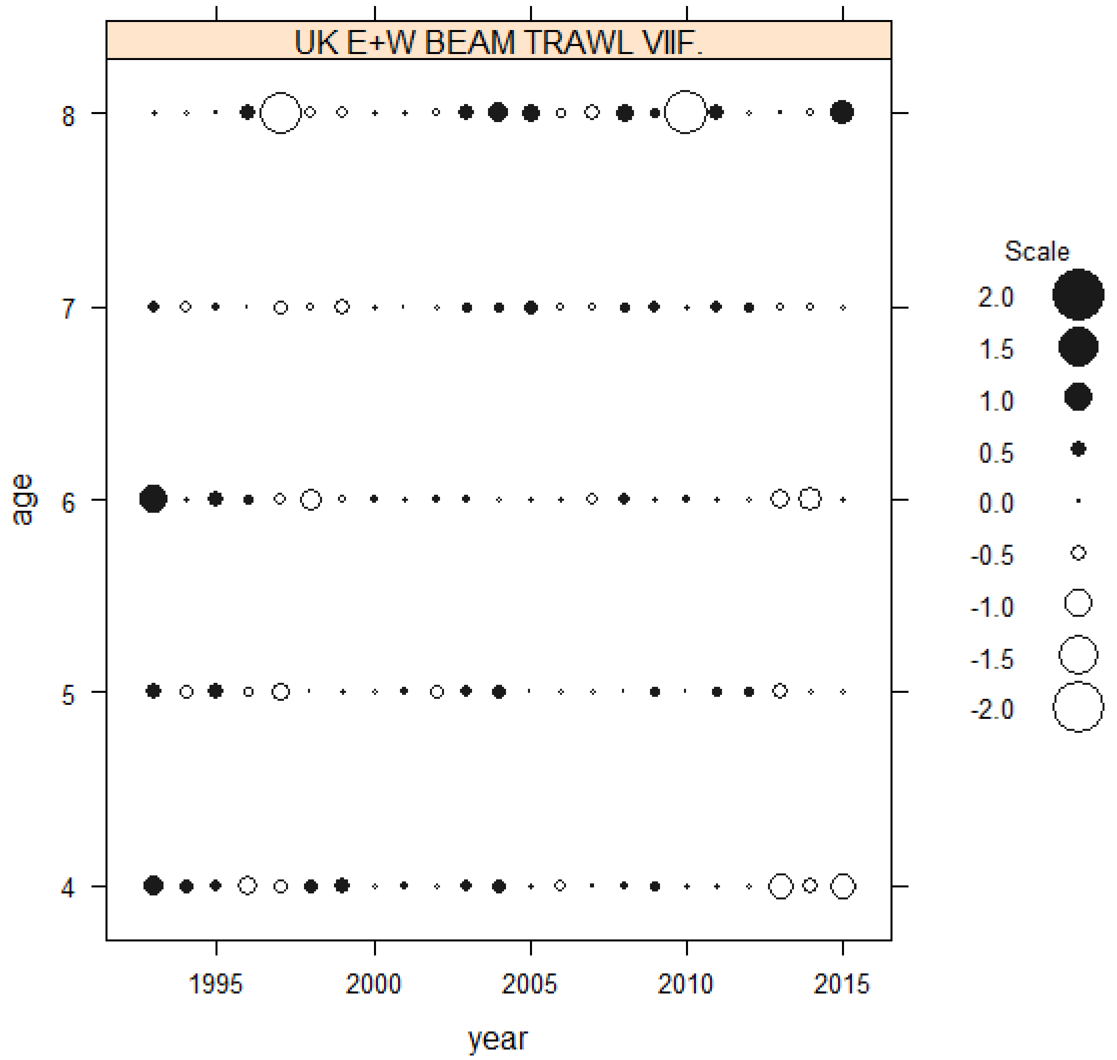


Figure 7.10.12. Plaice in Division 7.f–g: The Log catchability residuals for the fit TV_PTVS model fit to the UK commercial beam-trawl data.

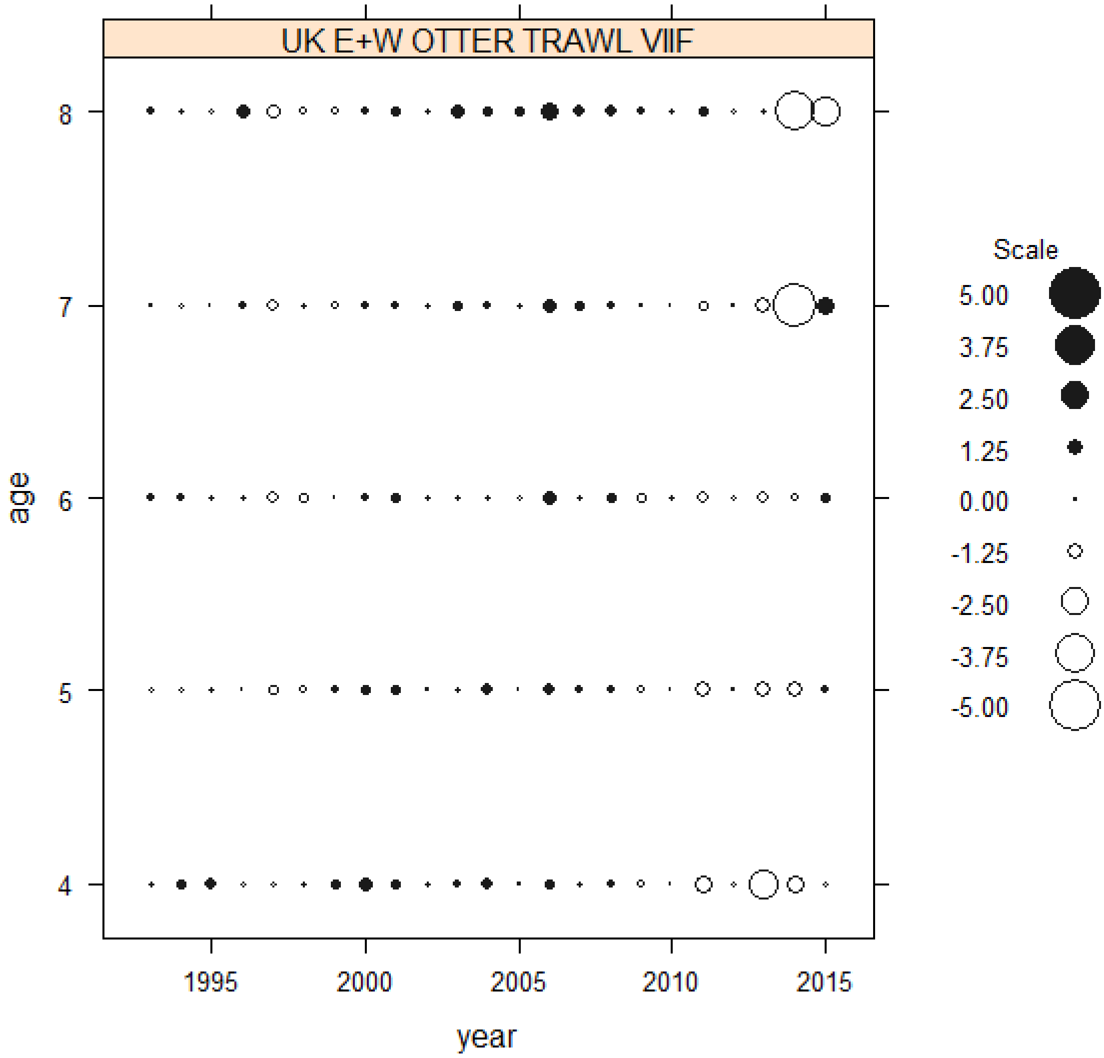


Figure 7.10.13. Plaice in Division 7.f–g: The Log catchability residuals for the fit TV_PTVS model fit to the UK commercial otter trawl data.

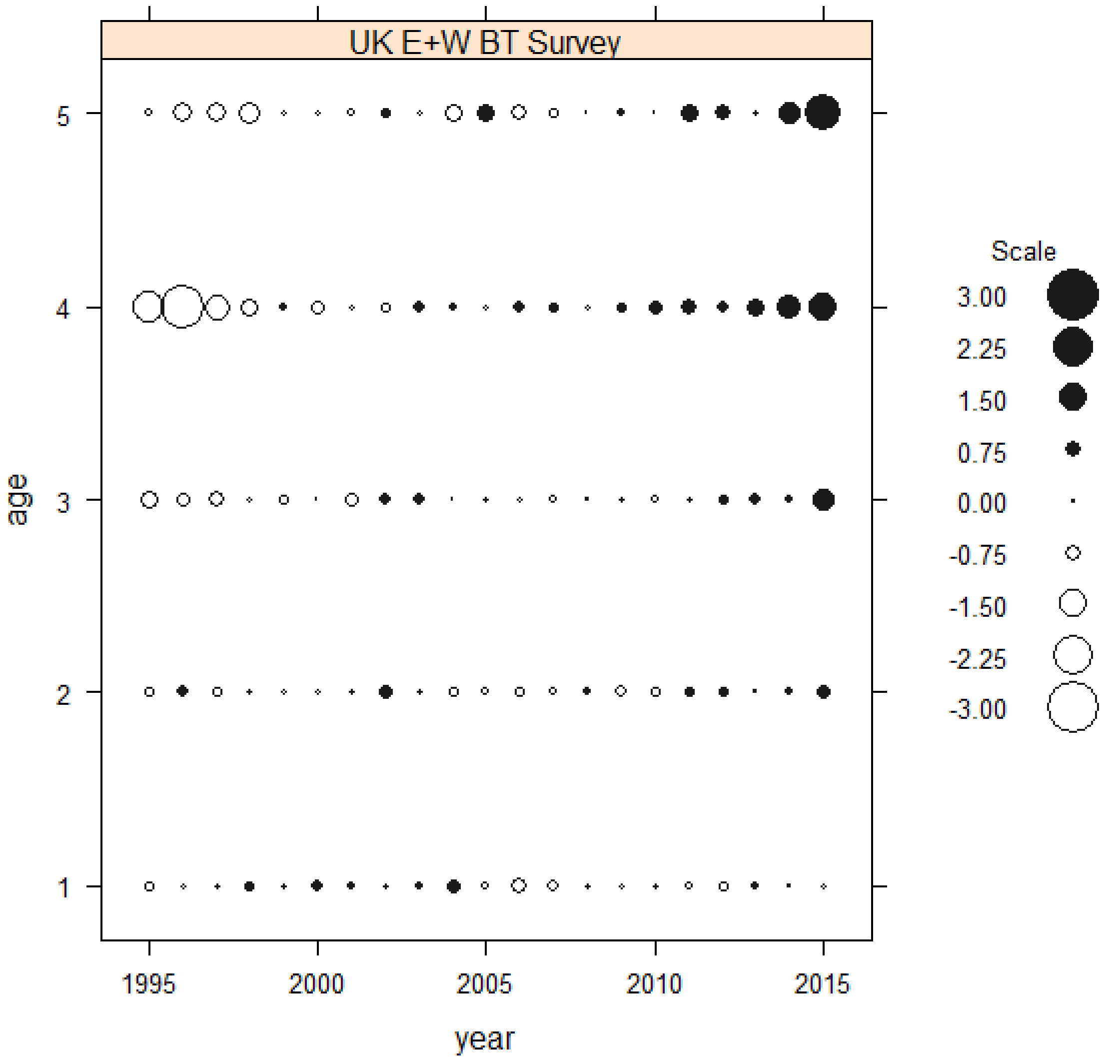


Figure 7.10.14. Plaice in Division 7.f–g: The Log catchability residuals for the fit TV_PTVS model fit to the UKBT survey.

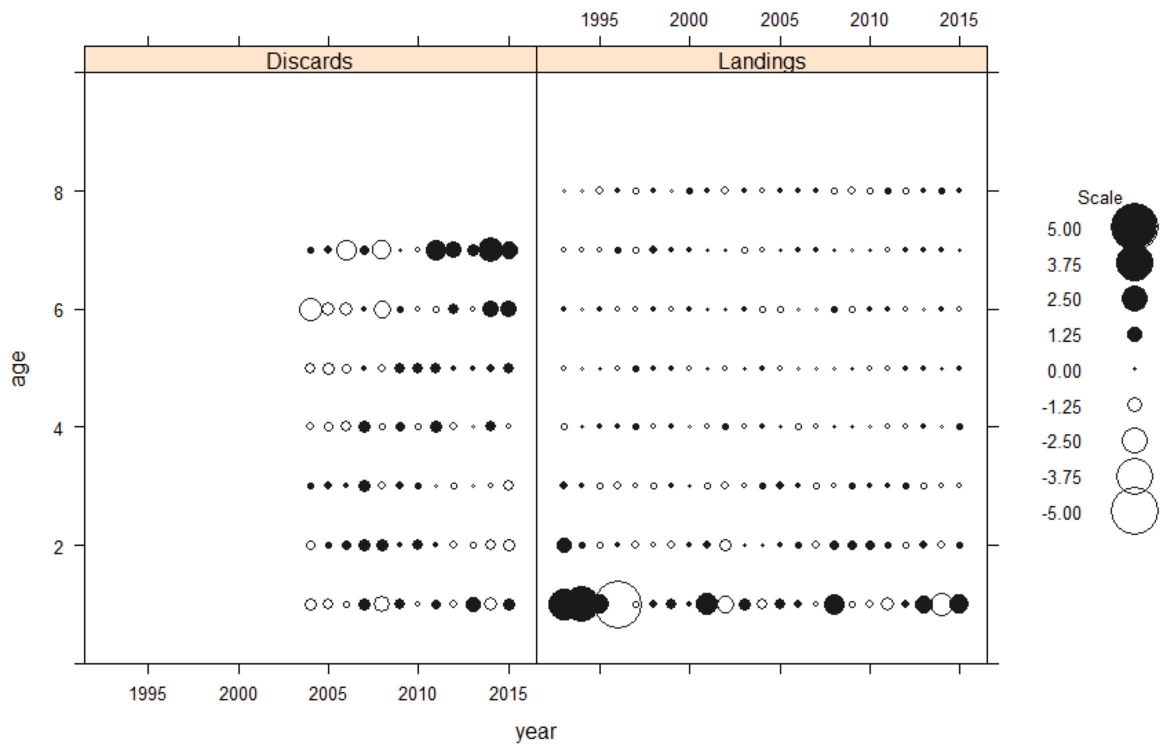


Figure 7.10.15. Plaice in Division 7.f–g: The Log residuals for the fit TV_PTVS model fit to the discard and landings numbers-at-age data.

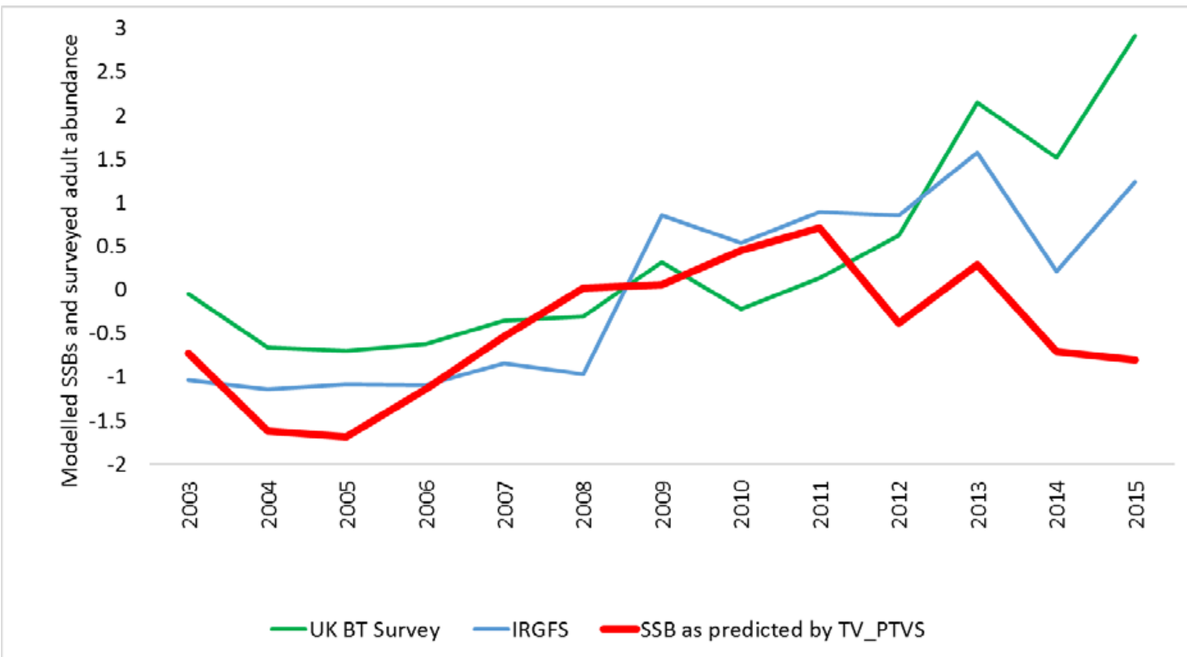


Figure 7.10.16. Plaice in Division 7f&g: The time-series of SSB as assessed by the AP model and survey adult fish (3+) trends.

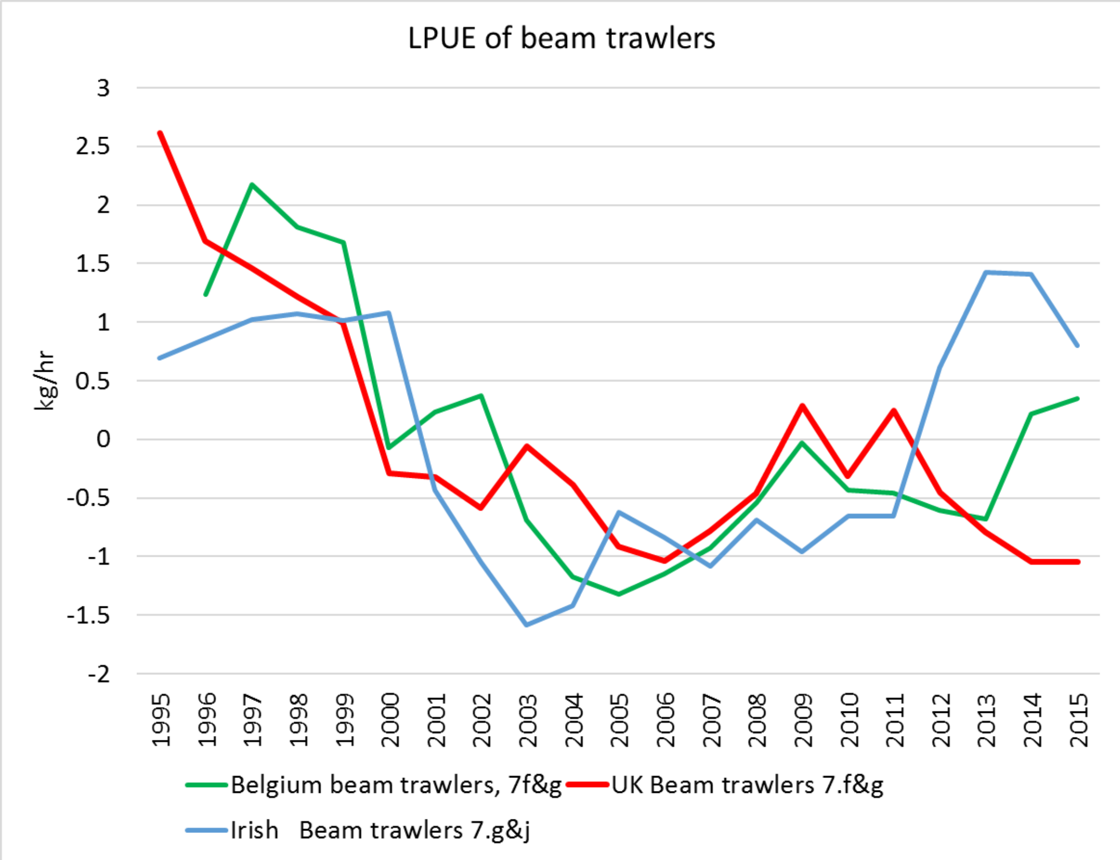


Figure 7.10.17. Plaice in Division 7f&g: The time-series of lpues of commercial beam trawlers.

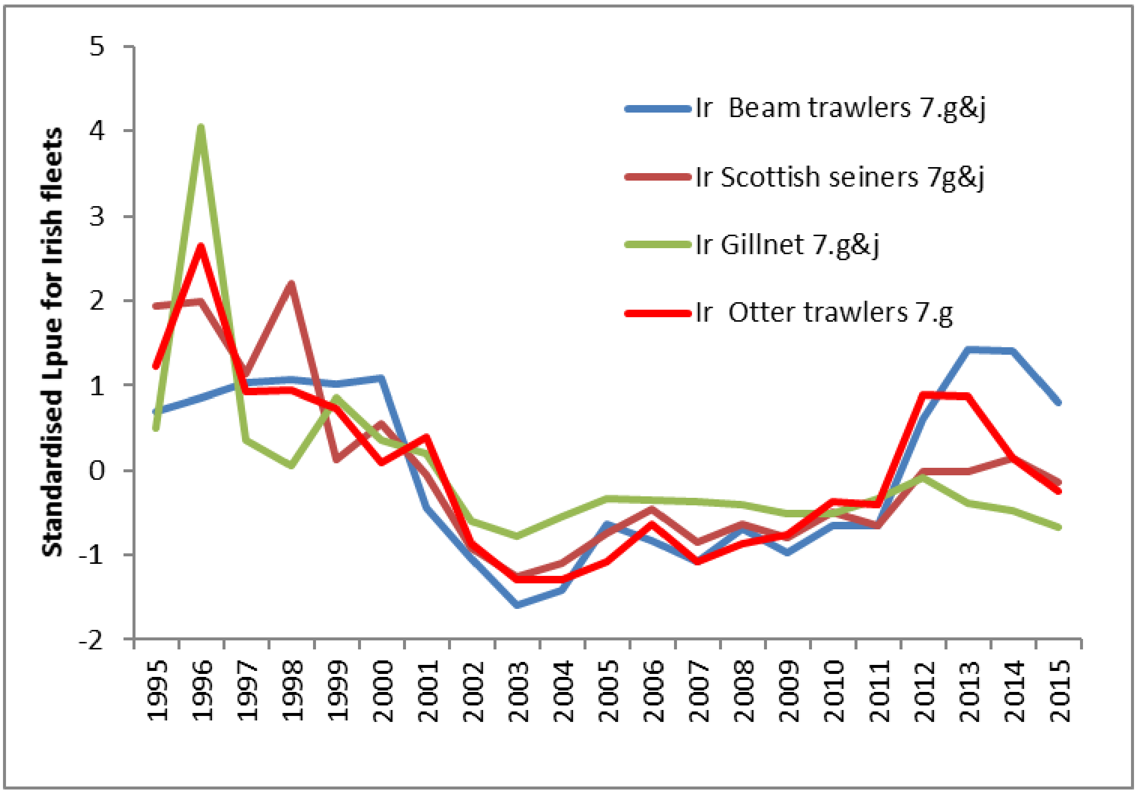


Figure 7.10.18. Plaice in Division 7f&g: The time-series of lpues of commercial Irish fleet.

7.11 Plaice in the southwest of Ireland (ICES Divisions VIIh–k)

Type of assessment in 2016

An update XSA assessment was performed for the VIIjk component of the landings according to the stock annex. New MSY and PA reference points were explored.

ICES advice applicable to 2015

Based on the ICES approach for data-limited stocks, ICES advises that catches should be no more than 135 tonnes, and bycatch and discards should be reduced.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/ple-7h-k.pdf

ICES advice applicable to 2016

Based on ICES approach to data-limited stocks, ICES advises that landings in 2016 should be no more than 135 t. Discards are known to take place but cannot be quantified; therefore total catches cannot be calculated.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/ple-iris.pdf

7.11.1 General

Stock description and management units

Plaice in VIIh–k are on the southwestern margins of the species distribution. Plaice in VIIj are mainly caught by Irish vessels on sandy grounds off the southwest of Ireland. Irish VMS and logbook data indicate that the VIIj landings occur close to shore and this species is a small component (up to 5%) of the landings in a mixed fishery. (Figure 7.11.1).

Plaice catches in VIIk are negligible. Division VIIh is also considered part of the stock for assessment purposes but plaice in VIIh are separated from the VIIj plaice by several hundred miles. The distribution of the landings (Figure 7.11.1) suggests that the VIIh plaice are a continuation of the plaice caught in the western English Channel (VIIe).

The TAC is set for Divisions VIIh,j and k. However, because no age-disaggregated data are available for VIIh, the assessment is performed for VIIjk only.

Management applicable to 2014 and 2015

TAC table 2015

Species: Plaice *Pleuronectes platessa*		**Zone:** VIIh, VIIj and VIIk (PLE/7HJK.)
Belgium	8	
France	17	
Ireland	59	
The Netherlands	34	
United Kingdom	17	
Union	135	
TAC	135	Analytical TAC Article 11 of this Regulation applies

TAC table 2016

Species: Plaice *Pleuronectes platessa*		**Zone:** VIIh, VIIj and VIIk (PLE/7HJK.)
Belgium	8	
France	17	
Ireland	59	
The Netherlands	34	
United Kingdom	17	
Union	135	
TAC	135	Analytical TAC Article 12(1) of this Regulation applies

Article 11 refers to the closure of the Porcupine Bank in May and July.

7.11.2 Data

Landings and discards

The nominal landings are given in Table 7.11.1. Historic Belgian landings from VIIj are considered to have been area misreported and have been removed from the total landings. Because age data were only available for Irish landings (which were mainly from VIIjk) the remainder of Section 7.11 concerns VIIjk only.

Table 7.11.2 gives the landings in VIIjk. Ireland has taken around 80–90% of the landings throughout the time-series.

Discard and retained catch numbers for the Irish VIIj OTB fleet in 2015 are shown by length in Figure 7.11.2a. Significant numbers of plaice were discarded at all size classes. No reliable time-series of discards-at-age is currently available and discard numbers are not included in the assessment. The proportion of the VIIj catch that was discarded varied between 10% and 100% since 2001, however the number of trips in some years was very low. Since 2007 the number of trips has been >5 per year and the average proportion of the catch that has been discarded in that period in the order of 30%.

Commercial effort and Lpue

The commercial effort landings and Lpue for the Irish otter trawl fleet in 7.j is shown in Figure 7.11.1b.

Landings numbers-at-age

Landings numbers-at-age are given in Table 7.11.3 and Figure 7.11.3. Figure 7.11.4 shows a bubble plot of the standardised landings proportions at-age. There is very little contrast in the numbers-at-age matrix. Figure 7.11.5 gives the stock weights (which are the same as the landings weights).

Biological

Natural mortality was assumed to be 0.12 for all ages and the proportion mature for age 4 is assumed to be 0.86 and 1 for all older ages.

Surveys and commercial tuning fleets

There is no survey index available for this stock (the Irish IBTS Q4 Groundfish Survey data are too noisy to be used). A commercial tuning index is available which uses Irish VMS data linked to logbook landings (see Gerritsen *et al.*, 2011 for details on linking VMS and logbook data). The data were used to identify an area where plaice are caught by OTB vessels (Figure 7.11.6). Next the effort and landings of the OTB vessels inside the plaice area was estimated (Figure 7.11.6). The VMS-based lpue showed similar trends to the lpue of Irish OTB vessels in the whole of VIIj, however by limiting the spatial extent, the index will be less sensitive to changes in the spatial distribution of the fleet; all vessels operating in this area are assumed to be capable of catching plaice (which is not the case further offshore).

The age composition of the Irish OTB fleet in VIIj was used for the tuning fleet (Table 7.11.5). Figure 7.11.7 shows the log standardised numbers-at-age in the tuning index by year and cohort. No year effects are obvious, but cohort tracking is not particularly good either. This is probably a consequence of the lack of contrast in recruitment (see 'Data quality'). Figure 7.11.8 shows the internal consistency regressions for the tuning fleet.

Data quality

The age data for 1995 were considered insufficient and for this year the combined age data for 1993–1996 were used. Sampling appears to be sufficient to establish landings numbers-at-age. The lack cohort tracking in the numbers-at-age matrix is most likely due to an absence of very strong or weak cohorts, rather than poor sampling or ageing.

7.11.3 Historical stock development

Target category: 3.2.0.

Model used: XSA

Software used: Lowestoft vpa95.exe and FLR with R version 2.15.3 and packages FLCore 2.5.0; FLEDA 2.5 and FLAssess 2.5.0

Exploratory assessment

Several exploratory assessments were carried out by means of a separable VPA and XSA. The initial VPA runs explored the year and age range to be used in the separable and the choices of reference age, final F and S. The XSA runs explored the choices of q-age, F-shrinkage and the minimum SE threshold. The results of these are available on the ICES SharePoint site of WGCSE 2013 under data for this stock.

Final assessment

The model was applied to landings numbers for ages 4–8+ for the years 1993–2015. The tuning fleet included ages 4–8 for the years 2006–2015.

Model Options:

Option	Setting
Ages catch dep stock size	None
Q plateau	6
Taper	No
F shrinkage SE	1.0
F shrinkage year range	5
F shrinkage age range	3
Fleet SE threshold	0.3
Prior weights	No

The diagnostics of the final XSA assessment are given in Table 7.11.6. Age classes 4 to 8+ were included in the model. Younger ages were omitted because significant discarding is expected to take place at these ages. Figure 7.11.9 shows the residuals. There are some year effects but the absolute values are small. Because the landings and the tuning fleet have nearly identical age compositions, the year effects result from the lpue estimate of the tuning fleet.

State of the stock

The summary table with a time-series of landings, recruitment, SSB and F is given in Table 7.11.10 and Figure 7.11.7. Recruitment in 2003–2014 years was stable at a lower level than at the start of the time-series and it appears to have declined sharply in 2015. The SSB has declined from around 400 tonnes in 1993 to around 100 t in recent years and it appears that SSB may have declined to a low of 44 t in 2015. F has been quite variable throughout the time-series but shows no clear trend.

7.11.4 MSY evaluation

WKProxy (ICES, 2016a) proposed an F_{MSY} reference point of F = 0.25, based on $F_{0.1}$ from a Thompson–Bell yield-per-recruit analysis of the landings numbers-at-age. This is a data-limited approach (which was in line with the ToRs of WKProxy); however the resulting reference point is not directly comparable with the outputs from the XSA (only the landings data are used in the Thompson–Bell approach). The working group is of the opinion that it would be more appropriate to move the stock to Category 2 next year and to apply the WKMSYREF4 (ICES, 2016b) methodology for estimating reference points (ICES, 2012). (Category 2: stocks with analytical assessments and forecasts that are only treated qualitatively).

An exploratory MSY evaluation following WKMSYREF4 guidelines is presented here. The stock–recruitment graph (Figure 7.11.11) suggests recruitment has been impaired for most of the time-series. However Figure 7.11.7 shows that recruitment was reduced first and SSB declined a few years later. Because there is no obvious stock–recruitment relationship (it appears to be a recruit–stock relationship) it is difficult to specify an appropriate SR model. The working group decided to set B_{lim} at the lowest SSB that generated high recruitment (354 t in 1999) and B_{PA} = 1.4 * Blim = 496. The inflection point of the segmented regression was also set at B_{loss} for the same reason.

The following settings were used (full code available on SharePoint):

```
# SR function
segreg3 <- function(ab, ssb) log(ifelse(ssb >= Blim, ab$a * Blim, ab$a * ssb))
# eqsim_run settings:
stocksetup <- list(data = stock,
  bio.years = c(2006, 2015),
  bio.const = FALSE,
  sel.years = c(2006, 2015),
  sel.const = FALSE,
  Fscan = seq(0,1,by=0.05),
  Fcv = 0.212,
  Fphi = 0.423,
  Blim = Blim,
  Bpa = Bpa,
  verbose = TRUE,
  extreme.trim=c(0.05,0.95)
  )
```

Where F_{cv} and F_{phi} were the same as those used by WKMSYREF4 for plaice in 7e. Figures 7.11.12 and 7.11.13 summarise the MSY evaluation. The analysis resulted in an estimate of F_{MSY} = 0.27 without a $B_{trigger}$ harvest control rule and F_{MSY} = 0.30 with a $B_{trigger}$ = B_{PA} HCR. These values are slightly higher than the F_{MSY} proxy of 0.25 proposed by WKProxy, however the results do not change the perception of the stock relative to any of these F reference points. Note that this is a preliminary analysis and the working group does not propose new reference points for this stock this year.

Biological reference points

Proxy-reference points were identified by WKProxy (2016) but also note the previous paragraph.

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$ proxy	-	No proxy identified
	$F_{MSY\ proxy}$	0.25	$F_{0.1}$ (ages 4–6), from age-based yield-per-recruit analysis using catch numbers-at-age

7.11.5 Uncertainties and bias in the assessment and forecast

The advice is based on an assessment model accepted for trends, used as an indicator of stock size. The uncertainty associated with the index values is not available. The assessment is only based on ages 4 and older; ICES does not have reliable information on younger ages.

The assessment is carried out on the landings in Divisions 7.j and 7.k. The trends in this area are assumed to be representative of the whole stock area (7hjk). No age information is available for Division 7.h. ICES is unable to assess stock trends in Division 7.h. The advice takes into account the reported landings from the full TAC area; Divisions 7.h–k.

The apparent reduction in SSB in 2015 is mainly driven by a reduction in relative abundance of young fish in recent years. It is unclear whether this lack of young fish in the landings (and commercial tuning lpue index) is due to increased discarding or poor recruitment. Table 7.11.1 shows that only the Irish landings have decreased. Landings by France and the UK have remained stable. If the effort of those countries is assumed to be unchanged, this suggests that the reduction in Irish landings and lpue may be due to increased discards, rather than a reduction in stock size.

The tuning index begins only in 2006 and there is limited contrast between the cohorts; therefore the assessment is driven mostly by the strong trend in 7jk landings in the first ten years of the time-series.

Discards in this stock may be considerable but are not presently included in the model because this might introduce more noise in the catch numbers-at-age matrix, particularly in the early years of the time-series when sampling levels were variable.

The use of a commercial tuning fleet has the potential to introduce bias if the behaviour of the fleet changes; for example the spatial distribution of effort can change over time, resulting in higher or lower catch rates of certain species. Additionally changes to the gear, vessel power, towing speed, etc. can influence the catch rates. By limiting the index to an area where plaice are known to be caught, some of this potential bias will be avoided. The working group applied a spatial stratification to check that changes in effort distribution within the plaice area did not affect the index and this did not appear to be the case. Because the stratified estimate is likely to be less precise, the final tuning index was based on the un-stratified estimate. More sophisticated modelling approaches to standardise the commercial index could be investigated for a future benchmark.

7.11.6 Recommendations for the next benchmark

WGCSE recommend that this stock is upgraded to a Category 2 stock (ICES, 2012) where the previous advice is increased or decrease based on the results of the assessment and forecast for VIIj carried out by WGCSE. The reference points could be defined according to the procedures set out in WKMSYREF4 as is shown in Section 7.14.4. ACOM would need to decide if this requires a benchmark or whether an intersessional review of WGCSE’s analysis is sufficient.

7.11.7 Management considerations

Plaice are taken as a minor bycatch in a mixed fishery and should be managed as such. Restricting the landings by TAC is unlikely to reduce the catches. It is therefore not desirable to apply another PA buffer in the advice for 2017.

Because plaice are caught in spatially distinct areas, restricting effort in these areas will be more effective than limiting landings. Additionally, management should focus on reducing discards. The recently introduced square mesh panels will be unlikely to effect on catches of undersized plaice. An increase in mesh size could improve selection, but will also affect the catches of marketable fish.

The TAC area includes Division VIIh. However, the landings from Divisions VIIjk are taken in the northeastern part of Division VIIj which is remote from the northern part of Division VIIh, where most of the Division VIIh landings are taken. It is likely that the plaice from Division VIIh are part of the Divisions VIIe or VIIfg stocks. No further information on stock structure is likely to become available.

For Division VIIh, only landings data are available. Landings in Division VIIh have fluctuated around 50% of the total landings of the stock (i.e. in Divisions VIIh–k) since 1993.

7.11.8 References

Gerritsen HD and Lordan C. 2011. Integrating Vessel Monitoring Systems (VMS) data with daily catch data from logbooks to explore the spatial distribution of catch and effort at high resolution. ICES J Mar Sci 68 (1): 245–252.

ICES. 2012. ICES implementation of advice for data-limited stocks in 2012. Report in support of ICES advice. ICES CM 2012/ACOM:68.

ICES. 2016a. Report of the Workshop to consider MSY proxies for stocks in ICES category 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015, ICES Headquarters, Copenhagen. ICES CM 2015/ACOM:61. 183 pp.

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

Table 7.11.1. Plaice in Divisions VII h–k (Southwest Ireland). Nominal landings (t), 1993–2015, as officially reported to ICES.

	VIIJK					VIIH					VIIJK	VIIH	VIIHJK	VIIHJK
	BEL	FRA	IRL	UK	OTH	BEL	FRA	IRL	UK	OTH	TOT*	TOT	TOT	WG EST
1993	0	8	383	46	0	0	56	0	179	0	437	235	672	655
1994	0	6	251	60	0	0	42	20	199	0	317	261	578	577
1995	0	12	317	90	0	0	48	4	196	0	419	248	667	542
1996	0	3	295	38	0	0	45	10	117	52	336	224	560	453
1997	0	6	337	32	0	0	63	7	106	0	375	176	551	645
1998	0	8	282	16	0	0	41	4	90	13	306	148	454	444
1999	42	0	296	15	0	3	0	3	67	1	311	74	385	406
2000	4	16	195	9	5	0	38	5	67	2	225	112	337	299
2001	0	16	157	6	3	27	34	3	67	0	182	131	313	261
2002	14	21	155	5	2	55	24	0	54	0	183	133	316	313
2003	4	7	125	9	6	16	25	2	47	0	147	90	237	217
2004	0	5	87	6	6	67	27	4	30	0	104	128	232	221
2005	0	4	88	2	0	32	16	2	26	0	94	76	170	164
2006	1	6	63	1	1	22	31	2	17	0	71	72	143	147
2007	2	9	72	2	11	7	21	0	18	2	94	48	142	120
2008	3	5	72	1	1	25	7	0	11	0	79	43	122	135
2009	4	7	71	2	0	1	37	0	30	0	80	68	148	148
2010	5	11	66	1	0	0	44	0	34	0	78	78	156	155
2011	6	11	67	2	0	4	47	6	42	0	80	99	179	178
2012	7	17	93	0	0	2	45	6	36	0	110	89	199	196
2013	0	14	51	0	0	0	35	1	40	0	65	76	141	182
2014	0	11	74	0	0	4	40	4	15	0	85	63	148	169
2015	0	10	23	0	0	5	50	2	17	0	33	73	107	114

*** Excluding Belgium.**

Table 7.11.2. (Removed).

Table 7.11.3. Landings numbers-at-age for plaice in VIIjk.

	2	3	4	5	6	7	8	9	10
1993	92.8	623.6	479.4	115.4	44.8	22.8	10.5	5.9	2.6
1994	103.7	340.2	259.7	82.1	45.5	18.3	8.1	5.0	2.9
1995	207.3	632.8	347.5	106.9	36.3	15.7	7.1	4.8	3.1
1996	76.9	314.5	228.1	127.0	37.1	23.4	4.9	3.0	0.7
1997	166.4	277.0	268.1	118.9	42.3	19.5	4.3	0.0	9.1
1998	46.5	355.2	163.9	102.9	38.3	25.6	10.4	4.0	3.0
1999	126.1	274.6	177.1	57.1	33.0	15.9	9.8	8.3	10.7
2000	72.3	158.2	186.4	62.5	34.9	6.5	4.9	3.4	3.2
2001	55.3	164.8	145.6	47.1	5.9	21.5	2.3	7.4	0.0
2002	49.9	143.8	159.4	50.6	39.1	40.9	11.6	3.4	1.9
2003	71.8	161.4	63.6	28.4	5.8	14.5	10.2	1.5	3.6
2004	30.9	120.8	91.2	26.5	11.9	1.7	2.4	3.9	1.5
2005	25.2	70.9	77.4	47.7	22.4	12.6	3.7	0.0	1.2
2006	16.7	40.7	52.6	38.2	12.4	6.5	1.1	1.1	2.4
2007	47.0	136.0	60.7	22.2	17.1	4.1	2.2	0.4	0.7
2008	54.6	105.9	70.0	20.5	4.8	1.9	1.3	0.1	0.2
2009	13.6	113.4	79.4	30.7	10.8	4.8	0.0	0.8	0.6
2010	55.9	42.2	59.9	43.1	18.2	4.3	1.5	1.5	1.1
2011	19.2	85.4	55.3	36.5	22.7	10.9	3.8	0.8	1.3
2012	12.5	128.4	103.4	37.4	29.5	12.6	6.8	1.9	2.9
2013	5.8	44.2	84.8	32.0	7.8	4.9	3.0	1.1	0.5
2014	9.8	48.8	89.3	71.7	25.0	4.6	3.8	2.3	0.6
2015	6.1	14.8	20.9	17.5	12.7	4.6	0.8	0.9	0.4

Table 7.11.4. Weight-at-age for plaice in VIIjk.

	2	3	4	5	6	7	8	9	10
1993	0.196	0.256	0.306	0.417	0.582	0.751	0.939	1.151	1.707
1994	0.222	0.302	0.368	0.460	0.563	0.708	0.873	1.029	1.347
1995	0.228	0.272	0.325	0.391	0.521	0.651	0.840	0.817	1.546
1996	0.298	0.379	0.432	0.463	0.512	0.529	0.493	0.398	2.324
1997	0.295	0.339	0.430	0.483	0.654	0.807	0.937	0.669	1.319
1998	0.249	0.308	0.419	0.529	0.690	0.779	0.757	0.941	1.287
1999	0.289	0.354	0.417	0.596	0.627	0.840	0.882	1.170	1.382
2000	0.273	0.348	0.420	0.486	0.609	0.807	1.107	1.439	1.424
2001	0.243	0.325	0.405	0.537	0.644	0.800	0.550	1.115	0.000
2002	0.211	0.296	0.328	0.415	0.498	0.567	0.701	1.014	1.204
2003	0.274	0.358	0.402	0.482	0.575	0.734	0.876	1.041	1.646
2004	0.259	0.310	0.341	0.448	0.550	0.631	0.637	0.900	1.333
2005	0.238	0.276	0.324	0.381	0.459	0.731	0.949	0.845	1.615
2006	0.272	0.319	0.370	0.438	0.519	0.794	0.895	0.791	1.612
2007	0.239	0.281	0.354	0.433	0.482	0.573	0.727	1.394	1.108
2008	0.239	0.282	0.336	0.358	0.529	0.754	0.399	1.100	1.507
2009	0.224	0.255	0.335	0.403	0.462	0.520	0.569	1.080	1.266
2010	0.257	0.310	0.342	0.369	0.462	0.563	0.739	0.735	0.893
2011	0.257	0.282	0.321	0.355	0.407	0.626	0.625	0.507	0.984
2012	0.244	0.284	0.312	0.364	0.429	0.465	0.562	0.701	1.039
2013	0.256	0.294	0.336	0.400	0.462	0.503	0.609	0.744	1.002
2014	0.250	0.288	0.321	0.377	0.425	0.471	0.526	0.609	0.992
2015	0.295	0.349	0.378	0.439	0.509	0.565	0.645	0.611	0.743

Table 7.11.5. Tuning data. The ages and years used in the assessment are in bold.

PLE7JK, WGCSE										
101										
IRL-VMS: nos per 1000 hours										
2006	2015									
1	1	0	1							
2	10									
1	250	611	790	573	186	98	17	16	35	#2006
1	482	1394	622	227	176	42	23	5	7	#2007
1	849	1648	1090	319	75	30	20	2	4	#2008
1	146	1219	853	329	116	51	0	8	7	#2009
1	585	441	627	451	191	45	16	15	11	#2010
1	270	1200	777	512	320	154	53	12	19	#2011
1	120	1236	996	360	284	121	66	18	28	#2012
1	61	471	902	340	83	52	32	12	6	#2013
1	114	569	1041	836	291	54	44	27	7	#2014
1	57	139	196	164	119	44	8	8	4	#2015

Table 7.11.6. XSA diagnostics.

FLR XSA Diagnostics 2016-04-29 12:04:09

Cpue data from indices

Catch data for 23 years 1993 to 2015. Ages 4 to 8.

	fleet	first age	last age	first year	last year	alpha	beta
1	IRL-VMS: nos per 1000 hours	4	7	2006	2015	<NA>	<NA>

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 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

age \ year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age \ year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
4	0.810	0.826	0.603	0.569	0.507	0.637	0.842	0.586	1.266	0.859
5	0.936	0.901	0.671	0.527	0.633	0.605	1.139	0.618	1.426	0.828
6	0.981	1.525	0.440	0.840	0.623	0.744	1.417	0.691	1.399	0.999
7	0.733	0.973	0.598	0.978	0.893	0.875	1.174	0.881	1.086	1.002
8	0.733	0.973	0.598	0.978	0.893	0.875	1.174	0.881	1.086	1.002

XSA population number (Thousand)

year \ age	4	5	6	7	8
2006	101	67	21	13	9
2007	115	40	23	7	6
2008	164	45	14	4	4
2009	194	80	20	8	2
2010	160	98	42	8	7
2011	125	85	46	20	11
2012	193	58	41	19	18
2013	203	74	17	9	8
2014	132	100	35	7	11
2015	38	33	21	8	3

Estimated population abundance at 1st January 2016

	age				
year	4	5	6	7	8
2016	15	14	13	7	3

Fleet: IRL-VMS: nos per 1000 hours

Log catchability residuals.

	year									
age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
4	0.373	0.010	0.117	-0.313	-0.453	0.068	-0.033	-0.293	0.562	-0.039
5	0.431	0.009	0.137	-0.477	-0.318	-0.070	0.181	-0.327	0.595	-0.162
6	0.346	0.405	-0.409	-0.143	-0.463	0.009	0.266	-0.345	0.443	-0.107
7	0.061	-0.044	-0.094	-0.003	-0.108	0.172	0.077	-0.108	0.201	-0.083

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

	4	5	6	7
Mean_Logq	2.1168	2.2017	2.3332	2.3332
S.E_Logq	0.2831	0.2831	0.2831	0.2831

Terminal year survivor and F summaries:

,Age 4 Year class =2011

source	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.8	14	2011
fshk	0.2	17	2011

,Age 5 Year class =2010

source	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.772	11	2010
fshk	0.228	11	2010

,Age 6 Year class =2009

source	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.736	6	2009
fshk	0.264	7	2009

,Age 7 Year class =2008

source	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.803	2	2008
fshk	0.197	3	2008

Table 7.11.7. Summary table for ple 7jk. Landings in tonnes. Recruitment (age 4) in thousands. SSB in tonnes.

Year	Land 7h-k	Land VIIjk	Recruit	Fbar	SSB
1993	672	437	726	0.933	400
1994	578	317	507	0.746	355
1995	667	419	647	0.728	360
1996	560	336	481	0.717	371
1997	551	375	474	0.809	403
1998	454	306	366	0.822	340
1999	385	311	360	0.77	354
2000	337	225	353	0.625	306
2001	313	182	229	0.554	269
2002	316	183	251	1.192	193
2003	237	147	149	0.66	151
2004	232	104	181	0.56	126
2005	170	94	157	0.944	115
2006	143	71	101	0.909	94
2007	142	94	115	1.084	72
2008	122	79	164	0.572	76
2009	148	80	194	0.645	104
2010	156	78	160	0.588	112
2011	179	80	125	0.662	103
2012	199	112	193	1.133	112
2013	141	65	203	0.632	106
2014	148	89	132	1.364	99
2015	107	33	38	0.895	44

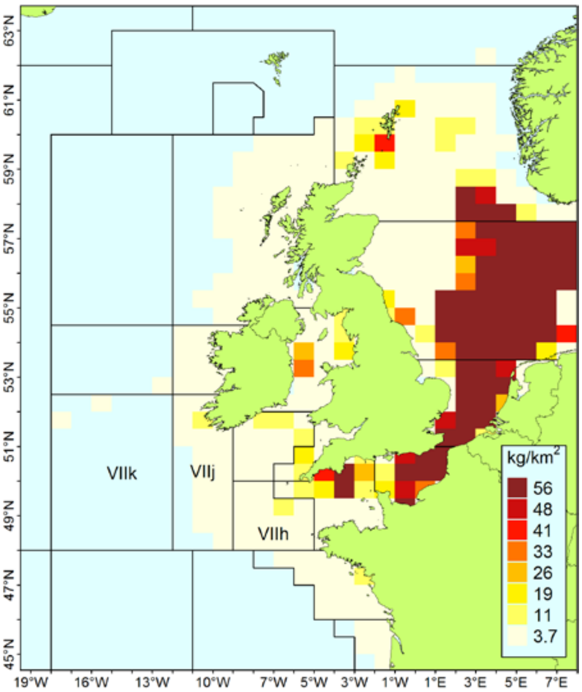


Figure 7.11.1. The spatial distribution of International landings of Plaice (2012 data, all gears combined; data from STECF).

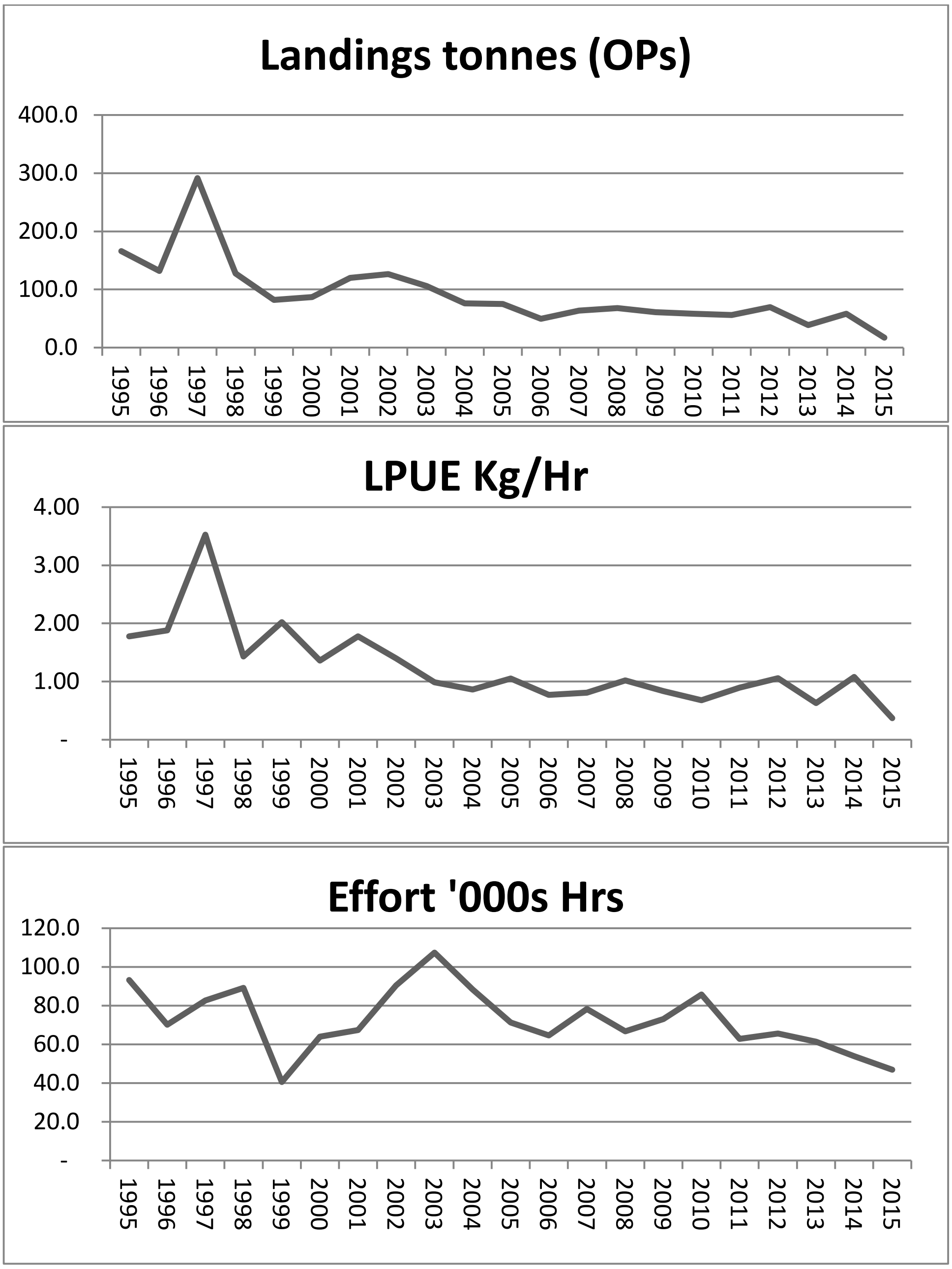


Figure 7.11.1b. Landings, Lpue and effort for Irish otter trawlers in VIIj.

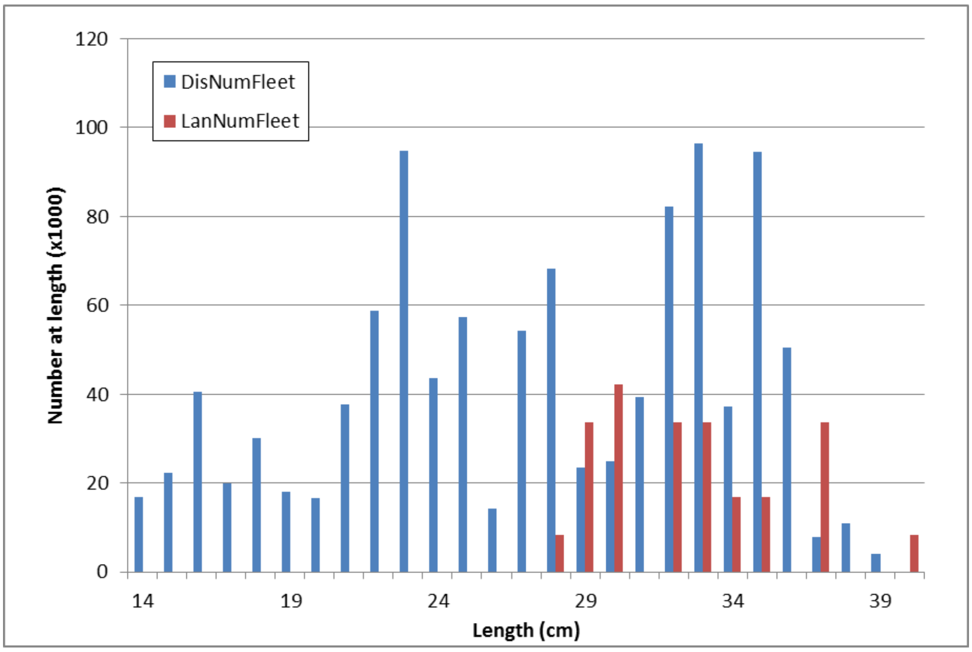


Figure 7.11.2a. Irish OTB discards in 7j during 2015. Numbers raised to fleet level using fishing effort (hours fished).

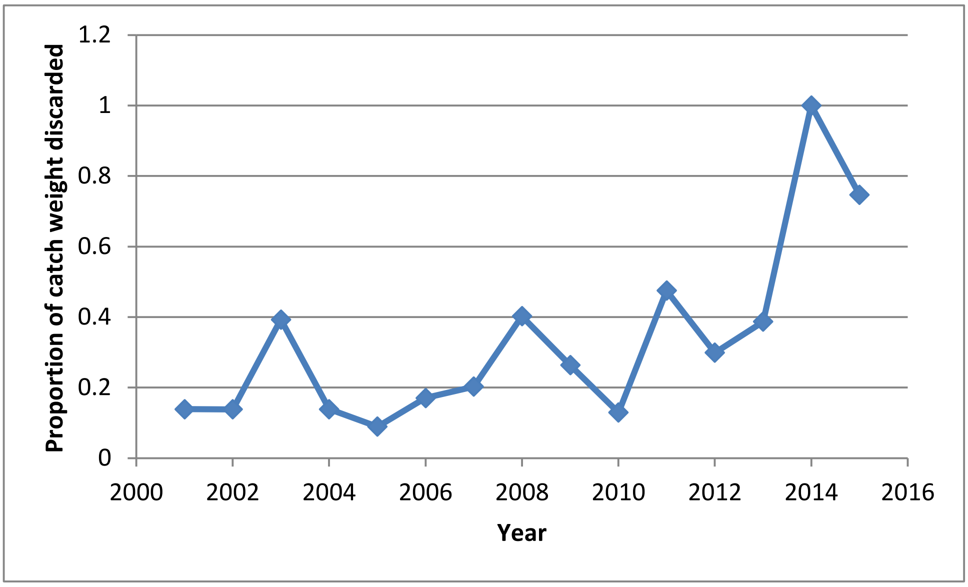


Figure 7.11.2b. Proportion of the catch discarded in the Irish OTB fleet in VIIj. Sampling levels have been variable.

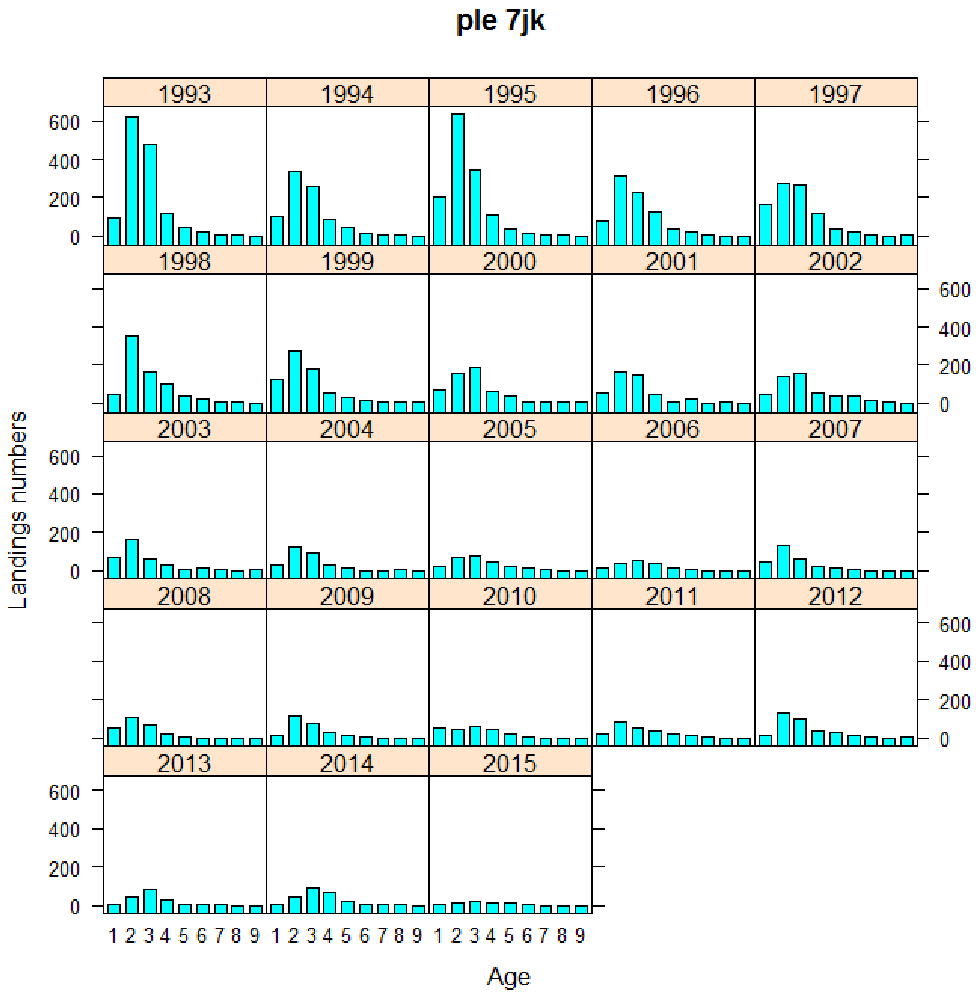


Figure 7.11.3. Age distribution of plaice landings in VIIjk between 1993 and 2015. All gears and quarters combined. The age data for 1995 were considered insufficient and for this year the combined age data for 1993–1996 were used.

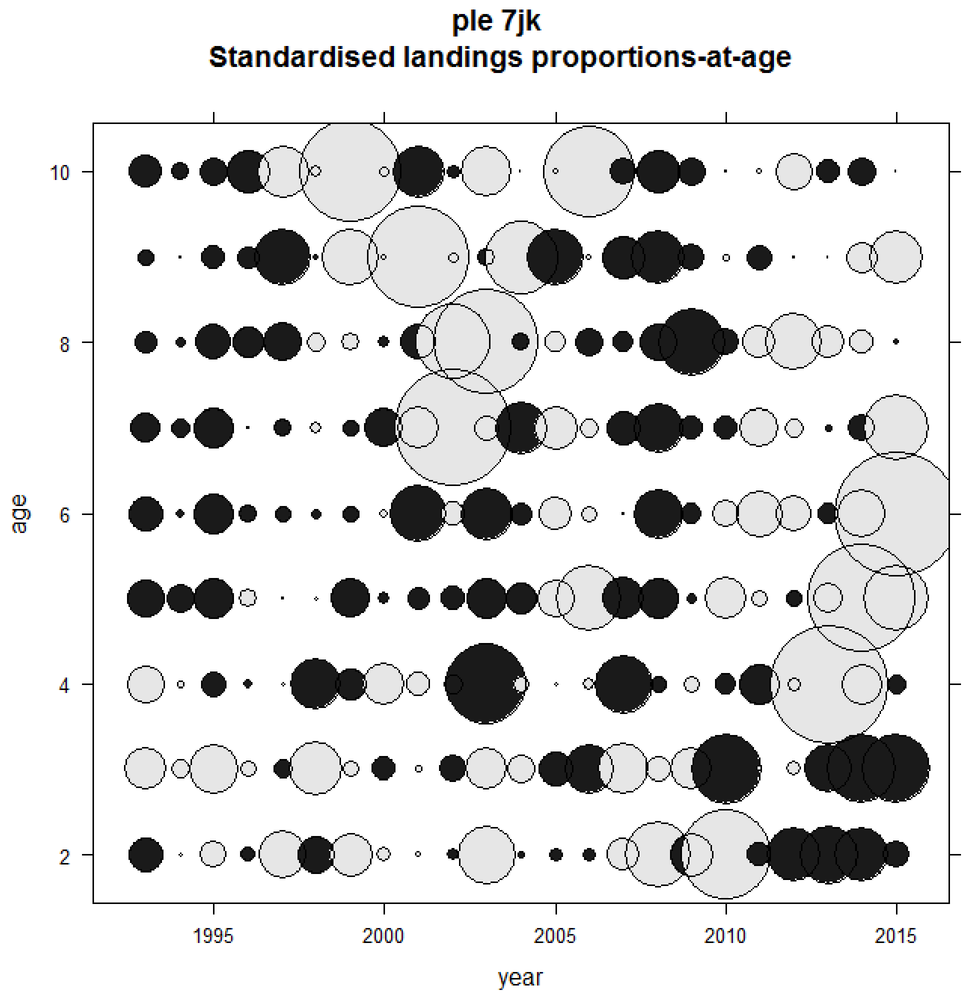


Figure 7.11.4. Standardised landings proportions-at-age for plaice in VIIjk. Grey bubbles represent higher than average catch-at-age and black bubbles represent lower than average catch-at-age.

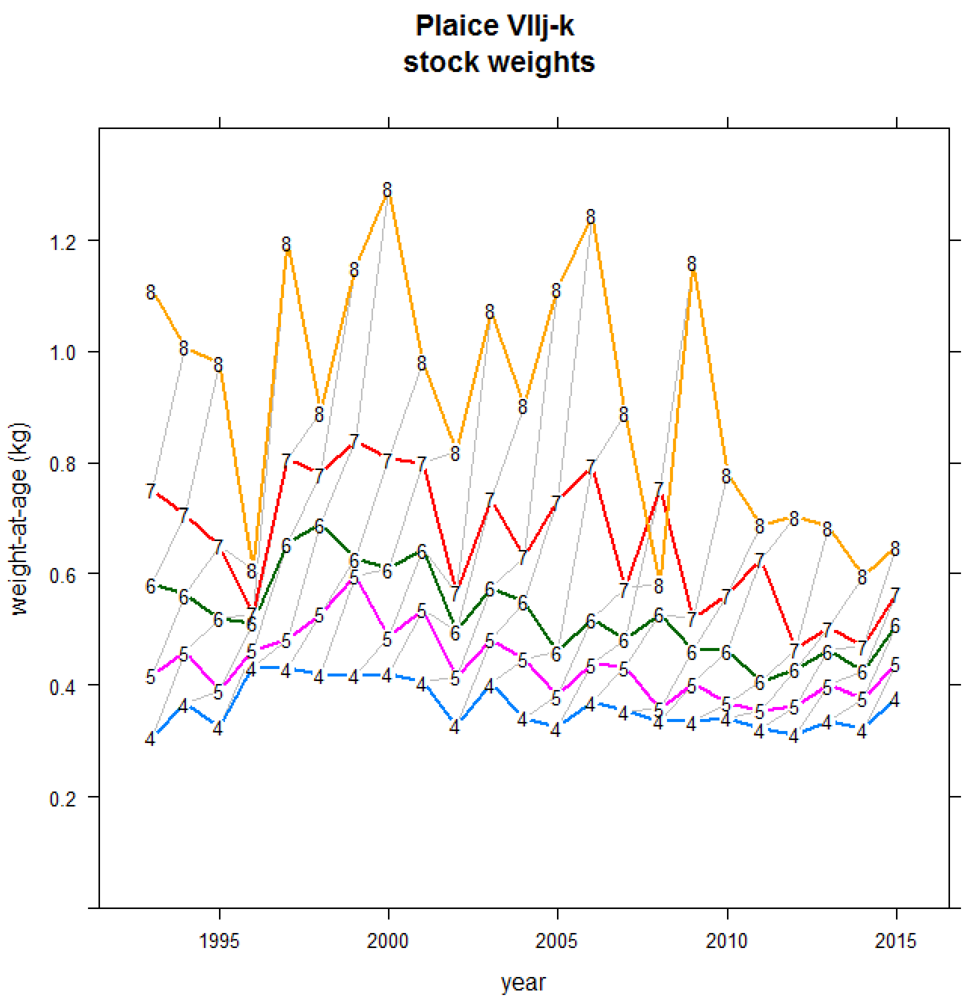
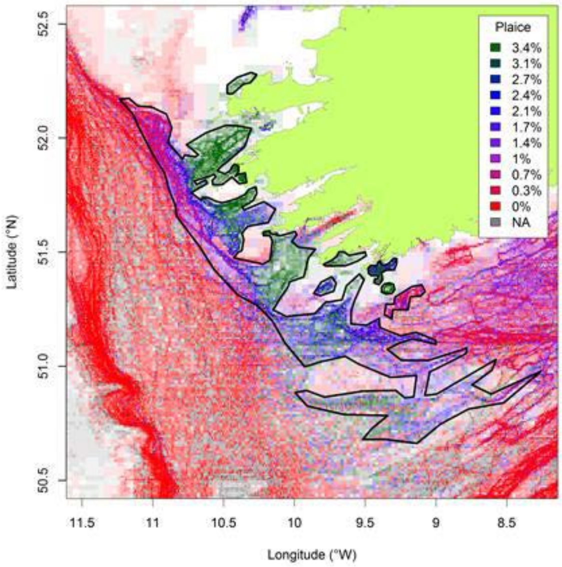


Figure 7.11.5. Landings weights / stock weights of ple7jk.



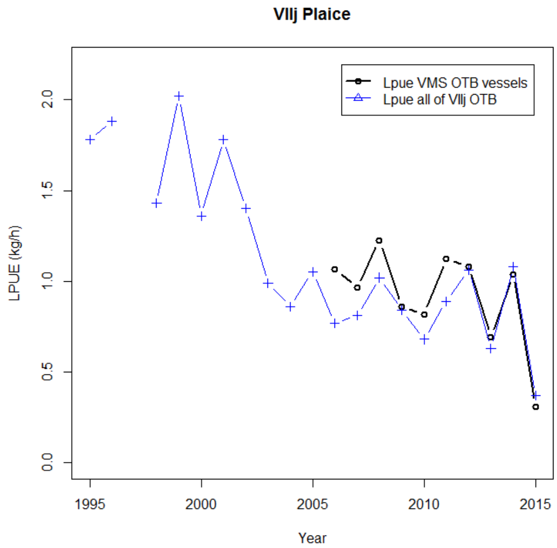
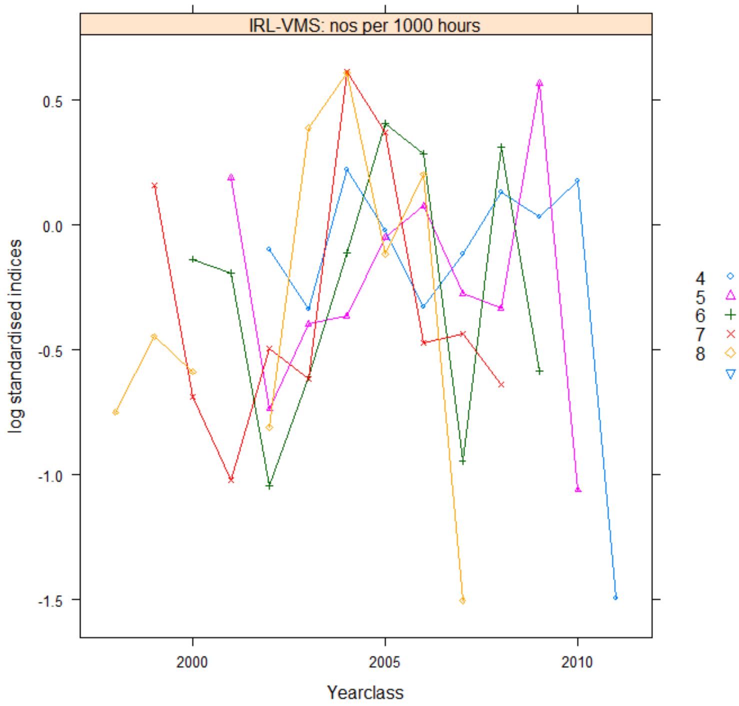


Figure 7.11.6. Top: the proportion of plaice in landings of Irish vessels with VMS over the years 2006–2014. The black line indicates the polygon inside which plaice are caught. Effort and landings from the VMS/logbooks data inside the polygon were used as a tuning index. Bottom: the VMS lpue index (black line) and the lpue of plaice in the whole of VIIj.



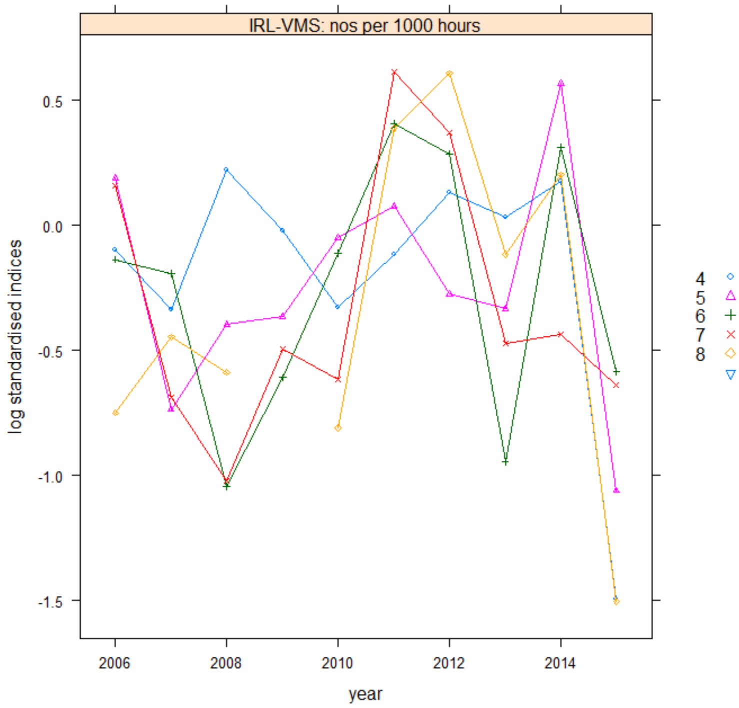


Figure 7.11.7. The log-standardised tuning index by year (top) and cohort (bottom). Due to the lack of contrast in the numbers-at-age cohorts are not tracked particularly well.

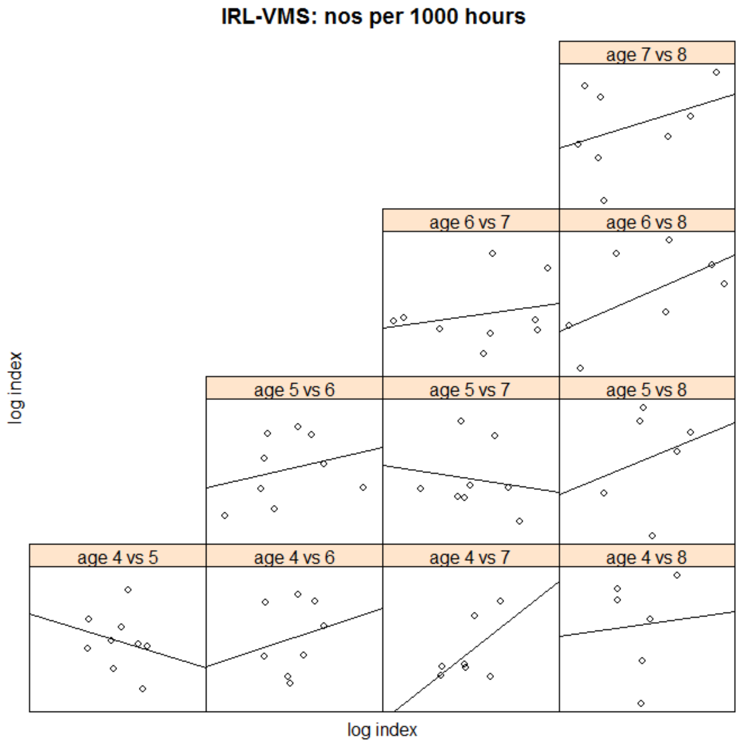


Figure 7.11.8. Internal consistency of the tuning fleet.

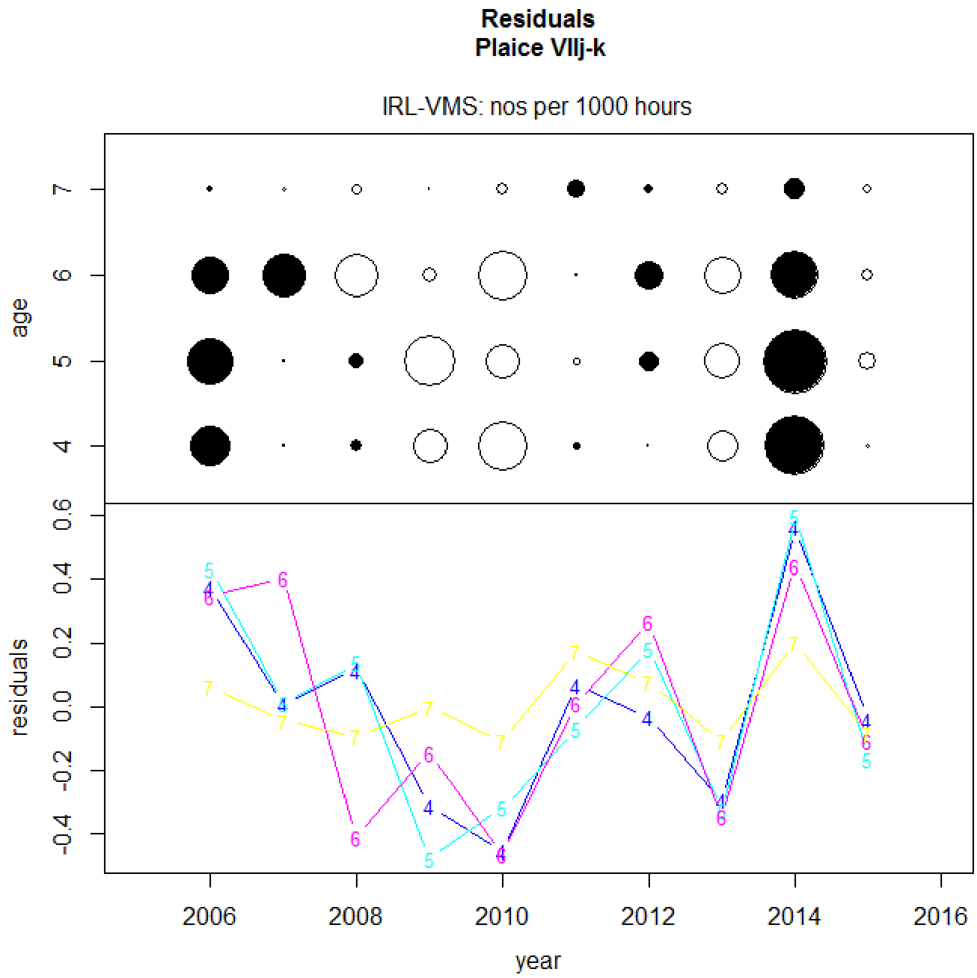


Figure 7.11.9. Residuals of the index fit.

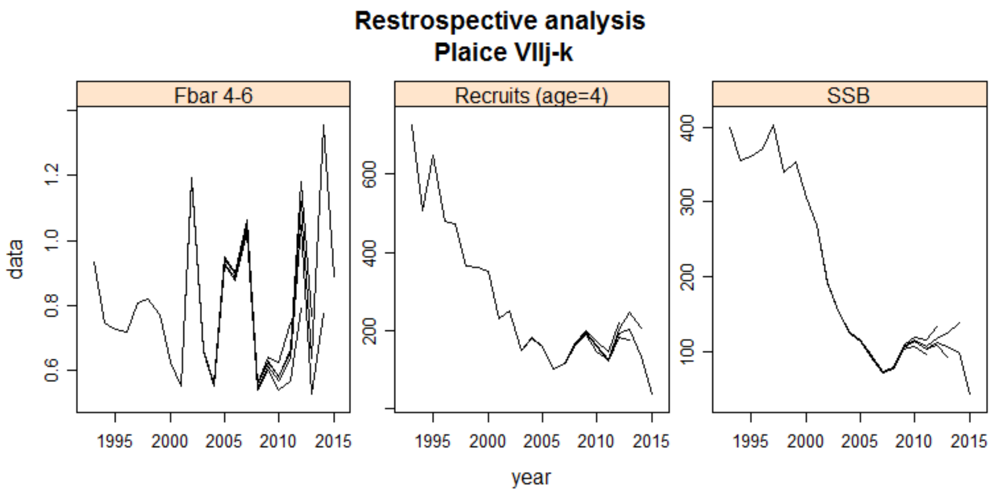


Figure 7.11.10. Retrospective analysis for

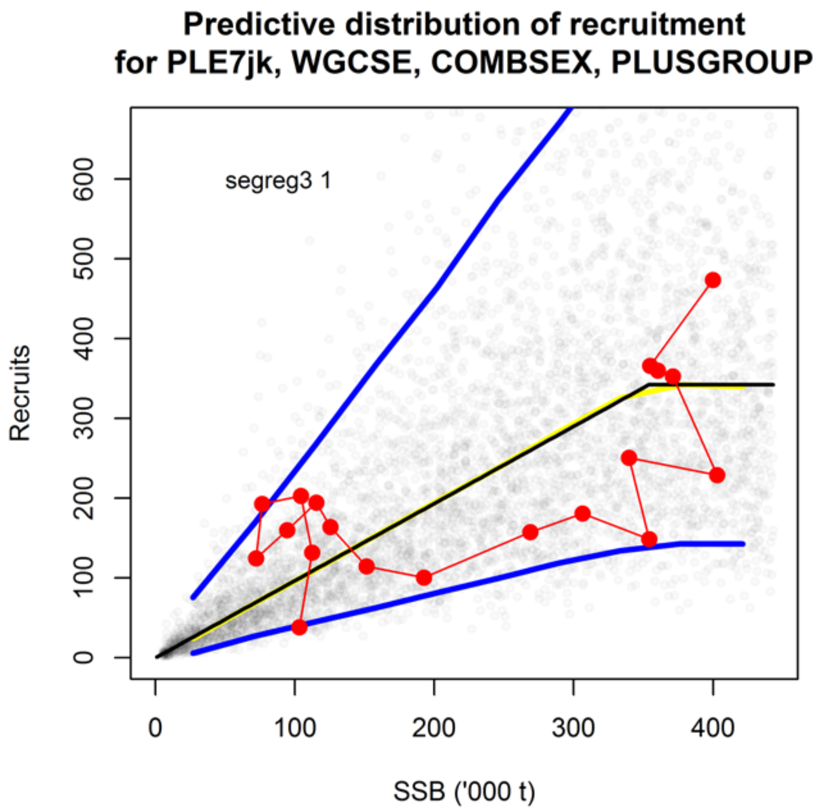


Figure 7.11.11. PleVIIjk stock–recruit plot. Because recruitment does not appear to be impaired at the lowest stock size, the inflection point of the segmented regression was chosen to be the lowest biomass that generated high recruitment.

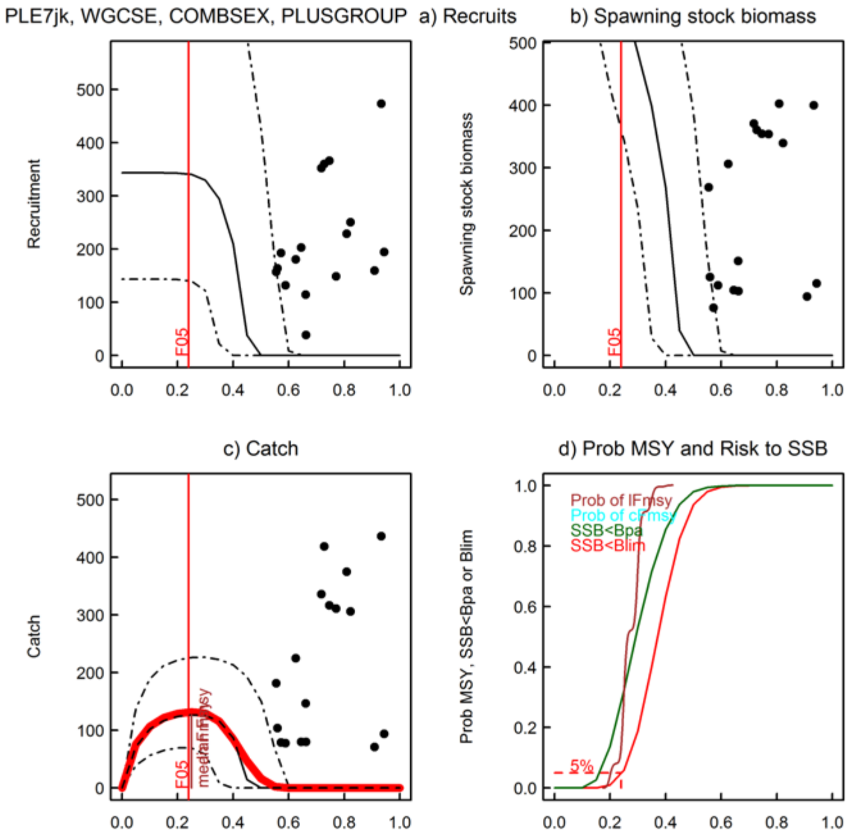


Figure 7.11.12. PleVIIjk Summary of MSY evaluations (without $B_{trigger}$ harvest control rule), a) simulated and observed recruitment, b)simulated and observed biomass, c) simulated an observed catch and d) Cumulative probability of F_{MSY} and SSB< B_{lim} and B_{pa}.

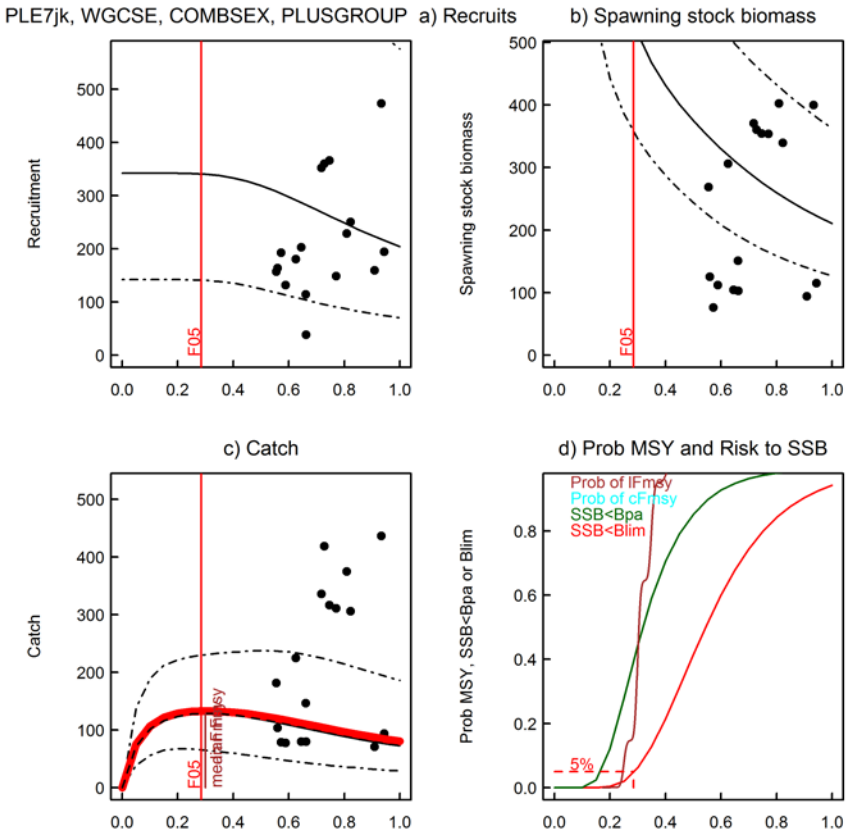


Figure 7.11.13 PleVIIjk Summary of MSY evaluations (with $B_{trigger}$=B_{lim} harvest control rule), a) simulated and observed recruitment, b)simulated and observed biomass, c) simulated an observed catch and d) Cumulative probability of F_{MSY} and SSB< B_{lim} and B_{pa}.

7.11.9 Audit of plaice in Division VIIh-k (ple-7h-k)

7.12 Sole in West of Ireland Division 7.bc

Type of assessment in 2016

No assessment was performed.

7.12.1 General

Stock Identity

Sole in 7.b are mainly caught by Irish vessels on sandy grounds in coastal areas. Sole catches in VIIc are negligible. In 7.b there are two distinct areas where sole are caught: an area around Galway Bay and an area in the north of VIIb which extends into 6.a (the Stags and Broadhaven Ground). The landings and lpue of sole in 7.bc appear to have been more or less stable since the start of the logbooks' time-series in 1995 (WD1, WGCSE 2009). It is not known how much exchange there is between sole on the Aran Grounds and those on the Stags Ground.

7.12.2 Data

The time-series of official landings is presented in Table 7.12.1 and Figure 7.12.1.

The time-series of otter-trawl landings effort and lpue since 1995 are shown in Figure 7.12.2. Lpue shows no trend over the time-series but has fluctuated more in recent years.

7.12.3 Historical stock development

No analytical assessment was performed.

Table 7.12.1. Landings of Sole in 7.bc as officially reported to ICES.

Year	BEL	FRA	UK	IRL	OTH	TOT	Year	BEL	FRA	UK	IRL	OTH	TOT	Unalloc	WG est
1908	0	0	1	37	0	38	1962	0	100	0	8	0	108		
1909	0	0	0	32	0	32	1963	0	172	0	19	0	191		
1910	0	0	0	28	0	28	1964	0	159	1	24	0	184		
1911	0	0	1	22	0	23	1965	0	95	5	24	0	124		
1912	0	0	1	22	0	23	1966	0	0	1	11	0	12		
1913	0	0	1	25	0	26	1967	0	78	0	11	0	89		
1914	0	0	1	43	0	44	1968	0	121	0	8	0	129		
1915	0	0	1	12	0	13	1969	0	86	1	9	0	96		
1916	0	0	0	14	0	14	1970	0	3	0	8	0	11		
1917	0	0	0	6	0	6	1971	0	0	2	5	0	7		
1918	0	0	0	7	0	7	1972	0	4	0	13	0	17		
1919	0	0	0	6	0	6	1973	0	0	0	12	0	12		
1920	0	0	9	5	0	14	1974	0	25	0	12	0	37		
1921	0	0	10	9	0	19	1975	0	7	0	19	0	26		
1922	0	0	4	9	0	13	1976	0	6	0	44	0	50		
1923	0	0	2	10	0	12	1977	0	3	0	14	0	17		
1924	0	0	15	64	0	79	1978	0	3	0	16	0	19		
1925	0	0	11	18	0	29	1979	0	6	0	13	0	19		
1926	0	7	10	18	0	35	1980	0	9	0	24	0	33		
1927	0	47	11	19	0	77	1981	0	6	0	47	0	53		
1928	0	49	8	16	0	73	1982	0	5	1	55	0	61		
1929	0	74	11	18	0	103	1983	0	9	0	40	0	49		
1930	0	52	5	22	0	79	1984	0	3	0	17	0	20		
1931	0	82	9	29	0	120	1985	0	6	0	44	0	50		
1932	0	122	10	27	0	159	1986	0	8	0	29	0	37		
1933	0	411	10	10	0	431	1987	0	2	0	39	0	41		
1934	0	217	10	13	0	240	1988	0	2	1	34	0	37		
1935	0	40	7	11	0	58	1989	0	0	0	38	0	38		
1936	0	43	20	9	0	72	1990	0	0	0	41	0	41		
1937	0	32	25	14	0	71	1991	0	5	0	46	0	51		
1938	0	44	21	7	0	72	1992	0	2	0	43	0	45		
1939	0	0	0	13	0	13	1993	0	1	0	59	0	60	0	60
1940	0	0	0	19	0	19	1994	0	1	0	60	0	61	9	70
1941	0	0	0	14	0	14	1995	0	2	0	59	0	61	-2	59
1942	0	0	0	8	0	8	1996	0	2	0	52	0	54	3	57
1943	0	0	0	11	0	11	1997	0	3	1	51	0	55	0	55
1944	0	0	0	16	0	16	1998	0	0	0	49	0	49	17	66
1945	0	0	0	20	0	20	1999	0	0	0	68	0	68	4	72
1946	0	0	12	10	0	22	2000	0	12	0	65	0	77	-9	68
1947	15	0	6	8	0	29	2001	0	7	0	53	0	60	0	60
1948	0	0	11	14	0	25	2002	0	14	0	50	0	64	-3	61
1949	0	41	12	12	0	65	2003	0	19	0	50	0	69	-5	64
1950	0	24	9	6	0	39	2004	0	18	0	49	0	67	2	69

Year	BEL	FRA	UK	IRL	OTH	TOT	Year	BEL	FRA	UK	IRL	OTH	TOT	Unalloc	WG est
1951	0	27	7	6	0	40	2005	0	7	0	38	0	45	-1	44
1952	0	40	2	6	0	48	2006	0	12	0	31	0	43	0	43
1953	0	99	2	4	0	105	2007	0	7	0	34	0	41	1	42
1954	0	116	1	7	0	124	2008	0	6	0	31	0	37	3	40
1955	0	66	1	9	0	76	2009	0	5	0	46	0	51	0	51
1956	0	161	1	6	0	168	2010	0	8	0	35	0	43	0	43
1957	0	94	1	4	0	99	2011	0	5	0	22	0	27	-5	22
1958	0	163	2	6	0	171	2012	0	7	0	38	0	45	-2	43
1959	0	327	1	8	0	336	2013	0	3	0	30	0	33	0	33
1960	0	80	1	9	0	90	2014	0	3	0	23	0	26	1	27
1961	0	110	1	12	0	123	2015	0	3	0	31	0	34	0	34

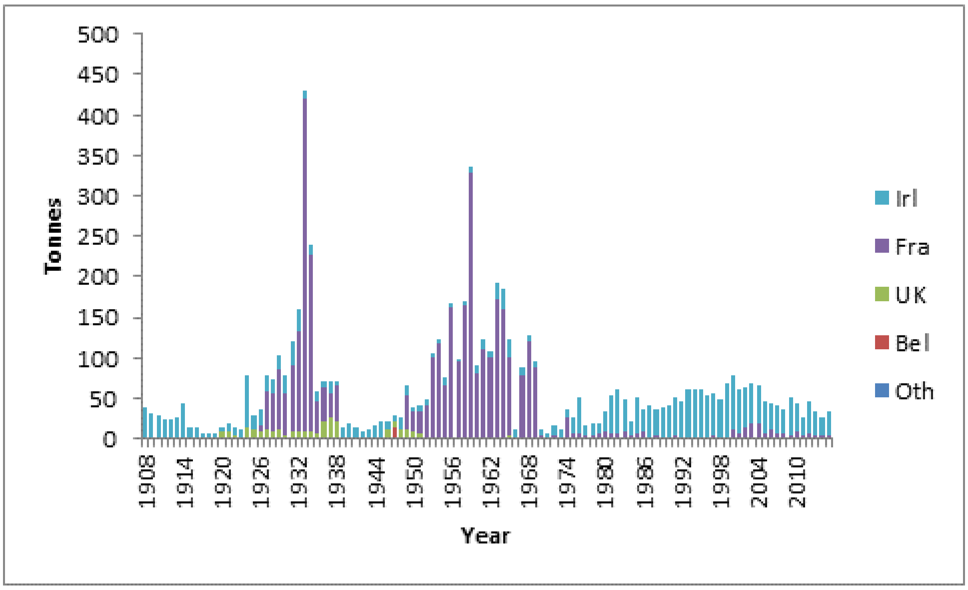


Figure 7.12.1. Landings of Sole in 7.bc as officially reported to ICES (1908–2015).

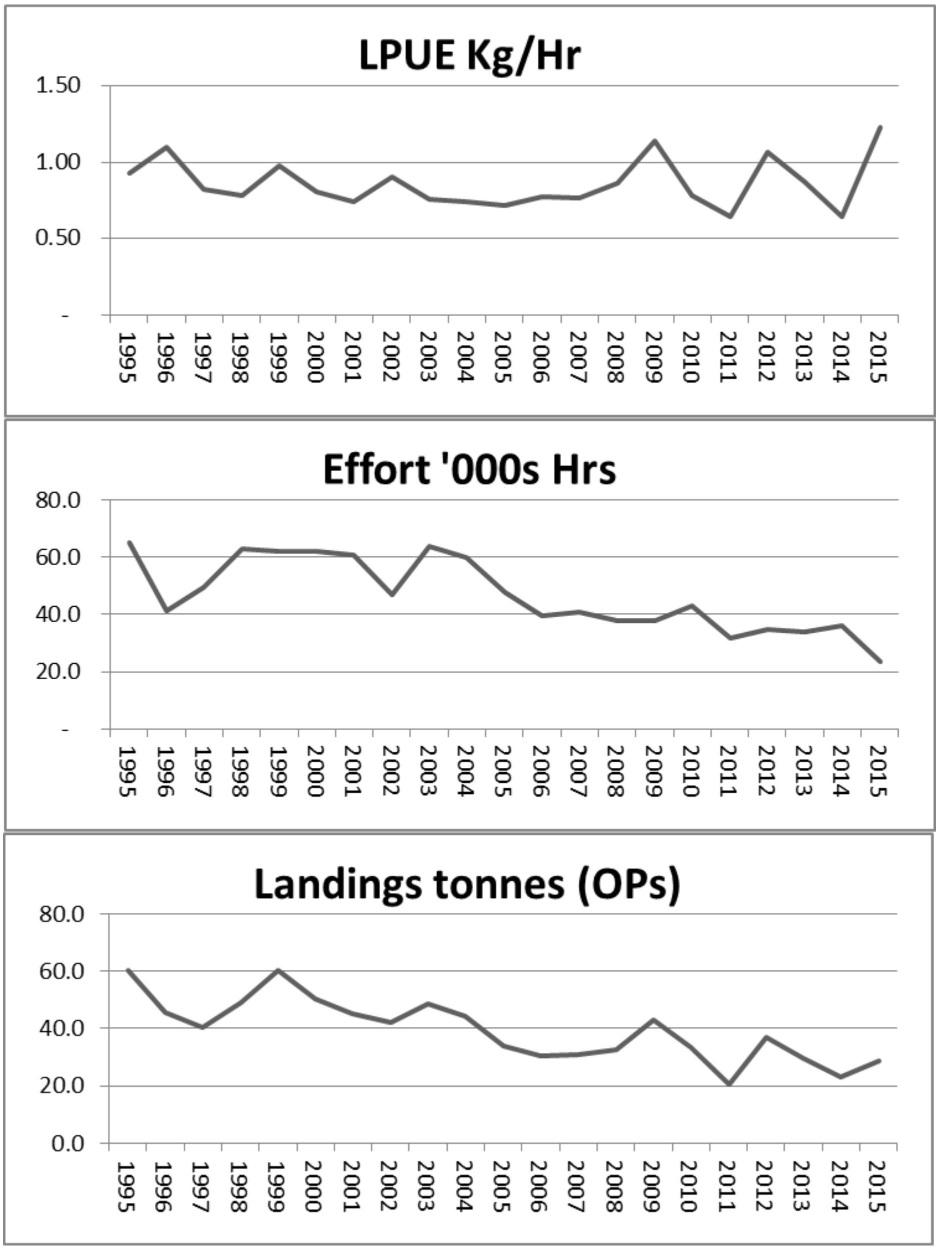


Figure 7.12.2. Sole in 7.b Irish otter trawl landings effort and lpue since 1995.

7.12.4 Audit of Sole in West of Ireland Division 7b-c

Date: 11/5/2016

Auditor: Tim Earl

7.12.4.1 General

No assessment, report updates landings data.

For single-stock summary sheet advice

1) Assessment type: SALY
2) Assessment: Not presented
3) Forecast: Not presented

4) Assessment model: None
5) Data issues: No issues
6) Consistency: No issues
7) Stock status: Not evaluated
8) Management Plan: None
9) General comments

Straightforward layout – figures seem to match the data that they are based on

7.12.4.2 Technical comments

None.

7.12.4.3 Conclusions

No assessment was performed

7.12.4.4 Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? N/a
- Is the assessment according to the stock annex description? No assessment
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? N/a
- Have the data been used as specified in the stock annex? N/a
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex?
- Is there any **major** reason to deviate from the standard procedure for this stock? N/a
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Continuation or multi-year advice?

7.13 Sole in Divisions 7.f and 7.g

Type of assessment in 2016

This assessment is an Update Assessment.

ICES advice applicable to 2015

In the advice for 2015, the stock status was presented as follows:

Fishing pressure				
	2011	2012	**2013**	
MSY (F_{MSY})	✗	✗	✗	Above target
Precautionary approach (F_{pa},F_{lim})	✓	O	✗	Harvest unsustainable

Stock size				
	2012	2013	**2014**	
MSY ($B_{trigger}$)	✓	✓	✓	Above trigger
Precautionary approach (B_{pa},B_{lim})	✓	✓	✓	Full reproductive capacity

MSY approach

Following the ICES MSY approach implies that fishing mortality is reduced to 0.31. The implied catches should be no more than 652 t. Discards are considered negligible. This is expected to lead to an SSB of 2352 t in 2016.

Precautionary approach

The fishing mortality in 2015 should be no more than F_{pa}. The implied catches should be no more than 760 t. This is expected to keep SSB above B_{pa} in 2016. Discards are considered negligible.

ICES advice applicable to 2016

In the advice for 2016, the stock status was presented as follows:

		Fishing pressure		
		2012	2013	2014
Maximum Sustainable Yield	F_{MSY}	✖	✖	✖ Above
Precautionary approach	F_{pa}, F_{lim}	○	○	○ Increased risk
Management Plan	F_{MGT}	-	-	- Not applicable

		Stock size		
		2013	2014	2015
Maximum Sustainable Yield	MSY $B_{trigger}$	✔	✔	✔ Above trigger
Precautionary approach	B_{pa}, B_{lim}	✔	✔	✔ Full reproductive capacity
Management Plan	SSB_{MGT}	-	-	- Not applicable

MSY approach

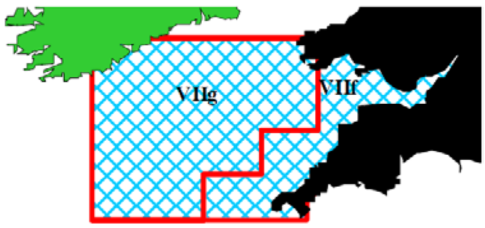
ICES advises that when the MSY approach is applied, catches in 2016 should be no more than 760 tonnes. If this stock is not under the EU landing obligation in 2016 and discard rates do not change from the average of the last three years (2012–2014), this implies landings of no more than 745 tonnes.

Technical comments made by the audit

No major deficiencies for the sole assessment in the Celtic Sea were reported.

7.13.1 General

Stock description and management units



Red Boxes - TAC/Management Areas
Blue Shading - Assessment Area

A TAC is in place for ICES Divisions 7.f and 7.g. These Divisions do correspond to the stock area. The basis for the stock assessment area 7.f and 7.g is described in detail in the Stock Annex.

Management applicable to 2015 and 2016

The sole fisheries in the Celtic Sea are managed by TAC and technical measures. The agreed TACs in 2015 and 2016 are presented in the text tables below. Technical measures in force for this stock are minimum mesh sizes and minimum landing size (24 cm). National regulations also restricted areas for certain types of vessels.

2015 TAC

Species:	Common sole *Solea solea*	Zone:	VIIf and VIIg (SOL/7FG.)
Belgium	532		
France	53		
Ireland	27		
United Kingdom	239		
Union	851		
TAC	851		Analytical TAC

2016 TAC

Species:	Common sole *Solea solea*	Zone:	VIIf and VIIg (SOL/7FG.)
Belgium	487		
France	49		
Ireland	24		
United Kingdom	219		
Union	779		
TAC	779		Analytical TAC

Three rectangles in the Celtic Sea (30E4, 31E4 and 32E3) were closed during the first quarter of 2005, and in February–March each year from 2006 onwards. A derogation has permitted beam trawlers to fish there in March 2005. The effects of this closure have been discussed in previous WGSSDS meetings and ACFM 2007, and evaluated at WKCELT 2014.

Fishery in 2015

The Expert Group estimated the total international landings at 830 t in 2015 (Table 7.13.1), which is 3% below the 2015 TAC or last year's forecast (851 t).

Early in the time-series officially reported landings included Divisions 7.g–k for some countries and their total was higher than the WG estimate. Since 1999 official landings correspond to Divisions 7.f and 7.g, and the total is lower than the working group estimate. During the period 2002–2005 the difference between the two estimates was substantial. This was mainly due to area misreporting, which was taken into account in the working group estimates (WKCELT 2014). In the recent years, the estimates are more similar.

7.13.2 Data

Landings

Annual length compositions for 2015 are given by fleet in Table 7.13.2. Length distributions of the total Belgian and UK(E&W) landings for the last 17 years are plotted in Figure 7.13.1. Belgium land a greater proportion of small fish compared to the UK(England & Wales).

Belgium, France, Ireland and UK have provided data this year under the ICES InterCatch format on a métier basis. Quarterly/yearly data for 2015 were available for landing numbers and weight-at-age, for most of the Belgian, Irish and UK fleets.

These comprise 97% of the international landings. Allocation has been made as follows: four groups of métiers with age distributions were set up: e.g. OTB_DEF_70–99, OTB_DEF_100–119, OTB_DEF_>=120 métiers and a group of all available métiers with age distributions (Overall). The OTB_DEF_70–99 (<1% of overall landings), OTB_DEF_100–119 (1.3% of overall landings) and OTB_DEF_>=120 (<1% of overall landings) métiers without age distributions were allocated with the group OTB_DEF_70–99, OTB_DEF_100–119 and OTB_DEF_>=120, respectively. The rest of the métiers without age distributions (6% of overall landings) were allocated to the group Overall.

For the period 2008–2015, the original total international catch weights-at-age were used. The stock weights were obtained using the Rivard weight calculator (http://nft.nefsc.noaa.gov./) that conducts a cohort interpolation of the catch weights.

Catch numbers-at-age are given in Table 7.13.3, and weights-at-age in the catch and the stock are given in Tables 7.13.4–7.13.5. Age compositions over the last 17 years are plotted in Figure 7.13.2. The standardised catch proportion-at-age is presented in Figure 7.13.3.

Discards

The available discard data indicate that discarding of sole is usually minor. From 2007 to 2015, discarding of sole in the UK fleet was estimated at about 1–9% in numbers. Discard rates of sole in the Belgian beam-trawl fleet were available to the expert group for 2004–2005 and 2008–2015 accounting for about 2–5% of the total sole catches in weight. The length distributions of retained and discarded catches of sole from the Belgian beam-trawl fleet for 2015 are presented in Figure 7.13.4a. The UK length distributions for 2015 from samples of UK gear except beam trawls and beam trawls are given in Figure 7.13.4b. The Irish length distributions for 2015 from samples of beam and otter trawls are shown in Figure 7.13.4c. It should be noted that the Irish otter trawl landings only amount to about 1.6% of the total international landings.

As an attempt to estimate an overall discard rate for the stock, individual discard estimates for 2013, 2014 and 2015 from the main métiers and countries were weighted according to their landed weights to arrive at an overall discard rate by year (Table 7.13.6). The percent of the métiers with discard information covering the total international landings is 90%, 90% and 93% for 2013, 2014 and 2015 respectively.

Assuming that discard rates do not change from the average of the last three years (2013–2015) and a fixed proportion of discards survive, a discard rate of around 0.03 (of the catch) could be assumed for this stock at the moment.

Biological

Natural mortality was assumed to be 0.1 for all ages and years. The maturity ogive is based on samples taken during the UK(E&W) beam trawl survey of March 1993 and 1994 and is applied to all years of the assessment.

The proportion of M and F before spawning was set to zero.

Surveys

Standardised abundance indices for the UK beam trawl survey (UK(E&W)-BTS-Q3)) are shown in Table 7.13.7 and Figure 7.13.5. Abundance at age 0 is highly variable and not used further on. The UK survey appears to track the stronger year classes reasonably well. The internal consistency plot indicates also a reasonable fit for most of the ages (Figure 7.13.6).

Commercial lpue

Available estimates of effort and lpue are presented in Tables 7.13.8–7.13.9 and Figure 7.13.7.

Belgian beam-trawl (BE-CTB) effort was at the highest levels in 2003–2005. During these years, effort shifted from the Eastern English Channel (7.d) to the Celtic Sea because of days at sea limitations in the former area. In 2006, these restrictions had been lifted and effort decreased substantially to about half of the values observed in the early 2000s. The sharp effort reduction in 2008 may be a combined result of the unrestricted effort regime in 7.d and the high fuel prices. The increase in 2012–2013 is due to the good opportunities of sole catches in the Celtic sea taken by the mobile Belgian fleet. In 2014–2015, effort decreased again to the lower level in 2009. Lpue peaked in 2002. After a sharp decline to its record low in 2004, lpue has been increasing gradually, levelling off in 2010–2013 at around 15 kg/hour. In 2014–2015, lpue increased to around 19–20 kg/hour.

The effort from the UK(E&W) beam trawl fleet (UK(E&W)-CBT) has declined sharply since the early 2000s to reach a record low in 2009, and stayed at that level ever since. However, it should be noted that the UK beam-trawl effort value for 2013 is extremely low compared to previous years and the 2014 and 2015 values are unavailable. As the UK administration switched to the EU electronic logbook system, inaccuracies in the reported effort were identified from 2013 onwards. Therefore, the absolute effort numbers for 2013–2015 could not be used and the UK(E&W)-CBT tuning indices for the three most recent years were excluded in this year’s assessment.

Details of the 2013–2015 UK beam trawl were unavailable due to reduced numbers of trips reporting this gear specific effort information via the newly introduced e-logbook system. The otter trawl fleet effort reporting was unaffected by this as these vessels were not reporting their landings via this method in 2013. However, for 2014 and 2015 also the UK otter trawl effort is unavailable. An initial inspection of an alternate effort indicator (days fished) suggest that the beam trawl and otter trawl effort in 2014 and 2015 significantly decreased.

Lpue of the UK beam trawlers was stable in the 1990s and 2000s, but at lower levels compared to the period before. In 2007, lpue increased considerably and gave a similar value for 2008. In 2009, there was a decrease to a level just above the mean of the time-series, followed by similar values for 2010, 2011 and 2012. Because of the effort reporting issues, the 2013–2015 values are unavailable.

Irish effort and lpue data are also presented. The main target species in the Irish fisheries are megrim, anglerfish, etc. The vessels usually operate on fishing grounds in the Western Celtic Sea with lower sole densities.

The internal consistency plots for the main two commercial lpue series, used in the assessment (UK(E&W)-CBT(1991–2012), BEL-CBT(1971–1996) and BEL-CBT2(1997–2015)), show high consistencies for the entire age range (Figure 7.13.8–7.13.9). However, the internal consistencies between the younger and older ages in the new Belgian commercial lpue series BEL-CBT2 (1997–2015) are rather low (Figure 7.13.9b).

Other relevant data

Reports from the UK industry suggest that the main issues affecting the fishery in 7.f and 7.g were displacement of effort due to the rectangle closures and the restrictions on the use of 80 mm mesh west of 7°W (Trebilcock and Rozarieux, 2009).

No additional information was received from the Belgian, French and Irish industries.

7.13.3 Stock assessment

The method used to assess Celtic Sea sole is XSA, using one survey and two commercial tuning series (Table 7.13.10). The Belgian commercial beam-trawl tuning fleet is now split into two parts (period 1971–1996 and 1997–2015). It should also be noted that the 2002, 2003 and 2004 numbers-at-age have been corrected for misreporting (See WKCELT 2014). Table 7.13.10 also includes tuning indices of the Irish ground fish survey (IGFS-IBTS_Q4) and the commercial UK otter trawl fleet (UK(E&W)-COT) which are not used in this assessment.

Data screening

As mentioned in Section 7.13.2, the 2013, 2014 and 2015 data from the UK(E&W) commercial tuning series were excluded from the assessment.

Adding the 2015 data to the time-series did not cause any additional anomalies compared to previous years. The “single fleet runs” are not presented in this report, but are available in ICES files.

Final update assessment

The final settings used in this year’s assessment are as detailed below:

	2014–2016 assessment		
Fleets:	Years	Ages	α–β
BEL-CBT commercial	1971–1996	2–9	0–1
BEL-CBT2 commercial	1997–assessment year-1	2–9	0–1
UK-CBT commercial	1991–2012	2–9	0–1
UK(E&W)-BTS-Q3 survey	1988– assessment year-1	1–5	0.75–0.85
-First data year -Last data year	1971 assessment year-1		
-First age -Last age	1 10+		
Time-series weights	None		
-Model	Mean q model all ages		
-Q plateau set at age	7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages		
-s.e. of the means	1.5		
-Min s.e. for pop. Estimates	0.3		
-Prior weighting	None		
Fbar (4–8)			

The catchability residuals for the final XSA are shown in Figure 7.13.10 and the XSA tuning diagnostics are given in Table 7.13.11. There may be some indications of a decreasing trend in the UK beam-trawl fleet (UK(E&W)-CBT) with predominantly positive residuals since 2007. The UK beam-trawl survey (UK(E&W)-BTS-Q3) shows a similar trend over the same time-series with predominantly negative residuals, indicating a possible conflicting signal between these two fleets. Single fleet runs (ICES files) show no apparent trends in catchability residuals for the survey but may indicate a trend in the UK beam-trawl fleet since 2007.

In this year's assessment, the estimates for the recruiting year class 2014 were estimated solely by the UK beam-trawl survey UK(E&W)-BTS-Q3) (Figure 7.13.11).

With the inclusion of the new commercial Belgian tuning series BE-CBT2 (1997–2015), the weighting of the final survival estimates were more equally spread over the two commercial series and the survey for the older ages with relative similar estimates by the commercial tuning files. However, as the most recent UK(E&W)-CBT indices (2013–2015) are not included in the assessment, the UK(E&W)-CBT gives no information on the youngest year classes (Figure 7.13.11).

Nevertheless, it should be noted that the UK beam-trawl survey is relatively consistent in the predicted year-class strengths at different ages (see ICES files), where the UK and Belgian (new) commercial tuning series have a higher variability in estimates of year-class strength at different ages.

F shrinkage gets low weights for all ages (maximum 3%). The weighting of the survey decreases for the older ages as only the tuning indices for the younger ages are used in the assessment (age range: 1–5). The commercial fleets (UK(E&W)-CBT and BE-CBT2) on the other hand are given more weight (Figure 7.13.11) for the older ages.

Retrospective patterns for the final run are shown in Figure 7.13.12. There appears to be a retrospective bias in estimating fishing mortality and SSB for successive years. In the most recent years, F was highly overestimated whereas SSB was underestimated. Recruitment in the first year may sometimes be overestimated but the overall retrospective pattern show reasonably consistent estimates.

The final XSA output is given in Table 7.13.12 (fishing mortalities) and Table 7.13.13 (stock numbers). A summary of the XSA results is given in Table 7.13.14 and trends in yield, fishing mortality, recruitment and spawning–stock biomass are shown in Figure 7.13.13.

Comparison with previous assessment

A comparison of the estimates of this year's assessment with last year's is given in Figure 7.13.14.

With the addition of the 2015 data, F and SSB were slightly downscaled. In last year's assessment, F and SSB for 2014 were estimated to be 0.44 and 2847 t respectively. This year's estimates for 2014 are 0.41 and 2826 t, a downward revision of 7% for F and 1% for SSB. The estimated recruitment by XSA in 2014 (3398 thousand fish) was significantly downscaled by 54% in this year's assessment (1559 thousand fish).

State of the stock

Trends in landings, SSB, F(4–8) and recruitment are presented in Table 7.13.14 and Figure 7.13.13.

During the eighties, fishing mortality increased for this stock. In the following decades, fishing mortality fluctuated between this higher level and F_{pa}. Since 2004, fishing mortality decreased and fluctuated between F_{pa} (0.34) and F_{MSY} (0.27). In 2010, fishing mortality began to increase again and is estimated in 2014 to be at 0.41. In 2015, F decreased and is estimated to be between F_{pa} and F_{MSY} at 0.31.

Recruitment has fluctuated around 5 million recruits with occasional strong year classes. The 1998 year class is estimated to be the strongest in the time-series (14 836 thousand fish) and the 2007 year class is also one of the stronger year classes (10 080 thousand fish). The 2009 year class is by far the lowest in the time-series (1928 thousand). The incoming recruitment (year class 2014) is estimated to be the second highest for this stock (10 172 thousand fish).

SSB has declined almost continuously from the highest value of 7554 t in 1971 to the lowest observed in the time-series in 1998. The exceptional year class of 1998 has increased SSB to above the long-term average. The good recruitment in 2008, the above average recruitment in 2009 and 2012 and the strong incoming recruitment (year class 2014) are predicted to keep SSB just above $B_{pa}/B_{trigger}$.

7.13.4 Short-term projections

The 2013 year class is estimated to be below average at 1.6 million fish at age 1. The XSA survivor estimates for this year class were used for further prediction.

The 2014 year class is estimated at 10 072 thousand fish at age 1, which is the second highest of the time-series and 106% higher than the GM (4946 thousand fish) used in last year's forecast. The estimate is solely coming from the UK(E&W)-BTS-Q3 survey. As this strong year class may be overestimated, the XSA age 1 estimate was revised down by 23% (7832 thousand fish at age 1). The exponential decay model was applied to calculate the age 2 survivors of this cohort (7087 thousand fish).

The long-term GM_{71-13} recruitment (4.9 million) was assumed for the 2015 and subsequent year classes.

The working group estimates of year-class strength used for prediction can be summarised as follows:

Year class	At age in 2016	XSA	GM	Source
2013	3	1195		XSA
2014	2	7087		XSA
2015	1	-	4933	GM 1971–2013
2016 & 2017	recruits	-	4933	GM 1971–2013

Population numbers at the start of 2016, estimated for ages 3 and older, were taken from the XSA output.

Fishing mortality was set as the mean over the last three years not scaled to 2015. Weights-at-age in the catch and in the stock are averages for the years 2013–2015. Input to the short-term predictions, the sensitivity analysis and the F_{MSY} analysis are shown in Table 7.13.15. Results are presented in Table 7.13.16 (management options) and Table 7.13.17 (detailed output). A short-term forecast plot is shown in Figure 7.13.15.

The working group decided to use a TAC constraint for the intermediate year (2016) as recent landings have been close to the TAC and a *status quo* fishing mortality gives higher landings (930 t) in the intermediate year than the agreed TAC (779 t).

Assuming a TAC constraint for 2016 of 779 t, implies a fishing mortality in 2016 of 0.30. The assumed landings using a *status quo* fishing mortality in 2017 is 1019 t. This results in a SSB of 2648 t in 2017 and 2719 t in 2018.

Assuming a TAC constraint for 2016 and a *status quo* F in 2017, the proportional contributions of recent year classes to the predicted landings and SSB are given in Table 7.13.18. The assumed GM recruitment accounts for about 4% of the landings in 2017 and about 15% of the 2018 SSB.

There are no known specific environmental drivers known for this stock.

7.13.5 MSY explorations

Investigations for possible F_{MSY} candidates for this stock were done at WGCSE 2010. ACOM adopted an F_{MSY} value of 0.31, based on stochastic simulations using a "Ricker" model (PLOTMSY program). $B_{trigger}$ was set to the B_{pa} value of 2200 t.

Exploratory analysis investigating possible revisions of MSY estimates were conducted at WGCSE 2014 with a recent version of PLotMSY (Cefas, 2014). The simulations indicated that there is no reason for using a particular weighting for any of the stock–recruitment relationships. The resulting F_{MSY} values were in line with the F_{MSY} of 0.31 used at that moment for this stock.

In response to the EC long-term management plans for western EU waters (ICES Subareas V to X), ICES WKMSYREF4 (October 2015, Brest (France)) used long-term stochastic simulations (Eqsim) to estimate F_{MSY} and appropriate ranges. The methodology used for stocks with age-based assessments follows the approaches developed in ICES WKMSYREF2 (ICES, 2014b) and WKMSYREF3 (ICES, 2014c) and is documented in the report of WKMSYREF4 (ICES, 2016c). Estimates of reference points B_{lim}, B_{pa}, F_{lim} and F_{pa} were provided, and the F_{MSY} ranges [F_{lower}, F_{upper}] deliver no more than 5% reduction in long-term yield compared with MSY.

The full available time-series of sole 7.f and 7.g recruitment was used to fit stock–recruitment models. The simulations indicated that there is no reason for using a particular weighting for any of the stock–recruitment relationships. The workshop decided to use a more conservative approach and to base the analysis on a segmented regression only with a breakpoint set at B_{lim} of 1700 t. B_{lim} was chosen as the lowest value of the SSB time-series (B_{loss}). The revised MSY reference points are more restrictive (F_{MSY}=0.27 instead of 0.31 and MSY $B_{trigger}$ = 2400 t instead of 2200 t) and demand a larger reduction in F to achieve the MSY objectives as foreseen in the basic regulation.

In order to be consistent with the ICES precautionary approach, F_{upper} is capped, so that the probability of SSB < B_{lim} is no more than 5%. Two approaches have been used to derive the values of the cap on F_{upper}. One conforms to the ICES MSY advice rule (AR), and requires reducing F linearly towards zero when SSB is below MSY $B_{trigger}$. The second uses a constant F without an advice rule; i.e. no reduction in F with SSB less than MSY $B_{trigger}$. Although the first often provides a wider F_{MSY} range, it requires the ICES MSY advice rule to be used (ICES, 2016d).

Stock code	MSY Flower	FMSY	MSY Fupper with AR	MSY Fupper with no AR
Sol-celt	0.15	0.27	0.42	0.36

7.13.6 Biological reference points

Precautionary approach reference points

The Working Group's current approach to reference points is outlined in Section 7.13.5. Current biological reference points are given in the text table below:

Reference points	ACFM 98 onwards	2016 onwards
F_{MSY}	0.31 (PLotMSY, WG 2010)	0.27 (Eqsim, WKMSYREF 4)
F_{lim}	0.52 (based on F_{loss}, WG 1998)	0.48 (based on segmented regression with B_{lim} as breakpoint)
F_{pa}	0.37 (F_{lim} x 0.72)	0.34 (F_{lim}/1.4)
B_{lim}	Not defined	1700 t (B_{loss} estimated in 2015)
B_{pa}	2200 t (based on B_{loss} (1991), WG 1998)	2380 t (B_{lim} *1.4)
$B_{trigger}$	B_{pa}	2400 t

Yield per Recruit analysis

Yield-per-recruit results, long-term yield and SSB, conditional on the present exploitation pattern and assuming a *status quo* F in 2016, are given in Table 7.13.19 and Figure 7.13.15. F_{MAX} is estimated to be 0.28, but was considered to be not well defined given the flat yield per recruit curve. Long-term yield and SSB (using GM recruitment and F_{sq}) are estimated to be 929 t and 2477 t respectively.

7.13.7 Management plans

There are no explicit management plans for Celtic Sea sole.

In 2006, the working group presented results from a series of medium-term scenarios, carried out in conjunction with 7.f and 7.g plaice, to simulate some possible management plans for the two stocks. Results indicated that an F in the range 0.27 to 0.49 in the long term would maintain yield at or above 95% of that given by F_{MAX}, whilst posing a low probability (<5%) of SSB falling below B_{lim}. Three-year average exploitation patterns were calculated and are given in Figure 7.13.16. The results of the F_{MSY} analysis, carried out during the 2014 WKMSYREF4 (ICES, 2016c) also confirm that a fishing mortality of 0.27 could be the long-term management objective for sole in 7.f and 7.g. Other species caught in the fishery (mixed fisheries) should also be considered.

7.13.8 Uncertainties and bias in assessment and forecast

Sampling

The major fleets fishing for 7.f and 7.g sole are sampled (approximately 97% of the total landings). Sampling is considered to be at a reasonable level.

Discards

Discard estimates, which are low (average discarding by weight is 3% of the catch) are not included in the assessment.

Surveys

The UK(E&W)-BTS-Q3 survey, which is solely responsible for the recruiting estimates, has been able to track year-class strength at ages greater than 0 rather well in the past. However, the strong year classes have sometimes been revised downward in previous assessments and therefore estimates of very strong year classes may cause bias in the forecast. The strong incoming recruitment (year class 2014) was revised down by 23% in the forecast and should therefore probably be of less concern regarding an overly optimistic forecast.

Consistency

The assessment provided by the Expert Group revised down F by 7% and SSB by 1%, indicating that there is no major concern about the uncertainty in the assessment and the forecast. Recruitment was revised down by 54% relative to last year's assessment. There is a slight retrospective pattern in estimating F and SSB in the last few years. Recruitment in the first year may sometimes be overestimated but the overall retrospective pattern show reasonably consistent estimates.

Misreporting

Area misreporting is known to have been considerable over the period 2002–2005. This was due to a combination of the good 1998 year class still being an important part of the catch composition and more restrictive TACs. The area misreporting has been corrected for the years 2002–2006 (WGSSDS 2007). At the WKCELT 2014, analysis revealed that there was additional misreporting taking place in 2002–2003 and 2004 which was not accounted for in the first correction done at WGSSDS in 2007. Since 2007, the area misreporting that could be estimated was negligible.

7.13.9 Recommendation for next Benchmark

Sole in 7.f and 7.g has been benchmarked in February 2014. WGCSE recommend that a new benchmark is planned for 2018 to take in new survey data.

Issue	Problem / Aim	Work needed / Work needed / possible direction of solution	Data needed to be able to do this: are these available / where should these come from?
Tuning series	Commercial UK(E&W)-CBT fleet The UK beam-trawl tuning series is included in the current assessment but only used up to 2012 because of effort reporting issues. A new tuning series was provided with effort in days instead of hours up to 2015. The inclusion of this new tuning series results in a significant upward revision of F and downward revision of SSB from the late 1990s up until now, compared to the original tuning series. UK-BTS-Q3 survey The UK-BTS-Q3 survey is the only survey used in the current assessment and is solely providing information on the recruiting age (age 1)	*Need to review the new UK-CBT tuning series with effort in days *Investigate if commercial tuning fleets should still be used in future assessments of sole in 7.f and 7.g. *Investigate if additional survey information (e.g. UK-Q1SWBeam, started in 2012) is available and can be incorporated in the assessment once the time-series is sufficiently long in 2018. *Additional survey data can confirm the info provided by the UK-BTS-Q3 survey.	*UK-CBT tuning series calculations *UK-Q1SWBeam tuning series *other available survey data
Fisheries & ecosystem issues and data	Trends in mean weights The mean weights have dropped over time (2000-2010) and recently increased again.	*What drives this change? *Is it driven by an ecosystem change? *Is there a similar trend in the weights from other stocks?	*information on the evolution in the Celtic Sea ecosystem

7.13.10 Management considerations

There is no apparent stock–recruitment relationship for this stock and no evidence of reduced recruitment at low levels of SSB (Figure 7.13.17).

SSB has declined almost continuously from the highest value of 7554 t in 1971 to the lowest observed in the time-series in 1998. The exceptional year class of 1998 has increased SSB to above the long-term average. The good recruitment in 2008, the above average recruitment in 2009 and 2012 and the strong incoming recruitment (year class 2014) are predicted to keep SSB just above $B_{pa}/B_{trigger}$.

The Celtic Sea is an area without days at sea limitations for demersal fisheries. In this context and given that many demersal vessels are very mobile, changes in effort measures in areas other than the Celtic Sea can influence the effort regime in the Celtic Sea (cfr. increased effort in Celtic Sea for Belgian beamers during 2004–2005 when days at sea limitations were in place for the Eastern English Channel).

7.13.11 Ecosystem considerations

Sole and plaice are predominantly caught by beam-trawl fisheries. Beam trawling is known to have an impact on the benthic communities, although less so on soft substrates and in areas which have been historically exploited by this fishing method. Benthic drop-out panels have been shown to release around 75% of benthic invertebrates from the catches. Information from the UK industry (Trebilcock and Rozarieux, 2009) suggests that uptake in 2008 was minimal.

7.13.12 References

Trebilcock P. and N. de Rozarieux. 2009. National Federation Fishermen's Organisation Annual Fisheries Reports. Cornish Fish Producers Organisation / Seafood Cornwall Training Ltd, March 2009.

ICES. 2009. Report of the Benchmark and Data Compilation Workshop for Flatfish (WKFLAT 2009), 6–13 February 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:31. 192 pp.

ICES. 2014. Report of the Benchmark WKCELT, 3–7 February 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:42. 194 pp.

ICES. 2014b. Report of the Workshop to consider reference points for all stocks (WKMSYREF2), 8–10 January 2014, ICES Headquarters, Copenhagen, Denmark. ICES CM 2014/ACOM:47. 91 pp.

ICES. 2014c. Report of the Joint ICES–MYFISH Workshop to consider the basis for F_{MSY} ranges for all stocks (WKMSYREF3), 17–21 November 2014, Charlottenlund, Denmark. ICES CM 2014/ACOM:64. 147 pp.

ICES. 2016c. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 183 pp.

ICES. 2016d. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES Subareas 5 to 10, ICES special request advice. 5 February 2016 Version 2; 13 May 2016.

Table 7.13.1. Celtic Sea Sole (7.f and 7.g). Official Nominal landings and data used by the Working Group (t).

Year	Belgium	Denmark	France	Ireland	UK(E.&W,NI.)	UK(Scotland)	Netherlands	Total-Official	Unallocated	Used by WG	TAC
1986	1039 *	2	146	188	611	-	3	1989	-389	1600	
1987	701 *	-	117	9	437	-	-	1264	-42	1222	1600
1988	705 *	-	110	72	317	-	-	1204	-58	1146	1100
1989	684 *	-	87	18	203	-	-	992	0	992	1000
1990	716 *	-	130	40	353	0	-	1239	-50	1189	1200
1991	982 *	-	80	32	402	0	-	1496	-389	1107	1200
1992	543 *	-	141	45	325	6	-	1060	-79	981	1200
1993	575 *	-	108	51	285	11	-	1030	-102	928	1100
1994	619 *	-	90	37	264	8	-	1018	-9	1009	1100
1995	763 *	-	88	20	294	-	-	1165	-8	1157	1100
1996	695 *	-	102	19	265	0	-	1081	-86	995	1000
1997	660 *	-	99	28	251	0	-	1038	-111	927	900
1998	675 *	-	98	42	198	-	-	1013	-138	875	850
1999	604	-	61	51	231	0	-	947	65	1012	960
2000	694	-	74	29	243	-	-	1040	51	1091	1160
2001	720	-	77	35	288	-	-	1120	48	1168	1020
2002	703	-	65	32	318	+	-	1118	227	1345	1070
2003	715	-	124	26	342	+	-	1207	185	1392	1240
2004	735	-	79	33	283	-	-	1130	119	1249	1050
2005	645	-	101	34	217	-	-	997	47	1044	1000
2006	576	-	75	38	232	-	-	921	25	946	950
2007	582	-	85	32	244	-	-	943	2	945	890
2008	466	-	68	28	218	-	-	780	20	800	964
2009	513	-	74	26	194	-	-	807	-2	805	993
2010	620	-	45	27	179	-	-	871	5	876	993
2011	766	-	50	30	168	-	-	1013	16	1029	1241
2012	843	-	48	33	175	-	-	1099	5	1104	1060
2013	789	-	49	42	206	-	-	1086	6	1092	1100
2014	705	-	59	28	252	-	-	1044	2	1042	1001
2015 ^	671	-	24	27	105	-	-	827	3	830	851

^Landings are preliminary.

*** including 7.g–k.**

Table 7.13.2. Sole in7.f and 7.g. Annual length distributions by fleet.

	UK (England & Wales)	Belgium	Ireland	
Length (cm)	Beam trawl	Beam trawl	Beam trawl	Otter trawl
17				
18				
19				
20				10
21				0
22	8			20
23	8	665		172
24	233	126841	134	274
25	1031	223747	268	386
26	3399	251836	179	355
27	7972	283817	893	1167
28	11894	236822	2278	1958
29	16297	197502	3082	2334
30	22652	217441	3484	2790
31	25308	144900	5136	3369
32	23547	127773	5136	3927
33	18347	92792	4243	3653
34	15599	71249	1563	3328
35	15241	72189	1161	2658
36	13429	46512	1027	1766
37	15408	48778	804	974
38	8278	32754	1519	1218
39	7469	26884	849	548
40	6584	24571	715	629
41	5171	12458	491	568
42	3277	6451	268	416
43	1630	5524	134	264
44	1817	2650	89	122
45	1144	1739	0	101
46	383	607	89	122
47	370	1296	45	51
48	176	507		162
49	72	251		41
50	78			30
51	28			20
52	0			10
53	0			41
54	10			20
55				0
56				0
57				0
58				0
59				0
60				20
61				10
Total	226861	2258556	33587	33534

Table 7.13.3. Catch numbers-at-age (in thousands).

	YEAR		1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	AGE											
		1	0	0	0	0	0	0	0	0	0	0
		2	386	541	364	155	119	312	314	318	328	657
		3	270	902	1882	438	287	834	438	741	560	972
		4	1341	314	748	863	336	560	349	339	747	876
		5	625	670	305	411	638	611	271	154	208	584
		6	433	329	352	209	304	559	244	159	154	180
		7	537	213	119	239	110	261	404	99	197	62
		8	763	232	110	97	102	131	120	198	124	96
		9	376	314	116	109	67	197	28	71	153	100
	+gp		1220	730	644	541	372	463	365	174	169	352
0	TOTALNUM		5951	4245	4640	3062	2335	3928	2533	2253	2640	3879
	TONSLAND		1861	1278	1391	1105	919	1350	961	780	954	1314
	SOPCOF %		100	100	100	100	100	100	100	100	100	100

	Table 1 Catch numbers at age			Numbers*10**-3								
	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
	AGE											
		1	0	0	0	0	0	0	0	0	0	0
		2	602	342	647	672	196	494	318	526	479	277
		3	675	831	1078	846	1473	1296	957	464	1164	994
		4	792	309	729	606	766	1173	797	879	601	1176
		5	399	467	284	542	565	526	577	441	621	399
		6	377	280	349	184	296	358	273	387	237	452
		7	150	207	225	277	100	193	205	127	188	138
		8	120	92	192	106	140	87	100	78	82	115
		9	94	111	52	47	73	103	61	67	24	50
	+gp		380	326	320	274	240	328	179	268	102	129
0	TOTALNUM		3589	2965	3876	3554	3849	4558	3467	3237	3498	3730
	TONSLAND		1212	1128	1373	1266	1328	1600	1222	1146	992	1189
	SOPCOF %		100	100	100	100	100	100	100	100	100	100

	Table 1 Catch numbers at age			Numbers*10**-3								
	YEAR		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	AGE											
		1	0	0	0	0	0	0	0	0	0	0
		2	1458	433	354	295	129	177	245	197	608	1721
		3	690	1700	863	790	1156	1035	890	932	1718	1480
		4	658	644	1104	739	1098	904	599	724	834	683
		5	496	409	332	864	420	424	400	297	282	241
		6	151	253	186	283	483	229	252	171	143	60
		7	156	61	161	149	133	192	127	108	80	56
		8	55	59	63	65	112	57	126	51	31	43
		9	46	28	83	42	65	43	45	52	23	19
	+gp		162	89	99	146	109	106	106	87	44	51
0	TOTALNUM		3872	3676	3245	3373	3705	3167	2790	2619	3763	4354
	TONSLAND		1107	981	928	1009	1157	995	927	875	1012	1091
	SOPCOF %		100	100	100	100	100	100	100	100	100	100

	Table 1 Catch numbers at age			Numbers*10**-3								
	YEAR		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	AGE											
		1	0	0	0	0	0	0	0	0	0	0
		2	704	29	132	476	290	685	335	214	607	281
		3	1918	1465	775	1926	916	1330	865	452	464	1317
		4	860	2202	1260	886	896	715	743	559	426	744
		5	436	660	2067	889	507	576	474	565	346	347
		6	242	249	447	807	426	163	325	277	292	258
		7	65	95	248	128	373	148	157	198	173	164
		8	39	54	89	67	51	178	145	76	103	118
		9	26	36	29	38	44	44	184	109	44	66
	+gp		81	51	84	55	45	51	70	172	193	118
0	TOTALNUM		4371	4841	5131	5272	3548	3890	3298	2622	2648	3413
	TONSLAND		1168	1345	1547	1398	1118	946	945	800	805	876
	SOPCOF %		100	100	100	100	100	100	100	100	100	100

	Table 1 Catch numbers at age			Numbers*10**-3			
	YEAR		2011	2012	2013	2014	2015
	AGE						
		1	0	0	0	0	0
		2	124	160	436	115	85
		3	1013	233	1065	628	806
		4	1444	1029	343	742	863
		5	398	1308	837	217	382
		6	273	364	693	430	140
		7	194	207	227	421	217
		8	133	136	80	138	117
		9	66	91	66	84	82
	+gp		199	246	166	218	132
0	TOTALNUM		3844	3774	3913	2993	2824
	TONSLAND		1029	1104	1093	1042	830
	SOPCOF %		100	100	100	100	100

Table 7.13.4. Sole in 7.f and 7.g. Catch weights-at-age (kg).

	YEAR		1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	AGE											
		1	0.039	0.106	0.081	0.063	0.046	0.114	0.098	0.068	0.023	0.048
		2	0.106	0.147	0.143	0.137	0.132	0.167	0.169	0.154	0.132	0.144
		3	0.167	0.186	0.202	0.205	0.212	0.218	0.235	0.234	0.232	0.234
		4	0.222	0.226	0.258	0.27	0.286	0.268	0.297	0.309	0.321	0.316
		5	0.272	0.264	0.311	0.329	0.355	0.316	0.355	0.378	0.401	0.392
		6	0.315	0.302	0.361	0.385	0.417	0.363	0.409	0.441	0.471	0.461
		7	0.352	0.34	0.408	0.436	0.473	0.409	0.46	0.499	0.531	0.523
		8	0.383	0.376	0.452	0.483	0.523	0.453	0.506	0.551	0.581	0.579
		9	0.408	0.413	0.493	0.525	0.567	0.496	0.548	0.598	0.622	0.627
	+gp		0.4397	0.5384	0.6021	0.6239	0.6715	0.6649	0.6681	0.7196	0.6636	0.7202
0	SOPCOFAC		0.9999	1.0009	1.0005	0.9995	0.9999	0.9988	0.9996	0.9979	1.0011	0.9992

	Table 2 Catch weights at age (kg)											
	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
	AGE											
		1	0.078	0.061	0.085	0.019	0.089	0.046	0.048	0.074	0.013	0.049
		2	0.154	0.156	0.173	0.131	0.17	0.144	0.146	0.157	0.109	0.134
		3	0.225	0.243	0.255	0.235	0.246	0.236	0.236	0.235	0.198	0.214
		4	0.292	0.324	0.33	0.33	0.317	0.321	0.32	0.309	0.28	0.291
		5	0.355	0.397	0.398	0.416	0.383	0.4	0.396	0.378	0.355	0.363
		6	0.414	0.462	0.459	0.494	0.444	0.471	0.466	0.442	0.424	0.43
		7	0.469	0.521	0.514	0.562	0.5	0.536	0.528	0.502	0.487	0.494
		8	0.519	0.572	0.561	0.622	0.552	0.594	0.584	0.557	0.543	0.553
		9	0.565	0.617	0.602	0.673	0.598	0.645	0.632	0.608	0.592	0.609
	+gp		0.6654	0.7043	0.6786	0.7716	0.7026	0.7479	0.7404	0.7385	0.6909	0.7474
0	SOPCOFAC		0.9999	0.9994	1.0004	0.9985	1.0016	1.0004	1.001	0.9993	0.9993	0.9993

	Table 2 Catch weights at age (kg)											
	YEAR		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	AGE											
		1	0.054	0.073	0.057	0.081	0.068	0.027	0.074	0.079	0.015	0.078
		2	0.15	0.147	0.134	0.151	0.147	0.124	0.156	0.163	0.122	0.166
		3	0.239	0.216	0.207	0.216	0.22	0.214	0.234	0.244	0.222	0.248
		4	0.32	0.281	0.275	0.276	0.288	0.296	0.307	0.32	0.315	0.322
		5	0.393	0.342	0.338	0.331	0.351	0.372	0.376	0.393	0.4	0.39
		6	0.459	0.398	0.396	0.38	0.409	0.439	0.44	0.462	0.478	0.451
		7	0.516	0.451	0.45	0.425	0.462	0.5	0.5	0.528	0.549	0.506
		8	0.566	0.499	0.5	0.465	0.51	0.552	0.555	0.589	0.613	0.553
		9	0.608	0.543	0.545	0.5	0.553	0.598	0.605	0.647	0.67	0.594
	+gp		0.674	0.6402	0.6445	0.5626	0.6429	0.6773	0.7071	0.7809	0.7655	0.6649
0	SOPCOFAC		0.9998	0.9995	0.9994	0.9996	0.9982	1.0008	0.9997	0.9994	1.0005	1

	Table 2 Catch weights at age (kg)											
	YEAR		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	AGE											
		1	0.066	0.054	0.123	0.066	0.068	0.085	0.075	0.128	0.128	0.127
		2	0.148	0.13	0.171	0.13	0.145	0.139	0.139	0.164	0.179	0.16
		3	0.225	0.202	0.218	0.194	0.219	0.192	0.2	0.198	0.221	0.186
		4	0.296	0.271	0.266	0.256	0.288	0.245	0.258	0.258	0.252	0.23
		5	0.363	0.336	0.313	0.317	0.354	0.297	0.313	0.309	0.32	0.31
		6	0.425	0.399	0.361	0.377	0.415	0.349	0.365	0.305	0.394	0.346
		7	0.482	0.457	0.408	0.435	0.473	0.4	0.414	0.412	0.417	0.404
		8	0.533	0.513	0.454	0.493	0.528	0.451	0.46	0.521	0.463	0.404
		9	0.579	0.564	0.501	0.549	0.578	0.501	0.503	0.532	0.481	0.53
	+gp		0.6773	0.7045	0.6386	0.7211	0.6898	0.6177	0.6087	0.5363	0.6216	0.5907
0	SOPCOFAC		0.9954	1.0001	1.0014	1.0003	1.0011	0.9992	0.9999	1.0009	0.9997	0.9994

	Table 2 Catch weights at age (kg)							
	YEAR		2011	2012	2013	2014	2015
	AGE						
		1	0.14	0.11	0.125	0.073	0.134
		2	0.162	0.162	0.179	0.17	0.163
		3	0.184	0.213	0.205	0.208	0.2
		4	0.223	0.247	0.253	0.273	0.254
		5	0.272	0.279	0.285	0.366	0.319
		6	0.354	0.324	0.334	0.393	0.352
		7	0.42	0.341	0.35	0.425	0.443
		8	0.447	0.377	0.475	0.484	0.516
		9	0.475	0.409	0.412	0.53	0.436
	+gp		0.6222	0.5376	0.5758	0.6855	0.5486
0	SOPCOFAC		0.9995	1.0001	0.9997	1.0011	0.9999

Table 7.13.5. Sole in 7.f and 7.g. Stock weights-at-age (kg).

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
AGE										
1	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
2	0.076	0.113	0.113	0.113	0.113	0.113	0.145	0.113	0.113	0.113
3	0.136	0.157	0.142	0.159	0.141	0.16	0.174	0.167	0.163	0.157
4	0.19	0.222	0.203	0.221	0.215	0.21	0.236	0.257	0.255	0.238
5	0.239	0.298	0.263	0.305	0.295	0.269	0.366	0.36	0.392	0.354
6	0.406	0.351	0.334	0.45	0.353	0.354	0.392	0.413	0.437	0.394
7	0.472	0.352	0.322	0.448	0.593	0.432	0.454	0.521	0.485	0.622
8	0.389	0.593	0.4	0.464	0.423	0.462	0.505	0.508	0.595	0.556
9	0.346	0.417	0.539	0.624	0.465	0.425	0.907	0.56	0.657	0.704
+gp	0.5826	0.6005	0.5822	0.6707	0.7112	0.728	0.7006	0.7826	0.6963	0.7714

Table 3 Stock weights at age (kg)

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
2	0.113	0.113	0.113	0.118	0.113	0.113	0.113	0.113	0.113	0.113
3	0.159	0.164	0.175	0.173	0.175	0.18	0.153	0.158	0.152	0.164
4	0.232	0.255	0.262	0.274	0.268	0.273	0.242	0.233	0.227	0.247
5	0.306	0.356	0.37	0.429	0.472	0.398	0.361	0.363	0.308	0.369
6	0.385	0.487	0.488	0.517	0.433	0.462	0.473	0.466	0.465	0.476
7	0.462	0.543	0.633	0.641	0.462	0.546	0.468	0.687	0.546	0.523
8	0.551	0.61	0.606	0.613	0.48	0.636	0.587	0.687	0.526	0.753
9	0.737	0.766	0.464	0.836	0.944	0.89	0.82	0.676	0.542	0.847
+gp	0.6627	0.8561	0.823	0.9784	0.7983	0.8435	0.8378	0.818	0.7522	0.9732

Table 3 Stock weights at age (kg)

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
2	0.113	0.113	0.148	0.113	0.113	0.104	0.113	0.113	0.11	0.062
3	0.179	0.184	0.196	0.135	0.143	0.186	0.178	0.195	0.204	0.169
4	0.23	0.265	0.267	0.227	0.233	0.284	0.276	0.282	0.317	0.306
5	0.356	0.388	0.392	0.329	0.335	0.387	0.386	0.371	0.433	0.434
6	0.536	0.498	0.47	0.43	0.441	0.486	0.495	0.454	0.541	0.534
7	0.376	0.751	0.492	0.521	0.54	0.573	0.598	0.529	0.635	0.603
8	0.859	0.754	0.576	0.599	0.629	0.647	0.689	0.593	0.712	0.648
9	0.735	0.475	0.636	0.661	0.705	0.708	0.766	0.644	0.772	0.677
+gp	0.6789	0.8963	0.7272	0.7572	0.8447	0.808	0.8923	0.7318	0.8525	0.707

Table 3 Stock weights at age (kg)

YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE										
1	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.108	0.115	0.112
2	0.113	0.113	0.158	0.116	0.149	0.143	0.117	0.141	0.151	0.143
3	0.187	0.189	0.205	0.176	0.213	0.188	0.177	0.176	0.19	0.183
4	0.312	0.289	0.258	0.248	0.275	0.235	0.236	0.232	0.223	0.226
5	0.434	0.403	0.317	0.329	0.337	0.284	0.294	0.274	0.287	0.28
6	0.538	0.512	0.381	0.415	0.399	0.334	0.35	0.261	0.349	0.333
7	0.619	0.609	0.449	0.502	0.459	0.386	0.406	0.389	0.357	0.399
8	0.68	0.691	0.521	0.587	0.52	0.441	0.46	0.542	0.437	0.41
9	0.725	0.757	0.594	0.667	0.579	0.496	0.513	0.526	0.501	0.495
+gp	0.7835	0.873	0.8123	0.8683	0.7369	0.6414	0.6622	0.495	0.5814	0.5789

Table 3 Stock weights at age (kg)

YEAR	2011	2012	2013	2014	2015
AGE					
1	0.13	0.086	0.107	0.049	0.165
2	0.143	0.151	0.14	0.146	0.109
3	0.172	0.186	0.182	0.193	0.184
4	0.204	0.213	0.232	0.237	0.23
5	0.25	0.249	0.265	0.304	0.295
6	0.331	0.297	0.305	0.335	0.359
7	0.381	0.347	0.337	0.377	0.417
8	0.425	0.398	0.403	0.412	0.468
9	0.438	0.428	0.394	0.502	0.459
+gp	0.5913	0.5593	0.5512	0.6381	0.5745

Table 7.13.6. Sole 7.f and 7.g. Discard rates.

Country	Year	Landings (L) (t)				Discards (D) (t)
BE		TBB	OTB	GNS	other	
	2012	786.828	55.767	0	0	21.023
	2013	746.751	40.031	0	1.475	19.061
	2014	666.183	36.317	0	0.604	12.08
	2015	640.168	33.623	0	0	12.729
UK	2012	153.388	21.528	4.346	1.138	0
	2013	177.3898	22.156	2.421	2.258	2.602
	2014	240.910	7.825	2.699	0.7851	2.950
	2015	87.039	13.878	2.917	0.7047	0.195
IR	2012	12.136	19.276	0	1.392	6
	2013	15.996	16.583	0	18.686	1
	2014	11.893	14.234	0	1.614	7.4
	2015	12.439	13.354	0.183	1.444	14.3

	total L	L corresponding with discard info	% coverage of L	total D	rate
2012	1104.28	818.24	0.74	27.02	0.032
2013	1092.76	978.88	0.90	22.66	0.023
2014	1041.88	934.01	0.90	22.40	0.023
2015	830.44	769.80	0.93	27.22	0.034
average 13-15			0.91	24.25	0.03

Table 7.13.7. Sole in 7.f and 7.g. Indices of abundance (No/100 km) for UK(E&W)-BTS-Q3.

	0	1	2	3	4	5	6	7	8	9
1988	30	81	326	49	19	5	0	0	0	0
1989	144	222	331	176	20	15	7	4	2	2
1990	30	385	313	50	16	4	7	3	0	0
1991	32	241	517	67	17	15	4	0	2	2
1992	4	394	260	139	30	18	10	1	2	1
1993	3	169	320	43	19	1	2	2	1	1
1994	1	333	387	99	14	7	7	0	0	2
1995	27	124	222	52	11	6	12	1	1	1
1996	3	150	211	54	23	6	2	3	1	2
1997	32	433	180	18	11	12	4	3	5	0
1998	90	770	411	51	10	7	4	2	1	5
1999	24	2464	250	32	14	5	4	4	1	0
2000	13	916	1356	31	22	5	0	2	1	1
2001	22	379	599	259	20	7	5	2	0	2
2002	8	663	238	127	102	12	6	2	3	0
2003	12	392	530	47	26	47	8	3	3	0
2004	56	749	377	87	13	19	37	4	2	0
2005	37	343	225	32	14	6	4	14	1	2
2006	11	273	201	39	13	7	0	2	10	0
2007	91	357	108	43	14	7	6	3	3	11
2008	5	1039	104	13	15	6	8	3	3	4
2009	1	509	318	24	6	8	3	2	2	2
2010	18	85	471	122	17	2	4	7	3	1
2011	17	501	52	139	69	7	2	6	3	0
2012	13	542	231	7	53	24	1	1	1	2
2013	9	279	518	43	13	24	15	1	5	1
2014	34	244	258	76	14	5	23	8	1	1
2015	28	747	48	44	31	7	3	13	6	0
Geomean	15	370	269	53	19	8	1	0.4	0.2	0.0
Mean	28	492	334	70	23	11	7	3	2	1

Table 7.13.8. Sole in 7.f and 7.g. Indices of effort.

	England & Wales		Belgium		Ireland		
Year	Otter trawl[1]	Beam trawl[1]	Beam trawl[2]	Beam trawl[4]	Otter trawl[3]	Scottish seine[4]	Beam trawl[4]
1971	-	-	11.06	-	-	-	-
1972	45.72	-	8.44	-	-	-	-
1973	45.28	-	17.39	-	-	-	-
1974	38.94	-	18.83	-	-	-	-
1975	33.53	-	16.38	-	-	-	-
1976	25.61	-	28.07	-	-	-	-
1977	27.16	-	24.11	-	-	-	-
1978	27.08	2.50	18.09	-	-	-	-
1979	23.84	1.96	18.90	-	-	-	-
1980	26.43	4.31	29.02	-	-	-	-
1981	24.10	6.24	35.39	-	-	-	-
1982	19.20	9.95	28.77	-	-	-	-
1983	17.61	12.35	34.95	-	-	-	-
1984	23.16	13.55	33.48	-	-	-	-
1985	25.24	18.70	40.49	-	-	-	-
1986	21.18	20.72	52.46	-	-	-	-
1987	24.43	38.76	37.26	-	-	-	-
1988	20.09	25.62	42.92	-	-	-	-
1989	17.61	20.26	53.58	-	-	-	-
1990	22.56	30.77	40.27	-	-	-	-
1991	18.57	40.81	18.05	-	-	-	-
1992	16.00	35.78	25.47	-	-	-	-
1993	13.79	39.64	31.27	-	-	-	-
1994	9.48	37.03	38.35	-	-	-	-
1995	8.46	37.59	47.81	-	63.56	6.43	20.78
1996	8.67	39.78	47.63	53.27	60.22	9.73	26.76
1997	8.14	43.00	51.98	57.36	65.10	16.13	28.36
1998	7.13	47.84	52.11	57.79	72.30	14.94	35.37
1999	5.69	50.87	55.03	55.11	51.66	8.01	41.09
2000	4.05	51.19	56.05	51.34	60.60	9.90	37.11
2001	4.42	49.32	52.06	54.90	69.43	16.33	39.71
2002	6.10	37.53	43.24	49.60	79.63	20.86	31.62
2003	9.94	40.71	42.81	62.73	86.87	20.91	49.42
2004	9.42	32.37	-	78.73	97.11	19.38	57.72
2005	12.09	27.73	-	64.50	126.19	14.81	51.76
2006	12.97	18.57	-	50.28	120.10	14.79	63.22
2007	10.66	15.37	-	45.72	137.13	15.82	56.63
2008	10.13	13.83	-	28.71	126.40	11.65	38.68
2009	8.97	12.31	-	30.85	137.61	8.19	39.13
2010	7.67	14.44	-	32.22	140.82	9.69	40.98
2011	7.44	13.79	-	39.58	120.79	11.01	35.33
2012	7.79	12.77	-	46.25	126.19	14.12	42.17
2013	4.27	0.78	-	45.16	118.20	13.15	38.48
2014	-	-	-	31.27	127.40	12.46	37.84
2015*	-	-	-	31.79	133.20	9.82	37.79

[1] Division 7.f only - Fishing hours (x10^3) corrected for fishing power.

[2] Fishing hours (x 10^3) corrected for fishing power using P = 0.000204 BHP^1.23.

[3] Division 7.g only - Fishing hours (x10^3).

[4] Fishing hours (x10^3).

*** provisional.**

Table 7.13.9. Sole in 7.f and 7.g. Lpue.

	UK	England & Wales			Belgium		Ireland		
	BT Survey[4]	Otter trawl[1]	Otter trawl[1]	Beam trawl[1]	Beam trawl[2]	Beam trawl[5]	Otter trawl[5]	Scottish seine[5]	Beam trawl[5]
Year	Division 7.f and 7.g	Division 7.f	Division 7.g[3]	Division 7.f	Division 7.f and 7.g	Division 7.f and 7.g	Division 7.g	Division 7.g	Division 7.g
1971	-	-	-	-	47.92	-	-	-	-
1972	-	2.42	2.11	-	37.06	-	-	-	-
1973	-	2.45	0.98	-	39.47	-	-	-	-
1974	-	2.10	1.83	-	37.81	-	-	-	-
1975	-	1.82	1.79	-	31.41	-	-	-	-
1976	-	2.02	1.30	-	30.50	-	-	-	-
1977	-	1.84	1.21	-	27.90	-	-	-	-
1978	-	1.82	1.17	13.99	23.35	-	-	-	-
1979	-	1.80	1.15	14.83	33.19	-	-	-	-
1980	-	1.86	1.55	18.99	29.73	-	-	-	-
1981	-	1.45	0.60	13.58	24.03	-	-	-	-
1982	-	1.73	0.56	11.79	25.93	-	-	-	-
1983	-	2.22	1.14	13.50	22.18	-	-	-	-
1984	-	1.53	1.70	13.59	20.78	-	-	-	-
1985	-	1.55	1.55	12.52	17.94	-	-	-	-
1986	-	1.38	0.99	10.94	17.83	-	-	-	-
1987	-	0.94	1.15	7.31	17.32	-	-	-	-
1988	71.14	0.62	0.27	4.39	15.29	-	-	-	-
1989	135.18	0.99	0.87	5.38	11.33	-	-	-	-
1990	90.67	0.76	0.67	5.98	15.64	-	-	-	-
1991	122.88	0.69	0.85	4.80	24.24	-	-	-	-
1992	115.79	1.00	1.25	4.14	18.57	-	-	-	-
1993	75.42	0.55	0.25	4.80	15.21	-	-	-	-
1994	107.77	0.90	0.27	4.26	13.94	-	-	-	-
1995	72.50	0.96	0.87	4.52	13.62	-	0.40	0.62	0.81
1996	70.15	0.66	0.52	3.94	11.27	11.45	0.73	0.05	0.88
1997	81.66	0.86	0.52	3.28	9.96	9.68	0.42	0.23	1.16
1998	135.41	0.60	0.40	2.67	10.12	9.64	0.48	0.11	1.13
1999	168.46	0.91	0.74	3.21	11.26	12.14	0.17	0.09	0.50
2000	236.43	0.49	1.85	3.36	11.90	13.77	0.19	0.05	0.26
2001	154.79	1.14	2.13	4.02	13.25	13.60	0.27	0.55	0.15
2002	118.11	0.78	3.60	5.64	18.71	17.80	0.42	0.29	0.14
2003	123.93	0.57	0.00	5.23	19.48	11.40	0.12	0.03	0.20
2004	149.65	0.60	0.19	5.75	-	9.17	0.18	0.02	0.20
2005	76.26	0.76	0.26	4.94	-	9.78	0.14	0.00	0.29
2006	68.96	1.16	0.60	5.97	-	10.70	0.11	0.05	0.29
2007	80.95	0.78	1.00	9.87	-	11.74	0.13	0.02	0.21
2008	115.96	0.82	0.86	9.46	-	14.51	0.12	0.02	0.31
2009	89.80	0.94	0.46	6.37	-	12.90	0.10	0.00	0.29
2010	109.55	1.01	0.63	5.92	-	16.00	0.13	0.01	0.21
2011	99.47	1.47	0.31	6.72	-	16.14	0.18	0.01	0.20
2012	101.45	1.67	0.47	6.47	-	16.36	0.15	0.01	0.48
2013	119.39	1.76	0.34	-	-	15.90	0.14	0.01	0.65
2014	86.75	-	-	-	-	20.48	0.12	-	0.34
2015 *	85.45	-	-	-	-	19.36	0.11	-	0.31

[1]Kg/hr corrected for GRT.

[2]Kg/hr corrected for fishing power using P = 0.000204 BHP^1.23

[3]Division 7.g (East).

[4]Kg/100km

[5]Kg/hour

* provisional

Table 7.13.10. Sole in 7.f and 7.g. Tuning series.

BE-CBT	Belgium Beam trawl (Effort = Corrected formula)												
1971	1996												
1	1	0	1										
2	14												
11.06	111	77	384	179	124	154	218	108	32	107	76	21	40
8.44	132	220	76	163	80	52	57	76	39	23	14	38	14
17.39	179	926	368	150	173	58	54	57	108	32	23	21	45
18.83	102	287	565	270	136	156	64	79	90	75	38	39	37
16.38	69	167	195	370	176	64	59	39	33	29	37	18	23
28.07	199	533	357	391	357	167	84	125	40	17	21	51	35
24.11	220	307	244	190	170	283	84	20	35	39	36	18	52
18.09	173	403	185	84	86	54	108	38	11	21	61	8	9
18.9	222	379	506	141	104	133	84	103	35	12	16	4	6
29.02	438	647	583	389	119	45	63	66	92	22	25	16	10
35.39	429	481	565	286	268	107	86	67	86	74	33	13	13
28.77	245	594	221	334	200	148	66	80	54	19	41	16	25
34.95	363	605	409	159	196	127	108	29	44	32	15	12	12
33.48	372	467	334	300	102	153	59	26	26	16	24	19	18
40.49	52	909	471	372	208	75	104	46	68	15	29	16	10
52.46	377	900	823	359	230	140	49	58	65	29	50	6	9
37.23	247	664	438	344	191	119	47	29	20	4	14	2	16
42.92	362	293	603	250	197	77	51	36	26	19	19	13	16
53.58	244	680	428	471	179	145	62	13	24	10	19	3	17
40.27	231	742	663	181	240	70	59	17	26	12	2	4	12
18.05	1028	380	225	131	29	26	9	7	13	8	4	1	2
25.47	327	1062	376	210	98	14	14	7	9	5	0	0.3	2
31.27	296	615	629	161	81	75	38	36	19	4	2	1	1
38.35	205	524	523	530	176	71	20	15	16	11	6	5	7
47.81	77	827	838	277	250	78	48	21	17	8	1	5	2
47.63	104	737	579	258	130	88	29	17	9	12	3	3	0
BE-CBT2	Belgium Beam trawl (Effort = Corrected formula)												
1997	2015												
1	1	0	1										
2	14												
49.22	179	615	351	224	133	69	51	21	15	17	7	3	2
52.04	156	724	571	176	94	79	31	23	20	8	6	9	7
48.2	459	1196	579	176	61	33	10	13	5	3	1	3	0
56.08	1436	1118	414	118	19	15	13	6	2	9	3	1	1
52.33	591	1375	676	292	166	36	15	10	10	6	16	1	1
50.28	105	1230	1623	543	155	53	26	14	1	1	1	4	1
66.57	146	494	852	1167	289	146	46	18	11	2	7	0	1
86.7	365	1456	633	562	390	52	15	9	2	2	1	0	0
69.77	166	650	571	360	279	144	23	16	4	5	2	0	1
61.87	497	890	418	297	80	59	41	16	6	3	2	1	0
59.16	232	564	458	269	153	83	64	55	5	5	1	3	3
39.95	134	234	283	322	138	82	33	43	36	11	1	0	0
43.35	389	263	222	169	142	93	43	19	25	36	9	2	0
50.59	212	895	491	205	141	85	67	28	23	7	6	12	0
57.92	87	705	960	252	165	120	79	34	57	13	16	6	0
65.37	128	167	749	985	264	139	89	58	36	42	14	21	25
66.6	392	755	251	617	476	154	36	38	15	10	11	8	12
45.85	105	462	493	141	256	255	63	46	21	16	18	12	13
48.12	70	693	683	278	86	148	76	56	23	26	9	11	7

Table 7.13.10 - Sole in 7.f and 7.g - Tuning series continued

Indices in bold are used in the assessment

UK(E&W)-CBT		**UK(E+W) 7.f Beam trawl**													
	1991	**2012**													
	1	**1**	**0**	**1**											
	1	**14**													
40.81		0	52	98	189	171	60	67	23	20	16	13	5	4	4
35.78		0	18	220	103	83	69	22	21	10	13	5	3	1	1
39.64		2	6	83	198	77	50	41	11	24	9	5	4	3	4
37.03		0	23	80	59	116	36	31	19	11	15	8	5	5	4
37.59		0	16	87	73	56	105	24	30	23	8	8	4	5	3
39.78		0	22	96	128	70	45	53	15	13	12	4	9	5	2
43		0	10	60	86	69	53	27	39	11	11	5	5	3	2
47.84		0	13	101	73	77	50	17	13	20	7	6	4	2	1
50.87		0	31	204	107	52	50	28	13	6	10	4	2	1	0
51.19		0	72	152	150	75	27	28	20	9	4	8	3	2	2
49.32		0	37	272	99	89	48	19	17	11	9	3	7	1	2
37.53		0	11	149	375	90	63	28	18	14	9	6	4	4	1
40.71		0	18	101	176	369	77	45	18	6	7	3	4	1	2
32.37		0	19	91	65	114	180	34	27	15	7	3	5	1	1
27.73		0	27	78	126	55	60	115	15	14	4	5	2	2	1
18.57		0	16	86	94	103	32	39	69	13	8	4	2	2	1
15.37		1	18	77	89	77	82	32	41	76	8	8	4	2	3
13.83		0	12	76	100	67	52	54	19	32	42	10	5	2	3
12.31		0	23	54	72	72	63	27	29	12	12	29	4	3	1
14.44		0	2	98	65	48	46	34	19	18	5	5	13	1	1
13.79		0	7	57	125	41	34	22	19	12	12	4	7	16	1
12.77		0	3	14	84	108	26	18	17	9	7	6	1	3	3

UK(E&W)-BTS-Q3		**UK(E+W) 7.f Corystes (automated indices since 1995)**									
	1988	**2015**									
	1	**1**	**0.75**	**0.85**							
	0	**9**									
74.120		22	**60**	**242**	**36**	**14**	**4**	0	0	0	0
91.909		132	**204**	**304**	**162**	**18**	**14**	6	4	2	2
69.858		21	**269**	**219**	**35**	**11**	**3**	5	2	0	0
123.410		40	**297**	**638**	**83**	**21**	**18**	5	0	3	2
125.078		5	**493**	**325**	**174**	**37**	**23**	12	1	2	1
127.672		6	**207**	**436**	**52**	**28**	**3**	2	2	1	1
120.816		1	**424**	**430**	**133**	**23**	**11**	9	0	0	3
114.886		31	**142**	**255**	**60**	**13**	**7**	14	1	1	1
118.592		3	**178**	**251**	**64**	**27**	**7**	3	4	1	3
114.886		37	**498**	**207**	**21**	**13**	**14**	5	3	6	0
114.886		104	**885**	**472**	**57**	**11**	**9**	5	2	1	5
118.592		29	**2922**	**297**	**38**	**16**	**7**	4	5	1	0
118.592		16	**1086**	**1608**	**37**	**26**	**6**	0	2	1	1
118.592		26	**449**	**711**	**307**	**23**	**9**	6	2	0	2
118.592		9	**786**	**283**	**151**	**121**	**14**	7	2	3	0
118.592		14	**465**	**628**	**55**	**30**	**56**	9	3	3	0
114.886		63	**862**	**434**	**99**	**15**	**22**	42	4	3	0
118.592		44	**407**	**267**	**38**	**16**	**7**	5	17	1	2
118.592		13	**324**	**238**	**47**	**16**	**8**	0	2	12	0
118.592		104	**424**	**128**	**51**	**16**	**13**	7	3	4	14
118.592		6	**1232**	**124**	**15**	**18**	**7**	9	4	3	5
118.592		1	**604**	**377**	**29**	**8**	**10**	4	3	3	2
118.592		19	**101**	**558**	**144**	**20**	**2**	7	9	4	2
118.592		22	**596**	**62**	**163**	**82**	**8**	2	7	3	0
118.592		16	**643**	**274**	**9**	**63**	**28**	1	1	1	3
118.592		11	**331**	**614**	**51**	**16**	**29**	18	1	6	1
118.592		40	**289**	**305**	**90**	**16**	**6**	27	9	1	1
118.592		33	**885**	**57**	**52**	**37**	**8**	4	16	7	0

Table 7.13.10 - Sole in 7.f and 7.g - Tuning series continued

Indices in bold are used in the assessment

IR - GFS : Irish Groundfish Survey (IBTS 4th Qtr) - 7.g Sole number at age (Interim indices for new Celtic Explorer series)

2003	2014									
1	1	0.79	0.92							
1	10									
832	1.0	5.2	1.1	3.2	3.0	4.1	4.0	0.0	1.0	0.0
980	1.0	8.0	6.0	5.0	1.0	2.0	1.0	0.0	0.0	1.0
845	0.0	0.0	6.0	2.0	4.0	2.0	2.0	0.0	0.0	0.0
1046	0.0	0.0	4.0	4.0	6.0	4.0	1.0	0.0	0.0	0.0
1168	0.0	2.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0
1139	2.0	9.0	7.0	3.0	2.0	0.0	2.0	0.0	1.0	0.0
1018	0.0	15.0	3.0	4.0	1.0	1.0	2.0	1.0	0.0	2.0
1381	0.0	12.0	24.7	9.1	8.2	1.0	3.0	3.9	0.0	2.1
1392	2.0	0.0	20.1	8.0	6.1	3.1	0.0	1.0	1.0	3.7
1470	0.0	7.0	3.0	3.0	3.0	1.0	0.0	0.0	0.0	0.0
1439	0.0	2.0	10.0	7.5	1.8	2.0	3.8	2.0	1.0	1.0
1487	0.1	3.4	7.7	8.0	6.1	3.7	0.5	0.1	0.1	0.1

UK (E+W) TRAWL 107F. (Processed as unsexed - from 2001WG)
(LPUE data reprocessed in 2014. Effort changed from hours to days)

1991	2015									
1	1	0	1							
1	10									
1066	0.0	1.7	6.4	12.9	11.1	3.5	3.3	1.1	0.8	0.8
899	0.0	8.4	29.6	10.4	6.9	5.9	1.5	1.8	0.8	0.9
836	0.1	0.8	3.7	10.2	3.8	2.0	1.4	0.3	0.6	0.2
623	0.0	1.7	4.3	2.4	4.9	1.7	1.5	1.1	0.6	0.7
580	0.0	2.3	12.0	5.3	2.5	4.5	0.9	1.2	0.7	0.2
593	0.1	2.8	4.3	5.0	2.4	1.4	1.4	0.3	0.5	0.2
577	0.0	2.0	8.2	6.9	4.1	2.1	0.7	1.2	0.4	0.3
517	0.0	2.0	4.0	2.7	2.1	1.3	0.4	0.3	0.5	0.1
396	0.1	8.5	12.4	3.5	1.6	1.2	0.8	0.4	0.1	0.3
284	0.0	0.9	1.8	1.6	0.7	0.2	0.2	0.2	0.1	0.0
309	0.0	1.5	10.1	2.3	1.7	0.6	0.3	0.2	0.2	0.1
416	0.0	0.5	4.8	8.3	1.8	1.0	0.3	0.2	0.2	0.1
696	0.1	1.6	2.8	3.3	6.7	1.0	0.7	0.3	0.1	0.1
641	0.0	1.0	4.8	2.9	3.3	4.9	0.9	0.6	0.4	0.2
876	0.0	2.7	5.0	6.3	2.3	2.6	5.0	0.7	0.7	0.2
924	0.0	0.4	7.2	7.8	9.7	3.0	4.0	7.0	1.3	0.9
798	0.0	0.5	2.6	3.6	3.3	3.3	1.2	1.5	2.6	0.3
711	0.0	0.4	3.6	5.0	3.9	2.9	2.8	0.9	1.6	2.2
656	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
565	0.0	0.2	5.5	3.8	2.4	2.2	1.1	0.8	1.0	0.2
525	0.0	0.7	5.8	8.8	3.2	3.3	2.4	1.3	1.2	0.9
543	0.0	3.8	2.9	9.6	10.0	3.4	2.5	1.5	1.3	0.8
280	0.0	0.3	5.4	0.9	2.3	2.6	1.2	0.6	0.4	0.2
156	0.0	0.0	0.3	0.6	0.1	0.4	0.4	0.2	0.1	0.1
79	0.0	0.1	0.6	1.4	1.1	0.5	0.5	0.4	0.2	0.1

Table 7.13.11. Sole 7.f and 7.g. XSA diagnostics.

Extended Survivors Analysis

CELTIC SEA SOLE WGCSE2016

CPUE data from file S7FGTUN.TXT

Catch data for 45 years. 1971 to 2015. Ages 1 to 10.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BE-CBT	1971	2015	2	9	0	1
BE-CBT2	1997	2015	2	9	0	1
UK(E&W)-CBT	1991	2015	2	9	0	1
UK(E&W)-BTS-Q3	1988	2015	1	5	0.75	0.85

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 = 1.500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 81 iterations

1

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0	0	0	0	0	0	0	0	0	0
2	0.173	0.113	0.058	0.073	0.048	0.078	0.041	0.082	0.031	0.065
3	0.369	0.307	0.196	0.154	0.199	0.218	0.184	0.373	0.146	0.283
4	0.341	0.322	0.296	0.256	0.35	0.31	0.32	0.397	0.427	0.273
5	0.356	0.354	0.385	0.269	0.304	0.285	0.453	0.414	0.417	0.362
6	0.254	0.31	0.321	0.313	0.293	0.37	0.406	0.408	0.344	0.461
7	0.212	0.369	0.28	0.302	0.259	0.333	0.471	0.423	0.413	0.26
8	0.222	0.295	0.273	0.206	0.31	0.307	0.366	0.297	0.436	0.171
9	0.398	0.334	0.336	0.224	0.176	0.254	0.317	0.27	0.512	0.445

1

XSA population numbers (Thousands)

YEAR \ AGE	1	2	3	4	5	6	7	8	9
2006	3.65E+03	4.52E+03	4.53E+03	2.60E+03	2.02E+03	7.63E+02	8.15E+02	9.40E+02	1.41E+02
2007	4.42E+03	3.30E+03	3.44E+03	2.83E+03	1.67E+03	1.28E+03	5.35E+02	5.97E+02	6.82E+02
2008	1.01E+04	4.00E+03	2.67E+03	2.29E+03	1.86E+03	1.06E+03	8.52E+02	3.35E+02	4.02E+02
2009	6.96E+03	9.12E+03	3.41E+03	1.98E+03	1.54E+03	1.14E+03	6.97E+02	5.82E+02	2.31E+02
2010	1.93E+03	6.30E+03	7.68E+03	2.65E+03	1.39E+03	1.07E+03	7.57E+02	4.66E+02	4.29E+02
2011	4.58E+03	1.74E+03	5.43E+03	5.69E+03	1.69E+03	9.28E+02	7.20E+02	5.29E+02	3.09E+02
2012	6.44E+03	4.14E+03	1.46E+03	3.95E+03	3.78E+03	1.15E+03	5.80E+02	4.67E+02	3.52E+02
2013	4.34E+03	5.83E+03	3.60E+03	1.10E+03	2.60E+03	2.17E+03	6.92E+02	3.28E+02	2.93E+02
2014	1.56E+03	3.93E+03	4.86E+03	2.24E+03	6.69E+02	1.55E+03	1.31E+03	4.10E+02	2.20E+02
2015	1.02E+04	1.41E+03	3.44E+03	3.80E+03	1.32E+03	3.99E+02	9.96E+02	7.82E+02	2.40E+02

Table 7.13.11 - Sole in 7.f and 7.g - XSA diagnostics - continued

Estimated population abundance at 1st Jan 2016

0.00E+00	9.20E+03	1.20E+03	2.35E+03	2.62E+03	8.34E+02	2.28E+02	6.95E+02	5.97E+02

Taper weighted geometric mean of the VPA populations:

4.89E+03	4.36E+03	3.64E+03	2.45E+03	1.48E+03	8.90E+02	5.53E+02	3.43E+02	2.13E+02

Standard error of the weighted Log(VPA populations) :

0.4137	0.3989	0.3682	0.3866	0.4312	0.4776	0.5517	0.7055	0.8611

1

Log catchability residuals.

Fleet : BE-CBT

Age	1971	1972	1973	1974	1975
1	No data for this fleet at this age				
2	0.07	-0.01	0.4	-0.04	-0.29
3	-0.51	0.16	0.37	-0.11	-0.35
4	0.27	-0.18	0.12	-0.04	-0.31
5	0.3	0.15	0.16	0.12	0
6	0.1	0.27	-0.12	0.43	0.22
7	0.45	-0.03	-0.32	0.12	0.31
8	0.29	0.18	-0.41	-0.02	-0.43
9	0.02	-0.1	-0.2	0.17	-0.08

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	No data for this fleet at this age									
2	0.39	0.05	0.22	0.25	1.02	0.38	0.05	0.28	0	-1.82
3	0.4	0.13	0.05	0.06	0.03	0.19	0.09	-0.05	-0.22	-0.09
4	-0.02	0	0.05	0.39	0.25	-0.11	-0.17	-0.27	-0.37	-0.15
5	0.25	-0.09	-0.45	0.11	0.17	-0.16	0.02	-0.26	-0.01	0.08
6	-0.21	0.05	-0.25	0.03	-0.1	0.14	0.15	-0.24	-0.16	0.01
7	0.12	0.18	-0.4	0.6	-0.88	0.13	0.35	0.1	0.17	-0.1
8	0.52	-0.03	-0.15	0.3	-0.17	-0.12	0.35	0.47	-0.1	0.17
9	0.11	-0.3	-0.22	0.05	0.01	0.11	0.48	-0.19	-0.29	-0.04

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	No data for this fleet at this age									
2	-0.26	0.25	-0.11	-0.47	-0.08	1.44	0.62	0.24	-0.34	-1.3
3	-0.02	-0.19	-0.57	-0.51	0.15	0.38	0.38	0.24	-0.24	0.05
4	-0.11	-0.02	-0.21	-0.17	0.1	0.06	0.28	-0.07	0.19	0.37
5	-0.07	-0.03	-0.08	-0.14	-0.07	-0.03	0.21	-0.24	0.13	-0.02
6	0.04	0.32	-0.09	0.04	0.16	-0.4	-0.04	-0.4	0.26	-0.14
7	0.01	0.64	-0.02	0.15	0.18	-0.49	-0.88	0.19	-0.12	0.01
8	-0.28	-0.15	0.58	0.16	0.26	-0.36	-0.97	0.44	-0.74	-0.03
9	-0.05	0.2	0.07	-0.21	-0.1	-0.31	-0.34	0.34	0.07	-0.21

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	No data for this fleet at this age									
2	-0.94	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	0.2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	0.13	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	-0.04	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6	-0.09	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
7	-0.45	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
8	-0.36	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
9	-0.26	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	No data for this fleet at this age									
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Table 7.13.11 - Sole in 7.f and 7.g - 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	2	3	4	5	6	7	8	9
Mean Log q	-6.2014	-5.0667	-4.8518	-4.8634	-4.8879	-4.9759	-4.9759	-4.9759
S.E(Log q)	0.6533	0.2787	0.2075	0.1704	0.2127	0.3828	0.388	0.2146

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	1.157	0	0	0	0	0
3	0	1.317	0	0	0	0	0
4	0	0.635	0	0	0	0	0
5	0	2.391	0	0	0	0	0
6	0	0.492	0	0	0	0	0
7	0	1.328	0	0	0	0	0
8	0	0.281	0	0	0	0	0
9	0	1.406	0	0	0	0	0
1							

Fleet : BE-CBT2

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	No data for this fleet at this age									
2	99.99	0.14	-0.37	0.68	0.82	0.59	-0.52	-0.93	0.04	-0.67
3	99.99	0.58	0.48	0.8	0.45	-0.2	0.33	-0.35	0.1	-0.19
4	99.99	0.38	0.88	0.67	-0.09	0.27	0.13	-0.12	-0.16	-0.36
5	99.99	0.41	0.27	0.55	-0.5	0.11	0.63	0.06	-0.28	0.06
6	99.99	0.69	0.33	0.06	-1.11	0.61	0.18	0.63	-0.51	-0.05
7	99.99	0.71	1.05	0.05	-0.89	0.1	0.19	0.58	-0.51	-0.7
8	99.99	0.24	0.56	-0.24	-0.51	-0.4	0.37	0.39	-1.28	-0.63
9	99.99	0.6	-0.02	0.36	-0.38	-0.2	0.08	0.37	-0.75	-0.5

Age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	No data for this fleet at this age									
2	0.77	0.34	-0.04	0.13	-0.28	0	-0.62	0.16	-0.42	0.17
3	0.11	-0.06	-0.34	-0.57	-0.29	-0.31	-0.57	0.1	-0.42	0.35
4	-0.36	-0.32	-0.2	-0.4	-0.01	-0.26	-0.26	-0.05	0.29	-0.03
5	-0.46	-0.33	0.16	-0.44	-0.28	-0.41	0.1	-0.03	0.23	0.15
6	-0.68	-0.48	0.01	-0.12	-0.23	-0.03	0.12	0.06	0.12	0.39
7	-0.96	-0.08	-0.21	0.05	-0.3	-0.01	0.3	0.18	0.42	0.03
8	-1.47	-0.49	-0.19	-0.59	-0.03	-0.13	0.02	-0.58	0.19	-0.44
9	-0.43	-0.75	-0.08	-0.47	-0.88	-0.46	-0.15	-0.43	0.53	0.57

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
Mean Log q	-6.9661	-5.6373	-5.383	-5.3632	-5.5313	-5.6349	-5.6349	-5.6349
S.E(Log q)	0.5071	0.4082	0.3566	0.3465	0.4602	0.5228	0.6022	0.4949

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	0.715	0	0	0	0	0
3	0	0.189	0	0	0	0	0
4	0	-1.606	0	0	0	0	0
5	0	-1.17	0	0	0	0	0
6	0	-0.511	0	0	0	0	0
7	0	-1.132	0	0	0	0	0
8	0	-1.532	0	0	0	0	0
9	0	-1.525	0	0	0	0	0
1							

Table 7.13.11 - Sole in 7.f and 7.g - XSA diagnostics - continued

Fleet : UK(E&W)-CBT

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	No data for this fleet at this age									
2	99.99	99.99	99.99	99.99	99.99	0.43	0.17	-1.11	0.3	0.16
3	99.99	99.99	99.99	99.99	99.99	0.05	0.31	-0.16	-0.25	-0.12
4	99.99	99.99	99.99	99.99	99.99	0.51	0.09	-0.03	-0.52	-0.39
5	99.99	99.99	99.99	99.99	99.99	0.53	0.05	-0.1	-0.24	-0.27
6	99.99	99.99	99.99	99.99	99.99	0.4	0.16	-0.23	-0.4	0.12
7	99.99	99.99	99.99	99.99	99.99	0.38	-0.03	0.09	-0.18	-0.2
8	99.99	99.99	99.99	99.99	99.99	0.5	-0.17	-0.3	-0.02	0.48
9	99.99	99.99	99.99	99.99	99.99	0.66	0.41	0.43	0.53	0.85

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	No data for this fleet at this age									
2	0.47	-0.58	-0.73	-0.05	-0.05	-0.09	-0.46	-0.51	0.1	0.47
3	0.18	-0.34	-0.13	0.24	-0.19	-0.49	-0.21	-0.18	-0.41	-0.12
4	0.24	0.02	-0.17	-0.16	-0.1	-0.69	-0.13	-0.3	-0.54	-0.04
5	-0.05	-0.03	0.14	-0.11	-0.26	-0.41	-0.26	0.01	-0.29	-0.29
6	-0.08	0.15	0.04	0.05	-0.42	-0.33	-0.18	0.04	-0.06	-0.42
7	-0.06	-0.02	-0.32	-0.09	-0.1	-0.4	-0.08	-0.03	0.13	0.07
8	-0.11	0.18	-0.14	0.04	0.04	-0.14	0.37	0.02	0.37	-0.05
9	0.39	0.16	0	-0.39	0.19	0.03	0.44	-0.16	0.82	0.37

Age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	No data for this fleet at this age									
2	0.56	1.15	0.63	0.58	-1.66	0.94	-0.72	99.99	99.99	99.99
3	0.25	0.57	0.87	0.38	0.02	-0.12	-0.15	99.99	99.99	99.99
4	0.26	0.3	0.73	0.64	0.13	0.05	0.1	99.99	99.99	99.99
5	0.29	0.38	0.26	0.58	0.13	-0.18	0.13	99.99	99.99	99.99
6	-0.14	0.49	0.34	0.57	0.15	0.07	-0.32	99.99	99.99	99.99
7	-0.1	0.39	0.51	0.14	0.11	-0.19	-0.04	99.99	99.99	99.99
8	0.33	0.49	0.4	0.35	0.04	-0.04	0.08	99.99	99.99	99.99
9	0.65	0.99	0.76	0.4	0.01	0.01	-0.3	99.99	99.99	99.99

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
Mean Log q	-8.9913	-6.9075	-6.2932	-5.9722	-5.776	-5.7115	-5.7115	-5.7115
S.E(Log q)	0.6863	0.3291	0.3656	0.279	0.2902	0.2208	0.2761	0.5089

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	-1.066	0	0	0	0	0
3	0	-1.099	0	0	0	0	0
4	0	-0.463	0	0	0	0	0
5	0	0.508	0	0	0	0	0
6	0	0.756	0	0	0	0	0
7	0	2.437	0	0	0	0	0
8	0	1.599	0	0	0	0	0
9	0	0.721	0	0	0	0	0
1							

Fleet : UK(E&W)-BTS-Q3

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	99.99	99.99	-1.4	-0.21	-0.5	-0.25	0.18	-0.7	0.33	-0.68
2	99.99	99.99	0.07	0.34	0.44	0.2	0.15	0.34	0.38	0.13
3	99.99	99.99	0.37	1.13	0.17	0.53	0.61	-0.02	0.83	0.2
4	99.99	99.99	-0.16	0.52	-0.1	0.14	0.75	-0.23	0.33	-0.2
5	99.99	99.99	-0.12	0.43	-0.04	0.7	1.03	-1.04	-0.24	0.07
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									

Table 7.13.11 - Sole in 7.f and 7.g - XSA diagnostics - continued

Age		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	1	-0.68	0.08	0.51	0.82	0.43	0.17	0.27	0.02	0.55	-0.07
	2	0.14	-0.21	0.29	-0.29	0.56	0.32	-0.05	0.29	0.3	-0.37
	3	0.51	-0.56	0.22	-0.44	-0.64	0.48	0.41	-0.11	0.21	-0.54
	4	0.61	0.13	0.09	0.09	0.22	-0.1	0.5	-0.21	-0.32	-0.65
	5	0.1	0.96	0.64	0.6	-0.16	-0.09	0.26	0.61	0.32	-0.29
	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									

Age		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	1	0.02	0.1	0.34	0	-0.51	0.4	0.14	-0.13	0.76	0
	2	-0.24	-0.59	-0.86	-0.56	0.18	-0.71	-0.11	0.38	0.04	-0.59
	3	-0.43	-0.12	-1.18	-0.8	0.03	0.52	-1.1	-0.12	-0.03	-0.12
	4	-0.45	-0.56	-0.25	-0.95	-0.24	0.37	0.48	0.45	-0.24	-0.05
	5	-0.65	-0.46	-0.67	-0.22	-1.7	-0.52	0.06	0.44	0.22	-0.22
	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									

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 q	-7.1375	-7.2654	-8.5385	-9.058	-9.2962
S.E(Log q)	0.4923	0.3902	0.5623	0.4101	0.6031

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	1.315	0	0	0	0	0
2	0	2.332	0	0	0	0	0
3	0	1.939	0	0	0	0	0
4	0	-0.424	0	0	0	0	0
5	0	-0.45	0	0	0	0	0
1							

Terminal year survivor and F summaries :

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2014

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
BE-CBT2	1	0	0	0	0	0	0
UK(E&W)-CBT	1	0	0	0	0	0	0
UK(E&W)-BTS-Q3	9204	0.501	0	0	1	1	0
F shrinkage mean	0	1.5				0	0

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
9204	0.5	0	1	0	0

Table 7.13.11 - Sole in 7.f and 7.g - XSA diagnostics - continued

1

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2013

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
BE-CBT2	1418	0.52	0	0	1	0.255	0.055
UK(E&W)-CBT	1	0	0	0	0	0	0
UK(E&W)-BTS-Q3	1116	0.311	0.654	2.1	2	0.712	0.07
F shrinkage mean	1401	1.5				0.033	0.056

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1195	0.26	0.32	4	1.234	0.065

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2012

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
BE-CBT2	2474	0.326	0.371	1.14	2	0.405	0.27
UK(E&W)-CBT	1	0	0	0	0	0	0
UK(E&W)-BTS-Q3	2236	0.273	0.059	0.22	3	0.57	0.295
F shrinkage mean	3048	1.5				0.026	0.224

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2348	0.21	0.11	6	0.544	0.283

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2011

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
BE-CBT2	2327	0.245	0.155	0.63	3	0.472	0.302
UK(E&W)-CBT	1	0	0	0	0	0	0
UK(E&W)-BTS-Q3	2954	0.23	0.108	0.47	4	0.51	0.245
F shrinkage mean	1881	1.5				0.018	0.362

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2618	0.17	0.09	8	0.539	0.273

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2010

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
BE-CBT2	934	0.212	0.143	0.67	4	0.552	0.329
UK(E&W)-CBT	407	0.702	0	0	1	0.029	0.638
UK(E&W)-BTS-Q3	753	0.226	0.105	0.47	5	0.398	0.394
F shrinkage mean	797	1.5				0.021	0.376

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
834	0.15	0.09	11	0.577	0.362

Table 7.13.11 - Sole in 7.f and 7.g - XSA diagnostics - continued

1
Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 2009

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
BE-CBT2	250	0.199	0.152	0.76	5	0.546	0.427
UK(E&W)-CBT	237	0.304	0.413	1.36	2	0.132	0.445
UK(E&W)-BTS-Q3	184	0.221	0.288	1.31	5	0.298	0.546
F shrinkage mean	302	1.5				0.024	0.365

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
228	0.14	0.13	13	0.92	0.461

Age 7 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
BE-CBT	1	0	0	0	0	0	0
BE-CBT2	650	0.195	0.069	0.36	6	0.549	0.276
UK(E&W)-CBT	585	0.237	0.355	1.5	3	0.191	0.302
UK(E&W)-BTS-Q3	966	0.219	0.094	0.43	5	0.239	0.194
F shrinkage mean	445	1.5				0.021	0.381

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
695	0.13	0.09	15	0.671	0.26

1
Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2007

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
BE-CBT2	576	0.204	0.124	0.6	7	0.526	0.177
UK(E&W)-CBT	667	0.19	0.068	0.36	4	0.276	0.154
UK(E&W)-BTS-Q3	619	0.219	0.183	0.83	5	0.175	0.165
F shrinkage mean	271	1.5				0.023	0.344

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
597	0.13	0.08	17	0.589	0.171

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2006

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
BE-CBT2	161	0.21	0.138	0.66	8	0.512	0.394
UK(E&W)-CBT	127	0.165	0.138	0.84	5	0.331	0.477
UK(E&W)-BTS-Q3	87	0.219	0.171	0.78	5	0.128	0.638
F shrinkage mean	218	1.5				0.029	0.306

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
139	0.13	0.09	19	0.71	0.445

1
1

Table 7.13.12. Sole in 7.f and 7.g. Fishing mortality.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.000
2	0.0840	0.0695	0.1067	0.0559	0.0427	0.1320	0.0734	0.0840	0.0726	0.246
3	0.1470	0.2565	0.3239	0.1623	0.1251	0.4128	0.2472	0.2213	0.1869	0.283
4	0.3950	0.2277	0.3120	0.2155	0.1618	0.3386	0.2696	0.2743	0.3230	0.439
5	0.4054	0.3112	0.3208	0.2515	0.2187	0.4353	0.2428	0.1636	0.2408	0.400
6	0.3232	0.3437	0.2382	0.3375	0.2662	0.2702	0.2754	0.1962	0.2187	0.302
7	0.4178	0.2325	0.1791	0.2255	0.2659	0.3417	0.2847	0.1533	0.3522	0.115
8	0.3579	0.2845	0.1618	0.1944	0.1270	0.5124	0.2319	0.1965	0.2606	0.258
9	0.2721	0.2178	0.2008	0.2136	0.1789	0.3412	0.1721	0.1871	0.2051	0.308
+gp	0.2721	0.2178	0.2008	0.2136	0.1789	0.3412	0.1721	0.1871	0.2051	0.308
FBAR 4-8	0.3799	0.2799	0.2424	0.2449	0.2079	0.3796	0.2609	0.1968	0.2790	0.303

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.000
2	0.1476	0.0857	0.1680	0.1229	0.0500	0.1078	0.1254	0.1133	0.1332	0.091
3	0.3804	0.2780	0.3736	0.3069	0.3808	0.4692	0.2793	0.2427	0.3472	0.396
4	0.3494	0.2668	0.3720	0.3304	0.4454	0.5240	0.5223	0.3961	0.4994	0.623
5	0.3248	0.3181	0.3720	0.4625	0.5166	0.5549	0.4691	0.5438	0.4772	0.645
6	0.4314	0.3533	0.3701	0.3895	0.4384	0.6416	0.5542	0.5864	0.5606	0.677
7	0.3919	0.3965	0.4721	0.4990	0.3370	0.5051	0.8424	0.4792	0.5588	0.661
8	0.3025	0.3933	0.6909	0.3771	0.4486	0.4866	0.4721	0.8116	0.5774	0.706
9	0.3835	0.4480	0.3581	0.3138	0.4286	0.6168	0.6650	0.5919	0.5544	0.748
+gp	0.3835	0.4480	0.3581	0.3138	0.4286	0.6168	0.6650	0.5919	0.5544	0.748
FBAR 4-8	0.3600	0.3456	0.4554	0.4117	0.4372	0.5424	0.5720	0.5634	0.5347	0.662

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.2185	0.1270	0.0962	0.0799	0.0445	0.0639	0.0733	0.0430	0.1189	0.1448
3	0.3021	0.3779	0.3542	0.2864	0.4466	0.5161	0.4572	0.3856	0.5508	0.4148
4	0.4383	0.4522	0.3998	0.5147	0.7123	0.6668	0.5657	0.7363	0.6260	0.3897
5	0.5153	0.4747	0.3942	0.5537	0.5495	0.5856	0.6228	0.5393	0.6319	0.3255
6	0.4762	0.4781	0.3643	0.6073	0.6106	0.5822	0.7401	0.5247	0.4786	0.2322
7	0.4610	0.3179	0.5641	0.4929	0.5691	0.4615	0.6621	0.7323	0.4411	0.3088
8	0.5324	0.2808	0.5571	0.4127	0.7533	0.4512	0.5540	0.5390	0.4194	0.3996
9	0.6034	0.5035	0.7010	0.7970	0.8317	0.6480	0.6882	0.4119	0.4401	0.4354
+gp	0.6034	0.5035	0.7010	0.7970	0.8317	0.6480	0.6882	0.4119	0.4401	0.4354
FBAR 4-8	0.4847	0.4007	0.4559	0.5163	0.6390	0.5495	0.6289	0.6143	0.5194	0.3312

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.1064	0.0078	0.0224	0.1116	0.0591	0.1733	0.1128	0.0579	0.0725	0.0480
3	0.2130	0.2986	0.2628	0.4552	0.2892	0.3691	0.3067	0.1961	0.1543	0.1989
4	0.4007	0.3584	0.4016	0.4778	0.3515	0.3414	0.3225	0.2962	0.2558	0.3504
5	0.4098	0.5413	0.5928	0.4868	0.4899	0.3557	0.3541	0.3853	0.2690	0.3044
6	0.5569	0.3853	0.7713	0.4293	0.4036	0.2544	0.3097	0.3207	0.3127	0.2934
7	0.3753	0.3905	0.7284	0.4587	0.3201	0.2118	0.3687	0.2803	0.3025	0.2586
8	0.3264	0.5416	0.6825	0.3857	0.2961	0.2219	0.2950	0.2725	0.2058	0.3096
9	0.3978	0.5004	0.5562	0.6197	0.4179	0.3984	0.3337	0.3356	0.2237	0.1765
+gp	0.3978	0.5004	0.5562	0.6197	0.4179	0.3984	0.3337	0.3356	0.2237	0.1765
FBAR 4-8	0.4138	0.4434	0.6353	0.4477	0.3723	0.2770	0.3300	0.3110	0.2691	0.3033

	2011	2012	2013	2014	2015	FBAR 13-15
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0777	0.0414	0.0819	0.0313	0.0654	0.0595
3	0.2182	0.1836	0.3728	0.1460	0.2826	0.2671
4	0.3102	0.3199	0.3974	0.4275	0.2727	0.3659
5	0.2851	0.4527	0.4138	0.4172	0.3617	0.3976
6	0.3701	0.4057	0.4083	0.3440	0.4607	0.4043
7	0.3333	0.4705	0.4228	0.4133	0.2600	0.3654
8	0.3072	0.3659	0.2965	0.4363	0.1710	0.3013
9	0.2540	0.3173	0.2704	0.5118	0.4450	0.4091
+gp	0.2540	0.3173	0.2704	0.5118	0.4450	
FBAR 4-8	0.3212	0.4029	0.3878	0.4077	0.3052	

Table 4.3.13. Sole in 7.f and 7.g. Stock numbers-at-age (start of year, in thousands).

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	9363	4177	3315	3305	2930	5157	4588	5441	3502	5096	4838	4862
2	5037	8472	3780	3000	2990	2652	4666	4151	4923	3169	4611	4377
3	2076	4191	7151	3074	2567	2593	2102	3923	3454	4143	2243	3600
4	4320	1621	2934	4680	2365	2049	1553	1486	2845	2593	2824	1387
5	1971	2634	1168	1943	3414	1820	1322	1073	1022	1864	1513	1802
6	1648	1189	1746	767	1367	2482	1066	938	824	727	1131	989
7	1653	1079	763	1245	495	948	1714	732	698	599	486	665
8	2666	985	774	577	899	343	610	1167	568	444	483	297
9	1659	1686	670	596	430	716	186	437	867	396	310	323
+gp	5370	3912	3714	2951	2383	1678	2422	1070	956	1391	1250	945
TOTAL	35764	29947	26016	22137	19841	20439	20229	20419	19660	20421	19689	19248

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	6754	4672	5617	3135	5706	4464	3720	8631	4218	4484	4463	3446
2	4399	6111	4227	5082	2836	5163	4039	3366	7809	3816	4057	4039
3	3636	3365	4890	3638	4129	2264	4172	3199	2782	5679	3041	3334
4	2467	2264	2240	3024	2059	2825	1607	2667	1949	1861	3522	1931
5	961	1539	1472	1298	1620	1105	1720	883	1295	1138	1071	2136
6	1186	600	877	795	675	917	581	966	419	700	640	654
7	629	741	367	512	379	351	462	300	444	235	393	403
8	405	355	407	237	279	148	197	239	140	253	155	202
9	182	183	220	235	132	158	59	100	107	74	173	80
+gp	1114	1066	721	745	385	627	251	256	374	235	205	277
TOTAL	21731	20896	21039	18701	18200	18022	16807	20606	19537	18477	17721	16503

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	3320	4025	5438	6303	14836	8105	4339	6916	5237	5870	5001	3648
2	3118	3004	3642	4920	5704	13424	7333	3926	6258	4739	5311	4525
3	3374	2699	2550	3062	4265	4582	10510	5966	3525	5537	3835	4530
4	2266	1953	1458	1461	1884	2225	2739	7685	4005	2452	3178	2599
5	1044	1006	907	749	633	912	1363	1660	4859	2425	1376	2023
6	1111	545	507	440	395	304	596	819	874	2430	1349	763
7	322	546	276	219	236	222	218	309	504	366	1432	815
8	222	165	311	129	95	137	147	136	189	220	209	940
9	121	95	95	162	68	57	83	96	71	86	135	141
+gp	201	232	223	270	129	151	258	136	206	124	138	163
TOTAL	15100	14270	15406	17715	28245	30119	27587	27648	25728	24250	21964	20147

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	GMST 71-13	AMST 71-13
1	4416	10080	6961	1928	4580	6443	4338	1559	10172	0	4933	5295
2	3301	3996	9121	6298	1744	4145	5830	3925	1411	9204	4489	4817
3	3443	2668	3412	7675	5432	1460	3598	4861	3442	1195	3621	3892
4	2834	2292	1984	2646	5692	3951	1100	2242	3801	2348	2434	2639
5	1671	1857	1542	1390	1687	3777	2596	669	1323	2618	1508	1657
6	1283	1061	1143	1067	928	1148	2173	1553	399	834	895	996
7	535	852	697	757	720	580	692	1307	996	228	534	618
8	597	335	582	466	529	467	328	410	782	695	335	443
9	682	402	231	429	309	352	293	220	240	597	213	323
+gp	259	632	1010	765	930	948	735	569	385	362		
TOTAL	19020	24176	26683	23421	22551	23270	21683	17316	22951	18081		

Table 7.13.14. Sole in 7.f and 7.g. Summary.

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 8
1971	9363	8989	7554	1861	0.2464	0.3799
1972	4177	7570	5950	1278	0.2148	0.2799
1973	3315	6306	5004	1391	0.2780	0.2424
1974	3305	6274	5280	1105	0.2093	0.2449
1975	2930	5531	4696	919	0.1957	0.2079
1976	5157	5072	4060	1350	0.3325	0.3796
1977	4588	5675	4426	961	0.2172	0.2609
1978	5441	4826	3519	780	0.2217	0.1968
1979	3502	4833	3635	954	0.2625	0.2790
1980	5096	5002	3790	1314	0.3467	0.3026
1981	4838	4414	3247	1212	0.3733	0.3600
1982	4862	4599	3356	1128	0.3362	0.3456
1983	6754	4966	3496	1373	0.3927	0.4554
1984	4672	5203	3755	1266	0.3372	0.4117
1985	5617	4662	3189	1328	0.4164	0.4372
1986	3135	4489	3243	1600	0.4933	0.5424
1987	5706	3640	2432	1222	0.5025	0.5720
1988	4464	3792	2605	1146	0.4400	0.5634
1989	3720	3166	2036	992	0.4873	0.5347
1990	8631	3796	2318	1189	0.5129	0.6623
1991	4218	3513	2038	1107	0.5432	0.4847
1992	4484	3777	2360	981	0.4157	0.4007
1993	4463	3801	2434	928	0.3812	0.4559
1994	3446	3233	2216	1009	0.4553	0.5163
1995	3320	3071	2133	1157	0.5424	0.6390
1996	4025	3060	2079	995	0.4787	0.5495
1997	5438	3009	1861	927	0.4982	0.6289
1998	6303	3104	1675	875	0.5224	0.6143
1999	14836	4298	1868	1012	0.5419	0.5194
2000	8105	3943	1982	1091	0.5504	0.3312
2001	4339	5449	3151	1168	0.3707	0.4138
2002	6916	5976	4072	1345	0.3303	0.4434
2003	5237	5624	3750	1547	0.4125	0.6353
2004	5870	4946	3320	1398	0.4211	0.4477
2005	5001	4880	3186	1118	0.3509	0.3723
2006	3648	4171	2733	946	0.3462	0.2770
2007	4416	4015	2860	945	0.3304	0.3300
2008	10080	4477	2571	800	0.3111	0.3110
2009	6961	5316	2913	805	0.2764	0.2691
2010	1928	5012	3169	876	0.2764	0.3033
2011	4580	4854	3382	1029	0.3043	0.3212
2012	6443	4642	3281	1104	0.3365	0.4029
2013	4338	4427	2856	1093	0.3827	0.3878
2014	1559	3979	2826	1042	0.3688	0.4077
2015	10172*	4986	2714	830	0.3058	0.3052
2016	4933 [1]	4128 [2]	2595 [2]			0.2981 [3]
Arith. Mean	5320	4675	3223	1122	0.3749	0.4095
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

[1] Geometric mean 1971-2013

[2] From forecast

[3] F corresponding to a TAC constraint in 2016

* revised down by 23% (7832 thousand) as input for the forecast

Table 7.13.15. Sole in 7.f and 7.g. Input for catch forecast and F_{MSY} analysis.

Input: TAC constraint for 2016 (779 t)
Catch and stock weights are mean 13-15
Recruits age 1 in 2016,17 and 18 GM (71-13)

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	4933	0.37	WS1	0.107	0.54
N2	7087	0.50	WS2	0.132	0.15
N3	1195	0.32	WS3	0.186	0.03
N4	2348	0.21	WS4	0.233	0.02
N5	2618	0.17	WS5	0.288	0.07
N6	834	0.15	WS6	0.333	0.08
N7	228	0.14	WS7	0.377	0.11
N8	695	0.13	WS8	0.428	0.08
N9	597	0.13	WS9	0.452	0.12
N10	362	0.13	WS10	0.588	0.08
H.cons selectivity			Weight in the HC catch		
sH1	0.0000	0.00	WH1	0.111	0.30
sH2	0.0595	0.43	WH2	0.171	0.05
sH3	0.2671	0.43	WH3	0.204	0.02
sH4	0.3659	0.22	WH4	0.260	0.04
sH5	0.3976	0.08	WH5	0.323	0.13
sH6	0.4043	0.14	WH6	0.360	0.08
sH7	0.3654	0.25	WH7	0.406	0.12
sH8	0.3013	0.44	WH8	0.492	0.04
sH9	0.4091	0.30	WH9	0.459	0.14
sH10	0.4091	0.30	WH10	0.603	0.12
Natural mortality			Proportion mature		
M1	0.1	0.1	MT1	0	0
M2	0.1	0.1	MT2	0.14	0.1
M3	0.1	0.1	MT3	0.45	0.1
M4	0.1	0.1	MT4	0.88	0.1
M5	0.1	0.1	MT5	0.98	0.1
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
Relative effort in HC fihery			Year effect for natural mortality		
HF16	1	0.1	K16	1	0.1
HF17	1	0.1	K17	1	0.1
HF18	1	0.1	K18	1	0.1
Recruitment in 2017 and 2018					
R17	4933	0.37			
R18	4933	0.37			

Table 7.13.16. Sole in 7.f and 7.g. Management option table.

MFDP version 1a
Run: S7FG
CELTIC SEA SOLE,WGCSE2016
Time and date: 17:14 06/05/2016
Fbar age range: 4-8

2016 Biomass	SSB	FMult	FBar	Landings
4128	2595	0.8126	0.2981	779

2017 Biomass	SSB	FMult	FBar	Landings	2018 Biomass	SSB
4341	2648	0.0000	0.0000	0	5309	3703
.	2648	0.1000	0.0367	118	5188	3588
.	2648	0.2000	0.0734	232	5071	3478
.	2648	0.3000	0.1101	343	4957	3371
.	2648	0.4000	0.1468	449	4848	3267
.	2648	0.5000	0.1834	553	4742	3168
.	2648	0.6000	0.2201	652	4640	3072
.	2648	0.7000	0.2568	749	4541	2979
.	2648	0.8000	0.2935	842	4446	2889
.	2648	0.9000	0.3302	932	4353	2803
.	2648	1.0000	0.3669	1019	4264	2719
.	2648	1.1000	0.4036	1103	4178	2639
.	2648	1.2000	0.4403	1185	4095	2561
.	2648	1.3000	0.4769	1263	4014	2486
.	2648	1.4000	0.5136	1340	3936	2413
.	2648	1.5000	0.5503	1413	3861	2343
.	2648	1.6000	0.5870	1485	3788	2275
.	2648	1.7000	0.6237	1554	3718	2210
.	2648	1.8000	0.6604	1620	3650	2147
.	2648	1.9000	0.6971	1685	3584	2086
.	2648	2.0000	0.7338	1748	3520	2027

Input units are thousands and kg - output in tonnes

Fmult corresponding to F_{MSY} = 0.736

.	2648	0.736	0.27	782	4506	2946

Fmult corresponding to Fpa = 0.927

.	2648	0.927	0.3401	956	4329	2780

Bpa = 2 400 t

Table 7.13.17. Sole in 7.f and 7.g. Detailed results.

MFDP version 1a
Run: S7FG
Time and date: 17:14 06/05/2016
Fbar age range: 4-8

Year: **2016** F multiplier: 0.8126 Fbar: 0.2981

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.000	0	0	4933	528	0	0	0	0
2	0.048	319	54	7087	933	992	131	992	131
3	0.217	222	45	1195	223	538	100	538	100
4	0.297	576	150	2348	547	2066	481	2066	481
5	0.323	690	223	2618	754	2566	739	2566	739
6	0.329	223	80	834	278	834	278	834	278
7	0.297	56	23	228	86	228	86	228	86
8	0.245	144	71	695	297	695	297	695	297
9	0.332	161	74	597	270	597	270	597	270
10	0.332	98	59	362	213	362	213	362	213
Total		2488	779	20897	4128	8878	2595	8878	2595

Year: **2017** F multiplier: 1 Fbar: 0.3669

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.000	0	0	4933	528	0	0	0	0
2	0.060	246	42	4464	588	625	82	625	82
3	0.267	1366	279	6110	1138	2749	512	2749	512
4	0.366	255	66	870	203	766	178	766	178
5	0.398	494	160	1578	455	1547	445	1547	445
6	0.404	545	196	1715	571	1715	571	1715	571
7	0.365	159	64	543	205	543	205	543	205
8	0.301	38	19	153	66	153	66	153	66
9	0.409	158	72	492	222	492	222	492	222
10	0.409	200	120	622	366	622	366	622	366
Total		3459	1019	21481	4341	9213	2648	9213	2648

Year: **2018** F multiplier: 1 Fbar: 0.3669

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.000	0	0	4933	528	0	0	0	0
2	0.060	246	42	4464	588	625	82	625	82
3	0.267	851	174	3805	709	1712	319	1712	319
4	0.366	1238	322	4232	986	3724	868	3724	868
5	0.398	171	55	546	157	535	154	535	154
6	0.404	305	110	960	320	960	320	960	320
7	0.365	303	123	1036	390	1036	390	1036	390
8	0.301	85	42	341	146	341	146	341	146
9	0.409	33	15	103	46	103	46	103	46
10	0.409	215	130	670	394	670	394	670	394
Total		3445	1012	21089	4264	9706	2719	9706	2719

Input units are thousands and kg - output in tonnes.

Table 7.13.18. Sole 7.f and 7.g. 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.

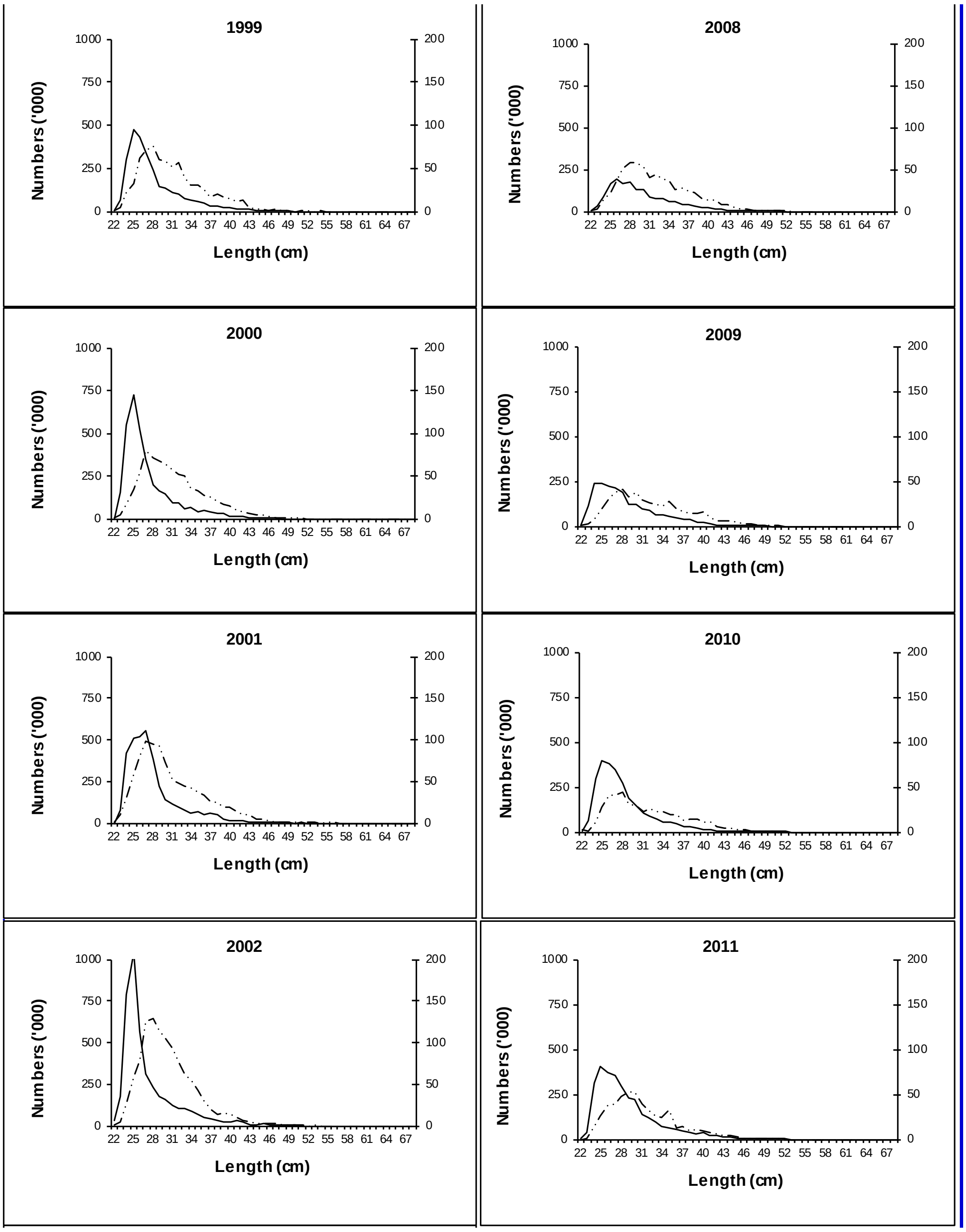
Year-class	2012	2013	2014	2015	2016	
Stock No. (thousands) of 1 year-olds	4338	1559	7832	4933	4933	
Source	XSA	XSA	XSA	GM71-13	GM71-13	
Status Quo F:						
% in 2016 landings	19.3	5.8	6.9	0.0	-	68.0
% in 2017 landings	15.7	6.5	27.4	4.1	0.0	46.3
						100.0
% in 2016 SSB	18.5	3.9	5.0	0.0	-	72.6
% in 2017 SSB	16.8	6.7	19.3	3.1	0.0	54.0
% in 2018 SSB	11.8	5.7	31.9	11.7	3.0	35.9

GM : geometric mean recruitment

Table 7.13.19. Sole in 7.f and 7.g. Yield per recruit summary table.

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	10.5083	4.0804	8.1776	3.7624	8.1776	3.7624
0.1000	0.0367	0.2267	0.1000	8.2444	2.8306	5.9200	2.5141	5.9200	2.5141
0.2000	0.0734	0.3531	0.1453	6.9829	2.1606	4.6648	1.8455	4.6648	1.8455
0.3000	0.1101	0.4342	0.1679	6.1742	1.7485	3.8623	1.4347	3.8623	1.4347
0.4000	0.1468	0.4909	0.1796	5.6094	1.4727	3.3034	1.1602	3.3034	1.1602
0.5000	0.1834	0.5329	0.1857	5.1914	1.2770	2.8911	0.9658	2.8911	0.9658
0.6000	0.2201	0.5654	0.1886	4.8688	1.1322	2.5742	0.8222	2.5742	0.8222
0.7000	0.2568	0.5913	0.1897	4.6119	1.0214	2.3228	0.7126	2.3228	0.7126
0.8000	0.2935	0.6125	0.1898	4.4023	0.9344	2.1186	0.6268	2.1186	0.6268
0.9000	0.3302	0.6301	0.1892	4.2278	0.8646	1.9493	0.5581	1.9493	0.5581
1.0000	0.3669	0.6451	0.1884	4.0801	0.8076	1.8068	0.5022	1.8068	0.5022
1.1000	0.4036	0.6580	0.1873	3.9535	0.7603	1.6852	0.4559	1.6852	0.4559
1.2000	0.4403	0.6691	0.1862	3.8436	0.7204	1.5803	0.4172	1.5803	0.4172
1.3000	0.4769	0.6790	0.1850	3.7473	0.6865	1.4887	0.3843	1.4887	0.3843
1.4000	0.5136	0.6877	0.1838	3.6621	0.6573	1.4083	0.3561	1.4083	0.3561
1.5000	0.5503	0.6954	0.1826	3.5862	0.6320	1.3370	0.3317	1.3370	0.3317
1.6000	0.5870	0.7024	0.1815	3.5181	0.6098	1.2734	0.3105	1.2734	0.3105
1.7000	0.6237	0.7088	0.1805	3.4566	0.5902	1.2163	0.2918	1.2163	0.2918
1.8000	0.6604	0.7145	0.1794	3.4007	0.5727	1.1648	0.2753	1.1648	0.2753
1.9000	0.6971	0.7198	0.1785	3.3498	0.5572	1.1181	0.2606	1.1181	0.2606
2.0000	0.7338	0.7246	0.1775	3.3030	0.5431	1.0755	0.2474	1.0755	0.2474

Reference point	F multiplier	Absolute F
Fbar(4-8)	1.0000	0.3669
FMax	0.7571	0.2778
F0.1	0.3082	0.1131
F35%SPR	0.3385	0.1242


1999
2008
2000
2009
2001
2010
2002
2011
Numbers ('000)
Length (cm)

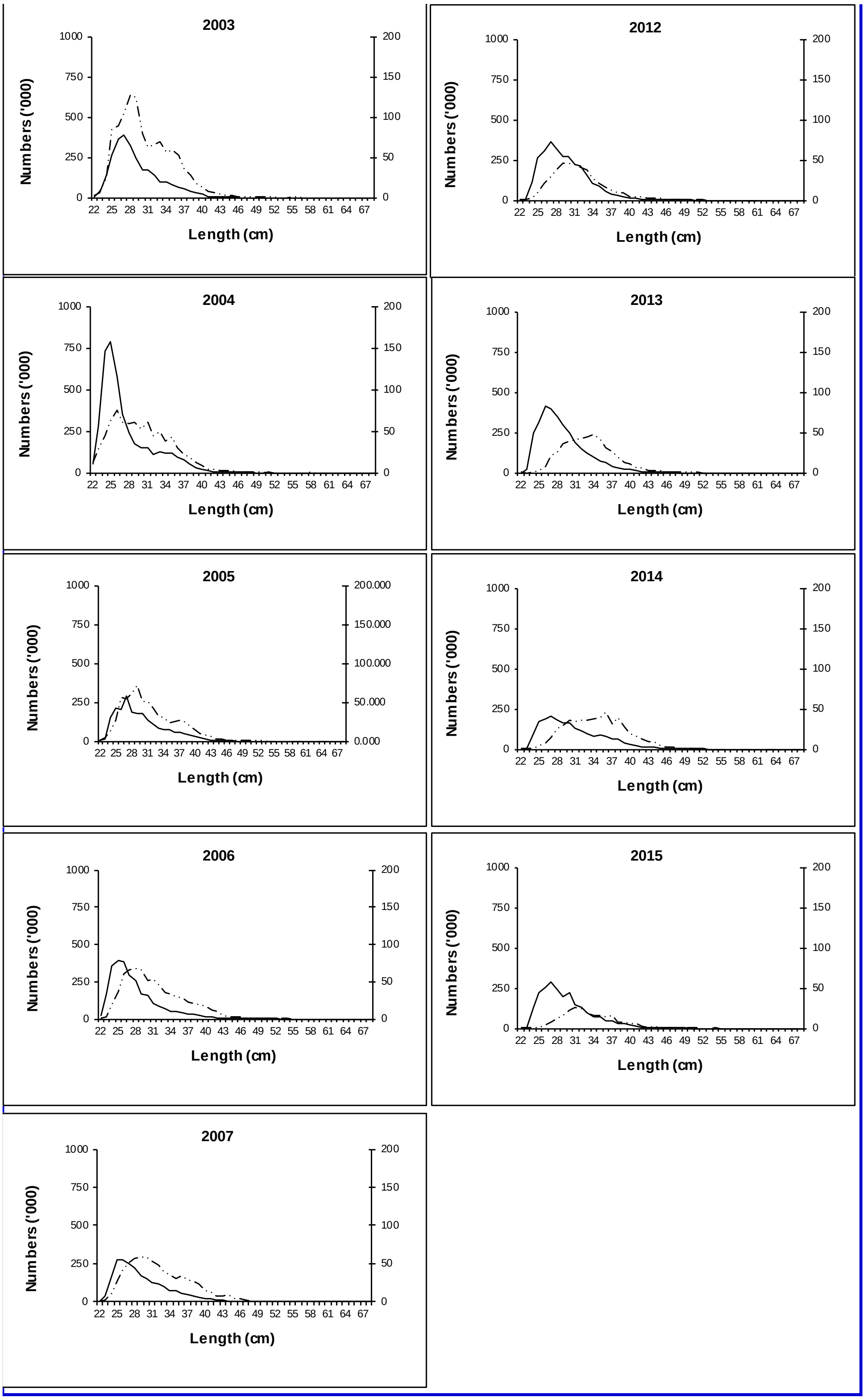
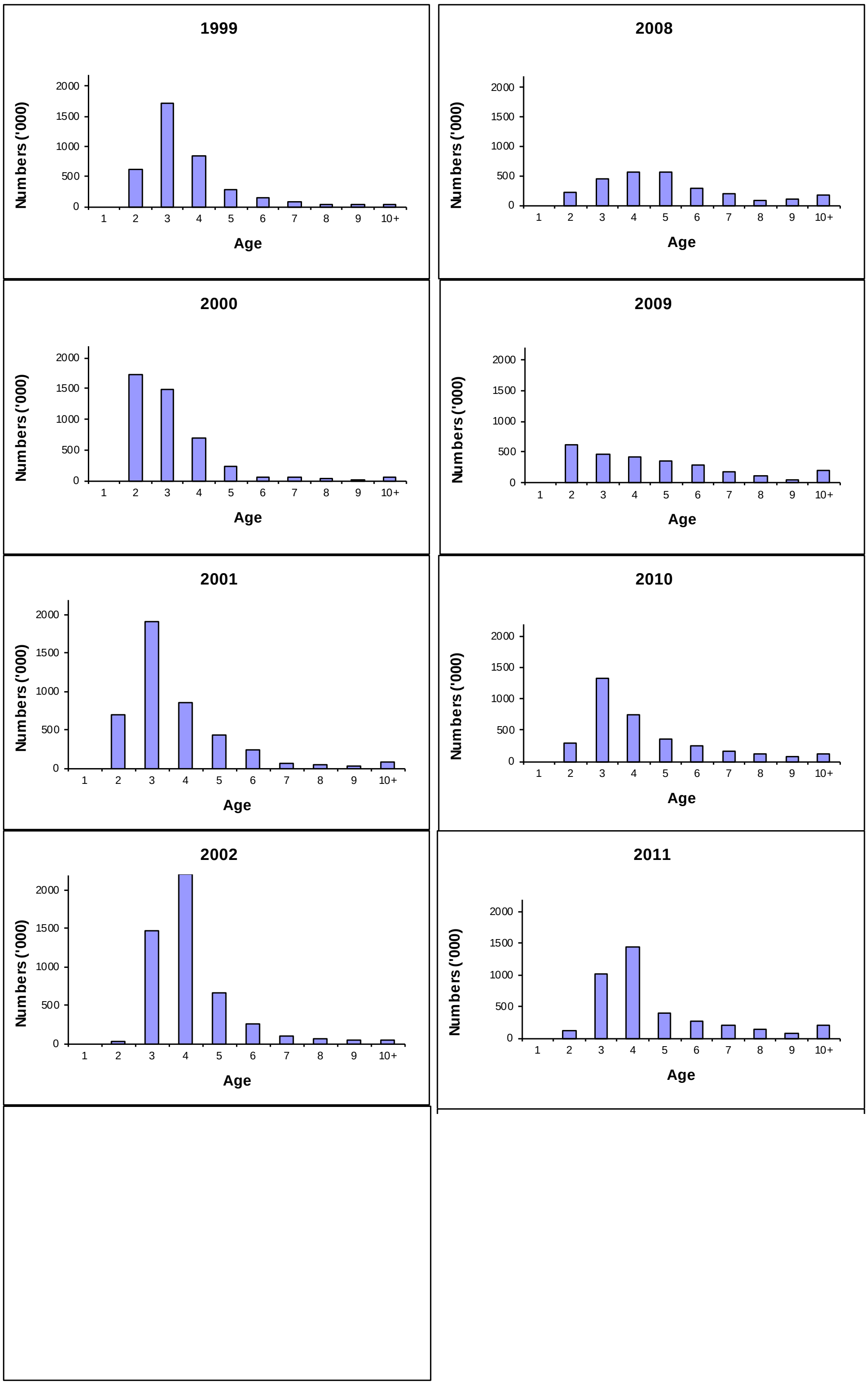


Figure 7.13.1. Sole in 7.f and 7.g. Dotted lines give the length distributions of UK (England and Wales) landings; solid lines of Belgian landings.


1999
2008
2000
2009
2001
2010
2002
2011
Numbers ('000)
Age
0
500
1000
1500
2000
1
2
3
4
5
6
7
8
9
10+

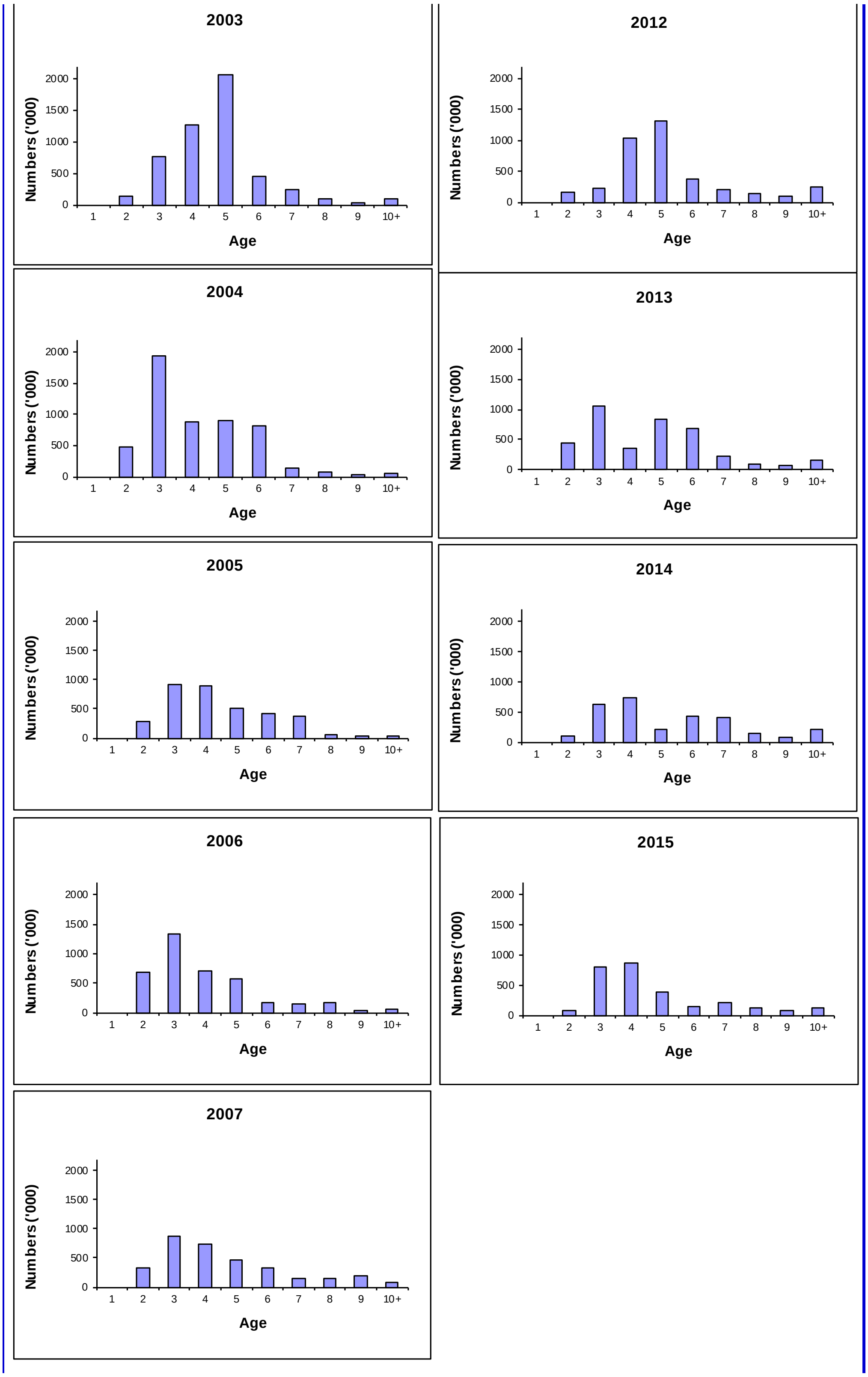


Figure 7.13.2. Sole in 7.f and 7.g. Age composition of landings.

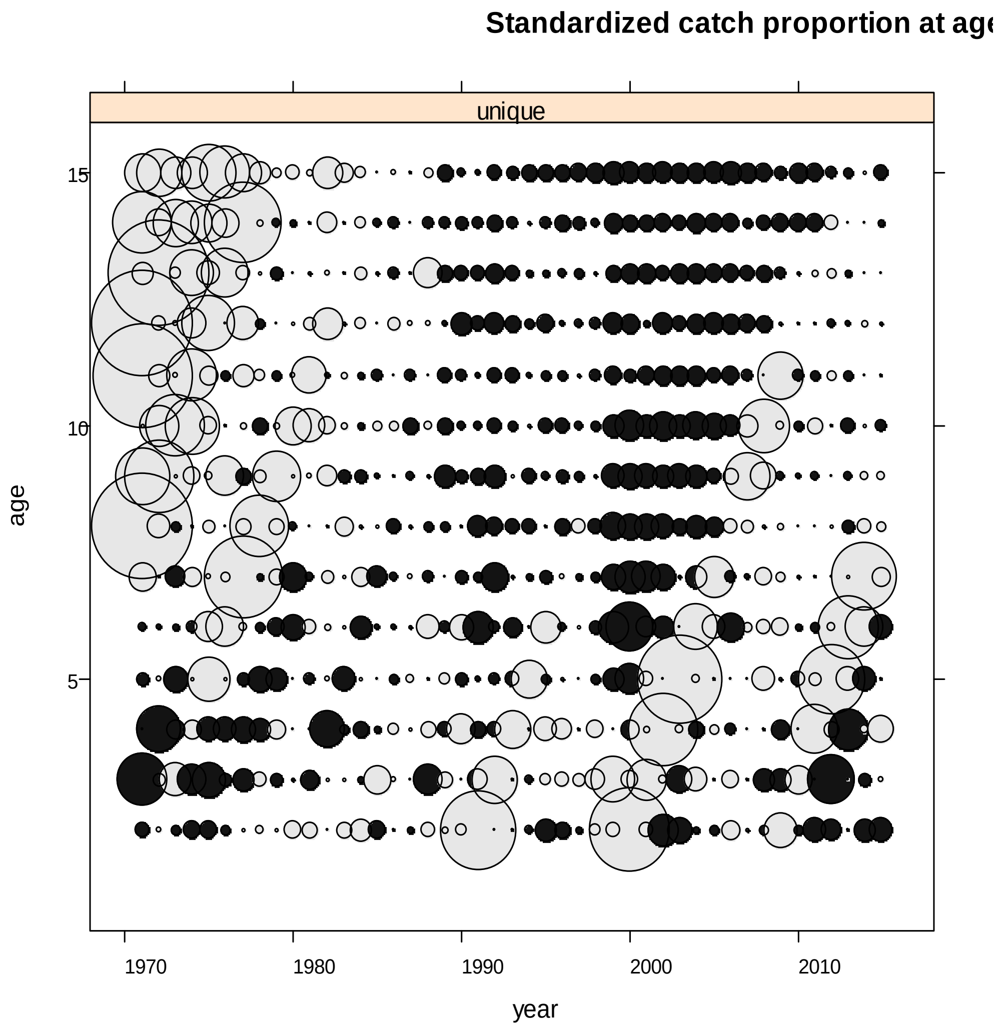


Figure 7.13.3. Sole 7.f and 7.g. Standardized catch proportion.

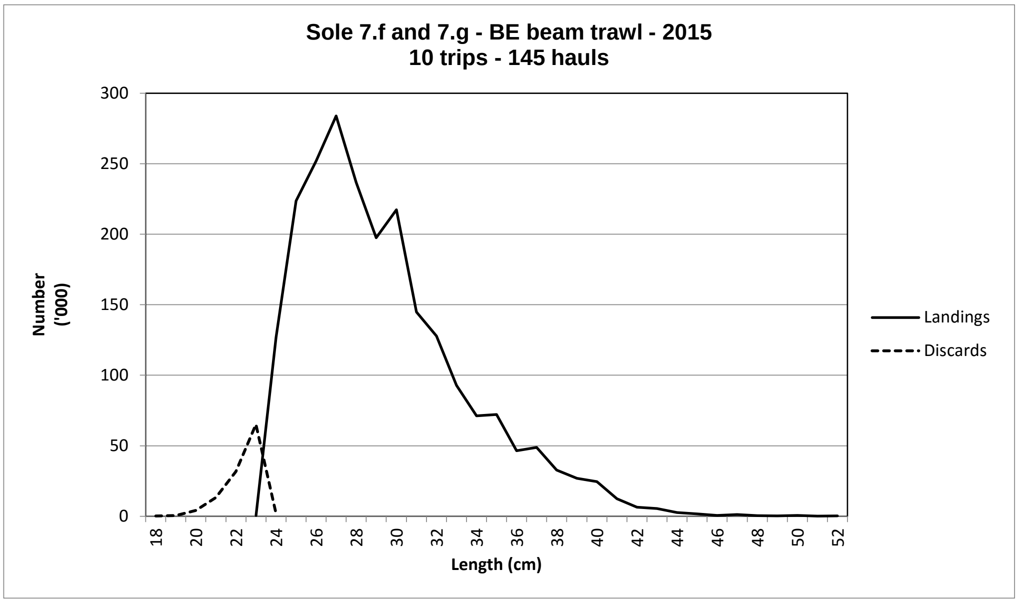
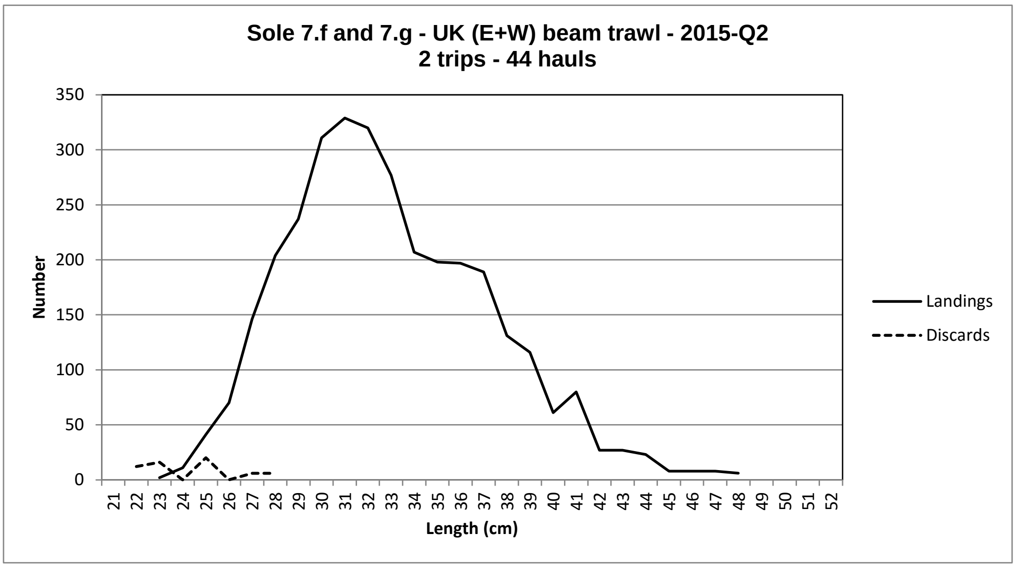
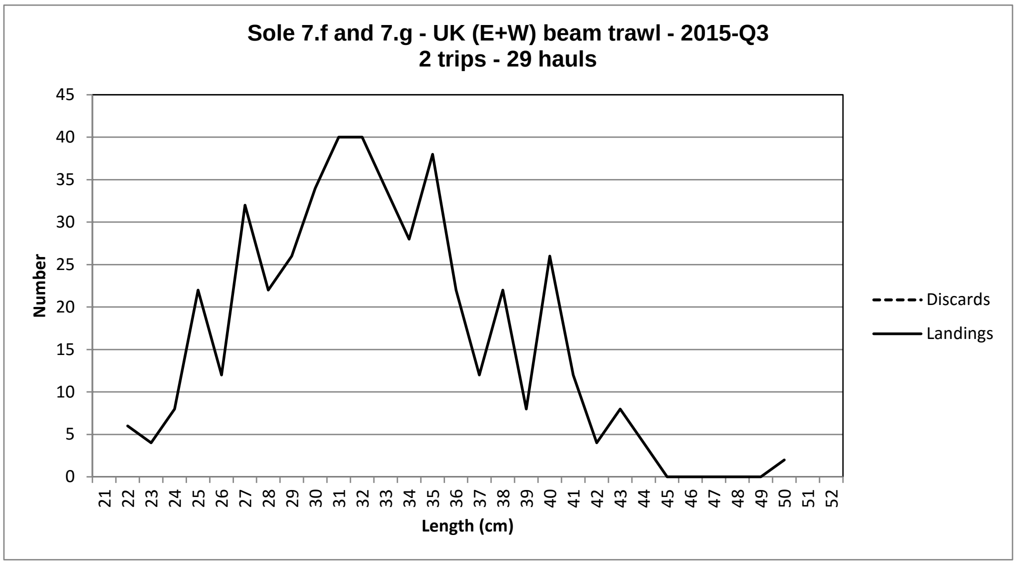


Figure 7.13.4a. Sole 7.f and 7.g. Belgian length distributions of discarded and retained fish from discard sampling studies.





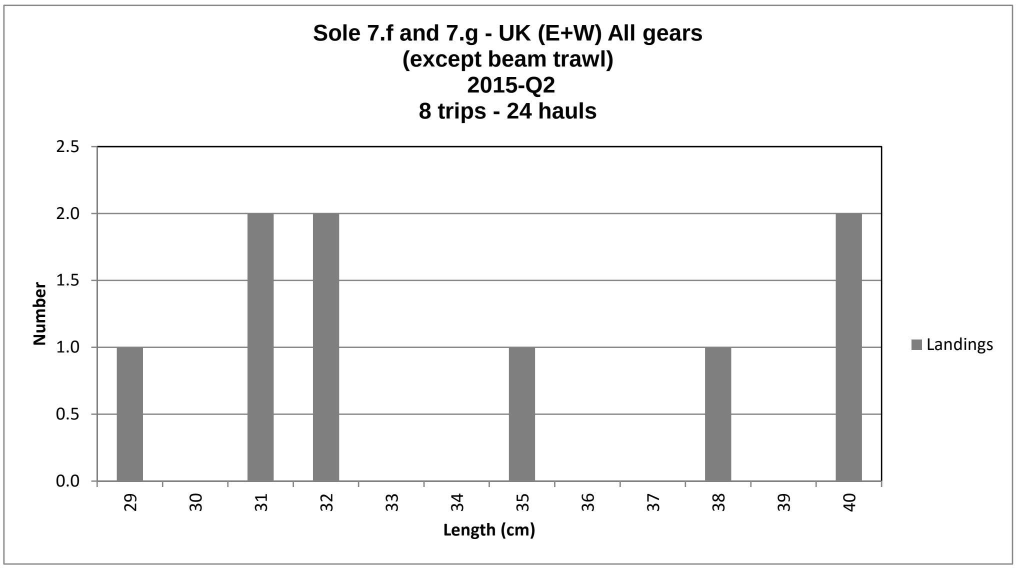
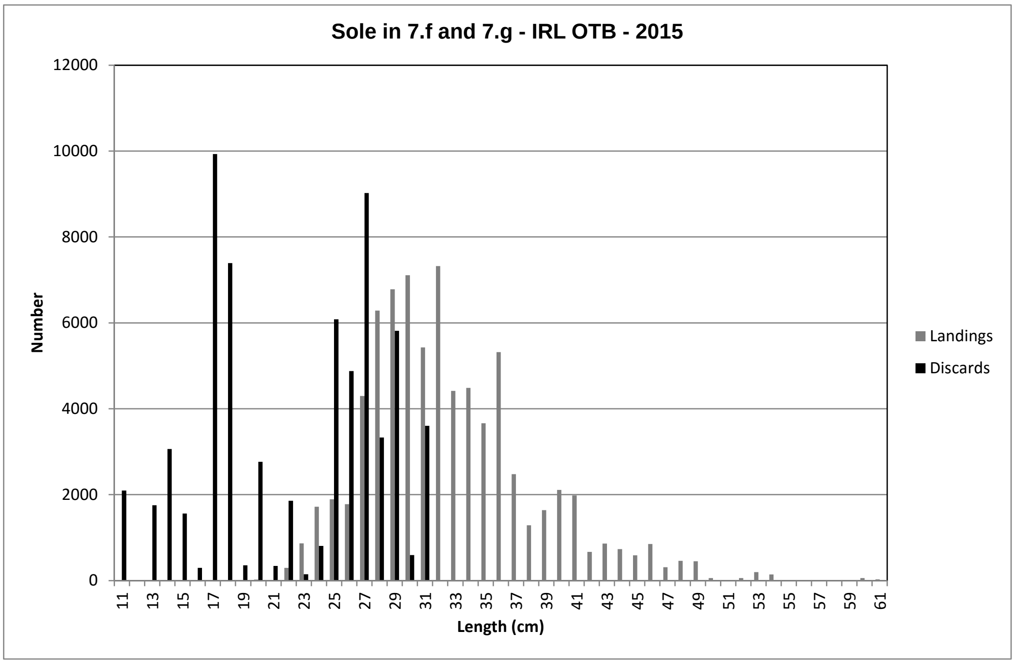


Figure 7.13.4b. Sole 7.f and 7.g. UK (E+W) Length distributions of discarded and retained fish from discard sampling studies.



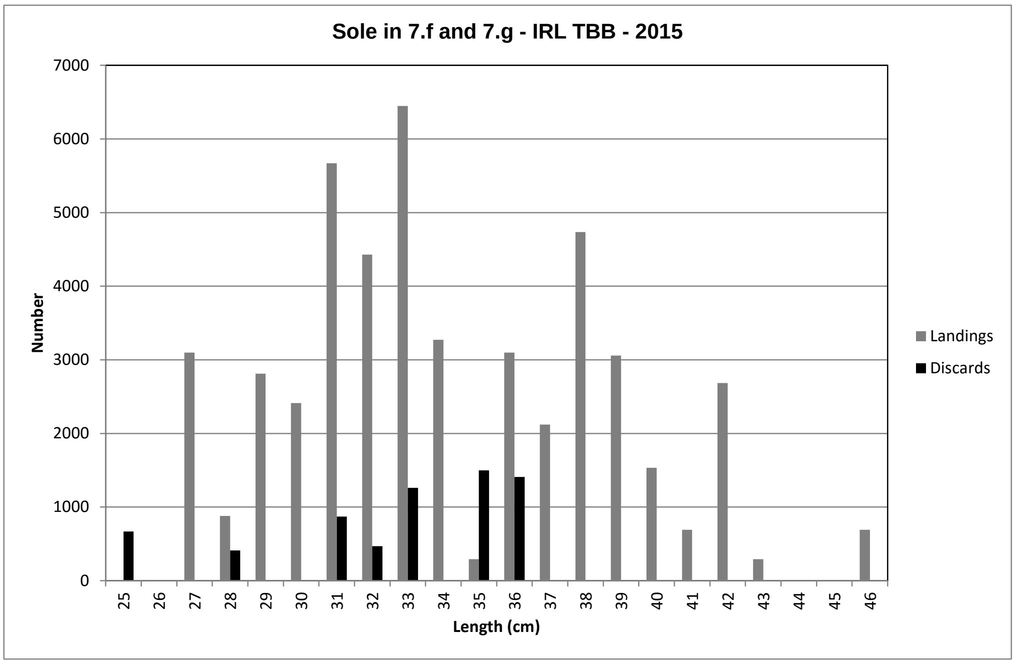


Figure 7.13.4c. Sole 7.f and 7.g. Ireland Length distributions of discarded and retained fish from discard sampling studies.

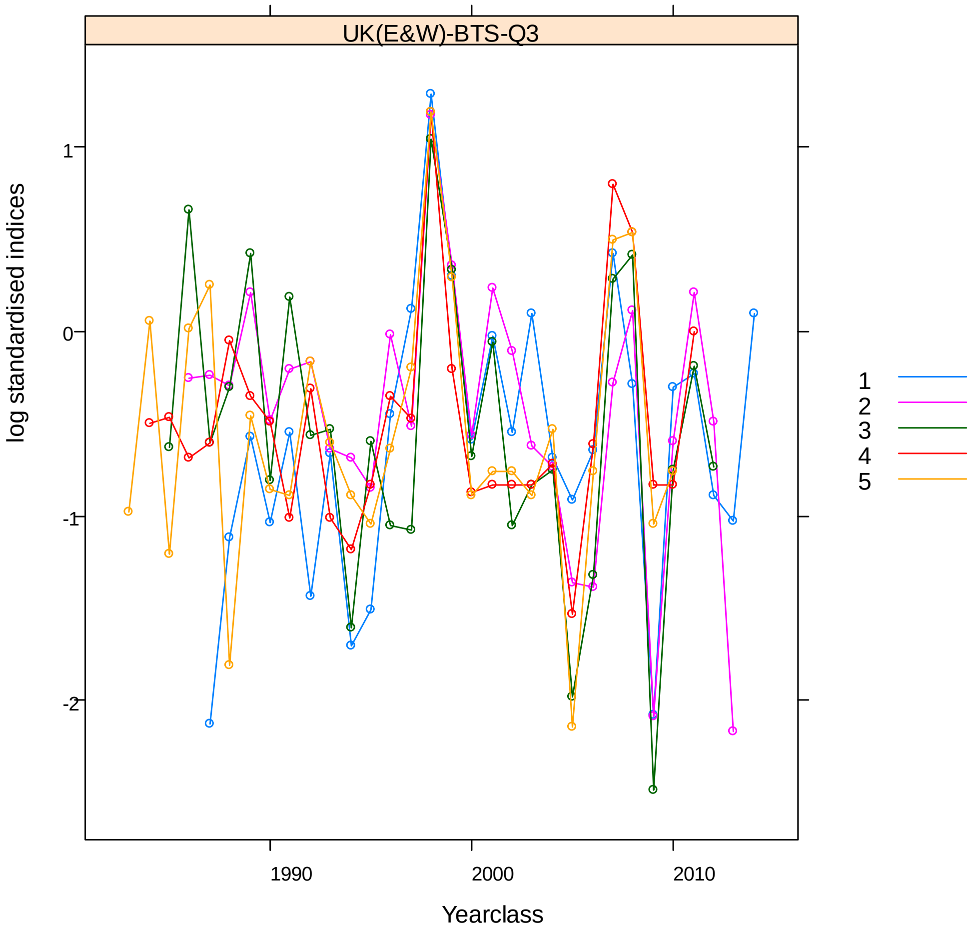


Figure 7.13.5. Sole 7.f and 7.g. Mean-standardised index of UK(E&W) 7.f and 7.g Corystes survey.

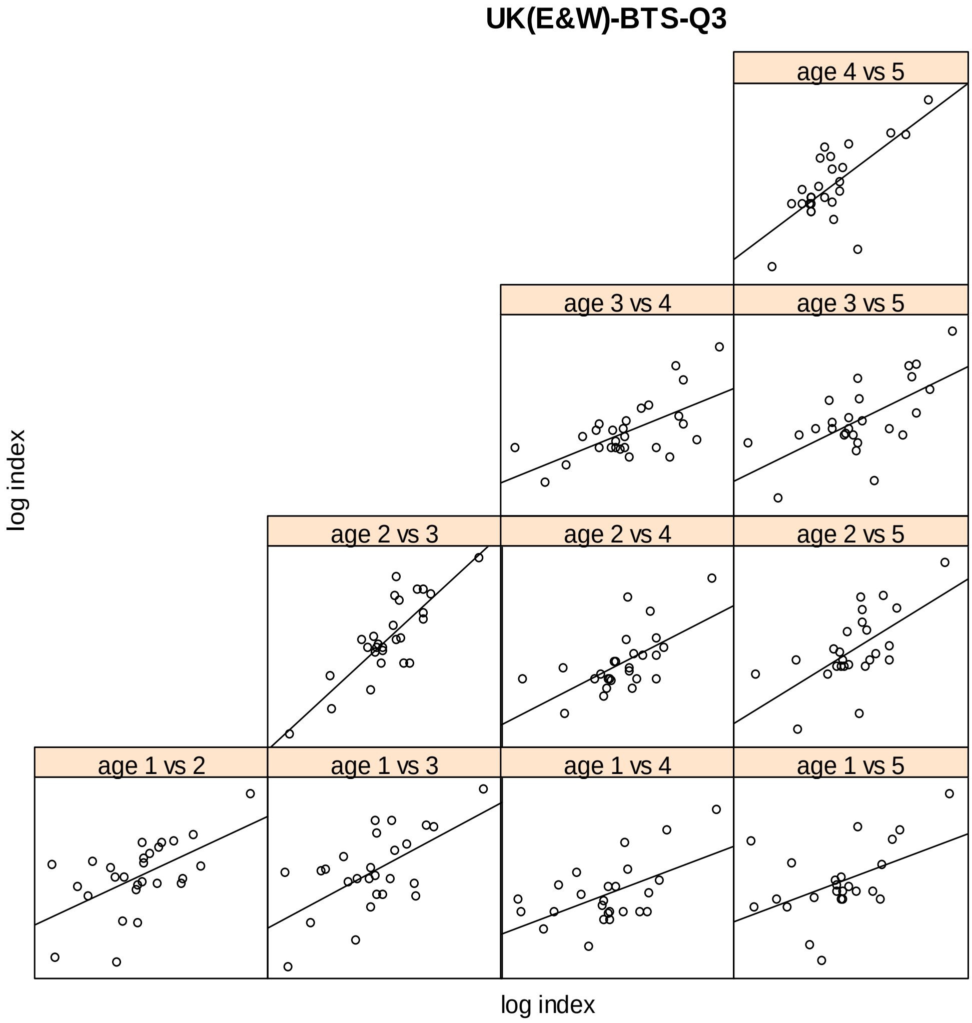
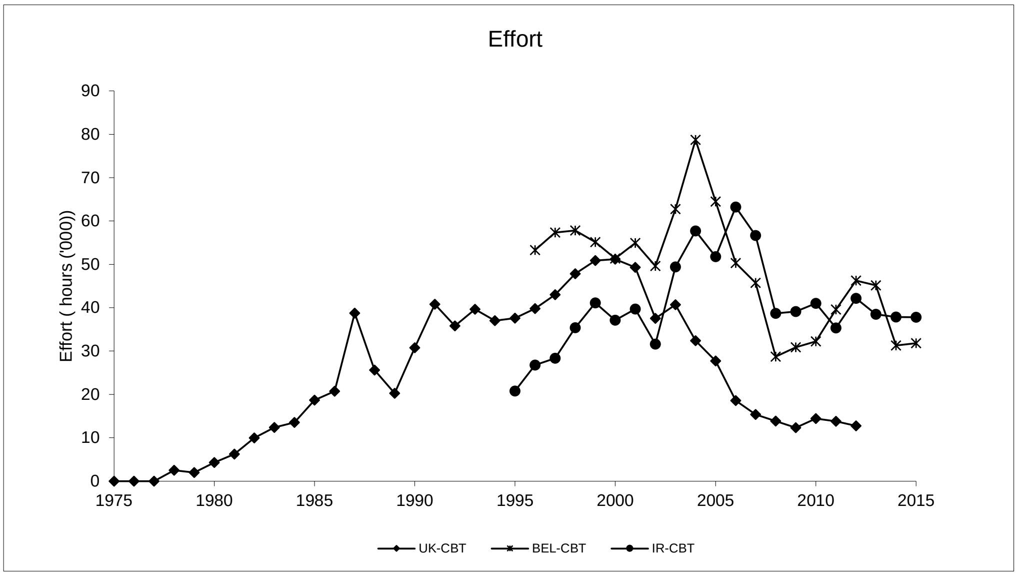


Figure 7.13.6. Sole in 7.f and 7.g. Consistency plot UK(E&W)-BTS-Q3 survey.



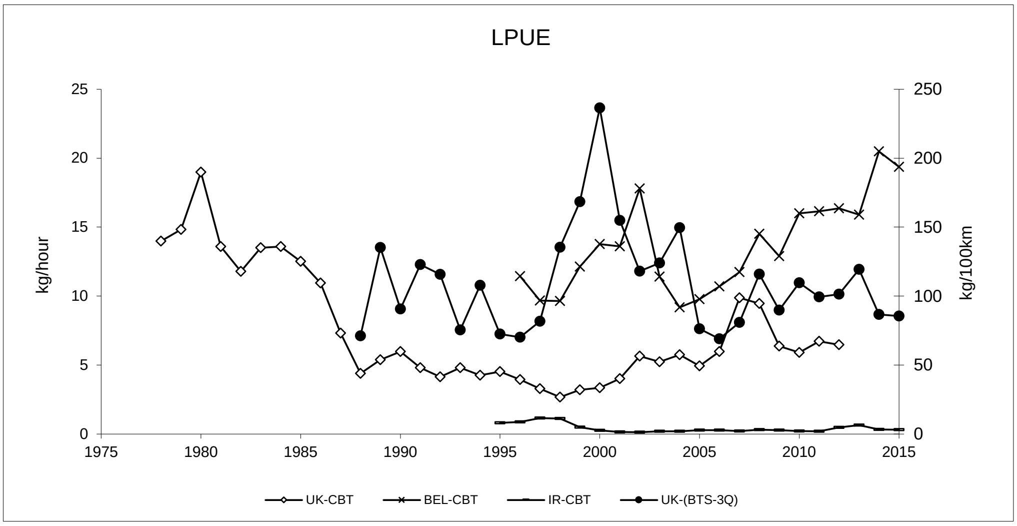


Figure 7.13.7. Sole in 7.f and 7.g. Effort (hours ('000) (BE-CBT and IR-CBT), hours ('000) GRT corrected (UK-CBT)) and lpue (kg/hour (BE-CBT and IR-CBT), kg/hour GRT corrected (UK-CBT), kg/100 km (UK-BTS-3Q)).

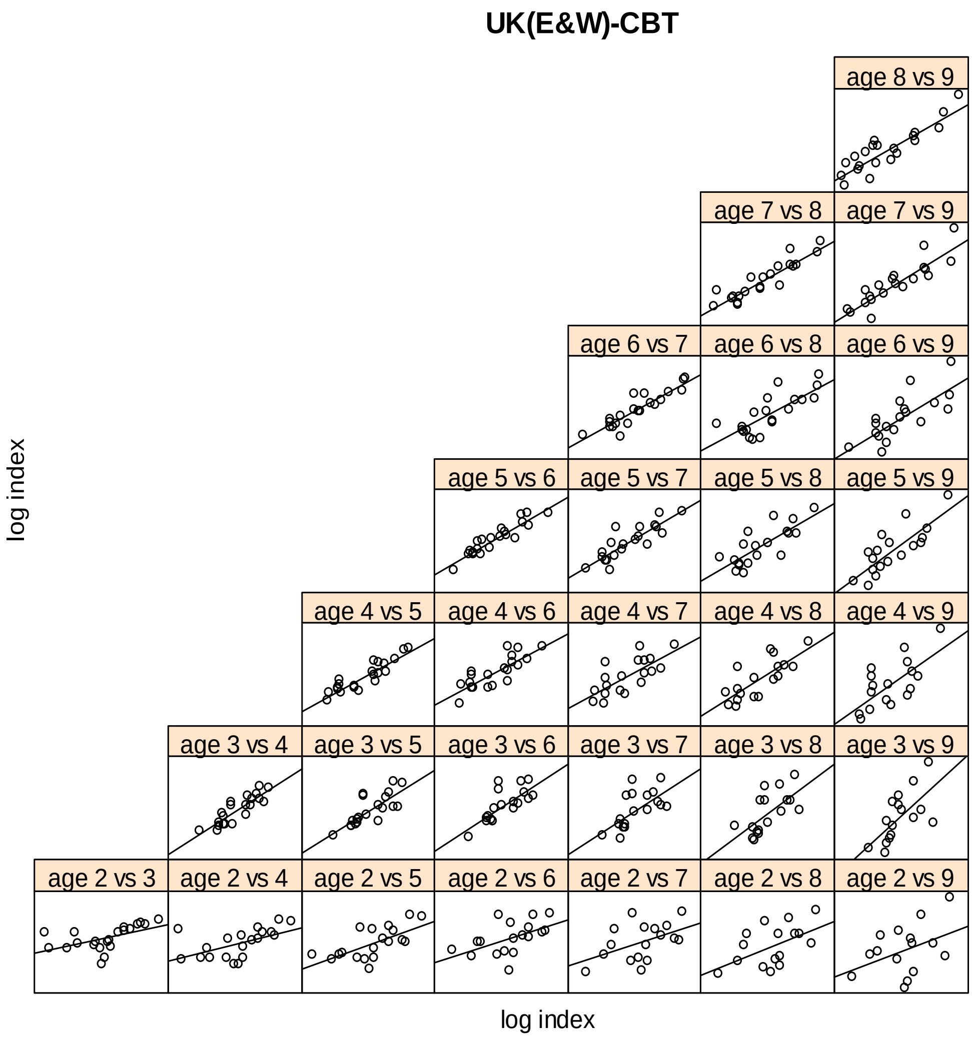


Figure 7.13.8. Sole in 7.f and 7.g. Consistency plot UK(E&W) beam trawl.

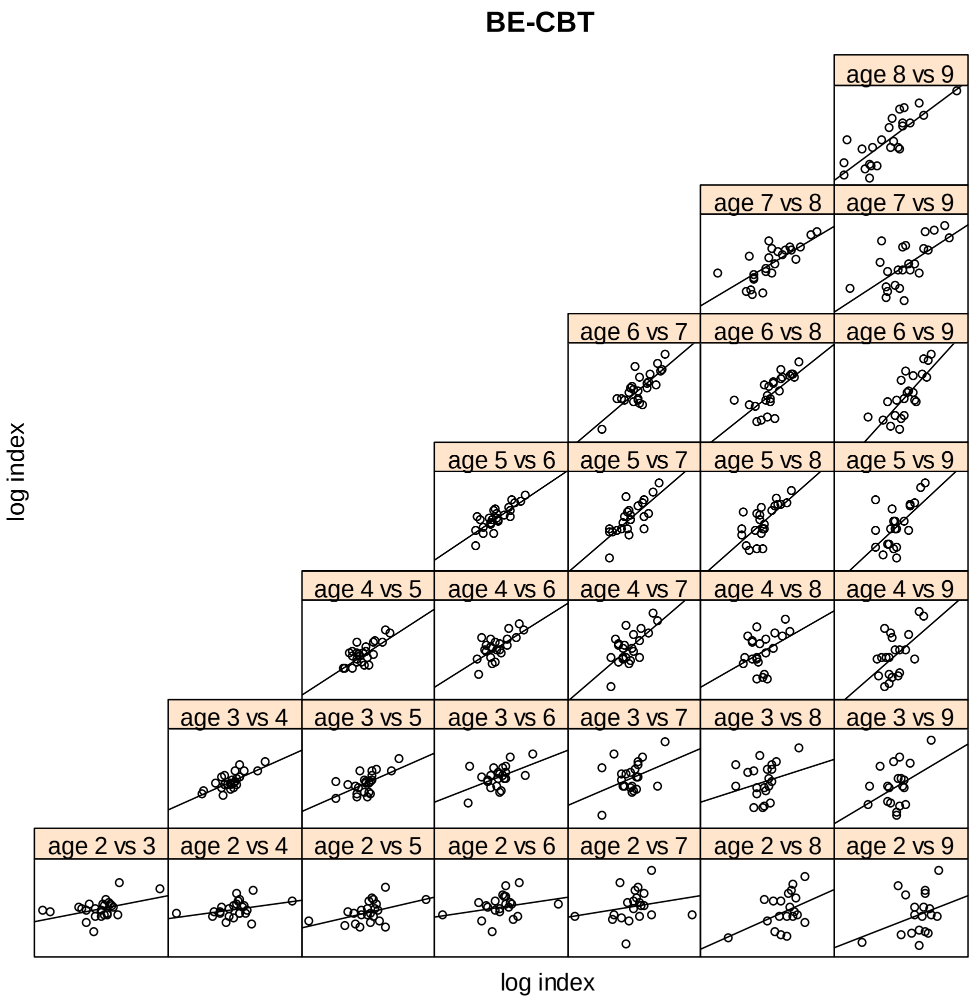


Figure 7.13.9a. Sole in 7.f and 7.g. Consistency plot Belgian beam trawl. Years: 1971–1996.

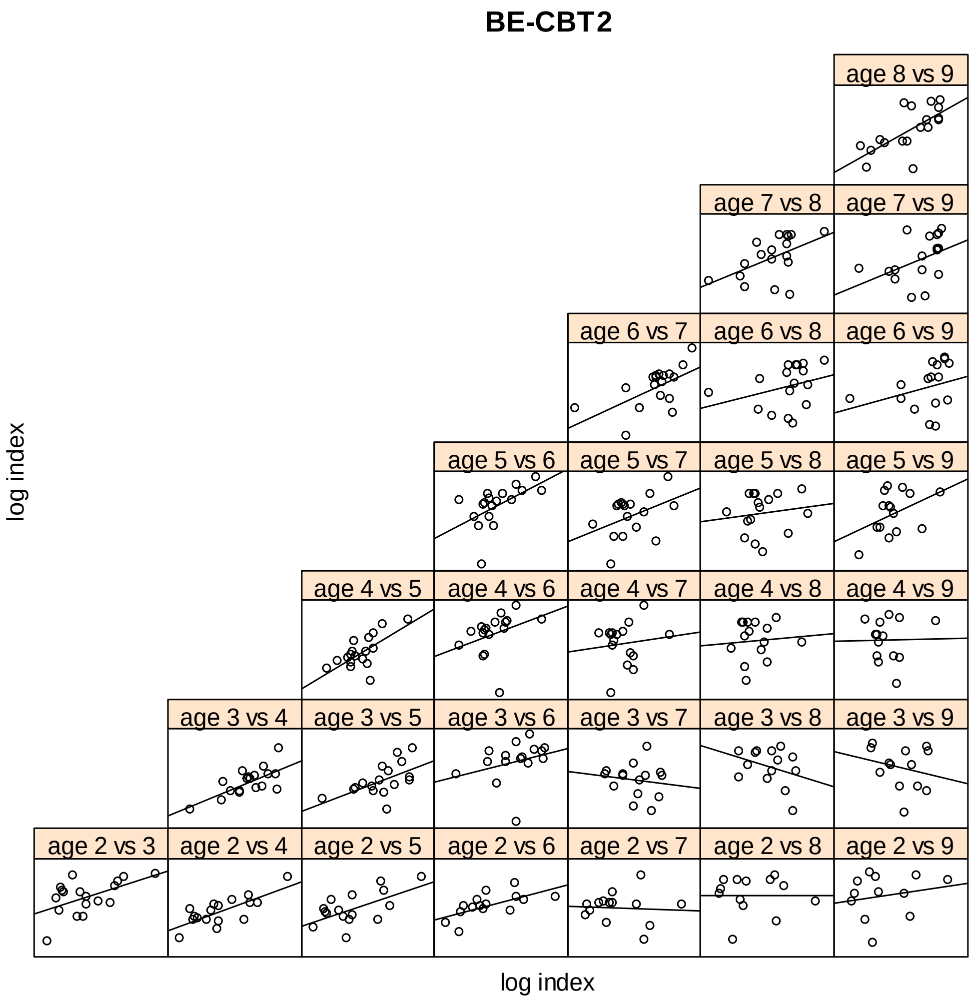


Figure 7.13.9b. Sole in 7.f and 7.g. Consistency plot Belgian beam trawl. Years: 1997–2015.

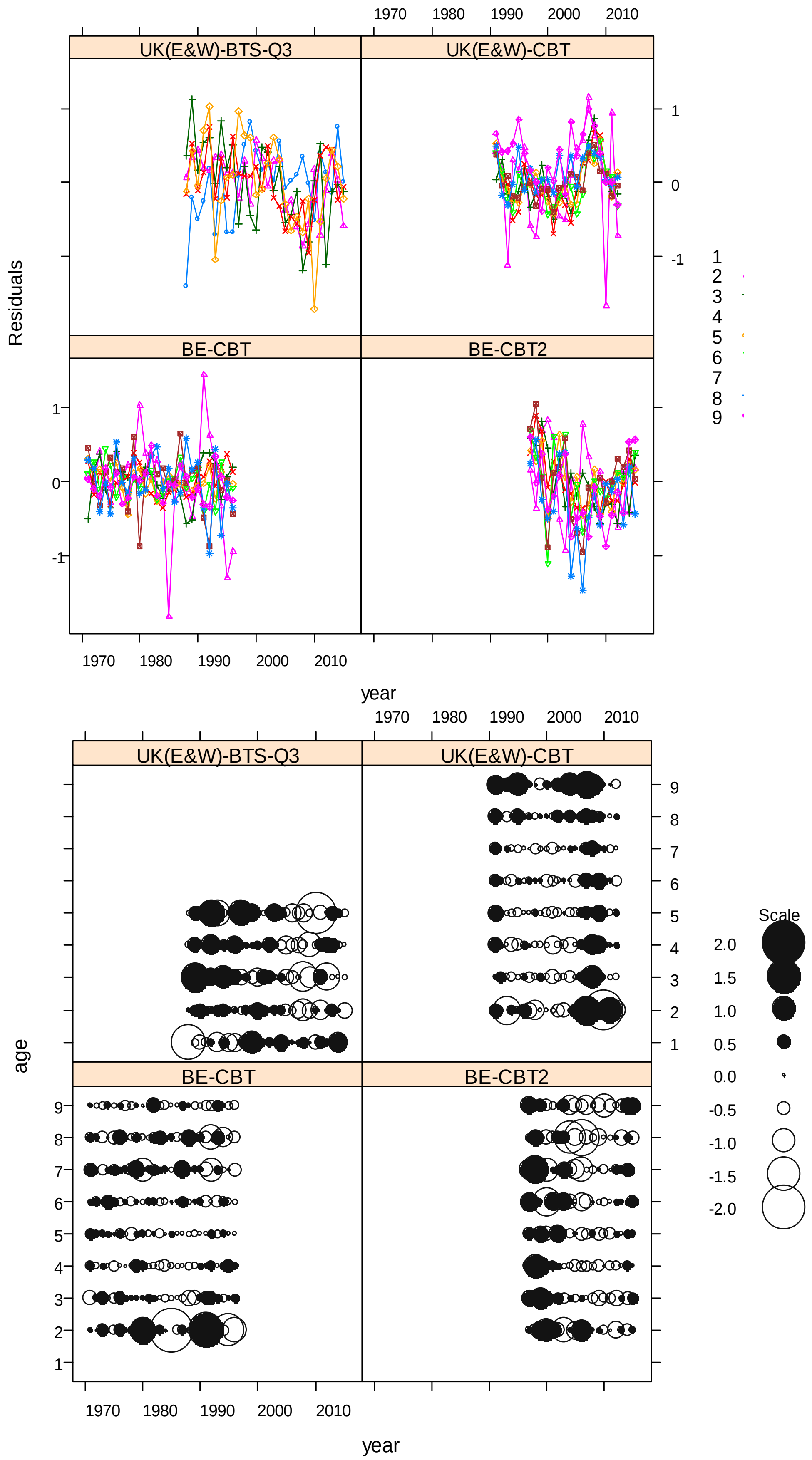


Figure 7.13.10. Sole in 7.f and 7.g. Catchability residuals for final XSA run.

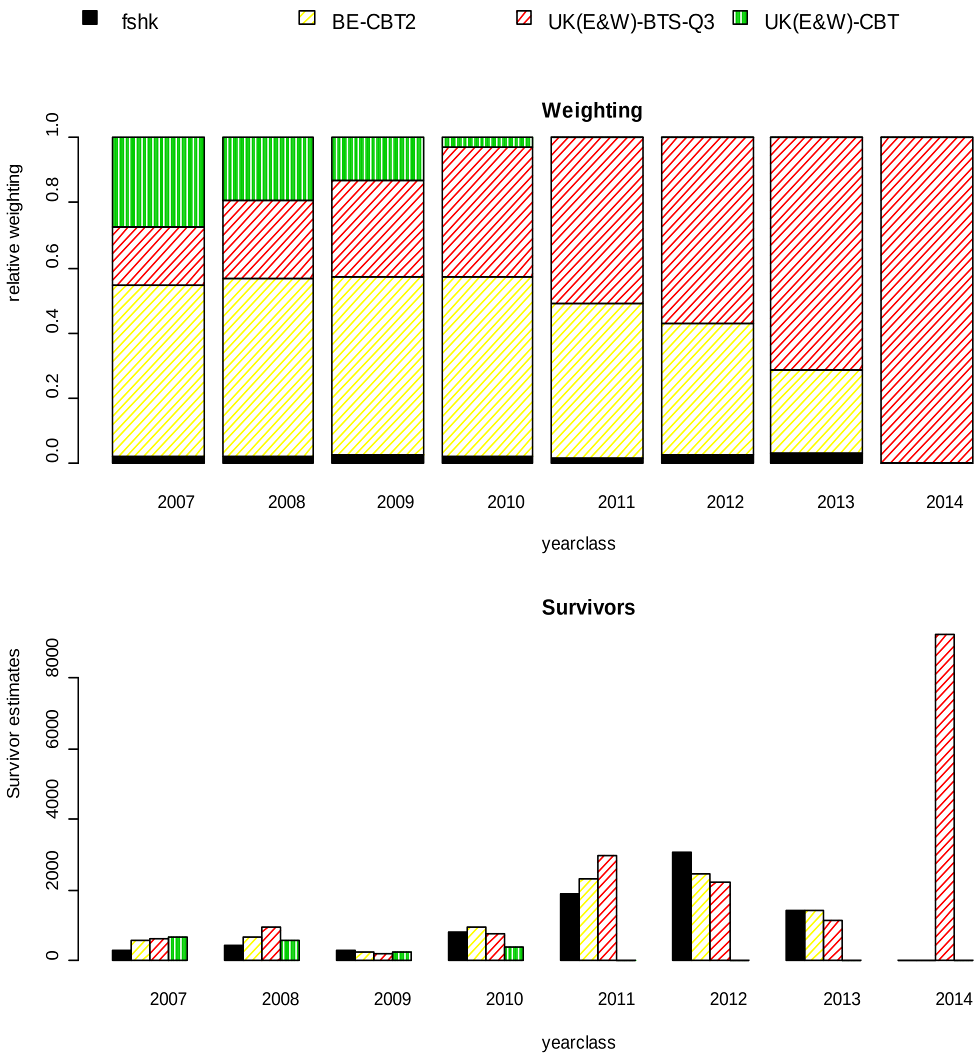


Figure 7.13.11. Sole in 7.f and 7.g. Estimates of survivors from different fleets and shrinkage, as well as their different weighting in the final XSA-run.

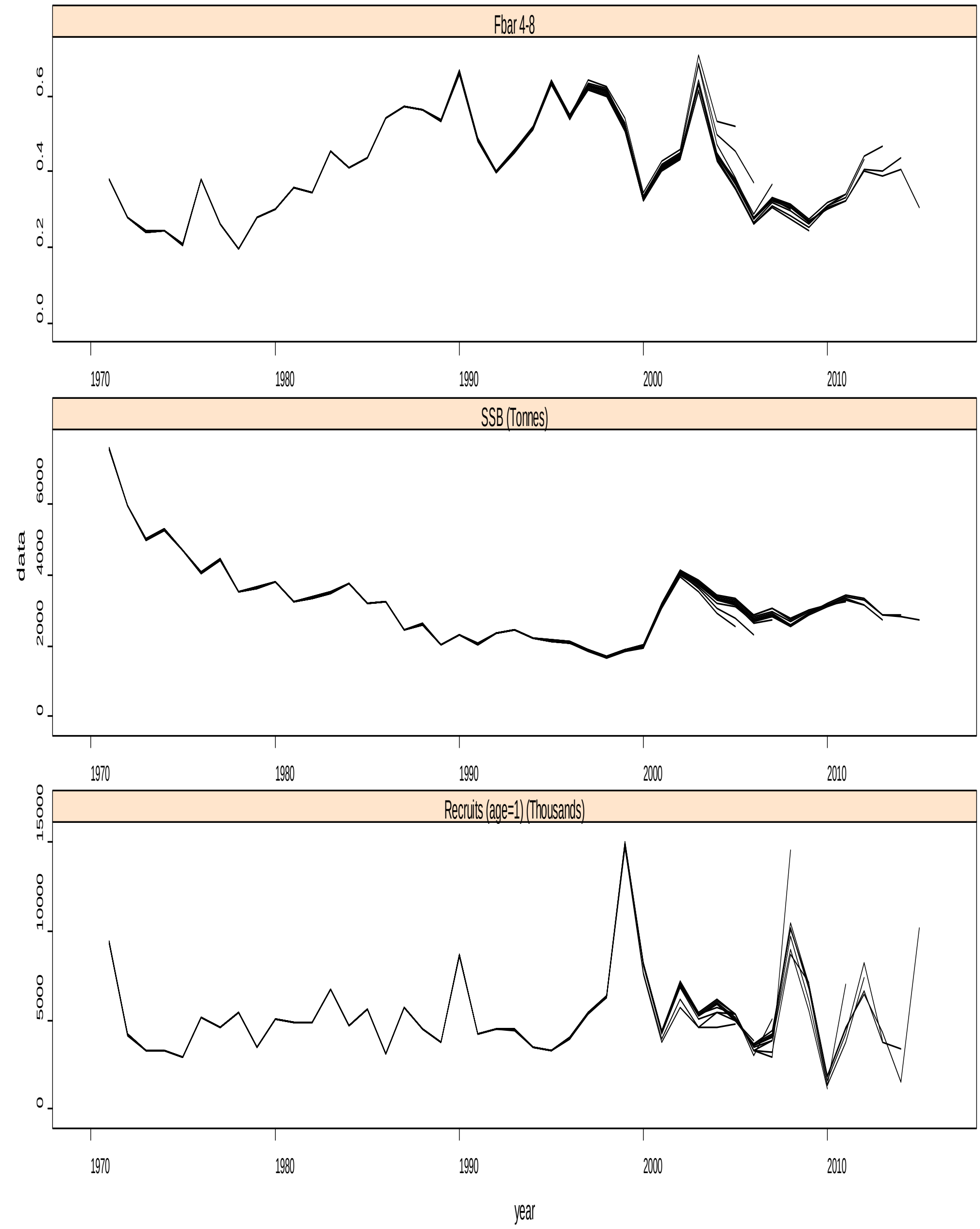


Figure 7.13.12. Sole 7.f and 7.g. Retrospective XSA analysis (shrinkage SE=1.5).

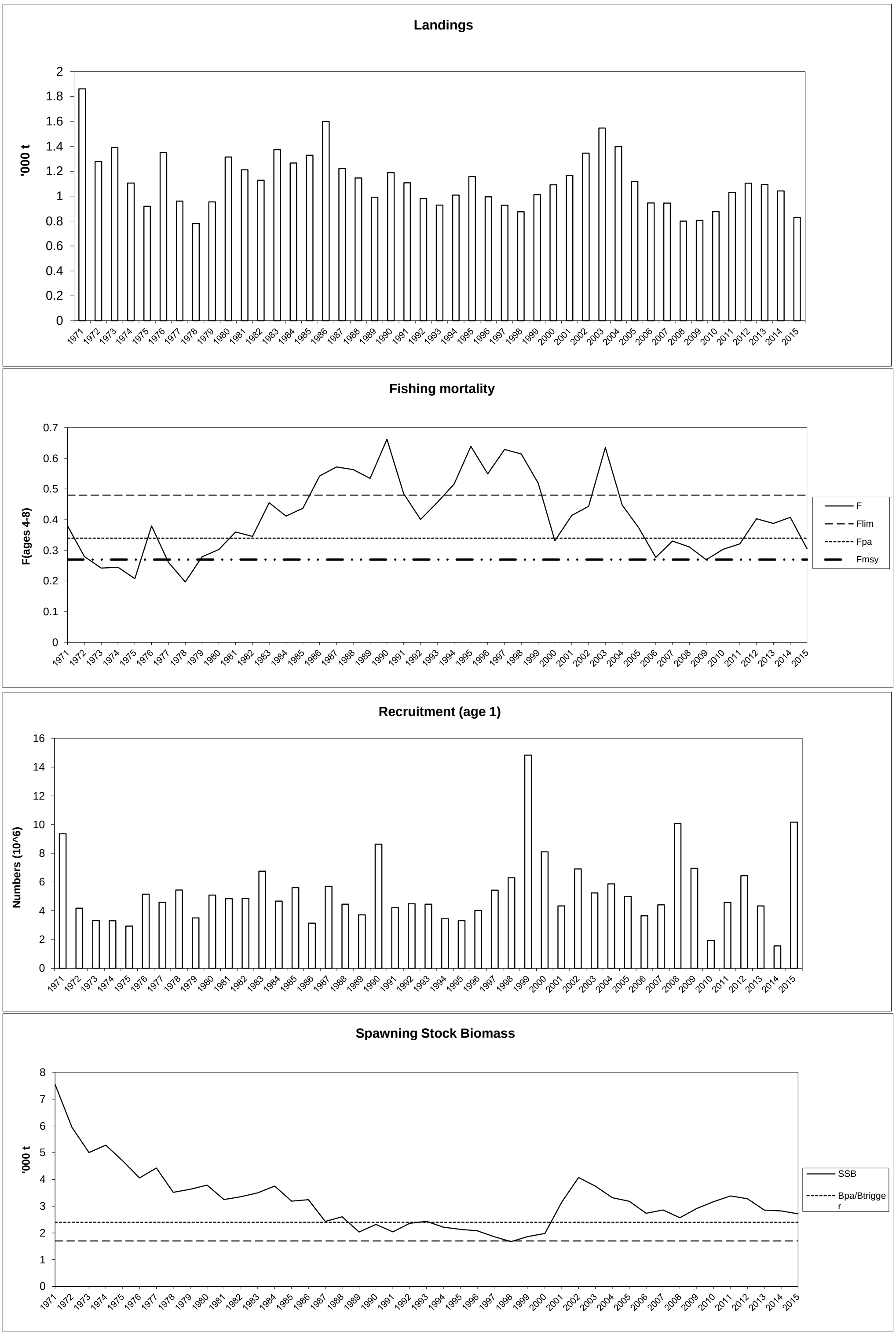
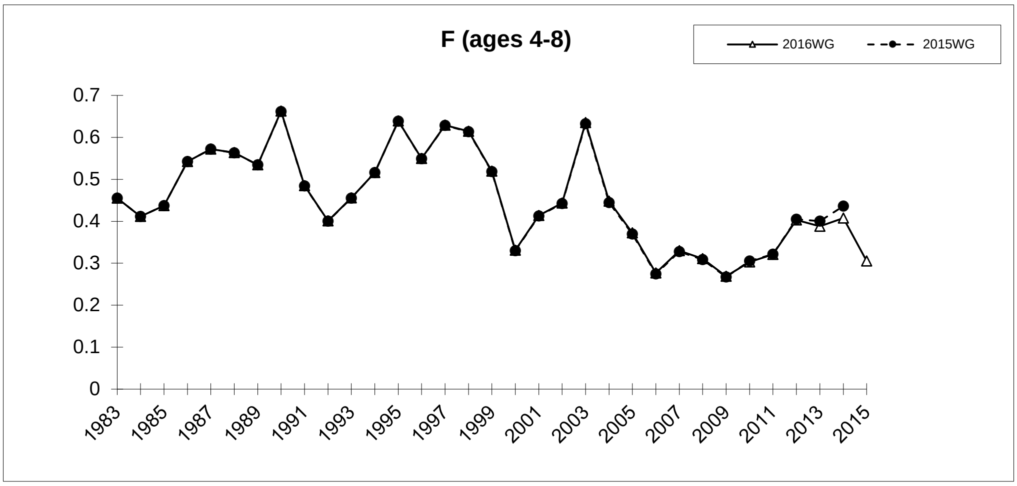
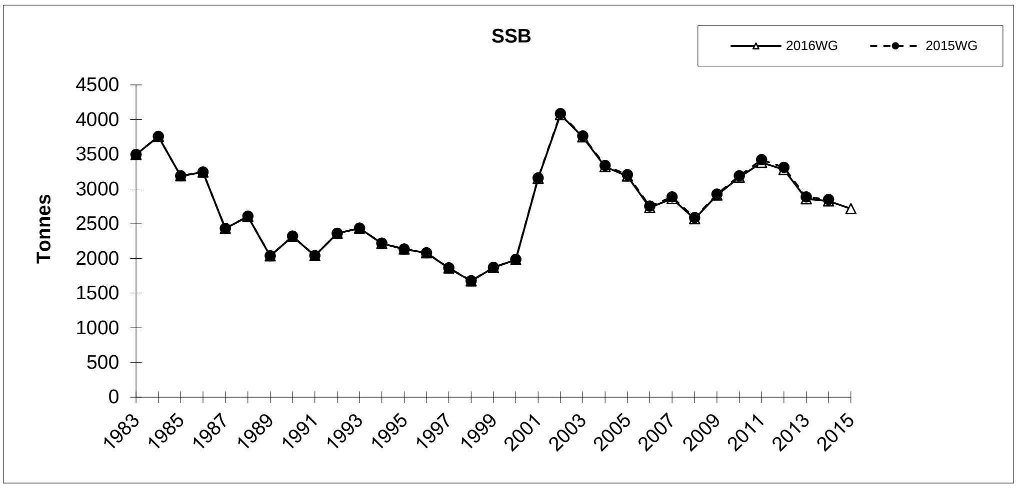


Figure 7.13.13. Sole in 7.f and 7.g. Summary plots.





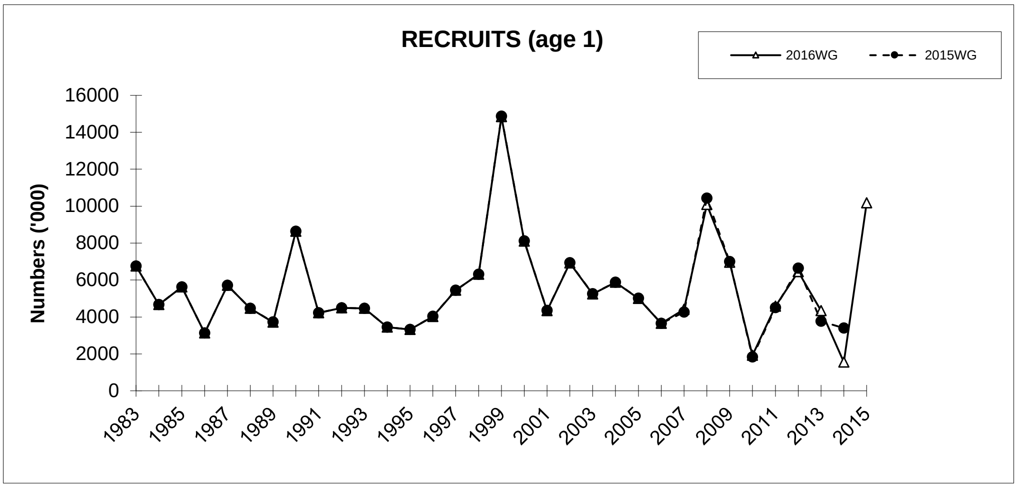
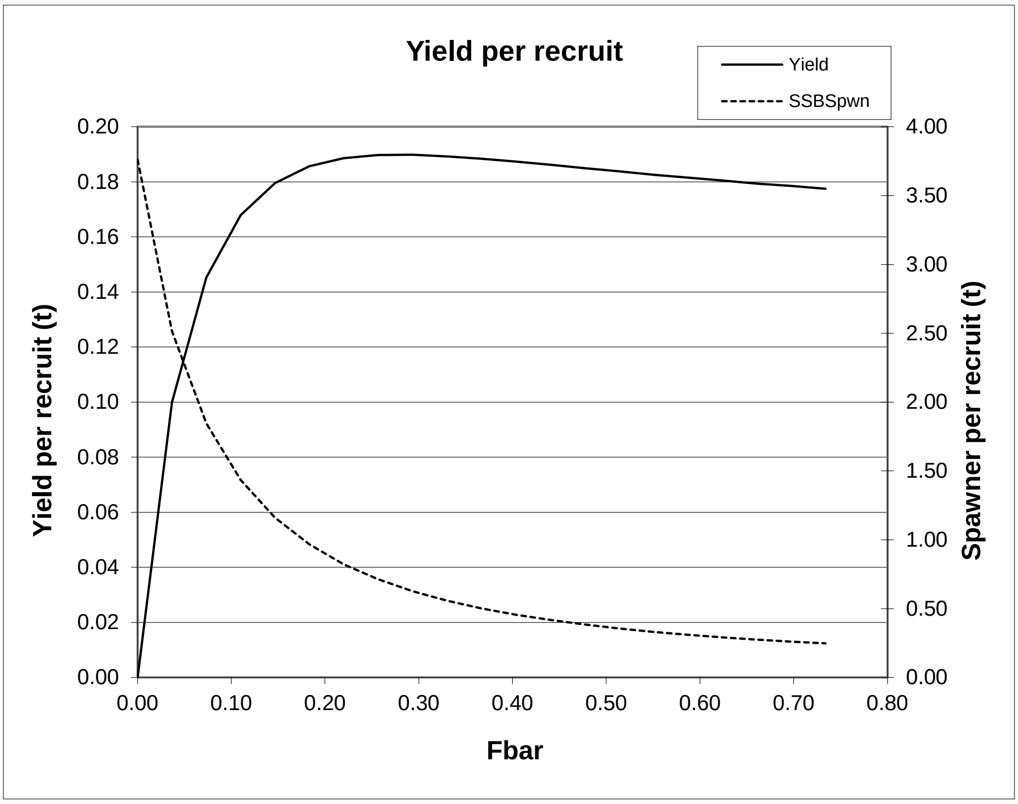


Figure 7.13.14. Sole 7.f and 7.g. Comparison with last year's assessment.



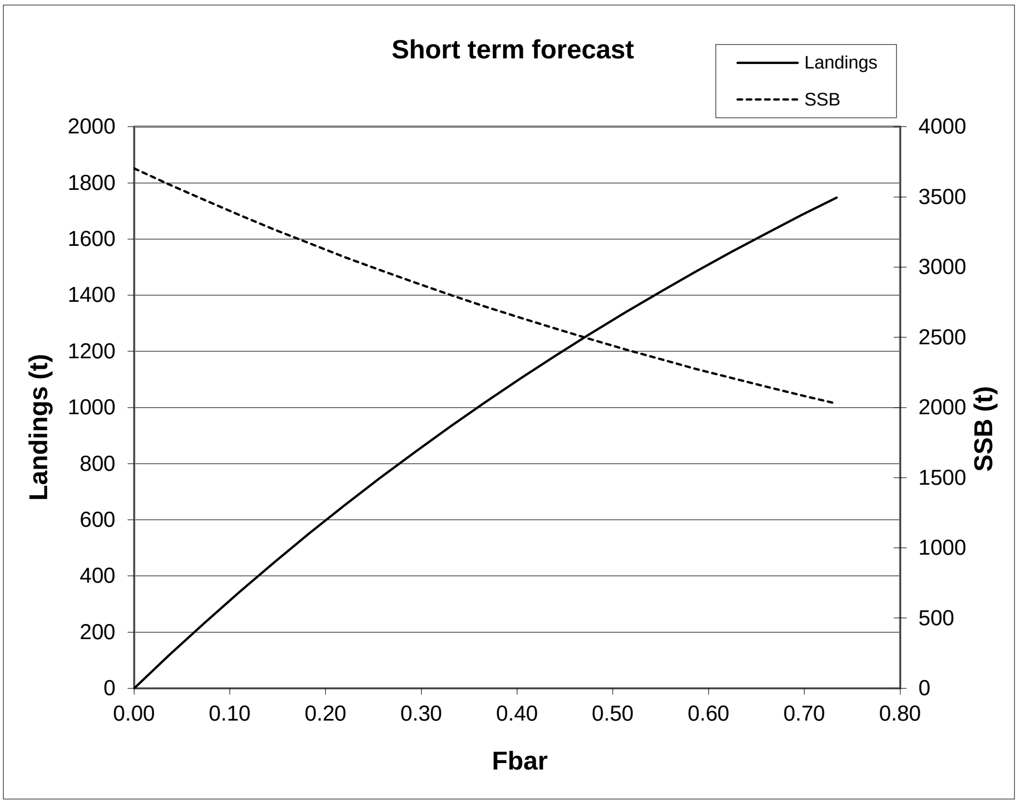


Figure 7.13.15. Sole in 7.f and 7.g. Yield per recruit and short-term forecast plots.

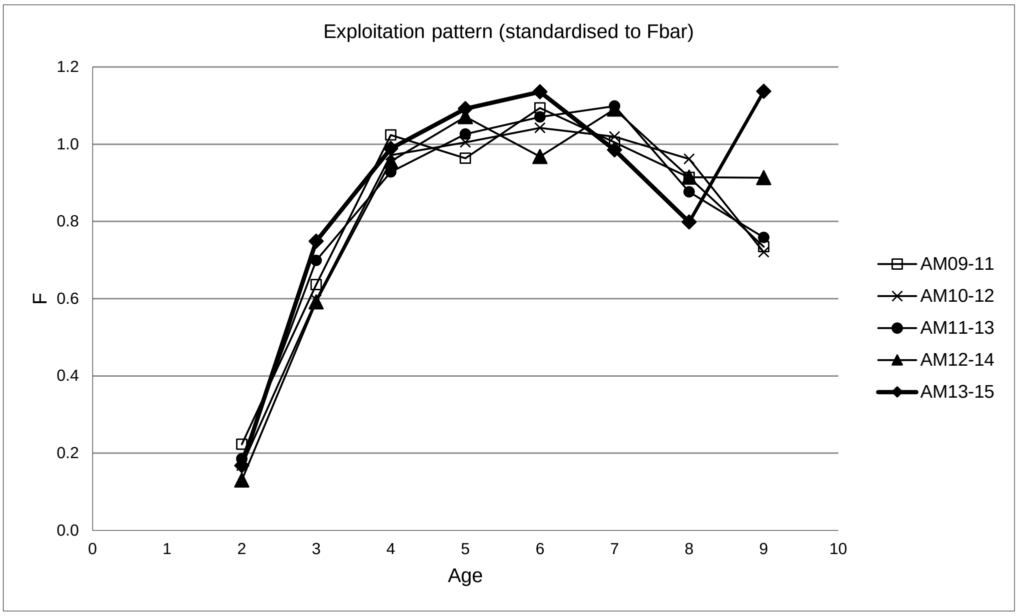


Figure 7.13.16. Sole in 7.f and 7.g. Three year average exploitation pattern, standardised to F_{bar} (4–8).

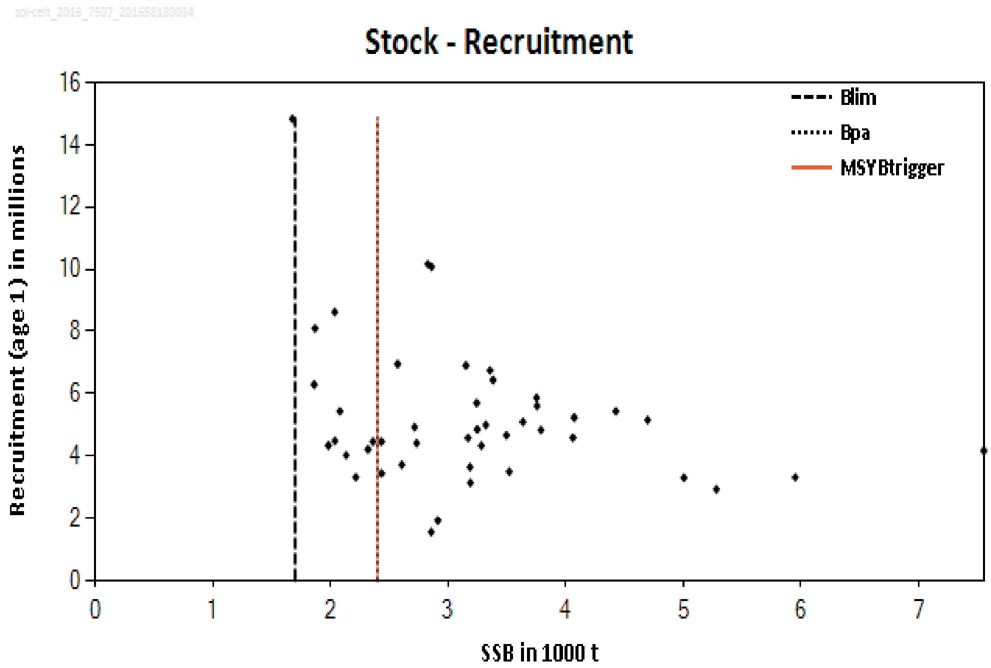


Figure 7.13.17. Sole 7.f and 7.g. Stock–recruitment plot.

7.13.13 Audit of sol-celt

Date: 23/05/2016

Auditor: Jonathan Gillson

7.13.13.1 General

ICES provides annual catch advice for this stock on the basis of the MSY approach. Annual catches have been around the TAC since 2012. A full analytical assessment and forecast were performed in 2016 in accordance with the procedures outlined in the stock annex.

1) Assessment type: Update/SALY. This stock was last benchmarked at WKCELT in 2014. One deviation from the procedures agreed at WKCELT includes truncating the UK commercial beam-trawl (UK(E&W)-CBT) fleet. Tuning information from the UK(E&W)-CBT fleet was truncated to span from 1991 to 2012, which is consistent with the two previous assessments. Lpue estimates for UK(E&W)-CBT fleet were excluded from the assessment after 2012 due to inaccuracies in effort in hours fished arising from changes to the UK effort recording system.
2) Assessment: Age-based analytical assessment using FLXSA with landings included in the model and discards considered in the catch forecast.
3) Forecast: Presented and consistent with the procedures used last year.
4) Assessment model: XSA using commercial landings and indices of abundance from one survey index (UK(E&W)-BTS-Q3) and three commercial tuning indices (BE-CBT, BE-CBT2 and UK(E&W)-CBT).
5) Data issues: Most issues are associated with the commercial fisheries data. A lack of effort in hours fished for the UK(E&W)-CBT fleet has resulted in the truncation of the commercial tuning index, which now spans from 1991 to 2012 in the assessment. Other issues with the commercial fisheries data are associated with the historical landings statistics. Official reported landings included Divisions 7.g–k between 1986 and 1998 but were subsequently corrected to correspond to Divisions 7.f and 7.g from 1999. Area misreporting is known to have taken place from 2002 to 2005 but has been accounted for in the assessment and is now considered to be negligible. Sampling of the commercial fishery is considered reasonable with 97% of the landings covered. In terms of fishery-independent data, only the UK beam-trawl (UK(E&W)-BTS-Q3) survey provides information on the abundance of recruits in the terminal year and the addition of another survey index would improve the accuracy of recruitment estimates in the future.
6) Consistency: The stock assessment settings are consistent with those used last year. This year's assessment slightly downscales estimates of SSB and F compared to last year, with SSB2014 and F2014 revised downwards by 1% and 7% respectively.
7) Stock status: SSB has been above MSY $B_{trigger}$ since 2001 and is forecast to remain at this level under the catch options considered. F has been above F_{MSY} since 2010 and has declined in 2015. Recruitment has been fluctuating around average for most of the time-series, but the 2014 year class is estimated to be the second highest on record. Although management measures have not been entirely effective in reducing fishing mortality to the value giving maximum sustainable yield, SSB has remained above the reference point for long-term sustainability over the past fifteen years.
8) Management Plan: No management plan for this stock.

7.13.13.2 General comments

The document was generally well written and easy to follow.

7.13.13.3 Technical comments

No major errors were identified in the report, tables or figures. Minor editorial and grammatical changes have been made to the report using track changes.

7.13.13.4 Conclusions

The assessment has been performed correctly and provides an appropriate basis for providing catch advice.

7.14 Sole in the Southwest of Ireland (ICES Divisions VIIh–k)

Type of assessment in 2016

An update XSA assessment was performed for the VIIjk component of the landings according to the stock annex. New MSY and PA reference points were explored.

ICES advice applicable to 2015

Based on ICES approach to data-limited stocks, ICES advises that that catches should be no more than 225 t in 2015. All catches are assumed to be landed.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/sol-7h-k.pdf

ICES advice applicable to 2016

ICES advises that when the precautionary approach is applied, catches in 2016 should be no more than 205 tonnes.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/sol-7h-k.pdf

7.14.1 General

Stock description and management units

Sole in VIIj are mainly caught by Irish vessels on sandy grounds off the southwest of Ireland. Catches in VIIk are negligible. VIIh is also considered part of the stock for assessment purposes but there is no evidence to suggest that this is actually the same stock (Figure 7.14.1). Irish VMS and logbook data indicate that the VIIj landings occur close to shore and this species is a small (but valuable) component (up to 5%) of the landings in a mixed fishery.

The TAC is set for Divisions VIIh,j and k. However, because no age-disaggregated data are available for VIIh, the assessment is performed for VIIjk only.

Management applicable to 2015 and 2016

TAC table 2015

Species: Common sole *Solea solea*		Zone: VIIh, VIIj and VIIk (SOL/7HJK.)
Belgium	32	
France	64	
Ireland	171	
The Netherlands	51	
United Kingdom	64	
Union	382	
TAC	382	Analytical TAC Article 11 of this Regulation applies

TAC table 2016

Species: Common sole *Solea solea*		Zone: VIIh, VIIj and VIIk (SOL/7HJK.)
Belgium	32	
France	64	
Ireland	171	
The Netherlands	51	
United Kingdom	64	
Union	382	
TAC	382	Analytical TAC Article 12(1) of this Regulation applies

Article 12(1) refers to the closure of the Porcupine bank in May and July.

Landings obligation

In 2016 the landings obligation will apply to this stock for the first time. According to the delegate regulation (EC, 2015) vessels where more than 5% of their landings using beam trawls were sole during the reference years (2013 & 2014) in ICES Divisions VIIb, VIIc and VIIf–VIIk will be covered by the Landings Obligation. The landings obligation will also apply to all catches of sole with trammelnets or gillnets. These vessels will have to land all sole in 2016. However a *de minimis* exemption will also apply allowing for up to a maximum of 3% of the annual catch to be discarded. Given the low discards observed in the fishery the landings obligation is unlikely to have a significant impact on this stock or the advice given for 2017.

7.14.2 Data

Landings and discards

The nominal landings are given in Table 7.14.1. Historic Belgian landings from VIIj are considered to have been area misreported and have been removed from the total landings. Because age data were only available for Irish landings (which were mainly from VIIjk) the remainder of Section 7.14 concerns VIIjk only.

Table 7.14.2 gives the landings in VIIjk. Generally Ireland has taken around 90% of the landings.

Discarding of sole in VIIjk is not considered to be a problem. In 2014 less than 1% of the catch was discarded and in 2015 there were no observation of sole discards on three observer trips (Figure 7.14.2).

Landings numbers-at-age

Landings numbers-at-age are given in Table 7.14.2 and Figure 7.14.3. Figure 7.14.4 shows a bubble plot of the standardised landings proportions-at-age. The numbers-at-age matrix shows quite good cohort tracking, suggesting that ageing is accurate and that recruitment is variable. Figure 7.14.5 gives the stock weights (which are the same as the landings weights).

Biological

Natural mortality was assumed to be 0.1 for all ages and the proportion mature is assumed to be as follows:

Age 2	Age 3	Age 4	Age 5	Age 6+
0.14	0.45	0.88	0.98	1.00

Surveys and commercial tuning fleets

There is no survey index available for this stock (the Irish IBTS Q4 Groundfish Survey data are too noisy to be used). A commercial tuning index is available which use Irish VMS data linked to logbook landings (see Gerritsen *et al.*, 2011 for details on linking VMS and logbook data). The data were used to identify an area where sole are caught by OTB vessels (Figure 7.14.6). Next the effort and landings of the OTB vessels inside the sole area was estimated. The VMS-based lpue showed similar trends to the lpue of Irish OTB vessels in the whole of VIIj, however by limiting the spatial extent, the index will be less sensitive to changes in the spatial distribution of the fleet. All vessels operating in this area are assumed to be capable of catching sole (which is not the case further offshore).

The age composition of the Irish OTB fleet in VIIj was used for the tuning fleet (Table 7.14.4). Figure 7.14.7 shows the log standardised numbers-at-age in the tuning index by year and cohort. No year effects are obvious, and cohort tracking appears to be reasonably good. Figure 7.14.8 shows the internal consistency regressions for the tuning fleet.

Data quality

Sampling appears to be sufficient to establish catch numbers-at-age. The tuning index is quite short and does, but should be long enough to inform the trends that are not already converged.

7.14.3 Historical stock assessment development

Target category: 3.2.0.

Model used: XSA.

Software used: Lowestoft vpa95.exe and FLR with R version 2.15.3 and packages FLCore 2.5.0; FLEDA 2.5 and FLAssess 2.5.0.

Exploratory assessment

Several exploratory assessments were carried out by means of a separable VPA and XSA. The initial VPA runs explored the year and age range to be used in the separable and the choices of reference age, final F and S. The XSA runs explored the choices of q-age, F-shrinkage and the minimum SE threshold. The results of these are available on the ICES SharePoint site of WGCSE under data for this stock.

Final assessment

The model was applied to catch numbers for ages 2–10+ for the years 1993–2015. The tuning fleet included ages 3–9 for the years 2006–2015.

Model Options:

Option	Setting
Ages catch dep stock size	None
Q plateau	7
Taper	No
F shrinkage SE	1.5
F shrinkage year range	5
F shrinkage age range	5
Fleet SE threshold	0.2
Prior weights	No

The diagnostics of the final XSA assessment are given in Table 7.14.5. Figure 7.14.9 shows the residuals. There are some year effects but the absolute values are small. Because the catch and the tuning fleet have nearly identical age compositions, the year effects result from the lpue estimate of the tuning fleet.

State of the stock

The summary table with a time-series of landings, recruitment, SSB and F is given in Table 7.14.6 and Figure 7.14.10. Note that the summary table in the WGCSE 2015 report was based on the wrong F-bar range and recruitment age (but the summary plot and the data for the advice were correct). Recruitment is variable without a clear trend. The SSB has declined from nearly 800 tonnes around 400 t in 2000–2009 but appears to have recovered to around 600 t in recent years F shows a slowly declining trend and currently appears to be quite low.

7.14.4 MSY evaluation

WKProxy (ICES, 2016a) proposed an F_{MSY} reference point of F = 0.17, based on $F_{0.1}$ from a Thompson–Bell yield-per-recruit analysis of the landings numbers-at-age. This is a data-limited approach (which was in line with the ToRs of WKProxy); however the resulting reference point is not directly comparable with the outputs from the XSA (only the landings data are used in the Thompson–Bell approach). The working group is of the opinion that it would be more appropriate to move the stock to Category 2 next year and to apply the WKMSYREF4 (ICES, 2016b) methodology for estimating reference points (ICES, 2012). (Category 2: stocks with analytical assessments and forecasts that are only treated qualitatively).

An exploratory MSY evaluation following WKMSYREF4 (ICES, 2016b) guidelines is presented here. The stock–recruitment graph (Figure 7.14.11) does not indicate that recruitment is impaired at the lowest observed biomass, therefore B_{lim} was set at B_{loss} = 355 and B_{PA} = 1.4 * B_{lim} = 497. The inflection point of the segmented regression was also set at B_{loss} for the same reason.

The following settings were used (full code available on SharePoint):

```
# SR function
segreg3 <- function(ab, ssb) log(ifelse(ssb >= Blim, ab$a * Blim,
ab$a * ssb))
# eqsim_run settings:
stocksetup <- list(data = stock,
  bio.years = c(2006, 2015),
  bio.const = FALSE,
  sel.years = c(2006, 2015),
  sel.const = FALSE,
  Fscan = seq(0,1,by=0.05),
  Fcv = 0.212,
  Fphi = 0.423,
  Blim = Blim,
  Bpa = Bpa,
  verbose = TRUE,
  extreme.trim=c(0.05,0.95)
  )
```

Where F_{cv} and F_{phi} were the same as those used by WKMSYREF4 for other sole stocks (ICES, 2016b). Figures 7.14.12 and 7.14.13 summarise the MSY evaluation. The analysis resulted in an estimate of F_{MSY} = 0.20 without a $B_{trigger}$ harvest control rule and F_{MSY} = 0.25 with a $B_{trigger}$ = B_{PA} HCR. These values are higher than the F_{MSY} proxy of 0.17 proposed by WKProxy, however the results do not change the perception of the stock relative to any of these F reference points. Note that this is a preliminary analysis and the working group does not propose new reference points for this stock this year.

MSY and Biological reference points

Proxy-reference points were identified by WKProxy (ICES, 2016a), but also note previous paragraph.

FRAMEWORK	REFERENCE POINT	VALUE	TECHNICAL BASIS
MSY approach	MSY $B_{trigger\ proxy}$	-	No proxy identified
	$F_{MSY\ proxy}$	0.17	$F_{0.1}$ (ages 3–6), from age-based yield-per-recruit analysis using catch numbers-at-age

7.14.5 Uncertainties and bias in the assessment and forecast

The assessment is carried out on the VIIjk part of the stock area only.

There is sufficient contrast in the landings-at-age matrix to inform the model. However there may be some data issues between 1999 and 2003 which result in erratic F estimates.

The use of a commercial tuning fleet has the potential to introduce bias if the behaviour or efficiency of the fleet changes. E.g. changes to the gear, vessel power, towing speed, etc. can influence the catch rates. By limiting the index to an area where sole are known to be caught, some of the potential bias due to changes in spatial effort distribution will be avoided. The working group applied a spatial stratification to check that changes in effort distribution within the sole area did not affect the index and this did not appear to be the case. Because the stratified estimate is likely to be less precise, the final tuning index was based on the un-stratified estimate. More sophisticated modelling approaches to standardise the commercial index could be investigated for a future benchmark.

7.14.6 Recommendations for the next benchmark

WGCSE recommend that this stock is upgraded to a Category 2 stock (ICES, 2012) where the previous advice is increased or decrease based on the results of the assessment and forecast for VIIj carried out by WGCSE. The reference points could be defined according to the procedures set out in WKMSYREF4 as is shown in Section 7.14.4. ACOM would need to decide if this requires a benchmark or whether an intersessional review of WGCSE's analysis is sufficient.

7.14.7 Management considerations

Fishing mortality has been slowly declining in the last ten years and SSB has been stable in recent years.

The TAC area includes Division VIIh. However, the landings from Divisions VIIjk are taken in the northeastern part of Division VIIj which is remote from the northern part of Division VIIh, where most of the Division VIIh landings are taken. It is likely that the sole from Division VIIh are part of the Divisions VIIe or VIIfg stocks. No further information on stock structure is likely to become available in the short term.

The catches are taken in a mixed fisheries and should be managed as such. Constraining the landings by TAC will not constrain the catches. Because sole are caught in spatially distinct areas, restricting effort in these areas will be more effective than limiting landings. The catches are taken in a mixed fisheries and should be managed as such. Constraining the landings by TAC will not constrain the catches. The TAC is currently not restrictive, but for some countries the quota appears to have become restrictive.

7.14.8 References

ICES 2012. ICES implementation of advice for data limited stocks in 2012. Report in support of ICES advice. ICES CM 2012/ACOM:68.

ICES. 2016a. Report of the Workshop to consider MSY proxies for stocks in ICES category 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015, ICES Headquarters, Copenhagen. ICES CM 2015/ACOM:61. 183 pp.

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

Table 7.14.1. Sole in Divisions VII h–k (Southwest Ireland). Nominal landings (t), 1993–2014, as officially reported to ICES. Belgian landings from VIIj are considered to have been area-misreported and are not included in the total. * Preliminary data.

	VII h					VII j				VII k			VII h Total	VII jk Total	VII hjk	VIIhjk
Row Labels	BEL	FRA	IRE	NL	UK	BEL	FRA	IRE	UK	FRA	IRE	UK	TOT	TOT	TOT	WG Est
1993		43			206		1	237	8				249	246	495	
1994		42	8		172			176	2				222	178	400	
1995		44	11		186		1	232	6	2			241	241	482	
1996		48	20	70	147		2	162	1		1		285	166	451	443
1997		56	16		111		2	187	1			1	183	191	374	564
1998		65	13	7	109		8	208	2	1			194	219	413	423
1999	5		8	1	96	96		199	1				110	200	310	381
2000		72	8	10	95	8	4	103		2			185	109	294	329
2001	6	86	11		111	7	11	113		2	1		214	127	341	325
2002	85	85	9		124	69	8	120		15	1		303	144	447	430
2003	122	113	23		78	48	20	82					336	102	438	245
2004	155	95	33		79	2	7	78					362	85	447	290
2005	90	86	28		112		7	69			1		316	77	393	326
2006	36	81	14	1	86	0	11	49	1	0	0	0	218	61	279	272
2007	31	69	4	0	91	0	9	73	0	0	1	0	195	83	278	277
2008	10	49	3	0	80	0	8	69	0	0	0	0	142	77	219	225
2009	11	70	0	0	58	0	9	60	0	0	0	0	139	69	208	208
2010	20	73	3	0	51	0	14	68	0	0	0	0	147	82	229	228
2011	10	70	1	0	54	0	23	63	0	1	0	0	135	87	222	237
2012	18	74	2	0	46	0	11	83	0	0	0	0	140	94	234	228
2013	4	69	1	0	47	0	7	84	0	0	0	0	121	91	212	211
2014	42	56	3	0	54	0	5	82	0	0	0	0	155	87	242	243
2015*	40	70	3	0	53	0	4	74	0	0	0	0	166	78	244	248

Table 7.14.2. Landings numbers-at-age for sole in VIIjk.

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1993	32.8	217.9	224.5	76.8	55.7	56.7	31.5	20.6	11.6	11.0	5.5	4.7	4.7	8.2	0.9
1994	23.5	117.3	130.2	68.8	40.8	22.4	19.1	10.9	12.0	13.0	10.7	4.0	3.3	11.0	12.1
1995	0.0	279.2	80.8	174.0	117.1	50.9	14.9	15.3	4.1	22.0	7.7	8.5	2.1	2.2	2.1
1996	12.3	45.9	115.9	80.4	52.7	54.2	31.5	8.1	4.8	5.6	10.0	2.6	5.3	6.3	20.9
1997	39.0	160.9	83.5	109.7	42.6	41.5	37.7	15.7	1.4	0.0	3.9	3.0	3.2	2.2	11.4
1998	23.5	137.2	113.3	58.9	92.7	40.0	43.1	34.4	8.8	5.4	2.8	5.0	2.8	0.0	29.7
1999	34.6	121.2	147.1	126.4	45.2	52.0	20.3	18.7	12.9	1.2	7.1	0.8	0.0	0.8	12.2
2000	36.7	89.0	77.2	38.9	26.9	14.7	19.5	10.0	15.4	7.3	2.8	0.0	1.6	0.0	3.2
2001	61.7	109.5	50.2	46.9	36.0	21.4	20.8	13.7	8.8	3.5	1.9	5.0	2.8	1.6	3.2
2002	8.6	94.2	124.1	44.4	25.6	26.2	10.1	5.6	16.3	5.2	13.9	3.5	3.7	2.2	14.9
2003	1.4	36.5	63.0	87.0	51.8	30.6	12.5	2.7	3.7	6.1	9.3	0.0	1.8	0.6	3.6
2004	6.9	18.0	90.1	46.7	35.5	18.3	13.3	5.7	7.8	1.2	6.8	1.2	4.4	3.4	12.0
2005	9.4	34.1	47.4	64.9	17.2	38.4	20.7	9.4	3.8	4.2	0.0	3.8	4.4	3.2	6.7
2006	12.8	29.1	29.7	27.6	37.7	17.8	15.7	10.8	6.0	3.8	1.3	0.6	1.4	1.3	8.6
2007	1.1	44.0	35.7	30.1	44.4	42.3	20.5	15.9	10.1	4.3	4.2	1.2	3.3	1.1	3.3
2008	1.2	24.7	89.6	42.6	21.5	20.3	25.0	10.5	7.9	4.8	2.8	3.2	2.0	1.4	3.9
2009	0.3	14.8	38.4	76.5	31.4	16.9	16.6	15.9	6.3	6.1	5.5	1.0	0.8	0.0	3.2
2010	5.0	48.5	49.5	54.0	47.3	13.7	8.8	9.1	8.8	6.2	6.7	2.9	3.1	0.2	4.8
2011	0.7	24.9	66.7	47.4	33.6	33.5	13.8	8.6	8.6	7.8	7.1	4.5	2.3	1.0	8.6
2012	0.7	11.4	48.1	70.8	33.6	31.0	26.4	9.8	9.1	6.8	8.2	5.5	3.3	2.6	7.0
2013	0.2	8.8	30.6	69.9	60.9	32.2	17.9	14.2	7.5	4.0	4.4	2.6	2.2	2.4	3.5
2014	1.5	21.5	28.5	38.2	64.2	53.7	21.7	12.1	8.7	4.0	2.9	2.6	1.6	2.1	2.9
2015	2.1	28.7	50.0	27.0	32.2	41.2	31.1	16.9	7.9	7.2	3.4	2.6	1.6	1.7	3.1

Table 7.14.3. Weight-at-age for sole in VIIjk.

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1993	0.154	0.221	0.275	0.342	0.412	0.455	0.511	0.496	0.628	0.567	0.762	0.499	0.505	0.777	1.095
1994	0.143	0.233	0.278	0.346	0.421	0.453	0.514	0.552	0.610	0.632	0.632	0.583	0.660	0.845	0.661
1995	0.141	0.194	0.322	0.362	0.338	0.370	0.493	0.452	0.722	0.579	0.401	0.297	0.836	0.350	0.607
1996	0.138	0.169	0.230	0.307	0.435	0.421	0.505	0.587	0.613	0.712	0.755	0.643	0.765	0.723	0.673
1997	0.133	0.200	0.281	0.334	0.409	0.526	0.618	0.592	0.679	0.679	0.691	0.848	0.889	0.695	0.974
1998	0.136	0.223	0.281	0.357	0.379	0.448	0.515	0.554	0.455	0.647	0.497	0.641	0.659	0.763	0.819
1999	0.152	0.192	0.308	0.345	0.400	0.426	0.461	0.575	0.578	0.657	0.449	0.896	0.592	0.832	0.760
2000	0.180	0.210	0.255	0.396	0.416	0.472	0.503	0.489	0.506	0.452	0.555	0.818	0.525	0.850	0.694
2001	0.164	0.228	0.295	0.337	0.394	0.481	0.548	0.530	0.587	0.795	0.542	0.740	0.967	0.867	0.438
2002	0.203	0.198	0.254	0.305	0.469	0.490	0.473	0.654	0.730	0.721	0.626	0.616	1.150	0.643	0.871
2003	0.168	0.191	0.296	0.323	0.329	0.378	0.371	0.575	0.499	0.548	0.477	0.557	0.446	0.779	0.640
2004	0.094	0.199	0.197	0.293	0.313	0.353	0.287	0.584	0.636	0.499	0.595	0.499	0.845	0.457	0.761
2005	0.131	0.168	0.198	0.249	0.383	0.313	0.340	0.446	0.525	0.468	0.604	0.489	0.393	0.437	0.841
2006	0.160	0.180	0.205	0.257	0.298	0.354	0.354	0.377	0.456	0.377	0.612	0.438	0.568	0.508	0.775
2007	0.154	0.208	0.268	0.282	0.329	0.341	0.378	0.395	0.449	0.376	0.418	0.554	0.494	0.594	0.527
2008	0.144	0.204	0.236	0.278	0.305	0.339	0.339	0.395	0.389	0.445	0.560	0.450	0.512	0.457	0.744
2009	0.123	0.196	0.234	0.265	0.268	0.318	0.386	0.420	0.393	0.417	0.368	0.476	0.828	0.480	0.527
2010	0.177	0.197	0.247	0.304	0.331	0.364	0.371	0.400	0.440	0.427	0.512	0.423	0.541	0.503	0.505
2011	0.186	0.207	0.236	0.260	0.298	0.340	0.420	0.479	0.469	0.523	0.580	0.600	0.597	0.485	0.639
2012	0.191	0.216	0.254	0.294	0.320	0.362	0.404	0.423	0.459	0.483	0.461	0.517	0.584	0.681	0.552
2013	0.141	0.226	0.268	0.302	0.339	0.352	0.404	0.440	0.483	0.483	0.546	0.614	0.477	0.557	0.647
2014	0.130	0.209	0.246	0.282	0.314	0.348	0.354	0.398	0.485	0.479	0.451	0.493	0.438	0.653	0.820
2015	0.152	0.206	0.231	0.284	0.316	0.319	0.330	0.374	0.393	0.455	0.476	0.533	0.404	0.643	0.510

Table 7.14.4. Tuning data. The ages (3–9) and years used in the assessment are in bold.

SOL7JK, WGCSE															
101															
IRL-VMS: nos per 1000 hours															
2006	2015														
1	1	0	1												
2	16														
1	172	390	398	369	506	239	210	145	81	52	18	9	19	17	115	#2006
1	14	591	480	405	597	569	276	214	136	58	56	17	44	14	44	#2007
1	19	412	1495	711	358	339	417	176	131	80	47	54	33	24	65	#2008
1	4	223	578	1150	472	254	249	238	95	92	83	15	12	0	49	#2009
1	64	624	638	695	609	177	113	117	113	79	86	38	39	3	61	#2010
1	10	343	919	654	463	462	191	118	119	107	97	62	32	14	119	#2011
1	9	145	612	901	427	394	335	125	115	86	105	70	42	33	89	#2012
1	4	155	536	1224	1067	563	313	248	131	70	77	45	39	42	62	#2013
1	25	361	477	640	1075	901	363	202	146	66	49	44	26	36	49	#2014
1	45	627	1094	591	703	901	681	369	173	158	75	57	36	37	68	#2015

Table 7.14.5. XSA diagnostics.

FLR XSA Diagnostics 2016-05-01 20:22:58

Cpue data from indices

Catch data for 23 years 1993 to 2015. Ages 2 to 10.

	fleet	first age	last age	first year	last year	alpha	beta
1	IRL-VMS: nos per 1000 hours	3	9	2006	2015	<NA>	<NA>

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 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.5

Minimum standard error for population
estimates derived from each fleet = 0.2

prior weighting not applied

Regression weights

year

age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

year

age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2	0.021	0.003	0.003	0.000	0.007	0.002	0.002	0.000	0.002	0.003
3	0.107	0.083	0.067	0.035	0.071	0.041	0.034	0.032	0.037	0.035

4	0.172	0.167	0.218	0.126	0.141	0.119	0.093	0.109	0.123	0.102
5	0.151	0.236	0.273	0.261	0.235	0.174	0.160	0.170	0.172	0.148
6	0.177	0.342	0.236	0.296	0.228	0.201	0.161	0.181	0.208	0.192
7	0.181	0.274	0.231	0.263	0.182	0.224	0.258	0.205	0.214	0.179
8	0.203	0.292	0.231	0.267	0.190	0.250	0.246	0.208	0.186	0.166
9	0.245	0.290	0.213	0.202	0.205	0.256	0.253	0.182	0.189	0.193
10	0.245	0.290	0.213	0.202	0.205	0.256	0.253	0.182	0.189	0.193

XSA population number (Thousand)

	age								
year	2	3	4	5	6	7	8	9	10
2006	652	301	198	207	244	113	90	52	111
2007	445	578	244	150	161	185	85	66	114
2008	503	402	481	187	108	104	127	58	142
2009	821	454	340	350	129	77	74	92	132
2010	731	742	397	271	244	87	53	52	185
2011	396	657	625	312	194	176	65	40	185
2012	327	358	571	502	237	143	127	46	200
2013	689	295	313	471	387	183	100	90	168
2014	975	623	258	254	359	293	135	74	151
2015	833	880	543	207	193	264	214	101	164

Estimated population abundance at 1st January 2016

	age								
year	2	3	4	5	6	7	8	9	10
2016	0	752	769	444	161	144	200	164	76

Fleet: IRL-VMS: nos per 1000 hours

Log catchability residuals.

	year									
age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
3	0.651	0.403	0.397	-0.355	0.201	-0.290	-0.547	-0.288	-0.188	0.017
4	0.135	0.107	0.591	-0.056	-0.105	-0.206	-0.533	-0.057	0.024	0.101
5	-0.374	0.080	0.441	0.291	0.030	-0.200	-0.363	0.014	-0.017	0.097
6	-0.325	0.335	0.178	0.302	-0.113	-0.171	-0.472	-0.037	0.058	0.245
7	-0.310	0.105	0.148	0.173	-0.348	-0.074	-0.015	0.076	0.080	0.165
8	-0.201	0.167	0.148	0.187	-0.308	0.042	-0.061	0.089	-0.067	0.091
9	-0.008	0.162	0.072	-0.096	-0.230	0.057	-0.030	-0.046	-0.050	0.238

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

	3	4	5	6	7	8	9
Mean_Logq	-0.2897	0.6982	1.0740	1.1878	1.1984	1.1984	1.1984
S.E_Logq	0.2454	0.2454	0.2454	0.2454	0.2454	0.2454	0.2454

Terminal year survivor and F summaries:

,Age 2 Year class =2013

Source

	scaledWts	survivors	yrcls
fshk	1	752	2013

,Age 3 Year class =2012

Source

	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.926	782	2012
fshk	0.074	622	2012

,Age 4 Year class =2011

Source

	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.958	491	2011
fshk	0.042	383	2011

,Age 5 Year class =2010

Source

	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.963	178	2010
fshk	0.037	128	2010

,Age 6 Year class =2009

Source

	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.958	185	2009
fshk	0.042	141	2009

,Age 7 Year class =2008

Source

	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.979	236	2008
fshk	0.021	162	2008

,Age 8 Year class =2007

Source

	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.979	179	2007
fshk	0.021	122	2007

,Age 9 Year class =2006

Source

	scaledWts	survivors	yrcls
IRL-VMS: nos per 1000 hours	0.979	96	2006
fshk	0.021	94	2006

Table 7.14.6. Summary table for sol 7jk. Catch/landings in tonnes (7jk only). Recruitment (age 3) in thousands. SSB in tonnes.

YEAR	CATCH	RECRUIT	FBAR	SSB
1993	246	897	0.369	679
1994	178	546	0.224	775
1995	241	889	0.409	649
1996	166	378	0.266	626
1997	191	570	0.344	606
1998	219	532	0.409	562
1999	200	468	0.587	426
2000	109	442	0.312	369
2001	127	630	0.256	395
2002	144	425	0.256	508
2003	102	556	0.266	395
2004	85	327	0.193	432
2005	77	254	0.177	373
2006	61	301	0.152	355
2007	83	578	0.207	390
2008	77	402	0.199	402
2009	69	454	0.18	398
2010	82	742	0.169	491
2011	87	657	0.134	548
2012	94	358	0.112	616
2013	91	295	0.123	622
2014	87	623	0.135	574
2015	78	880	0.119	597

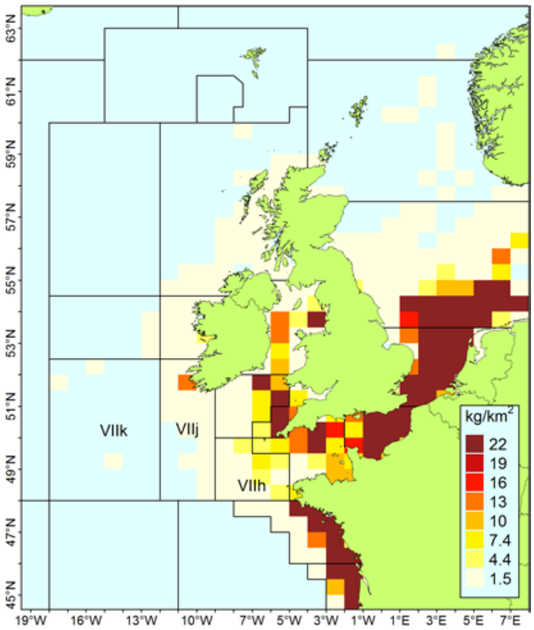


Figure 7.14.1. The spatial distribution of International landings of sole (2012 data, all gears combined; data from STECF).

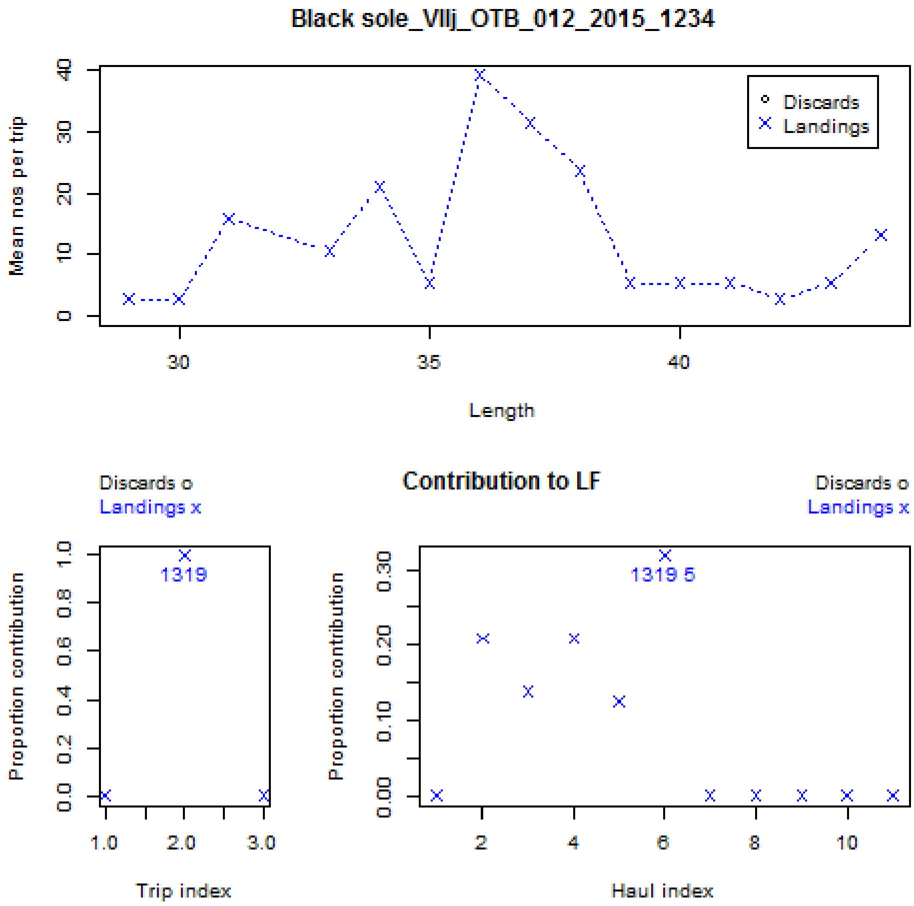


Figure 7.14.2. Irish OTB retained catches on observer trips in 7.j during2015. Numbers raised to fleet level using fishing effort (hours fished). No discards observed during 2015.

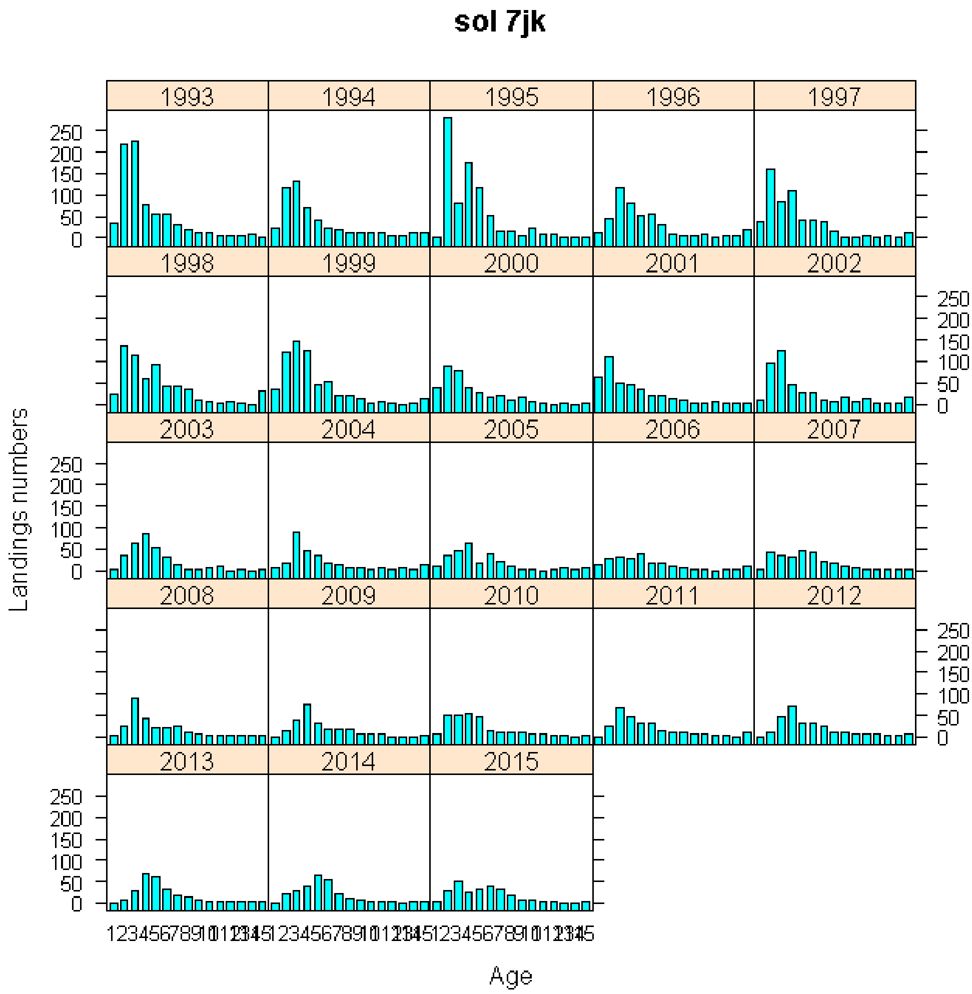


Figure 7.14.3. Age distribution of sole in VIIjk between 1993 and 2015. All gears and quarters combined.

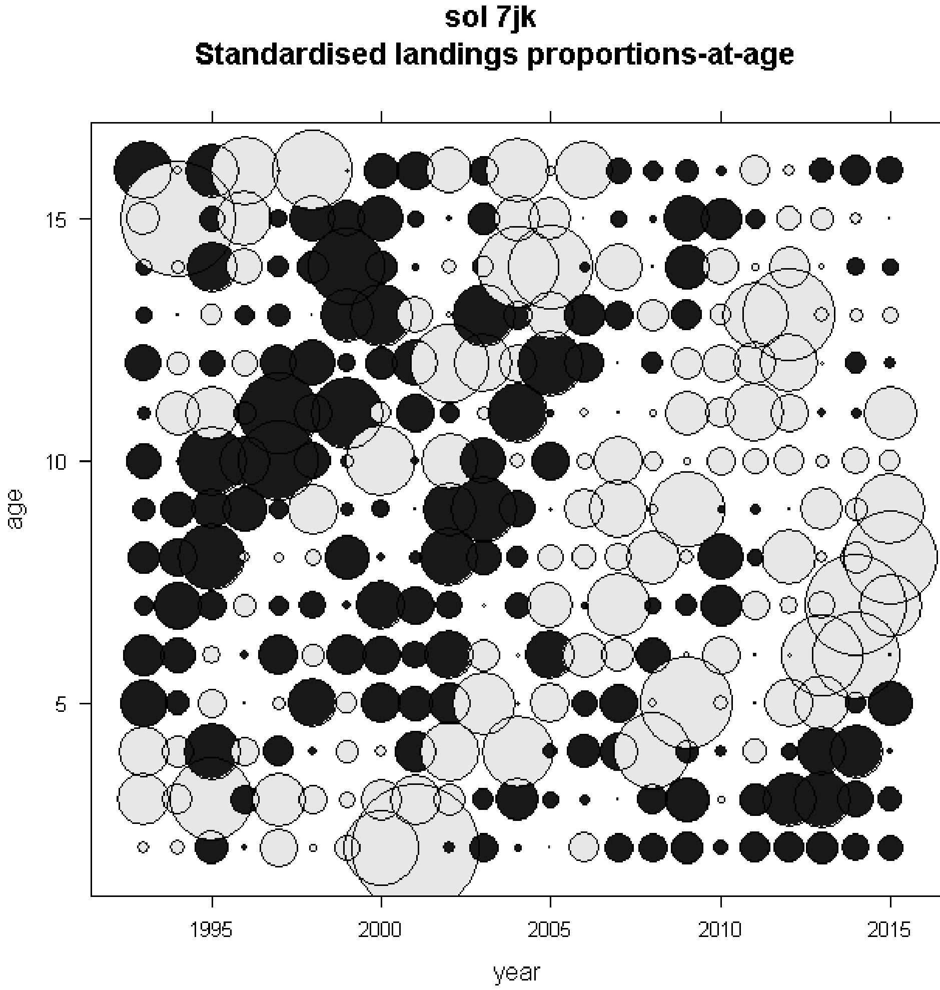


Figure 7.14.4. Standardised catch proportions-at-age for sole in VIIjk. Grey bubbles represent higher than average catch-at-age and black bubbles represent lower than average catch-at-age.

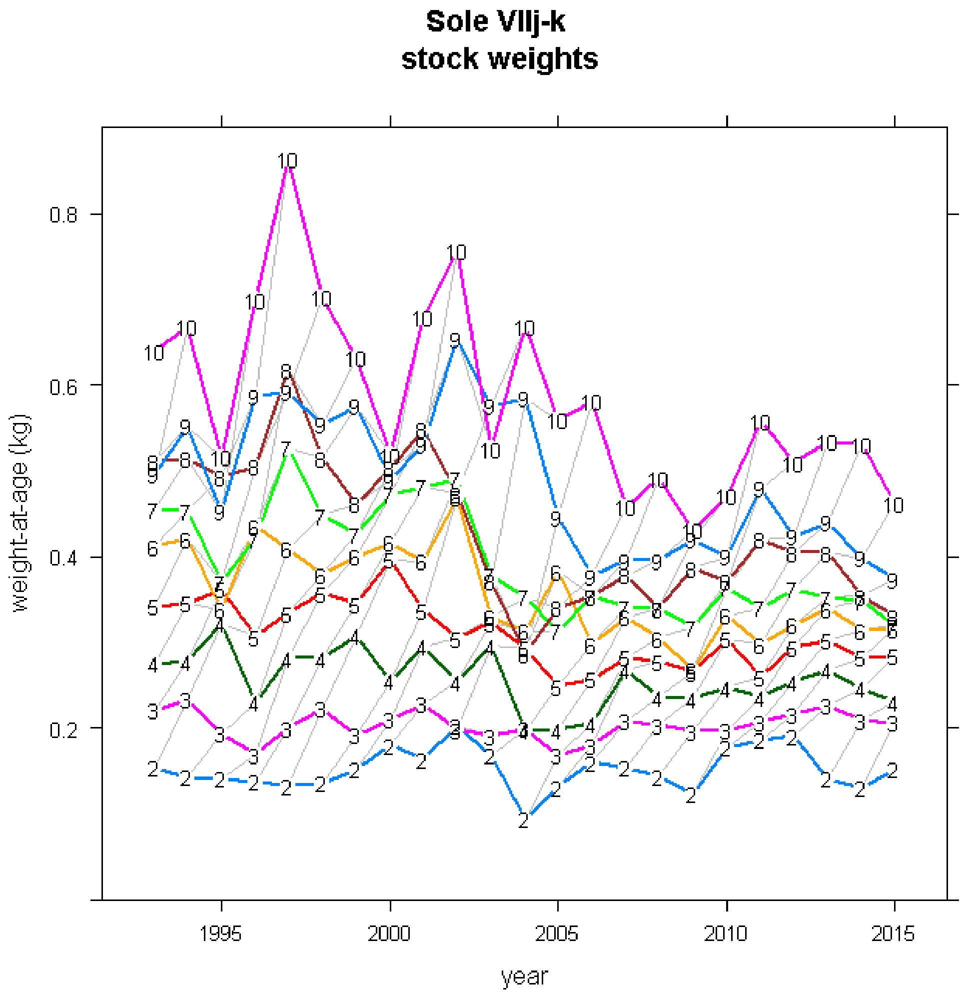
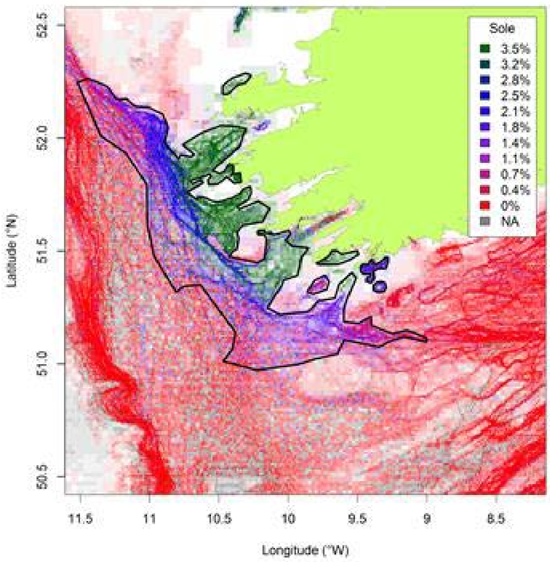


Figure 7.14.5. Catch weights/stock weights of sol7jk.



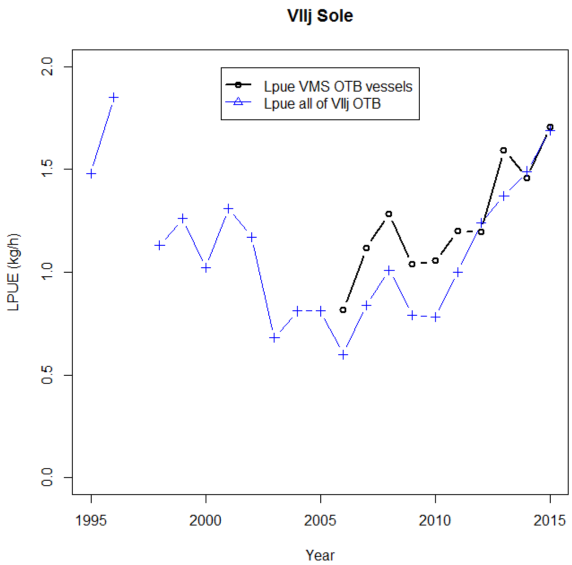


Figure 7.14.6. Top: the proportion of sole in landings of Irish vessels with VMS over the years 2006–2014. The black line indicates the polygon inside which sole are caught. Effort and landings from the VMS/logbooks data inside the polygon were used as a tuning index. Bottom: the VMS lpue index (black line) and the lpue of sole in the whole of VIIj.

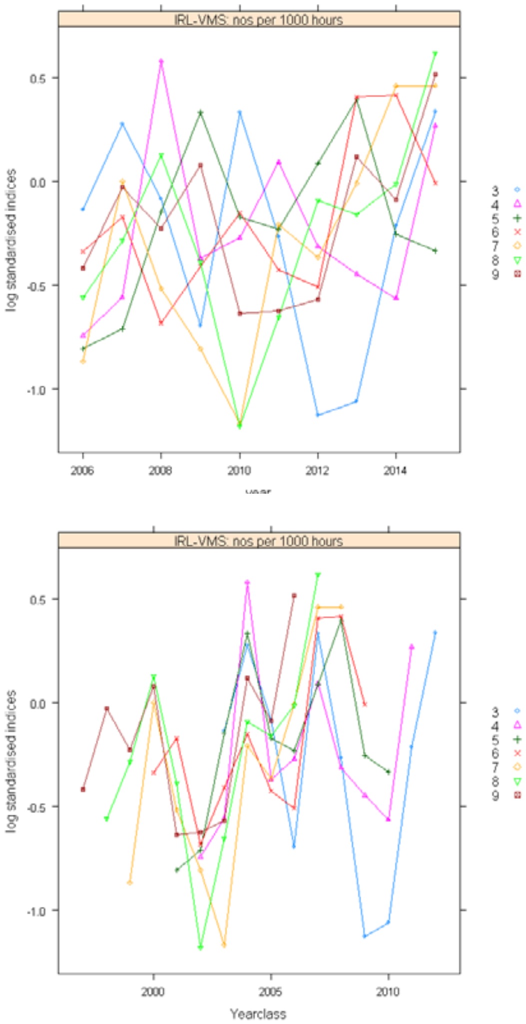


Figure 7.14.7. The log-standardised tuning index by year (top) and cohort (bottom). The cohorts are tracked quite well and no year effects are obvious.

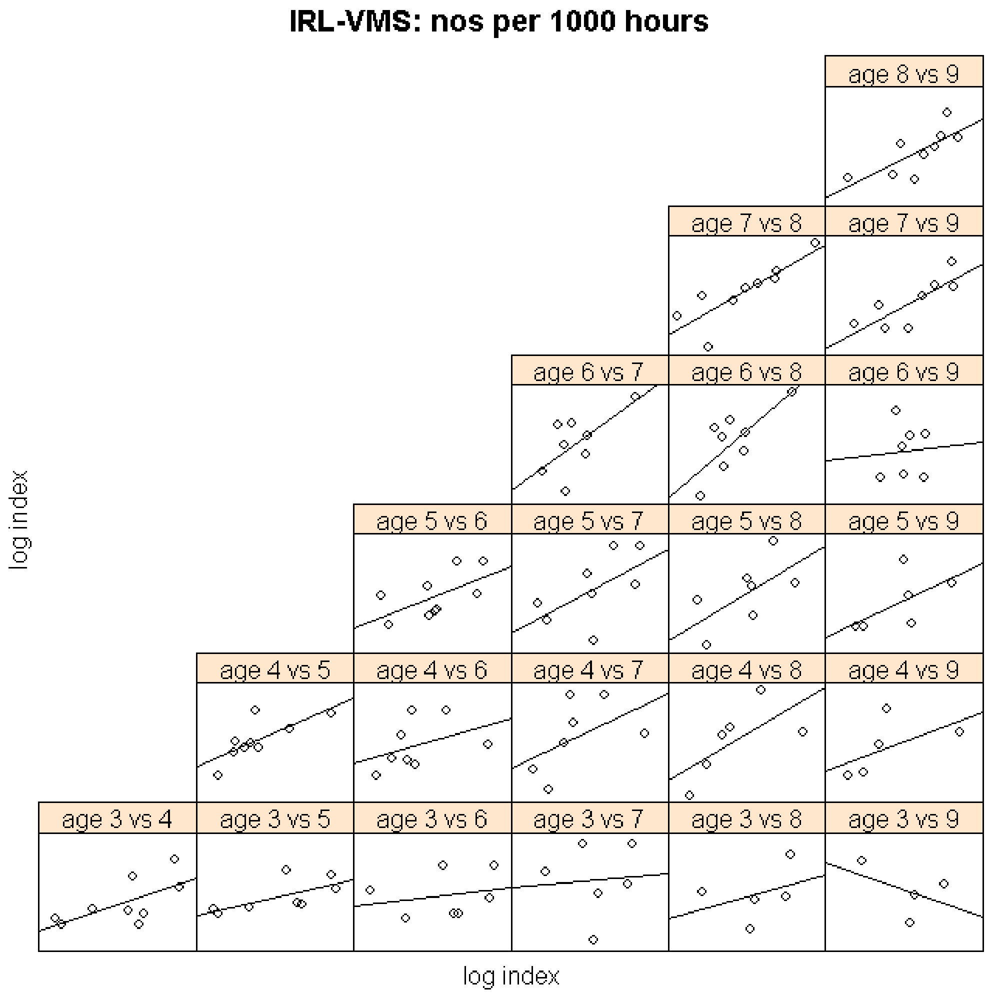


Figure 7.14.8. Internal consistency of the tuning fleet.

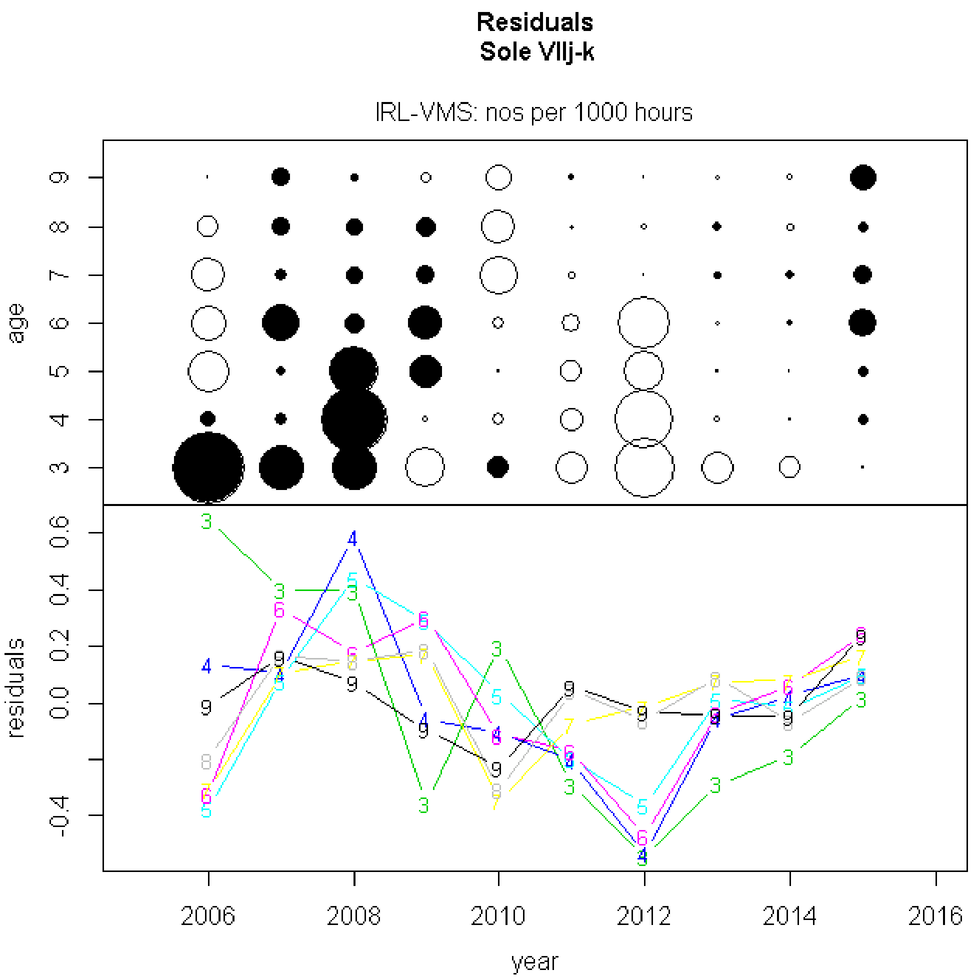


Figure 7.14.9. Residuals of the index fit.

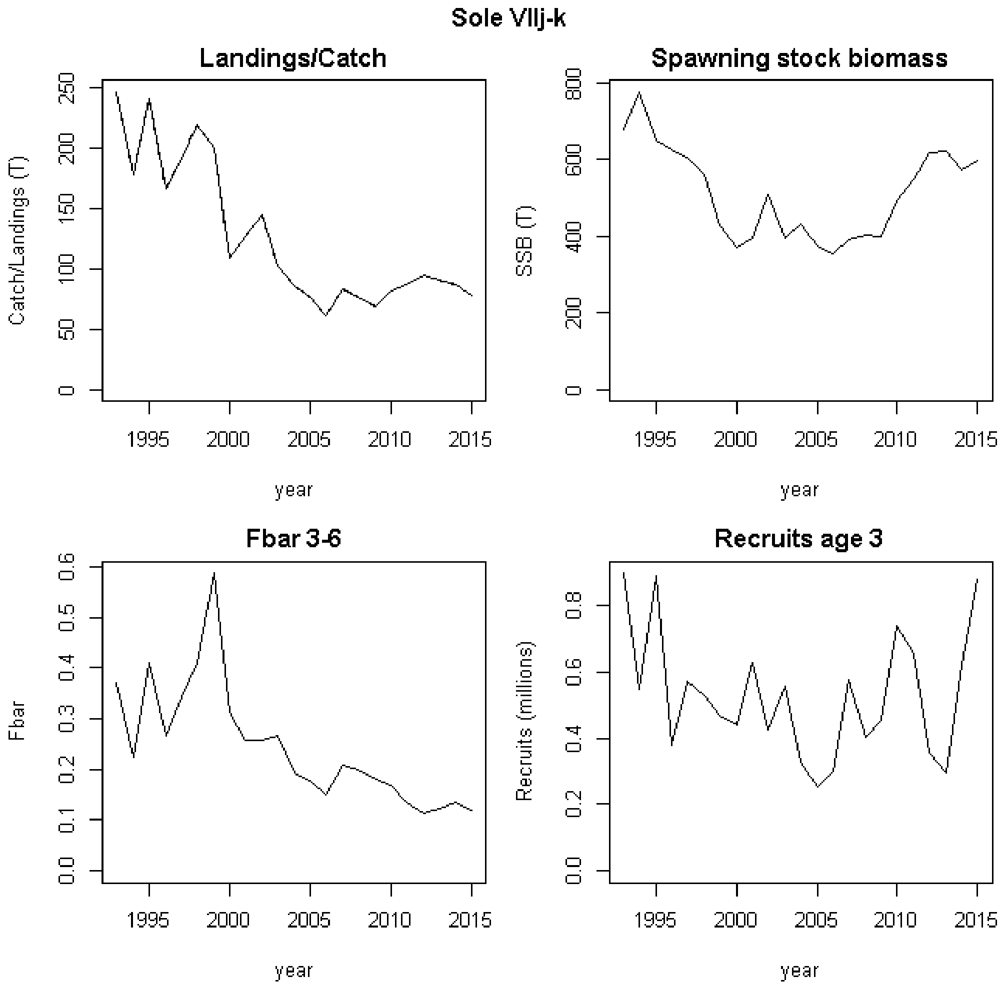


Figure 7.14.10. Stock summary plot.

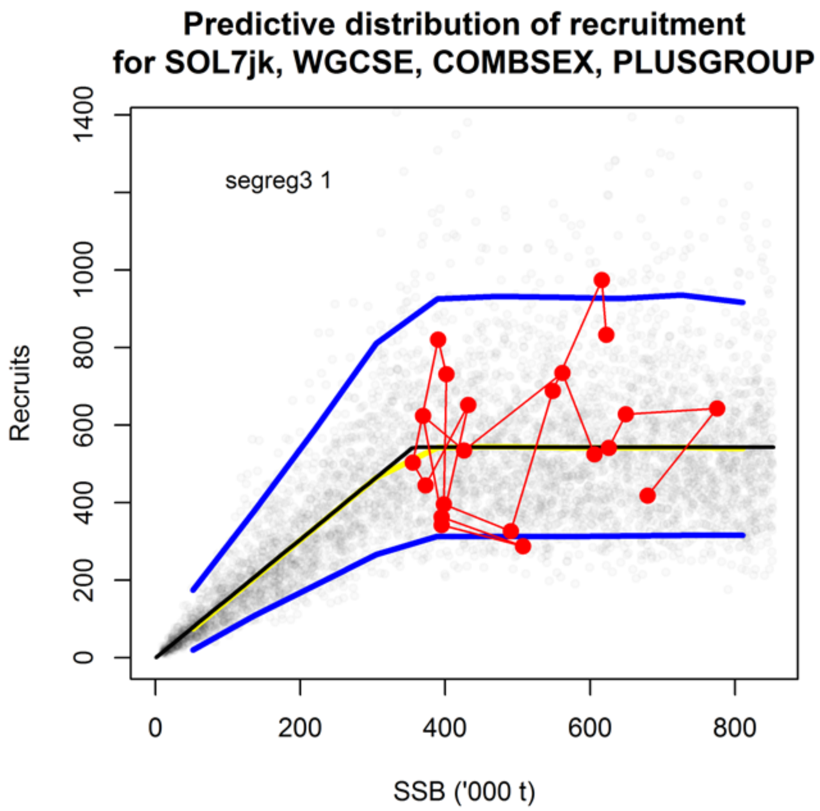


Figure 7.14.11. Sole VIIjk stock–recruit plot. Because recruitment does not appear to be impaired at the lowest stock size, the inflection point of the segmented regression was chosen to be B_{loss}.

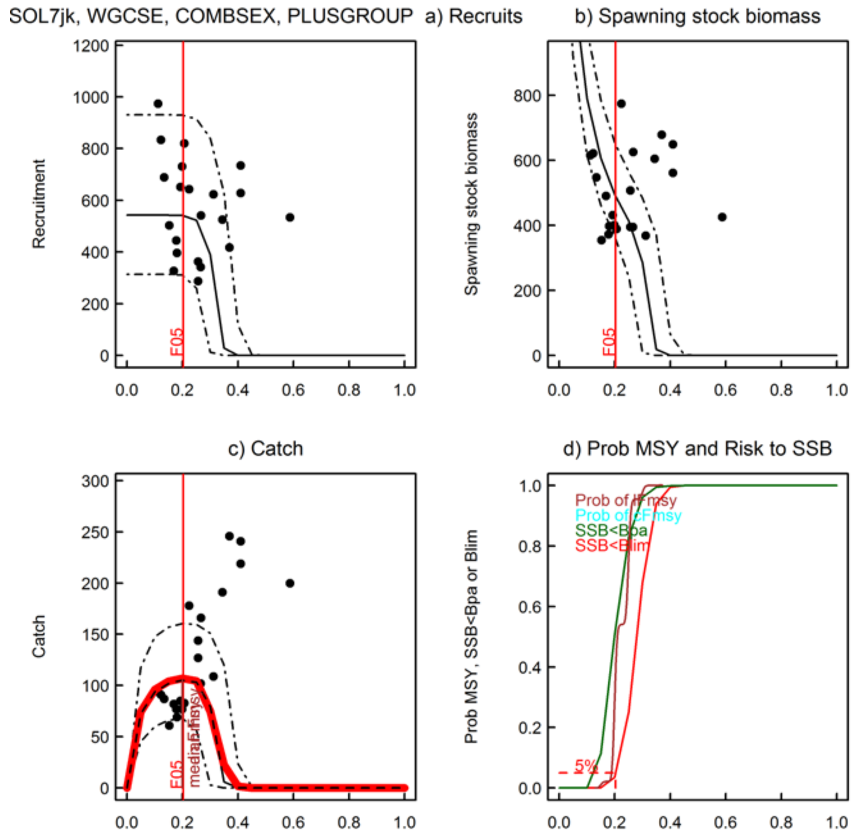


Figure 7.14.12. Sole VIIjk Summary of MSY evaluations (without $B_{trigger}$ harvest control rule), a) simulated and observed recruitment, b)simulated and observed biomass, c) simulated an observed catch and d) Cumulative probability of F_{MSY} and SSB <B_{lim} and B_{pa}.

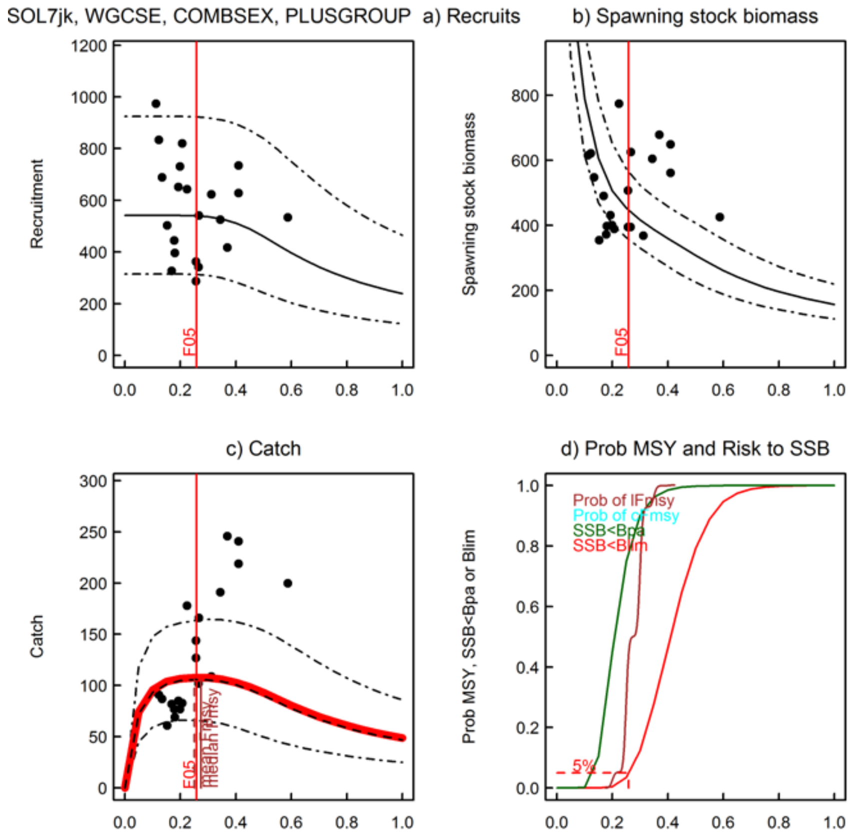


Figure 7.14.13. Sole VIIjk Summary of MSY evaluations (with $B_{trigger}$=B_{loss} harvest control rule), a) simulated and observed recruitment, b)simulated and observed biomass, c) simulated an observed catch and d) Cumulative probability of F_{MSY} and SSB <B_{lim} and B_{pa}.

7.15 Whiting in Division VIIb,c,e–k

Type of assessment in 2016

Full analytical assessment (XSA) and short-term forecast tuned with a single combined survey index according to the stock annex. Since WGCSE 2015 additional national discard data have been made available through InterCatch for data year 2015 incorporated into the current assessment. Biological reference points proposed by WKMSYREF4 (ICES, 2016) have been included also.

ICES advice applicable to 2016

ICES advises based on the MSY approach that catches in 2016 should be no more than 19 076 tonnes. If discards rates do not change from the average of the last three years this implies landings of no more than 15 395 tonnes.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/whg-7e-k.pdf

ICES advice applicable to 2015

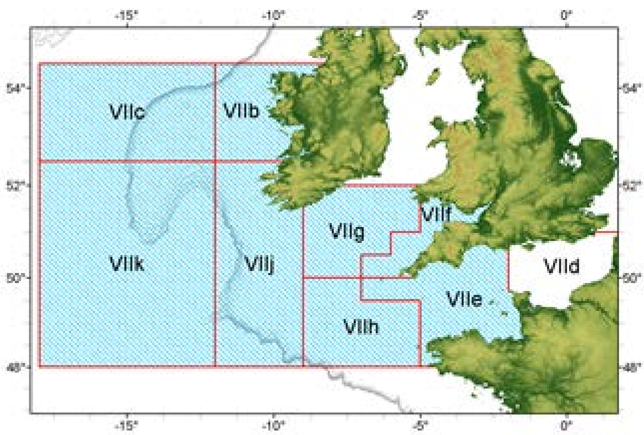
ICES advises based on the MSY approach that catches in 2015 should be no more than 18 501 tonnes. If discards rates do not change from the average of the last three years this implies landings of no more than 14 230 tonnes.

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/whg-7e-k.pdf

7.15.1 General

Stock description and management units

The TAC for whiting is set for Divisions VIIb, VIIc, VIId, VIIe, VIIf, VIIg, VIIh, VIIj and VIIk. The assessment area does not correspond to the TAC area. Whiting in VIIb,c are now assessed as part of VIIbc, e–k, while whiting in VIId are included in the WGNSSK assessment of the North Sea stock. Any management measures implemented for this stock should be consistent with the assessment area.



Red Boxes-TAC/Management Areas Blue Shading-Assessment Area.

The 2016 TAC for whiting VIIb–k has decreased from 24 500 t (2013) to 17 742 t (2015) and increased somewhat again to 22 778 t for 2016. ICES official landings for 2015 in VIIb–k is 17 254 t and therefore the current TAC is close to being restrictive.

TAC in 2015

Species:	Whiting *Merlangius merlangus*	Zone:	VIIb, VIIc, VIId, VIIe, VIIf, VIIg, VIIh, VIIj and VIIk (WHG/7X7A-C)
Belgium	172		
France	10 565		
Ireland	5 029		
The Netherlands	86		
United Kingdom	1 890		
Union	17 742		
TAC	17 742		Analytical TAC Article 11 of this Regulation applies Article 7(3) of this Regulation applies

Landings obligation

In 2016 the landings obligation will apply for this stock for the first time. According to the delegate regulation (EC, 2015) vessels where more than 25% of their landings using trawls and seines in the reference years (2013 & 2014) and area were specified gadoids (Cod, Haddock, Whiting & Saithe) will be covered by the Landings Obligation. This implies that all catches of whiting in the Celtic Sea and Western Channel by those vessels must be landed. However a 7% *de minimus* will also apply, meaning that these vessels can discard up to 7% of the whiting they catch. It is difficult to assess how this might impact of the fishery, the stock, the scientific data and the advice given for 2017 at this stage.

The fishery in 2015

ICES officially reported landings for Divisions VIIbc,e–k and landings as used by the Working Group are given in Table 7.15.1a. Catch for VIIbc,e–k in addition to landings for VIId (excluding discards) is also presented as a guide figure for comparison to the VIIb–k TAC.

The VIIbc,e–k whiting stock is primarily targeted by otter trawlers and to a lesser extent Scottish seines and beam trawls. An overview of landings by fleet is given in Table 7.15.1b and more generally recent effort trends in fleets catching whiting in the Celtic Sea is provided by STECF (STECF, 2015).

The spatial distributions of landings by Irish and UK fleets in 2014 are given in Figure 7.15.1. Irish catches are primarily from within VIIg particularly within 32E2 and 31E3. Landings also emanate, to a lesser extent from VIIj. In previous years French landings have exhibited similar spatial and temporal focus around 31E3. The majority of UK landings are from otter trawlers in VIIe, and focused within 29E5 and 29E6.

7.15.2 Data

Landings

National landings and numbers-at-age data were aggregated in InterCatch for the Area VIIbc,e–k following methodology described in the stock annex.

The allocation schemes below were used:

Discard raising scheme

1) GNS_AllCountries -> GNS_IRL&UK
2) TBB_BEL&UK -> TBB_UK
3) TBB_VIIj_IRL -> TBB_VIIg_IRL
4) SSC&SDN_AllAreas_AllCountries -> SDN_VIIeg_FRA
5) OTB_MIS_VIIbc_AllCountries -> OTB_VIIb_IRL
6) OTB_MIS_VIIjk_AllCountries -> OTB _VIIjk_IRL
7) OTB_MIS_VIIeh_ FRA -> OTB_VIIeg_ FRA
8) OTB_MIS_VIIeh_UKBELNED -> OTB _VIIe_UK
9) OTB_MIS_VIIeh_IRLNISCO -> OTB _VIIg_IRL
10) GTR_VIIeh_FRA -> OTB_VIIgeh_FRA

No	Unsampled	Sampled
1.	GNS_DIS _ALL->	GNS_DIS_ALL
2.	GNS_LAN_ALL ->	GNS_LAN_ALL
3.	SSC&SDN_LAN_ALL->	SSC_LAN_ALL
4.	TBB_DIS _ALL->	TBB_DIS_ALL
5.	TBB_LAN_ALL->	TBB_LAN_ALL
6.	OTB&SSC&Others_DIS_All *->	OTB&Others_DIS_All
7.	OTB&SSC&Others_LAN_All ->	OTB&MIS_LAN_All

Age sampling allocation scheme

The length compositions for 2015 from the main gears are displayed in Table 7.15.2 and Figure 7.15.2. The landings–length distributions are similar for the French and Irish OTB fleet as well as the UK fleet other than Beam Trawlers.

The international catch and landings numbers-at-age are given in Table 7.15.3 and Figure 7.15.3. It is possible to track the very strong 1999 and 2013 year classes in both datasets, but the strong 2009 recruitment is only apparent at some older ages. The age distribution has remained similar over time, with the exception of periods where strong year classes pass through older ages. Older ages (4+) were proportionally higher in the 2015 catch than in most of the preceding time-series. Age group 0 was included in the assessment data to allow inclusion of 0-group indices in the XSA, although landings at this age are not recorded in most years. Mean weights-at-age in the catch and stock (Tables 7.15.4 and 7.15.5) were derived as per methodology described in the stock annex. The stock weights are shown in Figure 7.15.4. There is some variability of stock weights particularly at older ages. Mean weight-at-age appears to have declined during the period of recent high fishing effort and landings between 2005–2008. There is some indication of an increasing trend in weights for ages 6 and 7 since 2008.

Discards

A time-series of discard data for Ireland and France was made available at WKCELT 2014 and is now included in the assessment. Procedures for raising discards to international landings are described above and in the stock annex. However, as more accurate national data become available through InterCatch, these are included in the assessment as an improvement over simply raising Irish and French OTB discards to the international landings to produce a catch time-series.

A summary of discarding rates at-age for 2015 as available in InterCatch is presented in Table 7.15.6. Data on discarding were also available from the UK and Belgium; however the time-series has not been evaluated and is thus omitted from the raising process in the assessment. Discarded whiting length distributions from 2015 for the main fleets is also presented in Figure 7.15.5. The available data suggest that discarding occurs well above the 27 cm MLS with fish being discarded above 40 cm in some fleets. Annual proportions at-age of discard numbers in the catch and also catch numbers in the predicted Stock from the XSA assessment are given in Figure 7.15.6. Data show a recent upward trend in discarding of all ages in the catch and stock.

Biological

Mean stock and catch weights-at-age data were calculated following the methodology described in the stock annex. Natural mortality is based on Lorenzen's model and thus a power function of catch weights-at-age. Maturity is knife-edge at-age 2.

The proportions of F and M before spawning were both set to zero to reflect the SSB calculation date of January 1st.

Surveys

The combined Q4 IBTS survey index for the Irish (IGFS) and French (EVHOE) time-series for ages 0–5 is given in Table 7.15.7. Further details for combining the survey series is given in the stock annex. The internal consistency of the survey tuning fleet was examined using pairwise scatterplots of log numbers-at-age (Figure 7.15.7), bearing in mind that the correlations may be impacted by changes in fishing mortality. Other than 0-grp fish, the index is reasonably consistent for older ages (Ages 1–5).

Cohort and year effects were examined with mean log standardized plots of indices by cohort Figure 7.15.7 and year Figure 7.15.8. The index is quite noisy and shows a number of year affects for some ages.

Commercial lpue

Commercial lpue, from 2000 to 2013, were evaluated at WKCELT 2014 and have been omitted from the assessment due to catchability trends.

7.15.3 Historical stock development

An XSA assessment was carried out for this stock applying the same settings as last year, using a truncated time-series 1999–2015 of combined landings and discards data. The settings previously used were applied again this year and are detailed within the stock annex.

Data screening & Final update assessment

The general methodology is outlined in Section 2. Exploratory analysis was carried out using FLR under R version 3.1.1. The packages FLCore 2.5, and FLXSA 2.5 and FLEDA 2.5 were used.

Catch date range:	Years	1999–2015
	Ages	0–7+
Fbar Age Range:		2–5
Assessment Method:		XSA
Survey Tuning-series:		
IGFS-EVHOE	Yrs	2003–2015
	Ages	0–5
Time taper:		No
Q plateau age:		5
F shrinkage S.E:		1.0
	Num yrs	5
	Num ages	3
Fleet S.E:		0.5

The full XSA diagnostics are given in Table 7.15.8. On the whole the estimates are reasonably consistent for ages 1+ given that whiting are prone to year effects in survey catches.

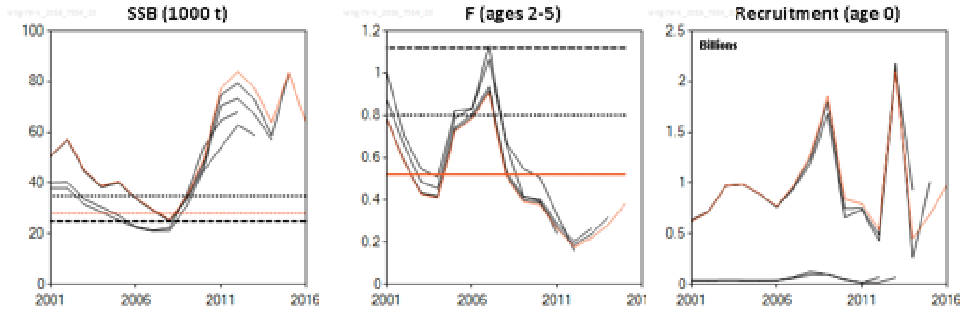
The log-catchability residuals from the XSA fit are plotted for the tuning-series in Figure 7.15.10. The residual patterns for the survey index does not show significant trends. Some year effects however are apparent 2005 and 2011.

The retrospective pattern is shown in Figure 7.15.11. A retrospective bias in F and SSB appears to be developing in this assessment with F being revised down and SSB being revised up. This is something that needs to be closely monitored by the WG.

Estimates of fishing mortality and stock numbers from the final XSA are given in Tables 7.15.9 and 7.15.10. These are summarized in Table 7.15.11 and Figure 7.15.12. The assessment this year reveals a slight increase in fishing mortality and recruitment in 2013 remains the second highest in the time-series.

Comparison with previous assessments

The current assessment is very consistent with last year. SSB in 2015 has been revised by <1% and F in 2014 has been revised down by 12%. Note in last year's WG report and Summary Sheet the final assessment was without a SoP correction. However, as SoP corrected assessment was the basis of the short-term forecast. This inconsistency has been corrected this year which is why the retrospective plot and the quality control plots below are different.



State of the stock

Trends in landings, F(2–5), SSB, and recruitment are presented in Table 7.15.11 and Figure 7.15.13. For the current time-series SSB displays a peak biomass in 2012 following strong recruitment of the 2009 year class and again 2015 following the 2013 recruitment.

Fishing mortality (F_{bar}) has declined since 2007, but is now seen to creep up slowly possibly in response to recent increased SSB. SSB is well within precautionary limits for this stock while F_{bar} is approaching F_{MSY}.

There has been two above average recruitments (2008 and 2009) entering the fishery in recent year prior to the 2013 cohort, estimated to be the second highest in the time-series. Notwithstanding a downward revision of the 2013 year-class F and catch-at-age suggest significant numbers of two year olds in the 2015 fishery.

There is no clear relationship between SSB and recruitment (Figure 7.15.14) nor is there evidence of reduced recruitment at the levels of SSB seen over the time-series.

7.15.4 Short-term projections

The short-term projection settings were as described in the stock annex with the following exceptions. The GM period was 1999–2014 (full time-series minus the last year).

The input values for the catch forecast (using FLR 2.5) are given in Table 7.15.13. The F-at-age values used were calculated as the mean of the XSA values from 2013–2015, unscaled. Catch and stock weights-at-age were also the mean of the period 2013–2015. Stock numbers-at-age in 2015 for ages 0 and older were obtained from the XSA. SSB values are calculated for 1 January.

Table 7.15.12 gives the management option table. Fishing at F_{MSY} = 0.52 in 2017 implies catches of 25.1 kt and landings of 19.8 kt.

The estimated contributions of recent year classes to the predicted catches and SSBs are given in Table 7.15.14 and Figure 7.15.15. The assumptions of $GM_{1999\text{-}2014}$ recruitment for 2017 and 2018 and the XSA estimate of recruitment in 2016 are predicted to contribute <2% to the landings in 2017 and 0% to SSB in 2018.

7.15.5 MSY evaluations and Biological reference points

ICES carried out and evaluation of MSY and PA reference points for this stock last year at WKMSYREF4 (ICES, 2016a). The results have been published earlier this year (ICES, 2016b) are summarized below:

Reference points

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	35 000 t	B_{pa}	ICES, 2016b
	F_{MSY}	0.52	Segmented regression with B_{lim} as the breakpoint Range = 0.32–0.67	ICES, 2016b
Precautionary approach	B_{lim}	25 000 t	B_{loss}, the lowest observed spawning–stock biomass.	2016a
	B_{pa}	35 000 t	B_{lim} X 1.4	ICES, 2016a
	F_{lim}	1.12	Based on segmented regression simulation of recruitment with B_{lim} as the breakpoint	2016a
	F_{pa}	0.80	F_{lim}/1.4	2016a
Management plan	SSB_{MGT}	Undefined		
	F_{MGT}	Undefined		

(Last changed in: 2016).

7.15.6 Management plans

No management plan has been agreed or proposed.

7.15.7 Uncertainties and bias in assessment and forecast

Sampling

Sampling levels of the landed catch for recent years are considered to be sufficient to support current assessment approaches. There has been SOP differences in some recent years particularly that have led to a disparity between the reported catch in tons (landings and discards) going into the assessment and the comparable ∑(CNAA x MWAA) coming out of the assessment. While the overall SOP checks are invariably <1%, any difference in the catches going into the assessment vs those coming out will cause concern. Rather than correct the national data provided therefore a SOP correction is now done within FLR once the initial data QC is complete to ensure corrections are minor and not masking a potential error/bias.

Ageing

Cohort tracking in the landings-at-age matrix appears fairly consistent up to age 6. Tracking deteriorates at older ages.

Discards

Discarding is a major feature of most fisheries catching whiting in the Celtic Sea. Sampling coverage of discarding has improved over time particularly since 2004. Attempts to reconstruct a time-series for the main Irish and French fleets failed to extend further back than 1999. No discard data were available for France prior to 2004 and had to be constructed as proportion-at-age for the recent years where data were available. Sampling levels for either country also did not allow for quarterly age-based reconstruction of the discards so a length-based ogive from Ireland had to be used to reconstruct the data for both countries. Discard estimates for the UK were not available at the benchmark, but are available now through InterCatch and have been included in the assessment.

Selectivity

Square-mesh panels in were introduced in the second half of 2012 to reduce catches and discards of smaller whiting and haddock. The current assessment does not show an obvious reduction in F-at-age since the introduction of this TCM (see Figures 7.15.6 and 7.15.12).

Surveys

The surveys for whiting are prone to year effects. However, cohort tracking for the 1+ fish is quite consistent for the combined tuning index.

Misreporting

The level of misreporting of this stock is not known and underreporting has previously been considered unlikely to have been a significant source of unaccounted mortality of whiting in the assessment because the TAC has been in excess of recent landings.

7.15.8 Recommendation for next benchmark

Overall, WGCSE recommend that cod, haddock and whiting in the Celtic Sea should be benchmarked together in 2018. The focus of the benchmark would be on streamlining data compilation procedures for fishery-dependent and survey data. This we give improved transparency and diagnostics surrounding commercial tuning fleets and surveys. The benchmark should also relook at the assessment methods and diagnostics given the potential for changes in selectivity in the commercial fishery. The benchmark should also investigate mixed fisheries and multi-species interactions as well as environmental drivers that may be impacting on growth and recruitment of all three species.

For whiting specifically:

- Attempts to run a more sophisticated model such as SAM were not concluded during WKCELT and need further evaluation.
- Simplification of the complexity of métiers and the raising process in InterCatch. This is error prone and places a significant onus on the stock coordinator as the last stage in the data raising process in the narrow window before the assessment.
- Mapping of survey indices by age show significant recruitment data available outside the current combined index area which could potentially be utilised to improve the 0-grp estimates.

7.15.9 Management considerations

Catches and SSB in VIIbc,e–k whiting fluctuate considerably depending on year-class strength. The 2008 and 2009 year classes were above average with 2013 being second highest in the time-series. These will be contributing to catches and SSB in the short term but the upturn in catches and SSB is likely to be short lived as recent recruitment is episodic and F appears to be increasing. Information from the French industry (M. Robert, Ifremer, pers. comm.) suggests landings for early 2016 have increased compared to 2015.

Discarding of this stock for different fleets is substantial and highly variable depending on gear and year-class strength. High levels of discarding for a species like whiting reduce the longer term yields one might expect from the stock so efforts to improve selection and reduce discards in the mixed fishery should be encouraged. ICES notes the introduction of square mesh panels in all trawl fisheries operating in ICES Divisions VIIfg. It is important that these measures are fully implemented and their effectiveness in reducing discards and the impact on commercial catches is monitored and evaluated. Further gear modifications to increase the likelihood of small whiting passing through the gear, such as introduction of larger minimum mesh sizes, separator panels, or grids may be needed.

Whiting are caught in directed gadoid trips and as part of mixed fisheries throughout the Celtic Sea, as well as bycatch within *Nephrops* fisheries. Discard rates are high as a consequence of the low market value of the species, particularly at smaller sizes. High-grading above the MLS to some extent is also prevalent in most fisheries.

From the 1 February to the 31 March fishing activity has been prohibited within ICES rectangles: 30E4, 31E4, 32E3 (excluding within six nautical miles from the baseline) annually since 2005 to protect the cod stock.

There have been major changes in fleet dynamics over the period of the assessment. Effort in the French gadoid fleet has been declining since 1999, but the effort has fluctuated in recent years due to the way the effort series is derived. Irish otter-trawl effort in VIIb–k has been declined slightly over the time-series.

7.15.10 References

EC. 2015. Commission Delegated Regulation (EU) 2015/2438 of 12 October 2015 establishing a discard plan for certain demersal fisheries in north-western waters.

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

ICES. 2016b. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES Subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

7.15.11 Tables

Table 7.15.1.a Whiting in Divisions VIIbc,e–k. Nominal Landings (t) as reported to ICES, and total landings as used by the Working Group.

	Official ICES Landings						Used by WG				VIIbc,e–k Catch +	
Year	BEL	FRA	IRL	UK_EW	Others	Total	Unallocated	WG Total	Dicards	Catch	VIId Landings	TAC
1998	479	11748	5549	1755	179	19710	-	-	-	-		
1999b	448	16418	6013	1354	27	24260	4082	20178	5420	25598	31401	
2000	194	9184	5358	1255	39	16030	385	15645	4400	20045	26117	
2001	171	7317	5365	948	31	13832	640	13192	9877	23070	29684	
2002	149	7546	5718	847	35	14295	655	13640	7336	20977	26338	
2003	129	5989	4516	763	21	11418	321	11097	3559	14656	21661	
2004	180	4870	4350	587	132	10119	-70	10189	6481	16670	21953	
2005	218	5886	5774	482	136	12496	285	12211	6700	18911	23812	
2006	128	4711	4570	413	129	9951	291	9660	12031	21691	25440	
2007	127	3575	4864	575	87	9228	141	9087	8456	17543	20934	19900
2008	122	3072	2406	618	36	6254	394	5860	2880	8740	11933	19900
2009	87	2815	2798	828	25	6553	40	6513	4101	10614	17183	16950
2010	101	3464	4331	792	93	8781	193	8588	3008	11596	17729	14407
2011	100	4311	4752	739	174	10076	592	9484	1954	11438	16902	16658
2012	170	3709	5842	763	142	10626	438	10188	2449	12637	16234	19053
2013	226	4007	6887	906	92	12118	187	11931	2512	14443	18700	24500
2014	222	4927	6873	1057	38	13117	158	12847	3895	16742	19954	19162
2015[a]	152	5640	6437	819	97	13145	298	12847	3895	16742	19954	17742

[a]**Provisional data.**

Table 7.15.1.b Whiting in Divisions VIIbc,e–k. Landings (t) by fleet.

Fleet	BEL	FRA	IRL	UK	Others	Total	%
OTB	25	5202	4132	359	3	9720	74%
SSC	7	97	2042	0	156	2300	17%
TBB	123	0	24	66	0	212	2%
Other	0	449	272	176	44	941	7%
	155	5748	6469	601	202	13174	100%

Table 7.15.2. Whiting in Divisions VIIb,c,e–k. Length distributions for Landings (Land) and Discards (Disc) for 2015 by country and main fleet (Numbers in '000s). UK is sample Nos raised by Sample Wt/Catch Wt.

	FRA	FRA	FRA	FRA	UK (E+W)	UK (E+W)	UK (E+W)	UK (E+W)	IRL	IRL	IRL	IRL
Labels	Land OTB	Disc OTB	Land Other	Disc Other	Land TBB	Disc TBB	Land Other	Disc Other	Land OTB	Disc OTB	Land Other	Disc Other
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	1	0	0	0	0	0	0
11	0	1	0	0	0	0	0	1	0	0	0	0
12	0	6	0	0	0	0	0	0	0	0	0	0
13	0	7	0	0	0	0	0	0	0	0	0	0
14	0	30	0	0	0	0	0	2	0	0	0	0
15	0	27	0	0	0	0	0	1	0	0	0	0
16	0	24	0	0	0	0	0	2	0	0	0	0
17	0	21	0	0	0	1	0	0	0	0	0	0
18	0	21	0	0	0	2	0	0	0	0	0	0
19	0	28	0	0	0	3	0	1	0	0	0	0
20	0	49	0	0	0	3	0	0	0	0	0	0
21	3	24	0	0	0	11	0	6	0	1	0	0
22	0	28	0	0	0	11	0	12	0	0	0	1
23	0	30	0	0	0	9	0	42	0	0	0	1
24	54	90	0	1	0	12	0	55	0	0	0	2
25	8	76	0	2	0	23	0	98	0	0	0	3
26	25	299	0	1	0	18	1	152	0	2	0	10
27	69	431	0	9	0	17	6	159	0	3	0	16
28	221	723	0	13	0	20	14	176	40	11	0	34
29	205	615	0	23	2	17	35	212	544	5	0	43
30	469	560	0	25	5	23	55	202	1701	14	0	45
31	606	479	2	31	9	13	96	192	2528	12	0	40
32	702	228	7	35	10	22	118	134	5541	5	0	47
33	854	64	11	28	13	16	142	68	6599	4	0	39
34	752	86	17	24	12	10	127	24	6937	1	0	24
35	603	75	19	19	12	8	123	21	4508	0	0	20
36	758	53	25	12	9	4	123	20	4588	0	0	19
37	800	30	26	2	10	3	104	10	5204	0	9	8
38	762	17	35	0	9	4	78	14	2670	0	0	8
39	585	3	32	0	8	2	55	1	2655	0	0	3
40	432	4	35	0	8	2	52	6	709	0	9	7
41	366	0	24	0	8	1	36	2	754	0	0	3
42	301	1	28	0	3	0	30	2	465	0	0	3
43	244	0	24	1	2	0	27	2	279	0	0	2
44	277	0	23	0	3	0	16	1	186	0	0	1

	FRA	FRA	FRA	FRA	UK (E+W)	UK (E+W)	UK (E+W)	UK (E+W)	IRL	IRL	IRL	IRL
Labels	**Land OTB**	**Disc OTB**	**Land Other**	**Disc Other**	**Land TBB**	**Disc TBB**	**Land Other**	**Disc Other**	**Land OTB**	**Disc OTB**	**Land Other**	**Disc Other**
45	150	0	22	0	2	0	10	0	168	0	9	1
46	175	1	20	0	3	0	8	0	5	0	9	2
47	119	0	17	0	1	0	7	1	2	0	0	0
48	94	0	11	2	2	0	4	0	2	0	2	0
49	58	0	11	0	2	0	7	0	2	0	0	0
50	62	0	7	0	2	0	5	0	3	0	2	0
51	76	0	8	0	2	0	7	2	2	0	15	0
52	30	0	6	0	0	0	3	0	1	0	2	0
53	26	0	4	0	0	0	2	0	1	0	11	0
54	32	0	4	0	2	0	1	1	2	0	9	0
55	16	0	4	0	0	0	2	0	1	0	13	1
56	25	0	2	0	0	0	2	0	1	0	2	0
57	31	0	2	0	0	0	1	0	0	0	9	0
58	13	0	4	0	0	0	2	0	0	0	2	0
59	8	0	1	0	0	0	0	0	0	0	2	0
60	6	0	1	0	0	0	1	0	0	0	0	0
61	4	0	1	0	0	0	1	0	0	0	0	0
62	3	0	0	0	0	0	0	0	0	0	0	0
63	1	0	1	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0
65	1	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0

Table 7.15.3. Whiting in Divisions VIIbc,e–k. The strong 1999 year class is distinct in both the catch and landings data, with some evidence of the strong 2009 year class appearing at older ages. Catch numbers-at-age ('000).

CATCH							
1999	2015						
0	7						
5370	20744	25958	14662	8745	8988	6670	1499
8176	26562	26304	12530	6122	2606	2101	2424
8795	26106	51391	13715	5317	2049	763	627
4569	13387	34320	24357	5968	1058	292	111
3687	12213	11836	10634	12778	1641	228	58
2474	27330	15052	6542	7242	6212	573	81
1421	10663	32482	12582	5080	4820	3718	155
5114	29760	44102	10995	4217	1750	1182	579
1017	14792	36137	12259	5297	1407	345	326
1650	8271	13274	6374	3291	859	215	68
538	8046	20840	7931	2654	770	192	202
348	4005	12591	10430	4761	1201	261	101
737	4691	8227	8281	5464	1738	355	84
156	5399	6662	10006	5578	1726	505	116
739	1076	6880	7160	10810	4379	938	217
159	13119	5728	7237	6301	7941	2033	353
262	4167	25420	8601	7555	2620	4344	805

LANDINGS							
1999	2015						
0	7						
0	3939	10140	12589	8598	8988	6670	1499
4	3177	9989	10774	6030	2606	2101	2424
0	298	11794	11628	5251	2049	763	627
7	926	6035	20342	5877	1058	292	111
0	306	3246	8574	12482	1641	228	58
40	1310	4358	5703	7214	6212	573	81
1	725	5991	8259	4969	4820	3718	155
0	868	6238	8187	3880	1750	1182	579
0	782	5142	8761	5249	1407	345	326
3	662	3555	5236	3273	859	215	68
0	463	4562	6267	2641	770	192	202
0	400	3571	7714	4293	1201	261	101
0	297	3215	6619	5316	1738	355	84
0	91	1192	7728	5277	1726	505	116
0	242	1713	3636	9300	3916	897	208
0	1664	1722	4551	4918	6830	1681	312
0	257	5836	3866	5309	2489	2887	803

Table 7.15.4. Whiting in Divisions VIIbc,e–k. Catch weights-at-age (kg).

	Age							
	0	1	2	3	4	5	6	7+
1999	0.027	0.133	0.222	0.341	0.427	0.440	0.496	0.623
2000	0.031	0.069	0.220	0.396	0.505	0.563	0.580	0.587
2001	0.032	0.112	0.185	0.378	0.529	0.633	0.760	0.777
2002	0.027	0.097	0.197	0.351	0.532	0.707	0.825	1.013
2003	0.029	0.094	0.211	0.360	0.452	0.629	0.831	1.087
2004	0.040	0.155	0.227	0.361	0.432	0.491	0.537	0.785
2005	0.020	0.105	0.195	0.361	0.501	0.504	0.487	0.674
2006	0.033	0.124	0.210	0.385	0.538	0.588	0.544	0.675
2007	0.042	0.121	0.201	0.364	0.497	0.642	0.609	0.638
2008	0.028	0.109	0.214	0.386	0.524	0.626	0.780	0.830
2009	0.026	0.117	0.206	0.395	0.549	0.653	0.689	0.951
2010	0.034	0.119	0.228	0.420	0.560	0.679	0.815	0.836
2011	0.024	0.126	0.239	0.444	0.613	0.811	0.954	1.211
2012	0.039	0.096	0.225	0.461	0.649	0.808	0.967	1.088
2013	0.053	0.130	0.209	0.358	0.600	0.704	0.915	0.864
2014	0.038	0.142	0.254	0.397	0.554	0.662	0.759	1.007
2015	0.018	0.102	0.220	0.375	0.573	0.778	0.671	0.929

Table 7.15.5. Whiting in Divisions VIIbc,e–k. Q1 Stock weights-at-age (kg) from Rivard corrected annual mean catch weights.

	AGE							
	0	1	2	3	4	5	6	7+
1999	0.0169	0.1034	0.1662	0.2802	0.3719	0.3832	0.4672	0.6230
2000	0.0163	0.0432	0.1711	0.2965	0.4150	0.4903	0.5052	0.5870
2001	0.0184	0.0589	0.1130	0.2884	0.4577	0.5654	0.6541	0.7770
2002	0.0145	0.0557	0.1485	0.2548	0.4484	0.6116	0.7227	1.0130
2003	0.0125	0.0504	0.1431	0.2663	0.3983	0.5785	0.7665	1.0870
2004	0.0247	0.0670	0.1461	0.2760	0.3944	0.4711	0.5812	0.7850
2005	0.0080	0.0648	0.1739	0.2863	0.4253	0.4666	0.4890	0.6740
2006	0.0172	0.0498	0.1485	0.2740	0.4407	0.5428	0.5236	0.6750
2007	0.0261	0.0632	0.1579	0.2765	0.4374	0.5877	0.5984	0.6380
2008	0.0137	0.0677	0.1609	0.2785	0.4367	0.5578	0.7076	0.8300
2009	0.0122	0.0572	0.1498	0.2907	0.4603	0.5850	0.6567	0.9510
2010	0.0177	0.0556	0.1633	0.2941	0.4703	0.6105	0.7295	0.8360
2011	0.0120	0.0655	0.1686	0.3182	0.5074	0.6739	0.8048	1.2110
2012	0.0214	0.0480	0.1684	0.3319	0.5368	0.7038	0.8856	1.0880
2013	0.0324	0.0712	0.1416	0.2838	0.5259	0.6759	0.8598	0.8640
2014	0.0232	0.0868	0.1817	0.2881	0.4453	0.6302	0.7310	1.0070
2015	0.0052	0.0623	0.1767	0.3086	0.4769	0.6565	0.6665	0.9290

Table 7.15.6. Whiting in Divisions VIIe–k. Summary of landings and discard data in 2015 provided to the Working Group.

WEIGHT IN TONNES										
Discards	**Country**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7+**	**Grand Total**
	Belgium	0	6	69	29	12	7	12	0	135
	France	1	105	980	316	171	15	145	1	1734
	Ireland	3	198	1925	711	364	31	305	0	3538
	UK (England)	0	42	420	51	18	10	18	0	560
	Other	0	8	76	24	13	1	11	0	134
	Total	5	359	3470	1131	578	64	492	2	6101
Landings	Belgium	0	1	40	28	28	26	26	5	155
	France	0	30	888	911	1662	862	1069	327	5748
	Ireland	0	23	832	1055	1960	975	1232	392	6469
	UK (England)	0	11	334	72	40	79	57	9	601
	Other	0	1	27	32	58	31	40	8	196
	Total	0	65	2120	2098	3748	1973	2423	740	13168
Number in 000's										
Discards	Country	0	1	2	3	4	5	6	7	Grand Total
	Belgium	3	47	351	103	43	12	33	0	593
	France	75	1119	5509	1325	633	30	407	1	9098
	Ireland	152	2313	10880	3002	1457	62	943	0	18810
	UK (England)	26	343	2416	203	64	25	42	1	3120
	Other	6	87	428	103	49	2	31	0	706
	Total	262	3910	19584	4735	2246	131	1457	2	32328
Landings	Belgium	0	2	106	55	44	39	32	7	287
	France	0	111	2424	1669	2328	1069	1255	349	9206
	Ireland	0	94	2250	1925	2791	1214	1481	419	10174

WEIGHT IN TONNES

Discards	Country	0	1	2	3	4	5	6	7+	Grand Total
	UK (England)	0	46	976	160	67	130	73	13	1465
	Other	0	3	80	56	79	37	46	13	314
	Total	0	1664	1722	4551	4918	6830	1681	294	21446

Table 7.15.7. Whiting in Divisions VIIbc,e–k. Combined survey abundance indices of age groups 0–5.

IGFSEVHOE No/Hr

	Age					
	0	1	2	3	4	5
2003	207.826	201.071	73.602	26.557	13.911	0.658
2004	698.971	186.364	79.658	19.396	7.531	5.387
2005	195.372	89.180	21.949	7.791	3.758	5.495
2006	459.365	144.858	70.157	14.538	6.327	1.488
2007	895.572	126.044	31.128	8.434	1.512	0.689
2008	536.870	199.458	62.553	11.364	3.787	1.175
2009	755.508	267.503	52.211	12.282	2.666	1.082
2010	108.815	282.721	120.372	26.990	4.408	1.341
2011	432.351	205.258	208.778	71.683	14.117	3.000
2012	261.964	147.137	88.250	77.797	10.675	2.054
2013	1229.544	90.559	64.323	20.139	27.930	8.694
2014	112.842	314.208	38.057	19.858	9.104	12.720
2015	273.468	97.528	144.185	11.552	6.130	7.197

Table 7.15.8. Whiting in Divisions VIIbc,e–k. XSA Diagnostics.

Run 1

FLR XSA Diagnostics 2016-05-11 10:25:12

Cpue data from indices

Catch data for 17 years 1999 to 2015. Ages 0 to 7.

	fleet	first age	last age	first year	last year	alpha	beta
1	IGFSEVHOENo/Hr	0	5	2003	2015	<NA>	<NA>

Time-series weights:

Tapered time weighting not applied

Catchability analysis:

Catchability independent of size for all ages

Catchability independent of age for ages >5

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 = 0.5

prior weighting not applied

Regression weights

age \ year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.190	0.105	0.045	0.033	0.011	0.029	0.036	0.010	0.033	0.049
2	0.743	0.776	0.238	0.283	0.119	0.051	0.094	0.105	0.127	0.150
3	0.620	0.786	0.459	0.336	0.344	0.160	0.120	0.210	0.231	0.447
4	0.806	1.075	0.715	0.487	0.481	0.419	0.206	0.247	0.396	0.565
5	0.966	0.984	0.642	0.462	0.562	0.417	0.286	0.318	0.374	0.365
6	0.643	0.642	0.474	0.354	0.348	0.400	0.251	0.309	0.296	0.457
7	0.643	0.642	0.474	0.354	0.348	0.400	0.251	0.309	0.296	0.457

XSA population number (Thousand)

year	0	1	2	3	4	5	6	7
2006	771349	264674	116427	30557	9449	3453	3014	1440
2007	979773	227726	92641	28915	9971	2745	881	810
2008	1283028	289259	86743	22253	7991	2214	688	215
2009	1854508	378789	117023	35692	8533	2544	781	804
2010	843524	547507	155055	46034	15472	3411	1074	411
2011	795445	249034	229079	71848	19798	6224	1303	304
2012	538638	234839	102330	113646	37129	8472	2749	623
2013	2096145	159022	95863	48608	61137	19654	4266	969
2014	452970	618845	66592	45074	23906	31051	9589	1639
2015	689038	133730	253338	30626	21702	10469	14313	2600

Estimated population abundance at 1st January 2016

year	0	1	2	3	4	5	6	7
2016	0	203428	53880	113889	11877	8024	4873	6196

Fleet: IGFSEVHOENo/Hr

Log catchability residuals.

year													
age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	-0.617	0.579	-0.599	0.406	0.834	0.053	0.026	-1.124	0.314	0.203	0.391	-0.466	0.000
1	0.468	0.144	-0.694	-0.003	-0.062	0.108	0.122	-0.209	0.273	0.005	-0.112	-0.208	0.167
2	0.525	0.458	-0.839	0.349	-0.208	0.108	-0.335	0.083	0.186	0.167	-0.075	-0.217	-0.202
3	-0.058	0.380	-0.384	0.201	-0.150	0.137	-0.359	0.180	0.559	0.148	-0.279	-0.200	-0.175
4	-0.187	-0.239	0.111	0.857	-0.404	0.436	-0.171	-0.268	0.598	-0.488	0.010	-0.049	-0.207
5	-0.719	-0.284	0.546	0.448	-0.078	0.386	0.015	0.020	0.103	-0.693	-0.066	-0.095	0.415

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

	0	1	2	3	4	5
Mean_Logq	-6.8150	-6.6328	-6.6023	-6.9179	-7.1359	-7.0592
S.E_Logq	0.3812	0.3812	0.3812	0.3812	0.3812	0.3812

Terminal year survivor and F summaries:

,Age 0 Year class =2015

source	scaledWts	survivors	yrcls
IGFSEVHOENo/Hr	1	203428	2015

,Age 1 Year class =2014

source	scaledWts	survivors	yrcls
IGFSEVHOENo/Hr	0.792	63698	2014
fshk	0.208	107804	2014

,Age 2 Year class =2013

source	scaledWts	survivors	yrcls
IGFSEVHOENo/Hr	0.775	93028	2013

fshk 0.225 172137 2013

,Age 3 Year class =2012

source

scaledWts survivors yrcls

IGFSEVHOENo/Hr 0.719 9971 2012

fshk 0.281 27697 2012

,Age 4 Year class =2011

source

scaledWts survivors yrcls

IGFSEVHOENo/Hr 0.695 6527 2011

fshk 0.305 14264 2011

,Age 5 Year class =2010

source

scaledWts survivors yrcls

IGFSEVHOENo/Hr 0.735 7376 2010

fshk 0.265 4389 2010

,Age 6 Year class =2009

source

scaledWts survivors yrcls

fshk 1 6042 2009

Table 7.15.9. Whiting in Divisions VIIbc,e–k. Fishing mortality (F)-at-age. F_{bar} range is 2–5.

	0	1	2	3	4	5	6	7+	F_{BAR} 2-5
2006	0.000	0.190	0.743	0.620	0.806	0.966	0.643	0.643	0.784
2007	0.000	0.105	0.776	0.786	1.075	0.984	0.642	0.642	0.905
2008	0.000	0.045	0.238	0.459	0.715	0.642	0.474	0.474	0.513
2009	0.000	0.033	0.283	0.336	0.487	0.462	0.354	0.354	0.392
2010	0.000	0.011	0.119	0.344	0.481	0.562	0.348	0.348	0.376
2011	0.000	0.029	0.051	0.160	0.419	0.417	0.400	0.400	0.262
2012	0.000	0.036	0.094	0.120	0.206	0.286	0.251	0.251	0.177
2013	0.000	0.010	0.105	0.210	0.247	0.318	0.309	0.309	0.220
2014	0.000	0.033	0.127	0.231	0.396	0.374	0.296	0.296	0.282

Table 7.15.10. Whiting in Divisions VIIbc,e–k. Stock number-at-age ('000).

YEAR	0	1	2	3	4	5	6	7
2006	771349	264674	116427	30557	9449	3453	3014	1440
2007	979773	227726	92641	28915	9971	2745	881	810
2008	1283028	289259	86743	22253	7991	2214	688	215
2009	1854508	378789	117023	35692	8533	2544	781	804
2010	843524	547507	155055	46034	15472	3411	1074	411
2011	795445	249034	229079	71848	19798	6224	1303	304
2012	538638	234839	102330	113646	37129	8472	2749	623
2013	2096145	159022	95863	48608	61137	19654	4266	969
2014	452970	618845	66592	45074	23906	31051	9589	1639
2015	689038	133730	253338	30626	21702	10469	14313	2600

Table 7.15.11. Whiting in Divisions VIIbc,e–k. Summary table.

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	F_{BAR} 2–5
	Age 0					
1999	2295352	119978	50349	25600	0.508	0.719
2000	1356009	93771	42393	20044	0.473	0.703
2001	623040	85585	50541	23073	0.457	0.781
2002	716927	77943	57302	20976	0.366	0.581
2003	970688	67768	44966	14657	0.326	0.428
2004	987460	82432	38841	16669	0.429	0.411
2005	896500	66601	40538	18907	0.466	0.725
2006	771349	60699	34251	21691	0.633	0.784
2007	979773	69606	29641	17542	0.592	0.905
2008	1283028	62704	25544	8739	0.342	0.513
2009	1854508	78891	34600	10673	0.308	0.392
2010	843524	94716	49345	11522	0.234	0.376
2011	795445	102999	77142	11452	0.148	0.262
2012	538638	106756	83957	12261	0.146	0.177
2013	2096145	156548	77310	14914	0.193	0.220
2014	452970	128184	63959	16824	0.263	0.282
2015	689038	95307	83393	19275	0.231	0.382
Geomean	981125					
Arith.						
Mean	1067670	91205	52004	16754	0.360	0.508
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 7.15.12. Whiting in Divisions VIIbc,e–k. Management options table.

Fmult	Catch17	Land17	Dis17	FCatch17	FLand17	FDis17	SSB18	% SSB Change
0	0	0	0	0	NA	NA	71218	123%
0.1	1812	1456	356	0.03	0.02	0.01	69611	121%
0.2	3569	2865	704	0.06	0.04	0.02	68056	118%
0.3	5271	4227	1044	0.09	0.06	0.03	66553	115%
0.4	6922	5545	1377	0.12	0.08	0.04	65100	113%
0.5	8523	6820	1703	0.15	0.1	0.04	63693	110%
0.6	10076	8054	2022	0.18	0.12	0.05	62333	108%
0.7	11582	9247	2335	0.21	0.14	0.06	61017	106%
0.8	13043	10402	2641	0.24	0.16	0.07	59744	103%
0.9	14461	11520	2941	0.27	0.18	0.08	58512	101%
1	15836	12602	3234	0.29	0.21	0.09	57320	99%
1.1	17171	13649	3522	0.32	0.23	0.1	56165	97%
1.2	18467	14663	3804	0.35	0.25	0.11	55048	95%
1.3	19725	15645	4081	0.38	0.27	0.12	53966	93%
1.4	20947	16595	4352	0.41	0.29	0.12	52919	92%
1.5	22134	17516	4618	0.44	0.31	0.13	51904	90%
1.6	23286	18408	4878	0.47	0.33	0.14	50922	88%
1.7	24406	19271	5134	0.5	0.35	0.15	49970	87%
1.8	25494	20108	5385	0.53	0.37	0.16	49048	85%
1.9	26551	20919	5632	0.56	0.39	0.17	48155	83%
2	27578	21704	5874	0.59	0.41	0.18	47289	82%

Additional Catch Options								
Catch17	Land17	Dis17	Basis	FCatch17	FLand17	FDis17	SSB18	dSSB
25125	19825	5300	FMSY	0.52	0.36	0.16	49360	-15%
0	0	0	F = 0	0	NA	NA	71218	23%
15836	12602	3234	F = Fsq	0.29	0.21	0.09	57320	-1%
42013	32424	9589	F = Flim	1.12	0.78	0.34	35449	-39%
34159	26673	7486	F = Fpa	0.8	0.56	0.24	41809	-28%
16995	13511	3484	Min FMSY	0.32	0.22	0.1	56317	-2%
30261	23744	6517	Max FMSY	0.67	0.47	0.2	45041	-22%
55765	41739	14026	Blim	2.02	1.41	0.61	25000	-57%
42578	32829	9750	Bpa	1.15	0.8	0.35	35000	-39%
42578	32829	9750	Btrigger	1.15	0.8	0.35	35000	-39%
15344	12215	3129	Stable SSB	0.28	0.2	0.09	57746	0%
28988	22778	6210	Stable TAC	0.63	0.44	0.19	46105	-20%

Input units are thousands and kg output in tonnes.

Table 7.15.13. Whiting in Divisions VIIbc,e–k. Input values for the catch forecast.

WHITING IN THE CELTIC SEA (VIIB,C,E–K), WGCSE 2016, COMBSEX

F_{bar} age range: 2–5

nyears +1

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	DSel	DCWt
0	981125	1.22	0	0	0.000	0.02	0	0.027	0	0.036
1	203425	0.86	0	0	0.000	0.073	0.004	0.24	0.027	0.108
2	53879	0.65	1	0	0.000	0.167	0.031	0.362	0.096	0.181
3	113887	0.5	1	0	0.000	0.294	0.188	0.497	0.108	0.247
4	11877	0.43	1	0	0.000	0.483	0.347	0.656	0.055	0.306
5	8024	0.4	1	0	0.000	0.654	0.323	0.749	0.029	0.411
6	4872	0.38	1	0	0.000	0.752	0.329	0.868	0.026	0.474
7	7344	0.36	1	0	0.000	0.933	0.336	1.164	0.018	0.435

nyears +2

AGE	N	M	MAT	PF	PM	SWT	SEL	CWT	DSEL	DCWT
0	981125	1.22	0	0	0	0.02	0	0.027	0	0.036
1	289658	0.86	0	0	0	0.073	0.004	0.24	0.027	0.108
2	83463	0.65	1	0	0	0.167	0.031	0.362	0.096	0.181
3	24774	0.5	1	0	0	0.294	0.188	0.497	0.108	0.247
4	51381	0.43	1	0	0	0.483	0.347	0.656	0.055	0.306
5	5165	0.4	1	0	0	0.654	0.323	0.749	0.029	0.411
6	3781	0.38	1	0	0	0.752	0.329	0.868	0.026	0.474
7	5934	0.36	1	0	0	0.933	0.336	1.164	0.018	0.435

nyears +3

AGE	N	M	MAT	PF	PM	SWT	SEL	CWT	DSEL	DCWT
0	981125	1.22	0	0	0	0.02	0	0.027	0	0.036
1	289658	0.86	0	0	0	0.073	0.004	0.24	0.027	0.108
2	118843	0.65	1	0	0	0.167	0.031	0.362	0.096	0.181
3	38376	0.5	1	0	0	0.294	0.188	0.497	0.108	0.247
4	11177	0.43	1	0	0	0.483	0.347	0.656	0.055	0.306
5	22344	0.4	1	0	0	0.654	0.323	0.749	0.029	0.411
6	2434	0.38	1	0	0	0.752	0.329	0.868	0.026	0.474
7	4720	0.36	1	0	0	0.933	0.336	1.164	0.018	0.435

Input units are thousands and kg output in tonnes.

Table 7.15.14. Whiting in Divisions VIIe–k. The detailed output for the *status quo* F forecast by age group.

NYears+1

Age	LF	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0	0	0	981125	19884	0	0
1	0.004	573	137	0.027	3587	386	203425	14938	0	0
2	0.031	1235	448	0.096	3521	636	53879	8980	53879	8980
3	0.188	12287	6105	0.108	10953	2707	113887	33426	113887	33426
4	0.347	2536	1663	0.055	710	218	11877	5733	11877	5733
5	0.323	1791	1341	0.029	196	80	8024	5249	8024	5249
6	0.329	998	866	0.026	225	107	4872	3666	4872	3666
7	0.336	1762	2051	0.018	97	42	7344	6854	7344	6854
Total	0.222	21182	12611	0.072	19289	4176	1384433	98730	199883	63908

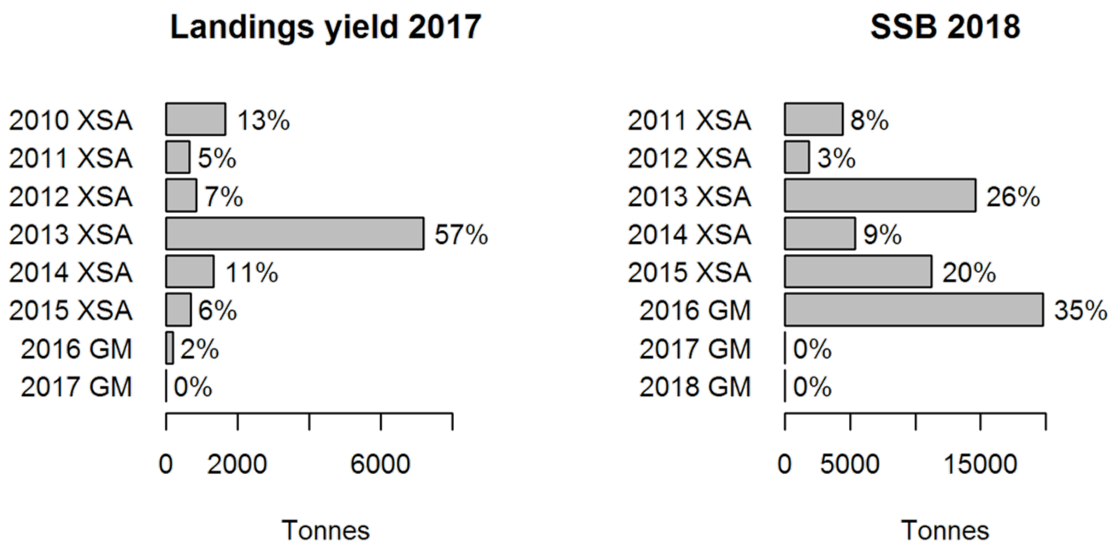
NYears+2

Age	LF	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0	0	0	981125	19884	0	0
1	0.004	816	195	0.027	5108	550	289658	21271	0	0
2	0.031	1914	694	0.096	5454	985	83463	13910	83463	13910
3	0.188	2673	1328	0.108	2383	589	24774	7271	24774	7271
4	0.347	10970	7192	0.055	3073	942	51381	24802	51381	24802
5	0.323	1153	863	0.029	126	52	5165	3379	5165	3379
6	0.329	774	672	0.026	175	83	3781	2845	3781	2845
7	0.336	1423	1657	0.018	79	34	5934	5538	5934	5538
Total	0.222	19723	12601	0.072	16398	3235	1445281	98900	174498	57745

NYears+3

Age	LF	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
0	0	0	0	0	0	0	981125	19884	0	0
1	0.004	816	195	0.027	5108	550	289658	21271	0	0
2	0.031	2725	988	0.096	7765	1403	118843	19807	118843	19807
3	0.188	4140	2057	0.108	3691	912	38376	11263	38376	11263
4	0.347	2386	1565	0.055	668	205	11177	5395	11177	5395
5	0.323	4987	3735	0.029	545	224	22344	14617	22344	14617
6	0.329	498	433	0.026	112	53	2434	1831	2434	1831
7	0.336	1132	1318	0.018	63	27	4720	4405	4720	4405
Total	0.222	16684	10291	0.072	17952	3374	1468677	98473	197894	57318

Table 7.15.15. Whiting in Divisions VIIbc,e–k. 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.



7.15.12 Figures

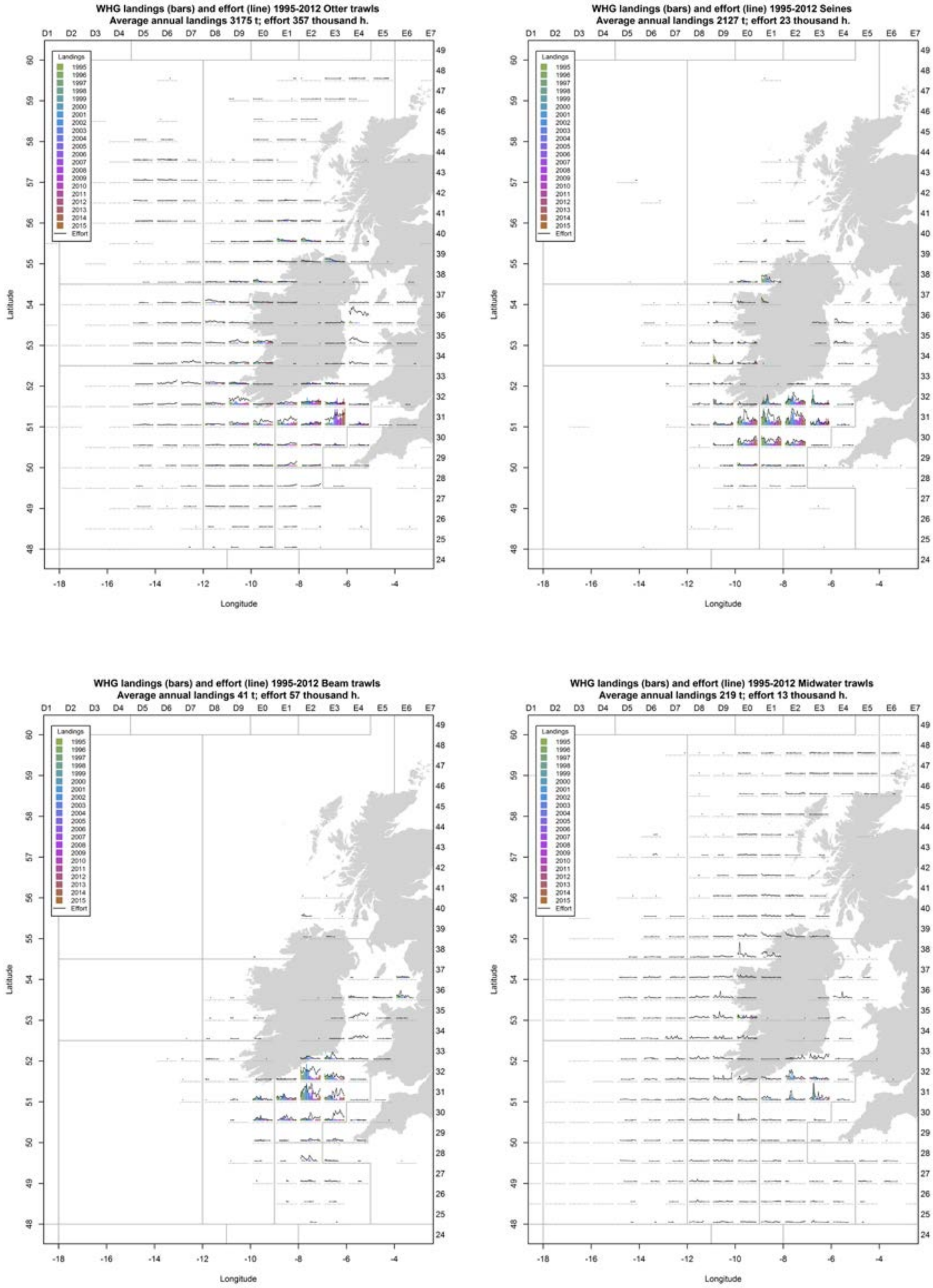


Figure 7.15.1. Irish landings for the main gear types in 1995–2015, along with annual average between 1995–2012.

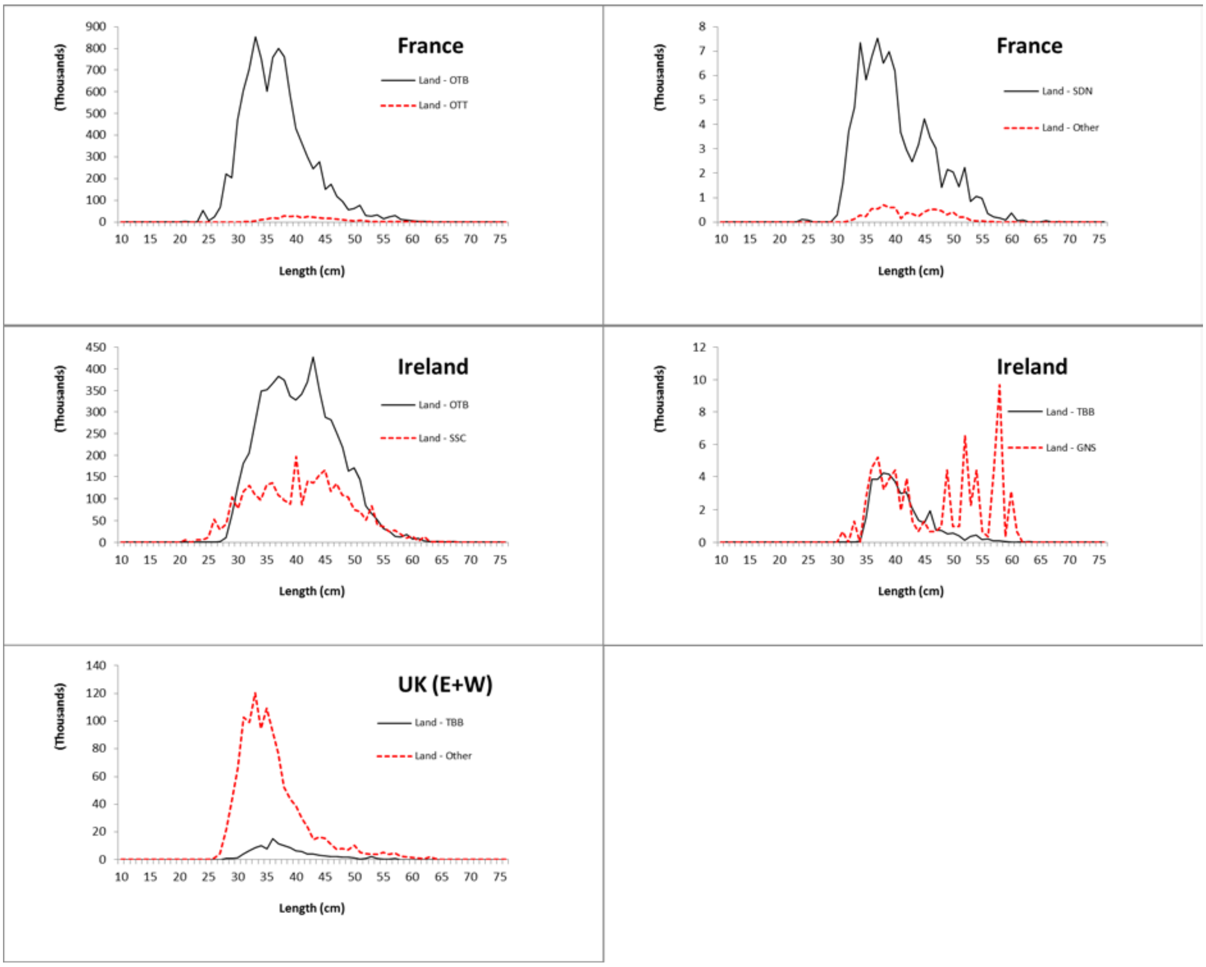
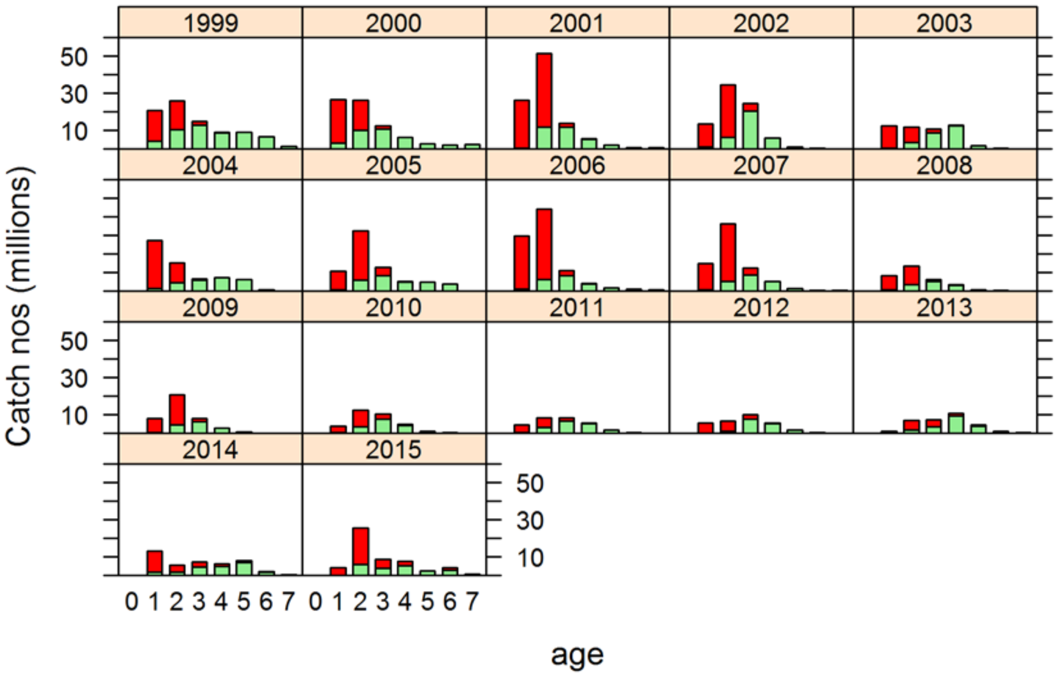


Figure 7.15.2. Whiting in VIIb,c,e–k (Celtic Sea). 2015 length compositions (raised numbers 000's) of French, UK and Irish Landings (Land) for the main fleets.



7.15.3. Whiting in VIIbc,e–k (Celtic Sea), annual Landings (grey) and Discards (white) by age composition.

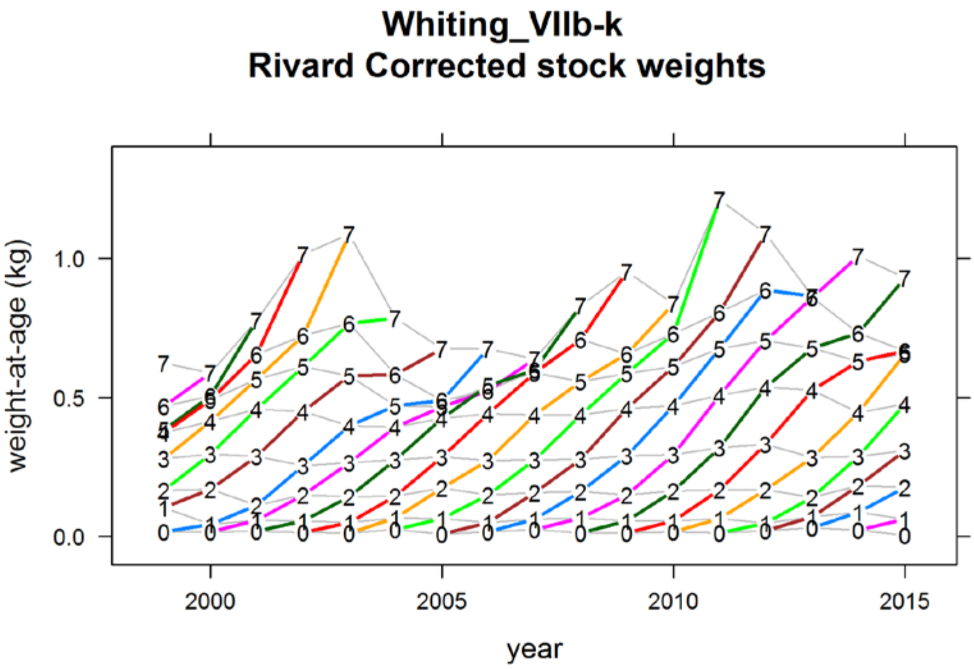


Figure 7.15.4. Whiting in VIIbc,e–k (Celtic Sea). Rivard corrected stock weights-at-age.

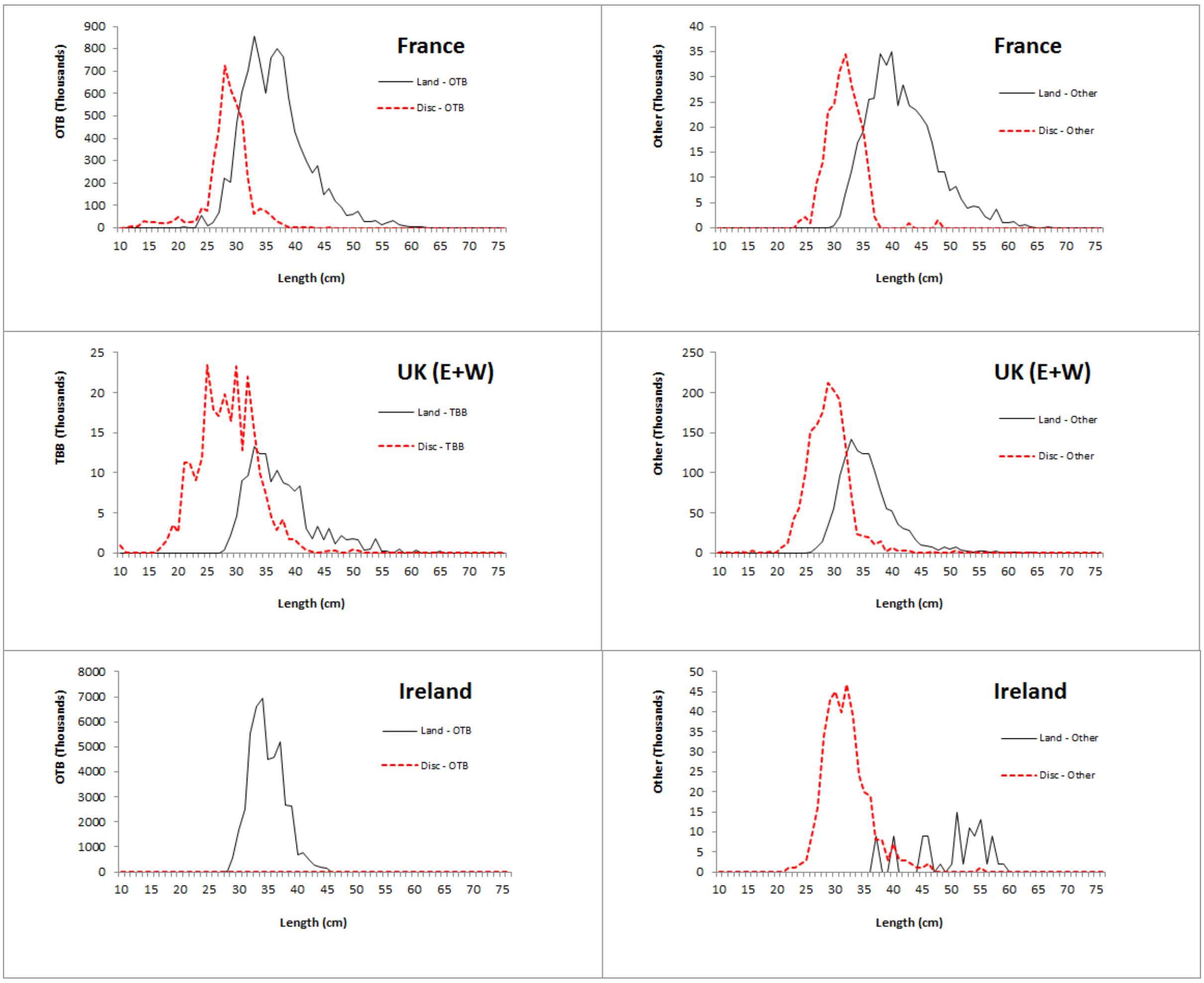


Figure 7.15.5. Whiting in VIIbc,e–k (Celtic Sea). 2015 Annual length compositions of Irish, UK and French Landings (Land) and Discards (Disc) for the main fleets. Numbers are provided raised to the catch for Ireland and France, and are raised from the sampled discard trips to the catch by weight for the UK.

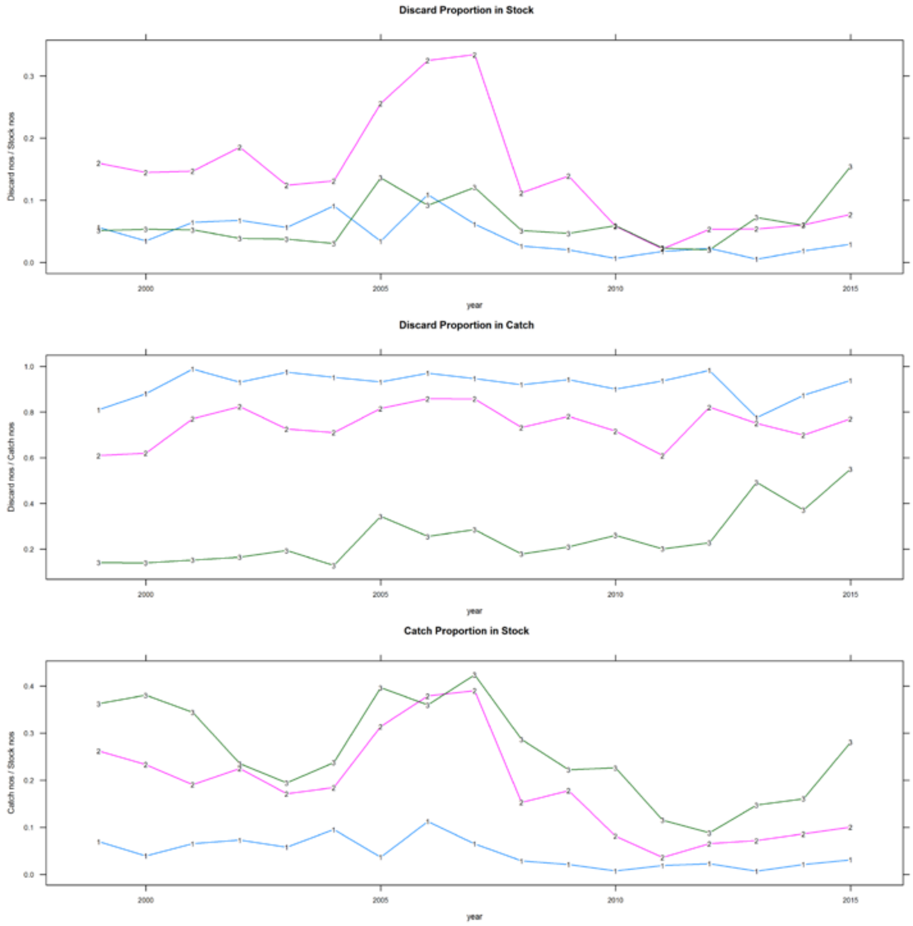


Figure 7.15.6. 2015 Annual proportions-at-age of Discard Nos in the Stock (above); Discard Nos in the Catch (middle) and Catch Nos in the Stock (below) from the assessment.

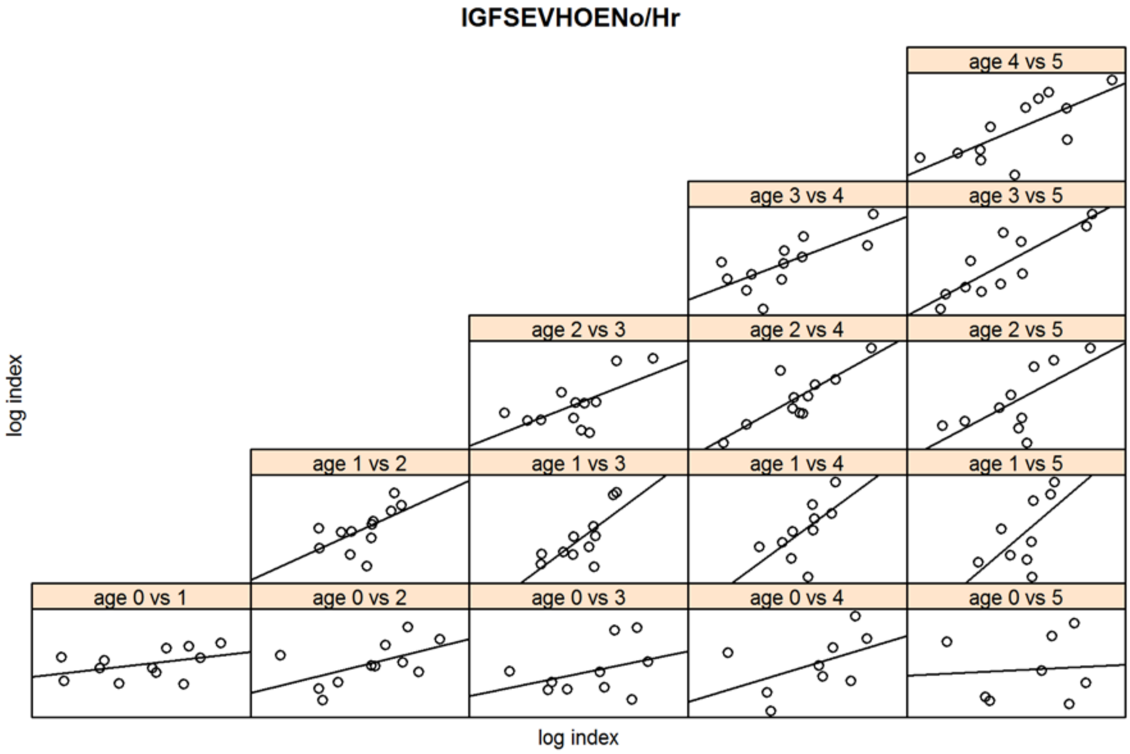
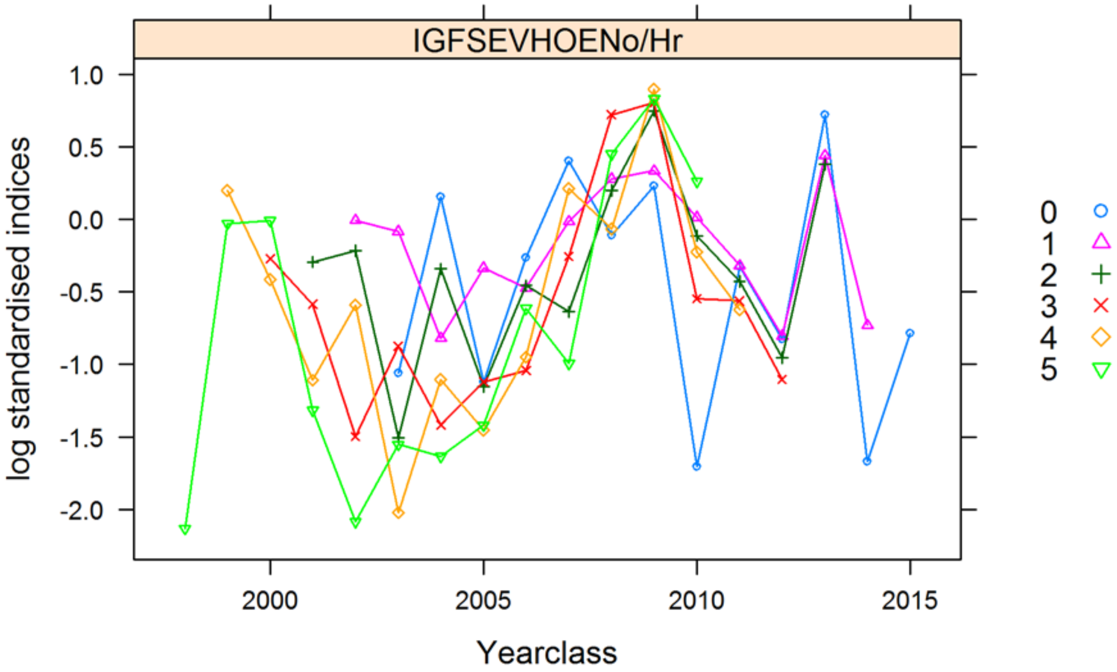


Figure 7.15.7. Whiting in VIIbc,e–k (Celtic Sea). Pairwise scatterplots for the log numbers-at-age for the IGFS-EVHOE combined survey index.



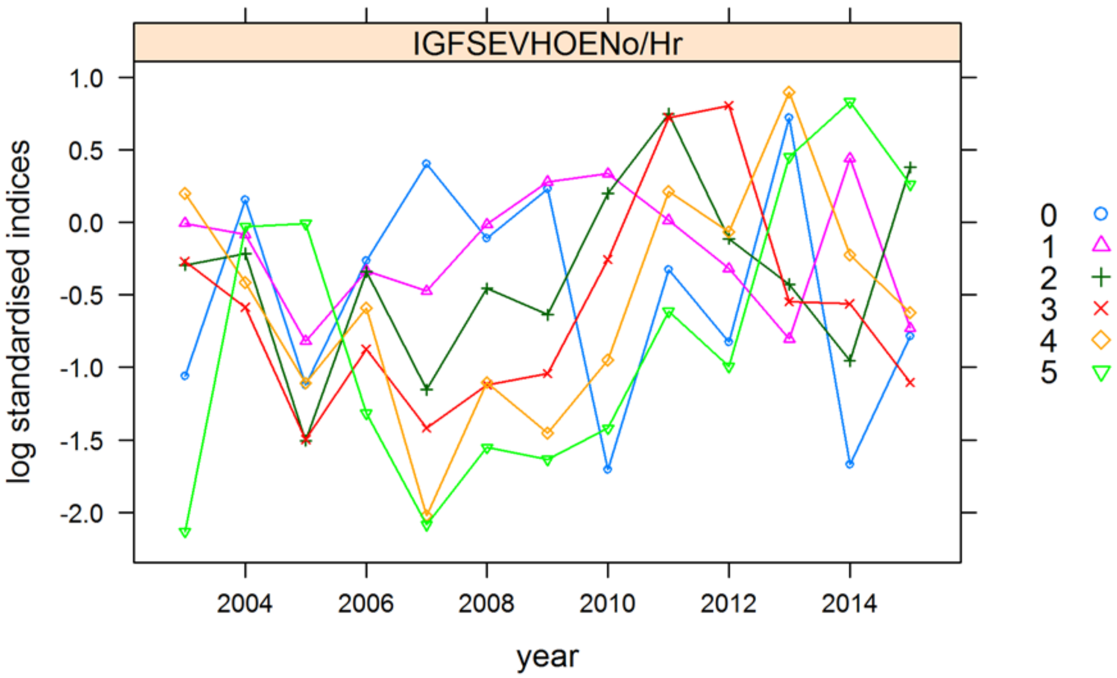


Figure 7.15.8. Whiting in VIIe–k (Celtic Sea). Mean log standardized plots of indices by year class (top panel) and by year (lower panel).

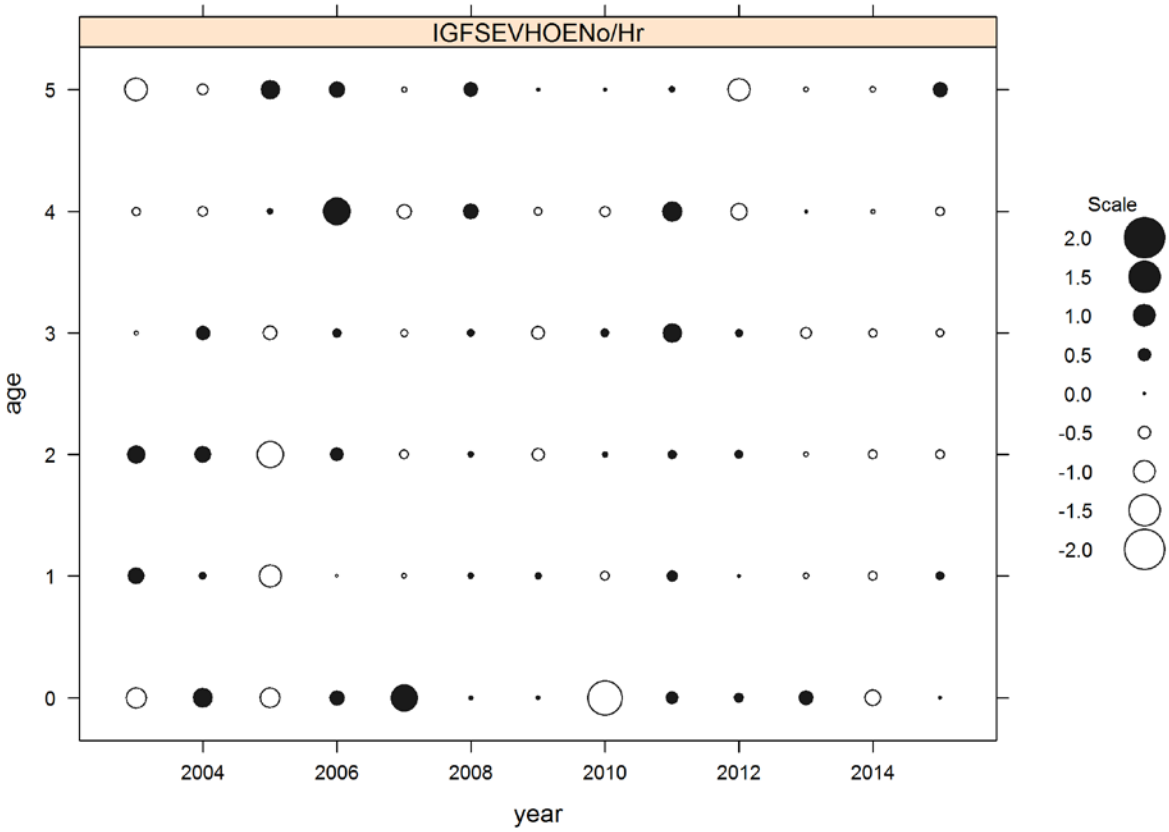


Figure 7.15.10. Whiting in VIIbc,e–k (Celtic Sea). Log fleet catchability residuals bubble plots.

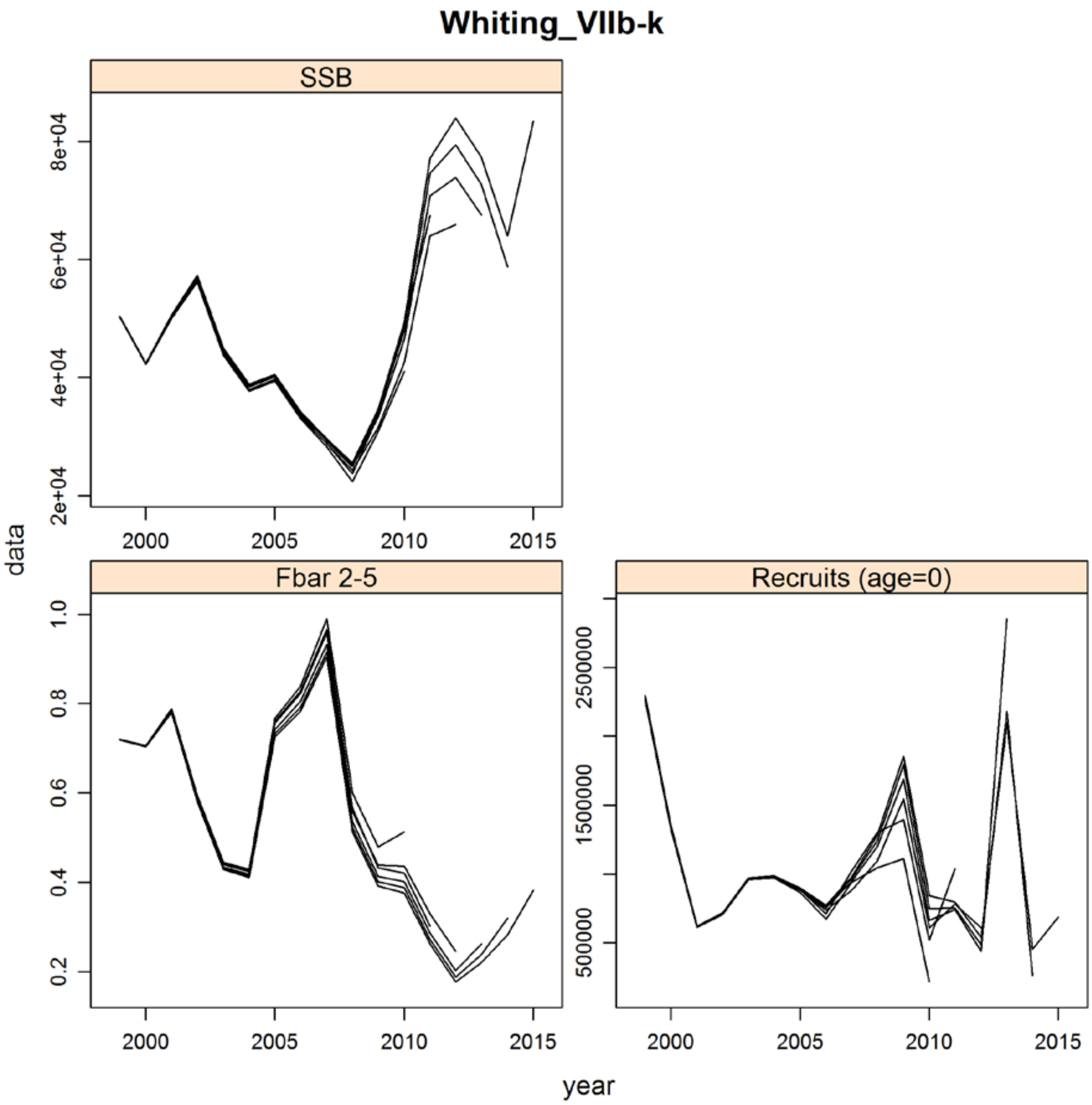


Figure 7.15.11. Whiting in VIIbc,e–k (Celtic Sea). Retrospective analysis.

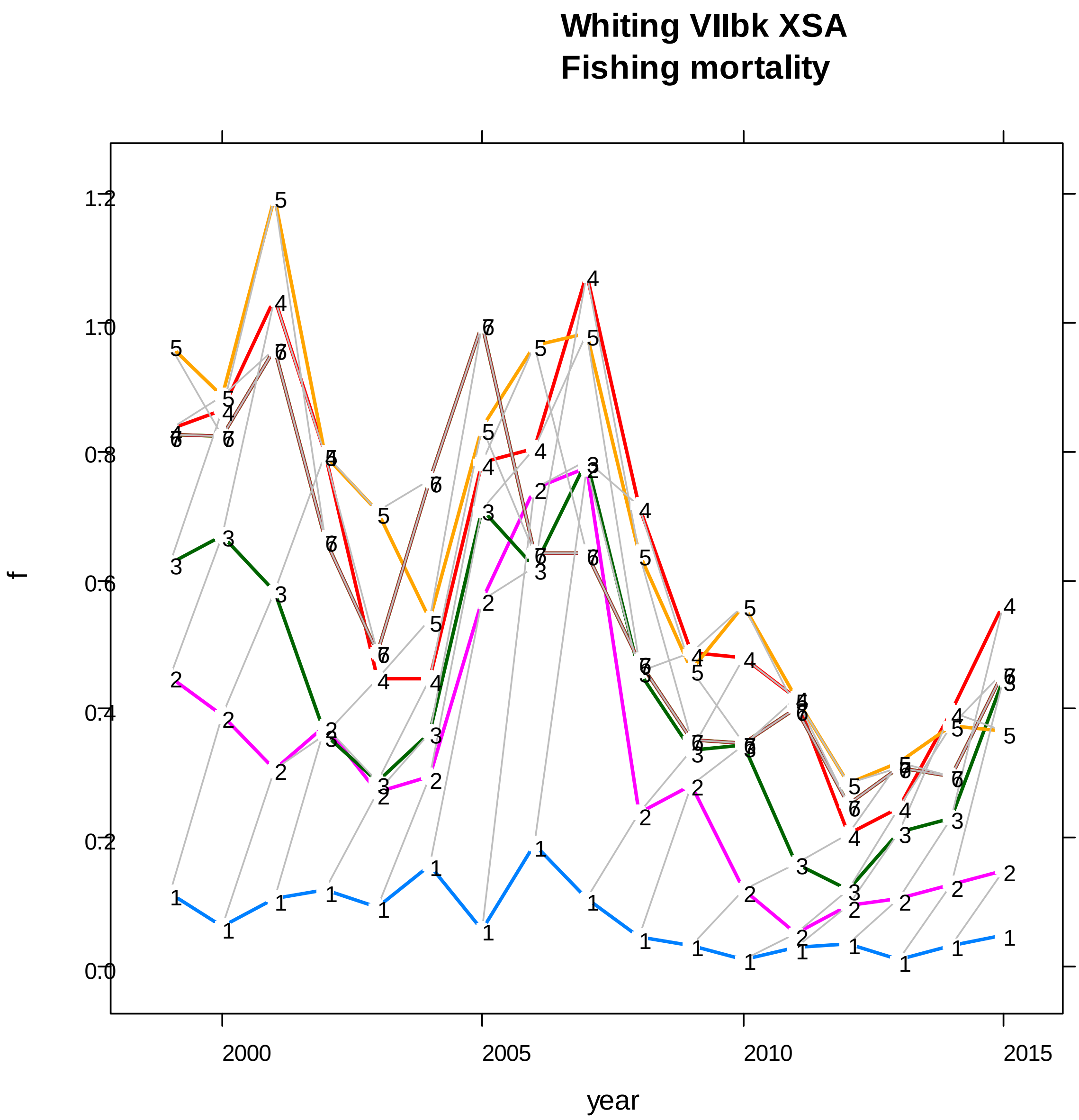


Figure 7.15.12. Whiting in VIIbc,e–k (Celtic Sea). Fishing mortality-at-age.

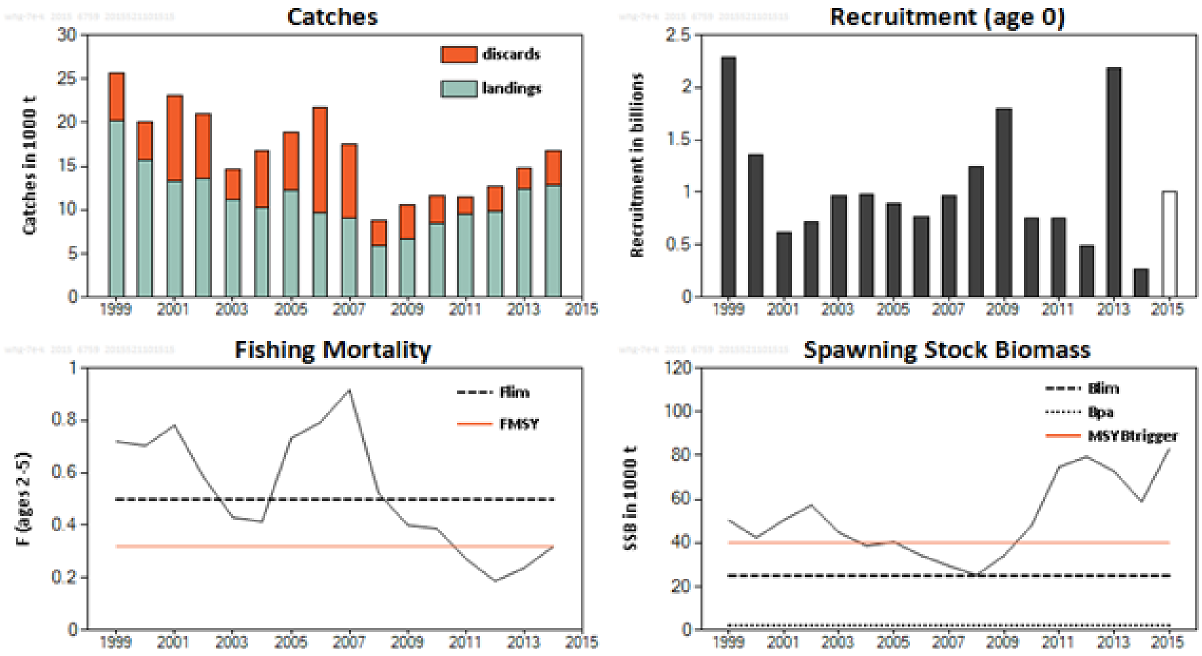


Figure 7.15.13. Whiting in VIIbc,e–k (Celtic Sea). Stock summary.

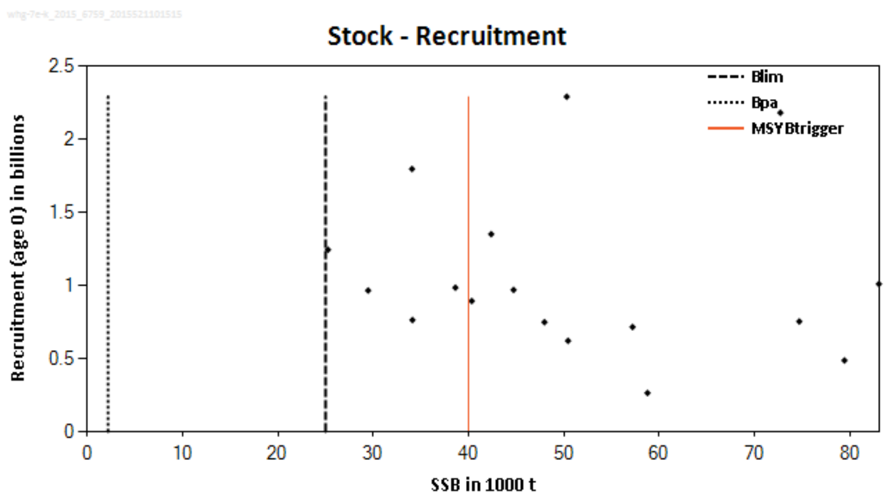


Figure 7.15.14. Whiting in VIIbc,e–k (Celtic Sea). Stock–recruitment relationship.

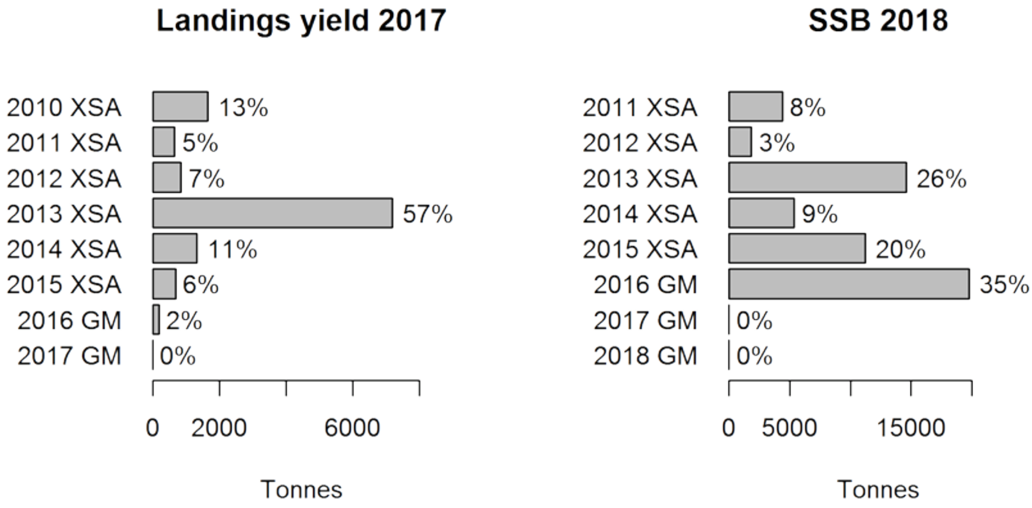


Table 7.15.15. Whiting in Divisions VIIbc,e-k. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

7.15.13 Audit of Whiting (*Merlangius merlangus*) in Divisions 7.b, 7.c, and 7.e-k (Southern Celtic seas and Eastern English Channel)

Date: 18.05.2016

Auditor: Vladimir Laptikhovsky

General

For single stock summary sheet advice

1) Assessment type: update

2) Assessment: analytical

3) Forecast: presented

4) Assessment model: XSA that uses catches in the model and in the forecast; tuning by one survey index ((EVHOE-WIBTS-Q4 & IGFS-WIBTS-Q4 combined: IGFSEVHOE)

5) Data issues: Data are available as described

6) Consistency: Consistent with previous assessments

7) Stock status: Whiting are caught in mixed fisheries with cod and haddock being fished at or below F_{MSY} in 2016 under all scenarios except the maximum scenario, reflecting that it is the least limiting stock for most fleets. SSB shows an increasing trend from 2008 and is well above B_{pa}. Recruitment has been below average since 2010 with the exception of the 2013 year class which is estimated to be the second highest in the series.

8) Management Plan: There is no management plan for whiting in this area.

General comments

Technical comments

None.

Conclusions

The assessment has been performed correctly

Checklist for audit process

General aspects

- Has the EG answered those TORs relevant to providing advice? Yes
- Is the assessment according to the stock annex description? Yes
- If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? N/A
- Have the data been used as specified in the stock annex? Yes
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? Yes
- Is there any **major** reason to deviate from the standard procedure for this stock? No
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes

7.17 *Nephrops* in Divisions 7.fgh FU20 (Labadie, Baltimore and Galley) and FU21 (Jones and Cockburn Banks)

Type of assessment in 2016

WGCSE 2016 estimated F_{MSY} reference points see Working Document 11 using based on the methods applied to other *Nephrops* stocks at FMSYREF4 (ICES, 2016). A full UWTV based assessment was carried out and catch options based on the new stock specific reference points are provided.

ICES advice applicable to 2015

"New data (catch and survey) available for this stock do not change the perception of the stock. Therefore, the advice for this fishery in 2015 is the same as the advice for 2014. This corresponds to landings of no more than 2500 tonnes. Considering that no discard ban is in place for 2015, and assuming that discard rates do not change from the average of the last two years (2013–2014) the resulting catch would be no more than 3366 tonnes.

In order to ensure the stock in this functional unit is exploited sustainably, management should be implemented at the functional unit level."

ICES advice applicable to 2016

"ICES advises that when the precautionary approach is applied, catches in 2016 (assuming zero discards) should be no more than 3045 tonnes. If instead discard rates continue at recent values (average of 2012–2014) and there is no change in assumed discard survival rate, this implies landings of no more than 2500 tonnes.

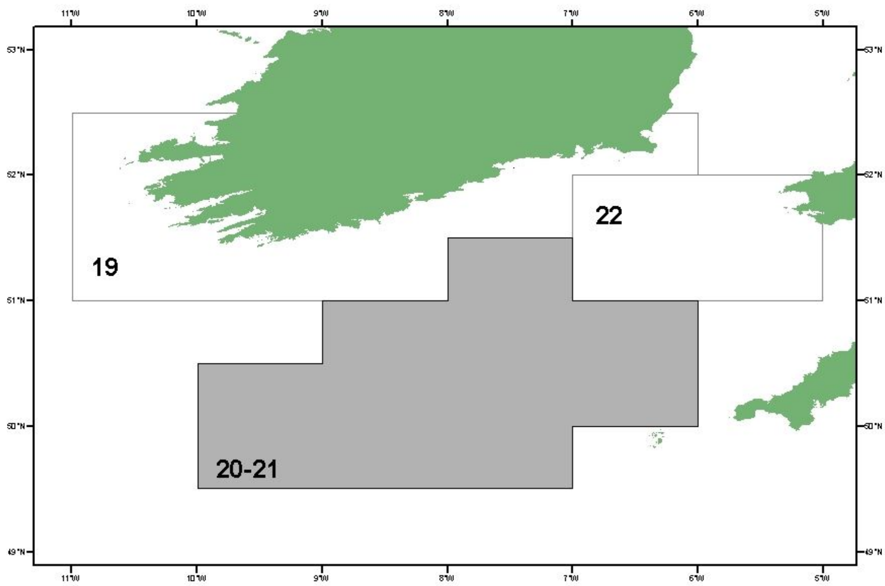
To ensure that the stock in functional units (FUs) 20 and 21 is exploited sustainably, management should be implemented at the functional unit level."

7.17.1 General

Stock description and management units

The FU20–21 *Nephrops* stock is included in the whole ICES Area 7 together with Irish Sea East and West [FU14, FU15], Porcupine Bank [FU16], Aran Islands [FU17], northwest Irish Coast [FU18], southeast and southwest Irish Coast [FU19], Smalls [FU22]. The TAC is set for Subarea 7 which does not correspond to the stock area.

Historically FU20–22 fishery and sampling data covered an amalgamation of several spatially distinct mud patches; FU20 NW Labadie, Baltimore and Galley, FU21 Jones and Cockburn and FU22 the Smalls. WGCSE 2013 recommended that FU20–22 should be split into FU20–21 and FU22 for the purposes of assessment and advice provision. There is evidence that the Celtic Sea *Nephrops* patches are linked in meta-population sense (O'Sullivan *et al*., 2015). However, fishing mortality and biological parameters (density, growth, M, etc.) may vary across the different patches.



Ecosystem aspects

Details of the ecosystem on FU20–21 are provided in the stock annex updated by WKCELT.

Fishery description

France, Ireland, and the UK are the main countries involved in the FU20–21 *Nephrops* fishery. In the early 2000s the Republic of Ireland fleet had on average 10% of the landings and this has increased to over 70% from this FU in recent times. A description of this fleet is given in the stock annex. The fishery on FU20–21 grounds operates throughout the year, weather permitting with a seasonal trend and has expanded in the mid-2000s. In 2011 Irish landings have been higher then French landings for the first time. The time-series of numbers of vessels with landings g is updated in Figure 7.17.1. The time-series of vessel power is shown as a box and kite plot in Figure 7.17.2.

French trawlers targeting *Nephrops* in the Celtic Sea operate mainly in the FU20–21 component of the stock. France dominated in the landings in the early 2000s on average 90% of landings and this has decreased to 40% in recent times. A description of this fleet is given in the stock annex. There is a slight increase in participation by the UK in this fishery in the most recent years.

Fishery in 2015

Ireland

In recent years several newer vessels specializing in *Nephrops* fishing have participated periodically in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates. There has been a trend for Irish vessels to switch to multi (quad) rig trawls since 2012. These vessels are more efficient at catching *Nephrops* (BIM, 2015).

In 2015, 83 vessels reported landings from FU20–21. Of these, 58 reported landings in excess of 10 t accounting for 92% of total Irish landings.

France

In 2015 29 French vessels reported landings from FU20–21 where many of these switch between FU20–21 and FU22 within a trip.

UK

18 UK(E&W) vessels reported landings for FU20–21 and two vessels from Northern Ireland.

Information from stakeholders

None available.

7.17.2 Data

InterCatch

Data were available in InterCatch and used on a trial basis.

Landings

The reported landings time-series is shown in Figure 7.17.3 and Table 7.17.1.

The reported Irish landings from FU2021 have increased since the mid-2000s to the highest in the time series in 2015 (1620 t). French landings have gradually decreased since the early 2000s to the present to the lowest level (355 t). Reported landings from the UK have fluctuated with no obvious trend. England had the highest landings at 120 t followed by Northern Ireland reporting 12 t, Scotland (9 t) and minor landings from Belgium less than 0.3 t.

The overall fishing profile remains typically seasonal with the majority of Irish and French landings coming from the 2nd and 3rd quarters (see stock annex).

Effort

Effort data are available for the Irish *Nephrops* directed fleet in FU2021 from 1995–2015. The effort series is based on the same criteria for FU15, 16, 17, 19and 22 (30% landings threshold) and will be contingent on the accuracy of landings data reported in logbooks. Effort data are not standardized, and hence do not take into account vessel capabilities, efficiency, seasonality or other factors that may bias perception of lpue as an abundance trend over the longer term. These data are not used in the assessment.

WGCSE 2015 recommended that effort data in Kw days should be presented as these data are more informative that uncorrected effort data. Effort data are available from 1995 for the Irish otter trawl *Nephrops* directed fleet. In 2015 this fleet accounted for ~95% of the landings compared with an average of 70% over the time period. Effort shows an increasing trend since the mid-2000s (Figure 7.17.4 and Table 7.17.2.).

Effort data in KW days are not available for France. Previously effort data were reported from 1983 to 2008 for the French *Nephrops* fleet for the combined Celtic Sea FU20–22 (see stock annex). Since 2009, a new registration system of official French statistics has changed the way fishing effort is computed and a new threshold method of 500 kg landed by trip is used to report effort. French fishing effort reported in hours and lpue (kg/hr) since 2009 shows an overall declining trend (Table 7.17.3).

Sampling levels

Sampling levels, data aggregating and raising procedures were reviewed by WKCELT 2014 and are documented in the stock annex. The time-series of samples is shown in Table 7.17.4 and remains sparse due to the offshore nature of the fishery.

Commercial length–frequency distributions

Prior to 2012 there was insufficient Irish sampling to generate length–frequency distributions although since then efforts are being progressed. For France limited data were available for 1997 and 2010 (see stock annex for details).

Length–frequency distributions of landings and discards for both countries from 2012 to 2015 are presented in Figure 7.17.5 along with the European (25 CL mm) and French (35 CL mm) minimum landings size also shown.

The short common series on LFDs for both countries shows that the LFDs differ between the two countries. The French fishery caught higher proportions of larger individuals (>35 mm) on average 70% compared to 50% for the Irish fishery for the available time-series.

Sex ratio

The sex ratio is male biased from the available French and Irish sampling data (Table 7.17.5).

Mean weight explorations

These raised numbers in the French landings and discards are different to those presented in WGCSE 2015 report. This is explained due to the raising method where previously for the French data a length–weight relationship given in text table below is applied to both sexes.

Parameter	Value	Source
Males and Females		
Length/weight - a	0.000095	Previously used to raise French data.
Length/weight - b	3.55	"

WGCSE 2016 used the length–weight relationship as described in stock annex to raise both countries sampling data which are based on Scottish data (Pope and Thomas, 1955).

The revised estimated annual mean weights in the landings and discards by country and also combined with a scaling to the international landings is shown in Figure 7.17.6.(c). The mean weight in the landings for France is higher than that in the Irish landings.

Discards

For the Irish data discard rates have been estimated using unsorted catch and discards sampling. This involves unsorted catch and discard samples being provided by vessels or collected by observers at sea on discard trips. The catch sample is partitioned into landings and discards using an on-board discard selection ogive derived for the discard samples. Due to sparse sampling effort annual aggregations are used to derive length distributions and selection ogives. The length–weight regression parameters given in the stock annex are used to calculate sampled weights and appropriate annual raising factors. The sampling intensity and coverage has varied over the short time-series and is relatively poor but at present it is the best available.

Estimated discard rates range between 26–34% of total catch by number and 13–23% of total catch by weight in the Irish fishery shown in Table 7.17.6. In the French fishery estimated discard rates range between 51–78% of total catch by number and 29–58% of total catch by weight shown in Table 7.17.7.

Estimated discard rates for bother countries combined in shown in Table 7.17.8 and these range between 32–53% of total catch by number and 18–33% of total catch by weight. Discard rate of females tends to be higher due to the smaller average size and market reasons as is observed in other *Nephrops* fisheries.

There is no information on discard survival rate in this fishery. 25% is assumed in line with other *Nephrops* stocks in the Celtic Sea (Charuau *et al*., 1982).

Abundance indices from UWTV surveys

The methods used during the survey were similar to those employed for UWTV surveys of *Nephrops* stocks around Ireland and elsewhere and are documented by WKNEPHTV (ICES, 2007), SGNEPS (ICES, 2009, 2010, 2012) and WGNEPS (ICES, 2013, 2014). SGNEPS 2012 (ICES, 2012) recommended that a CV (or relative standard error) of <20% is an acceptable precision level for UWTV survey estimates of abundance. UWTV surveys conducted in 2006 and 2012 are deemed exploratory as stations were chosen based on areas heavily fished by vessels (Doyle *et al*., 2013). These are likely to be biased estimate of density and cannot be extrapolated to estimate density for the whole area. A randomised isometric grid design was employed with UWTV stations at 6.0 nmi intervals for 2013–2015 surveys. The 2013 survey achieved partial coverage ~60% of the total area. The 2013 abundance has been scaled up to the entire area since densities in the un-surveyed part of the ground were not significantly different in 2014. In 2014 and 2015 full survey coverage was achieved. The geo-statistical analysis for years 2013 to 2015 follows the steps documented in Lordan *et al*., 2015.

The 2015 mean burrow density was 0.20 burrows/m^2 compared with 0.19 burrows/m^2 in 2014. The 2015 geostatistical abundance estimate was 2.0±0.02 billion a 2% decrease on the abundance for 2014 with a CV of 3% which is well below the upper limit of 20% recommended by SGNEPS 2012. Highest densities were general observed towards the north and southwest of the ground, and there were also high densities observed close to boundaries. Figure 7.17.7 shows the krigged contour and density plots for the time-series. The summary statistics from this geostatistical analysis are given in Table 7.17.9 and plotted in Figure 7.17.8. The estimation variance of the survey as calculated by EVA is very low (CVs in the order 3%).

Groundfish survey data

There are two IBTS- GFS catching *Nephrops* in FU2021: French groundfish survey EVHOE-WIBTS-Q4 since 1997 and Irish groundfish survey-Q4: IGFS-WIBTS-Q4 commenced in 2003 (Stokes *et al.,* 2014). These provide information on length–frequency compositions, mean size in the catches, cpue of *Nephrops* in FU2021. The mean size of the catches is stable over the time-series except in 2006 and 2008 which signals recruitment into the fishery in 2006 and 2007 as shown in Figure 7.17.9.

7.17.3 Assessment

Comparison with previous assessments

A *Nephrops* data-limited exploration was carried out by previous working groups; see stock annex on historical overview of previous methods (ICES, 2015). This approach estimated harvest rates of 4.4% which is very low relative to most other developed *Nephrops* fisheries and similar to the harvest rate in place for the Porcupine Bank (FU16).

In 2016 stock-specific reference points were estimated by this working group based on methods for other *Nephrops* stocks used by WKMSYREF4 (ICES, 2016). This is in accordance with recommendations by WKCELT 2014 where data improvements have been made for this stock such as:

- complete survey coverage of the stock area giving quality assured density estimates and abundance estimates conforming to WGNEPS recommendations; and also
- improved sampling data achieving better coverage and robust estimates of the various parameters need to calculate catch options (e.g. mean weight in the landings and discards, discard percentage in numbers).

As a result the WGCSE 2016 carried out a full UWTV based assessment for this stock for the first time.

State of the stock

UWTV abundance estimates suggest that the stock size is relatively stable over the short time-series. The 2015 estimate is a slight decrease from 2014 estimate by 2%.

No MSY $B_{trigger}$ has been proposed as the time-series is too short (three years of full TV survey coverage).

Table 7.17.10 and Figure 7.17.9 summarize recent harvest ratios which have been below the F_{MSY} proxy for the last three years.

7.17.4 Catch options table

Catch option table inputs and estimates of mean weight in landings and harvest ratios are presented in Table 7.17.10 and summarised below.

In line with previous practice an average (2013–2015) of mean weights is used to account for this variability. Three year average (2013–2015) of proportion of removals retained was used as is standard for other *Nephrops* stocks.

The basis for the catch options.

Variable	Value	Source	Notes
Stock abundance	Available October 2016	ICES (2016a)	UWTV survey 2016
Mean weight in landings	36.7 g	ICES (2016a)	Average 2013–2015
Mean weight in discards	16.1 g	ICES (2016a)	Average 2013–2015
Discard rate	40.5%	ICES (2016a)	Average 2013–2015 (by number). Calculated as discards divided by landings + discards.
Discard survival rate	25%	ICES (2016a)	Only applies in scenarios where discarding is allowed.
Dead discard rate	34.1%	ICES (2016a)	Average 2013–2015 (by number). Calculated as dead discards divided by removals (landings + dead discards). Only applies in scenarios where discarding is allowed.

A prediction of landings for the FU2021 using the approach agreed procedure proposed at WK*NEPH* 2009 and outlined in the stock annex will be made on the basis of the 2016 UWTV survey. This will be presented in October 2016 for the provision of advice.

7.17.5 Reference points

New reference points were estimated by this working group using the same method and approach used at WKMSYREF4 (ICES, 2016). The detailed analysis is available in working document 11. In the case of FU20–21 there is a limited number of years for which length–frequency data were available so the three year moving window could only be applied to give two estimates. The resulting potential F_{MSY} harvest rates and ranges are given in the following table.

year	Fmax	Fmax.low	Fmax.up	F35	F35.low	F35.up	F0.1	F0.1.low	F0.1.up
2012	9.12	6.51	12.60	11.03	6.11	13.21	5.91	5.08	15.11
2013	9.45	6.71	13.26	11.17	6.30	13.78	6.10	5.23	15.93

Given the low density in the area and combined sex $F_{0.1}$ was considered and appropriate F_{MSY} proxy.

Stock code	MSY Flower*	FMSY*	MSY Fupper* with AR	MSY Btrigger	MSY Fupper* with no AR
nep-2021	6.0%	6.0%	6.0%	Not defined	6.0%

*** Harvest rate (HR).**

No proposal has been made for MSY $B_{trigger}$ as the time-series is too short.

7.17.6 Management plans

There is no specific management plan for the FU20–21 *Nephrops*.

7.17.7 Quality of assessment and forecast

Since the benchmark 2014 UWTV and sampling coverage has been improving in this area. There are now two years of full UWTV survey coverage (2014–2015).

There are several key uncertainties and bias sources in the method used here (these are discussed further in WK*NEPH* 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007; WKNEPHBID 2008; SGNEPS 2009, WGNEPS 2014). Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates (Marrs *et al.*, 1996). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that is more accurate, although no more precise (WK*NEPH*, 2009). The survey estimates themselves are very precisely estimated (CVs ~3%) given the homogeneous distribution of burrow density and the modelling of spatial structuring. The cumulative bias estimates for FU20–21 are largely based on expert opinion. The precision of these bias corrections cannot yet be characterised, but is likely to be lower than that observed in the survey.

Sampling of landing and discards for FU20–21 remains low but there is a limited number of years for which length–frequency data were available so the three year moving window could only be applied to give two estimates to calculate F_{MSY} reference points.

French and Irish trawlers cover different areas and have presented contrasting features over the last decade. The French fleet moved gradually from the "Smalls" Ground (mainly 31E3) to the "Labadie" (30E2, increase of 28E2 in the early 2010s, although no trend is revealed within FU20–21 throughout the overall time-series): in the late 1990s, more than 40% of French landings were reported from the "Smalls" area whereas by the end of 2000s the contribution of this rectangle became minor (less than 10%). Irish vessels have increased their production on FU20–21 since the mid-2000s and a gradual expansion towards the southern rectangles is obvious during the recent years (stock annex).

7.17.8 Recommendations for next benchmark

This stock was last benchmarked by WKCELT (ICES, 2014). WGCSE will keep the stock under close review and recommend future benchmark as required.

7.17.9 Management considerations

The indications are the *Nephrops* in FU20–21 are lightly exploited now relative to the past and recent average landings are broadly sustainable. Overall effort in the fishery has declined to less than 25% of the peak effort observed in the early 1990s. Harvest rates based on recent landings and UWTV surveys suggest that the HR is low relative to most other *Nephrops* fisheries.

In recent years the Irish fishery in the area expanded whereas the French fishery continued to decline. The fishing patterns of the French and Irish fleet are very different with the Irish fleet specialising on *Nephrops* whereas the French fishery remains more mixed. French *Nephrops* fisheries in this area are fairly mixed also catching whiting, cod, megrim, anglerfish and other demersal species (Davie and

Lordan, 2011). *Nephrops* tend to dominate the landings of Irish fisheries in the area but catches are more mixed in the North (~50% *Nephrops*) and cleaner *Nephrops* towards the south (~75% *Nephrops*) (Gerritsen *et al.*, 2012). The French trawlers showed an overall decline in effort and landings during the last decade, mainly explained by decommissioning schemes associated to constraints linked to fuel prices.

In recent years several newer vessels specializing in *Nephrops* fishing have participated in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates.

UWTV survey coverage has improved. A new survey point will be available by autumn 2016 providing a more up to date estimate of density and abundance. The use of the most up to date survey information should be considered for this stock.

The ICES 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 controls to ensure effort and catch were in line with resources available.

7.17.10 References

Anon. 2011. Atlas of Demersal Discarding, Scientific Observations and Potential Solutions, Marine Institute, Bord Iascaigh Mhara, September 2011. ISBN 978-1-902895-50-5. 82 pp.

Charuau A., Morizur Y., Rivoalen J.J. 1982. Survival of discarded *Nephrops norvegicus* in the Bay of Biscay and in the Celtic Sea. ICES CM 1982/B:13.

Davie S., Lordan C. 2011. Definition, dynamics and stability of métiers in the Irish otter trawl fleet. Fish. Res. 111, 145-158. http://dx.doi.org/10.1016/j.fishres.2011.07.005 or http://hdl.handle.net/10793/673.

Gerritsen H.D., Lordan C. 2011. Integrating Vessel Monitoring Systems (VMS) data with daily catch data from logbooks to explore the spatial distribution of catch and effort at high resolution. ICES Journal of Marine Science, 68(1): 245–453.

Gerritsen H.D., Lordan C., Minto C., Kraak S.B.M. 2012. Spatial patterns in the retained catch composition of Irish demersal otter trawlers: High-resolution fisheries data as a management tool. Fisheries Research, Vol. 129–130, Pp 127–136. Available from http://www.sciencedirect.com/science/article/pii/S0165783612002032.

Lordan, C., Doyle, J., Fitzgerald, R., O'Connor, S., Blaszkowski, M., Stokes, D., Ni Chonchuir,G., Gallagher, J., Butler, R., Sheridan, M. ,Simpson, S., Blandon A. and Meakins, B. 2015. The Labadie, Jones and Cockburn Banks *Nephrops* Grounds (FU20–21) 2015 UWTV Survey Report and catch options for 2016. Marine Institute UWTV Survey report. http://hdl.handle.net/10793/1137.

ICES. 2009. Report of the Benchmark Workshop on *Nephrops* assessment (WK*NEPH*). ICES CM 2009/ACOM:33.

ICES. 2014a. Report of the Benchmark Workshop on Celtic Sea Stocks (WKCELT), 3–7 February 2014, ICES Headquarters, Copenhagen, Denmark. ICES CM 2014\ACOM:42. 194 pp.

ICES. 2014b. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 13–22 May 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:12.

ICES. 2016XX. EU request to ICES to provide F_{MSY} ranges for selected stocks in ICES subareas 5 to 10. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 5, Section 5.2.3.1.

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

O' Sullivan D., Lordan C., Doyle J., Berry A., Lyons K. 2013. Study of local hydrodynamics and larval dispersal on *Nephrops* fishing grounds. Irish Fisheries Investigation. No 26: Marine Institute.2014.http://hdl.handle.net/10793/985.

Stokes D., Gerritsen H., O'Hea B., Moore S.J., Dransfeld L. 2014. "Irish Groundfish Survey Cruise Report, 24 September–17 December 2014", FEAS Survey Series; 2014/01. http://hdl.handle.net/10793/1064.

Table 7.17.1. *Nephrops* FU 20–21. Landings in tonnes by country.

FU 20–21 Landings (t)				
Year	France	Rep. of Ireland	UK	Total
1995	3419	117	na	3536
1996	2721	101	na	2822
1997	1957	81	na	2038
1998	1583	130	na	1713
1999	1051	83	18	1152
2000	1661	107	10	1778
2001	1750	69	14	1833
2002	2559	104	11	2674
2003	2796	148	9	2953
2004	2140	299	4	2443
2005	2008	455	6	2469
2006	2066	450	7	2523
2007	1816	600	3	2419
2008	2036	937	7	2980
2009	1930	1202	13	3145
2010	975	756	62	1793
2011	566	637	34	1237
2012	453	708	28	1189
2013	486	844	57	1387
2014	465	1342	29	1837
2015	355	1620	141	2116

Table 7.17.2. *Nephrops* FU 20–21. Effort data for the Irish otter trawl *Nephrops* directed fleet.

Year	Effort (Kw Days)	Landings (tonnes)
1995	57	104
1996	49	74
1997	40	59
1998	56	102
1999	37	48
2000	39	62
2001	29	45
2002	78	165
2003	82	86
2004	159	164
2005	255	360
2006	301	348
2007	402	512
2008	562	920
2009	801	1,249
2010	498	633
2011	424	535
2012	357	534
2013	445	672
2014	885	1,170
2015	1,180	1,542

Table 7.17.3. *Nephrops* FU 20–21. Effort data for the French fleet.

Year	Effort France ('000 hrs)	LPUE France (kg/hr)
1983	231	14
1984	205	16
1985	203	16
1986	163	15
1987	190	15
1988	171	16
1989	179	17
1990	230	16
1991	225	11
1992	277	12
1993	268	13
1994	259	14
1995	239	15
1996	220	14
1997	187	13
1998	155	13
1999	151	11
2000	194	14
2001	170	15
2002	166	19
2003	192	18
2004	153	16
2005	147	16
2006	137	16
2007	102	19
2008	100	23
2009	93	23
2010	67	17
2011	52	12
2012	42	13
2013	48	12
2014	36	15
2015	35	11

Table 7.17.4. *Nephrops* FU 20–21. Sampling levels by country.

Ireland		Number of Samples			Numbers Measured		
Year	Quarter	Catch	Discards	Landings	Catch	Discards	Landings
2009	2	1			489		
2010	2	1			461		
2011	2	1			270		
2012	1	8	5	1	2654	2,024	1,747
2013	1	1	1		319	423	
2013	2	9	7	1	2514	2,038	2,187
2014	2	2	2		718	782	
2015	1			1			1,724
2015	2	6	6	2	2714	3,997	3,204
2015	3			4			4,750
2015	4	2	2		650	419	

France		Number of samples			Numbers measured		
Year	Quarter	Catch	Discards	Landings	Catch	Discards	Landings
2012	1		31	9		391	1,431
2012	2		13	8		198	1,202
2012	3		47	8		667	1,155
2012	4		6	6		16	860
2013	1		0	12		0	1,362
2013	2		68	72		1,120	3,151
2013	3		16	68		131	1,917
2013	4		2	14		12	1,303
2014	1		0	10		0	1,221
2014	2		40	47		1,127	3,536
2014	3		20	33		458	1,934
2014	4		0	9		0	1,360
2015	1		2	14		60	1,508
2015	2		24	44		520	3,249
2015	3		1	9		1	1,366
2015	4		0	9		0	1,357

Table 7.17.5. *Nephrops* FU 20–21. Sex ratio in the landings by country based on available sampling.

Ireland			
Year	**Females ('000s)**	**Males ('000s)**	**% Males in Landings**
2012	1,171	25,306	96%
2013	8,452	15,752	65%
2014	13,630	25,467	65%
2015	8,916	39,018	81%
France			
Year	**Females ('000s)**	**Males ('000s)**	**% Males in Landings**
2012	1,631	9,839	86%
2013	1,820	8,294	82%
2014	3,541	7,870	69%
2015	1,227	6,698	85%

Table 7.17.6. *Nephrops* FU 20–21. Landings and discards by number and weight (t), dead discard rate and discard rate by number, discard rate by weight and estimated mean weights (grs) in the landings and discards for Ireland.

Ireland										
Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	Discard Rate weight	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	%	tonnes	tonnes	gramme	gramme
2012	26.5	17.5	39.6	33%	40%	23%	708	207	26.7	11.9
2013	24.2	8.3	30.5	21%	26%	14%	844	137	34.9	16.4
2014	39.1	17.6	52.3	25%	31%	15%	1,342	233	34.3	13.3
2015	47.9	18.6	61.9	23%	28%	13%	1,620	248	33.8	13.4

***25% discards survival.**

Table 7.17.7. *Nephrops* FU 20–21. Landings and discards by number and weight (t), dead discard rate and discard rate by number, discard rate by weight and estimated mean weights (grs) in the landings and discards for France.

France										
Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	Discard Rate weight	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	%	tonnes	tonnes	gramme	gramme
2012	11.5	18.8	25.5	55%	62%	43%	453	344	39.5	18.4
2013	10.1	10.9	18.3	45%	52%	29%	486	195	48.1	17.9
2014	11.4	39.9	41.3	72%	78%	58%	465	639	40.8	16.0
2015	7.9	8.3	14.1	44%	51%	33%	355	174	44.8	21.0

***25% discards survival.**

Table 7.17.8. *Nephrops* FU 20–21. Landings and discards by number and weight (t), dead discard rate and discard rate by number, discard rate by weight and estimated mean weights (grs) in the landings combined by both countries and scaled to international landings based on available sampling.

Combined and scaled to the international landings										
Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	Discard Rate weight	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	millions	millions	%	%	%	tonnes	tonnes	gramme	gramme
2012	38.9	37.1	66.7	42%	49%	32%	1,189	565	30.6	15.2
2013	35.6	20.0	50.6	30%	36%	20%	1,387	347	38.9	17.3
2014	51.4	58.4	95.2	46%	53%	33%	1,836	886	35.7	15.2
2015	59.9	28.8	81.5	26%	32%	18%	2,116	452	35.3	15.7

***25% discards survival.**

Table 7.17.9. *Nephrops* FU 20–21. Results summary table for geo-statistical analysis of UWTV survey.

Ground	Year	Number of stations	Mean Density adjusted (burrows/m²)	Domain Area (km²)	Geostatistical Abundance Estimate adjusted (millions burrows)	CV on Burrow estimate
FU20–21	2006	9	0.44		nr	nr
	2012	54	0.57		nr	nr
	2013	55	0.16	5,701	942	3%
	2013*	55		10,014	1624	
	2014	98	0.19	10,014	2051	3%
	2015	96	0.2	10,014	2003	3%

*** the 2013 survey achieved partial coverage ~60% of the total area. The abundance has been scaled up to the entire area since densities in the unsurveyed part of the ground were not significantly different in 2014.**

nr= no reliable abundance estimate could be calculated because survey coverage was partial.

Table 7.17.10. ***Nephrops*** **FU 20–21. Short-term catch options prediction inputs and recent estimates of mean weight in landings and harvest rates.**

Year	Landings in number	Total discards in number*	Removals in number	Dead Discard Rate number	Discard Rate number	UWTV abundance estimate	95% Confidence Interval	Harvest rate	Landings	Total discards*	Mean weight in landings	Mean weight in discards
	millions	**millions**	**millions**	**%**	**%**	**millions**		**%**	**tonnes**	**tonnes**	**gramme**	**gramme**
2012	38.9	37.1	66.7	42%	49%	na			1,189	565	30.6	15.2
2013	35.6	20.0	50.6	30%	36%	1624	103	3.1%	1,387	347	38.9	17.3
2014	51.4	58.4	95.2	46%	53%	2051	131	4.6%	1,836	886	35.7	15.2
2015	59.9	28.8	81.5	26%	32%	2003	125	4.1%	2,116	452	35.3	15.7
			Average 13–15	**34.1%**	**40.5%**					**Average 13–15**	**36.7**	**16.1**

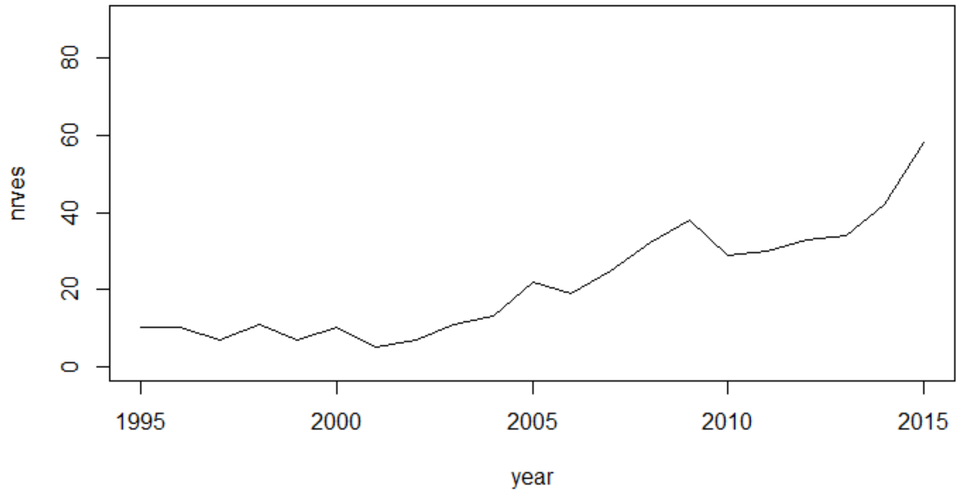


Figure 7.17.1. ***Nephrops*** **FU 20–21. Number of Irish vessels reporting landings >10 t.**

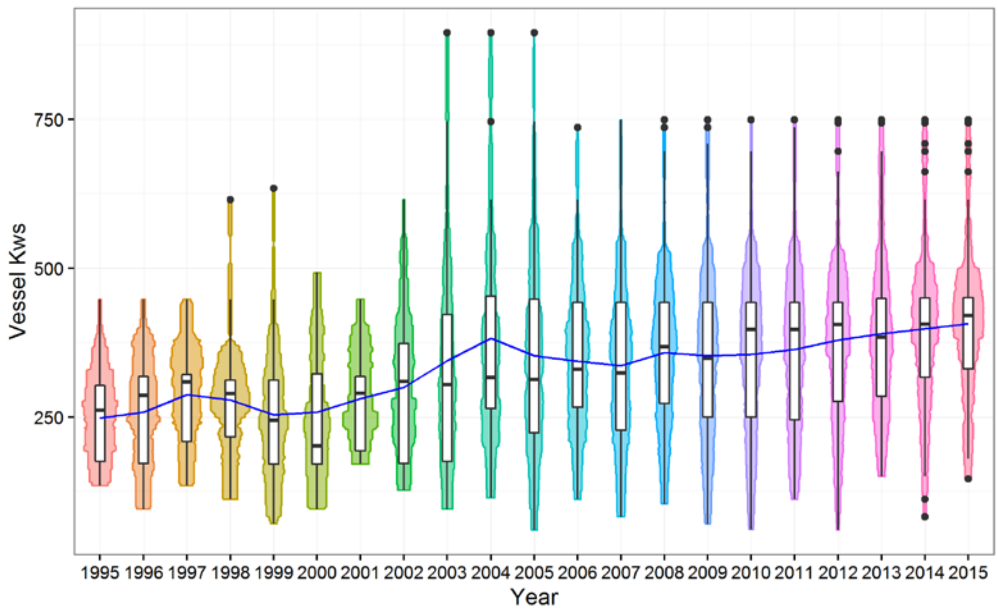


Figure 7.17.2. ***Nephrops*** **FU 20–21. Combined box and kite plot of vessel power on the FU20–21 grounds by year. The blue line indicates the mean.**

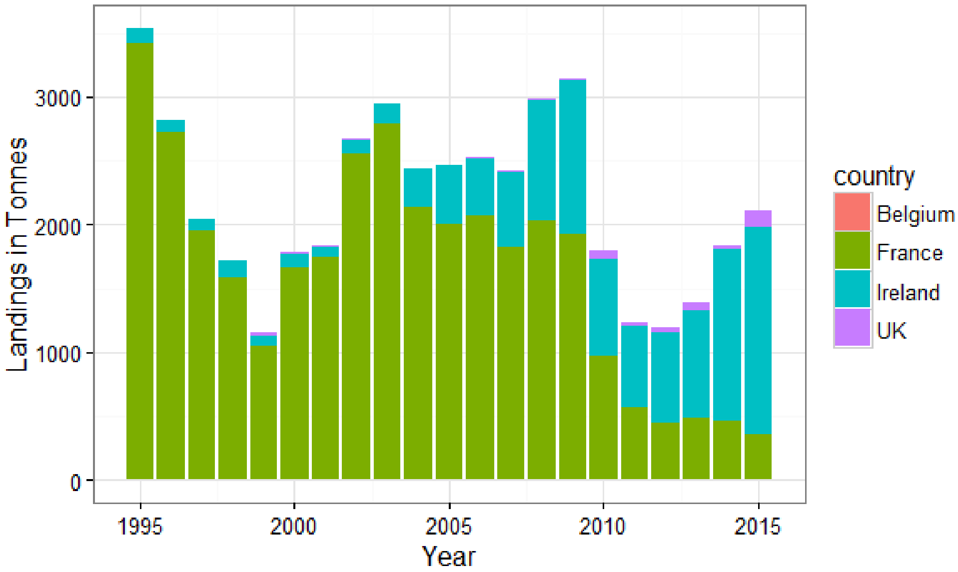


Figure 7.17.3. *Nephrops* FU 20–21. Landings in tonnes by country.

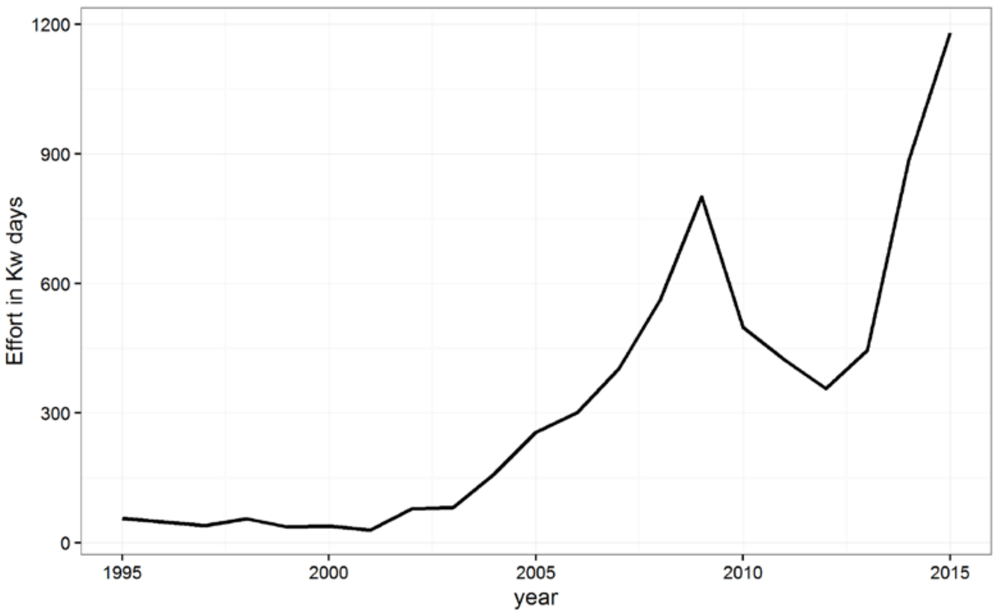


Figure 7.17.4. ***Nephrops*** **FU 20–21. Effort data (Kw days) for the Irish otter trawl** ***Nephrops*** **directed fleet.**

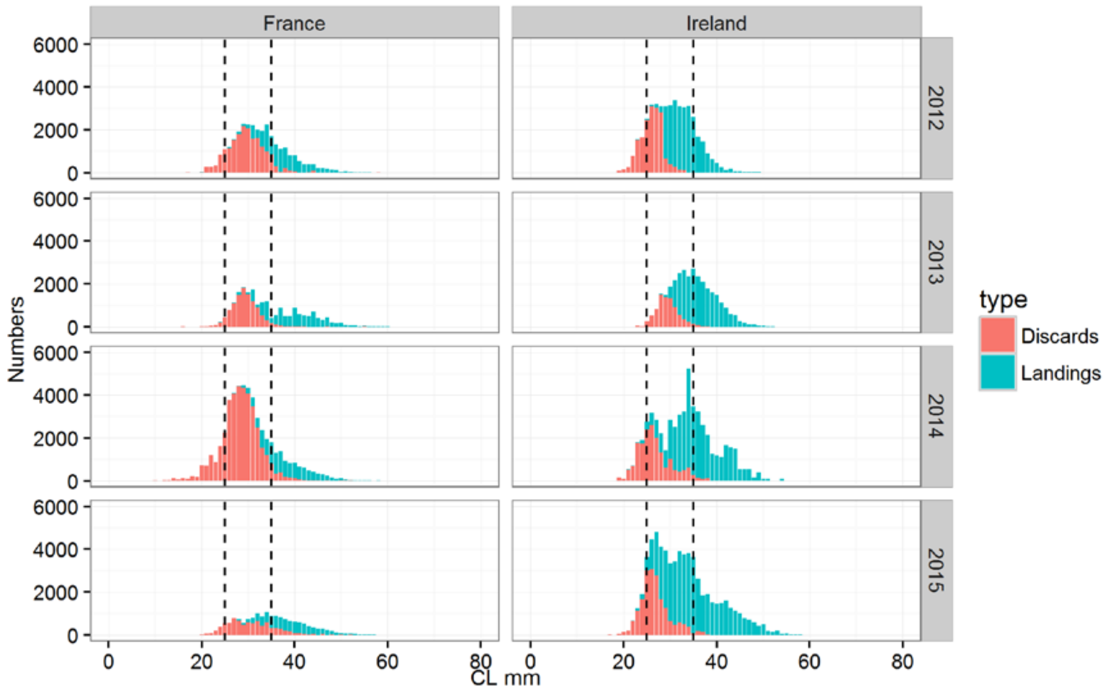


Figure 7.17.5. ***Nephrops*** **FU 20–21. Commercial length frequency distribution by country. Minimum landing size of 25 mm (European MLS) and 35 mm (French MLS) displayed.**

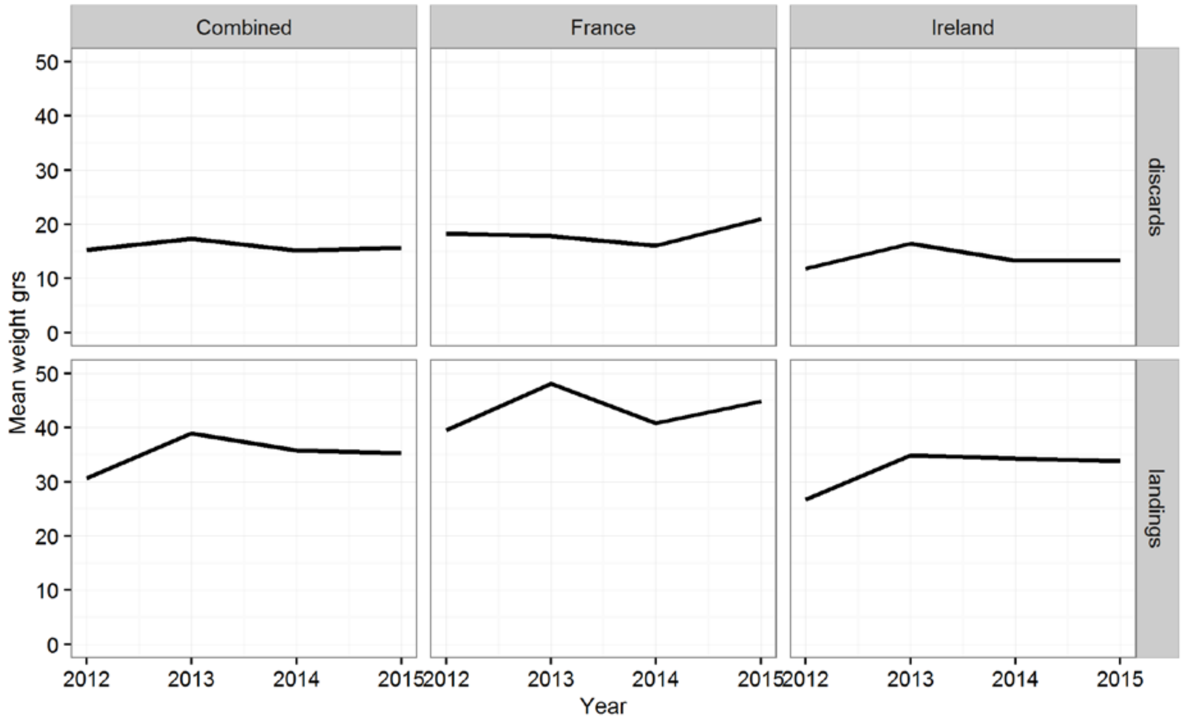


Figure 7.17.6. ***Nephrops*** **FU 20–21. Annual mean weights (gr) in the landings and discards by country and combined scaled to international landings.**

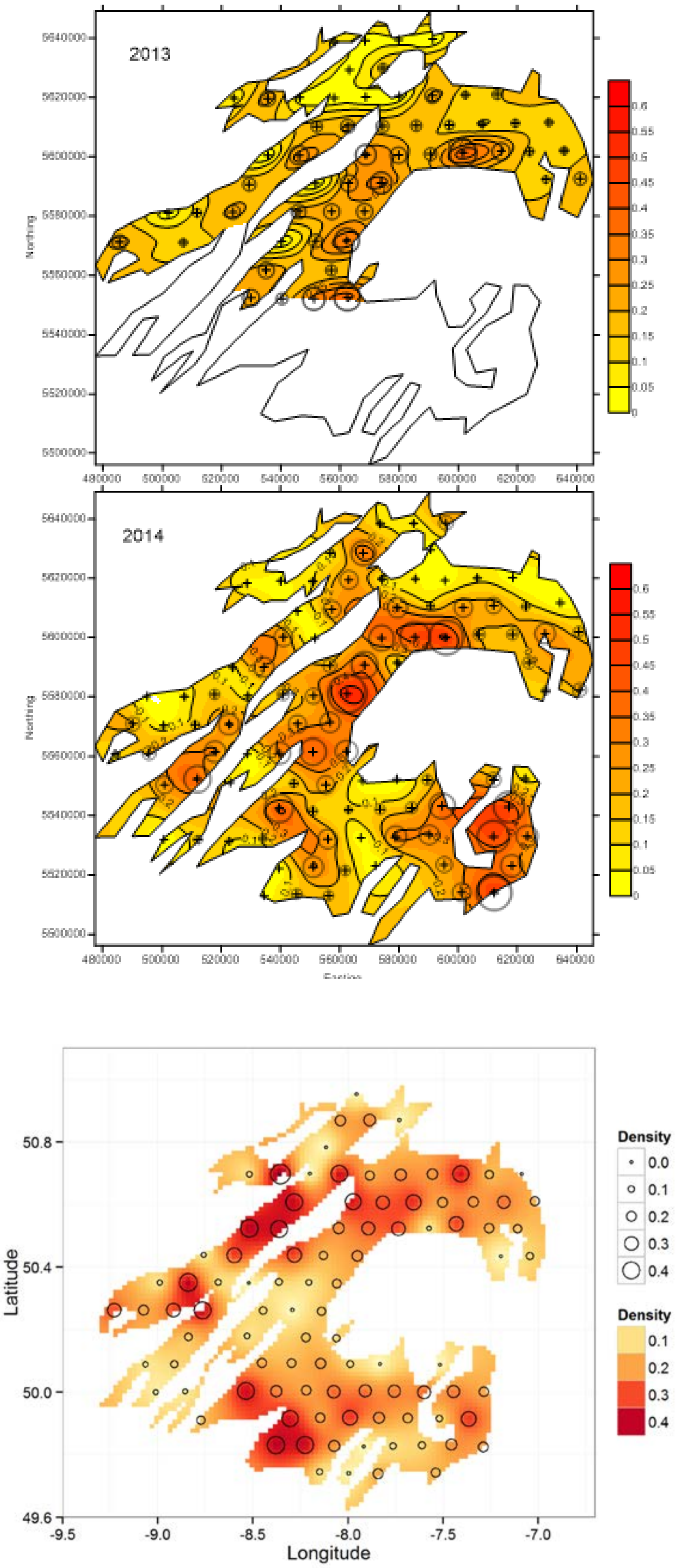


Figure 7.17.7. ***Nephrops*** **FU 20–21. Contour plots of krigged density estimates for the UWTV surveys from 2013 to 2015.**

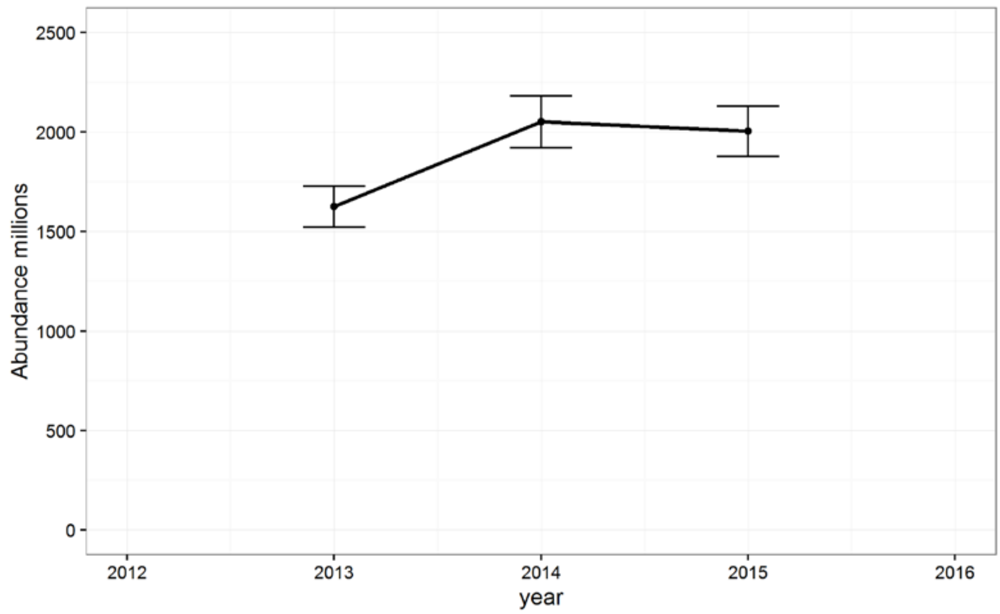


Figure 7.17.8. ***Nephrops*** **FU 20–21. Time-series of abundance estimates for FU20–21 (error bars indicate 95% confidence intervals).**

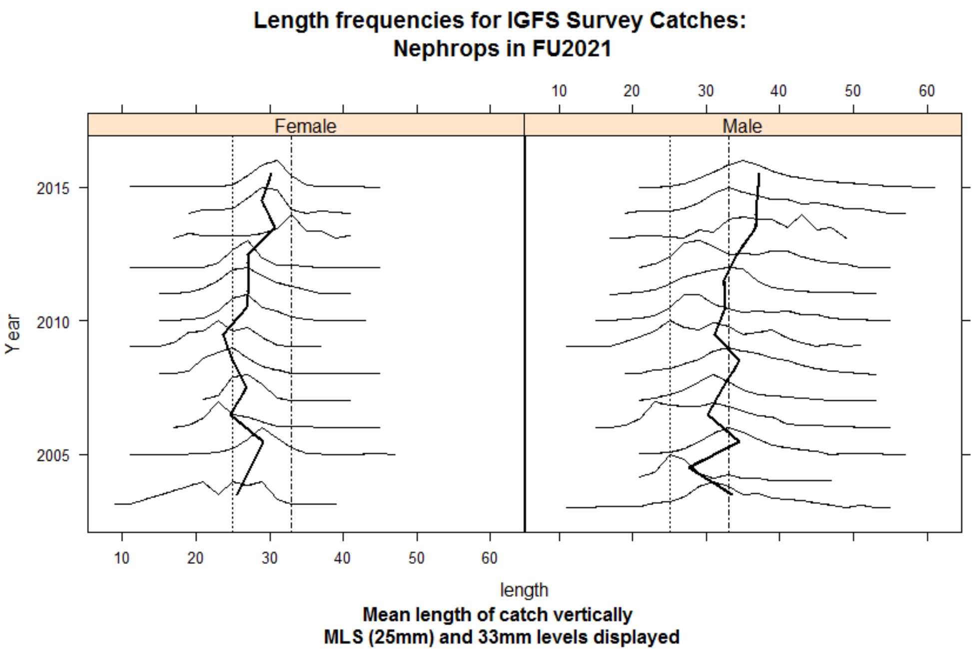


Figure 7.17.9.a. ***Nephrops*** **FU 20–21. Mean size trends for catches by sex from the IBTS-IGFS Irish survey in the Celtic Sea.**

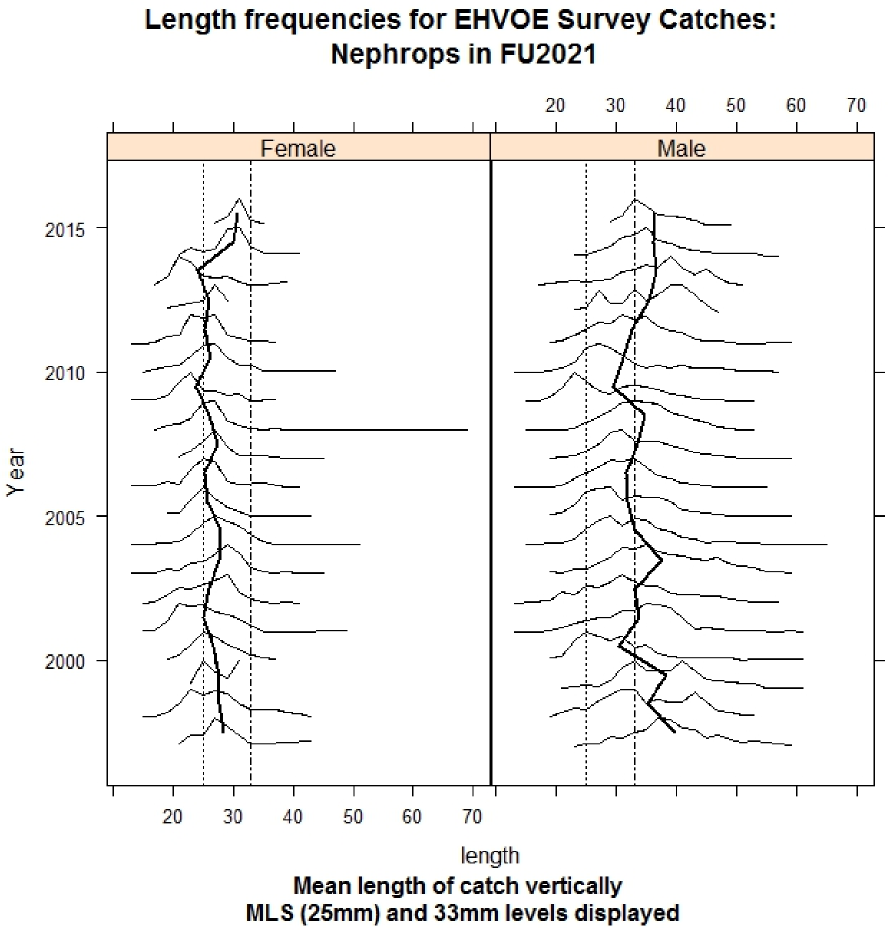


Figure 7.17.9.b. ***Nephrops*** **FU 20–21. Mean size trends for catches by sex from the IBTS-EVHOE French survey in the Celtic Sea.**

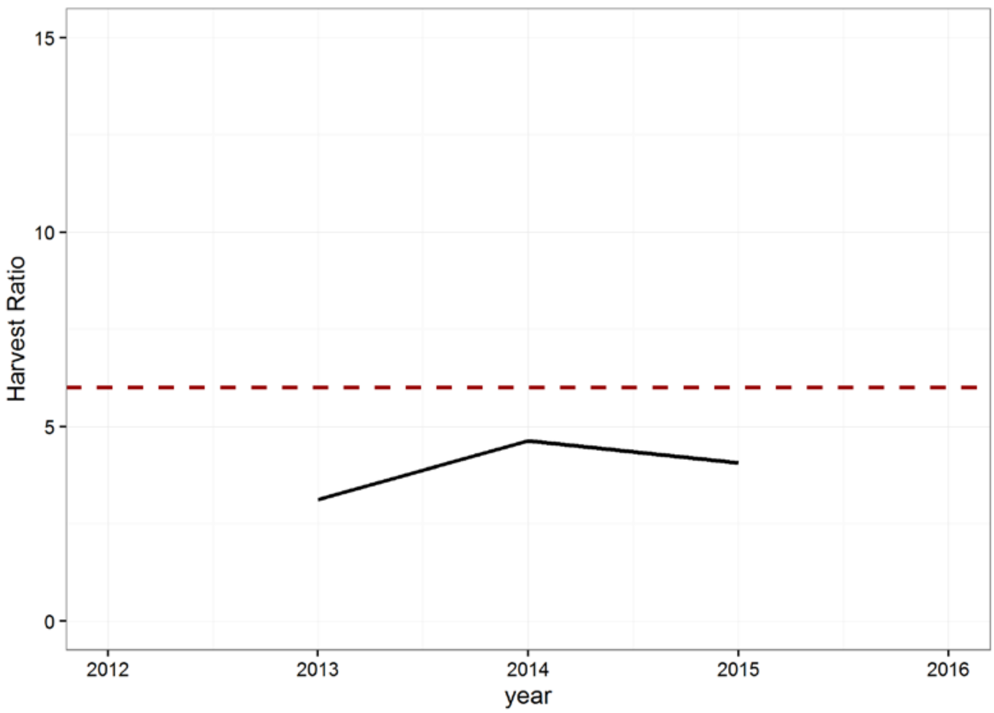


Figure 7.17.10. ***Nephrops*** **FU 20–21. Harvest ratio (% dead removed / UWTV abundance). The dashed and solid lines are the MSY proxy and the harvest rate respectively.**

8.2 Plaice in the Western Channel (ICES Division 7.e)

During this year's WGCSE an XSA assessment was performed with the settings defined in the stock annex. In addition, an exploratory assessment which incorporated available discard data (years 2012–2015) was also carried out for information.

Type of assessment in 2015

Last year's assessment report is available at: http://www.ices.dk/sites/pub/Publication Reports/Expert Group Report/acom/2015/WGCSE/08.02 Plaice VIIe 2015.pdf

ICES advice applicable to 2015

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/ple-echw.pdf

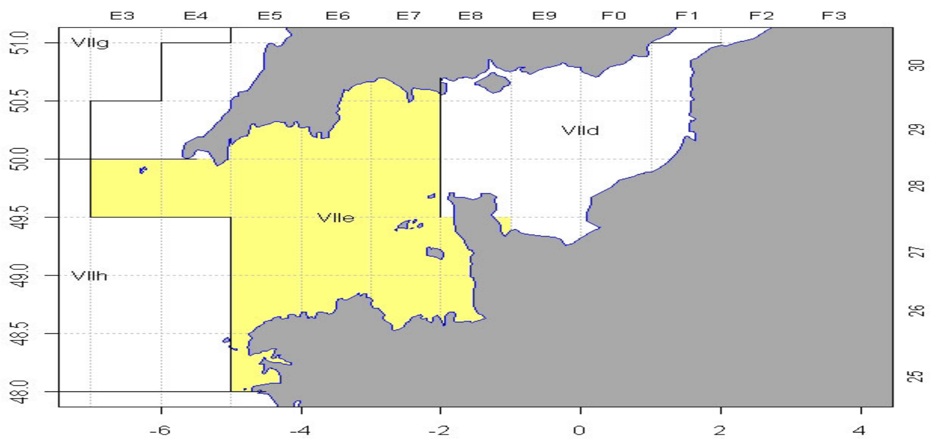
ICES advice applicable to 2016

Last year's advice is available at: http://www.ices.dk/sites/pub/Publication Reports/Advice/2015/2015/ple-echw.pdf

8.2.1 General

Stock description and management units

The management area for this stock is strictly that for ICES Division 7.e, called the Western English Channel. The TAC area does not correspond to the stock area given that it includes the larger component of 7.d (Eastern English Channel). However, WKFLAT 2010 found that a significant proportion of the catches of the 7.e stock are taken in the adjacent division during the spawning period. Plaice is not the main target species in 7.e, and it is generally taken as bycatch in fisheries targeting sole.



TAC area = 7.d-e; Assessment area = 7.e.

Management applicable to 2015 and 2016

There are technical measures in operation including a minimum 80 mm mesh size and a minimum landings size (27 cm) for this species.

The TAC and the national quotas by country for 2015

Species	Plaice *Pleuronectes platessa*	Zone	VIId and VIIe (PLE/7DE.)
Belgium	1018(7)		
France	3395(7)		
United Kingdom	1810(7)		
Union	6223		
TAC	6223		Analytical TAC

(7) In addition to this quota, a Member State may grant to vessels flying its flag and participating in trials on fully documented fisheries an additional allocation within an overall limit of 1 % of the quota allocated to that Member State, under the conditions set out in Chapter II of Title II of this Regulation.

(Source: Council Regulation (EU) 2015/1961).

The TAC and the national quotas by country for 2016

Species	Plaice *Pleuronectes platessa*	Zone	VIId and VIIe (PLE/7DE.)
Belgium	2037		
France	6788		
United Kingdom	3621		
Union	12 446		
TAC	12 446		Analytical TAC

(Source: Council Regulation (EU) 2015/104).

The fishery in 2015

A full description of the fishery is provided in the stock annex, Section A2.

In the Western English Channel, plaice are taken mainly as bycatch in bottom trawls targeting sole and anglerfish. In 2015, 94% of the landings were taken by bottom trawls (58% of these were beam trawls and 42% were otter trawls). Of the total international landings 73% were reported by the UK, 18% by France, 9% by Belgium and 0.06% by Ireland (Figure 8.2.1).

This stock is the smaller of the two plaice stocks that make up the larger TAC Area 7d–e. The landings from this stock amounted to 25% of the TAC in 2014 and 26% of the TAC in 2015.

Landings

National landings data reported to ICES and estimates of total landings used by the Working Group are given in Table 8.2.1. Total international reported landings in 2015 for 7.d were 1246 t. The Working Group estimate of the 2014 landings was revised upwards due to revisions to the landings by the UK and now amount to 1341 t (+0.15%).

Landings increased to near 3000 t during the latter half of the 1980s due to a series of good recruitments in 1987–1989, but subsequently dropped to levels fluctuating around 1500 t. After this period, landings declined to below the long-term average of the time-series at about 1200 t per annum. Since 2010, landings have increased slightly and are now stable slightly below 1500 t. Unallocated landings in recent years, are generally the additional French landings derived from sales note information.

In addition to the estimated 2015 landings for 7.e, an extra 178 tonnes was added from the 7.d plaice stock representing an adjustment for migration of 15% of the mature component of quarter 1 landings between the two divisions. This process was agreed at WKFLAT 2010, and the migration correction was revised at WKPLE 2015. The process has been described in the stock annex. A reciprocal correction was made to the 7.d plaice stock at WGNSSK 2016.

Data

Annual length composition data for 2015 was provided by the UK, France and Belgium (Figure 8.2.5). Length distributions of total UK(E&W) landings between 2006 and 2015 as used by the Working Group are illustrated in Figure 8.2.6.

Again this year, all nations provided data disaggregated by métier and by quarter and this was all uploaded into the ICES InterCatch database. Quarterly age compositions for landings in 2015 were available from the UK(E&W) only and were provided for five métiers. These data accounted for 73% of the total reported international landings. Additional landings data were available by quarter/métier for Belgium, France, Ireland, Netherlands, UK(E+W), UK(Guernsey) and UK(Jersey). These datasets were aggregated to an international age structure using the ICES InterCatch software.

An additional age composition representing the migration adjustment (15% of the mature component of quarter 1 landings for 7.d) for the combined nations of the UK(E&W), Belgium, France and the Netherlands was supplied on request by the WGNSSK coordinator for the 7.d plaice stock.

Details of the stratification of data provided to ICES in 2015 is given in the table below:

COUNTRY	FLEET	QUARTERLY DATA PROVISION			
		LANDINGS		DISCARDS	
		AGE STRUCTURE	TONNAGE	AGE STRUCTURE	TONNAGE
BELGIUM	OTB_CRU_70-99	–	Q1–Q4	–	–
BELGIUM	SSC_DEF_ALL	–	Q1	–	–
BELGIUM	TBB_DEF_70-99	–	Q1–Q4	–	–
FRANCE	DRB_ALL	–	Q1–Q4	–	–
FRANCE	GTR_DEF	–	Q1–Q4	–	–
FRANCE	GTR_DEF_>=220	–	Q1–Q4	–	Q2
FRANCE	GTR_DEF_120-219	–	Q1–Q4	–	Q2, Q4
FRANCE	GTR_DEF_100-119	–	Q1–Q4	–	–
FRANCE	MIS_MIS	–	Q1–Q4	–	Q2
FRANCE	OTB_DEF_100-119	–	Q1–Q4	–	Q2–Q4
FRANCE	OTB_DEF_70-99	–	Q1–Q4	–	Q1–Q4
FRANCE	OTT_DEF_100-119	–	Q1–Q4	–	–
FRANCE	SDN_DEF_70-99	–	Q1, Q2, Q4	–	Q2
FRANCE	TBB_DEF_70-99	–	Q1–Q4	–	Q2
IRELAND	OTB_DEF_70-99	–	Q4	–	–
IRELAND	SSC_DEF_100-119	–	Q4	–	–
NETHERLANDS	SSC_DEF_70-99	–	Q1	–	–
NETHERLANDS	SSC_DEF_70-99_FDF	–	Q1, Q4	–	–
UK (GUERNSEY)	ALL FLEETS	–	Q1–Q4	–	–
UK (JERSEY)	ALL FLEETS	–	Q1–Q4	–	–
UK (ENGLAND & WALES)	GNS_DEF_all	Q1–Q4	–		Q2–Q4
UK (ENGLAND & WALES)	GTR_DEF_all	–	Q2–Q4	–	Q3, Q4
UK (ENGLAND & WALES)	LLS_FIF	–	Q1–Q4		–
UK (ENGLAND & WALES)	MIS_MIS	Q1–Q4	–	Q1–Q4	–
UK (ENGLAND & WALES)	OTB_CRU_16-31	–	Q1, Q2, Q4	–	–
UK (ENGLAND & WALES)	OTB_CRU_70-99	–	Q3	–	–
UK (ENGLAND & WALES)	OTB_DEF_>=120	Q1–Q4	–	Q2–Q4	–
UK (ENGLAND & WALES)	OTB_DEF_70-99	Q1–Q4	–	Q1–Q4	–
UK (ENGLAND & WALES)	TBB_CRU_16-31	–	Q1, Q2, Q4	–	–
UK (ENGLAND & WALES)	TBB_DEF_>=120	–	Q4	–	–
UK (ENGLAND & WALES)	TBB_DEF_70-99	Q1–Q4	–	Q1–Q4	–
7.d MIGRATION (INT)	ALL FLEETS	ANNUAL	–	ANNUAL	–

The method for the derivation of the international catch numbers and the calculation of the catch and stock weights-at-age has been fully described in the Stock Annex, Section B1. Landings numbers-at-age (including the migration element) are given in Table 8.2.2 and plotted for the period 2006 to 2015 in Figure 8.2.7. Catch and stock weights-at-age are given in Tables 8.2.3 and 8.2.4.

Catch weights are assumed to be mid-year values and stock weights are interpolated back (in year) to January 1st, as standard for this stock. The standard settings used for natural mortality and the proportions of F and M before spawning were used (see the Stock Annex). This is consistent with the procedures developed and agreed at the benchmark workshop held in February 2010 (WKFLAT) and updated at the inter-benchmark meeting (IBPWCFlat2) in 2015.

Discards

Although discards have not been used in the assessment of 7.e plaice in the past, some discard data are available. Discard tonnages are available within InterCatch and were provided by the UK(E&W) for the years 2012–2015. In 2015 France provided discard tonnages for the first time. Belgium provided some discard data in 2012 and 2013. Age samples for discards have only been provided by the UK(E&W) but cover the years 2012–2015. Information about length distributions from samples for discards was provided by the UK, France and Belgium in 2015.

Although some discard information is available, the final update assessment did not use these data in accordance with the stock annex but an alternative assessment including the discard data were performed during WGCSE 2016. For this assessment available discard data within InterCatch by métier and quarter were used to raise total discards for this stock.

Available information on reported discard tonnage indicates a notable increase in discards in the recent years. During the past WGCSE meetings the discard rate was calculated for those métiers for which discard data were available within InterCatch. The total discard ratio was then estimated by calculating the arithmetic mean of the individual ratios. During this year's WGCSE data screening it turned out that this methodology caused a crucial underestimation of the actual discards. The reason for this underestimation is that there are some fleets with low discard rate, but these fleets only have a minor contribution to the total catches. Hence, the total ratio is biased towards these smaller fleets and does not reflect actual and reported discards. Even by looking at the total reported discards a substantial increase in discards was evident. It was decided to calculate the total discard ratio for plaice in 7.e as the weighted mean of available discard data, weighted by the contribution of the métier to the total catches. The composition of landings and discards is shown in Figure 8.2.2 and a comparison of the results from the different methods is shown in Figure 8.2.3. The agreed total discards ratios (weighted mean) are 24, 18, 45 and 52% for the years 2012–2015 respectively.

Biological

The natural mortality and the maturity ogives used were identical to previous assessments and as described in the stock annex.

Surveys

IBPWCFlat2 2015 updated the derivation of cpue estimates for the research surveys to make full use of the available sampling data. Updated cpue estimates exhibited similar temporal trends to those presented at previous Working Groups but with more variability due to the inclusion of additional numbers-at-age information.

Two surveys currently provide abundance estimates to the Working Group (Figure 8.2.4). The UK(E&W) commercial beam-trawl survey (UK-WEC-BTS) was terminated in 2013 due to a lack of UK science funding and excluded from the assessment input data in 2015. Detailed information on the survey protocols and area coverage can be found in the Stock Annex.

Since 2003, the UK Fisheries Science Partnership (FSP: Cefas-UK industry cooperative project) has been conducting a survey using commercial vessels with scientific observers and following a standard grid of stations extending from the Scilly Isles to Lyme Bay (UK FSP-7e). This survey covers a substantially larger area than the UK-WEC-BTS survey and is thought to be more representative of stock dynamics in UK waters. This dataset was first included in the 2007 assessment. There have been a number of vessel changes, gear changes and temporal variations in this survey series, but overall the survey has performed well in tracking year classes. Aggregated cpue estimates for the UK FSP-7e survey fluctuated below the average of the time-series until 2011. After that the index increased to the highest levels on record in 2014 but dropped in 2015.

Indices of abundance-at-age for the Quarter 1 South West Beam trawl (Q1SWBeam) survey started in 2006 and were included in the assessment for the first time in 2015. Including the Q1SWBeam survey in the assessment was considered appropriate by IBPWCFlat 2015 given the ability to track the progression of year classes among ages with few clear year effects and the loss of abundance estimates from the UK-WEC-BTS survey after 2013.

The Q1SWBeam survey is based on a stratified random survey approach that covers the entire region of the management area and some adjacent waters. The survey shows strong gradients in species composition within the Western Channel justifying the stratification approach. Age information provides estimates of abundance for all ages in the assessment. Theoretically, this removes the necessity of retaining the commercial lpue-at-age estimates. Internal consistency estimation is very difficult given the short time-series, and relatively small contrast in cohort strength observed (based on other series). Despite this, some cohort tracking is apparent and the signal matches the cohort signal from other survey series, particularly the UK FSP-7e survey. Cpue estimates for the Q1SWBeam survey gradually increased from 2006 to 2012 and increased rapidly thereafter to reach the highest levels on record in 2014 and dropped in 2015.

Commercial fleet effort and lpue

IBPWCFlat2 2015 revised the effort time-series for the UK beam (UK WECBT) and otter trawl (UK WECOT) fleets due to fluctuations in lpue estimates after 2012 arising from modifications in the UK e-logbook effort recording system. Revised landings numbers, effort in days and lpue estimates in kg per 1000 days exhibited similar temporal trends to those presented previously, except with greater stability after 2012. UK beam-trawl effort (days fished) in 2015 was 6% higher than observed in 2014 and was around the average of the last ten years. More detailed information on the distribution of effort by area and trends in the fishery can be found in the Stock Annex.

UK(E&W) otter trawl effort (days fished-GRT corrected) in 2015 was 32% lower than observed in 2014. Effort for the otter trawl fleet has declined since 1989 to reach the lowest levels on record in 2015.

UK(E&W) beam trawl effort (days fished-GRT corrected) increased between 1992 and 2004, and then remained stable at this high level until 2008. Effort in 2009 fell dramatically back to the levels observed in 2000, followed by an increase in 2010 to reach the high levels observed in the mid-2000s. Beam-trawl effort remained relatively stable above the long-term average of the time-series in the last three years.

8.2.2 Stock assessment

Catch-at-age analysis

During this year's WGCSE an XSA assessment was performed with the settings defined in the stock annex. In addition, an exploratory assessment which incorporated available discard data (years 2012–2015) was also carried out for information.

Data compilation and screening

The age range for the analysis was 2–10+ in accordance with the updated procedures outlined at IBPWCFlat2 2015 and detailed in the stock annex. The landings data were processed according to the stock annex and formed the reference dataset for this year's assessment. An additional dataset was created that included discards for 2012–2015. The process was the same as for the landings only assessment. Total catches were generated by raising discards by métier using InterCatch and the total catches in 7.e were corrected for migration by including 15% of mature quarter 1 landings and discards from 7.d.

As this was an update assessment, full data screening, tuning data and extensive exploratory XSA trials were not carried out.

For landings data screening, a separable VPA was carried out using the standard settings detailed in the stock annex. The results showed large negative residuals for age 2 in 2013 and 2014, possibly indicating some missing catch data for this age. A separable VPA carried out using the total catches including the discards had smaller residuals for age 2 in 2013 and 2014 but a high positive value in 2015. A catch curve analysis of the reported landings showed a decrease of the younger ages in recent years and an increase in older ages (Figure 8.2.8). The catch curves for the discards include only data for 2012–2015 but in general show an increase for all ages.

Available tuning information consisted of five fleets: three UK commercial series, UK otter historic, UK otter trawl, UK beam trawl; and two UK survey series: FSP-7e (UK(E&W)) and Q1SWBeam but in accordance with the decision of WGCSE in 2015, only the UK surveys were analysed and used in the assessment (Table 8.2.5). All used tuning indices indicate highly consistent year-class estimates. The cpue values for the FSP-7e and Q1SWBeam show a very similar pattern (Figure 8.2.9). Older ages increased in recent years whereas the younger ages decreased. Furthermore, both surveys indicate low values for age 2 in 2012 and 2013. The UK FSP-7e survey data for 2008 continue to be excluded from the assessment as decided at WGCSE 2009. Both surveys aggregated over all ages showed a significant drop in the cpue for 2015 compared to 2014 (Figure 8.2.4) but preliminary Q1SWBeam data for 2016 do not follow this trend and indicate an increase in 2016.

Update assessment

The settings used for the final run are shown in the table below. The full assessment history is given in the stock annex.

		2014 XSA	2015 XSA	2016 XSA	2016 XSA DISCARD TRIAL
Catch-at-age data	Landings	1980–2013, 1–10+, 15% mature Q1 catch from 7.d added	1980–2014, 2–10+,15% mature Q1 catch from 7.d added	1980–2015, 2–10+, 15% mature Q1 catch from 7.d added	1980–2015, 2–10+, 15% mature Q1 catch from 7.d added
	Discards	–	–	–	2012–2015, 2–10+, 15% mature Q1 catch from 7.d added
Fleets	UK-WEC-BTS – Survey	1986–2013, 1–8	–	–	–
	UK WECOT – Commercial	1988–2013, 3–9	–	–	–
	UK WECOT– Commercial historic	1980–1987, 2–9	–	–	–
	UK WECBT – Commercial	1989–2012, 3–9 (exc 2013)	–	–	–
	FSP-7e – Survey	2003–2013, 2–8 (exc. 2008)	2003–2014, 2–8 (exc. 2008)	2003–2015, 2–8 (exc. 2008)	2003–2015, 2–8 (exc. 2008)
	Q1SWBeam – Survey	–	2006–2014, 2–9	2006–2015, 2–9	2006–2015, 2–9
Taper		No	No	No	No
Taper range		–	–	–	–
Ages catch dep. Stock size		None	None	None	None
q plateau		7	6	6	6
F shrinkage se		2.5	1.0	1.0	1.0
Year range		5	3	3	3
Age range		4	3	3	3
Fleet SE threshold		0.5	0.3	0.3	0.3
Prior weighting		–	–	–	–
Plus group		10	10	10	10
F Bar Range		F(3–6)	F(3–6)	F(3–6)	F(3–6)

The log catchability residuals for the XSA run (landings only) are shown in Figure 8.2.10.

The residuals showed some variability with higher residuals for the youngest age (age 2) and the older ages. The residuals for both surveys indicate higher positive residuals for 2014, coinciding with the survey values for this year.

On average, the UK FSP-7e survey had the strongest influence (≥47%) on the survivor estimates across all ages. The Q1SWBeam survey frequently provided a relatively smaller contribution to survivor estimates The contribution of both surveys to survivor estimates was relatively similar across the year-classes (>90%), except for 2013 (80.3%). Fishing mortalities and stock numbers estimated from the final run are given in Tables 8.2.6 and 8.2.7, and the assessment summary is shown in Table 8.2.8. The 2008–2011 above average year classes have led to a further increase in spawning–stock biomass in 2014. The increase in SSB is mainly driven by stronger older age classes whereas the younger age classes appear to be below average. Landings in 2015 remained at a similar level to the three previous years. Fishing mortality has declined by 31% between 2014 and 2015.

A seven-year retrospective analysis (Figure 8.2.11) was conducted in accordance with the procedures agreed at IBPWCFlat2 2015. The recruitment showed a large retrospective pattern with strong underestimation in 2013 and 2014, and overestimation in 2014. The deviations for fishing mortality and spawning–stock biomass were less pronounced.

Retrospective patterns in stock status and fishing mortality estimates exhibited an unacceptably high degree of temporal variability since the late-1990s, thereby indicating an excessive level of uncertainty and a lack of robustness in the assessment outputs. At present, a full analytical assessment of the status of the plaice 7.e stock with a high degree of confidence is not possible given the inherent retrospective bias. Consequently, since 2015 the Working Group assessed the status of the plaice 7.e stock using a qualitative evaluation of survey trends only in accordance with the ICES Data-Limited Stock (DLS) category 3 approach.

Comparison with previous assessments

Exactly as in the last year this year's category 3 assessment is indicative of trends only. Relative values for recruitment, spawning–stock biomass and fishing mortality estimates exhibited similar temporal trends to absolute values presented at previous working groups. Fishing mortality is estimated to have decreased by 31% between 2014 and 2015, and is now at the lowest level on record, 67% below the long-term average of the time-series. Spawning–stock biomass is estimated have increased by 21% between 2014 and 2015.

Alternative assessment with discards included

An alternative assessment was deployed to incorporate available discard data for 2012–2015. XSA was used as assessment method and exactly the same setting and surveys as used for the landings only assessment were used, but catches included landings and discards. Furthermore, the migration correction from 7.d was also corrected for discards.

A comparison of the results of the two assessment is shown in Figure 8.2.13. The estimated recruitments are very similar throughout the time-series. Until about 2010 the recruitment from the assessment using total catches is marginally lower and starting in 2011 is notably higher. Historical fishing mortality is marginally lower until 2011, then marginally higher in 2012 and 2013. After that fishing mortalities estimated from the two assessment diverge. The model using only landings implies a continuous decrease in fishing mortality from 2012–2015 whereas the model using total catches indicates a strong increase in 2014 and a further but slower increase in 2015. SSB results are very similar except for 2015. If total catches are used the SSB still increases but the increase is substantially slowed down in 2015.

The residuals are shown in Figure 8.2.14 and the retro-analysis in Figure 8.2.15. The residuals for the FSP-7e and the Q1SWBeam are very similar in both assessments. The retro analysis from the total catches assessment indicate a slightly larger variability.

State of the stock

At WGCSE it was decided to use the assessment which used only the landings data as final assessment. A summary of this assessment is given in Table 8.2.8 and Figure 8.2.12. Relative values have been presented for recruitment, spawning–stock biomass and fishing mortality estimates given that the Category 3 assessment is indicative of trends only.

Spawning–stock biomass was relatively stable from 1982 to 1985 and then increased until 1989 above the long-term average following strong recruitment events during the mid-1980s. Subsequently, spawning stock biomass decreased until 1996. A strong year class in 1996 generated an increase in spawning–stock biomass between 1996 and 2000. However, successive poor year classes resulted in spawning–stock biomass declining to the lowest levels in 2007. A combination of above average recruitment from 2010 to 2012, and a reduction in fishing mortality has increased spawning–stock biomass since 2008 to reach the highest level on record in 2015.

Fishing mortality gradually increased from the 1980s up until the 2000s, peaking briefly in 2007. Following a large reduction in fishing mortality in 2009, this assessment shows a general decline that has reached the lowest levels on record in 2015.

Two periods of below average recruitment in the period 1990–1995 and from 1999–2009 contributed to the decrease in yield and spawning–stock biomass between 2007 and 2009. This assessment estimates that recruitment has been above the long-term geometric mean (1980–2014) since 2010.

However, the optimistic stock development in recent years is uncertain due to assessment uncertainty and omitting discard information. The decision to omit discard data is mainly due to uncertainty in the actual discard rate and unknown proportion of surviving plaice in the discards. The actual stock status is likely to be between the stock levels suggested by the two assessment models performed during WGCSE 2016.

8.2.3 Short-term projections

As in 2015 plaice in 7.e continues to be treated as a category 3.2.0 stock and the assessment is indicative of trends only. Therefore, catch advice was provided by applying the ICES DLS framework for category 3 stocks where temporal trends in spawning–stock biomass are used as an index of stock development. The advice is based on a comparison of the two latest index values (index A) with the three preceding values (index B), multiplied by the recent advised catch. The SSB estimates from the landings only assessment are used as index values for this stock.

The basis for the catch options for 2017 has been presented in Table 8.2.9. For stocks in ICES data categories 3–6, one catch option is provided.

The index ratio suggests an increase by more than 20% (48%) and therefore the uncertainty cap was applied. The stock status relative to candidate reference points is unknown. The precautionary buffer was not applied given the large increase in the spawning–stock biomass index.

If the index is replaced by the SSB estimates from the alternative assessment including the discards or the two used survey indices on their own (FSP-7e and Q1SWBeam) the advised change in the catches would be +30%, +99% and +100% respectively. For these indices the uncertainty cap came into force and also capped the catch increase at a level of 20%. Hence, the choice to use the landings only assessment as the basis of the advice appears to be reasonable as alternative approaches lead to the same result.

Catches of plaice in 7.e should not exceed 2714 t in 2017 when the precautionary approach is applied.

As the discard rate is increasing in the recent past for this year's advice only the past two years were used to calculate the average discard rate. If this stock is not under the EU landing obligation in 2017 and discard rates do not change from the average (2014–2015), landings should be no more than 1391 t.

The proportion of the landings taken in 7.d calculated this year (10%) differs notably from the estimate from last year's advice (14%). The reason for this difference is that at this year's WGCSE meeting only the mature proportion of the landings in quarter 1 in 7.d was used for the calculation in accordance with WKPLE 2015 and the stock annex. WGCSE 2015 failed to correct this calculation and used the total 15% quarter 1 landings in 7.d. instead of just the mature proportion of these landings.

Assuming the same proportion of plaice 7.e is taken in 7d as on average in the last ten years (2006–2015), this will correspond to catches of no more than 2454 t in 7.e. If this stock is not under the EU landing obligation and discard rates do not change from the average (2012–2014), this implies landings of no more than 1258 t in 7.e in 2017.

8.2.4 Biological reference points

Reference points for 7.e plaice were calculated at WKMSYREF4 2015 using the results from an XSA with parameters implemented at WGCSE 2015. In contrast to the WGCSE assessment 2015, absolute values from the XSA assessment were used instead of the relative values for the calculation of the values. ICES did not adopt these reference point due to the classification of the plaice 7.e as category 3.

Instead MSY proxies were calculated at WKMSYPROXY 2015 (ICES, 2016b) which are presented in the following table.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$ proxy	1910 t	F_{MSY} (estimated by SPiCT from model parameters using data from 1980-2014)	WKPROXY 2015 (ICES, 2016b)
	F_{MSY} proxy	0.56	0.5 x B_{MSY} (estimated by SPiCT from model parameters using data from 1980–2014)	WKPROXY 2015 (ICES, 2016b)

If the assessment results are treated as absolute values, the stock is in a desirable state.

8.2.5 Management plans

There is no management plan in place for this stock.

8.2.6 Uncertainties and bias in assessment and forecast

A degree of uncertainty exists over the landings statistics for this stock given that mature plaice migrate between 7.d and 7.e during the spawning period. The current assessment applies a spawning migration correction that reallocates 15% of quarter 1 landings for the mature proportion of the catch from 7.d to 7.e. Consequently, the assessment results depend on the mixing rate assumption estimated from existing tagging data. Further work is required to examine stock structure and the mixing rate during the spawning period. Additional data are also needed to determine if the current mixing rate remains valid given the increased abundance of plaice stocks in the English Channel in recent years.

Revisions to plaice migration rates between 7.d and 7.e outlined at WKPLE 2015 resulted in problems with the derivation of international catch numbers and weights-at-age in the time available at this year's Working Group. The revised migration correction included reallocating 15% of quarter 1 landings for the mature proportion of the catch from 7.d to 7.e and applying the associated age composition to plaice 7.e. Data corrected for the revised migration rate included an amended landings tonnage and an associated age composition (numbers and mean weights-at-age) between 1980 and 2014 provided by the plaice 7d stock assessor. For each year, the corrected data were added to the international annual age composition for plaice 7.e following standard procedures outlined in the stock annex. The resulting combined dataset consisted of revised annual landings, catch numbers-at-age and weights-at-age that was included in the assessment for the first time in 2015.

There is a heavy reliance on the age composition data derived from UK(E&W) sampling. Around 25% of the landings for this stock are taken by countries that do not provide age-based data and this situation is improved only slightly once the migration correction data from 7.d are added.

Reliable discard data are only available for 2012–2015 and these data are mainly from the UK(E&W). France reported discard data for the first time in 2016 for 2012. Historical discards rate are highly uncertain but available discard data reported imply a significant increase in the last years. Discards are not included in the assessment. The assessment contains a certain degree of uncertainty due to excluding discards and is likely to be overly optimistic. Fishing mortality is likely to be higher and SSB lower than estimated by the current assessment. The decision to exclude discards in the assessment is based on the uncertainty in the available discards data and unknown discard survival rate of plaice.

8.2.7 Recommendation for next Benchmark

A benchmark assessment was developed for this stock at WKFLAT 2010 and an inter-benchmark meeting (IBPWCFlat2) subsequently convened in 2015 to revise the input data and update the XSA assessment settings. Nevertheless, any future benchmark meeting will need to consider the following issues.

- Smoothing of stock and catch weights. The raw catch weights are corrected for migration from 7.d and then smoothed using a polynomial function of 2nd degree. Even though the fit seems to quite reasonable different more appropriate methods should be evaluated.
- Abundance estimates derived from the UK FSP-7e and Q1SWBeam surveys included in the assessment are spatially restricted to the same areas as the commercial tuning fleets, and therefore little population abundance in-

formation exists along the French coast. Cpue estimates from additional research surveys in French coastal waters would improve the robustness of future assessment outputs.

- Investigate the addition of age-composition information from the French and Belgian fleets. These fleets collectively account for about 30% of the total landings of this stock. In particular, inclusion of French data would add information on the stock dynamics on the French coast.
- Discard estimates should continue to be collected for inclusion in future assessments to provide a better understanding of the international catch composition and improve estimates of total mortality.

8.2.8 Management considerations

The stock unit (Division 7.e) does not correspond with the management unit (Divisions 7.d and 7.e), and this divisional mismatch hampers the effective management of plaice in the Western English Channel. However, some provision must be made to consider the effective management of adjacent plaice stocks given that components of the 7.e stock are also taken during spawning period in 7.d. WKPLE 2015 revised the established migration correction, so that 15% of quarter 1 landings for the mature proportion of the catch are reallocated from 7.d to 7.e and the associated age composition is applied to plaice 7.e.

The total allowable catch (TAC) for the management area for 2016 has been doubled compared to 2015 which might lead to overexploitation of the 7.e plaice stock.

The discard rate in 7.e has increased substantially in recent years and averaged 49% in 2014–2015. The discard rate is now higher than for the more easterly plaice stocks (North Sea and Eastern English Channel) but not as high as for the more westerly stocks (Bristol Channel, Celtic Sea and Irish Sea). Discarding should be monitored closely and information from additional fleets is desirable.

Due to migration patterns, catches of this stock also occur in Division 7.d during the spawning period; therefore, to be consistent with the advised catch for the Division 7.e plaice stock, the actual catches of plaice in Division 7.e should be lower than the advised catch for the stock. ICES has calculated the corresponding actual catches in Division 7.e, assuming that the proportion of Division 7.e stock catches taken in Division 7.d remains as in previous years (i.e. 10%, the average of 2006–2015, taking the age structure of the population into account). As the mixing rate of the two plaice stocks is uncertain, this calculation provides only a first approximation.

Plaice are primarily taken as bycatch in the beam-trawl fishery targeting a mixed species fishery including sole, monk and cuttlefish, and as part of a mixed demersal fishery by otter trawlers. The restrictions under the management plan for sole 7.e appear to have benefited the plaice stock.

A full analytical assessment of the plaice 7.e stock was not possible at WGCSE 2016 due to uncertainties in the assessment and available data for landings and discards. Consequently, this year’s category 3 assessment is indicative of trends only. Relative values presented for recruitment, spawning–stock biomass and fishing mortality estimates had similar temporal trends to absolute values presented at previous Working Groups. This year’s trends-based assessment estimates that spawning–stock biomass is at a record high and fishing mortality is at a record low.

8.2.9 References

Council Regulation (EU) 2015/104 of 19 January 2015 fixing for 2015 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union vessels, in certain non-Union waters, amending Regulation (EU) No 43/2014 and repealing Regulation (EU) No 779/2014. OJ L22/1.

Council Regulation (EU) 2015/1961 of 26 October 2015 amending Regulation (EU) 2015/104 as regards certain fishing opportunities. OJ L 287/1.

Council Regulation (EU) 2016/72 of 22 January 2016 fixing for 2016 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, and amending Regulation (EU) 2015/104. OJ L22/1.

ICES. 2015a. Report of the Benchmark Workshop on Plaice (WKPLE), 23–27 February 2015, ICES Headquarters, Copenhagen, Denmark. ICES CM 2015/ACOM:33. 200 pp.

ICES. 2015b. Report of the Inter-Benchmark Protocol of West of Channel Flatfish (IBPWCFlat), From January to March 2015, By correspondence. ICES CM 2015/ACOM:36. 157 pp.

ICES. 2015c. Report of the Second Inter-Benchmark Protocol on West of Channel Flatfish (IBPWCFlat2), June–September 2015, By correspondence. ICES CM 2015/ACOM:55. 142 pp.

ICES. 2015d. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 12–21 May 2015, ICES Headquarters, Copenhagen, Denmark. ICES CM 2015/ACOM:12.

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

ICES. 2016b. Report of the Workshop to consider MSY proxies for stocks in ICES category 3 and 4 stocks in Western Waters (WKProxy), 3–6 November 2015, ICES Headquarters, Copenhagen. ICES CM 2015/ACOM:61. 183 pp.

Table 8.2.1. Plaice in 7.e. Nominal landings (t) in Division 7e, as used by the Working Group.

Year	Landings											Discards	
	Belgium	Denmark	Netherlands	France	UK (E &W) incl. CI's	Others	Total reported	Unallocat-ed*	Total	7.e stock caught in	As used by WG	Reported discards	ICES esti-mate dis-
1976	5	-	-	323	312	-	640	-	640	-	640		
1977	3	-	-	336	363	-	702	-	702	-	702		
1978	3	-	-	314	467	-	784	-	784	-	784		
1979	2	-	-	458	515	-	975	2	977	-	977		
1980	23	-	-	325	609	9	966	113	1079	99	1178		
1981	27	-	-	537	953	-	1517	−16	1501	175	1676		
1982	81	-	-	363	1109	-	1553	135	1688	190	1878		
1983	20	-	-	371	1195	-	1586	−91	1495	219	1714		
1984	24	-	-	278	1144	-	1446	101	1547	211	1758		
1985	39	-	-	197	1122	-	1358	83	1441	236	1677		
1986	26	-	-	276	1389	-	1691	119	1810	268	2078		
1987	68	-	-	435	1419	-	1922	36	1958	314	2272		
1988	90	-	-	584	1654	-	2328	130	2458	377	2835		
1989	89	-	-	448	1712	-	2249	109	2358	384	2742		
1990	82	2	-	N/A	1891	2	1977	616	2593	392	2985		
1991	57	-	-	251	1326	-	1634	214	1848	335	2183		
1992	25	-	-	419	1110	14	1568	56	1624	258	1882		
1993	56	-	-	284	1080	24	1444	−27	1417	197	1614		
1994	10	-	-	277	998	-	1285	−129	1156	248	1404		
1995	13	-	-	288	857	-	1158	−127	1031	216	1247		
1996	4	-	-	279	855	-	1138	−94	1044	222	1266		
1997	6	-	-	329	1038	1	1374	−51	1323	260	1583		
1998	22	-	-	327	892	1	1242	−111	1131	215	1346		
1999	12	-	-	194	947	-	1153	146	1299	244	1543		
2000	4	-	-	360	926	+	1290	−9	1281	345	1625		
2001	12	-	-	303	797	-	1112	−6	1106	204	1310		
2002	27	-	-	242	978	+	1247	10	1257	215	1472		
2003	39	-	-	216	985	-	1240	37	1277	110	1387		
2004	46	-	-	184	912	-	1142	70	1212	126	1337		
2005	48	-	-	198	887	-	1133	70	1203	117	1319		
2006	52	-	-	223	964	-	1239	74	1313	97	1411		
2007	84	-	-	202	678	-	964	39	1003	143	1146		
2008	66	-	-	148	674	-	888	88	976	135	1112		
2009	53	-	2	191	726	5	977	−54	923	101	1024		
2010	51	-	2	227	837	2	1119	−27	1092	116	1208		
2011	141	-	3	274	932	6	1356	−22	1334	83	1417		
2012	136	-	-	224	1006	-	1366	0	1366	126	1492	309	380
2013	99	-	-	215	1037	-	1351	0	1351	121	1472	229	291
2014	41	-	-	322	978	-	1341	-2	1339	149	1488	796	1226
2015	111	-	1	224	909	1	1246	-1	1245	178	1423	1230	1408

***Estimated by the Working Group.**

****Migration correction (15% of the mature population caught in Quarter 1 in Division 7.d) added to stock.**

Table 8.2.2. Plaice in 7.e. Catch numbers-at-age.

	NUMBERS-AT-AGE [THOUSANDS]									
year/age	2	3	4	5	6	7	8	9	10+	TOTALNUM
1980	754	758	244	226	62	63	22	13	137	2279
1981	667	2068	555	118	101	20	46	18	94	3688
1982	279	1928	1371	257	87	82	16	28	121	4168
1983	720	799	1613	586	101	40	47	2	99	4009
1984	928	1650	659	518	191	90	28	33	50	4146
1985	596	1424	1326	154	248	140	27	15	51	3980
1986	914	2326	908	478	110	127	66	29	61	5018
1987	1063	2083	1355	648	228	86	49	44	51	5608
1988	1817	4627	1087	456	149	112	38	24	52	8362
1989	269	2748	2873	825	268	118	94	31	100	7326
1990	331	3151	2668	1198	263	133	76	56	71	7946
1991	557	1192	1876	956	510	103	43	33	51	5320
1992	699	1299	734	646	441	258	69	32	49	4227
1993	670	1377	631	262	267	216	165	39	85	3712
1994	326	1503	831	250	106	116	78	84	63	3357
1995	322	732	943	263	118	56	79	68	88	2667
1996	1050	668	379	382	122	59	38	47	105	2848
1997	861	2228	435	177	147	75	31	17	99	4070
1998	536	1482	1107	155	64	60	22	21	61	3507
1999	650	2135	1124	407	92	37	39	17	45	4546
2000	351	1157	2037	496	181	38	14	22	52	4348
2001	469	785	788	950	145	79	19	11	37	3283
2002	1017	1190	460	394	456	106	42	12	40	3718
2003	886	964	532	182	166	236	58	45	38	3107
2004	471	1364	566	338	107	74	109	51	38	3119
2005	796	880	775	277	146	50	49	58	48	3080
2006	995	1358	517	379	115	61	27	18	53	3523
2007	393	1077	699	287	199	72	31	10	50	2819
2008	919	703	570	259	112	87	32	15	29	2727
2009	647	1255	297	151	79	32	21	7	17	2505
2010	759	974	758	215	114	47	16	18	23	2924
2011	1132	1441	725	255	75	50	27	12	18	3735
2012	204	1561	1066	373	253	101	51	21	35	3664
2013	137	1075	1377	510	200	149	45	49	36	3579
2014	241	780	1514	786	312	115	54	43	27	3872
2015	180	512	712	910	495	203	54	41	29	3135

Table 8.2.3. Plaice in 7.e. Catch weights-at-age.

	Catch weights-at-age [kg]								
year/age	2	3	4	5	6	7	8	9	10+
1980	0.328	0.433	0.536	0.638	0.738	0.837	0.935	1.031	1.387
1981	0.272	0.399	0.524	0.645	0.764	0.88	0.994	1.104	1.443
1982	0.3	0.388	0.47	0.544	0.612	0.673	0.727	0.774	0.883
1983	0.224	0.338	0.446	0.547	0.642	0.73	0.812	0.888	1.085
1984	0.252	0.353	0.458	0.566	0.677	0.791	0.907	1.027	1.499
1985	0.222	0.337	0.45	0.561	0.669	0.775	0.878	0.979	1.341
1986	0.26	0.353	0.45	0.551	0.655	0.764	0.877	0.994	1.489
1987	0.285	0.344	0.415	0.499	0.595	0.705	0.827	0.961	1.377
1988	0.225	0.31	0.407	0.515	0.634	0.764	0.905	1.058	1.397
1989	0.224	0.293	0.37	0.454	0.547	0.647	0.756	0.872	1.166
1990	0.269	0.314	0.369	0.435	0.512	0.599	0.697	0.806	1.076
1991	0.251	0.315	0.388	0.471	0.564	0.668	0.781	0.905	1.242
1992	0.283	0.341	0.412	0.497	0.594	0.705	0.828	0.965	1.315
1993	0.262	0.336	0.416	0.501	0.593	0.691	0.794	0.903	1.188
1994	0.263	0.332	0.407	0.488	0.575	0.667	0.765	0.868	1.122
1995	0.282	0.362	0.444	0.53	0.618	0.708	0.802	0.898	1.082
1996	0.268	0.37	0.473	0.576	0.68	0.785	0.89	0.996	1.214
1997	0.272	0.345	0.426	0.513	0.607	0.708	0.815	0.93	1.194
1998	0.19	0.313	0.435	0.556	0.675	0.794	0.912	1.029	1.34
1999	0.206	0.295	0.382	0.466	0.548	0.628	0.706	0.781	1.005
2000	0.205	0.292	0.379	0.466	0.553	0.64	0.727	0.814	1.063
2001	0.218	0.301	0.388	0.48	0.576	0.677	0.782	0.891	1.267
2002	0.25	0.323	0.401	0.485	0.575	0.67	0.77	0.875	1.18
2003	0.265	0.37	0.474	0.575	0.673	0.77	0.864	0.956	1.269
2004	0.299	0.36	0.428	0.503	0.586	0.677	0.775	0.88	1.199
2005	0.292	0.365	0.443	0.526	0.614	0.706	0.803	0.905	1.13
2006	0.295	0.36	0.432	0.511	0.598	0.692	0.793	0.901	1.118
2007	0.255	0.333	0.415	0.499	0.586	0.677	0.77	0.867	1.104
2008	0.281	0.357	0.44	0.53	0.626	0.728	0.837	0.953	1.306
2009	0.242	0.379	0.513	0.643	0.77	0.893	1.012	1.127	1.382
2010	0.273	0.363	0.459	0.56	0.666	0.776	0.892	1.013	1.281
2011	0.241	0.351	0.463	0.577	0.693	0.811	0.931	1.052	1.376
2012	0.207	0.31	0.413	0.515	0.618	0.721	0.824	0.927	1.239
2013	0.268	0.318	0.382	0.458	0.548	0.65	0.766	0.894	1.354
2014	0.192	0.272	0.356	0.443	0.533	0.626	0.723	0.822	1.156
2015	0.196	0.287	0.381	0.478	0.577	0.68	0.785	0.894	1.171

Table 8.2.4. Plaice in 7.e. Stock weights-at-age.

	Stock weights-at-age [kg]								
year/age	2	3	4	5	6	7	8	9	10+
1980	0.275	0.381	0.485	0.587	0.688	0.788	0.886	0.983	1.342
1981	0.207	0.336	0.462	0.585	0.705	0.823	0.937	1.049	1.393
1982	0.253	0.345	0.43	0.508	0.579	0.643	0.701	0.751	0.874
1983	0.164	0.282	0.393	0.497	0.595	0.687	0.772	0.851	1.059
1984	0.202	0.302	0.405	0.512	0.621	0.733	0.849	0.967	1.433
1985	0.163	0.28	0.394	0.506	0.615	0.722	0.827	0.929	1.295
1986	0.215	0.306	0.401	0.5	0.603	0.709	0.82	0.935	1.422
1987	0.261	0.313	0.378	0.455	0.545	0.648	0.764	0.892	1.292
1988	0.186	0.266	0.357	0.46	0.573	0.698	0.833	0.98	1.309
1989	0.193	0.258	0.33	0.411	0.5	0.596	0.701	0.813	1.098
1990	0.25	0.29	0.34	0.401	0.472	0.554	0.647	0.75	1.009
1991	0.224	0.282	0.35	0.428	0.516	0.615	0.723	0.842	1.167
1992	0.259	0.31	0.375	0.453	0.544	0.648	0.765	0.895	1.231
1993	0.227	0.298	0.375	0.458	0.547	0.641	0.742	0.848	1.126
1994	0.23	0.297	0.369	0.447	0.531	0.62	0.715	0.816	1.063
1995	0.243	0.322	0.403	0.487	0.573	0.663	0.755	0.85	1.031
1996	0.217	0.319	0.421	0.524	0.628	0.732	0.837	0.943	1.16
1997	0.237	0.308	0.385	0.469	0.559	0.657	0.761	0.872	1.129
1998	0.128	0.251	0.374	0.495	0.616	0.735	0.853	0.971	1.283
1999	0.16	0.25	0.339	0.424	0.508	0.589	0.667	0.743	0.972
2000	0.162	0.248	0.335	0.422	0.509	0.596	0.683	0.771	1.019
2001	0.178	0.259	0.344	0.434	0.528	0.626	0.729	0.836	1.205
2002	0.215	0.285	0.361	0.443	0.529	0.621	0.719	0.822	1.119
2003	0.211	0.318	0.422	0.524	0.624	0.722	0.817	0.911	1.227
2004	0.272	0.329	0.393	0.464	0.544	0.63	0.725	0.827	1.136
2005	0.257	0.328	0.404	0.484	0.569	0.659	0.754	0.853	1.074
2006	0.265	0.326	0.395	0.471	0.554	0.644	0.741	0.846	1.057
2007	0.217	0.294	0.374	0.457	0.542	0.631	0.723	0.818	1.052
2008	0.245	0.318	0.398	0.484	0.577	0.676	0.782	0.894	1.238
2009	0.171	0.311	0.447	0.579	0.707	0.832	0.953	1.07	1.329
2010	0.229	0.318	0.411	0.509	0.612	0.72	0.834	0.952	1.215
2011	0.186	0.295	0.407	0.52	0.635	0.752	0.87	0.991	1.313
2012	0.156	0.259	0.361	0.464	0.567	0.67	0.773	0.876	1.187
2013	0.247	0.291	0.348	0.418	0.501	0.597	0.706	0.828	1.27
2014	0.153	0.231	0.314	0.399	0.487	0.579	0.674	0.772	1.101
2015	0.152	0.241	0.334	0.429	0.527	0.628	0.732	0.839	1.113

Table 8.2.5. Plaice in 7.e. Tuning fleet data available. Data in bold have been used for tuning.

W.CHANNEL PLAICE 2016 WGCSE

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FSP-7e

2003 2015

1 1 0.75 0.80

2 9

1 0.344 0.343 0.216 0.041 0.042 0.051 0.034 0.022

1 0.237 0.839 0.158 0.279 0.026 0.016 0.045 0.011

1 0.327 0.426 0.240 0.090 0.040 0.013 0.017 0.037

1 0.623 0.420 0.187 0.100 0.044 0.021 0.005 0.006

1 0.114 0.278 0.159 0.066 0.026 0.008 0.006 0.006

1 0.494 0.213 0.124 0.032 0.019 0.015 0.005 0.002

1 0.440 0.446 0.153 0.061 0.034 0.023 0.008 0.003

1 0.740 0.583 0.385 0.048 0.042 0.012 0.006 0.002

1 1.036 0.800 0.314 0.110 0.010 0.018 0.013 0.002

1 0.322 1.242 0.582 0.136 0.135 0.012 0.014 0.012

1 0.206 1.421 1.267 0.440 0.203 0.076 0.028 0.008

1 1.320 1.643 2.076 0.802 0.568 0.156 0.029 0.035

1 0.803 1.187 0.904 1.005 0.508 0.120 0.013 0.055

Q1SWBeam

2006 2015

1 1 0 0.25

1 11

1 1.46029 **31.1894 24.244 19.115 5.3835 2.6963 0.15127 0.11942 0.23884** 0.56317 0

1 0.86782 **14.7809 34.368 28.319 4.9883 5.5958 1.92605 4.75535 0.2503** 3.992 0.2503

1 0.95099 **33.5532 17.429 9.116 5.4635 0.9659 1.52183 2.21499 1.97899** 0 0.87797

1 1.2131 **45.3574 46.921 17.865 10.8005 3.0442 4.16085 0.32375 0.20433** 0.32375 0.32375

1 0.97592 **45.0547 39.746 27.094 4.3481 1.8618 2.7469 0.76424 0.37545** 0 0

1 1.68844 **53.339 71.562 27.498 6.8859 5.8433 3.34697 0.4592 0.52773** 0.10502 0.33006

1 0 **9.1228 59.258 30.977 14.8202 5.2353 7.44347 0.47268 3.17135** 0 0

1 0.30036 **18.0403 91.824 65.429 12.689 3.9641 2.53072 2.00951 0.80336** 0 0

1 1.01423 **65.9025 148.705 178.597 63.2579 10.6805 1.33557 2.33955 0.93872** 0.48829 0.28101

1 0 **36.3433 46.731 27.17 40.4109 30.2577 4.39114 5.31769 0.94758** 2.08315 0

Table 8.2.6. Plaice in 7.e. Fishing mortality-at-age.

	Fishing mortality-at-age									
year/age	2	3	4	5	6	7	8	9	10+	F(3-6)
1980	0.120	0.419	0.457	0.423	0.766	0.407	0.341	0.507	0.507	0.516
1981	0.107	0.503	0.562	0.378	0.309	0.553	0.540	0.469	0.469	0.438
1982	0.104	0.461	0.670	0.502	0.481	0.401	1.073	0.655	0.655	0.528
1983	0.128	0.436	0.803	0.616	0.342	0.392	0.389	0.375	0.375	0.549
1984	0.187	0.433	0.710	0.591	0.375	0.525	0.469	0.458	0.458	0.527
1985	0.095	0.438	0.676	0.318	0.571	0.474	0.261	0.437	0.437	0.501
1986	0.144	0.580	0.504	0.498	0.358	0.585	0.390	0.446	0.446	0.485
1987	0.080	0.508	0.727	0.748	0.427	0.477	0.425	0.444	0.444	0.602
1988	0.174	0.523	0.493	0.520	0.341	0.348	0.361	0.351	0.351	0.469
1989	0.033	0.392	0.656	0.789	0.602	0.452	0.501	0.521	0.521	0.609
1990	0.101	0.593	0.746	0.572	0.565	0.616	0.531	0.574	0.574	0.619
1991	0.164	0.568	0.784	0.594	0.463	0.409	0.376	0.418	0.418	0.602
1992	0.184	0.631	0.756	0.619	0.548	0.408	0.476	0.479	0.479	0.639
1993	0.154	0.594	0.657	0.608	0.511	0.515	0.453	0.495	0.495	0.592
1994	0.162	0.548	0.804	0.536	0.480	0.396	0.319	0.400	0.400	0.592
1995	0.159	0.589	0.725	0.580	0.471	0.452	0.469	0.466	0.466	0.591
1996	0.181	0.516	0.634	0.666	0.526	0.412	0.575	0.507	0.507	0.585
1997	0.169	0.643	0.684	0.627	0.528	0.663	0.359	0.519	0.519	0.621
1998	0.064	0.443	0.704	0.504	0.438	0.388	0.364	0.398	0.398	0.522
1999	0.171	0.352	0.649	0.552	0.574	0.451	0.419	0.483	0.483	0.532
2000	0.155	0.469	0.606	0.606	0.461	0.448	0.280	0.398	0.398	0.535
2001	0.146	0.550	0.614	0.577	0.321	0.339	0.377	0.347	0.347	0.516
2002	0.326	0.596	0.662	0.652	0.550	0.374	0.280	0.403	0.403	0.615
2003	0.216	0.530	0.529	0.542	0.575	0.556	0.328	0.488	0.488	0.544
2004	0.179	0.542	0.622	0.693	0.653	0.492	0.489	0.491	0.491	0.627
2005	0.222	0.531	0.617	0.645	0.666	0.656	0.654	0.482	0.482	0.615
2006	0.313	0.651	0.624	0.637	0.554	0.587	0.816	0.475	0.475	0.616
2007	0.172	0.595	0.760	0.783	0.747	0.735	0.615	0.758	0.758	0.721
2008	0.216	0.475	0.665	0.643	0.743	0.796	0.784	0.633	0.633	0.632
2009	0.176	0.465	0.341	0.331	0.372	0.441	0.390	0.357	0.357	0.377
2010	0.129	0.395	0.516	0.405	0.406	0.357	0.372	0.656	0.656	0.431
2011	0.119	0.349	0.522	0.296	0.219	0.285	0.326	0.459	0.459	0.347
2012	0.021	0.220	0.427	0.507	0.488	0.464	0.477	0.418	0.418	0.410
2013	0.022	0.139	0.280	0.339	0.512	0.541	0.351	1.068	1.068	0.317
2014	0.039	0.153	0.269	0.233	0.327	0.569	0.344	0.593	0.593	0.246
2015	0.024	0.100	0.186	0.235	0.206	0.333	0.515	0.432	0.432	0.182

Table 8.2.7. Plaice in 7.e. Stock numbers-at-age.

	Stock numbers-at-age [thousands]									
year/age	2	3	4	5	6	7	8	9	10+	sum
1980	7067	2350	707	696	122	199	82	36	364	11623
1981	6961	5558	1371	397	404	50	118	52	265	15175
1982	3004	5545	2981	693	241	263	26	61	266	13080
1983	6382	2402	3102	1353	372	132	156	8	335	14243
1984	5788	4982	1378	1232	648	235	79	94	143	14579
1985	6959	4260	2865	601	605	395	123	44	154	16006
1986	7234	5611	2437	1293	388	303	218	84	180	17748
1987	14732	5555	2786	1306	697	240	150	131	151	25748
1988	12071	12065	2965	1194	548	403	132	87	186	29652
1989	8717	8995	6343	1606	630	346	253	82	259	27230
1990	3646	7479	5389	2920	648	306	195	136	172	20890
1991	3917	2922	3665	2268	1462	326	147	102	157	14965
1992	4421	2950	1469	1484	1111	816	192	89	137	12670
1993	4979	3263	1392	612	709	570	482	106	229	12341
1994	2313	3785	1598	640	295	377	302	271	201	9783
1995	2325	1745	1942	634	332	162	225	195	249	7809
1996	6736	1760	859	834	315	184	91	125	279	11183
1997	5868	4986	932	404	380	165	108	46	258	13147
1998	9173	4394	2324	417	191	199	75	67	195	17036
1999	4392	7631	2501	1019	223	110	120	47	124	16167
2000	2593	3284	4758	1159	520	112	62	70	168	12726
2001	3669	1970	1823	2301	561	291	63	42	134	10854
2002	3885	2813	1008	874	1146	361	184	38	129	10439
2003	4846	2488	1375	461	404	586	220	123	105	10609
2004	3056	3464	1299	719	238	202	298	141	104	9519
2005	4245	2267	1787	619	319	110	109	162	133	9750
2006	3931	3015	1182	855	288	145	51	50	148	9665
2007	2645	2549	1395	561	401	147	72	20	99	7890
2008	5016	1976	1247	579	227	169	62	34	66	9376
2009	4256	3583	1090	569	270	96	67	25	60	10016
2010	6666	3166	1996	687	362	165	55	41	50	13188
2011	10683	5198	1891	1057	407	214	102	33	53	19637
2012	10164	8408	3253	995	697	290	143	66	108	24123
2013	6737	8823	5988	1882	531	380	162	79	57	24637
2014	6727	5845	6813	4013	1189	283	196	101	64	25231
2015	8056	5739	4450	4617	2819	760	142	123	86	26792

Table 8.2.8. Plaice in 7.e. Assessment summary. Note that relative values have been presented given that the full analytical assessment was rejected due to large retrospective patterns.

Year	Recruitment (age 2) [relative]	TSB [relative]	SSB [relative]	Landings [t]	Relative landings/ relative SSB	Fbar(3-6) [relative]
1980	1.205	0.515	0.781	1178	0.928	0.986
1981	1.187	0.611	0.928	1676	1.112	0.836
1982	0.512	0.667	1.011	1878	1.142	1.009
1983	1.089	0.644	0.977	1714	1.080	1.049
1984	0.987	0.643	0.975	1758	1.109	1.007
1985	1.187	0.654	0.992	1677	1.040	0.956
1986	1.234	0.768	1.165	2078	1.097	0.926
1987	2.512	0.895	1.358	2272	1.029	1.150
1988	2.059	0.973	1.476	2835	1.181	0.896
1989	1.487	1.056	1.603	2742	1.052	1.164
1990	0.622	1.022	1.552	2985	1.184	1.182
1991	0.668	0.832	1.263	2183	1.064	1.149
1992	0.754	0.707	1.072	1882	1.080	1.219
1993	0.849	0.612	0.929	1614	1.069	1.131
1994	0.394	0.524	0.796	1404	1.086	1.130
1995	0.397	0.474	0.719	1247	1.067	1.129
1996	1.149	0.465	0.706	1266	1.103	1.118
1997	1.001	0.490	0.744	1583	1.309	1.185
1998	1.564	0.508	0.770	1346	1.075	0.998
1999	0.749	0.563	0.855	1543	1.111	1.015
2000	0.442	0.613	0.930	1626	1.075	1.023
2001	0.626	0.552	0.838	1310	0.962	0.985
2002	0.663	0.507	0.769	1472	1.178	1.174
2003	0.827	0.515	0.782	1387	1.091	1.039
2004	0.521	0.469	0.712	1337	1.156	1.198
2005	0.724	0.453	0.687	1319	1.182	1.174
2006	0.670	0.426	0.646	1411	1.345	1.177
2007	0.451	0.354	0.537	1146	1.313	1.377
2008	0.855	0.361	0.547	1112	1.250	1.206
2009	0.726	0.401	0.609	1024	1.034	0.720
2010	1.137	0.505	0.766	1207	0.970	0.822
2011	1.822	0.643	0.975	1417	0.894	0.662
2012	1.734	0.800	1.213	1492	0.756	0.784
2013	1.149	1.043	1.583	1472	0.572	0.606
2014	1.147	1.114	1.690	1490	0.542	0.469
2015	0.900*	1.345	2.041	1424	0.429	0.347

*** relative geometric mean (1980–2014).**

Table 8.2.9. Plaice in 7e. The basis for the catch options for 2017. Note that one catch option is provided for stocks in ICES data categories 3–6.

Plaice 7.e stock	
Basis	Value
Index A (2013, 2014)	1.87
Index B (2010, 2011, 2012)	1.26
Index ratio (A/B)	1.48
Uncertainty cap (applied)	1.2
Recent advised catch for 2015 for the stock	2262 t
Average discard rate (2014-2015)	0.49
Precautionary buffer (Not applied)	–
Catch advice for the stock*	2714 t
Landings corresponding to the catch advice for the stock	1391 t
*(recent advised catch) × (uncertainty cap).	

Plaice in 7.e	
Basis	Value
Proportion of 7.e stock catches taken in 7.d (2006–2015)	0.10
Catch of plaice 7.e corresponding to the advice for the stock	2454 t
Landings of plaice 7.e corresponding to the advice for the stock	1258 t

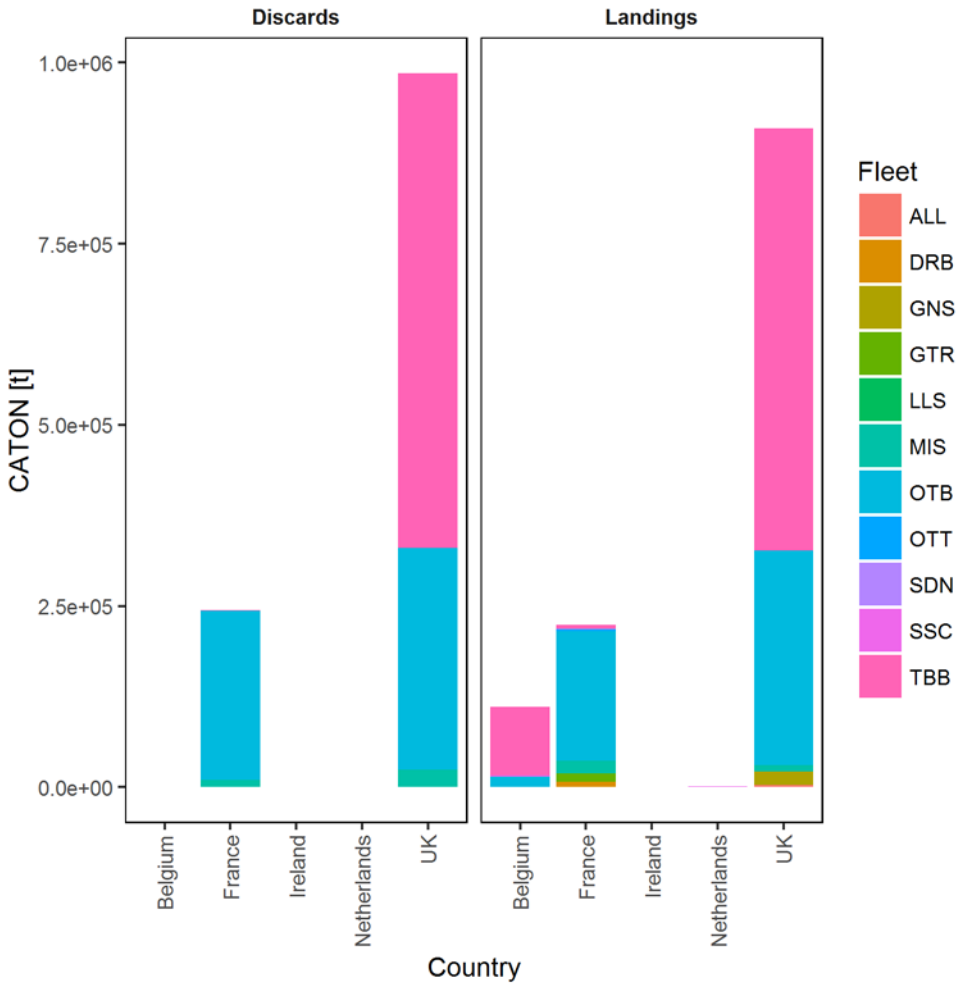


Figure 8.2.1. Plaice in 7.e. Landings and discards reported to InterCatch per country and métier in 2015.

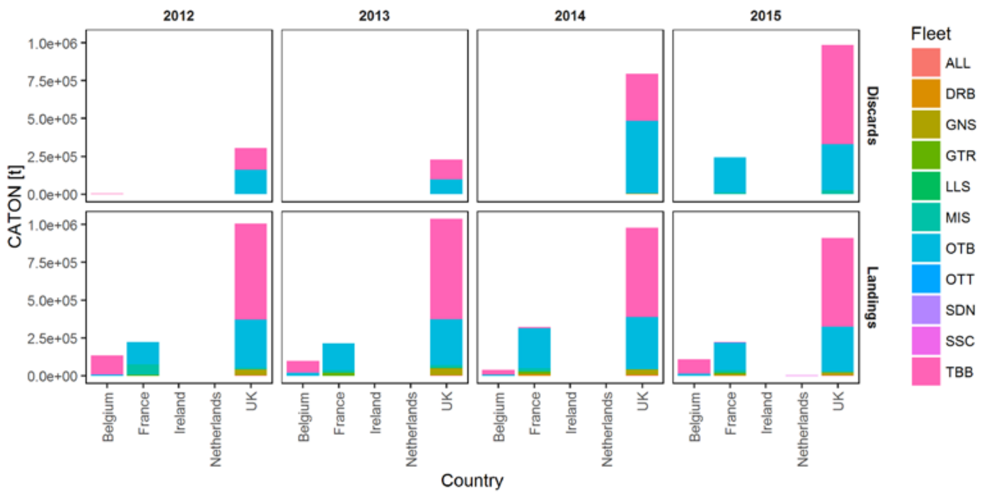


Figure 8.2.2. Plaice in 7.e. Landings and discards reported to InterCatch per country and métier for the years 2012–2015.

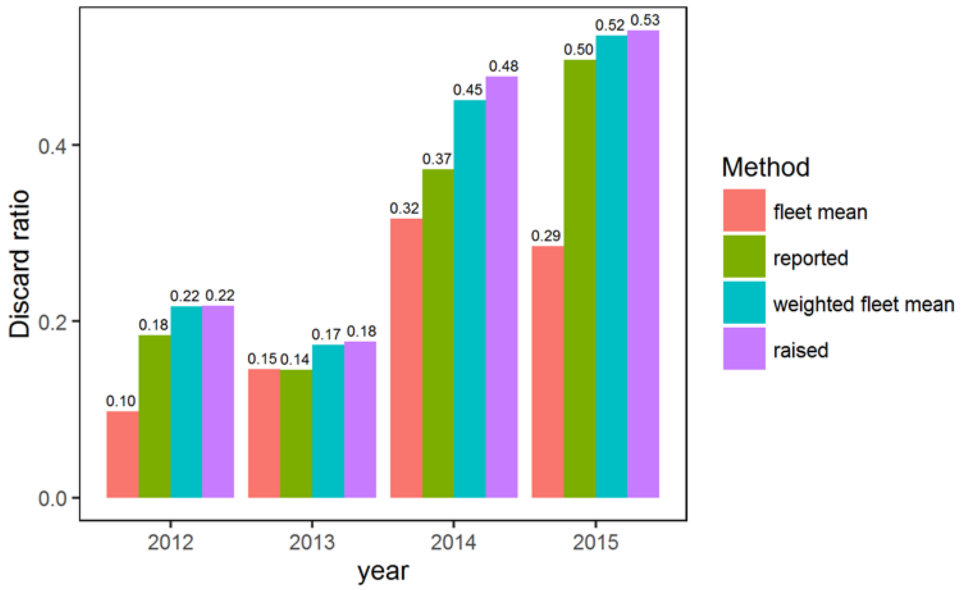


Figure 8.2.3. Plaice in 7.e. Discard ratios for 2012–2015. "Fleet mean" is the mean of the ratios for all fleets which reported discards, "reported" is the proportion of reported discards in the reported catches, "weighted fleet mean" is the mean of the ratios for all fleets which reported discards weighted by the catch of the individual fleets and "raised" is the proportion of the discards as raised within InterCatch in the total catch.

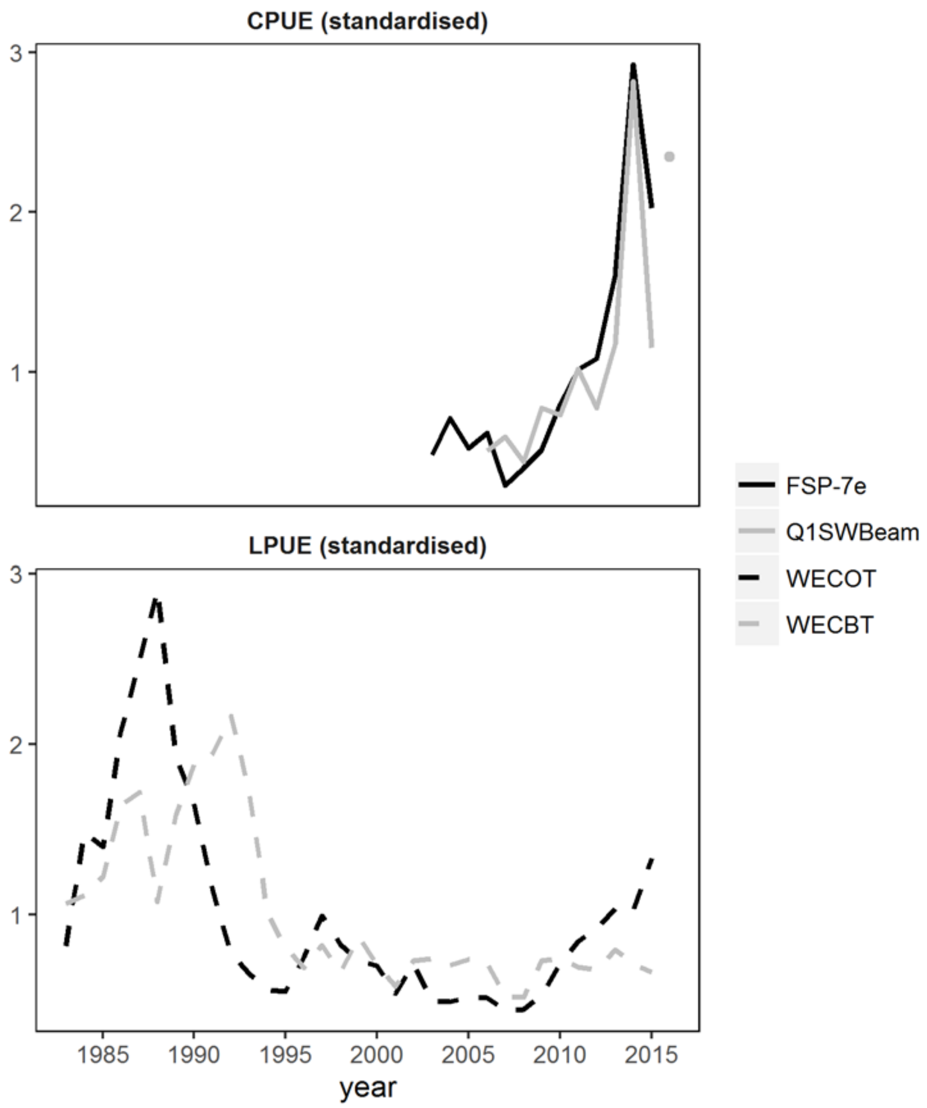


Figure 8.2.4. Plaice in 7.e. Means standardised cpue and lpue. Lpue values are only shown for historical reasons but were not used in the assessment. The grey dot in the cpue plot is based on preliminary data from the Q1SWBeam survey in 2016.

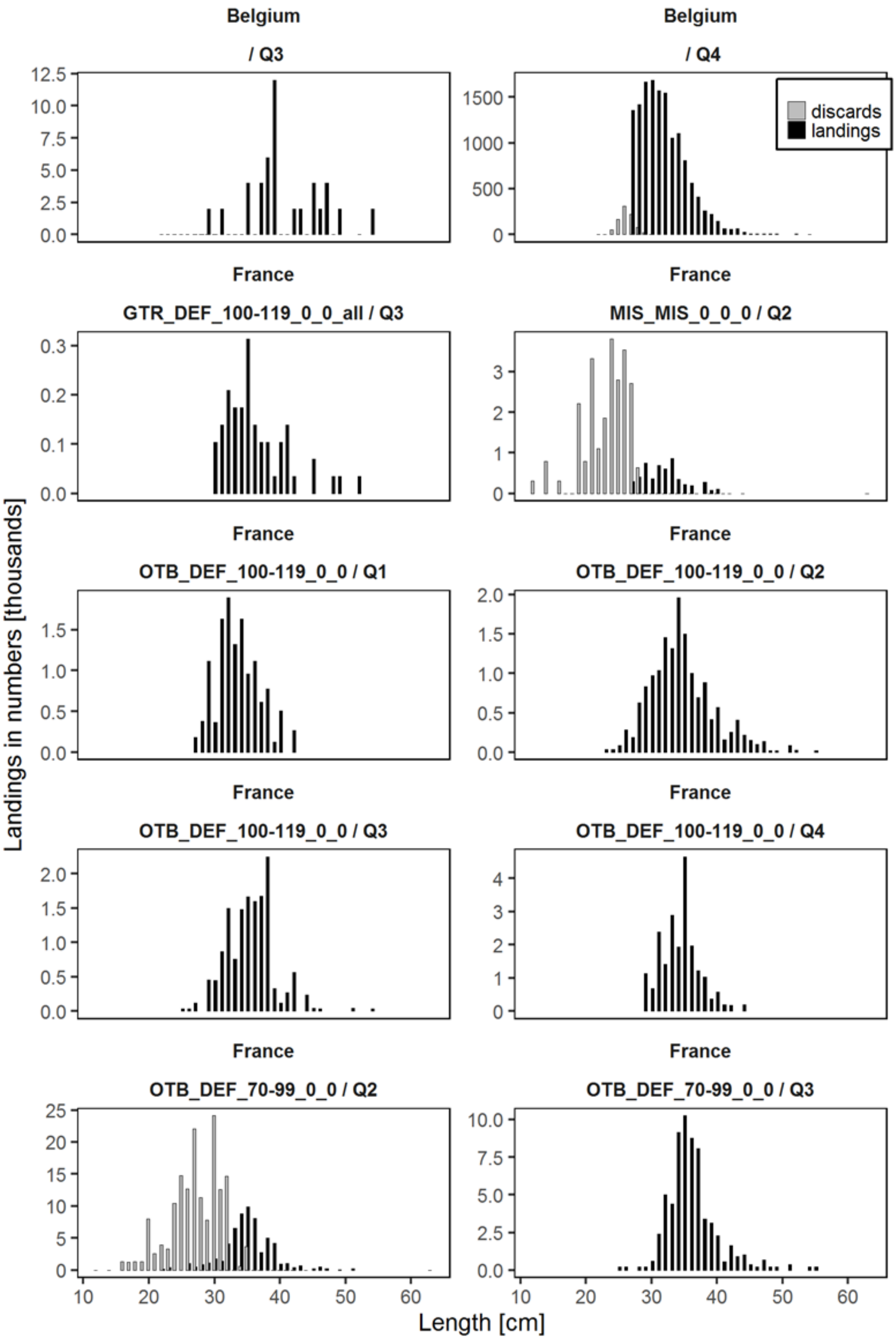


Figure 8.2.5. Plaice in 7.e. Length distributions of discards and landings by Country, Fleet and Quarter (2015).

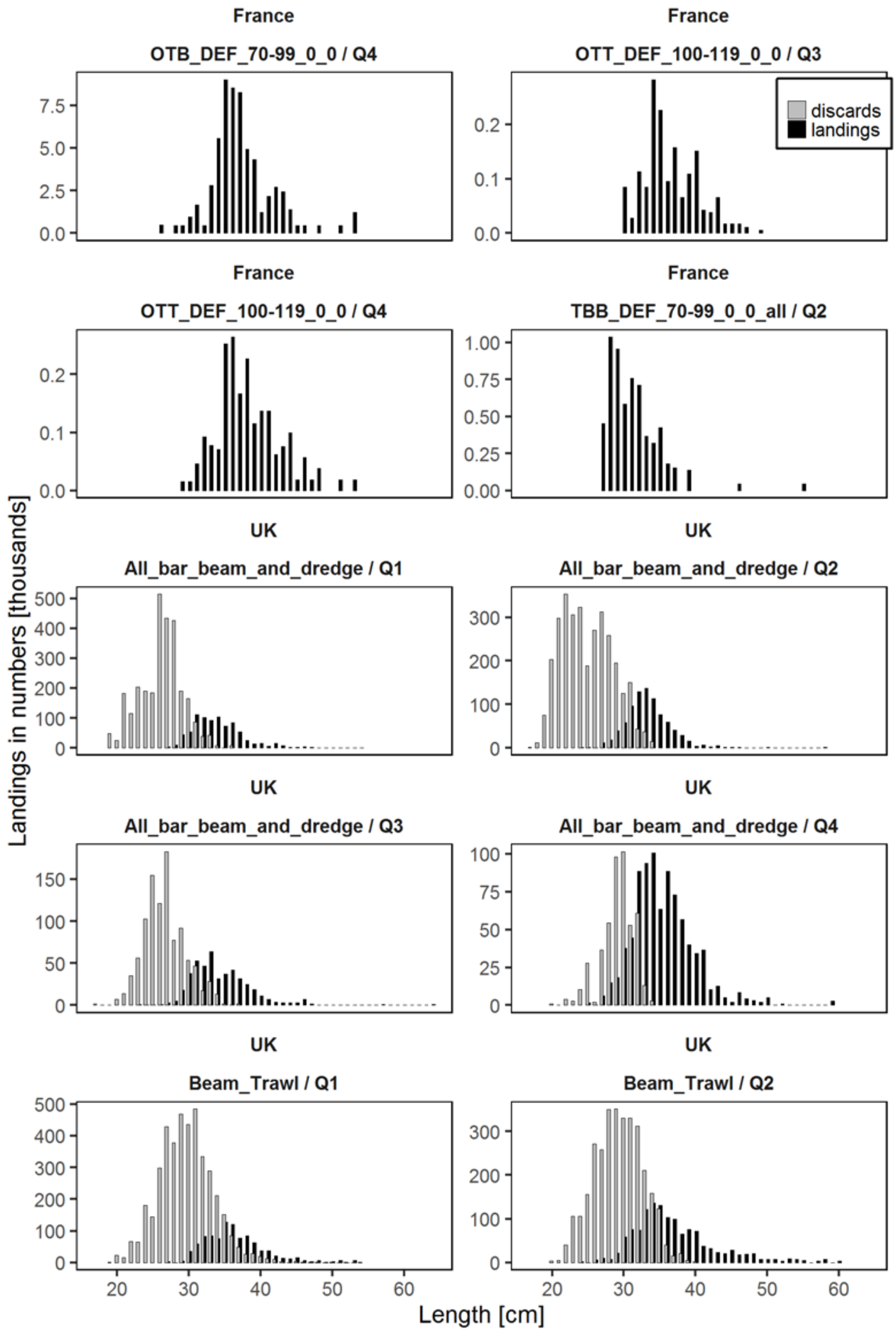


Figure 8.2.5 (continued). Plaice in 7.e. Length distributions of discards and landings by Country, Fleet and Quarter (2015).

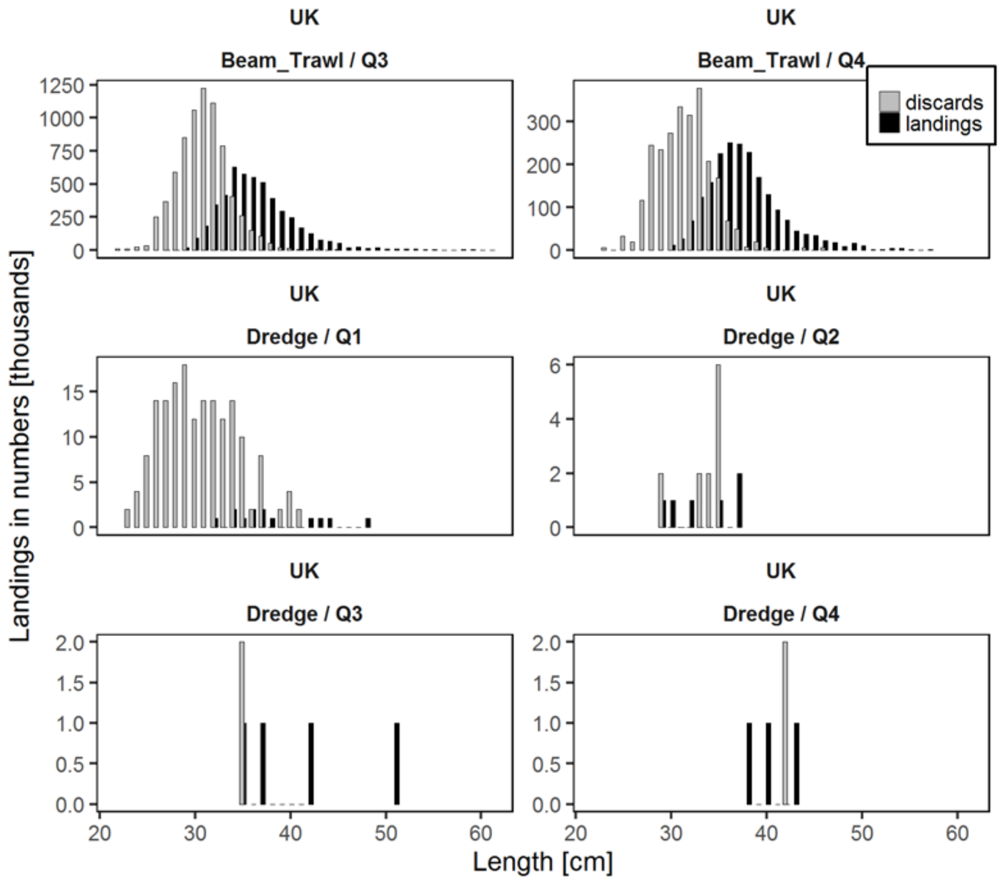


Figure 8.2.5 (continued). Plaice in 7.e. Length distributions of discards and landings by Country, Fleet and Quarter (2015).

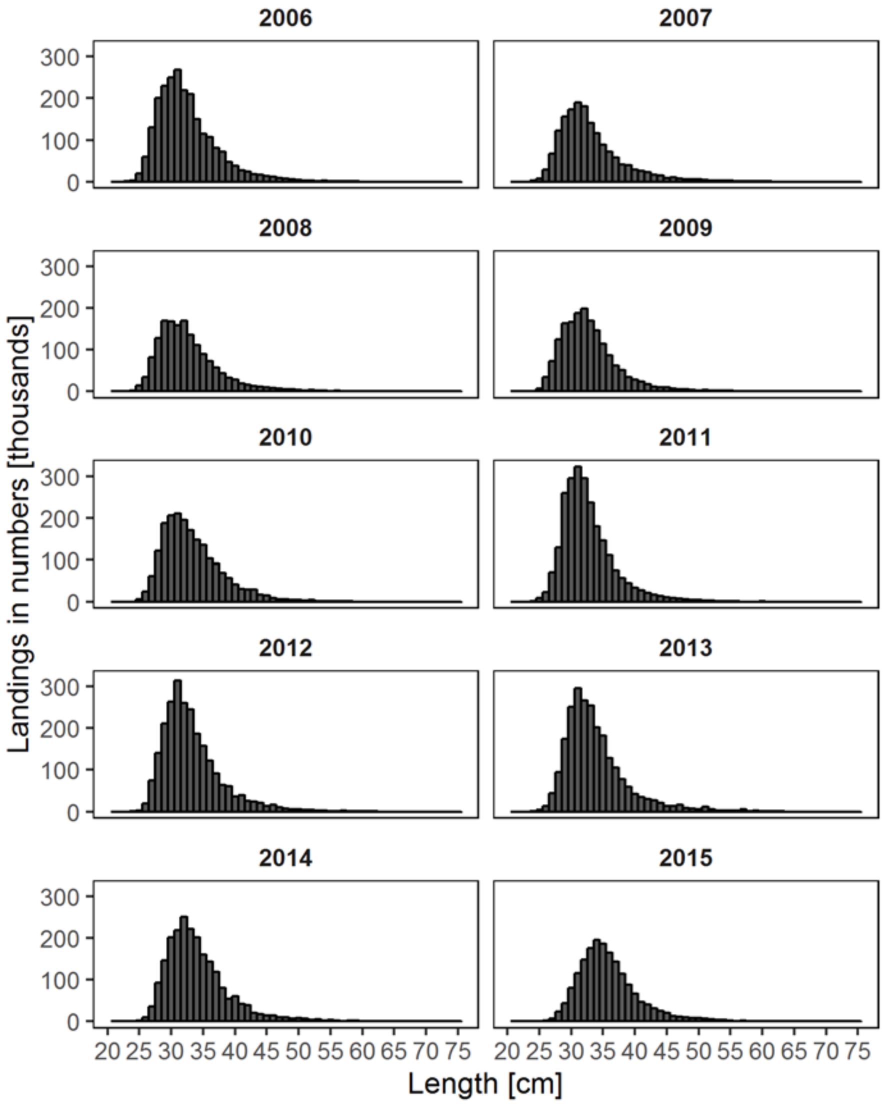


Figure 8.2.6. Plaice in 7.e. Length distributions of UK (E&W) landings between 2006 and 2015.

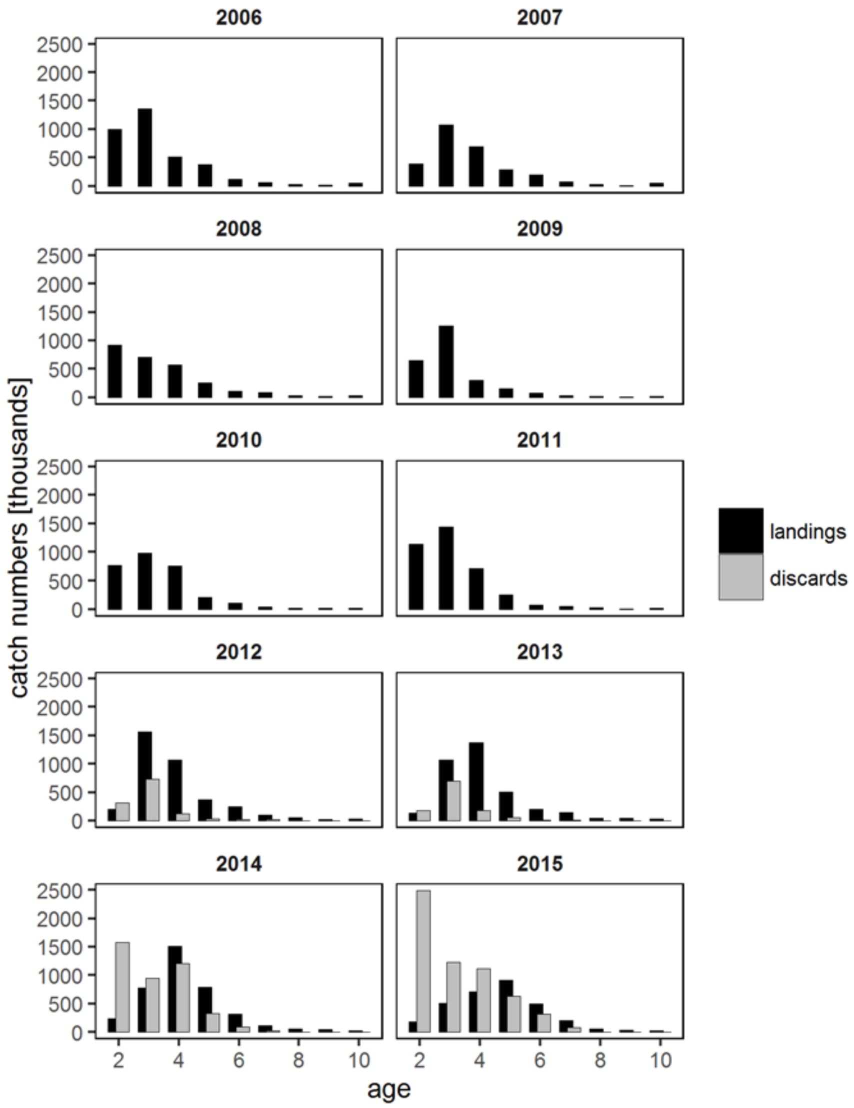


Figure 8.2.7. Plaice in 7.e. Age composition of reported international catches. Discard data was only provided from 2012 onwards in InterCatch.

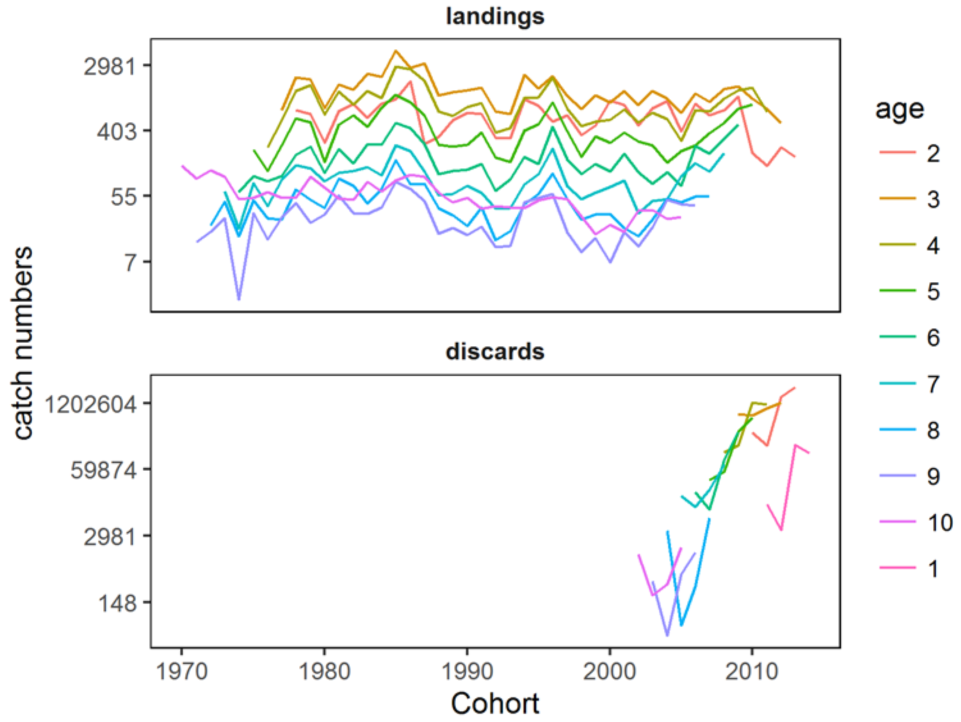


Figure 8.2.8. Plaice in 7.e. Catch curve analysis for reported landings and discards-at-age.

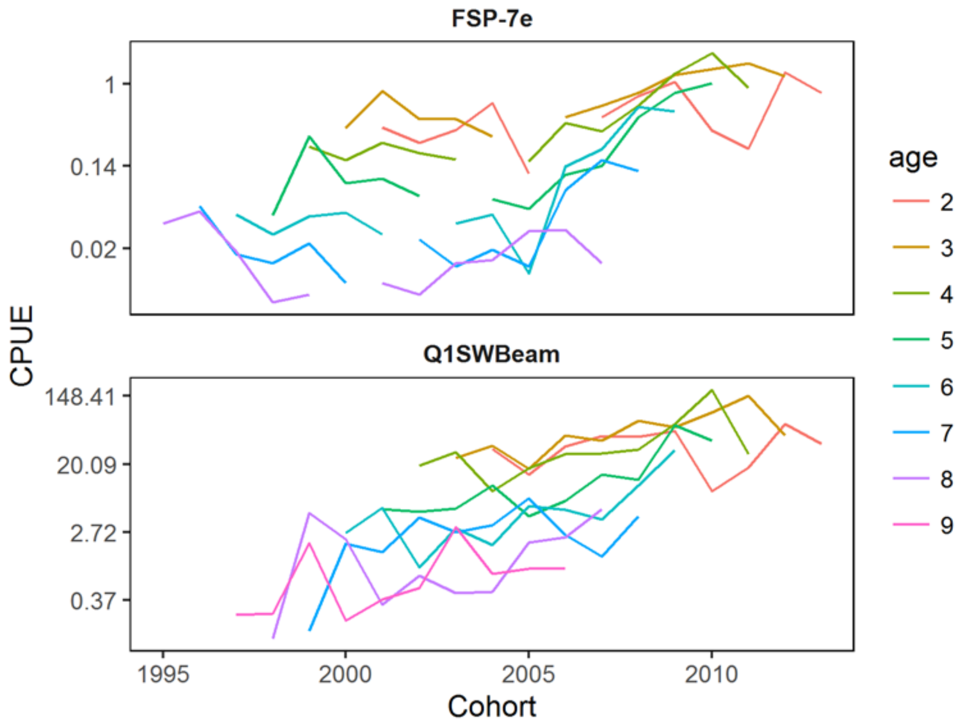


Figure 8.2.9. Plaice in 7.e. Cpue at-age for FSP-7e and Q1SWBeam survey.

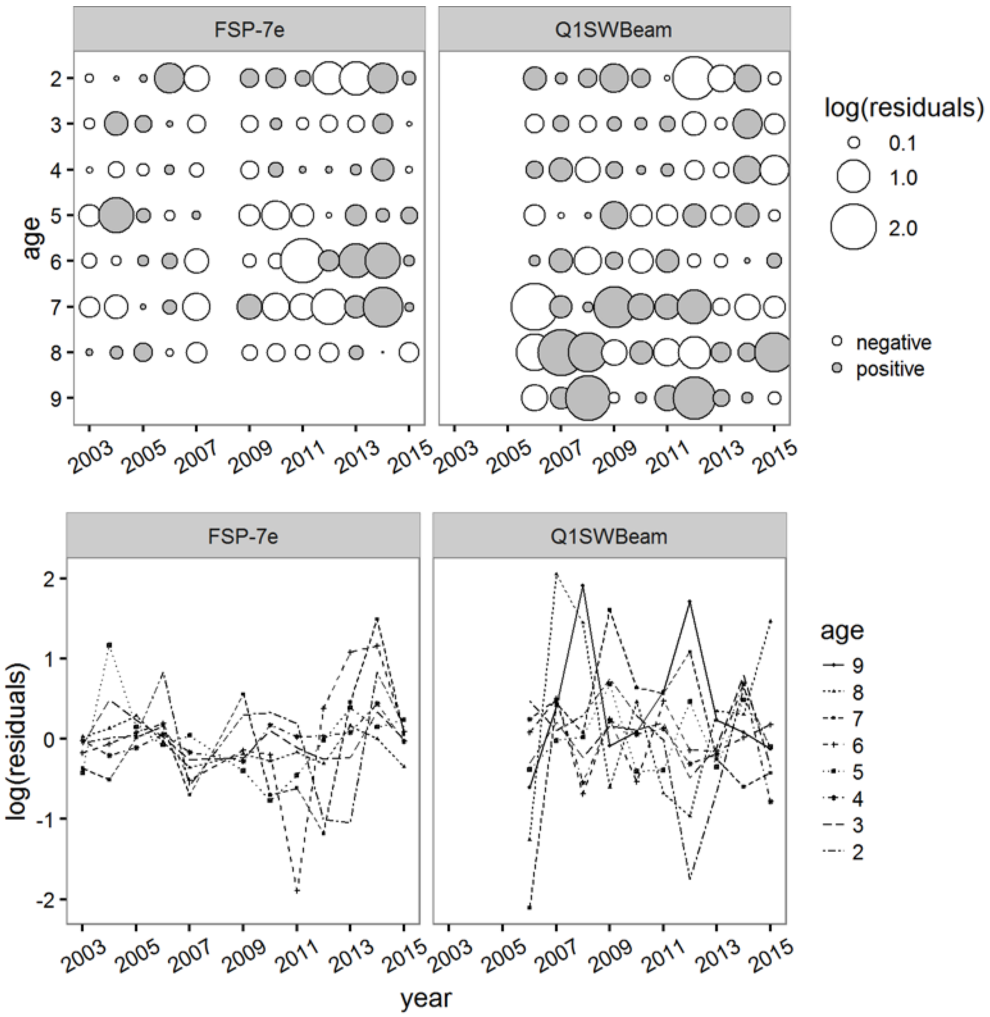


Figure 8.2.10. Plaice in 7.e. XSA survey log catchability residuals.

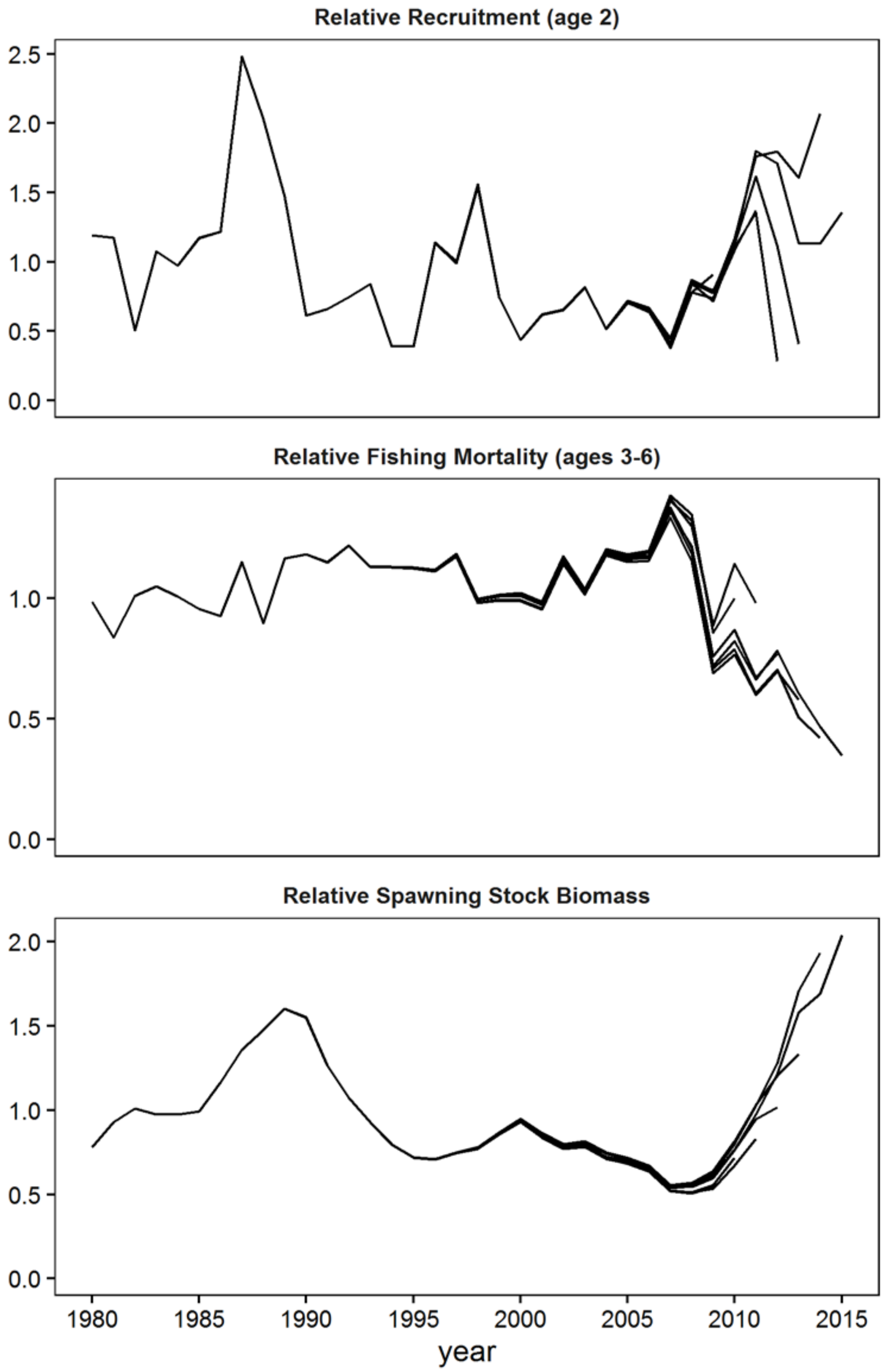


Figure 8.2.11. Plaice in 7.e. Five-year retrospective of recruitment, spawning–stock biomass and fishing mortality estimates.

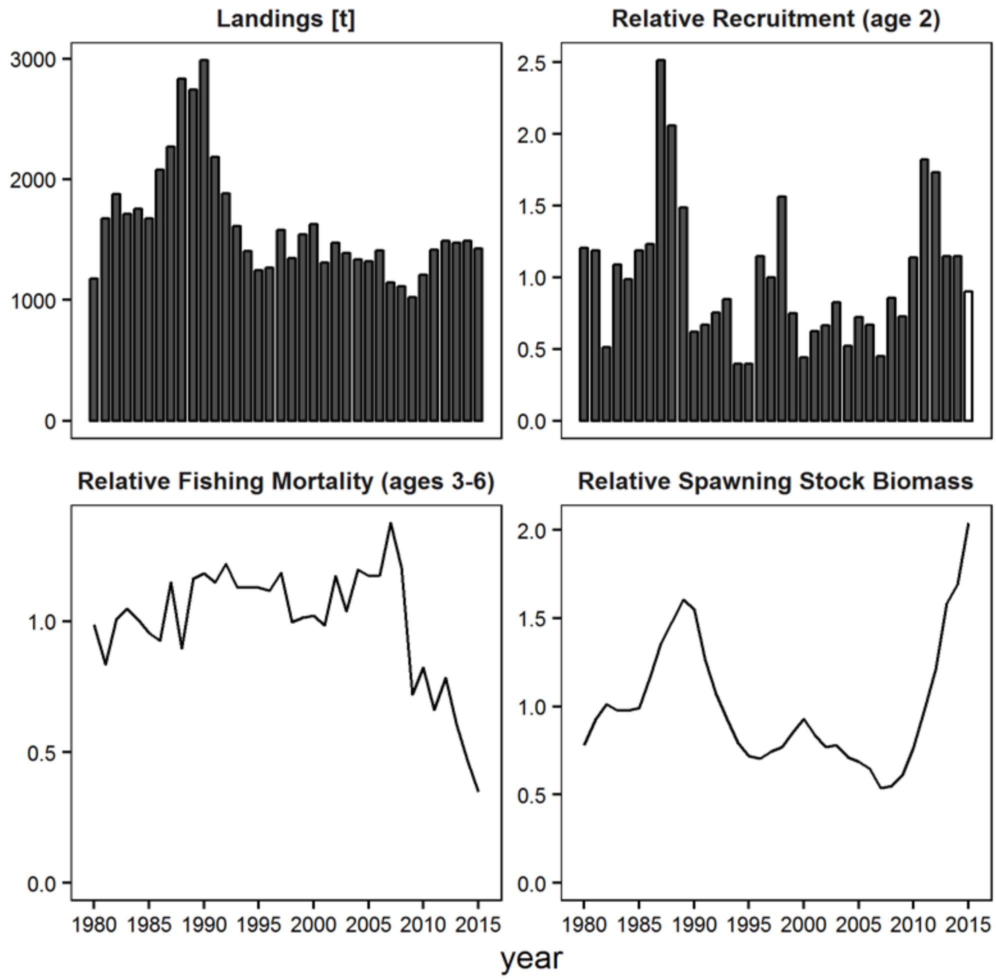


Figure 8.2.12. Plaice in 7.e. Summary of XSA final assessment.

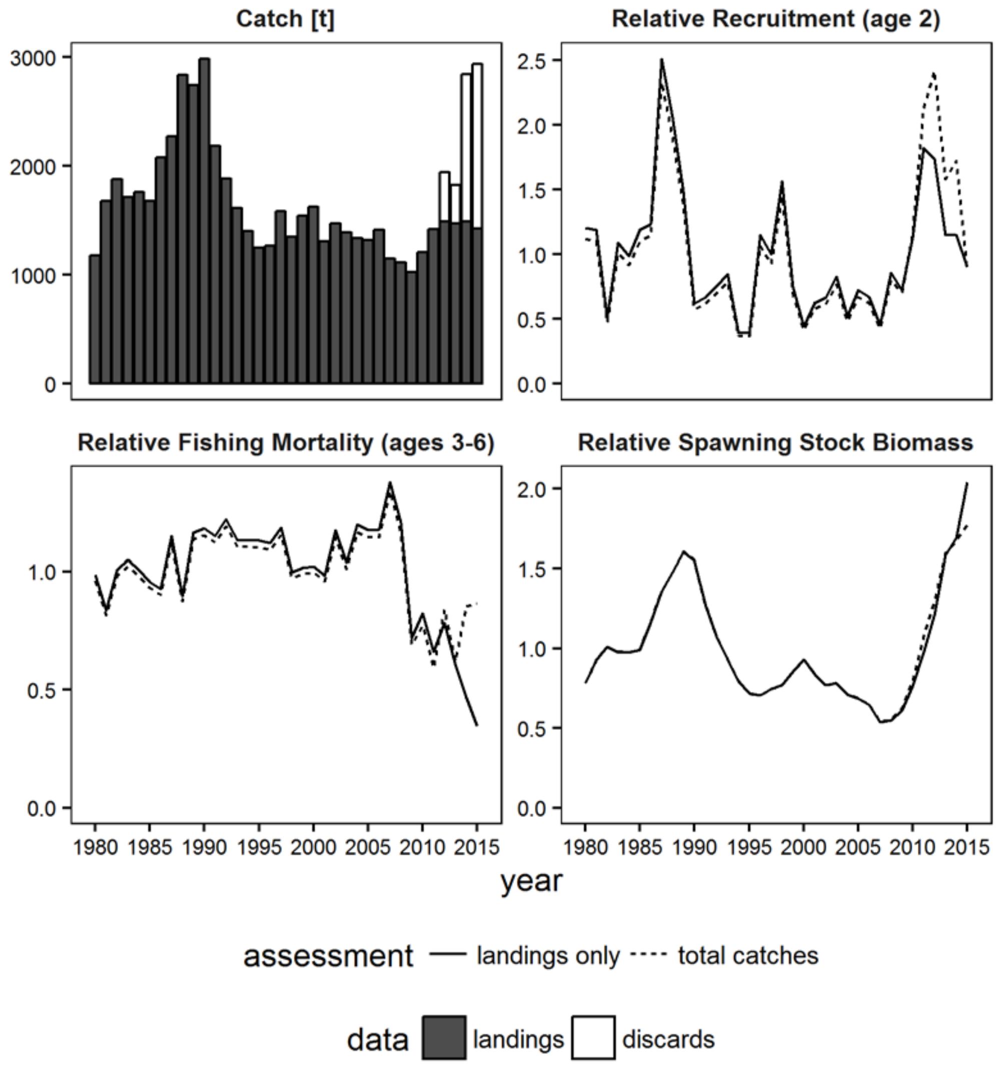


Figure 8.2.13. Plaice in 7.e. Comparison of the results for the landings only assessment and the alternative assessment including discards.

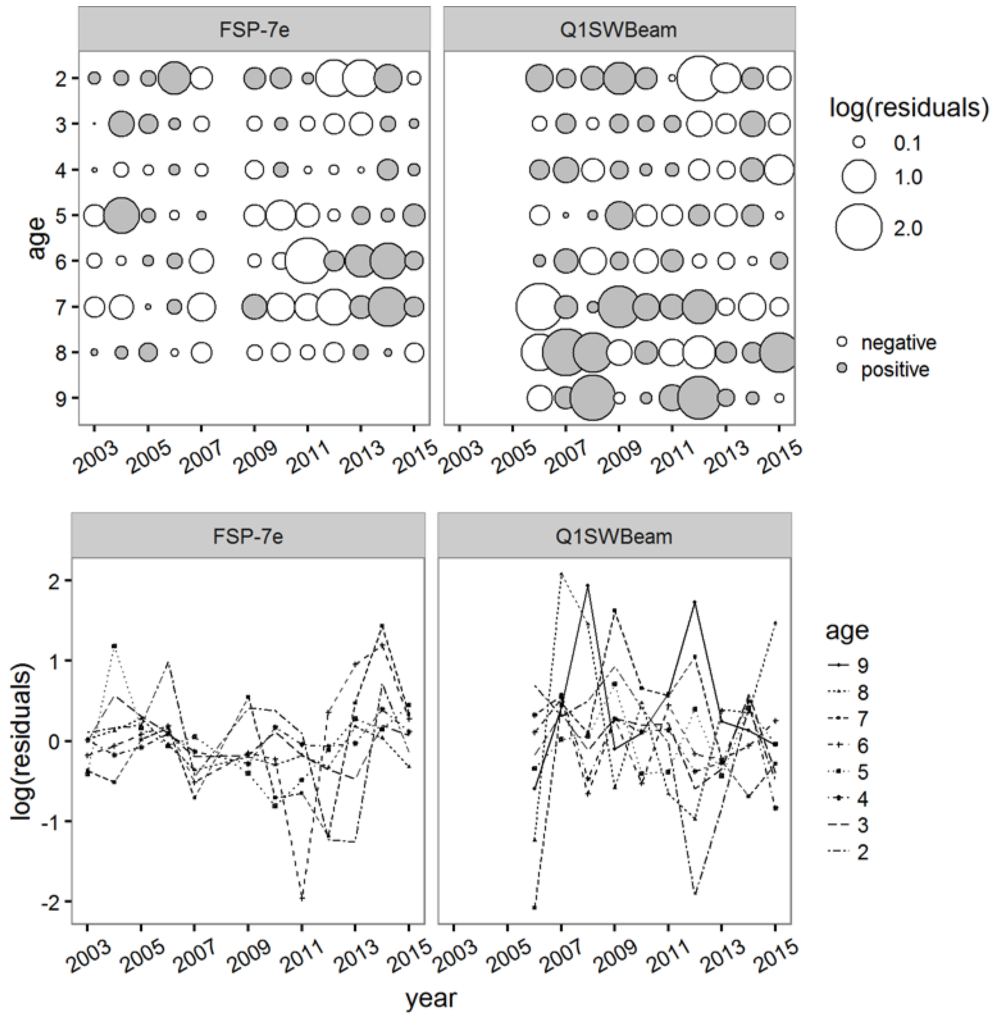


Figure 8.2.14. Plaice in 7.e. Residuals of the alternative assessment including discards.

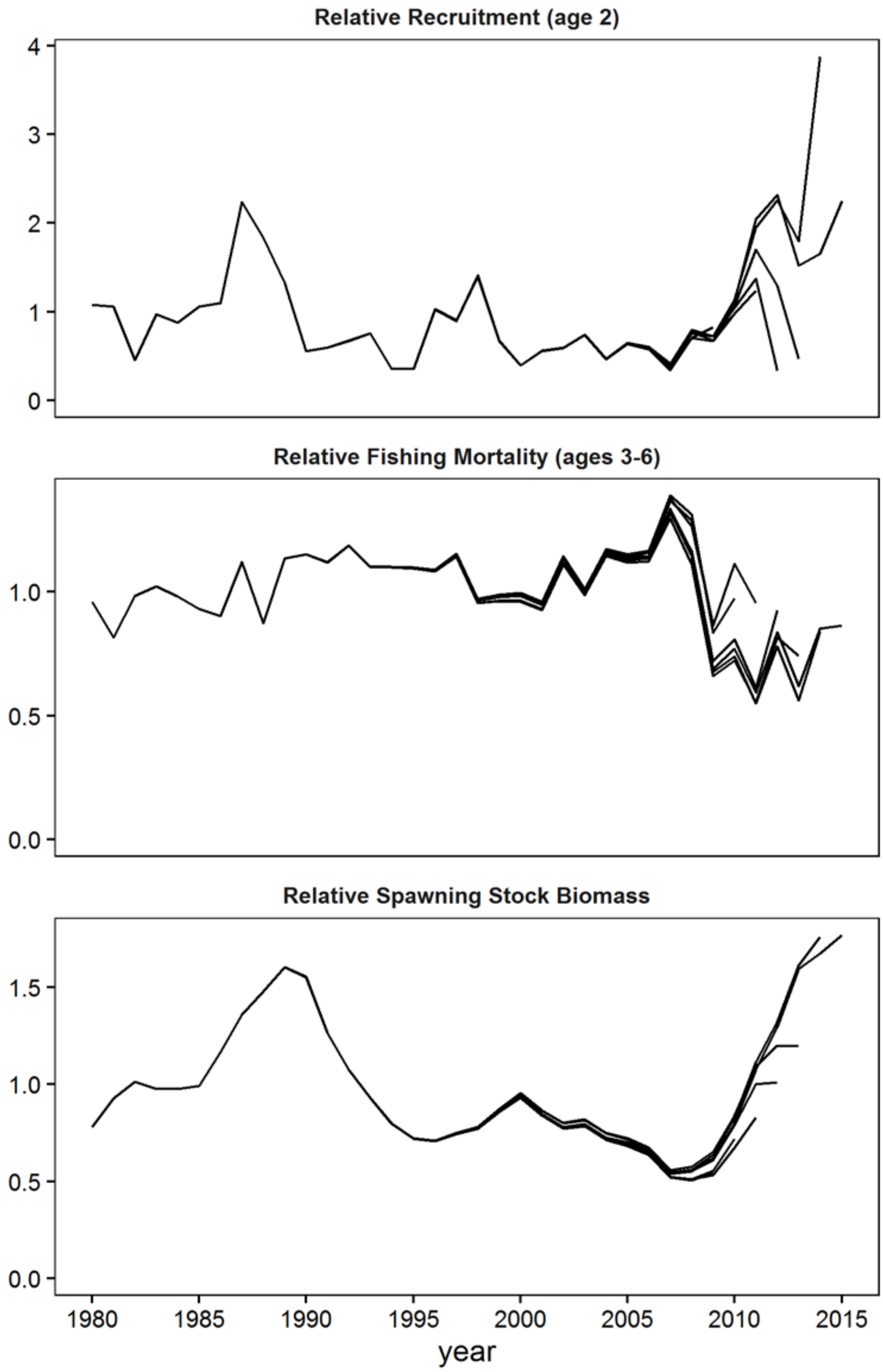


Figure 8.2.15. Plaice in 7.e. Retro plot for the alternative assessment including discards.

8.2.10 Audit of Plaice in the Western Channel (ICES Division 7.e)

Date: 17 May 2016

Reviewer: Sara-Jane Moore

General

Stock data category 3. Trends-based assessment. Landings only included in assessment.

For single stock summary sheet advice

1) Assessment type: Update
2) Assessment: XSA
3) Forecast: A short-term forecast was presented
4) Assessment model: XSA using two surveys FSP-7e Survey and Q1SWBeam Survey
5) Consistency: Relative values for recruitment, spawning–stock biomass and fishing mortality estimates exhibited similar temporal trends to absolute values presented at previous working groups
6) Stock status: The SSB trends from the assessment are used as the index of stock development. The advice is based on a comparison of the two latest index values (index A) with the three preceding values (index B), multiplied by the recent advised catch. If the assessment results are treated as absolute values, the stock is in a desirable state.
7) Man. Plan.: No management plan has been agreed or proposed

General comments

The report was well written and the assessment followed the methods detailed in the stock annex.

Technical comments

Discards data should be available for this stock collected since 2003 under DCF reg.

Conclusions

The assessment has been performed correctly.

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice? **Yes**
- Is the assessment according to the stock annex description? **Yes**
- Is general ecosystem information provided and is it used in the individual stock sections. Some ecosystem information is provided in the Stock Annex.
- If a management plan has been agreed, has the plan been evaluated? **No management plan.**

For update assessments

- Have the data been used as specified in the stock annex? **Yes**
- Has the assessment, recruitment and forecast model been applied as specified in the stock annex? **Yes**
- Is there any **major** reason to deviate from the standard procedure for this stock? **N/A**
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Relative values for recruitment, spawning–stock biomass and fishing mortality estimates only presented and so the ICES framework for category 3 stocks was applied.

8.3 Sole in Division 7.e

Type of assessment in 2015

Last year's assessment report is available:

http://ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2015/WGCSE/08.03_Sole%207.e_2015.pdf

ICES advice applicable to 2015

Last year's advice is available:

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/sol-echw.pdf

Technical consideration

General comments

Data inputs and assessment methods are consistent with the stock annex.

The RG agrees with the way that tuning indices were treated. Nevertheless, the RG is concerned about the time trend in the residuals: the early UK-CBT and the late UK-CBT fleets showed a strong decreasing trend and a dome shaped trend, respectively. Although the value of the residuals is relatively small, the trend is problematic. The RG suggests that the working group perform an exploratory run that does not include the UK-CBT index.

WKFLAT 2012 discussed these issues at length as well as conducting the requested exploratory analysis and reported the need for the inclusion of this fleet in the assessment. Without the UK-CBT fleet, there is currently insufficient information on the older ages to run the assessment, which will instead inappropriately use shrinkage to estimate a large proportion of the SSB. The development of the survey series will alleviate this problem in time, but currently the number of parameters required to estimate q's precludes sensible assessment results in the absence of this fleet. The residual trends are consistent with the changes in the spatial distribution of the fleet as described in the report and the working group would be more concerned with an assessment where trends in residuals were absent from this fleet.

The RG agrees that discard data should be more widely collected. A sensitivity analysis that includes an approximate discard percentage, which is added to the landings, should be provided to help guide management advice and improve estimates of total fishing mortality.

Fleet-raised discard estimates were available individually in 2015 for UK non-FDF beam trawlers and *Nephrops* otter trawlers, comprising 88% of the total UK landings. Discards comprised less than 1% of the fleets' catches. After including the UK FDF fleet with zero discards, the UK catch represents 59% of the total international catch and the UK discards were less than 1% of the total UK catch. UK discards decreased from 1.9% to 0.8% between 2014 and 2015 indicating that discarding remains relatively low compared to other stocks. Discard estimates were available in 2015 for French gillnets, trammelnets and demersal otter trawlers that contributed over 83% of the total French landings. Discards comprised less than 1% of the catches from the gillnet and trammelnet fleets and 22% of the catches from the demersal otter trawl fleets. No quantitative information was available for Belgian discards in 2015, but qualitative information indicates that discarding of sole is very low. Consequently, discarding of sole in Division 7.e is considered to be negligible.

Minor retrospective patterns exist for SSB and F, but are generally not very large. However, recruitment has been very noisy in the last five years of the retrospective analysis.

Noisy recruitment estimates do not stem from retrospective bias. The abundance estimates of age 2 sole are highly variable over time and come from two relatively short time-series, the UK-FSP and Q1SWBeam survey indices. These survey indices are able to distinguish strong and weak year classes which is why they are included in the assessment. However, the UK-FSP and Q1SWBeam survey indices are not used in the forecast due to temporal variability in abundance estimates for age 2 sole. Instead, long-term geometric mean recruitment from the entire time-series replaces the XSA estimate. Consequently, there is no concern with respect to management advice.

8.3.1 General

Stock description and management units

The TAC specified for ICES Area 7.e is consistent with the assessment area.

Official national landings data as reported to ICES and the landings estimates as used by the Working Group are given in Table 8.3.1.

Official landings in 2015 were 772 t, a 9% undershoot of the TAC in 2015 (851 t). Total ICES landings were estimated at 774 t in 2015, 9% below the TAC. A UK single area licence scheme introduced at the end of 2008 stopped the previous practice of misreporting; previous UK landings estimates have been corrected for area misreporting to ICES Division 7.d which brought UK landings into line with the national quota. Landings have been stable at around 850 t over the last five years, with the UK taking about 55% of the TAC and France reporting the majority of the remainder. The proportion of French landings has steadily decreased from 49% in 2010 to reach 35% in 2015.

Management applicable to 2015 and 2016

2015 (Council Regulation (EC) No. 104/2015)

Species:	Common sole *Solea solea*	**Zone:**	VIIe (SOL/07E.)
Belgium	30 [1]		
France	320 [1]		
United Kingdom	501 [1]		
Union	851		
TAC	851		Analytical TAC Article 7(3) of this Regulation applies

[1] In addition to this quota, a Member State may grant to vessels flying its flag and participating in trials on fully documented fisheries an additional allocation within an overall limit of 5 % of the quota allocated to that Member State, under the conditions set out in Chapter II of Title II of this Regulation.

Maximum number of days a vessel may be present within the area by category of regulated gear per year

Regulated gear	Maximum number of days	
Beam trawls of mesh size ≥ 80 mm	BE	164
	FR	175
	UK	207
Static nets with mesh size ≤ 220 mm	BE	164
	FR	178
	UK	164

2016 (Council Regulation (EC) No. 72/2016)

Species:	Common sole *Solea solea*	**Zone:**	VIIe (SOL/07E.)
Belgium	35		
France	369		
United Kingdom	575		
Union	979		
TAC	979		Analytical TAC Article 7(2) of this Regulation applies

Maximum number of days a vessel may be present within the area by category of regulated gear per year

Regulated gear	Maximum number of days	
Beam trawls of mesh size ≥ 80 mm	BE	164
	FR	175
	UK	207
Static nets with mesh size ≤ 220 mm	BE	164
	FR	178
	UK	164

Landings obligation

In 2016 the landings obligation will apply to this stock for the first time. According to the delegate regulation (EC, 2015) vessels where more than 10% of their landings using beam trawls were sole during the reference years (2013 & 2014) will be covered by the Landings Obligation. The landings obligation will also apply to all catches of sole with trammelnets or gillnets. These vessels will have to land all sole in 2016. However a *de minimis* exemption will also apply allowing for up to a maximum of 3% of the annual catch to be discarded. Given the low discards observed in the fishery the landings obligation is unlikely to have a significant impact on this stock or the advice given for 2017.

8.3.2 Data

Landings

Landings of sole in Division 7.e have been around 1000 t for most of the time-series, but decreased to near 700 t between 2009 and 2010. With subsequent increases in available quota, landings steadily increased to reach 885 t in 2014. Sole landings have, however, declined to 772 t in 2015 due to France not taking all the available national quota. France landed 243 t in 2015, a 24% undershoot of the available quota (320 t). A combination of structural changes in the French fleets and variation in market forces resulted in fishers exploiting alternative fishing opportunities inside and outside the division. Industry reports from France indicate a decrease in fishing effort on sole with fleets targeting other economically valuable species (e.g. cephalopods and bivalve molluscs) and some vessels exiting the fishery. A 10% reduction in the total number of French vessels operating in the division and a decline in fishing effort for gillnetters (-25%) and demersal otter trawlers (-20%) was evident in 2015. Only minor revisions were made to the 2014 landings data (+1 tonne) used by the working group.

Data

Total international catch numbers-at-age (Table 8.3.2, Figure 8.3.1) and catch and stock weights-at-age (Tables 8.3.3, 8.3.4, Figure 8.3.2) were derived in accordance with the procedures outlined in the stock annex. Some UK age information was used to supplement sparse French age information at larger lengths between 2009 and 2014. The differences in the length distributions between the different fleets are shown in Table 8.3.5.

Sampling levels are detailed in InterCatch.

Discards

Discard data indicates that discarding in 2015 was relatively minor for the UK and Belgian fleets (Figures 8.3.3a and 8.3.3b). Occasional trips may show some discarding of sole below the minimum landings size.

Total international discards averaged 2.6% of total catch weight in 2015. Discards comprised only 0.8% of UK catch and 0.6% of Belgian catch. Discarding from French fleets, however, was higher at 17% of the total catch with demersal trawlers providing the bulk of the discards below the minimum landings size. Substantial discarding of undersized sole occurs occasionally in the coastal waters by French trawlers using modified gears to target cuttlefish. However, it has not been possible up until now to use these data when extrapolating discards samples to the fleet-level given the relatively low sampling rate of this seasonal activity. The French discards estimates in

2015 include all samples to show the magnitude of the issue, and highlight the need for further work to build a coherent time-series of discard estimates. The selectivities of the gears used to target sole are highly selective for fish above the minimum landings size and only a few sporadic cases of high-grading (included in the numbers above) have been observed. Consequently, discarding of sole is relatively low compared to other stocks.

No discard information is included in the assessment given that it is currently not possible to provide discard estimates for the entire time-series. Nevertheless, excluding discard estimates from the assessment is unlikely to have any major impact on the perception of stock status given the minor scale of the problem.

Biological

Natural mortality was assumed to be constant over ages and years at 0.1 and the maturity ogive from Divisions 7.f and 7.g was used in accordance with the procedures outlined in the stock annex and adopted in previous assessments. The review group suggested developing temporally variable maturity data for this stock. However, the surveys usually used for such estimates are conducted in September due to the much better quality control on staging individuals. This time of year has been determined to be unreliable for estimating maturity for this species as gonadal development has not commenced. A new quarter 1 survey may provide better data which will be considered at the next benchmark meeting.

Survey indices

IBPWCFlat2 2015 updated the derivation of cpue estimates for the UK-FSP and Q1SWBeam surveys to make full use of the available sampling data. Updated cpue estimates exhibited similar temporal trends to those presented previously but with more variability due to the inclusion of additional numbers-at-age information.

Aggregated cpue estimates for the UK-FSP and Q1SWBeam surveys increased between 2012 and 2014 to reach the highest levels of the time-series. Cpue estimates for ages 6–8 increased in both survey indices during this time period. A decrease in aggregated cpue estimates was evident in both survey indices between 2014 and 2015 due to reductions in the abundance of sole aged 3–7. Year-class estimates from the surveys have remained below average since 2012.

Abundance estimates derived from the surveys are given in Table 8.3.7 and shown in Figures 8.3.5 and 8.3.6, plotted by year class and by year. Year-class tracking was relatively good with historical consistency in the estimation of strong and weak cohorts and no major year effects in cpue estimates. Notable differences between the commercial and survey tuning series are the 1998 year class. This is well represented in the commercial data, but less clearly in the survey data. The 1998 year class was also seen to be very strong in the 7.f and 7.g stock and may represent some overspill of recruitment from that stock in the adjacent western part of 7.e, not observed by the Q1SWbeam survey.

The UK-FSP survey

The UK Fisheries Science Partnership (UK-FSP) conducted another survey, now in its 13th year (only twelve years used for sole due to data issues), of sole and plaice abundance in the Western English Channel. The results indicate that sole continue to be widespread in the area and that a large number of cohorts contribute to the stock. The working group has reported on this survey on several occasions and the information is now included in the assessment following the benchmark in 2012. Abundance estimates for the UK-FSP survey decreased to just above the average of the time-series between 2014 and 2015.

The Q1SWBeam survey

Abundance estimates for the Quarter 1 South West Beam trawl (Q1SWBeam) survey started in 2006 and have been included in the assessment for the fourth time. The survey shows strong gradients in species composition within the Western English Channel (justifying the stratification approach), although there is some indication that more appropriate post stratification could potentially provide an increase in precision of single species abundance estimates. Aggregated cpue estimates for the Q1SWBeam survey increased to reach the highest levels on record between 2012 and 2014 and then subsequently decreased to below the average of the time-series in 2015.

Commercial fleets effort and lpue

IBPWCFlat2 2015 revised the effort time-series for the UK commercial beam (UK-CBT) and otter trawl (UK-COT) fleets due to fluctuations in lpue estimates after 2012 arising from modifications in the UK e-logbook effort recording system. Revised landings numbers, effort in days and lpue estimates in kg per 1000 days exhibited similar temporal trends to those presented previously, except with greater stability after 2012 (Figure 8.3.4; Table 8.3.6).

Effort for under 24 m UK beam trawlers in days fished steadily increased between 1992 and 2012 to reach the highest levels on record (Figure 8.3.4, Table 8.3.6). In contrast, effort for over 24 m UK beam trawlers increased from 1992 to 2004 and then decreased to below the average of the time-series thereafter. Beam trawlers over 24 m have declined in favour of smaller boats due to a combination of the UK decommissioning scheme and the substantial increases in fuel costs, making the larger boats commercially unviable. The decline of the larger boats has resulted in a resurgence of the use of under 24 m vessels. Given the licence transfer rules currently in force in the UK, restructuring of the fleets will lead to a 10% decrease in the kW day capacity of replaced vessels not withstanding any latent capacity. Only minor differences (6%) in effort for the UK-CBT fleet were observed between 2014 and 2015. Current effort levels for the UK-CBT fleet are slightly above (2.6%) the average of the last ten years.

UK otter trawl (UK-COT) effort has been in continual decline since the early-1970s and is currently at the lowest levels on record with values approximately one-fifth of those seen in the late-1980s (Figure 8.3.4 and Table 8.3.6). Gross registered tonnage corrected effort used in the assessment shows a strong decline in effort in the main fleet exploiting the stock in 2009 as vessels moved out of the area following the introduction of the UK single area licensing scheme (Figure 8.3.4, Table 8.3.7).

Otter trawl effort included as tuning information in the assessment has declined steadily since 1989 and is now at historically low levels, but this fleet takes only a small proportion (8%) of the landings.

All fleets exhibited an increase in lpue estimates from the low point in 2004 to around the average of the time-series thereafter. Lpue estimates for UK beam trawlers under and over 24 m steadily decreased from 1988 to 2004 and then increased from 2004 to 2005. Since 2008, lpue estimates for the UK-CBT fleet have been relatively stable below the average of the time-series. For the UK-COT fleet, lpue estimates have been relatively consistent, fluctuating around the average of the time-series since 1993.

Age disaggregated commercial abundance indices for the UK-CBT-late and UK-COT fleets are given in Table 8.3.7 and plotted mean standardised by cohort and year in Figures 8.3.5 and 8.3.6. The UK-CBT-late fleet shows good year-class tracking indicated by the consistent estimation of strong and weak year classes at different ages with little indication of year effects in the time-series. In addition, the UK-COT fleet shows good year-class tracking over the middle of the time period and indicates a decline in lpue in the early-1980s. This is likely in part caused by the strong year effect seen for this fleet in 1991 and to a lesser degree in 2004. The causes of this are not clear from anecdotal evidence, but sampling for the fleet is now at relatively low levels due to the small size of the fleet and landings. In 2013, the review group commented on the use of commercial tuning data which appears to show undesirable trends. The reasons for using these data were justified by WKFLAT 2012 and these reasons still apply.

Information from the fishing industry

No comments were received in 2016 regarding the assessment or management of this stock beyond the information from the UK fisheries science partnership already formally included in the assessment process. Industry reports from France indicate a decrease in fishing effort on sole in 2015, with fleets increasingly targeting other economically valuable species and some vessels exiting the fishery.

8.3.3 Stock assessment

Model used: Extended Survivors Analysis (XSA) as outlined in the stock annex by IBPWCFlat2 2015.

Software used: FLR – FLXSA (FLCore 2.5.0; R 2.15.3) and the Lowestoft VPA suite version 3.2. (Darby and Flatman, 1995).

Model options chosen: Data included in the assessment were identical to previous years, although some alterations to the French age compositions were necessary due to a lack of age information in Q3.

Assessment input data characteristics: catch numbers-at-age excluding discards and four tuning fleets (two fishery-independent surveys: UK-FSP and Q1SWBeam; and two commercial lpue time-series: UK-CBT-late and UK-COT). At IBPWCFlat2 2015, the XSA model parameterisation was updated to incorporate revised tuning information due to modfications in the UK e-logbook effort recording system.

Data screening

Data screening procedures identified no anomalies in the catch numbers-at-age, weights or tuning information used in the 2016 assessment. The data were consistent with the previous assessment conducted at the 2015 working group.

Tuning information consisted of four fleets: two UK commercial time-series (UK-CBT-late and UK-COT) and two UK standardised research surveys (UK-FSP and Q1SWBeam). Commerical lpue estimates in kg per 1000 days fished for the UK-CBT-late and UK-COT fleets were included in the assessment for the second time. IBPWCFlat2 2015 decided to exclude the UK-CBT-early fleet from the tuning indices due to the time-series contributing relatively little to assessment outputs except for noise and the log catchability residuals from the fitted data showed a decreasing trend over time.

Details of the derivation of the tuning fleets are presented in the stock annex, and the tuning information available for this assessment is shown in Table 8.3.7. All four of the tuning indices possess relatively consistent year-class estimates with few clear year effects (Figures 8.3.5 and 8.3.6).

Final update assessment

The working group fitted the XSA model developed by WKFLAT 2012 using the updated assessment settings agreed at IBPWCFlat2 2015, which had no major impacts on the diagnostics or the interpretation of the assessment.

The XSA assessment settings used at the last two working groups are shown in the table below and more historic settings have been included in the stock annex.

Figures 8.3.7 to 8.3.9 show the residual plots from the final fitted XSA model, a comparison of stock status and fishing mortality estimates from the 2015 assessment and the XSA survivor weightings.

Recruitment, SSB and F estimates only exhibited minor deviation from the 2015 assessment (Figure 8.3.8). Temporal trends in recruitment, SSB and F estimates were virtually identical with relatively minor differences in absolute values over the last decade. On average, SSB estimates were 3% lower and F estimates were 3% higher than the previous assessment from 2005. XSA diagnostic tables, stock numbers-at-age and fishing mortalities-at-age for the final assessment are shown in Tables 3.8.8–3.8.10.

A five-year retrospective analysis showed some retrospective bias during the mid-to-late 2000s, but confirms a greater degree of temporal stability in SSB and F estimates after this period (Figure 8.3.10). Some of the retrospective bias in SSB and F estimates observed in the assessment undoubtedly results from the loss of influence of the UK-FSP and Q1SWBeam survey time-series which is too short for an unbiased retrospective analysis. Temporal variation in SSB and F estimates in the most recent period resulted from noise rather than retrospective bias.

XSA assessment settings used at the last two working groups.

	WGCSE 2015*	WGCSE 2016
Assessment age range	2–12+	2–12+
Fbar age range	F(3–9)	F(3–9)
Assessment method	XSA	XSA
Tuning Fleets:		
Q1SWBeam	2006–2014 2–11 (non-offset)	2006–2015 2–11 (non-offset)
UK-FSP	2004–2014 2–11	2004–2015 2–11
UK combined beam (early) Ages	–	–
UK combined beam (late) Ages	2003–2014 3–11	2003–2015 3–11
UK otter trawl Ages	1988–2014 3–11	1988–2015 3–11
UK-WEC-BTS Ages	–	–

	WGCSE 2015*	WGCSE 2016
Time taper	Yes	Yes
Power model	Tricubic	Tricubic
Taper range	15 years	15 years
P shrinkage	No	No
Q plateau age	7	7
F shrinkage S.E	0.5	0.5
Number of years	3	3
Number of ages	5	5
Fleet S.E.	0.4	0.4

***Note that the XSA assessment settings were updated to incorporate revised tuning information at IBPWCFlat2 2015.**

State of the stock

Stock trends are shown in Table 8.3.11 and plotted in Figure 8.3.8.

SSB is estimated to have increased between 1972 and 1980 following successive strong recruitment events. Subsequently, SSB declined from 1981 to 1993 and remained relatively stable until 2009. After this period, SSB increased in response to a decrease in F. In 2015, SSB is estimated to be 3977 t.

The base level of recruitment has remained relatively stable throughout the time-series, fluctuating without major temporal trend at around 4–5 million recruits. Recruitment variability has decreased since 1991, however, with none of the substantial year classes that maintained a higher level of biomass observed during the 1970s and 1980s. Recruitment over the last decade has been fluctuating around the long-term average of the time-series.

Fishing mortality was relatively stable at a low level between 1969 and 1978, after which it increased sharply until 1983 and fluctuated at a higher level before peaking briefly in 1989–1990. After a period of temporal variability, F decreased abruptly to below the F_{MSY} target of 0.29 in 2009 and has remained below this level ever since. In 2015, F was estimated to be 0.196.

Information consistent with the decrease in fishing mortality in the most recent years is provided by the recent decline in UK landings and effort (Figure 8.3.4). Total international landings are around the agreed TAC, but vary year to year. Slight increases in effort for UK beam trawlers from 2009 to 2012 did not have the commensurate effect on F due to a shift in the spatial distribution of the fleet. UK beam trawlers are operating further offshore than in the past in areas of lower sole abundance to take advantage of other fishing opportunities.

The age structure of sole 7.e continues to be more extended than other sole stocks in European waters, implying low mortality rates, with the plus group at-age 12 containing a high proportion of the catches and including some individuals aged 33–38 in recent years.

8.3.4 Short-term projections

Reported landings were 52 tonnes (6%) above the agreed TAC in 2014 (832 t). However, this year saw an undershoot of the TAC by 77 tonnes (-9%). Reported landings and working group estimates are trending around the TAC estimate, but French landings are still subject to a lag between reaching the TAC and closure of the fishery so that a rescaled F interim year assumption remains prudent.

F estimates 2013–2015 indicate a slight decrease which is likely to be linked to the small but remaining retrospective pattern. Consequently, rescaling F_{2015} by average F_{13-15} is considered appropriate for the forecast as per the stock annex. The mean catch and stock weights-at-age 2013–2015 were also used.

Estimating year-class abundance

Recruitment was forecast using a long-term geometric mean (1969–2015) due to temporal variability in the time-series and the lack of distinct periods of successive high or low recruitment in recent years.

Year class	Thousands	Basis	Surveys	Commercial	Shrinkage
2013	4550	XSA	66%	-	34%
2014	3911	GM (69–15)			
2015	3911	GM (69–15)			
2016	3911	GM (69–15)			

Complete input data for the short-term forecast are shown in Table 8.3.12, and the resulting forecast estimates landings in 2016 to be 809 t, 170 t (-17%) less than the TAC (979 t) in 2016 (Table 8.3.13).

SSB estimated at 4031 t in 2016 will increase to 4143 t in 2017 at the current level of F assuming long-term geometric (1969–15) recruitment for the 2014 year class.

The proportions that the 2013–2017 year classes will contribute to landings in 2016 and to SSB in 2017 are given in Table 8.3.14. Year classes for which geometric recruitment has been assumed contributed to 15.6% of the landings for 2017 and 24.6% of the SSB for 2018.

The 2014 year class that has been replaced with long-term geometric (1969–15) recruitment contributes to 11.6% of the landings in 2017 and 15.0% of the SSB in 2018.

A full management options table is provided in Table 8.3.15. The management plan for this stock requires exploitation at $F_{MGT} = 0.27$ leading to a projected yield of 1106 t in 2017.

Output for the short-term forecast under the MSY approach is presented in Figure 8.3.11. The MSY approach requires exploitation at $F_{MSY} = 0.29$ leading to a projected yield of 1178 t in 2017 and an SSB of 3882 t in 2018.

8.3.5 Biological reference points

The most recent reference points for this stock were developed by WKMSYREF4 in 2015 and are presented in the table below.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	2900 t	Based on the 5th percentile of the distribution of SSB when fishing at F_{MSY} (0.29) with no error (WKMSYREF4).	ICES (2016)
	F_{MSY}	0.29	Based on the peak of the median landings yield curve (WKMSYREF4).	ICES (2016)
Precautionary approach	B_{lim}	2000 t	Based on B_{pa}/1.4 (WKMSYREF4).	ICES (2016)
	B_{pa}	2900 t	Based on Bloss (1999 yc). Lowest SSB with high recruitment (WKMSYREF4).	ICES (2016)
	F_{lim}	0.44	Based on a segmented regression simulation of recruitment with B_{lim} as the breakpoint and no error (WKMSYREF4).	ICES (2016)
	F_{pa}	0.32	Based on F_{lim}*exp(-1.645*σ); σ=0.2 (WKMSYREF4).	ICES (2016)
Management plan	SSB_{MGT}	Undefined		
	F_{MGT}	0.27		EC (2007)

8.3.6 MSY-evaluation

The working group did not conduct any further MSY evaluations given the repeat of the evaluation at WKMSYREF4 in 2015 and little or no change in the selection pattern given by the current assessment.

8.3.7 Management plan

The commission implemented a management plan for the recovery of the stock early in 2007 (Council Regulation (EC) No 509/2007). ICES evaluated the management plan and concluded that:

> The long-term management target (F_{MGT} = 0.27) is precautionary in the sense that it ensures that there is a less than 5% chance of SSB declining below previously observed levels, as well as maintaining yield within 10% of MSY (*WGCSE note: long-term yield at F_{MAX}*) (working group, 2005; working group, 2006).

8.3.8 Uncertainties in assessment and forecast

The methodology provided is as robust as possible, and does not currently appear to suffer from a serious retrospective pattern but the effect is beginning to re-emerge as the trimmed commercial fleet increases in length, as predicted by WKFLAT 2012. Modifications to the UK e-logbook effort recording system in 2012 and the loss of lpue estimates from the UK Western Channel Beam Trawl survey (UK-WEC-BTS) in 2013 are also likely to have contributed to the minor retrospective patterns in SSB and F. The short-term forecast is relatively insensitive to such problems and management targets and limits are sufficiently removed from the current state so that the risk to the stock is small.

Two uncertainties that cannot be quantified in the assessment limit the accuracy of the the short-term forecast. Firstly, the likely F in 2016 remains uncertain. Secondly, the size of recent year classes have been estimated to be weak in the assessment, except for in the terminal year. Previous assessments have estimated recruitment in the most recent period to be among the lowest on record. However, recruitment in 2015 is estimated to be around the long-term average of the time-series. Recruitment in 2016 was forecasted using a long-term geometric mean (1969–2015) due to temporal variability in the time-series and the lack of distinct periods of successive high or low recruitment in recent years.

Discarding

Discarding is considered to be negligible in this fishery, averaging 2.6% of total international catch weight in 2015. Nevertheless, a time-series of available discard information raised to the fleet level should be developed to deal with potential future discard issues effectively and improve estimates of total mortality. UK fleet-raised discard estimates were available individually in 2015 for UK non-FDF beam trawlers and *Nephrops* otter trawlers. The landings obligation will apply to some fleets catching sole in 2016. The landings advice has been topped up with the available discard information to give catch advice so developing a time-series of discard information appears to be less urgent than in the past.

Surveys

The assessment methodology includes two survey indices. The Q1SWBeam survey added to the assessment in 2012 covers the entire management area, providing fishery-independent tuning information for the entire age range used in the assessment. Therefore, the assessment now relies much less on the commercial tuning information and is less susceptible to localised exploitation by the fishery. However, there is still some uncertainty with respect to the precision of this information particularly when the duration of the time-series remains relatively short. Consequently, commercial tuning information is still used in the assessment to maintain the balance between accuracy and precision required by management. Survey information for the recruiting year class remains temporally variable and is not used in the forecast for this reason.

Sampling

Age and length sampling for this stock is mostly adequate. Age data from the largest two sectors operating in this fishery (UK and France, together taking 95% of landings) are included in the assessment. French age data between 2009 and 2014 were insufficient at older ages to raise the length compositions, and therefore UK age data were used to cover the larger fish. In 2015, French age data were sufficient to raise the length compositions for larger fish, but no age data were avaliable in Q3.

Consistency

The assessment for this stock was last benchmarked in 2012 and an inter-benchmark was held in 2015. The 2016 assessment is consistent with the previous assessment conducted in 2015. Temporal trends in recruitment, SSB and F estimates were virtually identical. Across the entire time-series, SSB and F estimates were less than 1% lower and higher, respectively, than the previous assessment. SSB in 2014 was revised down by 6% and F was revised up by 5%.

Misreporting

Area misreporting, mainly to Area 7.d had declined to low levels in recent years, through a combination of enforcement and a substantial increase in the TAC in 2005. Some attempts to prosecute UK fishers for misreporting to area 7.h have been made, however to date, none of those prosecutions have been successful due to a lack of legally acceptable evidence.

Levels of under reporting are thought to have been serious in the early 1980s prior to the shift to area misreporting. Although it is clear that levels of under reporting are also much lower now, no quantitative information is available on the size of the problem in the fishery.

Landings from the UK beam-trawl fleet, historically the main contributors to area misreporting, in 2010–2015 were in line with the TAC, suggesting improved compliance. The decrease in landings is also consistent with a reduction in effort by the main fleet and a decline in F observed on the plaice 7.e stock, a major bycatch of the sole fishery.

8.3.9 Recommendation for the next benchmark

There is no requirement to benchmart this stock in the short term.

Lpue estimates for the UK-CBT and UK-COT fleets should be closely monitored to avoid the recurrence of innaccuracies in commercial tuning information observed at the 2014 and 2015 working groups. Minor retrospective patterns in stock status and fishing mortality estimates have begun to re-merge but are expected to stablise as the duration of the lpue time-series increases in future. Consequently, the next benchmark should evaluate the temporal stability of the retrospective patterns and determine whether the assessment settings need to be revised.

8.3.10 Management considerations

Effort restrictions have been sufficient to ensure an observable decrease in F in recent years. Decommissioning in the UK fleet in 2007–2008 reduced the capacity of the fleet. In addition, the UK single area licensing scheme appears to have been effective since 2009 and resulted in the UK fleet utilising fishing opportunities in other ICES divisions so that effective effort and F in Division 7.e dropped markedly. A catch quota scheme based on an assumed 30% discarding by weight is currently running in the UK for beam trawlers. This value is well in excess of the likely discarding in the fleet, which was less than 1% of total catch weight in 2015. Consequently, as this concession continues to be granted to boats in the fishery this will lead to additional mortality.

France provided discard estimates for the first time at the 2016 working group. Discard estimates from France were higher (17%) than the UK (0.8%) and Belgium (0.6%). French discard estimates should, therefore, be closely monitored in future to determine whether discarding by French fleets continues at the current level. Although total international discards increased from 1.1% to 2.6% between 2014 and 2015, the increase in discarding is of no major concern to management given that it is mainly an artefact of the addition of French discard estimates and remains at a relatively low level compared to other stocks with the majority of discards comprised of sole below the minimum landings size.

Plaice are taken as bycatch in this fishery, and therefore management advice for sole must also take into account the advice for plaice. The effort reductions in 2009 positively impacted the plaice stock with a sizeable reduction in F. Anglerfish, cuttlefish, and lemon sole are also important bycatches in this fishery. The UK beam-trawl fleet has recently started to land sizeable quantities of gurnards for human consumption.

8.3.11 Ecosystem considerations

See stock annex.

8.3.12 Regulations and their effects

Management of this stock is mainly by TAC. In 2005, effort restrictions were implemented for beam trawlers and entangling gears targeting sole in this fishery to enforce the TAC and improve data quality. To date, the latter restrictions have not been limiting in this fishery, in part due to the large numbers of days available, but also because in the UK fleet there appears to remain some latent effort/over-capacity in the beam-trawl fleet despite decommissioning. WKFLAT 2012 observed a change in the distribution of the fleet due to multispecies considerations (foregoing higher cpue for sole in favour of taking a larger proportion of other available resources). Under the current pattern of exploitation, effort restrictions are commensurate with the TAC as indicated by the negligible contribution of high-grading to the total mortality. However if the availability of other resources such as monkfish, scallops, cuttlefish and lemon sole were to decrease, then economics may drive the fishery back to areas of higher sole abundance in which case current effort restrictions may not be sufficient to ensure an appropriate relationship between TAC and effort restrictions.

In November 2008, the UK introduced a single area licensing scheme for beam trawlers, which is thought to be highly effective in eliminating the current practice of area misreporting by this fleet, but will have had little effect on the fishery in 2008. UK landings and effort data indicate that the measure has been effective since 2009.

Mesh restrictions for towed gears are set to 80 mm codends, which correspond well with the minimum landing size of sole at 24 cm. Consequently, there is little discarding of sole in this fishery and this view has not changed in spite of the more restrictive TAC on the UK beam-trawl fleet.

8.3.13 Changes in fishing technology and fishing patterns

The UK industry applied for MSC certification in 2009 and started to adopt larger codend meshes and square mesh panels to limit the impact of fishing activities on vulnerable marine habitats. However, these changes appear to minimally affect the catch rates of sole and the degree of uptake of these measures in the fleet remains unclear. Changes in fishing patterns to make the most of available opportunities for other species in this multispecies fishery have changed fleet behaviour. To date, the evidence suggests that these effects are more substantial than those associated with changes in the fishing gear, but both will need to be monitored in the future.

8.3.14 Changes in the environment

See stock annex.

8.3.15 Refernces

EC. 2015. Commission Delegated Regulation (EU) 2015/2438 of 12 October 2015 establishing a discard plan for certain demersal fisheries in north-western waters.

Table 8.3.1. Sole in Division 7.e. Nominal landings (tonnes) as used by ICES.

Year	Belgium	France	Netherlands	Ireland	Jersey	Guernsey	UK (E, W & NI)	UK other	Unallocated	Total
1974		323							104	427
1975	3	271				2	215			491
1976	4	352				1	259			616
1977	3	331					272			606
1978	4	384					453		20	861
1979	1	515				2	663			1181
1980	45	447		13		1	763			1269
1981	16	415	1			4	784		-5	1215
1982	98	321				15	1013		-1	1446
1983	47	405	3		2	16	1025			1498
1984	48	421			9	14	878			1370
1985	58	130			9	8	894		310	1409
1986	62	467			3	6	831		50	1419
1987	48	432			1	5	626		168	1280
1988	67	98			0	4	780		495	1444
1989	69	112	6			3	610		590	1390
1990	41	81			1	3	632		556	1315
1991	35	325					477		15	852
1992	41	267				2	457	9	119	895
1993	59	236			1		479	18	111	904
1994	33	257					546		-38	800
1995	21	294			1	2	562		-24	856
1996	8	297					428		91	833
1997	13	348		1	13	13	470		91	949
1998	40	343			17	3	369		108	880
1999	13				18	3	375		548	957
2000	4	241			22	5	386		256	914
2001	19	224			20	5	382		419	1069
2002	33	198			15	5	289		566	1106
2003	1	363		1	15	5	235		458	1078
2004	7	302			7	6	172		581	1075
2005	26	406			17	5	505		80	1039
2006	32	357			4	4	568	0	56	1022
2007	34	384		2	2		525	4	64	1015
2008	28	312		0	2	6	464		96	908
2009	17	386			1	3	374	3	-83	701
2010	17	375			2	3	361	2	-62	698
2011	22	401			2	4	422		-50	801
2012	39	325		0	1	2	504		1	872
2013	30	319			2	4	532		-4	883
2014	25	351			1	5	503		-1	884
2015*	42	243			1	2	484		-2	774

*** Landings in 2015 are preliminary.**

Table 8.3.2. Sole in Division 7.e. Catch numbers-at-age (000's).

Year/Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	89	53	51	146	71	45	82	167	426	250	227
3	322	232	201	412	396	349	567	419	318	1123	803
4	80	322	246	167	433	220	170	472	384	347	811
5	149	90	198	115	89	178	199	161	206	214	250
6	210	83	65	113	99	71	115	135	103	189	229
7	21	112	80	14	120	80	28	92	70	103	174
8	50	13	156	25	17	43	53	47	74	72	103
9	26	35	10	134	52	32	26	59	10	77	90
10	20	52	35	39	30	24	22	51	24	38	104
11	9	22	55	54	4	55	24	14	32	27	28
+gp	63	113	113	106	136	106	171	213	159	203	290
Total	1037	1127	1207	1323	1446	1202	1456	1830	1804	2644	3108
Landings	353	391	432	437	459	427	491	616	606	861	1181

Table 8.3.2. Sole in Division 7.e. Catch numbers-at-age (000's) continued.

Year/Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	175	245	128	91	333	287	246	487	443	390	341
3	559	806	1451	753	663	1700	1618	809	1438	871	902
4	497	651	916	1573	826	756	971	1091	596	1233	581
5	630	467	553	583	758	469	421	427	728	497	553
6	126	389	352	351	325	585	321	204	374	509	244
7	183	179	240	267	204	179	336	224	153	225	265
8	140	126	136	294	129	97	84	229	162	110	143
9	65	76	113	119	152	103	75	47	109	107	103
10	56	58	81	73	54	85	90	50	39	113	75
11	130	55	61	37	28	29	74	41	50	48	85
+gp	342	211	294	262	255	125	127	162	171	214	235
Total	2902	3262	4324	4401	3727	4414	4363	3771	4262	4316	3525
Landings	1269	1215	1446	1498	1370	1409	1419	1280	1444	1390	1315

Table 8.3.2. Sole in Division 7.e. Catch numbers-at-age (000's) continued.

Year/Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	450	316	209	97	95	365	216	265	280	307	145
3	415	1434	704	657	308	445	831	606	915	599	1401
4	483	417	1107	558	629	364	724	536	500	751	531
5	289	297	351	558	427	298	325	336	398	367	497
6	220	115	219	112	411	235	180	209	255	229	268
7	93	112	151	106	131	257	194	151	114	107	178
8	111	61	78	49	101	68	173	80	103	53	100
9	68	74	60	57	61	61	44	127	54	68	55
10	37	26	56	44	33	49	20	35	107	51	43
11	31	23	31	50	18	37	40	34	25	88	42
+gp	145	90	79	99	142	143	88	162	123	91	159
Total	2341	2964	3045	2388	2356	2321	2835	2543	2874	2710	3419
Landings	852	895	904	800	856	833	949	880	957	914	1069

Table 8.3.2. Sole in Division 7.e. Catch numbers-at-age (000's) continued.

Year/Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
2	332	598	398	258	500	201	281	166	68	91	31
3	1251	835	1080	469	786	852	752	540	348	499	227
4	843	953	448	834	472	755	678	385	394	476	525
5	387	645	445	449	606	293	376	333	329	405	400
6	322	130	526	366	250	362	163	202	204	233	355
7	129	74	164	293	224	179	184	66	127	156	231
8	105	50	116	113	185	130	105	74	49	80	137
9	94	58	61	80	85	110	71	37	71	39	67
10	33	63	54	45	56	55	67	50	20	34	44
11	18	14	35	24	31	27	39	35	34	28	39
+gp	85	61	85	96	87	99	89	65	78	93	124
Total	3599	3482	3412	3027	3282	3062	2805	1955	1723	2136	2180
Landings	1106	1078	1075	1039	1023	1015	908	701	698	801	872

Table 8.3.2. Sole in Division 7.e. Catch numbers-at-age (000's) continued.

Year/Age	2013	2014	2015	Geometric mean 2013-2015	Arithmetic mean 2013-2015
2	120	198	187	164.40	168.33
3	324	320	344	329.17	329.33
4	483	466	390	444.43	446.33
5	595	426	363	451.45	461.33
6	280	410	271	314.51	320.33
7	214	168	233	203.09	205.00
8	147	112	116	124.07	125.00
9	98	79	83	86.29	86.67
10	48	61	49	52.35	52.67
11	23	27	32	27.09	27.33
+gp	110	97	69	90.30	92.00
Total	2441	2364	2136	2309.97	2313.67
Landings	883	885	772	844.97	846.67

Table 8.3.3. Sole in Division 7.e. Catch weights-at-age (kilograms).

Year/Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	0.188	0.187	0.151	0.194	0.203	0.183	0.181	0.170	0.197	0.180	0.187
3	0.245	0.223	0.222	0.227	0.224	0.224	0.214	0.217	0.248	0.241	0.237
4	0.332	0.294	0.296	0.272	0.262	0.281	0.299	0.286	0.302	0.303	0.327
5	0.329	0.314	0.367	0.369	0.310	0.379	0.358	0.323	0.356	0.390	0.423
6	0.367	0.354	0.350	0.408	0.381	0.434	0.403	0.390	0.399	0.439	0.460
7	0.522	0.434	0.359	0.458	0.414	0.372	0.435	0.454	0.502	0.377	0.468
8	0.455	0.498	0.431	0.495	0.459	0.464	0.497	0.413	0.463	0.486	0.477
9	0.463	0.442	0.455	0.402	0.466	0.475	0.591	0.475	0.517	0.489	0.565
10	0.606	0.512	0.476	0.454	0.537	0.487	0.651	0.478	0.484	0.488	0.522
11	0.647	0.528	0.388	0.508	0.654	0.474	0.535	0.583	0.552	0.540	0.569
+gp	0.660	0.594	0.654	0.600	0.561	0.731	0.676	0.628	0.682	0.670	0.725

Table 8.3.3. Sole in Division 7.e. Catch weights-at-age (kilograms) continued.

Year/Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	0.189	0.174	0.213	0.188	0.209	0.162	0.174	0.174	0.170	0.167	0.216
3	0.254	0.226	0.208	0.251	0.242	0.225	0.237	0.245	0.244	0.222	0.270
4	0.343	0.322	0.276	0.272	0.304	0.296	0.297	0.310	0.312	0.275	0.322
5	0.389	0.382	0.345	0.307	0.379	0.358	0.354	0.370	0.375	0.326	0.370
6	0.525	0.478	0.424	0.390	0.389	0.389	0.407	0.425	0.432	0.375	0.416
7	0.560	0.515	0.495	0.419	0.478	0.469	0.456	0.474	0.484	0.422	0.458
8	0.609	0.534	0.507	0.475	0.539	0.520	0.502	0.518	0.531	0.467	0.498
9	0.646	0.599	0.520	0.532	0.559	0.531	0.544	0.557	0.572	0.510	0.534
10	0.655	0.620	0.523	0.610	0.601	0.519	0.583	0.590	0.608	0.551	0.567
11	0.600	0.710	0.561	0.553	0.722	0.584	0.618	0.618	0.639	0.590	0.597
+gp	0.783	0.661	0.659	0.667	0.639	0.817	0.703	0.665	0.694	0.692	0.664

Table 8.3.3. Sole in Division 7.e. Catch weights-at-age (kilograms) continued.

Year/Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	0.182	0.166	0.146	0.183	0.192	0.214	0.186	0.191	0.208	0.201	0.203
3	0.255	0.238	0.209	0.241	0.248	0.262	0.244	0.247	0.257	0.257	0.245
4	0.323	0.305	0.268	0.295	0.301	0.308	0.300	0.300	0.303	0.309	0.287
5	0.386	0.366	0.324	0.347	0.351	0.354	0.354	0.350	0.347	0.357	0.326
6	0.445	0.423	0.376	0.396	0.397	0.399	0.406	0.397	0.389	0.400	0.365
7	0.499	0.474	0.425	0.442	0.441	0.442	0.455	0.441	0.429	0.440	0.402
8	0.549	0.520	0.470	0.484	0.481	0.484	0.503	0.482	0.467	0.475	0.438
9	0.594	0.561	0.513	0.524	0.518	0.524	0.548	0.520	0.502	0.507	0.472
10	0.634	0.597	0.551	0.561	0.552	0.564	0.592	0.555	0.535	0.534	0.505
11	0.669	0.627	0.587	0.595	0.583	0.602	0.633	0.586	0.566	0.557	0.537
+gp	0.742	0.684	0.672	0.671	0.652	0.695	0.734	0.661	0.637	0.645	0.615

Table 8.3.3. Sole in Division 7.e. Catch weights-at-age (kilograms) continued.

Year/Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
2	0.181	0.173	0.176	0.180	0.168	0.183	0.197	0.176	0.169	0.200	0.162
3	0.236	0.241	0.230	0.235	0.226	0.244	0.245	0.252	0.258	0.261	0.240
4	0.290	0.306	0.282	0.289	0.280	0.299	0.292	0.322	0.339	0.319	0.311
5	0.342	0.367	0.334	0.342	0.331	0.350	0.337	0.385	0.412	0.375	0.373
6	0.391	0.425	0.385	0.393	0.378	0.395	0.382	0.443	0.476	0.428	0.428
7	0.439	0.479	0.435	0.443	0.421	0.436	0.425	0.494	0.532	0.480	0.476
8	0.485	0.530	0.485	0.492	0.461	0.471	0.468	0.540	0.580	0.528	0.516
9	0.529	0.577	0.533	0.539	0.497	0.501	0.509	0.579	0.619	0.575	0.548
10	0.570	0.620	0.581	0.585	0.529	0.526	0.549	0.612	0.650	0.618	0.572
11	0.610	0.660	0.628	0.629	0.558	0.546	0.588	0.639	0.673	0.660	0.589
+gp	0.705	0.746	0.756	0.746	0.667	0.616	0.652	0.702	0.699	0.750	0.664

Table 8.3.3. Sole in Division 7.e. Catch weights-at-age (kilograms) continued.

Year/Age	2013	2014	2015	Arithmetic mean 2013-2015
2	0.172	0.191	0.179	0.181
3	0.228	0.254	0.242	0.241
4	0.283	0.313	0.301	0.299
5	0.337	0.366	0.355	0.353
6	0.389	0.415	0.405	0.403
7	0.439	0.459	0.450	0.449
8	0.489	0.499	0.491	0.493
9	0.536	0.533	0.528	0.532
10	0.583	0.563	0.560	0.569
11	0.628	0.588	0.587	0.601
+gp	0.740	0.709	0.678	0.709

Table 8.3.4. Sole in Division 7.e. Stock weights-at-age (kilograms).

Year/Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	0.125	0.120	0.090	0.130	0.105	0.125	0.144	0.146	0.156	0.156	0.141
3	0.200	0.195	0.170	0.200	0.170	0.200	0.221	0.198	0.221	0.217	0.216
4	0.270	0.255	0.240	0.265	0.235	0.265	0.267	0.247	0.278	0.276	0.287
5	0.330	0.305	0.295	0.325	0.290	0.320	0.327	0.294	0.332	0.330	0.352
6	0.380	0.355	0.345	0.380	0.340	0.370	0.385	0.338	0.382	0.380	0.414
7	0.425	0.395	0.390	0.420	0.390	0.410	0.435	0.380	0.425	0.425	0.463
8	0.460	0.430	0.420	0.460	0.435	0.455	0.479	0.417	0.462	0.463	0.502
9	0.490	0.465	0.445	0.490	0.475	0.490	0.516	0.456	0.497	0.498	0.539
10	0.520	0.490	0.470	0.520	0.510	0.515	0.545	0.491	0.527	0.526	0.574
11	0.550	0.510	0.490	0.540	0.540	0.530	0.569	0.523	0.553	0.555	0.608
+gp	0.609	0.541	0.544	0.558	0.585	0.571	0.628	0.595	0.629	0.630	0.719

Table 8.3.4. Sole in Division 7.e. Stock weights-at-age (kilograms) continued.

Year/Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	0.125	0.119	0.117	0.120	0.108	0.150	0.140	0.137	0.131	0.139	0.187
3	0.206	0.197	0.195	0.195	0.192	0.204	0.206	0.210	0.208	0.195	0.243
4	0.288	0.276	0.265	0.250	0.268	0.258	0.268	0.278	0.278	0.249	0.296
5	0.360	0.358	0.335	0.307	0.339	0.311	0.326	0.341	0.344	0.300	0.346
6	0.436	0.427	0.398	0.365	0.400	0.364	0.381	0.398	0.404	0.350	0.393
7	0.513	0.490	0.455	0.420	0.453	0.416	0.432	0.450	0.459	0.398	0.437
8	0.575	0.543	0.506	0.475	0.501	0.468	0.480	0.497	0.508	0.444	0.478
9	0.620	0.582	0.536	0.520	0.545	0.520	0.524	0.538	0.552	0.488	0.516
10	0.650	0.616	0.562	0.570	0.577	0.571	0.564	0.574	0.591	0.531	0.551
11	0.674	0.645	0.585	0.615	0.607	0.621	0.601	0.605	0.624	0.571	0.583
+gp	0.714	0.699	0.632	0.709	0.696	0.790	0.692	0.659	0.687	0.675	0.654

Table 8.3.4. Sole in Division 7.e. Stock weights-at-age (kilograms) continued.

Year/Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	0.144	0.128	0.114	0.153	0.163	0.189	0.156	0.162	0.183	0.172	0.181
3	0.219	0.202	0.178	0.212	0.221	0.238	0.215	0.220	0.233	0.230	0.224
4	0.290	0.272	0.239	0.268	0.275	0.285	0.272	0.274	0.280	0.284	0.266
5	0.355	0.336	0.296	0.322	0.326	0.331	0.327	0.325	0.326	0.333	0.307
6	0.416	0.395	0.350	0.372	0.374	0.376	0.380	0.374	0.369	0.379	0.346
7	0.473	0.449	0.401	0.419	0.419	0.420	0.431	0.419	0.410	0.421	0.384
8	0.524	0.498	0.448	0.463	0.461	0.463	0.480	0.462	0.448	0.458	0.420
9	0.572	0.542	0.492	0.505	0.500	0.504	0.526	0.501	0.485	0.492	0.455
10	0.614	0.580	0.532	0.543	0.536	0.544	0.570	0.537	0.519	0.521	0.489
11	0.652	0.613	0.570	0.578	0.568	0.583	0.612	0.571	0.551	0.546	0.521
+gp	0.731	0.677	0.659	0.659	0.641	0.677	0.717	0.650	0.624	0.643	0.602

Table 8.3.4. Sole in Division 7.e. Stock weights-at-age (kilograms) continued.

Year/Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
2	0.152	0.137	0.149	0.152	0.138	0.151	0.172	0.136	0.121	0.169	0.120
3	0.209	0.207	0.203	0.208	0.197	0.214	0.221	0.215	0.215	0.231	0.202
4	0.263	0.274	0.256	0.263	0.254	0.272	0.268	0.287	0.300	0.290	0.276
5	0.316	0.337	0.308	0.316	0.306	0.325	0.315	0.354	0.376	0.347	0.343
6	0.367	0.396	0.360	0.368	0.355	0.373	0.360	0.415	0.445	0.402	0.402
7	0.415	0.452	0.410	0.419	0.400	0.416	0.404	0.469	0.505	0.454	0.453
8	0.462	0.505	0.460	0.468	0.442	0.454	0.447	0.518	0.557	0.504	0.497
9	0.507	0.554	0.509	0.516	0.479	0.486	0.489	0.560	0.600	0.552	0.532
10	0.550	0.599	0.557	0.562	0.514	0.514	0.529	0.596	0.636	0.597	0.561
11	0.591	0.641	0.605	0.607	0.544	0.536	0.569	0.626	0.663	0.639	0.581
+gp	0.689	0.732	0.734	0.726	0.662	0.614	0.640	0.698	0.696	0.738	0.664

Table 8.3.4. Sole in Division 7.e. Stock weights-at-age (kilograms) continued.

Year/Age	2013	2014	2015	Arithmetic mean 2013-2015
2	0.144	0.157	0.146	0.149
3	0.200	0.223	0.212	0.212
4	0.256	0.284	0.272	0.271
5	0.310	0.340	0.329	0.326
6	0.363	0.391	0.381	0.378
7	0.414	0.438	0.428	0.427
8	0.464	0.480	0.471	0.472
9	0.513	0.517	0.510	0.513
10	0.560	0.549	0.544	0.551
11	0.606	0.576	0.574	0.585
+gp	0.729	0.706	0.673	0.703

Table 8.3.5. Sole in Division 7.e. Landings length–frequency distributions.

Length (cm)	UK Beam trawl	UK other	French nets	French trawl	French other
0	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	0	0	0	0
17	0	0	0	0	0
18	0	0	0	0	0
19	0	0	0	0	0
20	0	0	0	0	0
21	0	0	0	92	0
22	0	87	0	651	0
23	0	345	0	2684	0
24	777	528	0	44336	1455
25	1838	283	58	48611	1676
26	8062	1989	292	46747	4738
27	14767	2944	117	45152	3621
28	29043	3697	350	51838	3905
29	50488	5710	359	45707	907
30	73227	10097	700	35007	330
31	93173	8199	785	43557	157
32	104935	13459	1296	41737	157
33	102108	13225	1179	26243	94
34	97570	10556	1399	22274	47
35	94376	11974	879	18993	63
36	72609	11289	1457	20690	0
37	60118	11498	1054	11641	16
38	54093	10379	803	10356	16
39	41206	10844	552	11300	16
40	28924	7019	619	5568	16
41	21907	7078	300	4417	0
42	13014	2494	260	4487	0
43	9263	5001	587	1170	0
44	6319	3452	260	1185	0
45	4561	1429	175	1759	0
46	3462	628	327	1349	0
47	1843	1378	58	54	0
48	1057	1111	58	946	0
49	528	577	134	44	0
50	304	447	67	155	0
51	171	132	67	490	0
52	105	175	0	0	0
53	156	13	0	0	0
54	10	51	67	0	0
55	0	13	0	0	0
56	0	3	0	0	0
57	0	0	0	0	0
58	0	0	0	0	0
59	0	0	0	0	0
60	0	0	0	0	0
Total	990016	158104	14260	549245	17214

Table 8.3.6. Sole in Division 7.e. Landings, effort and mean standardised lpue for the UK commercial beam-trawl fleet.

Year	Effort (days) BT < 24m	Effort (days) BT > 24m	Landings (tonnes) BT < 24m	Landings (tonnes) BT > 24m	LPUE (kg per 1000 days) BT < 24m	LPUE (kg per 1000 days) BT > 24m	LPUE MS* (kg per 1000 days) BT < 24m	LPUE MS* (kg per 1000 days) BT > 24m
1988	2527	2971	293	391	115.97	131.77	1.95	2.88
1989	1956	3938	162	340	83.06	86.37	1.39	1.89
1990	1958	3518	179	314	91.51	89.12	1.54	1.95
1991	1458	2412	134	206	92.22	85.47	1.55	1.87
1992	1342	1993	143	197	106.22	98.63	1.78	2.15
1993	1432	2678	154	194	107.71	72.54	1.81	1.58
1994	2241	4574	161	236	71.97	51.50	1.21	1.13
1995	2017	4917	134	257	66.28	52.30	1.11	1.14
1996	1999	5592	106	178	52.99	31.84	0.89	0.70
1997	1991	5377	132	199	66.30	37.10	1.11	0.81
1998	2357	4945	99	164	42.12	33.19	0.71	0.73
1999	2518	4512	115	141	45.70	31.32	0.77	0.68
2000	2913	5237	134	151	45.85	28.84	0.77	0.63
2001	3746	5874	148	142	39.57	24.11	0.66	0.53
2002	3482	5957	110	104	31.55	17.51	0.53	0.38
2003	3785	6811	93	94	24.44	13.78	0.41	0.30
2004	3512	7100	64	69	18.12	9.66	0.30	0.21
2005	3305	6684	191	236	57.72	35.27	0.97	0.77
2006	3277	6595	224	236	68.27	35.79	1.15	0.78
2007	4027	5594	225	196	55.77	35.10	0.94	0.77
2008	4629	4924	213	154	45.94	31.36	0.77	0.69
2009	4040	3523	185	115	45.85	32.66	0.77	0.71
2010	4727	3064	201	94	42.42	30.64	0.71	0.67
2011	5913	2790	258	92	43.65	32.95	0.73	0.72
2012	7188	2609	314	86	43.65	33.01	0.73	0.72
2013	6322	2444	329	93	52.02	38.13	0.87	0.83
2014	5870	2900	308	104	52.54	35.95	0.88	0.79
2015	6258	3039	310	101	49.55	33.12	0.84	0.73

Note that the lpue time-series for the UK commercial beam-trawl fleet was revised at IBPWCFlat2 due to modifications in the UK e-logbook effort recording system in 2012.

***MS refers to mean standardised lpue.**

Table 8.3.7. Sole in Division 7.e. Tuning information used in the assessment.

W CHANNEL SOLE 2016 WGCSE, 2-11, SEXES COMBINED,
104

UK-CBT-late
2003 2015
1 1 0 1
3 11

10.600	130.700	168.870	129.960	21.430	18.320	10.280	13.490	6.670	2.190	2.060	3.350	2.820
10.610	146.500	61.530	53.460	75.230	11.350	14.960	7.490	5.980	4.270	2.120	1.180	1.890
9.990	210.390	326.300	132.940	155.210	132.090	27.410	32.600	22.540	14.240	8.300	5.950	4.840
9.870	376.870	186.460	243.450	85.590	108.340	106.980	37.220	20.670	13.690	13.610	6.680	2.990
9.620	456.040	261.420	105.820	103.550	54.210	62.070	51.470	15.340	11.120	10.410	8.440	8.170
9.550	294.030	286.060	126.100	67.890	65.420	42.340	39.540	36.270	14.540	11.800	4.300	6.000
7.560	190.030	182.630	152.830	89.590	26.020	27.900	13.230	16.100	12.910	4.850	3.740	1.920
7.790	80.090	179.700	157.570	101.240	51.980	25.240	22.590	8.230	16.750	25.390	7.420	3.880
8.700	243.760	148.580	186.660	121.430	81.660	35.560	15.790	20.250	10.830	14.110	8.260	2.100
9.800	129.790	307.880	139.020	143.590	91.490	66.220	30.490	17.810	14.830	8.550	12.250	11.030
8.770	81.920	242.490	288.920	134.340	93.180	72.270	44.150	24.500	10.730	9.840	8.140	9.840
8.770	111.720	201.150	169.620	201.190	99.910	67.460	43.840	30.630	15.940	7.710	9.340	4.900
9.300	137.050	178.210	198.830	135.740	117.190	65.740	45.950	31.780	20.590	11.010	5.520	5.960

UK-COT
1988 2015
1 1 0 1
3 11

4.260	30.970	15.730	19.290	8.630	2.550	2.550	1.830	0.350	0.760	0.400	0.860	0.250
4.610	15.090	18.340	9.220	11.750	4.720	2.420	2.360	2.010	1.400	1.120	0.990	0.650
4.420	18.300	12.560	9.210	6.090	5.530	2.080	1.830	1.120	0.900	0.620	0.960	0.510
4.000	10.040	7.030	4.120	2.460	0.960	1.440	0.420	0.410	0.230	0.270	0.080	0.180
4.110	26.240	6.000	3.600	1.190	1.140	0.480	0.650	0.170	0.090	0.070	0.180	0.100
3.760	12.450	17.560	5.380	3.440	2.490	1.260	1.000	0.920	0.560	0.130	0.320	0.300
3.420	12.420	11.460	12.350	2.500	2.600	1.230	1.350	1.030	1.180	0.620	0.450	0.270
3.290	5.250	9.750	6.340	6.170	1.890	1.490	0.910	0.520	0.250	0.590	0.320	0.180
2.590	9.470	6.540	4.370	3.150	3.540	0.950	0.760	0.680	0.450	0.440	0.420	0.180
3.010	15.160	8.810	4.780	2.830	2.900	2.530	0.630	0.280	0.430	0.310	0.260	0.270
2.700	8.740	7.580	4.250	2.490	1.530	0.930	1.470	0.310	0.440	0.380	0.350	0.120
2.490	11.560	5.840	4.910	2.890	1.450	1.460	0.740	1.490	0.390	0.570	0.190	0.190
2.680	6.670	8.410	4.030	2.640	1.240	0.590	0.810	0.620	0.990	0.100	0.210	0.050
2.730	18.020	5.270	4.960	2.690	2.010	1.120	0.700	0.510	0.500	0.660	0.250	0.220
2.450	9.880	6.120	2.390	2.670	1.270	0.820	0.330	0.200	0.250	0.170	0.270	0.110
2.270	4.610	5.870	4.800	1.040	0.850	0.490	0.540	0.270	0.130	0.150	0.220	0.170
2.330	6.050	2.580	2.230	3.250	0.460	0.570	0.300	0.240	0.180	0.130	0.070	0.090
1.760	6.440	9.560	3.530	4.130	3.440	0.740	0.900	0.580	0.450	0.250	0.190	0.140
1.700	6.930	3.270	4.130	1.360	1.630	1.750	0.600	0.310	0.200	0.190	0.120	0.050
1.920	9.320	5.440	2.300	2.320	1.190	1.410	1.130	0.360	0.210	0.240	0.200	0.200
1.750	5.610	4.850	2.080	1.150	1.180	0.750	0.750	0.700	0.320	0.230	0.110	0.100
1.850	7.970	5.470	3.920	2.170	0.640	0.830	0.390	0.520	0.450	0.180	0.120	0.080
2.210	2.710	5.850	4.740	3.150	1.630	0.810	0.740	0.300	0.600	0.830	0.280	0.160
1.930	6.510	3.320	3.890	2.460	1.640	0.580	0.310	0.370	0.190	0.370	0.190	0.060
2.070	4.240	9.160	3.970	4.060	2.300	1.760	0.820	0.490	0.460	0.330	0.440	0.350
1.590	1.780	4.030	4.990	2.360	1.540	1.320	0.790	0.490	0.230	0.170	0.170	0.190
1.410	2.030	3.390	2.850	3.390	1.720	1.230	0.860	0.640	0.330	0.160	0.190	0.100
0.980	1.620	1.970	1.860	1.590	1.350	0.700	0.500	0.420	0.250	0.120	0.070	0.090

Q1SWBeam-nonoffset
2006 2015
1 1 0.1 0.25
2 11

1.000	14.000	17.700	9.900	19.500	12.000	9.800	10.500	4.700	3.200	7.000	0.900	1.500	0.400	0.900
1.000	12.300	36.800	16.200	2.000	7.300	2.600	2.700	6.900	5.600	4.400	0.100	1.500	1.200	0.400
1.000	12.000	27.300	26.800	11.500	8.700	3.400	10.200	9.600	5.700	2.400	1.700	1.900	1.400	1.000
1.000	3.200	23.600	19.400	17.700	6.300	2.600	2.900	1.500	5.100	7.400	0.800	0.900	0.100	0.900
1.000	21.100	26.100	27.400	19.400	11.200	11.900	2.100	1.900	2.100	1.400	1.300	1.200	1.100	0.600
1.000	12.400	25.000	20.700	18.000	8.800	4.500	6.400	2.700	0.300	2.000	1.100	0.400	0.500	0.200
1.000	2.300	23.200	26.800	11.000	9.700	11.500	5.900	4.000	0.100	1.800	2.400	0.400	2.100	0.100
1.000	3.700	12.500	23.600	21.600	14.700	11.900	8.500	7.800	6.500	1.000	6.100	1.100	4.600	1.100
1.000	5.200	25.300	31.100	13.400	19.200	13.300	25.000	7.500	2.700	3.800	1.500	1.300	1.100	1.500
1.000	5.100	10.500	13.200	16.400	13.100	12.600	7.500	7.600	3.300	3.600	1.000	2.800	3.800	0.000

FSP-UK
2004 2015
1 1 0.7 0.75
2 11

1.000	0.145	0.545	0.316	0.266	0.129	0.060	0.087	0.037	0.014	0.016
1.000	0.103	0.196	0.242	0.109	0.157	0.145	0.036	0.029	0.014	0.015
1.000	0.153	0.341	0.155	0.213	0.098	0.116	0.134	0.026	0.026	0.018
1.000	0.119	0.447	0.204	0.077	0.091	0.060	0.048	0.103	0.019	0.026
1.000	0.219	0.304	0.265	0.247	0.043	0.037	0.015	0.057	0.033	0.002
1.000	0.087	0.300	0.311	0.161	0.061	0.040	0.028	0.015	0.018	0.047
1.000	0.120	0.197	0.246	0.181	0.127	0.036	0.021	0.027	0.018	0.024
1.000	0.084	0.454	0.100	0.198	0.092	0.051	0.005	0.013	0.007	0.011
1.000	0.046	0.366	0.375	0.171	0.117	0.034	0.044	0.028	0.003	0.006
1.000	0.050	0.358	0.430	0.361	0.170	0.092	0.052	0.037	0.006	0.000
1.000	0.099	0.313	0.405	0.319	0.214	0.120	0.071	0.035	0.043	0.002
1.000	0.128	0.239	0.330	0.183	0.126	0.106	0.075	0.057	0.023	0.025

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics.

Extended Survivors Analysis

W CHANNEL SOLE 2016 WGCSE SEXES COMB

CPUE data from file SOL7ETU3a.DAT

Catch data for 47 years. 1969 to 2015. Ages 2 to 12.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
UK-CBT-late	2003	2015	3	11	0	1
UK-COT	1988	2015	3	11	0	1
Q1SWBeam-nonoffset	2006	2015	2	11	0.1	0.25
FSP-UK	2004	2015	2	11	0.7	0.75

Time series weights :

Tapered time weighting applied
Power = 3 over 15 years

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 3 years or the 5 oldest ages.
S.E. of the mean to which the estimates are shrunk = .500

Minimum standard error for population estimates derived from each fleet = .400

Prior weighting not applied

Tuning converged after 48 iterations

Regression weights	0.482	0.610	0.725	0.820	0.893	0.944	0.976	0.993	0.999	1.000

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics continued.

Fishing mortalities

Year/Age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2	0.117	0.053	0.070	0.047	0.014	0.026	0.010	0.043	0.071	0.044
3	0.273	0.267	0.254	0.167	0.118	0.120	0.075	0.123	0.138	0.153
4	0.372	0.405	0.313	0.179	0.158	0.211	0.160	0.201	0.234	0.222
5	0.416	0.369	0.321	0.223	0.204	0.216	0.246	0.244	0.244	0.257
6	0.346	0.416	0.321	0.255	0.185	0.195	0.266	0.244	0.237	0.216
7	0.295	0.394	0.343	0.186	0.226	0.189	0.270	0.227	0.202	0.183
8	0.272	0.249	0.375	0.201	0.184	0.193	0.225	0.245	0.160	0.188
9	0.306	0.230	0.188	0.197	0.268	0.195	0.221	0.221	0.180	0.154
10	0.343	0.299	0.193	0.175	0.142	0.179	0.311	0.219	0.188	0.144
11	0.276	0.244	0.319	0.131	0.153	0.263	0.280	0.234	0.164	0.128

XSA population numbers (Thousands)

Year/Age	2	3	4	5	6	7	8	9	10	11
2006	4750	3460	1600	1870	901	919	815	339	202	135
2007	4110	3830	2380	996	1120	577	619	562	226	130
2008	4390	3520	2650	1440	623	667	352	436	404	151
2009	3790	3700	2470	1750	944	409	428	219	327	301
2010	5220	3270	2830	1870	1270	662	307	317	163	248
2011	3770	4660	2630	2190	1380	955	478	231	219	128
2012	3280	3320	3740	1930	1600	1030	716	356	172	166
2013	3010	2940	2790	2890	1360	1110	710	517	258	114
2014	3020	2610	2350	2070	2040	966	798	503	375	188
2015	4550	2550	2060	1690	1460	1460	714	616	380	281

Estimated population abundance at 1st Jan 2016

0	3940	1980	1490	1180	1070	1100	536	478	298

Taper weighted geometric mean of the VPA populations:

3850	3270	2570	1860	1280	855	555	380	254	169

Standard error of the weighted Log(VPA populations) :

0.1992	0.2074	0.2082	0.2639	0.3259	0.3722	0.3452	0.3655	0.3495	0.3884

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics continued.

Log catchability residuals.

Fleet: UK-CBT-late

Year/Age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
3	-0.28	-0.50	0.57	0.75	0.86	0.50	0.21	-0.58	0.07	-0.37	-0.57	-0.13	0.04
4	-0.54	-1.17	0.26	0.34	0.32	0.26	0.05	-0.14	-0.34	-0.11	0.08	0.08	0.03
5	-0.79	-1.37	-0.03	0.36	0.16	-0.05	0.14	0.06	-0.03	-0.30	0.14	-0.06	0.25
6	-1.58	-0.95	0.13	0.00	0.03	0.15	0.22	-0.02	-0.03	-0.09	0.10	0.10	-0.03
7	-1.19	-1.81	0.19	0.28	0.12	0.15	-0.12	0.08	0.03	-0.01	0.03	0.22	-0.10
8	-1.28	-1.08	-0.49	0.38	0.12	0.37	-0.09	0.10	-0.10	0.01	0.23	0.00	0.04
9	-0.64	-1.30	0.18	0.21	0.02	0.00	-0.17	0.00	-0.19	-0.07	0.04	0.04	-0.18
10	-0.92	-1.04	0.23	0.16	-0.24	-0.01	-0.38	-0.40	0.11	0.16	0.14	-0.02	-0.08
11	-1.01	-0.84	0.31	0.12	-0.04	0.12	-0.54	-0.11	0.06	0.00	0.14	0.01	-0.22

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

Age	3	4	5	6	7	8	9	10	11
Mean Log q	-5.072	-4.5474	-4.4422	-4.4246	-4.5167	-4.5167	-4.5167	-4.5167	-4.5167
S.E(Log q)	0.4831	0.2889	0.3064	0.2675	0.3594	0.3118	0.2607	0.3001	0.2825

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
3	0.71	0.48	5.96	0.27	13	0.36	-5.07
4	1.41	-0.57	3.2	0.21	13	0.43	-4.55
5	1.22	-0.42	3.76	0.34	13	0.40	-4.44
6	1.17	-0.49	3.95	0.53	13	0.33	-4.42
7	0.89	0.34	4.76	0.58	13	0.34	-4.52
8	0.88	0.41	4.72	0.62	13	0.29	-4.50
9	0.85	0.75	4.8	0.76	13	0.22	-4.59
10	0.94	0.19	4.65	0.61	13	0.29	-4.59
11	1.38	-1.13	4.37	0.55	13	0.37	-4.58

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics continued.

Fleet : UK-COT

Year/Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
3	0.55	0.25	-0.01	-0.10	0.89	0.58	0.65	0.31	0.52	-0.64	0.02	-0.16	-0.62	-0.24	-0.07
4	-0.08	-0.45	-0.16	-0.63	0.67	0.25	0.25	0.08	0.15	-0.11	-0.44	0.13	-0.11	0.02	-0.03
5	0.13	-0.40	-0.30	-0.79	0.33	0.29	0.19	-0.21	0.13	0.07	-0.15	-0.05	0.03	-0.07	0.07
6	0.09	0.08	-0.85	-0.35	0.46	-0.17	0.06	-0.01	0.13	-0.01	-0.20	0.12	-0.01	0.06	-0.01
7	0.22	0.00	-0.48	-1.26	0.52	0.08	0.16	0.07	-0.18	0.12	-0.13	0.11	-0.13	0.23	-0.07
8	-0.05	-0.13	-0.55	-0.59	-0.13	0.26	0.19	0.27	0.04	0.16	-0.47	0.18	0.17	0.06	-0.01
9	0.49	-0.73	-0.08	-0.76	0.56	0.08	0.06	-0.03	-0.04	0.08	-0.37	0.11	-0.04	0.18	-0.22
10	0.60	-0.14	-0.35	-0.50	0.54	-0.04	-0.14	-0.02	-0.17	-0.21	-0.15	0.36	0.18	0.18	0.09
11	0.35	0.53	-0.06	-0.25	0.83	-0.11	-0.15	0.24	-0.25	0.06	-0.24	0.32	0.25	0.20	-0.14

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

Age	3	4	5	6	7	8	9	10	11
Mean Log q	-7.1449	-6.7434	-6.6895	-6.6437	-6.7557	-6.7557	-6.7557	-6.7557	-6.7557
S.E(Log q)	0.4731	0.2633	0.2034	0.181	0.2786	0.254	0.2471	0.2414	0.2837

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
3	0.67	0.60	7.46	0.31	15.00	0.33	-7.14
4	1.00	0.01	6.75	0.39	15.00	0.28	-6.74
5	1.25	-0.73	6.48	0.53	15.00	0.26	-6.69
6	0.95	0.27	6.67	0.79	15.00	0.18	-6.64
7	0.90	0.41	6.76	0.69	15.00	0.26	-6.76
8	0.90	0.41	6.68	0.70	15.00	0.24	-6.72
9	0.89	0.49	6.69	0.74	15.00	0.23	-6.78
10	0.95	0.20	6.67	0.70	15.00	0.24	-6.73
11	1.29	-0.89	7.15	0.57	15.00	0.36	-6.70

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics continued.

Fleet: Q1SWBeam-nonoffset

Year/Age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2	0.54	0.55	0.46	-0.72	0.84	0.63	-0.91	-0.35	-0.01	-0.44
3	-0.20	0.43	0.21	0.00	0.22	-0.18	0.08	-0.41	0.42	-0.44
4	-0.27	-0.17	0.21	-0.07	0.14	-0.06	-0.16	0.01	0.47	-0.26
5	0.37	-1.28	0.09	0.31	0.33	0.10	-0.26	0.01	-0.13	0.28
6	0.46	-0.24	0.50	-0.25	0.02	-0.30	-0.34	0.23	0.09	0.04
7	0.21	-0.63	-0.52	-0.33	0.72	-0.63	0.25	0.21	0.45	-0.02
8	0.39	-0.69	1.22	-0.26	-0.25	0.42	-0.06	0.32	1.26	0.18
9	0.47	0.34	0.92	-0.25	-0.37	0.28	0.25	0.54	0.53	0.33
10	0.62	1.05	0.47	0.57	0.37	-1.86	-2.70	1.05	-0.20	-0.02
11	1.78	1.36	0.61	1.02	-0.45	0.59	0.22	0.00	0.83	0.36

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	11
Mean Log q	-6.3298	-5.0116	-4.7336	-4.8456	-4.701	-4.6816	-4.6816	-4.6816	-4.6816	-4.6816
S.E(Log q)	0.639	0.3224	0.237	0.4368	0.2916	0.4765	0.682	0.4882	1.3189	0.8322

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	0.37	1.59	7.55	0.5	10	0.21	-6.33
3	0.85	0.27	5.47	0.33	10	0.29	-5.01
4	0.88	0.32	5.12	0.51	10	0.22	-4.73
5	0.55	1.46	6.05	0.62	10	0.22	-4.85
6	1.55	-1.13	3.35	0.39	10	0.45	-4.7
7	0.75	0.71	5.21	0.55	10	0.37	-4.68
8	0.77	0.44	4.85	0.36	10	0.5	-4.41
9	0.64	1.72	4.96	0.78	10	0.21	-4.39
10	0.42	1.01	5.27	0.32	10	0.55	-4.86
11	1.34	-0.39	3.79	0.17	10	0.86	-4.15

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics continued.

Fleet : FSP-UK

Year/Age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2	0.76	0.02	0.30	0.15	0.70	-0.09	-0.11	-0.14	-0.61	-0.42	0.28	0.11
3	0.34	-0.05	0.09	0.26	-0.05	-0.18	-0.51	-0.03	0.06	0.20	0.19	-0.04
4	0.37	-0.17	0.01	-0.09	0.00	0.13	-0.25	-1.04	-0.11	0.35	0.48	0.40
5	0.20	-0.29	0.16	-0.26	0.50	-0.19	-0.15	-0.21	-0.21	0.13	0.34	0.00
6	-0.17	0.31	0.29	0.05	-0.18	-0.29	0.09	-0.31	-0.16	0.36	0.18	-0.04
7	0.15	0.53	0.58	0.46	-0.21	0.24	-0.31	-0.36	-0.78	0.11	0.50	-0.05
8	0.99	0.02	0.83	0.06	-0.45	-0.15	-0.12	-1.98	-0.19	0.00	0.13	0.32
9	0.59	0.31	0.09	0.91	0.54	-0.10	0.17	-0.30	0.05	-0.04	-0.10	0.17
10	0.14	-0.01	0.64	0.18	0.07	-0.34	0.34	-0.88	-1.39	-1.17	0.41	-0.27
11	0.82	0.59	0.62	1.01	-1.66	0.67	0.21	0.17	-0.68		-1.99	0.11

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	11
Mean Log q	-10.4854	-9.0488	-8.9103	-8.8688	-9.0959	-9.2703	-9.2703	-9.2703	-9.2703	-9.2703
S.E(Log q)	0.3884	0.2276	0.457	0.2614	0.2383	0.4373	0.7574	0.3507	0.7595	1.0625

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	0.64	0.80	9.67	0.41	12	0.25	-10.49
3	1.08	-0.19	9.13	0.41	12	0.26	-9.05
4	2.75	-0.79	10.77	0.03	12	1.29	-8.91
5	0.85	0.46	8.67	0.59	12	0.23	-8.87
6	0.85	0.66	8.81	0.73	12	0.21	-9.10
7	1.20	-0.39	9.78	0.34	12	0.56	-9.27
8	0.57	1.02	8.09	0.44	12	0.42	-9.44
9	0.73	1.19	8.29	0.74	12	0.23	-9.15
10	0.69	0.62	8.31	0.36	12	0.49	-9.57
11	0.94	0.05	9.23	0.12	11	1.06	-9.46

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics continued.

Fleet disaggregated estimates of survivors:

Age 2 Catchability constant w.r.t. time and dependent on age
Year class = 2013

UK-CBT-late	
Age	2
Survivors	0
Raw Weights	0

UK-COT	
Age	2
Survivors	0
Raw Weights	0

Q1SWBeam-nonoffset	
Age	2
Survivors	2540
Raw Weights	2.095

FSP-UK	
Age	2
Survivors	4403
Raw Weights	5.709

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK-CBT-late	1	0	0	0	0	0	0
UK-COT	1	0	0	0	0	0	0
Q1SWBeam-nonoffset	2540	0.676	0	0	1	0.177	0.068
FSP-UK	4403	0.409	0	0	1	0.484	0.04
F shrinkage mean	4229	0.5				0.339	0.041

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3939	0.29	0.15	3	0.512	0.044

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics continued.

Age 3 Catchability constant w.r.t. time and dependent on age
Year class = 2012

UK-CBT-late

Age	3	2
Survivors	2066	0
Raw Weights	3.314	0

UK-COT

Age	3	2
Survivors	1842	0
Raw Weights	3.458	0

Q1SWBeam-nonoffset

Age	3	2
Survivors	1280	1967
Raw Weights	5.364	1.749

FSP-UK

Age	3	2
Survivors	1897	2625
Raw Weights	5.364	4.765

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK-CBT-late	2066	0.509	0	0	1	0.118	0.147
UK-COT	1842	0.498	0	0	1	0.123	0.163
Q1SWBeam-nonoffset	1422	0.344	0.185	0.54	2	0.254	0.207
FSP-UK	2210	0.286	0.162	0.57	2	0.362	0.138
F shrinkage mean	2758	0.5				0.143	0.112

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1978	0.18	0.11	7	0.615	0.153

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics continued.

Age 4 Catchability constant w.r.t. time and dependent on age
Year class = 2011

UK-CBT-late

Age	4	3	2
Survivors	1533	1305	0
Raw Weights	5.007	2.693	0

UK-COT

Age	4	3	2
Survivors	1446	1172	0
Raw Weights	5.007	2.81	0

Q1SWBeam-nonoffset

Age	4	3	2
Survivors	1151	2263	1055
Raw Weights	5.007	4.359	1.454

FSP-UK

Age	4	3	2
Survivors	2238	1808	983
Raw Weights	3.453	4.359	3.963

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK-CBT-late	1449	0.315	0.077	0.24	2	0.183	0.228
UK-COT	1341	0.313	0.101	0.32	2	0.186	0.244
Q1SWBeam-nonoffset	1494	0.262	0.242	0.92	3	0.257	0.222
FSP-UK	1568	0.247	0.243	0.98	3	0.28	0.212
F shrinkage mean	1689	0.5				0.095	0.198

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1493	0.14	0.08	11	0.622	0.222

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics continued.

Age 5 Catchability constant w.r.t. time and dependent on age
Year class = 2010

UK-CBT-late

Age	5	4	3	2
Survivors	1511	1276	667	0
Raw Weights	4.833	3.823	2.076	0

UK-COT

Age	5	4	3	2
Survivors	1270	1202	635	0
Raw Weights	4.833	3.823	2.166	0

Q1SWBeam-nonoffset

Age	5	4	3	2
Survivors	1553	1879	783	473
Raw Weights	3.624	3.823	3.359	1.146

FSP-UK

Age	5	4	3	2
Survivors	1179	1915	1436	641
Raw Weights	4.833	2.636	3.359	3.122

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK-CBT-late	1215	0.250	0.214	0.86	3	0.209	0.250
UK-COT	1084	0.249	0.190	0.76	3	0.210	0.277
Q1SWBeam-nonoffset	1215	0.230	0.270	1.17	4	0.232	0.250
FSP-UK	1182	0.213	0.214	1.00	4	0.271	0.257
F shrinkage mean	1242	0.50				0.078	0.246

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1179	0.11	0.09	15	0.822	0.257

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics continued.

Age 6 Catchability constant w.r.t. time and dependent on age
Year class = 2009

UK-CBT-late

Age	6	5	4	3	2
Survivors	1036	1004	1156	740	0
Raw Weights	5.036	3.941	3.205	1.807	0

UK-COT

Age	6	5	4	3	2
Survivors	1059	992	953	909	0
Raw Weights	5.036	3.941	3.205	1.885	0

Q1SWBeam-nonoffset

Age	6	5	4	3	2
Survivors	1111	935	1082	1154	2015
Raw Weights	5.036	2.955	3.205	2.924	0.966

FSP-UK

Age	6	5	4	3	2
Survivors	1030	1503	1515	1136	933
Raw Weights	5.036	3.941	2.21	2.924	2.632

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK-CBT-late	1008	0.215	0.075	0.35	4	0.219	0.227
UK-COT	995	0.214	0.031	0.15	4	0.220	0.230
Q1SWBeam-nonoffset	1118	0.204	0.085	0.42	5	0.236	0.207
FSP-UK	1187	0.192	0.096	0.50	5	0.262	0.196
F shrinkage mean	909	0.5				0.063	0.249

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1068	0.1	0.04	19	0.387	0.216

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics continued.

Age 7 Catchability constant w.r.t. time and dependent on age
Year class = 2008

UK-CBT-late

Age	7	6	5	4	3	2
Survivors	998	1213	1261	990	1175	0
Raw Weights	5.203	4.102	3.192	2.675	1.419	0

UK-COT

Age	7	6	5	4	3	2
Survivors	1024	1170	1137	1253	1124	0
Raw Weights	5.203	4.102	3.192	2.675	1.48	0

Q1SWBeam-nonoffset

Age	7	6	5	4	3	2
Survivors	1077	1205	1112	937	921	2543
Raw Weights	3.278	4.102	2.394	2.675	2.296	0.75

FSP-UK

Age	7	6	5	4	3	2
Survivors	1041	1310	1255	986	1069	982
Raw Weights	3.919	4.102	3.192	1.845	2.296	2.045

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK-CBT-late	1109	0.194	0.053	0.27	5	0.237	0.182
UK-COT	1124	0.194	0.036	0.18	5	0.237	0.18
Q1SWBeam-nonoffset	1109	0.194	0.095	0.49	6	0.221	0.182
FSP-UK	1127	0.183	0.052	0.28	6	0.248	0.179
F shrinkage mean	842	0.5				0.057	0.233

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1100	0.09	0.03	23	0.333	0.183

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics continued.

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7
Year class = 2007

UK-CBT-late

Age	8	7	6	5	4	3	2
Survivors	558	670	594	396	382	299	0
Raw Weights	5.179	4.228	3.293	2.53	1.981	1.028	0

UK-COT

Age	8	7	6	5	4	3	2
Survivors	529	673	529	507	346	283	0
Raw Weights	5.179	4.228	3.293	2.53	1.981	1.073	0

Q1SWBeam-nonoffset

Age	8	7	6	5	4	3	2
Survivors	638	839	675	413	506	666	260
Raw Weights	1.593	2.664	3.293	1.897	1.981	1.664	0.511

FSP-UK

Age	8	7	6	5	4	3	2
Survivors	736	879	765	434	189	321	489
Raw Weights	1.3	3.184	3.293	2.53	1.366	1.664	1.392

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK-CBT-late	520	0.181	0.107	0.59	6	0.265	0.193
UK-COT	512	0.181	0.105	0.58	6	0.266	0.196
Q1SWBeam-nonoffset	604	0.194	0.113	0.58	7	0.198	0.168
FSP-UK	544	0.184	0.195	1.06	7	0.214	0.185
F shrinkage mean	474	0.5				0.058	0.21

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
536	0.09	0.06	27	0.668	0.188

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics continued.

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7
Year class = 2006

UK-CBT-late

Age	9	8	7	6	5	4	3	2
Survivors	397	479	492	437	464	416	590	0
Raw Weights	5.36	4.566	3.616	2.724	2.123	1.714	0.823	0

UK-COT

Age	9	8	7	6	5	4	3	2
Survivors	385	509	421	538	412	429	803	0
Raw Weights	5.36	4.566	3.616	2.724	2.123	1.714	0.859	0

Q1SWBeam-nonoffset

Age	9	8	7	6	5	4	3	2
Survivors	666	1690	587	341	528	549	479	756
Raw Weights	3.218	1.404	2.278	2.724	1.592	1.714	1.333	0.385

FSP-UK

Age	9	8	7	6	5	4	3	2
Survivors	564	545	534	407	386	370	400	966
Raw Weights	5.36	1.146	2.723	2.724	2.123	1.182	1.333	1.049

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK-CBT-late	450	0.171	0.040	0.24	7	0.268	0.162
UK-COT	455	0.170	0.070	0.41	7	0.268	0.161
Q1SWBeam-nonoffset	585	0.192	0.157	0.82	8	0.187	0.127
FSP-UK	496	0.179	0.089	0.50	8	0.226	0.148
F shrinkage mean	343	0.5				0.051	0.208

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
478	0.09	0.05	31	0.552	0.154

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics continued.

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 7
Year class = 2005

UK-CBT-late

Age	10	9	8	7	6	5	4	3	2
Survivors	276	311	374	296	290	317	314	493	0
Raw Weights	5.41	4.515	3.512	2.637	2.098	1.617	1.242	0.526	0

UK-COT

Age	10	9	8	7	6	5	4	3	2
Survivors	325	356	354	331	244	318	346	408	0
Raw Weights	5.41	4.515	3.512	2.637	2.098	1.617	1.242	0.549	0

Q1SWBeam-nonoffset

Age	10	9	8	7	6	5	4	3	2
Survivors	291	503	409	384	220	414	279	368	514
Raw Weights	0.445	2.71	1.08	1.661	2.098	1.213	1.242	0.852	0.238

FSP-UK

Age	10	9	8	7	6	5	4	3	2
Survivors	228	269	297	137	219	255	339	282	345
Raw Weights	1.351	4.515	0.882	1.986	2.098	1.617	0.857	0.852	0.65

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK-CBT-late	311	0.165	0.046	0.28	8	0.293	0.139
UK-COT	330	0.165	0.042	0.25	8	0.294	0.131
Q1SWBeam-nonoffset	359	0.199	0.104	0.52	9	0.157	0.121
FSP-UK	242	0.185	0.09	0.49	9	0.201	0.175
F shrinkage mean	170	0.5				0.054	0.24

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
298	0.09	0.05	35	0.516	0.144

Table 8.3.8. Sole in Division 7.e. XSA detailed survivor diagnostics continued.

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 7
Year class = 2004

UK-CBT-late

Age	11	10	9	8	7	6	5	4	3	2
Survivors	180	220	233	227	232	220	257	292	529	0
Raw Weights	5.501	4.553	3.627	2.848	2.281	1.792	1.318	0.852	0.339	0

UK-COT

Age	11	10	9	8	7	6	5	4	3	2
Survivors	195	268	216	268	197	222	254	242	430	0
Raw Weights	5.501	4.553	3.627	2.848	2.281	1.792	1.318	0.852	0.354	0

Q1SWBeam-nonoffset

Age	11	10	9	8	7	6	5	4	3	2
Survivors	322	183	386	211	120	228	304	277	345	384
Raw Weights	1.136	0.374	2.177	0.876	1.437	1.792	0.988	0.852	0.549	0.135

FSP-UK

Age	11	10	9	8	7	6	5	4	3	2
Survivors	249	336	215	185	156	245	185	224	290	302
Raw Weights	0.693	1.137	3.627	0.715	1.718	1.792	1.318	0.588	0.549	0.368

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK-CBT-late	221	0.160	0.057	0.36	9	0.316	0.130
UK-COT	230	0.160	0.054	0.34	9	0.317	0.125
Q1SWBeam-nonoffset	256	0.208	0.125	0.60	10	0.141	0.112
FSP-UK	220	0.191	0.072	0.38	10	0.171	0.130
F shrinkage mean	157	0.5				0.055	0.177

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
224	0.09	0.04	39	0.426	0.128

Table 8.3.9. Sole in Division 7.e. Stock numbers-at-age (000's).

Year/Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	1874	1343	3826	2568	2264	3107	2967	2791	6556	4657	4389
3	2380	1611	1164	3414	2185	1981	2769	2606	2367	5527	3976
4	625	1848	1237	863	2698	1600	1461	1966	1960	1839	3933
5	966	490	1365	885	621	2029	1238	1160	1330	1408	1334
6	1513	732	358	1047	691	478	1667	931	896	1007	1070
7	159	1170	584	262	840	532	365	1399	714	714	732
8	507	124	952	452	224	646	406	304	1178	580	547
9	572	412	100	713	386	187	544	317	230	995	456
10	262	494	340	81	518	300	138	468	231	199	827
11	90	218	397	274	37	440	248	105	375	186	144
+gp	636	1123	821	542	1222	850	1756	1598	1866	1385	1493
Total	9585	9564	11144	11102	11687	12149	13559	13645	17703	18497	18901

Table 8.3.9. Sole in Division 7.e. Stock numbers-at-age (000's) continued.

Year/Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	4702	8130	4679	3866	5968	6982	3765	5848	3879	3735	2816
3	3755	4088	7124	4113	3412	5083	6044	3173	4828	3089	3008
4	2834	2866	2932	5066	3006	2456	2982	3930	2102	3001	1966
5	2787	2091	1974	1782	3087	1934	1504	1774	2519	1335	1543
6	970	1923	1448	1260	1058	2073	1303	961	1199	1587	736
7	751	758	1370	976	806	648	1319	874	675	729	952
8	497	506	516	1011	629	535	417	874	578	465	445
9	397	316	337	337	635	446	392	297	573	369	316
10	327	298	214	198	192	430	306	283	224	415	232
11	650	243	214	117	110	123	309	191	208	166	268
+gp	1702	934	1035	828	982	532	529	754	713	743	739
Total	19372	22154	21844	19554	19885	21242	18870	18959	17498	15633	13021

Table 8.3.9. Sole in Division 7.e. Stock numbers-at-age (000's) continued.

Year/Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	7166	3907	3356	2363	3416	4001	3398	4485	3610	6765	5550
3	2223	6056	3235	2837	2045	3001	3273	2869	3806	3000	5829
4	1864	1617	4116	2258	1943	1558	2292	2171	2020	2574	2145
5	1226	1227	1067	2671	1512	1159	1063	1385	1454	1352	1615
6	870	834	828	632	1886	962	766	653	934	937	874
7	434	578	646	541	465	1316	647	522	391	602	630
8	609	304	416	440	389	297	946	401	328	245	443
9	267	446	217	302	351	256	204	691	287	200	172
10	189	177	334	140	218	260	173	143	505	208	116
11	139	136	136	249	84	167	189	138	96	354	140
+gp	656	528	344	487	646	650	413	647	475	368	524
Total	15643	15811	14694	12919	12956	13625	13364	14104	13906	16606	18037

Table 8.3.9. Sole in Division 7.e. Stock numbers-at-age (000's) continued.

Year/Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
2	3877	5482	2913	4096	4754	4106	4386	3792	5221	3769	3282
3	4884	3192	4391	2258	3461	3826	3525	3701	3273	4659	3324
4	3942	3229	2094	2946	1597	2383	2651	2474	2835	2631	3741
5	1435	2765	2015	1468	1872	996	1438	1754	1872	2190	1927
6	989	931	1889	1400	901	1117	623	944	1271	1381	1597
7	537	588	718	1209	919	577	667	409	662	955	1028
8	401	363	461	494	815	619	352	428	307	478	716
9	305	263	281	307	339	562	436	219	317	231	356
10	103	187	183	197	202	226	404	327	163	219	172
11	64	62	109	114	135	130	151	301	248	128	166
+gp	297	276	262	450	378	480	342	556	576	421	534
Total	16834	17338	15316	14937	15373	15022	14975	14906	16745	17063	16842

Table 8.3.9. Sole in Division 7.e. Stock numbers-at-age (000's) continued.

Year/Age	2013	2014	2015	2016	Geometric mean 1969-2013	Arithmetic mean 1969-2013
2	3014	3023	4551	0	3920	4165
3	2940	2613	2547	3939	3328	3540
4	2791	2353	2060	1978	2303	2468
5	2885	2066	1685	1493	1528	1633
6	1363	2044	1465	1179	1031	1100
7	1107	966	1460	1068	685	744
8	710	798	714	1100	477	519
9	517	503	616	536	342	375
10	258	375	380	478	241	268
11	114	188	281	298	165	192
+gp	552	672	600	702	656	748
Total	16253	15602	16359	12771		

Table 8.3.10. Sole in Division 7.e. Fishing mortality-at-age.

Year/Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	0.0511	0.0427	0.0140	0.0615	0.0336	0.0152	0.0295	0.0651	0.0708	0.0582	0.0560
3	0.1532	0.1641	0.1998	0.1356	0.2115	0.2049	0.2425	0.1853	0.1523	0.2404	0.2385
4	0.1438	0.2025	0.2343	0.2279	0.1849	0.1561	0.1304	0.2910	0.2305	0.2208	0.2445
5	0.1763	0.2131	0.1655	0.1474	0.1630	0.0966	0.1850	0.1577	0.1775	0.1743	0.2190
6	0.1575	0.1264	0.2119	0.1199	0.1626	0.1704	0.0753	0.1658	0.1281	0.2198	0.2544
7	0.1506	0.1064	0.1555	0.0590	0.1624	0.1710	0.0829	0.0717	0.1083	0.1651	0.2868
8	0.1085	0.1148	0.1885	0.0591	0.0812	0.0720	0.1472	0.1756	0.0686	0.1395	0.2206
9	0.0480	0.0927	0.1086	0.2192	0.1515	0.1987	0.0511	0.2159	0.0476	0.0846	0.2321
10	0.0841	0.1176	0.1133	0.6897	0.0630	0.0894	0.1809	0.1224	0.1142	0.2256	0.1419
11	0.1099	0.1117	0.1558	0.2298	0.1243	0.1405	0.1076	0.1505	0.0935	0.1672	0.2276
+gp	0.1099	0.1117	0.1558	0.2298	0.1243	0.1405	0.1076	0.1505	0.0935	0.1672	0.2276
$FBAR_{3-9}$	0.1340	0.1457	0.1806	0.1383	0.1596	0.1528	0.1307	0.1804	0.1304	0.1778	0.2423

Table 8.3.10. Sole in Division 7.e. Fishing mortality-at-age continued.

Year/Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	0.0400	0.0322	0.0291	0.0249	0.0605	0.0442	0.0712	0.0917	0.1278	0.1163	0.1363
3	0.1701	0.2323	0.2410	0.2137	0.2286	0.4334	0.3305	0.3118	0.3756	0.3518	0.3787
4	0.2039	0.2730	0.3983	0.3952	0.3411	0.3906	0.4190	0.3449	0.3537	0.5654	0.3724
5	0.2712	0.2676	0.3492	0.4212	0.2983	0.2944	0.3483	0.2919	0.3621	0.4959	0.4729
6	0.1466	0.2390	0.2946	0.3467	0.3896	0.3517	0.2996	0.2525	0.3976	0.4112	0.4282
7	0.2952	0.2847	0.2034	0.3396	0.3091	0.3419	0.3118	0.3136	0.2725	0.3928	0.3456
8	0.3515	0.3048	0.3249	0.3652	0.2438	0.2123	0.2377	0.3220	0.3485	0.2855	0.4104
9	0.1881	0.2893	0.4335	0.4615	0.2896	0.2773	0.2261	0.1821	0.2235	0.3631	0.4169
10	0.1979	0.2295	0.5030	0.4890	0.3505	0.2316	0.3703	0.2052	0.2013	0.3371	0.4133
11	0.2364	0.2701	0.3529	0.4016	0.3173	0.2836	0.2898	0.2557	0.2894	0.3590	0.4041
+gp	0.2364	0.2701	0.3529	0.4016	0.3173	0.2836	0.2898	0.2557	0.2894	0.3590	0.4041
$FBAR_{3-9}$	0.2324	0.2701	0.3207	0.3633	0.3000	0.3288	0.3104	0.2884	0.3334	0.4094	0.4036

Table 8.3.10. Sole in Division 7.e. Fishing mortality-at-age continued.

Year/Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	0.0683	0.0887	0.0678	0.0443	0.0296	0.1008	0.0692	0.0642	0.0851	0.0489	0.0279
3	0.2183	0.2862	0.2596	0.2788	0.1725	0.1694	0.3106	0.251	0.2911	0.2355	0.2912
4	0.3177	0.3161	0.3325	0.301	0.4163	0.282	0.4034	0.3007	0.3012	0.3662	0.3016
5	0.2848	0.2935	0.4237	0.2479	0.3523	0.3145	0.388	0.2948	0.3392	0.3361	0.3908
6	0.3091	0.1563	0.3263	0.2062	0.2603	0.2964	0.2836	0.411	0.3387	0.2973	0.3882
7	0.2557	0.2288	0.2826	0.2305	0.3501	0.2299	0.3792	0.363	0.3671	0.2076	0.3517
8	0.2117	0.2369	0.2206	0.1255	0.3177	0.2754	0.2133	0.2349	0.3983	0.2559	0.2725
9	0.3111	0.191	0.3413	0.2231	0.2018	0.2889	0.2553	0.2152	0.221	0.4407	0.4113
10	0.2301	0.1668	0.1938	0.4048	0.1712	0.2207	0.1319	0.2968	0.2535	0.2976	0.4919
11	0.2641	0.1963	0.2736	0.2385	0.2608	0.2628	0.2532	0.305	0.3165	0.3006	0.3835
+gp	0.2641	0.1963	0.2736	0.2385	0.2608	0.2628	0.2532	0.305	0.3165	0.3006	0.3835
$FBAR_{3-9}$	0.2726	0.2441	0.3124	0.2304	0.2959	0.2652	0.319	0.2958	0.3224	0.3056	0.3439

Table 8.3.10. Sole in Division 7.e. Fishing mortality-at-age continued.

Year/Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
2	0.0943	0.1218	0.1549	0.0685	0.1172	0.0528	0.0697	0.0471	0.0138	0.0258	0.0098
3	0.3138	0.3217	0.2992	0.2461	0.2729	0.2667	0.254	0.1666	0.1185	0.1196	0.0746
4	0.2546	0.3715	0.2549	0.3534	0.3719	0.4051	0.3129	0.1788	0.1581	0.2112	0.1597
5	0.333	0.2813	0.264	0.3882	0.416	0.3693	0.321	0.2226	0.2043	0.216	0.2465
6	0.4195	0.1593	0.3463	0.321	0.3456	0.4164	0.321	0.2554	0.185	0.1954	0.2662
7	0.2909	0.1428	0.2751	0.294	0.2954	0.3942	0.3425	0.1859	0.226	0.1889	0.2697
8	0.3228	0.1552	0.3075	0.276	0.2723	0.2493	0.3752	0.2012	0.1838	0.193	0.2247
9	0.3902	0.2635	0.2573	0.3198	0.3064	0.2303	0.1885	0.1973	0.2677	0.1955	0.2213
10	0.4048	0.4395	0.3747	0.2732	0.343	0.2989	0.1931	0.1752	0.1417	0.1795	0.3114
11	0.3584	0.2661	0.4153	0.2541	0.2758	0.2436	0.3191	0.1313	0.1532	0.2633	0.2797
+gp	0.3584	0.2661	0.4153	0.2541	0.2758	0.2436	0.3191	0.1313	0.1532	0.2633	0.2797
$FBAR_{3-9}$	0.3321	0.2422	0.2863	0.3141	0.3258	0.333	0.3022	0.2011	0.1919	0.1885	0.2089

Table 8.3.10. Sole in Division 7.e. Fishing mortality-at-age continued.

Year/Age	2013	2014	2015	Arithmetic mean 2013-2015
2	0.0427	0.0712	0.0443	0.0527
3	0.1230	0.1379	0.1529	0.1379
4	0.2007	0.2336	0.2217	0.2186
5	0.2445	0.2442	0.2571	0.2486
6	0.2438	0.2369	0.2160	0.2322
7	0.2270	0.2021	0.1833	0.2041
8	0.2450	0.1596	0.1880	0.1975
9	0.2213	0.1798	0.1535	0.1849
10	0.2192	0.1882	0.1444	0.1839
11	0.2340	0.1645	0.1277	0.1754
+gp	0.2340	0.1645	0.1277	0.1754
$FBAR_{3-9}$	0.2150	0.1991	0.1961	0.2034

Table 8.3.11. Sole in Division 7.e. Assessment summary.

Year	Recruitment Age 2 (000's)	TSB (tonnes)	SSB (tonnes)	Landings (tonnes)	Yield//SSB	Fbar (Ages 3-9)
1969	1874	2927	2437	353	0.14	0.134
1970	1343	3023	2652	391	0.15	0.146
1971	3826	2838	2390	432	0.18	0.181
1972	2568	3091	2395	437	0.18	0.138
1973	2264	3266	2778	459	0.17	0.160
1974	3107	3512	2896	427	0.15	0.153
1975	2967	4428	3670	491	0.13	0.131
1976	2791	4102	3403	616	0.18	0.180
1977	6556	5339	4098	606	0.15	0.130
1978	4657	5429	4074	861	0.21	0.178
1979	4389	6014	4865	1181	0.24	0.242
1980	4702	6387	5338	1269	0.24	0.232
1981	8130	5957	4572	1215	0.27	0.270
1982	4679	5916	4575	1446	0.32	0.321
1983	3866	5377	4374	1498	0.34	0.363
1984	5968	5462	4430	1370	0.31	0.300
1985	6982	5568	4009	1409	0.35	0.329
1986	3765	5257	4013	1419	0.35	0.310
1987	5848	5310	4112	1280	0.31	0.288
1988	3879	5120	4043	1444	0.36	0.333
1989	3735	4318	3442	1390	0.40	0.409
1990	2816	4222	3287	1315	0.40	0.404
1991	7166	4220	2991	852	0.28	0.273
1992	3907	4101	2937	895	0.30	0.244
1993	3356	3581	2811	904	0.32	0.312
1994	2363	3787	3055	800	0.26	0.230
1995	3416	3870	3069	856	0.28	0.296
1996	4001	4157	3053	833	0.27	0.265
1997	3398	3846	2921	949	0.32	0.319
1998	4485	3973	2920	880	0.30	0.296
1999	3610	3989	2856	957	0.34	0.322
2000	6765	4392	2916	914	0.31	0.306
2001	5550	4630	2970	1069	0.36	0.344
2002	3877	4325	3123	1106	0.35	0.332
2003	5482	4545	3411	1078	0.32	0.242
2004	2913	4172	3232	1075	0.33	0.286
2005	4096	4248	3352	1039	0.31	0.314
2006	4754	3954	2955	1023	0.35	0.326
2007	4106	4101	3034	1015	0.33	0.333
2008	4386	4080	2908	908	0.31	0.302
2009	3792	4342	3363	701	0.21	0.201
2010	5221	4819	3773	698	0.18	0.192
2011	3769	5116	3870	801	0.21	0.189
2012	3282	4958	4113	872	0.21	0.209
2013	3013	4795	3995	883	0.22	0.215
2014	3023	5082	4259	885	0.21	0.199
2015	4550	4924	3977	772	0.19	0.196

Table 8.3.12. Sole in Division 7.e. Input data for the short-term forecast.

2016

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	3911	0.10	0.14	0.00	0.00	0.149	0.051	0.181
3	3939	0.10	0.45	0.00	0.00	0.212	0.133	0.241
4	1978	0.10	0.88	0.00	0.00	0.271	0.211	0.299
5	1493	0.10	0.98	0.00	0.00	0.326	0.240	0.353
6	1179	0.10	1.00	0.00	0.00	0.378	0.224	0.403
7	1068	0.10	1.00	0.00	0.00	0.427	0.197	0.449
8	1099	0.10	1.00	0.00	0.00	0.472	0.190	0.493
9	536	0.10	1.00	0.00	0.00	0.513	0.178	0.532
10	478	0.10	1.00	0.00	0.00	0.551	0.177	0.569
11	298	0.10	1.00	0.00	0.00	0.585	0.169	0.601
12	701	0.10	1.00	0.00	0.00	0.703	0.169	0.709

2017

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	3911	0.10	0.14	0.00	0.00	0.149	0.051	0.181
3	3364	0.10	0.45	0.00	0.00	0.212	0.133	0.241
4	3120	0.10	0.88	0.00	0.00	0.271	0.211	0.299
5	1450	0.10	0.98	0.00	0.00	0.326	0.240	0.353
6	1063	0.10	1.00	0.00	0.00	0.378	0.224	0.403
7	853	0.10	1.00	0.00	0.00	0.427	0.197	0.449
8	794	0.10	1.00	0.00	0.00	0.472	0.190	0.493
9	822	0.10	1.00	0.00	0.00	0.513	0.178	0.532
10	406	0.10	1.00	0.00	0.00	0.551	0.177	0.569
11	362	0.10	1.00	0.00	0.00	0.585	0.169	0.601
12	763	0.10	1.00	0.00	0.00	0.703	0.169	0.709

2018

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	3911	0.10	0.14	0.00	0.00	0.149	0.051	0.181
3	3364	0.10	0.45	0.00	0.00	0.212	0.133	0.241
4	2665	0.10	0.88	0.00	0.00	0.271	0.211	0.299
5	2287	0.10	0.98	0.00	0.00	0.326	0.240	0.353
6	1032	0.10	1.00	0.00	0.00	0.378	0.224	0.403
7	769	0.10	1.00	0.00	0.00	0.427	0.197	0.449
8	634	0.10	1.00	0.00	0.00	0.472	0.190	0.493
9	594	0.10	1.00	0.00	0.00	0.513	0.178	0.532
10	623	0.10	1.00	0.00	0.00	0.551	0.177	0.569
11	307	0.10	1.00	0.00	0.00	0.585	0.169	0.601
12	860	0.10	1.00	0.00	0.00	0.703	0.169	0.709

Table 8.3.13. Sole in Division 7.e. Single option output.

Year = 2016, F / F $_{13-15}$ = 0.934, F_{bar} = 0.196

Age	F	Catch No	Yield	Stock No	Biomass	SS No	SSB
2	0.051	185	33	3911	583	548	82
3	0.133	467	113	3939	834	1773	375
4	0.211	358	107	1978	535	1741	471
5	0.240	303	107	1493	487	1463	477
6	0.224	225	91	1179	446	1179	446
7	0.197	182	82	1068	456	1068	456
8	0.190	182	90	1099	519	1099	519
9	0.178	83	44	536	275	536	275
10	0.177	74	42	478	263	478	263
11	0.169	44	27	298	174	298	174
12	0.169	104	74	701	493	701	493
Total		2208	809	16680	5065	10883	4031

Year = 2017, F / F $_{13-15}$ = 0.934, F_{bar} = 0.196

Age	F	Catch No	Yield	Stock No	Biomass	SS No	SSB
2	0.051	185	33	3911	583	548	82
3	0.133	399	96	3364	712	1514	320
4	0.211	565	169	3120	845	2746	743
5	0.240	295	104	1450	473	1421	464
6	0.224	203	82	1063	402	1063	402
7	0.197	145	65	853	364	853	364
8	0.190	131	65	794	374	794	374
9	0.178	128	68	822	422	822	422
10	0.177	63	36	406	223	406	223
11	0.169	54	32	362	212	362	212
12	0.169	113	80	763	536	763	536
Total		2281	831	16908	5147	11291	4143

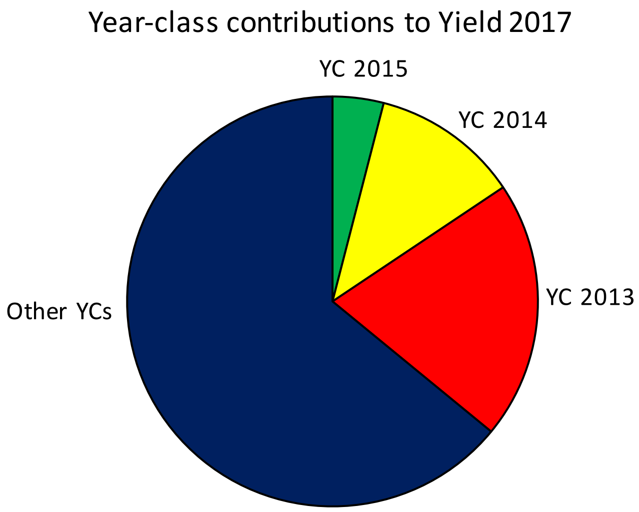
Year = 2018, F / F $_{13-15}$ = 0.934, F_{bar} = 0.196

Age	F	Catch No	Yield	Stock No	Biomass	SS No	SSB
2	0.051	185	33	3911	583	548	82
3	0.133	399	96	3364	712	1514	320
4	0.211	483	144	2665	721	2345	635
5	0.240	465	164	2287	746	2241	731
6	0.224	197	80	1032	391	1032	391
7	0.197	131	59	769	328	769	328
8	0.190	105	52	634	299	634	299
9	0.178	92	49	594	305	594	305
10	0.177	96	55	623	343	623	343
11	0.169	46	27	307	180	307	180
12	0.169	128	90	860	604	860	604
Total		2326	850	17045	5212	11466	4217

Input units are in 000's and kg; output in tonnes.

Table 8.3.14. Sole in Division 7.e. Year-class sources and contributions for the short-term forecast.

Year-class	Source	Yield 2016	Yield 2017	SSB 2016	SSB 2017	SSB 2018
2013	XSA	13.9	20.3	9.3	17.9	17.3
2014	GM 1969-2015	4.1	11.6	2.0	7.7	15.0
2015	GM 1969-2015		4.0		2.0	7.6
2016	GM 1969-2015					1.9
2017	GM 1969-2015					0



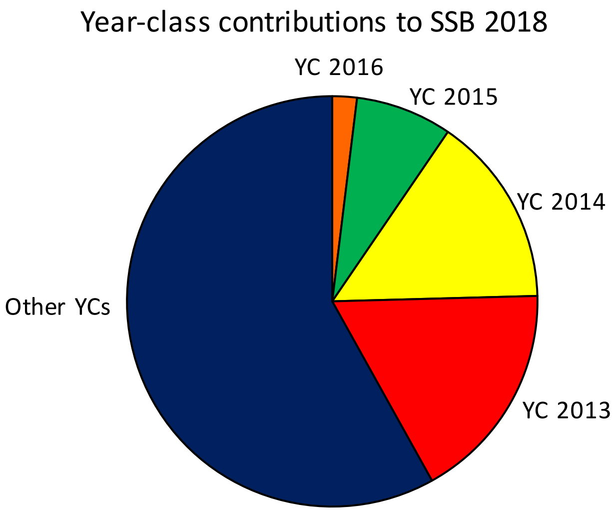


Table 8.3.15. Sole in Division 7.e. Management options output.

SSB 2017	TSB 2017	F-mult	F	Basis	Yield 2017	SSB 2018	TSB 2018	% SSB Change	% TAC Change
4143	5147	0.0	0.000	F2016	0	5026	6057	21	-100
4143	5147	0.1	0.020	F2016	90	4938	5965	19	-91
4143	5147	0.2	0.039	F2016	179	4852	5875	17	-82
4143	5147	0.3	0.059	F2016	265	4767	5786	15	-73
4143	5147	0.4	0.078	F2016	351	4684	5700	13	-64
4143	5147	0.5	0.098	F2016	434	4603	5614	11	-56
4143	5147	0.6	0.118	F2016	517	4523	5531	9	-47
4143	5147	0.7	0.137	F2016	597	4444	5449	7	-39
4143	5147	0.8	0.157	F2016	677	4367	5368	5	-31
4143	5147	0.9	0.176	F2016	754	4292	5289	4	-23
4143	5147	1.0	0.196	F2016	831	4217	5212	2	-15
4143	5147	1.1	0.216	F2016	906	4145	5136	0	-7
4143	5147	1.2	0.235	F2016	979	4073	5061	-2	0
4143	5147	1.3	0.255	F2016	1051	4003	4987	-3	7
4143	5147	1.3769	0.270	F_{MGT}	1106	3951	4932	-5	13
4143	5147	1.4	0.275	F2016	1122	3935	4915	-5	15
4143	5147	1.4789	0.290	F_{MSY}	1178	3882	4860	-6	20
4143	5147	1.5	0.294	F2016	1192	3867	4845	-7	22
4143	5147	1.6	0.314	F2016	1261	3801	4775	-8	29
4143	5147	1.6319	0.320	F_{pa}	1282	3781	4754	-9	31
4143	5147	1.7	0.333	F2016	1328	3736	4707	-10	36
4143	5147	1.8	0.353	F2016	1394	3673	4640	-11	42
4143	5147	1.9	0.373	F2016	1458	3610	4575	-13	49
4143	5147	2.0	0.392	F2016	1522	3549	4510	-14	55
4143	5147	2.2439	0.440	F_{lim}	1672	3404	4358	-18	71
4143	5147	3.1943	0.626	MSY $B_{trigger}$	2199	2900	3825	-30	125
4143	5147	3.2879	0.645	B_{pa}	2247	2855	3778	-31	129
4143	5147	5.3506	1.049	B_{lim}	3111	2039	2909	-51	218

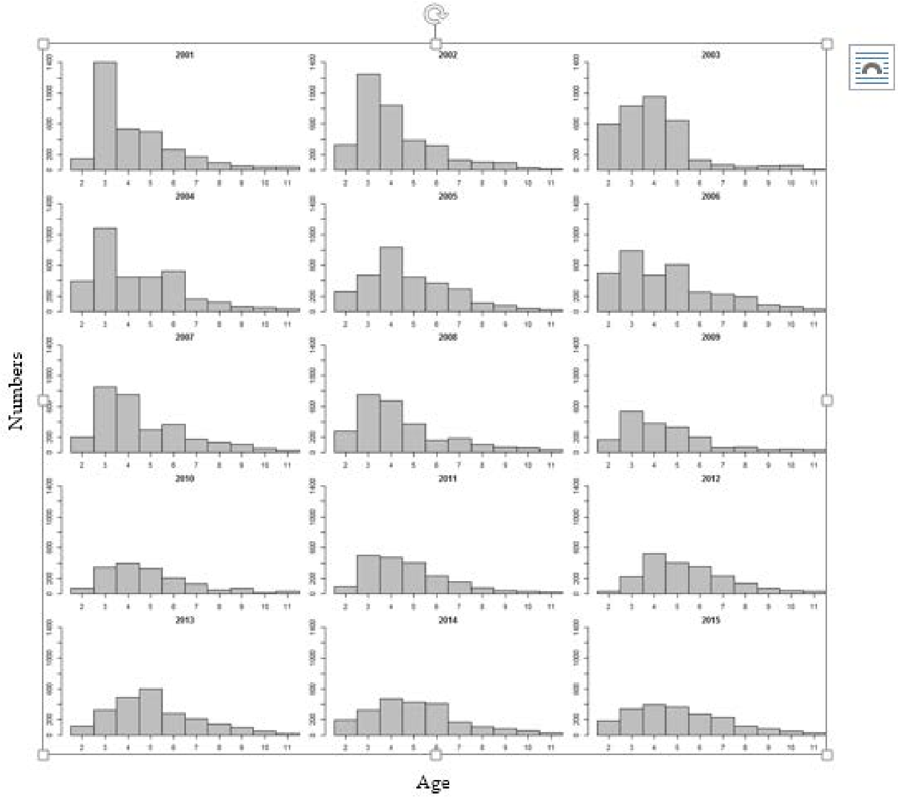


Figure 8.3.1. Sole in Division 7.e. International landings numbers-at-age.

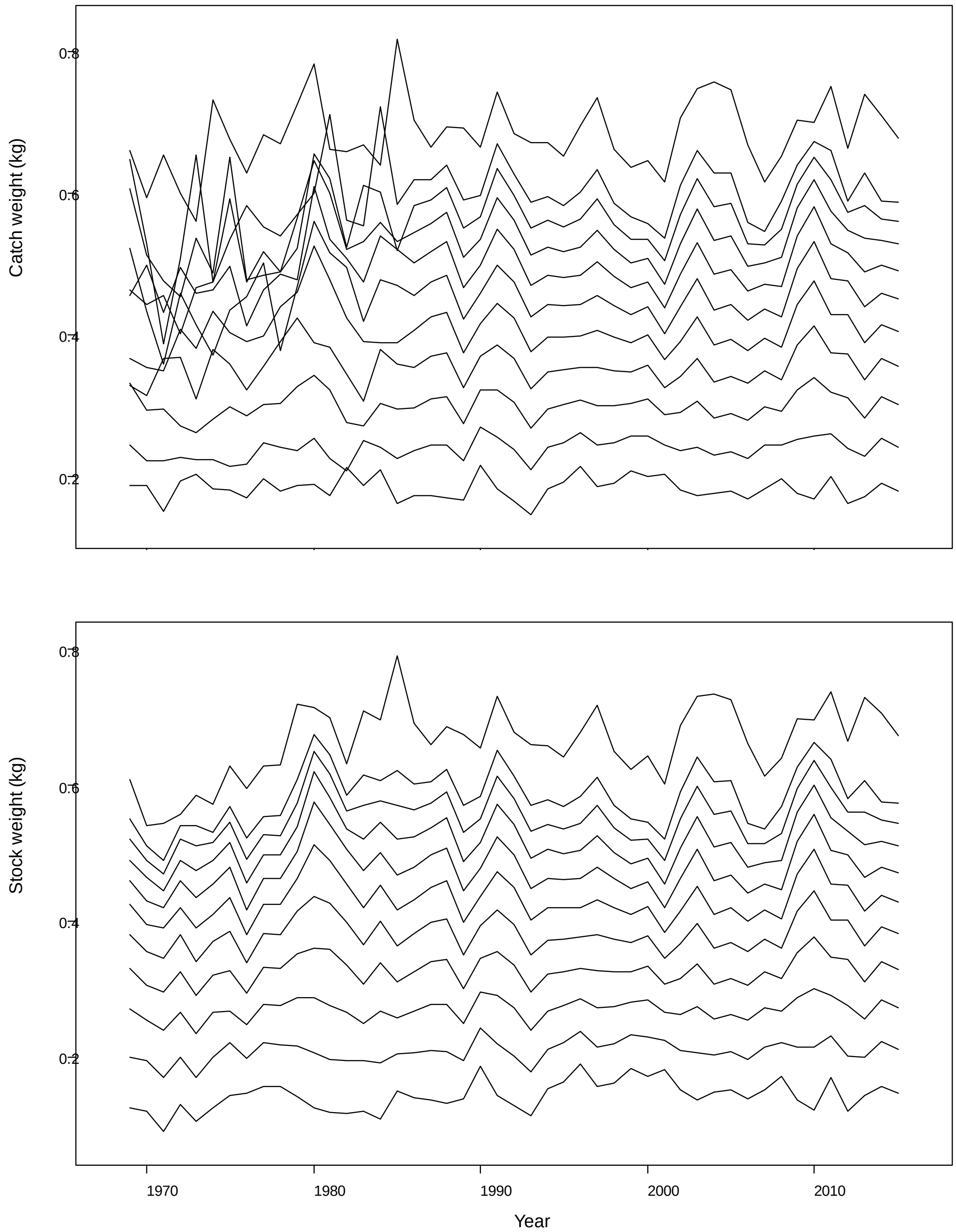


Figure 8.3.2. Sole in Division 7.e. Catch and stock weights-at-age (ages 2 to 12+).

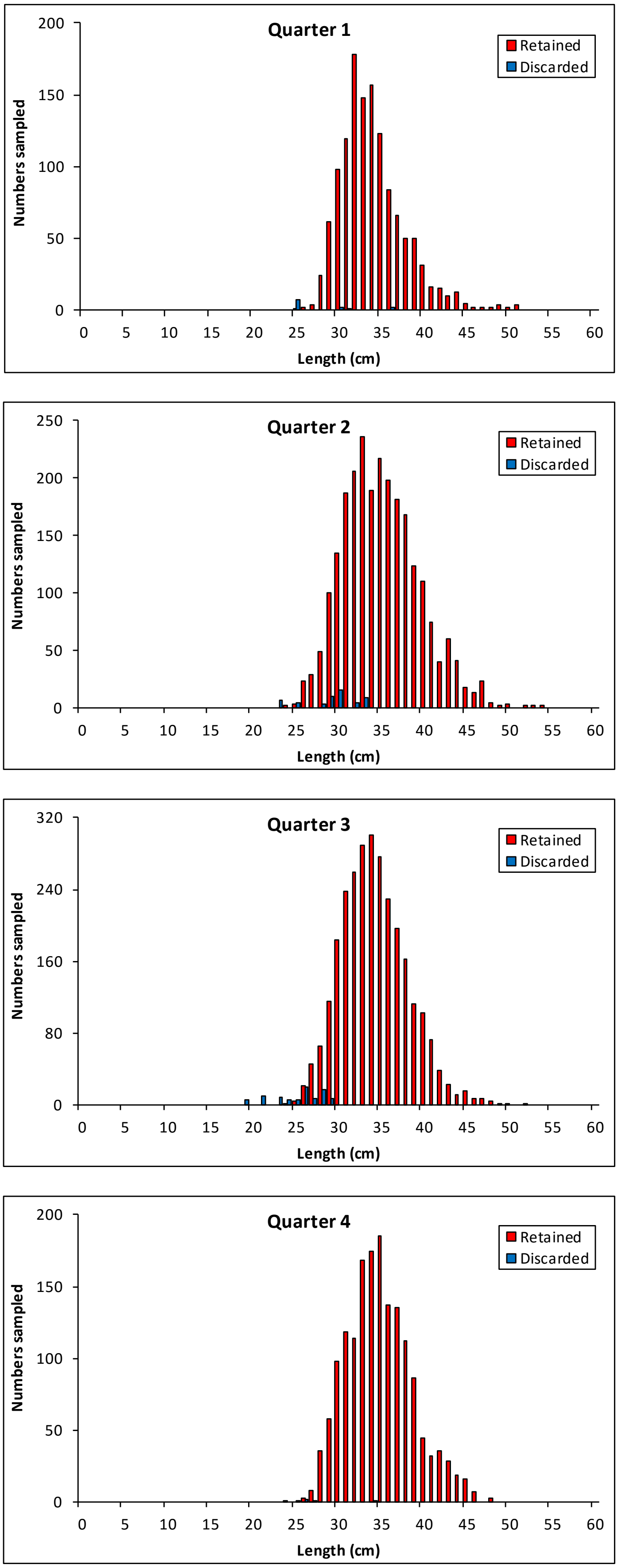


Figure 8.3.3a. Sole in Division 7.e. Discards by quarter from sampled trips for the UK.

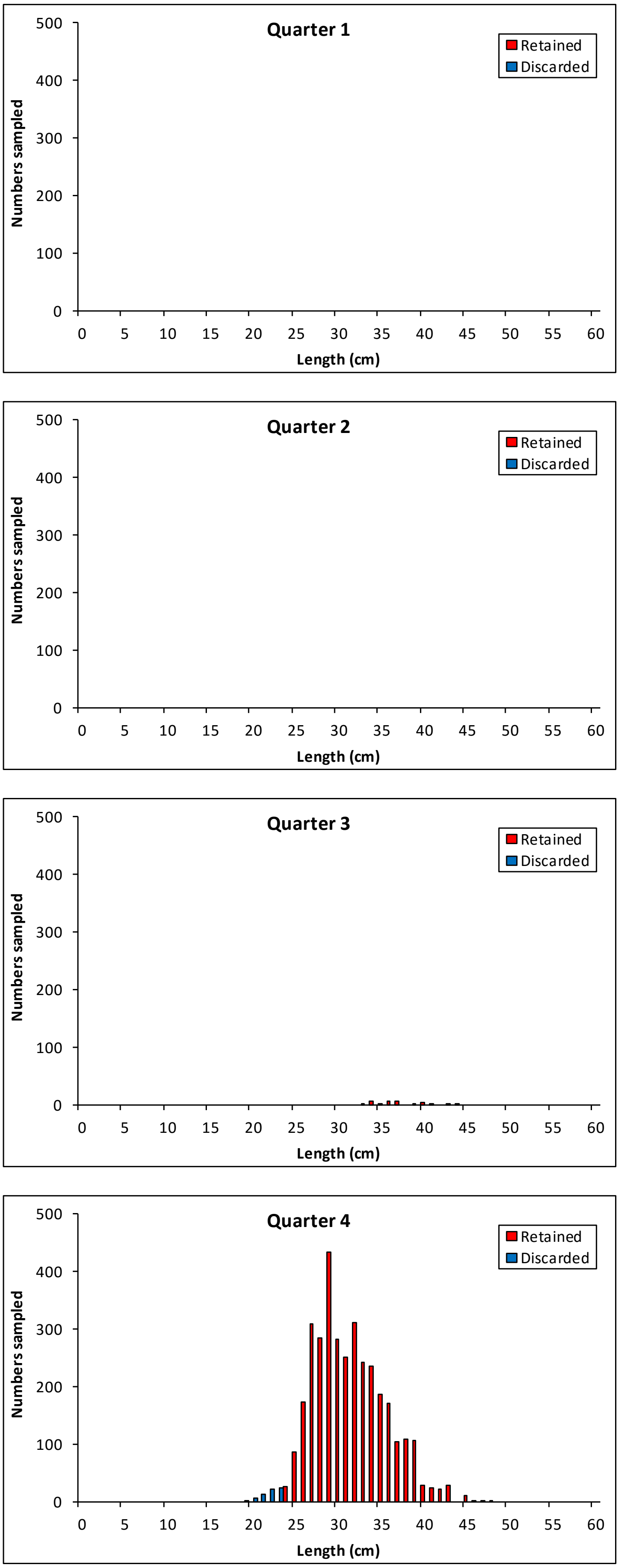
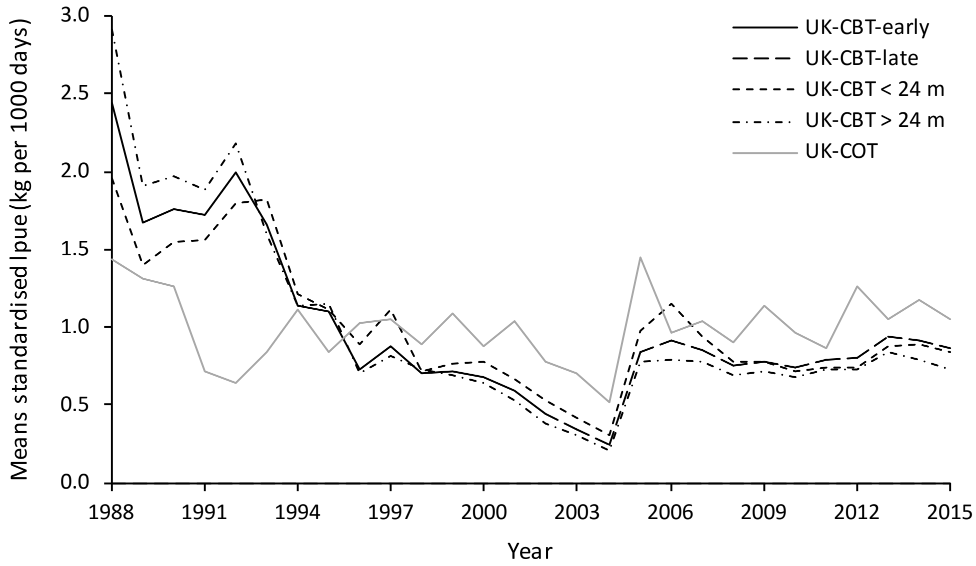


Figure 8.3.3b. Sole in Division 7.e. Discards by quarter from sampled trips for Belgium.



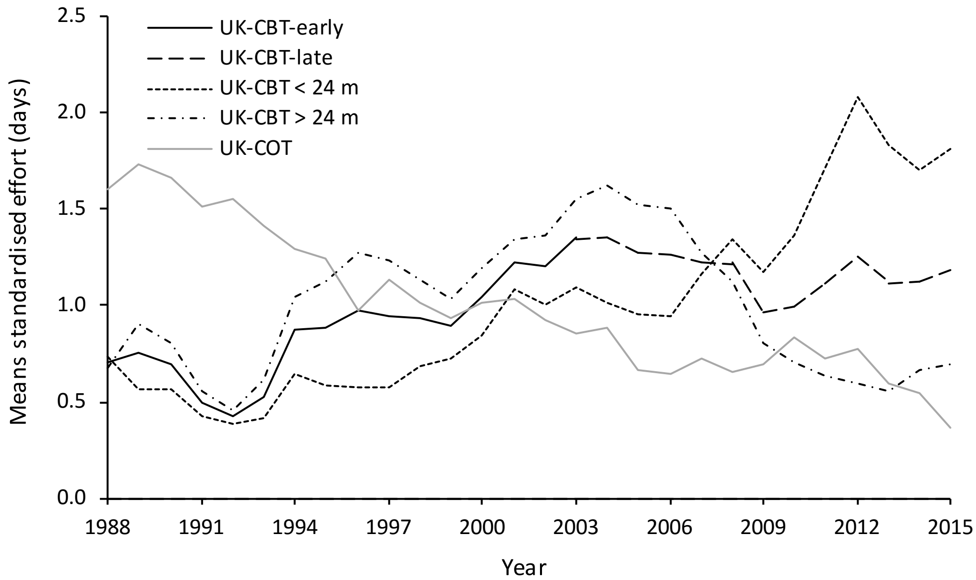


Figure 8.3.4. Sole in Division 7.e. Means standardised lpue and effort for the UK commercial fleets.

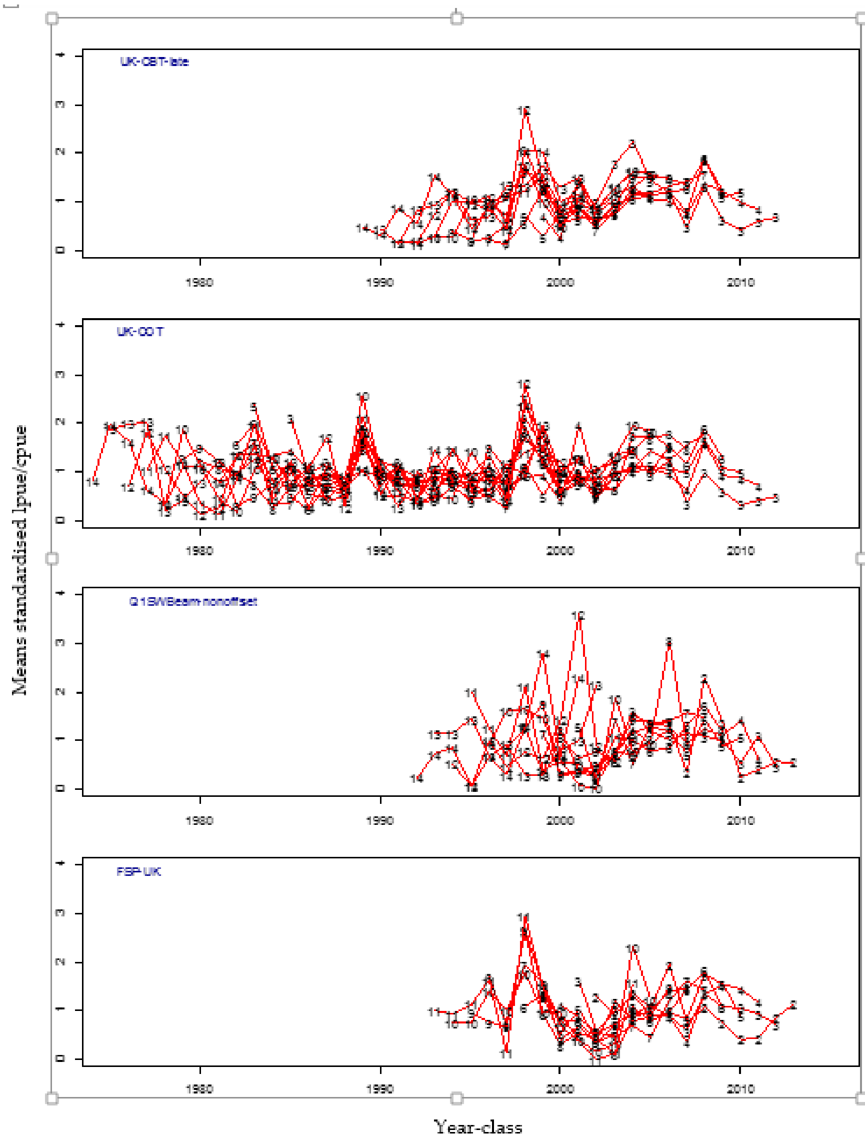


Figure 8.3.5. Sole in Division 7.e. Means standardised lpue/cpue by year class. Note the cohorts differ on the x-axes due to the differences in the length and age ranges of the tuning series.

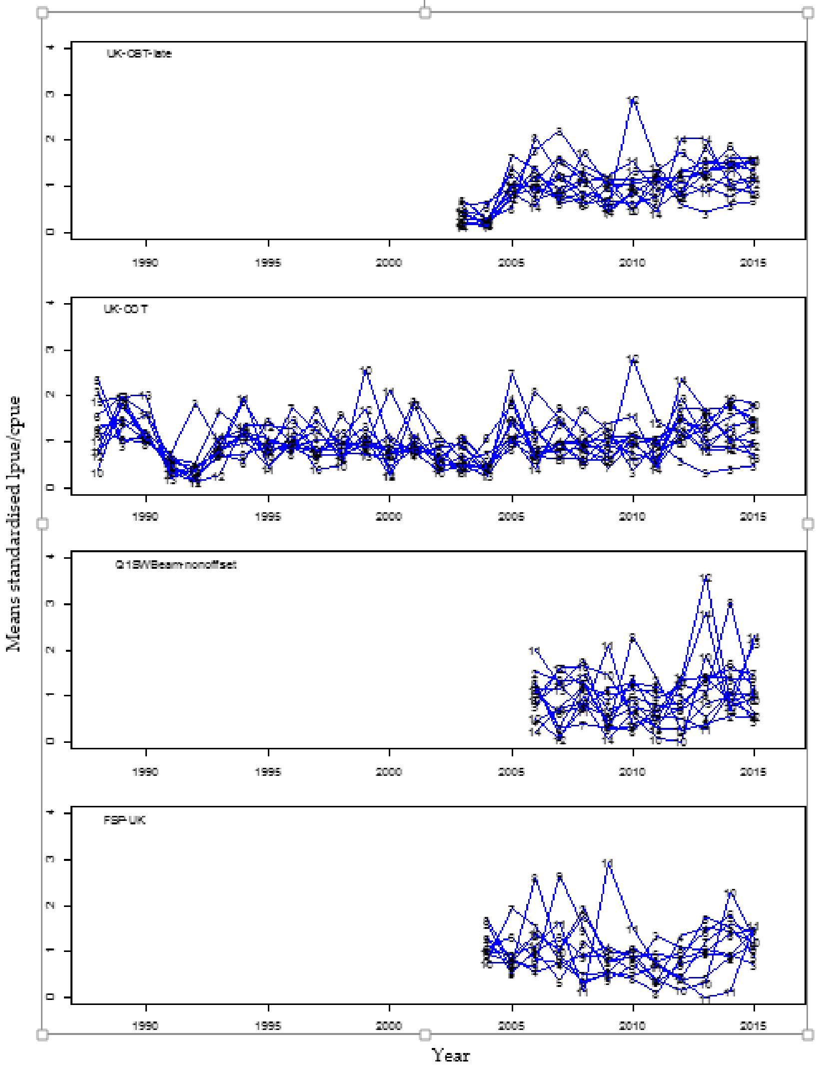


Figure 8.3.6. Sole in Division 7.e. Means standardised lpue/cpue by year. Note the cohorts differ on the x-axes due to the differences in the length and age ranges of the tuning series.

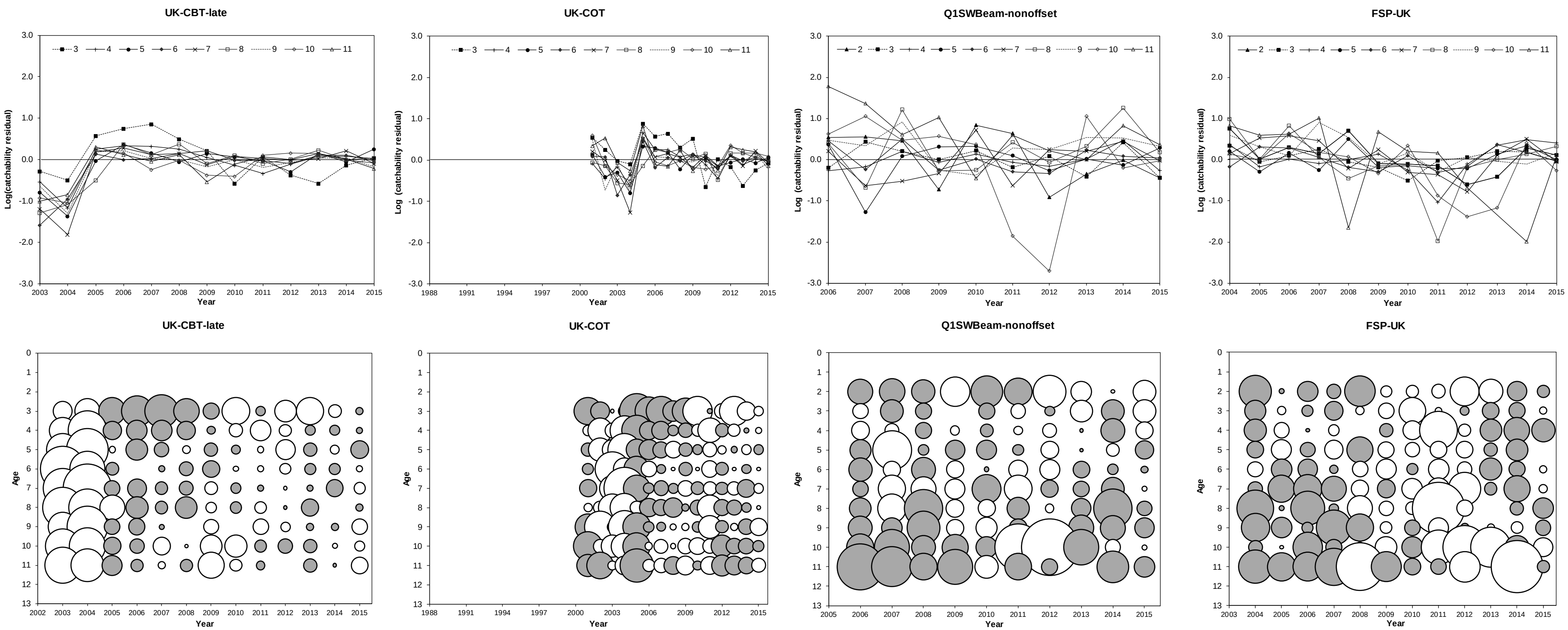


Figure 8.3.7. Sole in Division 7.e. XSA fleet log catchability residuals. Note that the application of time-series weighting set as a tricubic taper with a range of 15 years excludes log catchability residuals for the UK-COT fleet prior to 2001.

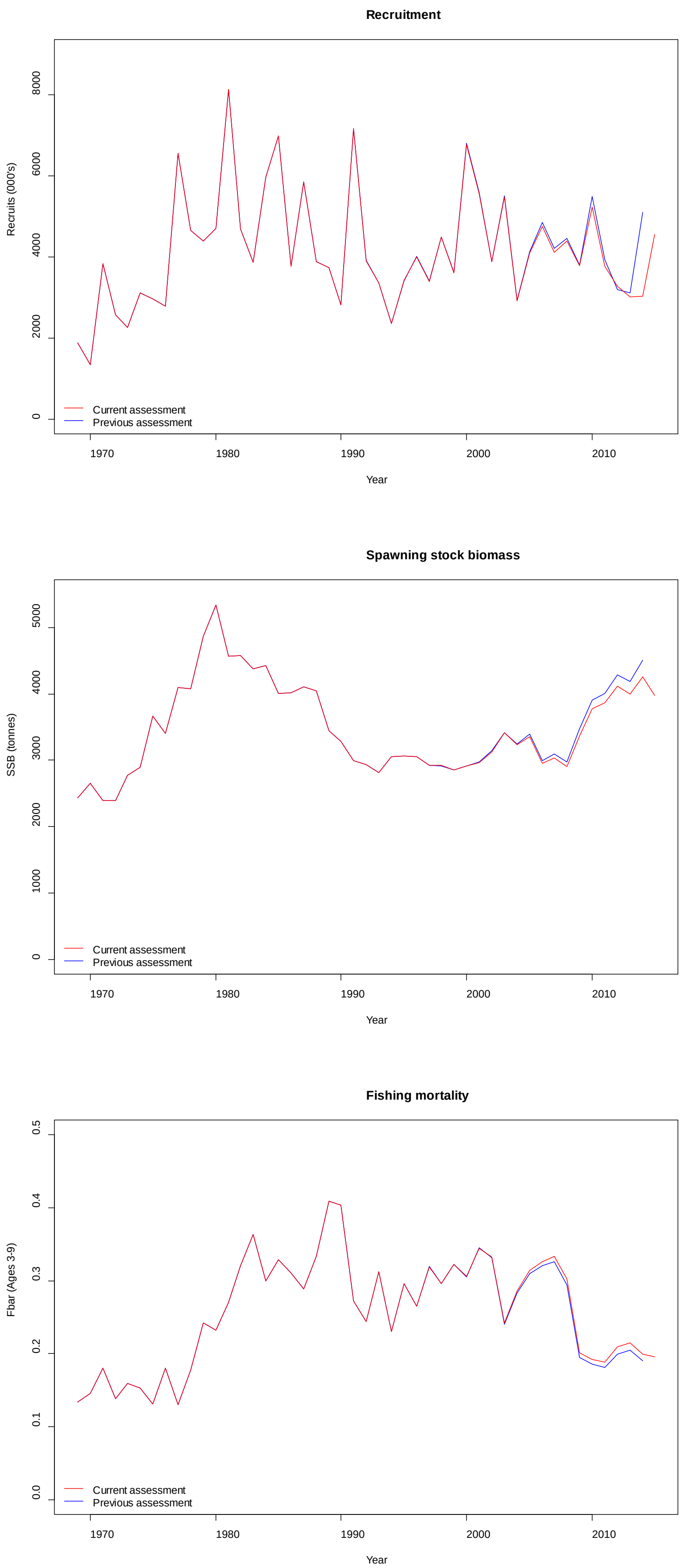


Figure 8.3.8. Sole in Division 7.e. Stock status and fishing mortality estimates for the current XSA assessment compared to the previous XSA assessment conducted at ICES WGCSE 2015.

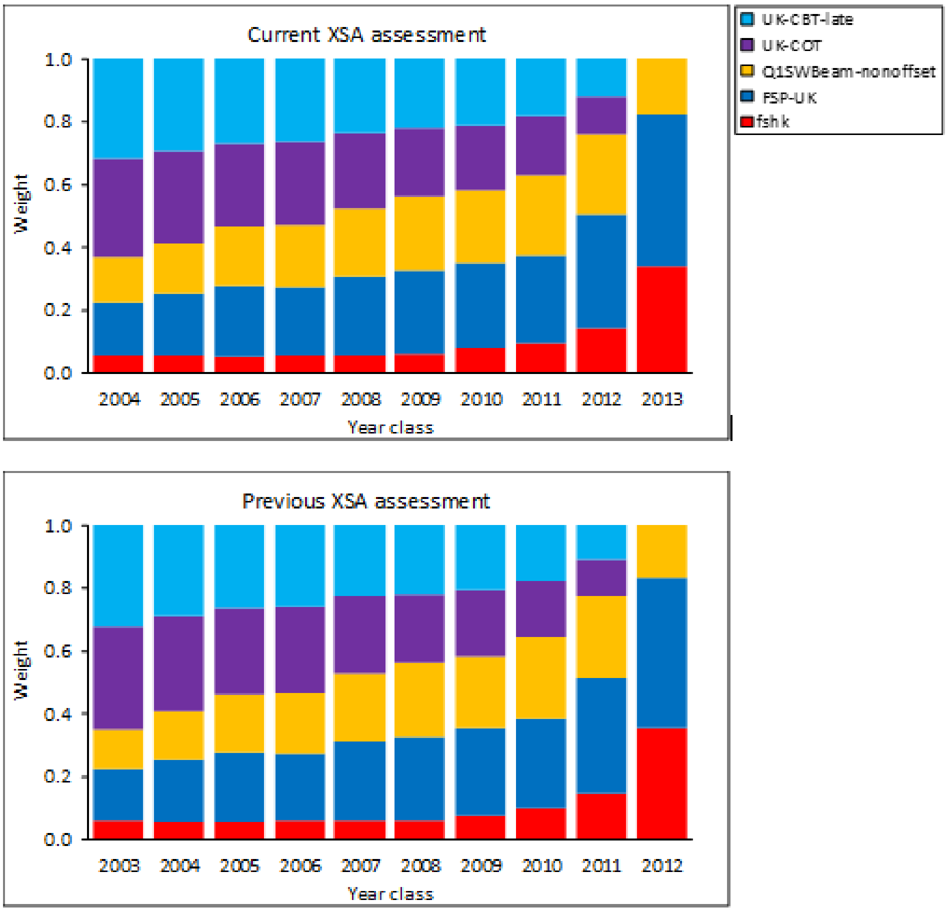


Figure 8.3.9. Sole in Division 7.e. Scaled weights for the current XSA assessment and the previous XSA assessment conducted at ICES WGCSE 2015.

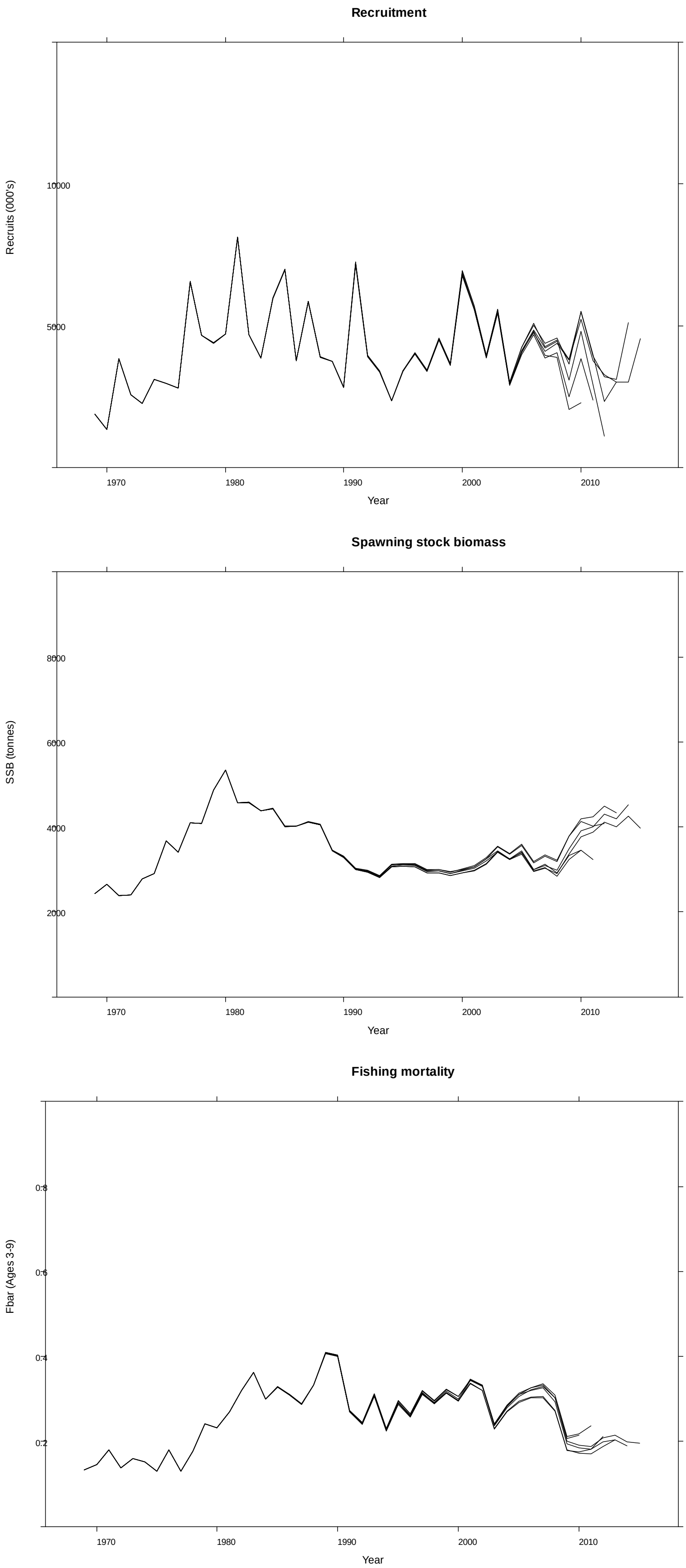


Figure 8.3.10. Sole in Division 7.e. Five-year retrospective of stock status and fishing mortality estimates.

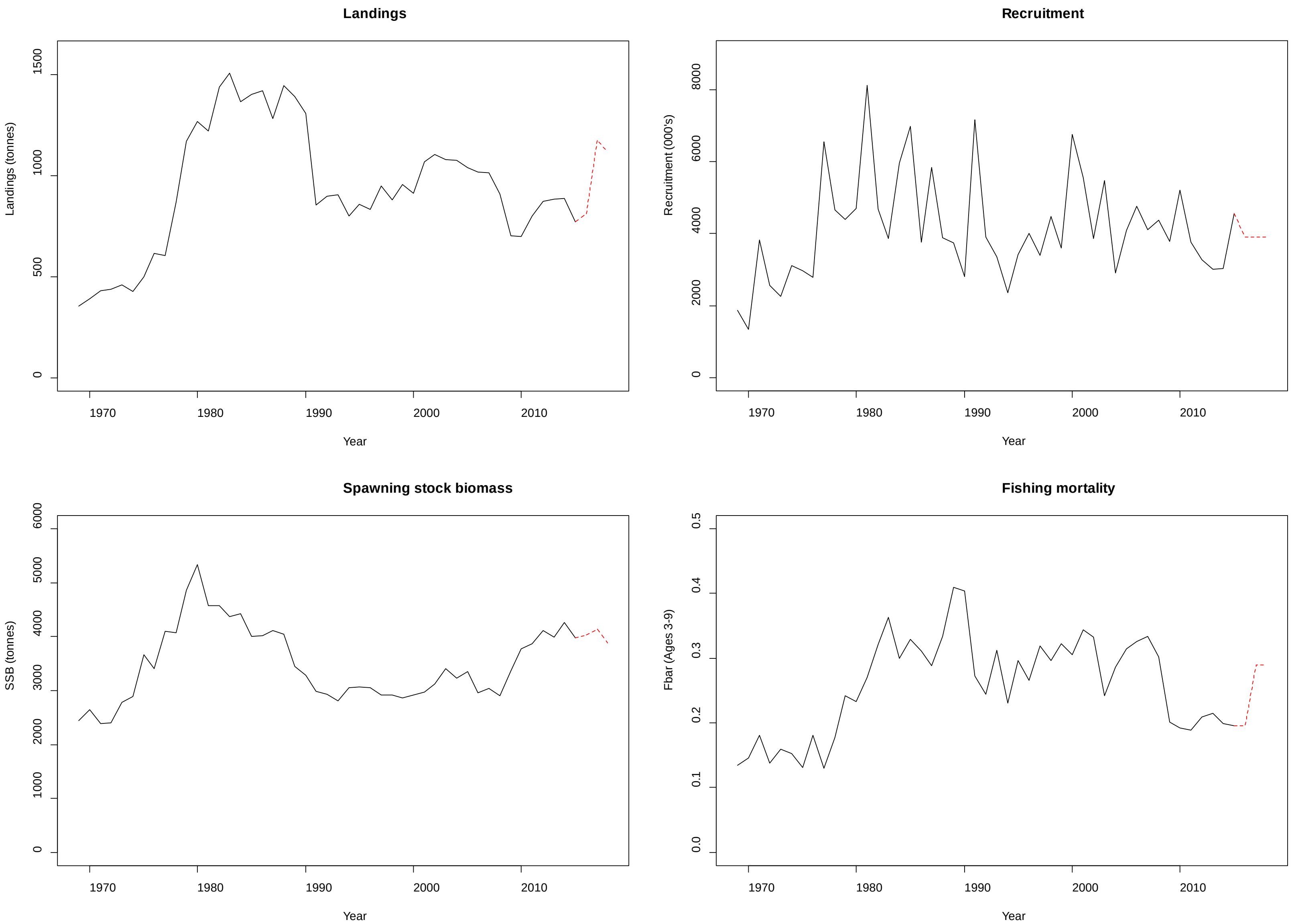


Figure 8.3.11. Sole in Division 7.e. Output for the short-term forecast under the MSY approach. Note that the dashed red line represents the forecast output.

8.3.16 Audit Sol-echw

Audit of Sole in 7e (sol-echw) Date: 23/5/2016 Auditor: Marianne Robert

General

ICES provides annual catch advice for this stock based on the MSY approach. Advice is topped up based on unchange discards rate. Last benchmarck WKFLAT 2012 but IBPWCFlat2 2015 (The second Inter benchmark protocol of Western English channel Flatfish) provides new recommandation for the assessemnt. At IBPWCFlat2 2015, the XSA model parameterisation was updated to incorporate revised tuning information due to modfications in the UK e-logbook effort recording system.

Fot single stock summary sheet advice

1) Assessment type: update/DALY XSA

2) Assessment: analytical FLXSA (and VPA.95) used two UK commercial time-series (UK-CBT-late and UK-COT) and two UK standardised research surveys (UK-FSP and Q1SWBeam). Biological paramater are in line with the stock annex. These XSA settings are as outlined in the FLXSA control object in the stock annex.

3) Forecast: Short-term forecast is presented and conducted in R. The stock annex mentioned "appropraite forecast parameter are largely based on diagniostics of the assessment" Advice sheet and report: F(2013–2015) rescaled : "F estimates 2013–2015 indicate a slight decrease which is likely to be linked to the small but remaining retrospective pattern. Consequently, rescaling F2015 by average F13-15 is considered appropriate for the forecast as per the stock annex. The mean catch and stock weights-at-age 2013-2015 were also used."

   rec=gm(1969–2015) => GM long-term time-series including the last datapoint was used the stock annex stipulates "In 2015, IBPWCFlat2 decided to forecast recruitment using a long-term geometric mean (1969–2014) due to temporal variability in the time-series and the lack of distinct periods of successive high or low recruitment in recent years. IBPWCFlat2 also issued a caveat that recruitment should be forecast using a short-term geometric mean if distinct period of successive low or high recruitment is evident over the final three years (ICES, 2015b)." the report says "Recruitment was forecast using a long-term geometric mean (1969–2015) due to temporal variability in the time-series and the lack of distinct periods of successive high or low recruitment in recent years."

4) Assessment model: FLXSA and VPA.95

5) Data issues: An inter-benchmark workshop in 2015 (IBPWCFlat2; ICES, 2015) the analytical assessment was updated to incorporate revised tuning data following changes in the UK e-logbook effort recording system (ICES, 2015). This has produced a more robust assessment with respect to the biases experienced previously.

   Discarding of sole in the sampled fleets is considered to be negligible. The landings obligation will apply to some fleets catching sole in 2016. The landings advice has been topped up with the available discard information to give catch advice.

FR discards estimates in 2015 is substantially higher than previous years. The French discards estimates in 2015 include all samples (including some derived with modified gears) to show the magnitude of the issue, and highlight the need for further work to build a coherent time-series of french discard estimates.

6) Consistency: The assessment is consistent with last year assessment. Figure 8.3.10 shows not clear trends in the retro (noise only). Recruitment has been very noisy in the last five years of the retro.

7) Stock status: F is estimated below F_{MSY} since 2009 and SSB above $MSYB_{trigger}$. Recruitement is variable without clear trend.

8) Management Plan: A management plan has been agreed by the EU in 2007 (EC, 2007). In its current phase, it aims at keeping F at the target value of 0.27 with a 15% TAC constraint. This plan has not been evaluated by ICES.

General comments

Report is clear and well written. Stcok annex is very detailed. Some minor suggestions are given below.

Technical comments

All technical comments were addressed by the stock coordinator during the report finalization process.

Conclusions

The assessment and forecast have been performed correctly. The catch options inputs and table in the advice sheet are consistent with the tables and description in the WG report.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice? Yes . Is the assessment according to the stock annex description? Yes . If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? A management plan exists and the catch option table includes the management plan rationale.

Have the data been used as specified in the stock annex? yes . Has the assessment, recruitment and forecast model been applied as specified in the stock annex? yes. Is there any major reason to deviate from the standard procedure for this stock? No. Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes

This an r-Markdown document to check and validate the assessment and STF for Sole 7e (echw) at WGCSE 2016.

```
#install.packages("FLCore", repos="http://flr-project.org/R")
#install.packages("FLXSA", repos="http://flr-project.org/R")
#install.packages("FLAssess", repos="http://flr-project.org/R")
#install.packages("knitr", repos="http://flr-project.org/R")
#install.packages("tidyr", repos="http://flr-project.org/R")
```

```
rm(list=ls())
library(FLCore)

## Warning: package 'FLCore' was built under R version 3.1.2

## Loading required package: lattice

## Loading required package: MASS

## FLCore (Version 2.5.20150116, packaged: 2015-01-23 08:53:29 UTC)

##
## Attaching package: 'FLCore'

## The following objects are masked from 'package:base':
##
##     cbind, rbind

library(FLAssess)

## Loading required package: FLash

## Warning: package 'FLash' was built under R version 3.1.2

library(FLXSA)
library(knitr)

## Warning: package 'knitr' was built under R version 3.1.3

library(tidyr)

##
## Attaching package: 'tidyr'

## The following object is masked from 'package:FLCore':
##
##     expand

sessionInfo()

## R version 3.1.1 (2014-07-10)
## Platform: i386-w64-mingw32/i386 (32-bit)
##
## locale:
## [1] LC_COLLATE=French_France.1252  LC_CTYPE=French_France.1252
## [3] LC_MONETARY=French_France.1252 LC_NUMERIC=C
## [5] LC_TIME=French_France.1252
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
## [1] tidyr_0.2.0          knitr_1.12.3         FLXSA_2.5.20140808
## [4] FLAssess_2.5.20130716 FLash_2.5.2          FLCore_2.5.20150116
## [7] MASS_7.3-33          lattice_0.20-29
##
## loaded via a namespace (and not attached):
## [1] digest_0.6.8    evaluate_0.9    grid_3.1.1      htmltools_0.2.6
## [5] rmarkdown_0.8   stats4_3.1.1    stringr_0.6.2   tools_3.1.1
## [9] yaml_2.1.13
```

Read the stock objext

set the main directory and data and output directories.

```
maindir <- 'C:/Users/marobert/Documents/work/ICES/2016/WGCSE/audit sol echw/'
datadir <- 'C:/Users/marobert/Documents/work/ICES/2016/WGCSE/audit sol echw/VPA/VPA/'
```

read in the input files for this stock.

```
stock <- readFLStock(file.path(datadir,"SOL7EIND.DAT",sep=""),no.discards=T)
tun<- readFLIndices(file.path(datadir,"SOL7ETU3a.dat",sep=""),type="VPA")
```

```
units(stock)[1:17] <- as.list(c(rep(c("tonnes","thousands","kg"),4), "NA", "NA", "f", "NA", "NA"))
summary(stock)
```

```
## An object of class "FLStock"
##
## Name: W CHANNEL SOLE 2016 WGCSE SEXES COMB
## Description: Imported from a VPA file. ( C:/Users/marobert/Documents/work/ICES/2016/WGCSE/audit sol echw/
VPA/VPA//SOL7EIND.DAT ).  Wed May 25 11:41:47 2016
## Range:   min   max pgroup  minyear maxyear minfbar maxfbar
## 2   15  NA  1969    2015    2   15
## Quant: age
##
## catch        : [ 1 47 1 1 1 1 ], units =  tonnes
## catch.n      : [ 14 47 1 1 1 1 ], units =  thousands
## catch.wt     : [ 14 47 1 1 1 1 ], units =  kg
## discards     : [ 1 47 1 1 1 1 ], units =  tonnes
## discards.n   : [ 14 47 1 1 1 1 ], units =  thousands
## discards.wt  : [ 14 47 1 1 1 1 ], units =  kg
## landings     : [ 1 47 1 1 1 1 ], units =  tonnes
## landings.n   : [ 14 47 1 1 1 1 ], units =  thousands
## landings.wt  : [ 14 47 1 1 1 1 ], units =  kg
## stock        : [ 1 47 1 1 1 1 ], units =  tonnes
## stock.n      : [ 14 47 1 1 1 1 ], units =  thousands
## stock.wt     : [ 14 47 1 1 1 1 ], units =  kg
## m            : [ 14 47 1 1 1 1 ], units =  NA
## mat          : [ 14 47 1 1 1 1 ], units =  NA
## harvest      : [ 14 47 1 1 1 1 ], units =  f
## harvest.spwn : [ 14 47 1 1 1 1 ], units =  NA
## m.spwn       : [ 14 47 1 1 1 1 ], units =  NA
```

```
#stock@m
#stock@mat
#stock@m.spwn
```

For sole 7e discards are not included in the assessment currently. (catch and landings number identical, discards slots empty) Natural mortality set to 0.1 : in line with the stock annex. Maturity:in line with the stock annex catch weight and stock weight different => ok harvest.spwn and m.spwn equal to zero : in line with the stock annex

```
summary(tun)
```

```
## An object of class "FLIndices"
##
## Elements: UK-CBT-late UK-COT Q1SWBeam-nonoffset FSP-UK
##
## Name: UK-CBT-late
##  Description: W CHANNEL SOLE 2016 WGCSE, 2-11, SEXES COMBINED, . Imported from VPA file.
##  Range:  min   max pgroup  minyear maxyear startf  endf
##     3  11  11  2003    2015    0   1
##  Quant: age
##  dim: 9 13 1 1 1
## Name: UK-COT
##  Description: W CHANNEL SOLE 2016 WGCSE, 2-11, SEXES COMBINED, . Imported from VPA file.
##  Range:  min   max pgroup  minyear maxyear startf  endf
##     3  11  11  1988    2015    0   1
##  Quant: age
##  dim: 9 28 1 1 1
## Name: Q1SWBeam-nonoffset
##  Description: W CHANNEL SOLE 2016 WGCSE, 2-11, SEXES COMBINED, . Imported from VPA file.
##  Range:  min   max pgroup  minyear maxyear startf  endf
##     2  11  11  2006    2015    0.1 0.25
##  Quant: age
##  dim: 10 10 1 1 1
## Name: FSP-UK
##  Description: W CHANNEL SOLE 2016 WGCSE, 2-11, SEXES COMBINED, . Imported from VPA file.
##  Range:  min   max pgroup  minyear maxyear startf  endf
##     2  11  11  2004    2015    0.7 0.75
##  Quant: age
##  dim: 10 12 1 1 1
```

Tuning information consisted of four fleets: two UK commercial time-series (UK-CBT-late and UK-COT) and two UK standardised research surveys (UK-FSP and Q1SWBeam). Time-series length are not update in the stock annex (year range upto 2014 only, ok in the report section)

save the stock object incase we need to load it independently later.

```
save(stock,tun,file=file.path(datadir,'sol7e_stock.Rdata'))
```

set some of the parameters for this stock i.e. Fbar range, plusgroup, recruit age, fmsy, msybtrigger, interim year TAC.

```
stock@range[c("minfbar","maxfbar")] = c(3,9)
fbarage <- 3:9
stock <- setPlusGroup(stock,plusgroup=12)
fmsy <- 0.29
msybtrig <- 2900
TAC<-979 # check 2016 TAC
rage <- 2 #Recruitment age
```

run XSA output the F-at-age matrix to compare with the final assessment. Final XSA output is saved gerenrate a stock summary table which will be outputed later.

```
xsa.control <- FLXSA.control(tol = 1e-09, maxit = 200,  min.nse = 0.4,  fse  = 0.5,
                    rage = 0,   qage  = 7,   shk.n   = FALSE, shk.f = TRUE,
                    shk.yrs = 3, shk.ages= 5,  tsrange = 15,
                    tspower = 3)
# in the script of Jonathan
#control <- FLXSA.control(fse = 0.5, rage = 0, qage = 7, shk.n = FALSE, shk.f = TRUE, shk.ages = 5, shk.yrs = 3, min.nse
= #0.4, tspower = 3, tsrange = 15, maxit= 200)


tun.sel<-tun
xsa<-FLXSA(stock=stock, indices=tun.sel, control=xsa.control)
fout <- as.data.frame(xsa@harvest)
fout <-fout[,c(1,2,7)]
names(fout)[3] <- 'f'
fout <- tidyr::spread(fout,age,f)

save(xsa,file=file.path(datadir,'sol7e_xsa.Rdata'))
stock@stock.n <- xsa@stock.n;  stock@harvest <- xsa@harvest

summary<-data.frame(year=stock@range['minyear']:stock@range['maxyear']
            #,catch=c(stock@catch)
            ,land=c(stock@landings)
            ,recruit=c(stock@stock.n[as.character(rage)])
            ,tsb=c(tsb(stock))
            ,ssb=c(ssb(stock))
            ,fbar=c(apply(stock@harvest[as.character(fbarage)],2,mean))
            )

knitr::kable(subset(fout,year>2000),row.names=F, digits=3)
```

year	2	3	4	5	6	7	8	9	10	11	12
2001	0.028	0.291	0.302	0.391	0.388	0.352	0.273	0.411	0.492	0.384	0.384
2002	0.094	0.314	0.255	0.333	0.419	0.291	0.323	0.390	0.405	0.358	0.358
2003	0.122	0.322	0.372	0.281	0.159	0.143	0.155	0.264	0.439	0.266	0.266
2004	0.155	0.299	0.255	0.264	0.346	0.275	0.308	0.257	0.375	0.415	0.415
2005	0.068	0.246	0.353	0.388	0.321	0.294	0.276	0.320	0.273	0.254	0.254
2006	0.117	0.273	0.372	0.416	0.346	0.295	0.272	0.306	0.343	0.276	0.276
2007	0.053	0.267	0.405	0.369	0.416	0.394	0.249	0.230	0.299	0.244	0.244
2008	0.070	0.254	0.313	0.321	0.321	0.343	0.375	0.189	0.193	0.319	0.319
2009	0.047	0.167	0.179	0.223	0.255	0.186	0.201	0.197	0.175	0.131	0.131
2010	0.014	0.118	0.158	0.204	0.185	0.226	0.184	0.268	0.142	0.153	0.153
2011	0.026	0.120	0.211	0.216	0.195	0.189	0.193	0.196	0.179	0.263	0.263
2012	0.010	0.075	0.160	0.246	0.266	0.270	0.225	0.221	0.311	0.280	0.280

2013	0.043	0.123	0.201	0.244	0.244	0.227	0.245	0.221	0.219	0.234	0.234
2014	0.071	0.138	0.234	0.244	0.237	0.202	0.160	0.180	0.188	0.164	0.164
2015	0.044	0.153	0.222	0.257	0.216	0.183	0.188	0.154	0.144	0.128	0.128

consistent with the report : Table 8.3.10. Sole in Division 7.e. Fishing mortality-at-age continued

Running the STF

```
years<-stock@range['minyear']:stock@range['maxyear']
nyears <-length(years)
ages <- stock@range['min']:stock@range['max']
nages <- length(ages)

catchoptions <- function() {
 out <- data.frame(Catch=round(c(landings(stf1)[,nyears+2]+discards(stf1)[,nyears+2]))
          ,Land=round(c(landings(stf1)[,nyears+2]))
          ,Dis=round(c(discards(stf1)[,nyears+2]))
          ,FCatch=round(mean(harvest(stf1)[as.character(fbarage),nyears+2]),2)
          ,FLand=round(mean((harvest(stf1)*landings.n(stf1)/catch.n(stf1))[as.character   (fbarage),nyears+2]),2)
          ,FDis=round(mean((harvest(stf1)*discards.n(stf1)/catch.n(stf1))[as.character(fbarage),nyears+2]),2)
          ,SSB=round(c(ssb(stf1)[,nyears+3]),0)
          ,SSB.change= round((c(ssb(stf1)[,nyears+3])/ssbInt-1)*100,0)
          ,TAC.chanage=round((c(landings(stf1)[,nyears+2])/TAC-1)*100,0)
 )
 names(out) <- paste0(names(out),c(rep(max(years)+2-2000,6),max(years)+3-2000,
           max(years)-2000+2, max(years)-2000+1))
 return(out)
}
#Extends an FLStock object along the year dimensin and prepares some of the slots for forward stock projection,
stf0 <- stf(stock, nyears=3, wts.nyears=3, fbar.nyears=3)


# recruitment assumtion
GM <- round(exp(mean(log(c(stock@stock.n[as.character(rage)])[1:(nyears)]))),0)
GM

## [1] 3911

stock.n(stf0)[1,nyears+1] <- GM
stock.n(stf0)[1,nyears+2] <- GM
stock.n(stf0)[1,nyears+3] <- GM

srr <- FLSR(segreg) # not used as we are using GM but required under setup

# F assumption
# fsq <- mean(harvest(stf0)[as.character(fbarage),nyears-2:0])

# from jonathan's scrip
Fy <- as.vector(fbar(stf0)[,ac(2015)])#F2015 value saved as a vector
Fy1 <- apply(harvest(stf0)[,ac(2013:2015)],1,mean)#Mean F at age for the last 3 years
Fy1 <- ((Fy1/mean((Fy1)[ac(3:9),,,,,]))*(Fy))#Average F at age weighted by terminal year Fbar
fsq <- quantMeans(Fy1[ac(3:9)])
#fsq <- round(fsq, digits = 2)
fsq

## An object of class "FLQuant"
## , , unit = unique, season = all, area = unique
##
##     year
## age   1
##   all 0.19609
##
## units:  f

fsq<-0.196


ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,fsq,0),quantity=rep('f',3)))
stf1  <- project(stf0, ctrl, srr)
```

```
ssbInt <- c(ssb(stf1)[,nyears+2]) # ssb in intermediate year (1 jan)
tsbInt <- c(tsb(stf1)[,nyears+2]) # ssb in intermediate year (1 jan)
landInt <- c(landings(stf1)[,nyears+1]) # catch in intermediate year, assuming fsq

out <- NULL
for(f in seq(0,2,by=0.1)){
  ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,f*fsq,0),quantity=rep('f',3)))
  stf1  <- project(stf0, ctrl, srr)
  out <- rbind(out,data.frame(Fmult=f,catchoptions()))
}
```

```
#setup for other options
fmsyapproach <- fmsy*ifelse(ssbInt/msybtrig>1,1,ssbInt/msybtrig)

# other options
ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,fmsyapproach,0),quantity=rep('f',3)))
stf1  <- project(stf0, ctrl, srr)
msyapproach <- catchoptions()
ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,fmsy,0),quantity=rep('f',3)))
stf1  <- project(stf0, ctrl, srr)
msy <- catchoptions()
ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,fmsy,0),quantity=rep('f',3)))
stf1  <- project(stf0, ctrl, srr)
msy <- catchoptions()
ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,0.45,0),quantity=rep('f',3)))
stf1  <- project(stf0, ctrl, srr)
msymax <- catchoptions()
ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,0.2,0),quantity=rep('f',3)))
stf1  <- project(stf0, ctrl, srr)
msymin <- catchoptions()
ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,TAC,0),quantity=c('f','landings','f')))
stf1  <- project(stf0, ctrl, srr)
TACstable <- catchoptions()
ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,TAC*1.15,0),quantity=c('f','landings','f')))
stf1  <- project(stf0, ctrl, srr)
TACplus15 <- catchoptions()
ctrl <- projectControl(data.frame(year=max(years)+1:3,val=c(fsq,TAC*0.85,0),quantity=c('f','landings','f')))
stf1  <- project(stf0, ctrl, srr)
TACminus15 <- catchoptions()
```

Outputs

The detailed catch option table and other stock-specific catch options are also listed.

```
summary <- rbind(summary, c(max(years)+1,landInt, GM, tsbInt, ssbInt, fsq))

knitr::kable(summary,row.names=F, digits = c(0, 0, 0, 0, 0 , 2))
```

year	land	recruit	tsb	ssb	fbar
1969	353	1874	2927	2437	0.13
1970	391	1343	3023	2652	0.15
1971	432	3826	2838	2390	0.18
1972	437	2568	3091	2395	0.14
1973	459	2264	3266	2778	0.16
1974	427	3107	3512	2896	0.15
1975	491	2967	4428	3670	0.13
1976	616	2791	4102	3403	0.18
1977	606	6556	5339	4098	0.13
1978	861	4657	5429	4074	0.18
1979	1181	4389	6014	4865	0.24
1980	1269	4702	6387	5338	0.23

1981	1215	8130	5957	4572	0.27
1982	1446	4679	5916	4575	0.32
1983	1498	3866	5377	4374	0.36
1984	1370	5968	5462	4430	0.30
1985	1409	6982	5568	4009	0.33
1986	1419	3765	5257	4013	0.31
1987	1280	5848	5310	4112	0.29
1988	1444	3879	5120	4043	0.33
1989	1390	3735	4318	3442	0.41
1990	1315	2816	4222	3287	0.40
1991	852	7166	4220	2991	0.27
1992	895	3907	4101	2937	0.24
1993	904	3356	3581	2811	0.31
1994	800	2363	3787	3055	0.23
1995	856	3416	3870	3069	0.30
1996	833	4001	4157	3053	0.27
1997	949	3398	3846	2921	0.32
1998	880	4485	3973	2920	0.30
1999	957	3610	3989	2856	0.32
2000	914	6765	4392	2916	0.31
2001	1069	5550	4630	2970	0.34
2002	1106	3877	4325	3123	0.33
2003	1078	5482	4545	3411	0.24
2004	1075	2913	4172	3232	0.29
2005	1039	4096	4248	3352	0.31
2006	1023	4754	3954	2955	0.33
2007	1015	4106	4101	3034	0.33
2008	908	4386	4080	2908	0.30
2009	701	3792	4342	3363	0.20
2010	698	5221	4819	3773	0.19
2011	801	3769	5116	3870	0.19
2012	872	3282	4958	4113	0.21
2013	883	3013	4795	3995	0.22
2014	885	3023	5082	4259	0.20
2015	772	4550	4924	3977	0.20
2016	809	3911	5147	4143	0.20

Consistent with Table 8.3.11

```
other <- rbind(msyapproach, msy, msymax, msymin, TACstable,TACplus15, TACminus15)
# need to be updated
other$Fmult <- other$FLand17/fsq
out <- rbind(out,other[, c(10,1:9)])
out$basis <- c(paste0('Fsq*',seq(0,2,by=0.1)),'msyapproach', 'msy', 'msymax', 'msymin', 'TACstable','TACplus15', 'TACminus15')
knitr::kable(out,row.names=F, digits= c(2,0,0,0,2,2,2,0,0,0,0))
```

Fmult	Catch17	Land17	Dis17	FCatch17	FLand17	FDis17	SSB18	SSB.change17	TAC.chanage16	basis
0.00	0	0	0	0.00	NaN	NaN	5026	21	-100	Fsq*0
0.10	90	90	0	0.02	0.02	0	4938	19	-91	Fsq*0.1
0.20	179	179	0	0.04	0.04	0	4852	17	-82	Fsq*0.2
0.30	265	265	0	0.06	0.06	0	4767	15	-73	Fsq*0.3
0.40	351	351	0	0.08	0.08	0	4684	13	-64	Fsq*0.4
0.50	434	434	0	0.10	0.10	0	4603	11	-56	Fsq*0.5

0.60	516	516	0	0.12	0.12	0	4523	9	-47	Fsq*0.6
0.70	597	597	0	0.14	0.14	0	4445	7	-39	Fsq*0.7
0.80	676	676	0	0.16	0.16	0	4368	5	-31	Fsq*0.8
0.90	754	754	0	0.18	0.18	0	4292	4	-23	Fsq*0.9
1.00	830	830	0	0.20	0.20	0	4218	2	-15	Fsq*1
1.10	905	905	0	0.22	0.22	0	4145	0	-8	Fsq*1.1
1.20	979	979	0	0.24	0.24	0	4074	-2	0	Fsq*1.2
1.30	1051	1051	0	0.25	0.25	0	4004	-3	7	Fsq*1.3
1.40	1122	1122	0	0.27	0.27	0	3935	-5	15	Fsq*1.4
1.50	1192	1192	0	0.29	0.29	0	3868	-7	22	Fsq*1.5
1.60	1260	1260	0	0.31	0.31	0	3802	-8	29	Fsq*1.6
1.70	1327	1327	0	0.33	0.33	0	3737	-10	36	Fsq*1.7
1.80	1393	1393	0	0.35	0.35	0	3674	-11	42	Fsq*1.8
1.90	1458	1458	0	0.37	0.37	0	3611	-13	49	Fsq*1.9
2.00	1522	1522	0	0.39	0.39	0	3550	-14	55	Fsq*2
1.48	1178	1178	0	0.29	0.29	0	3882	-6	20	msyap-proach
1.48	1178	1178	0	0.29	0.29	0	3882	-6	20	msy
2.30	1703	1703	0	0.45	0.45	0	3375	-19	74	msymax
1.02	846	846	0	0.20	0.20	0	4203	1	-14	msymin
1.22	979	979	0	0.24	0.24	0	4074	-2	0	TACstable
1.43	1126	1126	0	0.28	0.28	0	3932	-5	15	TACplus15
1.02	832	832	0	0.20	0.20	0	4216	2	-15	TACmi-nus15

consitent with Table 6.3.45.3 advice sheet (except minor difference coming from rounding)

The stfout function below generates detailed STF output tables for the *status quo* forecast. These are picked up to make the Landings and SSB contribution plot. The forecast will be extremely sensitive to the 2014 year-class estimate and also GM assumptions.

```
p <- c(1,1,1,1,1,1,1) # fudge because this is a landings only STF
stfout <- function(i){
 out <- data.frame(Age=ages
  ,LF=round(c(harvest(stf1)[,i])*p,3)
  ,CatchNos=round(c(landings.n(stf1)[,i]))
  ,Yield=round(c((landings.n(stf1)*landings.wt(stf1))[,i]),0)
  ,DF=round(c(harvest(stf1)[,i])*(1-p),3)
  ,DCatchNos=round(c(discards.n(stf1)[,i]))
  ,DYield=round(c((discards.n(stf1)*discards.wt(stf1))[,i]),0)
  ,StockNos=round(c(stock.n(stf1)[,i]))
  ,Biomass=round(c((stock.n(stf1)*stock.wt(stf1))[,i]))
  ,SSNos=round(c((stock.n(stf1)*mat(stf1))[,i]))
  ,SSB=round(c((stock.n(stf1)*stock.wt(stf1)*mat(stf1))[,i]))
  )
 out <- rbind(out,colSums(out))
 nrows <- nrow(out)
 out[nrows,1] <- 'Total'
 out[nrows,2] <- round(mean((harvest(stf1)[,i]*p)[as.character(fbarage)]),3)
 out[nrows,5] <- round(mean((harvest(stf1)[,i]*(1-p))[as.character(fbarage)]),3)
 return(out)
 }


stfout1 <- stfout(nyears+1)

## Warning in c(harvest(stf1)[, i]) * p: la taille d'un objet plus long n'est
## pas multiple de la taille d'un objet plus court
```

```
## Warning in c(harvest(stf1)[, i]) * (1 - p): la taille d'un objet plus long
## n'est pas multiple de la taille d'un objet plus court
```

```
knitr::kable(stfout1,row.names=F)
```

Age	LF	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
2	0.051	184	33	0	0	0	3911	583	548	82
3	0.133	467	113	0	0	0	3939	834	1773	375
4	0.211	358	107	0	0	0	1978	535	1741	471
5	0.240	303	107	0	0	0	1493	487	1463	477
6	0.224	225	91	0	0	0	1179	446	1179	446
7	0.197	182	82	0	0	0	1068	456	1068	456
8	0.190	182	90	0	0	0	1099	519	1099	519
9	0.178	83	44	0	0	0	536	275	536	275
10	0.177	74	42	0	0	0	478	263	478	263
11	0.169	44	27	0	0	0	298	174	298	174
12	0.169	104	74	0	0	0	701	493	701	493
Total	0.196	2206	810	0	0	0	16680	5065	10884	4031

```
stfout2 <- stfout(nyears+2)
```

```
## Warning in c(harvest(stf1)[, i]) * p: la taille d'un objet plus long n'est
## pas multiple de la taille d'un objet plus court

## Warning in c(harvest(stf1)[, i]) * p: la taille d'un objet plus long n'est
## pas multiple de la taille d'un objet plus court
```

```
knitr::kable(stfout2,row.names=F)
```

Age	LF	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
2	0.051	185	33	0	0	0	3911	583	548	82
3	0.133	400	96	0	0	0	3363	712	1514	320
4	0.211	566	169	0	0	0	3121	845	2746	743
5	0.240	295	104	0	0	0	1450	473	1421	464
6	0.224	204	82	0	0	0	1063	402	1063	402
7	0.197	145	65	0	0	0	853	364	853	364
8	0.191	131	65	0	0	0	794	374	794	374
9	0.179	128	68	0	0	0	822	422	822	422
10	0.178	63	36	0	0	0	406	223	406	223
11	0.169	54	32	0	0	0	362	212	362	212
12	0.169	113	80	0	0	0	763	536	763	536
Total	0.196	2284	830	0	0	0	16908	5146	11292	4142

```
stfout3 <- stfout(nyears+3)
```

```
## Warning in c(harvest(stf1)[, i]) * p: la taille d'un objet plus long n'est
## pas multiple de la taille d'un objet plus court

## Warning in c(harvest(stf1)[, i]) * p: la taille d'un objet plus long n'est
## pas multiple de la taille d'un objet plus court
```

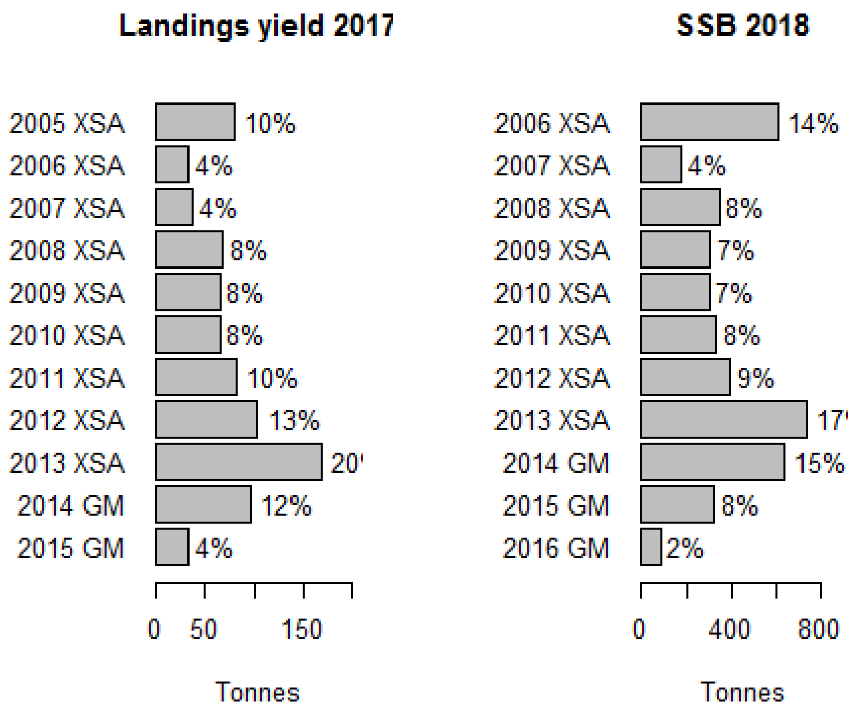
```
knitr::kable(stfout3,row.names=F)
```

Age	LF	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos	SSB
2	0	0	0	0	0	0	3911	583	548	82
3	0	0	0	0	0	0	3363	712	1513	320
4	0	0	0	0	0	0	2664	721	2344	635
5	0	0	0	0	0	0	2286	746	2240	731
6	0	0	0	0	0	0	1032	390	1032	390
7	0	0	0	0	0	0	769	328	769	328

8	0	0	0	0	0	0	634	299	634	299
9	0	0	0	0	0	0	593	305	593	305
10	0	0	0	0	0	0	622	343	622	343
11	0	0	0	0	0	0	307	180	307	180
12	0	0	0	0	0	0	860	604	860	604
Total	0	0	0	0	0	0	17041	5211	11462	4217

```
par(mfrow=c(1,2),mar=c(5,8,4,1),cex=0.8)
nrows <- nrow(stfout2)
yield <- stfout2[-nrows,'Yield']
prop <- paste0(round(100*yield/sum(yield)),'%')
labels <- paste(max(years)-ages+2,rep(c('GM','XSA'),c(2,nages-2)))
b <- barplot(yield,horiz=T,names=labels,las=1,xlab='Tonnes',main=paste('Landings yield',max(years)+2),xlim=c(0,ma
x(yield)*1.25))
text(yield,b,prop,adj=-0.2)

ssb <- stfout3[-nrows,'SSB']
prop <- paste0(round(100*ssb/sum(ssb)),'%')
labels <- paste(max(years)-ages+3,rep(c('GM','XSA'),c(3,nages-3)))
b <- barplot(ssb,horiz=T,names=labels,las=1,xlab='Tonnes',main=paste('SSB',max(years)+3),xlim=c(0,max(ssb)*1.25)
)
text(ssb,b,prop,adj=-0.2)
```



Input table and management option table are consistent with the report. Minor differences (due to rounding ?) Year-class sources and contributions for short-term forecast consistent with the report

9.2 Pollack in the Celtic Seas (ICES Subareas 6 and 7)

Type of assessment in 2016

In 2016, ICES ACOM assumes that no assessment has to be done this year for category 3–6 stocks.

The Celtic Sea and West of Scotland (Subareas 6 and 7) pollack stock is considered as data-limited stock, classified by ICES WKLIFE II (ICES CM2012/ACOM:79) as category 4.1.2 stock. DCAC (Depletion-Corrected Average Catch) method is recommended to assess this stock.

ICES advice applicable to 2017

The ICES advice based on precautionary approach, renew last ICES advice: “Catches should be no more than 1% more than recent catch (last three years), and should not exceed 4200 tons in 2017.”

9.2.1 General

Stock Identity

This section is not dedicated to a ‘stock’, it relates to a species in a wider region where data are available. The stock structure of pollack populations in this ecoregion is not clear. ICES does not necessarily advocate that 6 and 7 constitutes a management unit for pollack, and further work is required.

Nevertheless, WGNEW 2014 (ICES, 2014) bases on a study on genetic differences between Pollack populations in the North East Atlantic conducted by Charrier *et al.* (2006) to consider than pollack population in the Western Channel extending into the Eastern Channel, the Celtic Sea, the Irish Sea, and the northern part of the French west coast (Areas 7.e–j and 8.a,b - landings from the intermediate Areas 6a and 4c are generally small) could constitute a single stock.

Management applicable to 2017

The TAC for pollack is set for ICES Subareas 6 (and 5.a,b; international waters of 12 and 14) and 7 separately, and for 2016 as follows:

Species:	Pollack *Pollachius pollachius*	**Zone:**	VI; Union and international waters of Vb; international waters of XII and XIV (POL/56-14)
Spain	6		
France	190		
Ireland	56		
United Kingdom	145		
Union	397		
TAC	397		Precautionary TAC

Species:	Pollack *Pollachius pollachius*	**Zone:**	VII (POL/07.)
Belgium	420 (1)		
Spain	25 (1)		
France	9 667 (1)		
Ireland	1 030 (1)		
United Kingdom	2 353 (1)		
Union	13 495 (1)		
TAC	13 495		Precautionary TAC Article 11 of this Regulation applies

(1) Special condition: of which up to 2 % may be fished in: VIIIa, VIIIb, VIIId and VIIIe (POL/*8ABDE).

Annex III to Council Regulation (EC) No 43/2009 (2), as amended by Regulation (EC) No 1288/2009 (3), and Regulation (EU) No 579/2011 of the European Parliament and of the Council (4), establishes within ICES Division 6.a zone in which fishing activities are prohibited. These regulations essentially make directed fisheries for pollack in the West of Scotland illegal.

Biology

0-group pollack are found in shallow coastal waters and may therefore be protected from fisheries in the early life stages. Pollack is benthopelagic, found mostly close to the shore over hard bottom (Quero and Vayne, 1997; Svetovidov, 1986). It usually occurs at 40–100 m depth but is found down to 200 m. A maximum size of 130 cm, a maximum weight of 18.1 kg and a maximum age of 15 years are reported (Cohen *et al.*, 1990). Growth is thus fairly rapid, approaching 10 cm per year, and probably more according to recent studies (Figure 9.2.1). There is a migration from the coast to deeper waters as it grows. Recent studies on length-at-maturity for pollack suggest that 50% of the individuals are mature at a length between 35–42 cm (Cardinale *et al.*, 2012; Heino *et al.*, 2012). More recent studies of maturity stages on Pollack in Iberian waters (Alonso-Fernández *et al.*, 2013) show that length at maturity is significantly different between females (47.5 cm) and males (36.1 cm). Studies under process in France in 2015 show that size-at-maturity could be higher for Celtic Sea Pollack (close to 60 cm for females) (Figure 9.2.2). Spawning occurs mainly in the first half of the year, at about 100 m depth, but a lack of knowledge still remains.

The fisheries

Since ten years official landings in both Subareas 6 and 7 are very stable approximately around 4000 tons, but showed a significate increase from 2012 to 2014 (Tables 9.2.1–9.2.2 and Figure 9.2.3), but catches slightly decreased in 2015 (3741 tons, minus 28%).

As previous years, in 2015 99% of the landings originated from the Subarea 7, especially in ICES Division 7.e (Figure 9.2.4). UK, France and Ireland together comprised 99% of the official landings (Figure 9.2.5). Catches from Ireland (especially from Subdivisions 7.g and 7.j) are quite stable, but French and UK catches show severe decreases. This decrease is mainly due to 7.e catches (60% decrease from 2014 to 2015, from 3084 tons in 2014 to 1224 tons in 2015.

Most pollack in the Celtic Sea ecoregions is caught by trawls (especially as bycatches), gillnets and trolling lines, and other gears come to complement the landings, such as seinenets or beam trawls (Figure 9.2.6).

Pollack is also an important species for recreational fishing, especially by angling and spearfishing, both from shore and from boats, but data remain poor. A recent study conducted in France in 2011–2013 by Levrel *et al.* (2013) estimated to 3300 tons the yearly recreational fishery catches of pollack, among which 2274 tons would be kept, but no other information on recreational pollack catches in this stock area is known. WGRFS 2012 (ICES, 2012b) listed pollack in the Northeast Atlantic as a species for which recreational fishery sampling should be included in the new DC-MAP because of the potential impact of recreational fisheries on its population dynamics and because it is of strong socio-economic importance.

Surveys

Pollack may be caught by Irish bottom trawl surveys such (IGFS-WIBTS). Only some individuals could be caught by French or UK survey. The abundance indexes estimated by IGFS-WIBTS are erratic, and the too low number of individuals caught by EVHOE-WIBTS-Q4 is not sufficient to estimate any trend of abundance indexes.

9.2.2 Data

Landings

The nominal landings are given in Tables 9.2.1 and 9.2.2 for ICES Subarea 6 and 7 respectively.

The French fishing locations for Pollack (Figure 9.2.7) shows a predominance of ICES Division 7.e and inshore areas. Length frequencies of catches (French observers, all gears) are given in Figure 9.2.8.

In 2015, the total landings show a significant decrease (3741 tons) comparatively to the previous years (5255 tons in 2014, -28%). Catches are below the landings recommended by previous ICES advices (catch should not be more than 4200 tons). But nevertheless, respectively quotas allocated to the main fishing countries were not achieved, except for Ireland.

9.2.3 MSY explorations

As long as the stock units are not well defined, it will not be possible to estimate MSY reference points. This stock has been categorized by WKLIFE (ICES, 2012) as category 4 data-limited and in this situation it was suggested to run a DCAC (Depleted-Corrected Adjusted Catch) method to estimate a yield likely to be sustainable (MacCall, 2009). The DCAC-method was applied during WGCSE 2016 with the same model settings as applied the previous year (ICES, 2014).

The inputs to the DCAC method are further detailed:

Sum of catch: The period over which the catches is summed is 1986–2015, i.e. 30 years, as 1986 is the year where Ireland recomposed a time-series of landings after 13 years of missing declaration. In subarea VI, the landings by Spain were removed as they appear only over the period 1981–1988. In Subarea 7, the French landings in 1999 are missing and are replaced by the mean of the previous and following year. The value used is 158 214 tons for Subarea 7 and 6601 tons for Subarea 6.

Natural mortality: set to 0.2 arbitrarily. The standard deviation and distribution are set at 0.4 and lognormal, after a series of trial settings.

F_{MSY} to M: MacCall (2009) proposes a value of 0.6 for vulnerable stocks. Values of 0.6, 0.8 and 1.0 are used in order to test the sensitivity of the outputs.

B_{MSY} to B_0: 0.5 will be used in line with a value proposed by MacCall (2009).

Depletion delta: is the fractional reduction in biomass from the beginning to the end of the time-series, relative to unfished biomass. A value of 0.5 is commonly used, whereas a value of 0 means that the biomass is unchanged and a value of 1 means that the stock is totally depleted. For Subarea 6, values of 0.8 and 0.9, for Subarea 7, values of 0.5, 0.6 and 0.7 will be used.

Given the fact that three F_{MSY}/M-values and two Depletion Deltas are tested for Subarea 6, a total of six DCAC-runs was carried out for this subarea. In the case of Subarea 7, nine DCAC-runs were completed (three F_{MSY}/M-values * three Depletion Deltas). Tables 4.5.3 and 4.5.4 give an overview of all the input parameters of the 15 runs.

The results are as below:

SUBAREA 6		F_{MSY} TO M		
		0.6	0.8	1.0
Depl. Δ	0.8	145	158	167
	0.9	140	153	168
Average		155		

SUBAREA 7		F_{MSY} TO M		
		0.6	0.8	1.0
Depl. Δ	0.5	3995	4243	4409
	0.6	3815	4087	4272
	0.7	3652	3943	4145
Average		4062		

The DCAC (Depletion-Corrected Average Catch) outputs (table above and Figure 9.2.10) suggest that yield in Subarea 6 could be increased up to 155 tons (comparable result as in the previous years' computations, when DCAC was 156 tons). The possibility to increase the catch is supported by evidence of very low effort on targeting this species due to restrictive regulations for inshore fisheries in the area. In 2012, the fisheries advice for this subarea was calculated as a 10% increase of the average landings of the three preceding years (2010–2012), as the three year average landings were only around 1/3 of the DCAC. The 2013 re-examination gave almost identical results, so the advice was not changed. The three year average landings (2013–2015) remains at a very stable and low level (less than 50 tons), and is still only around 2/3 of the new DCAC-value (see Table 9.2.5). The perception of the stock does not change, and WGCSE confirms that the same advice as last year is still valid for Subarea 6.

In Subarea 7, the range of sustainable yield estimated by DCAC averaged 4062 tons (4020 tons in 2015) (Table 9.2.5). This is supported by the observation than landings for the last 20 years have been around that level without any signs of decline (the lower 1999 yield being the consequence of a problem in the French database). The differences between the three year average landings and the calculated mean DCAC-values were very similar in 2012 and 2013, but this difference slightly increased in 2014. In 2015, the same increasing trend continued to be observed (average landings 15.9% higher than DCAC in 2014 and 120% in 2015), but this trend appears to have reversed this year. 2015 official landings in VII are inside the DCAC confidence interval and above the ICES advice (>4200 tons). Moreover, the global results given by DCAC computations made at the whole Division 7 level do not adequately bring out the severe decrease observed in 7.e, while trends of catches in other subdivisions stay quite stable.

The DCAC is not built to provide information on SSB and level of fishing effort (nor recent trends). In the absence of such information and basing on the stability of DCAC results, WGCSE would renew the same advice as last year for Subarea 7 (no decrease in landings advised, but *"Catches should be no more than 1% more than recent catch (last three years), **and should not exceed 4200 tons**"*).

Therefore also the combined advice for Subareas 6 and 7 doesn't change in comparison with the 2015 advice.

9.2.4 Uncertainties in assessment and forecast

The main uncertainty in the assessment is that the recreational catch is not estimated and used. As last year, WGCSE highlights that if managers want to actively manage pollack fisheries in 6 and 7 then better data on recreational fisheries will be needed. From preliminary data it seems likely that catches in recreational fisheries are of a similar order of magnitude to, or larger than, commercial landings.

Another important issue is directly linked to the choice of the assessment model used for Pol-celt stock. By construction, the DCAC method only uses long time-series of official landings. It may not reflect recent stock fluctuations or changes in the fisheries, smoothed by the length of the time-series. So new computations of DCAC are always very close to the previous year's results, even if recruitment or SSB highly fluctuate. In the other hand, DCAC method could not take into account trends of fishing effort. Outputs of the model could only conduct to a same advice as the last years. Many other models are now available to assess data-limited stocks all over the world, and WGCSE considers it is relevant to explore new assessment models for Pol-celt stock, which could be done within a specific benchmark workshop for pollack.

Progress in the qualification of the status of pollack in the Celtic Seas can be made by processing all the data available through the EU fisheries monitoring programmes in place in all EU Member States since 2002 (EU, 2010). This can only be achieved if experts are formally designated as stock coordinator and stock assessor in order to take the leadership on the needed analysis.

As already pointed out by the ICES RGCS in 2011 (see Section 9.2.1 of WGCSE 2013) and in the text above, more information is also needed on details of the fisheries (more spatial detail in landings data; especially for the earlier years in the time-series, landings by gear, length compositions, discards); life-history/biological parameters and recreational fisheries (catch and effort statistics).

9.2.5 Ecosystem considerations

No information.

9.2.6 Management considerations

TAC for Subarea 7 includes ICES Division 7.d, which is not in the remit of the Celtic Sea ecoregion. TAC set for both Subarea 6 and 7 are not in line with the current estimates of catches and estimated sustainable yields, and therefore are not constraining.

9.2.7 References

Alonso-Fernández A., Villegas-Ríos D., Valdés-López M., Olveira-Domínguez B. and Saborido-Rey F. 2013. Reproductive biology of pollack (*Pollachius pollachius*) from the Galician shelf (northwest Spain). Journal of the Marine Biological Association of the United Kingdom, 2013, 93(7): 1951–1963.

Cardinale M., H. Svedäng, V. Bartolino, L. Maiorano, M. Casini and H. Linderholm, 2012. Spatial and temporal depletion of haddock and pollack during the last century in the Kattegat-Skagerrak. J. Appl. Ichthyol. 28(2): 200–208.

Cohen D.M., T. Inada, T. Iwamoto and N. Scialabba. 1990. FAO Species Catalogue. Vol. 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. FAO Fish. Synop. 125(10).x+442p. Rome: FAO.

Charrier G., Durand J.D., Quiniou L., Laroche J. 2006. An investigation of the population genetic structure of pollack (*Pollachius pollachius*) based on microsatellite markers. ICES Journal of Marine Science 63, 1705–1709.

EU. 2010. Commission Decision (EU) No 2010/93/EU of 18 December 2009 adopting a multiannual Community programme for the collection, management and use of data in the fisheries sector for the period 2011-2013. Official Journal of the European Union, L 41/8.

Heino M., Svåsand T., Nordeide J. T. and Otterå H. 2012. Seasonal dynamics of growth and mortality suggest contrasting population structure and ecology for cod, pollack, and saithe in a Norwegian fjord. ICES Journal of Marine Science, 69: 537–546.

ICES. 2011. Report of the Working Group for Celtic Seas Ecoregion (WGCSE). ICES CM 2011/ACOM:12. 1572 pp.

ICES. 2012. Report of the Working Group on Assessment of New MoU Species (WGNEW).

ICES. 2012. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 9–18 May 2012, Copenhagen, Denmark. ICES CM 2012/ACOM:12. 1725 pp.

ICES. 2012b. Report of the ICES Working Group on Recreational Fisheries Surveys 2012 (WGRFS), 7–11 May 2012, Esplores Spain ICES CM 2012/ACOM:23. 51 pp.

ICES. 2012. Report of The Workshop to Finalize the ICES Data-limited Stock (DLS) Methodologies Documentation in an Operational Form for the 2013 Advice Season and to make Recommendations on Target Categories for Data-limited Stocks (WKLIFE II), 20–22 November 2012, Copenhagen, Denmark. ICES CM 2012/ACOM:79. 46 pp.

ICES. 2014. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 13–22 May 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:12. 2034 pp.

ICES. 2014. Report of the Working Group on Assessment of New MoU Species WGNEW, 24–28 March 2014, Copenhagen, ICES CM 2014/ACOM:21. 162 pp.

Levrel H., Bellanger M., Le Goff R. and Drogou M. 2013. La pêche récréative en mer en France métropolitaine (Atlantique, Manche, Mer du Nord, Méditerranée). Résultats de l'enquête 2011–2013. http://archimer.ifremer.fr/doc/00162/27300/.

MacCall, A. D. 2009. Depletion-corrected average catch: a simple formula for estimating sustainable yields in data-poor situations. ICES Journal of Marine Science, 66: 2267–2271.

Quéro J.C. and J.J. Vayne. 1997. Les poissons de mer des pêches françaises. Editions Delachaux et Niestlé. 304 pp.

Svetovidov A. N. 1986. Gadidae. *In* Fishes of the North-eastern Atlantic and the Mediterranean (Whitehead P.J.P., Bauchot M.-L., Hureau J.-C., Nielsen J. and Tortonese E., eds), pp. 680–710. Paris: UNESCO.

Table 9.2.1. Landings of Pollack in Subarea 6 as officially reported to ICES.

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Belgium	1	-	-	-	-	-	-	-	-	1
Denmark	-	-	-	-	-	-	-	-	-	-
France	-	-	-	-	-	-	-	-	-	-
Germany	-	-	-	-	-	-	-	-	23	6
Ireland	-	-	-	-	-	-	-	-	-	-
Netherlands	-	-	1	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-
Portugal	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-
Sweden	-	-	-	-	-	-	-	-	-	-
UK	295	484	503	422	452	566	528	547	710	607
Subarea VI	296	484	504	422	452	566	528	547	733	614

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Belgium	15	1	2	6	1	1	2	1	5	1
Denmark	-	-	-	-	-	-	-	-	-	-
France	-	-	-	-	-	-	-	-	-	-
Germany	-	1	8	2	1	1	-	1	2	4
Ireland	-	125	197	204	130	402	200	263	214	282
Netherlands	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	148	-
Portugal	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-
Sweden	-	-	-	-	-	-	-	1106	1012	1224
UK	441	259	235	320	368	496	428	413	500	667
Subarea VI	456	386	442	532	500	900	630	1784	1881	2178

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Belgium	2	1	1	2	6	<0.5	7	-	-	-
Denmark	-	-	-	-	-	-	-	-	-	-
France	-	-	-	-	-	-	-	196	196	310
Germany	1	5	1	-	-	1	-	-	-	-
Ireland	398	75	127	-	-	-	-	-	-	-
Netherlands	-	-	-	-	3	1	1	1	-	-
Norway	-	-	-	-	-	4	-	2	4	-
Portugal	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-
Sweden	756	750	779	-	-	-	-	-	-	-
UK	447	256	317	503	359	393	519	493	553	350
Subarea VI	1604	1087	1225	505	368	399	527	692	753	660

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Belgium	-	-	-	-	-	<0.5	-	-	-	-
Denmark	-	-	<0.5	-	-	-	-	<0.5	<0.5	<0.5
France	36	342	272	331	212	224	145	108	128	111
Germany	-	-	-	-	-	1	-	-	-	1
Ireland	-	-	-	-	-	-	223	103	163	103
Netherlands	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-
Portugal	-	-	-	-	-	-	-	-	-	-
Spain	-	55	95	86	222	283	2217	860	1925	-
Sweden	-	-	-	-	-	-	-	-	-	-
UK	233	185	103	148	194	328	187	259	221	179
Subarea VI	269	582	470	565	628	836	2772	1330	2437	394

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium	-	-	-	-	-	-	-	-	-	-
Denmark	-	-	<0.5	-	-	-	<0.5	-	-	-
France	76	31	21	39	34	64	29	14	21	-
Germany	-	-	-	-	-	3	-	1	-	-
Ireland	150	145	23	12	26	83	97	69	60	73
Netherlands	-	-	-	-	-	-	-	-	-	-
Norway	1	-	-	-	-	-	1	2	-	3
Portugal	-	-	-	-	-	-	-	-	<0.5	-
Spain	-	4	-	-	-	-	-	-	-	-
Sweden	-	-	-	-	-	-	-	-	-	-
UK	192	189	203	273	276	354	210	162	147	136
Subarea VI	419	369	247	324	336	504	337	248	228	212

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Belgium	-	-	-	<0.5	<0.5	-	-	-	-	-
Denmark	-	-	-	-	-	-	-	-	-	-
France	11	8	9	3	2	23	3	10	8	6
Germany	2	-	-	-	-	-	-	-	-	-
Ireland	62	108	26	88	68	28	25	21	21	5
Netherlands	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	1	1	-	-	6	1	-
Portugal	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	4	-	-	-
Sweden	-	-	-	-	-	-	-	-	-	-
UK	116	101	96	111	65	16	5	21	23	25
Subarea VI	191	217	131	203	136	67	37	58	53	36

	2010	2011	2012	2013	2014	2015
Belgium	-	2	-	-	-	-
Denmark	-	-	-	-	-	-
France	4	3	2	1	1	-
Germany	-	-	-	-	-	-
Ireland	34	8	10	34	25	23
Netherlands	-	-	-	-	-	-
Norway	<0.5	-	-	-	-	-
Portugal	-	-	-	-	-	-
Spain	-	-	-	-	-	-
Sweden	-	-	-	-	-	-
UK	39	34	33	22	18	25
Subarea VI	78	47	45	57	44	48

Table 9.2.2. Landings of Pollack in Subarea 7 as officially reported to ICES.

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Belgium	93	74	80	34	17	38	67	219	342	158
Denmark	-	-	-	-	-	-	-	-	-	-
France	-	-	-	-	-	-	-	-	-	-
Germany	-	2	10	-	4	-	1	6	17	32
Ireland	-	-	-	-	-	-	-	-	-	-
Netherlands	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-
UK	375	380	336	252	365	247	155	367	233	251
Subarea VII	468	456	426	286	386	285	223	592	592	441

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Belgium	317	268	367	95	299	362	456	417	214	142
Denmark	-	-	-	-	-	-	-	-	-	-
France	-	-	-	-	-	-	-	-	-	-
Germany	-	-	1	-	-	-	-	-	-	-
Ireland	-	360	369	411	342	335	438	474	508	794
Netherlands	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-
UK	267	210	170	176	194	231	175	202	167	161
Subarea VII	584	838	907	682	835	928	1069	1093	889	1097

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Belgium	165	114	142	89	299	295	339	157	186	151
Denmark	-	-	-	-	-	-	-	1	21	18
France	-	-	-	-	-	-	-	3569	5496	5119
Germany	1	-	-	-	-	-	-	-	14	76
Ireland	724	673	1073	-	-	-	-	-	-	-
Netherlands	-	-	-	3	13	17	4	1	8	1
Norway	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-
UK	120	116	123	127	223	290	421	465	515	696
Subarea VII	1010	903	1338	219	535	602	764	4193	6240	6061

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Belgium	237	244	154	167	207	269	241	149	191	145
Denmark	7	-	-	-	-	-	-	-	-	-
France	5242	5814	4253	6214	3927	3741	4574	5213	5211	3893
Germany	-	-	-	-	-	-	-	-	-	-
Ireland	-	-	-	-	-	-	1335	848	1066	994
Netherlands	1	3	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-
Spain	1	23	32	26	486	20	17	19	22	18
UK	769	780	1022	1045	1100	1022	1795	2010	1740	1487
Subarea VII	6257	6864	5461	7452	5720	5052	7962	8239	8230	6537

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium	133	76	62	55	94	88	94	99	92	86
Denmark	-	-	-	-	-	2	-	-	-	-
France	4831	3211	2849	2325	2621	2315	2684	2443	2375	-
Germany	-	-	-	-	-	-	-	-	-	-
Ireland	1066	1045	1014	1137	921	1107	1190	984	886	976
Netherlands	-	-	-	-	-	-	6	4	1	-
Norway	-	-	-	-	-	-	-	<0.5	-	3
Spain	26	22	19	7	8	4	5	7	11	19
UK	1914	1962	1889	2135	2391	2168	2519	2540	2347	1703
Subarea VII	7970	6316	5833	5659	6035	5684	6498	6077	5712	2787

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Belgium	71	100	117	113	104	98	79	91	76	42
Denmark	-	-	-	-	-	-	-	-	-	-
France	2422	2515	2481	2284	1914	2198	2213	1970	1579	1641
Germany	-	-	-	-	-	-	-	-	-	-
Ireland	1069	1274	1308	1151	1049	728	809	782	738	828
Netherlands	-	-	-	-	1	1	1	3	1	4
Norway	-	-	-	-	-	-	-	-	-	-
Spain	5	9	17	12	13	16	28	1	14	3
UK	1810	1987	1999	1788	1705	1684	1531	1764	1453	1545
Subarea VII	5377	5885	5922	5348	4786	4725	4661	4611	3861	4063

	2010	2011	2012	2013	2014	2015
Belgium	35	37	43	39	84	32
Denmark	-	-	-	-	-	-
France	1846	1784	1421	1790	2042	1142
Germany	-	-	-	-	-	-
Ireland	942	967	1165	1249	1096	1060
Netherlands	2	2	1	1	1	-
Norway	-	-	-	-	-	-
Spain	3	4	3	11	14	21
UK	1381	1825	1836	1838	2122	1485
Subarea VII	4209	4619	4469	4928	5359	3740

Table 9.2.3. Input parameters for the six DCAC runs carried out for pollack in Subarea 6.

	POL–CELT 2016 – 6 – RUN 1	POL–CELT 2016 – 6 – RUN 2	POL–CELT 2016 – 6 – RUN 3	POL–CELT 2016 – 6 – RUN 4	POL–CELT 2016 – 6 – RUN 5	POL–CELT 2016 – 6 – RUN 6
sumC	6601	6601	6601	6601	6601	6601
CV sumC	0	0	0	0	0	0
n° of yrs	30	30	30	30	30	30
iterations	10.000	10.000	10.000	10.000	10.000	10.000
M	0,2	0,2	0,2	0,2	0,2	0,2
stdev M	0,4	0,4	0,4	0,4	0,4	0,4
F_{MSY}/M	0,6	0,8	1	0,6	0,8	1
stdev F_{MSY} to M	0,2	0,2	0,2	0,2	0,2	0,2
distr F_{MSY} to M	normal	normal	normal	normal	normal	normal
B_{MSY}/B_0	0,5	0,5	0,5	0,5	0,5	0,5
stdev B_{MSY}/B_0	0,1	0,1	0,1	0,1	0,1	0,1
up lim B_{MSY}/B_0	1	1	1	1	1	1
low lim B_{MSY}/B_0	0	0	0	0	0	0
depletion delta Δ	0,8	0,8	0,8	0,9	0,9	0,9
stdev Δ	0,1	0,1	0,1	0,1	0,1	0,1
distr Δ	normal	normal	normal	normal	normal	normal

Table 9.2.4. Input parameters for the 9 DCAC runs carried out for pollack in Subarea 7.

	POL-CELT 2016 – 7 – RUN 1	POL-CELT 2016 – 7 – RUN 2	POL-CELT 2016 – 7 – RUN 3	POL-CELT 2016 – 7 – RUN 4	POL-CELT 2016 – 7 – RUN 5	POL-CELT 2016 – 7 – RUN 6	POL-CELT 2016 – 7 – RUN 7	POL-CELT 2016 – 7 – RUN 8	POL-CELT 2016 – 7 – RUN 9
sumC	158 214	158 214	158 214	158 214	158 214	158 214	158 214	158 214	158 214
CV sumC	0	0	0	0	0	0	0	0	0
n° of yrs	30	30	30	30	30	30	30	30	30
iterations	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
M	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2
stdev M	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4
F_{MSY}/M	0,6	0,8	1	0,6	0,8	1	0,6	0,8	1
stdev F_{MSY} to M	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2
distr F_{MSY} to M	normal								
B_{MSY}/B_0	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
stdev B_{MSY}/B_0	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
up lim BMSY/B0	1	1	1	1	1	1	1	1	1
low lim B_{MSY}/B_0	0	0	0	0	0	0	0	0	0
depletion delta Δ	0,5	0,5	0,5	0,6	0,6	0,6	0,7	0,7	0,7
stdev Δ	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
distr Δ	normal								

Table 9.2.5. Comparison of the 2015 and 2014 DCAC results.

DCAC	6	% CHANGE	7	% CHANGE
2016	155	-0.64	4062	+1.04
2015	156	-1.3	4020	+0.9
2014	158	-2.5	3986	1.5
2013	162	0	3928	-2
Average landings	6	% diff. to DCAC	7	% diff. to DCAC
2013-2015	49	31.61%	4587	112.9%

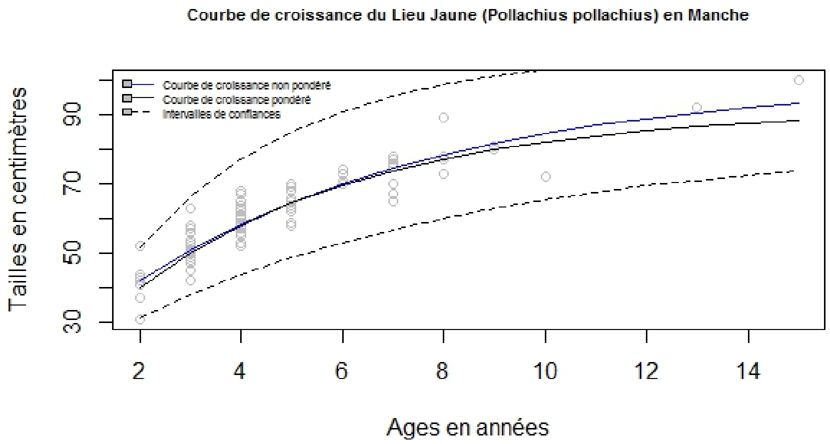


Figure 9.2.1. Pollack growth in the English Channel (Source: Ifremer, 2015).

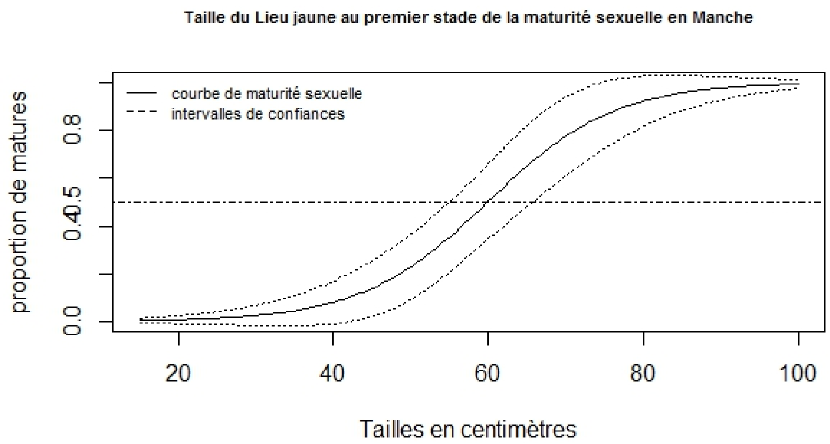


Figure 9.2.2. Pollack maturity curves in the English Channel (Source: Ifremer, 2015).

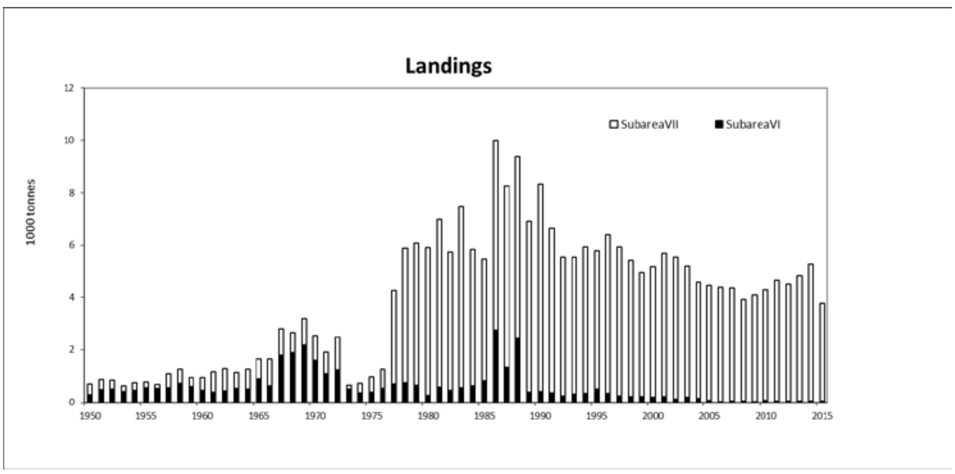


Figure 9.2.3 – Pollack landings in the Celtic Seas.

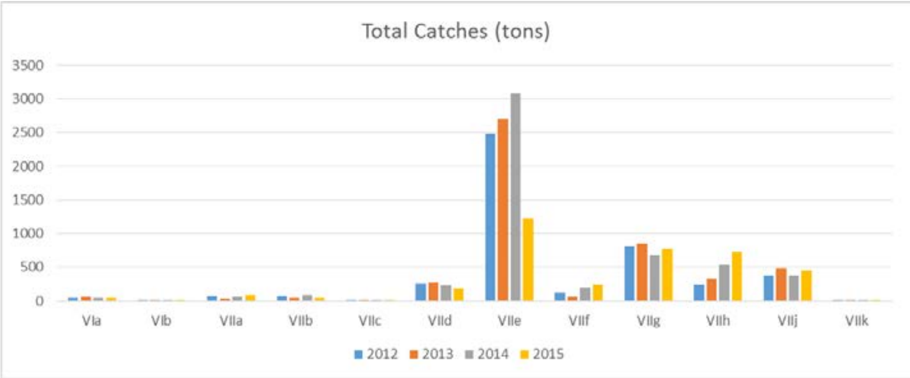


Figure 9.2.4.Pollack landings by ICES division in 2015 in the Celtic Seas.

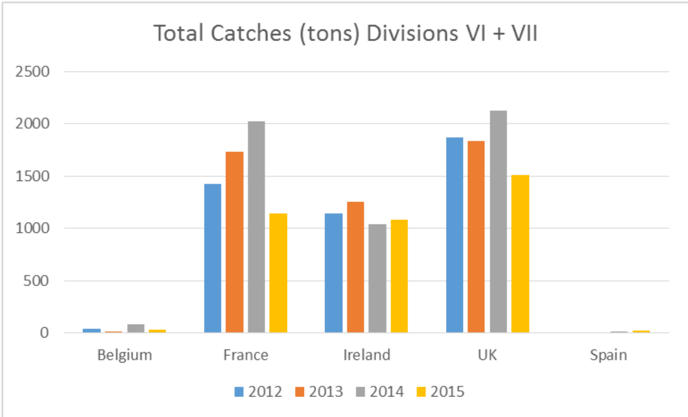


Figure 9.2.5. Contributions of different countries in pollack landings in the Celtic Seas.

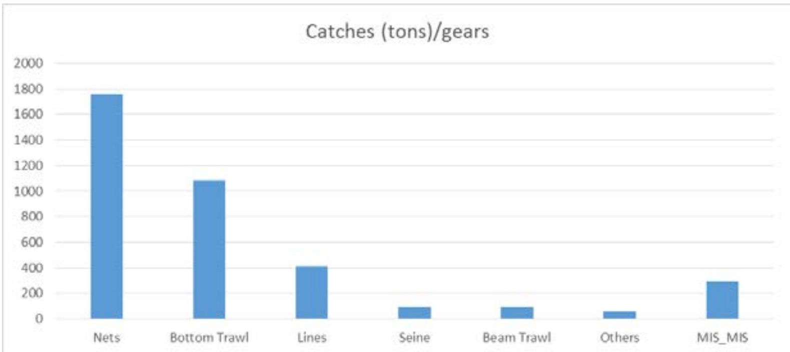


Figure 9.2.6. Pollack in the Celtic Seas. Catches per gear in 2015 (all countries).

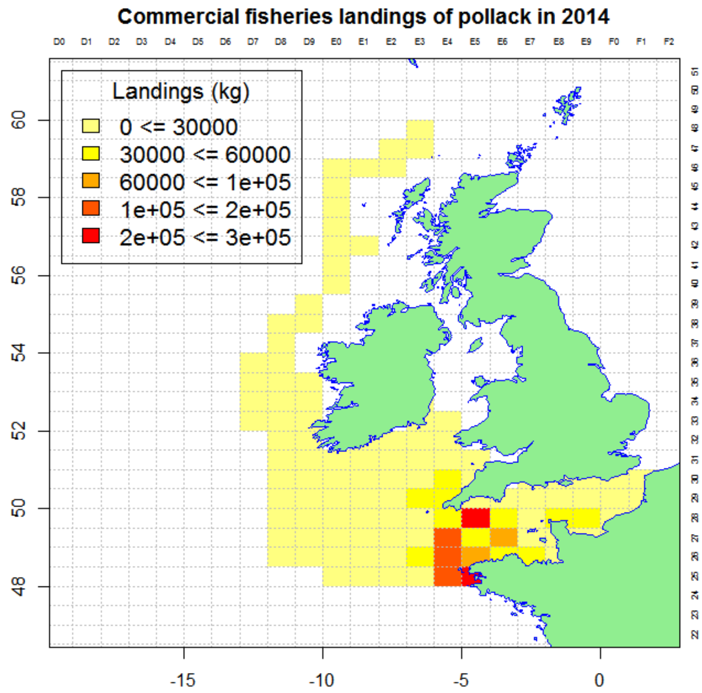


Figure 9.2.7. Pollack in the Celtic Seas. Distribution of catches in the French landings 2014.

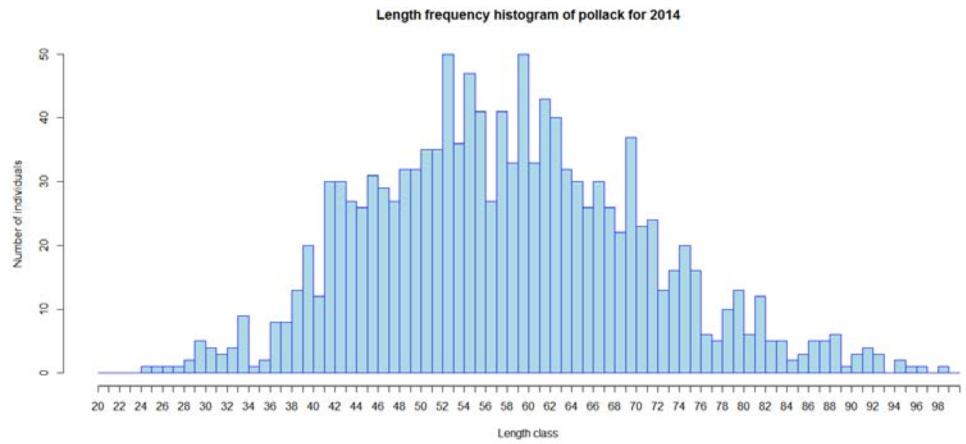


Figure 9.2.8. Length frequency of pollack in French catches (observations at sea in 2014).

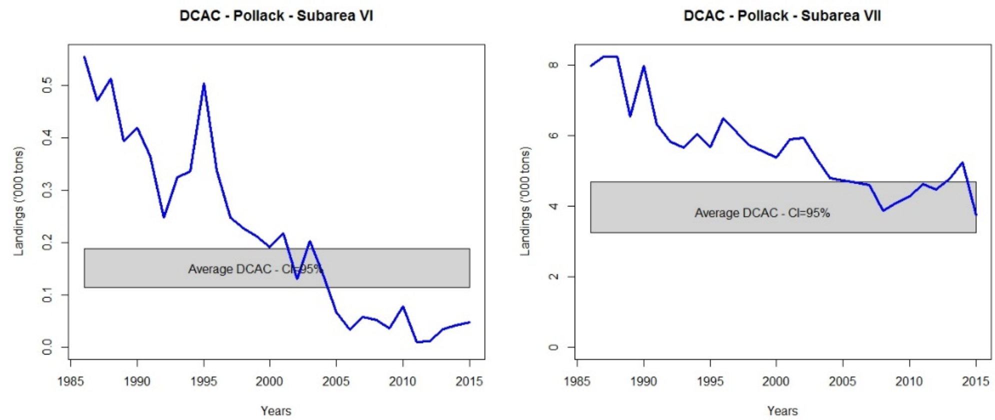


Figure 9.2.10. Pollack in the Celtic Seas. Results of DCAC for Subarea 6 (left panel) and Subarea 7 (right panel).

9.3 Grey gurnard in the Celtic Seas (ICES Subareas 6 and 7.ac and 7.e–k)

This section is not currently available.

10.1 Sea bass in 4.bc and 7.a,d–h (North Sea, Channel, Celtic Sea and Irish Sea)

Type of assessment

This is an update assessment using the Stock Synthesis model (SS3; Methot 2000, 2011) implementation developed at IBPBass (ICES, 2014).The stock is treated as Category 1 with full analytical assessment. .Last year's assessment is available in the WGCSE 2014 report.

(File names, WGCSE SharePoint paths and location in the files of key assessment model outputs are given in the readme file in the Sea bass 47 Report folder on WGCSE 2015 SharePoint).

ICES advice applicable to 2016

The ICES advice for management of sea bass fisheries in 2016 is available in the ICES Advice released in 2015, and states that "ICES advises that when the MSY approach is applied, total landings (commercial and recreational) in 2016 should be no more than 541 tonnes. ICES cannot quantify the corresponding catches. ICES advises that a management plan is urgently needed to develop and implement measures to substantially reduce fishing mortality throughout the range of the stock".

Technical consideration

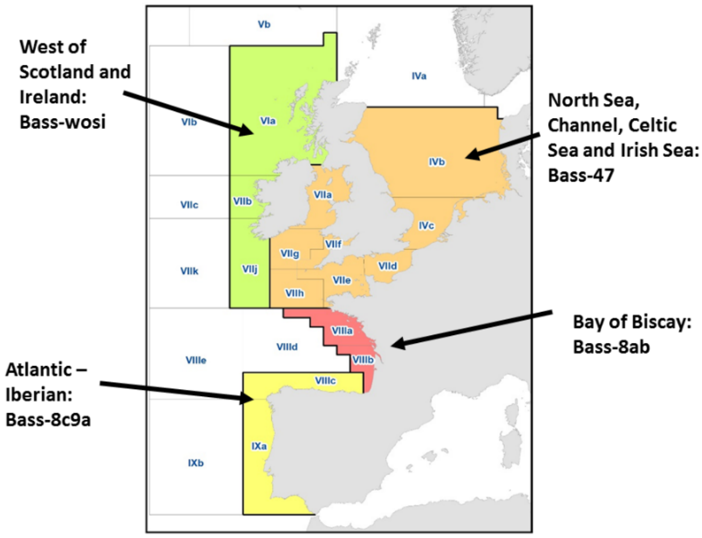
Data inputs and methods for this year's update assessment methods are consistent with the stock annex.

The 2014 Review Group for WGCSE highlighted some aspects of the sea bass assessment that the WG should explore and evaluate. These included: the assumption of constant recreational fishing mortality over time; discrepancies among the pre-recruit survey indices; definition of current stock units; and possible development of a sex-disaggregated assessment. The RG recommended that the model configurations and settings should be further explored and simulation studies could be conducted to test the impacts of key assumptions made in the assessment. WGCSE appreciates the comments and intends to further develop and test the assessment through future benchmark assessments. Uncertainties and bias in the update assessment and forecast are addressed in Section 10.1.7.

10.1.1 General

Stock description and management units

ICES currently assesses NE Atlantic sea bass in four stock and management units. The rationale behind these is given in the stock annex. The Bay of Biscay and Atlantic Iberian stocks are assessed by the ICES Working Group for the Bay of Biscay and the Iberic Waters Ecoregion (ICES, WGBIE). Tagging studies are currently underway in France and the UK to help evaluate connectivity within and between the four bass populations.



Management applicable to 2015

Previous advice from ICES, showing a rapid decline in sea bass biomass in the North Sea, Channel, Celtic Sea and Irish Sea caused by poor recruitment with continued high levels of fishing; European Sea bass are not subject to EU TACs and quotas in 4.bc and 7.a,d–h (North Sea, Channel, Celtic Sea and Irish Sea). In 2015, the European Council has adopted measures to help sea bass recover. Effective emergency measures in January 2015 placed (i) a ban on targeting the fish stock by pair-trawling during the spawning season up until the end of April 2015.; (ii) a bag limit of three sea bass per day for recreational fishing has been imposed (EU Regulation 2015/523 of 25 March 2015); (iii) a monthly catch limit (1.5 t for pelagic trawlers; 1.8 t for bottom trawlers; 1 t for driftnets; 1.3 t for liners; 3 t for purse seiners) and (iv) an increase in the minimum size of northern sea bass from 36 cm to 42 cm from July 2015. Moreover, a continued area closure around Ireland for commercial fishing is set up (as in previous years). (source: http://ec.europa.eu/fisheries/cfp/fishing_rules/sea-bass/index_en.htm).

Management applicable to 2016

The European Commission is working with Member States to identify more effective control measures to reduce fishing mortality towards F_{MSY}. Measures introduced in 2015 and completed in 2016 (given in the table below), include reduction or prohibition of landings depending on gears and months. These developments affect the short-term forecast assumptions for this stock and will have implications for how the stock assessment is conducted in future years.

2016 measures	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Bottom trawlers	X (1% by catch)	X (1% by catch)	X (1% by catch)	X (1% by catch)	X (1% by catch)	X (1% by catch)	1 t	1 t	1 t	1 t	1 t	1 t
Seiners	X (1% by catch)	X (1% by catch)	X (1% by catch)	X (1% by catch)	X (1% by catch)	X (1% by catch)	1 t	1 t	1 t	1 t	1 t	1 t
Pelagic trawlers	X	X	X	X	X	X	1 t	1 t	1 t	1 t	1 t	1 t
Drift Gillnets	X	X	X	X	X	X	1 t	1 t	1 t	1 t	1 t	1 t
Hooks	1.3t	X	X	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t
Lines	1.3t	X	X	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t
Set Gillnets	1.3t	X	X	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t	1.3t

Fishery in 2015

The time-series of official landings figures and the landings used by the WG are given in Table 10.1.1.2. Differences occur where national scientists have had to rework official figures, for example to attribute landings more accurately to the stock area.

A period of rapid growth in the fishery in the 1990s and early 2000s coincided with an expansion of the stock biomass and spatial distribution. As a non-TAC species, bass has provided additional fishing opportunities for vessels with restricted quotas for other species. The growth in fishery landings halted rapidly around 2005 and reported landings fluctuated around 4000 t up to 2013 (Figure 10.1.1.1a; Table 10.1.1.1). A decrease is observed since (mainly due to bad weather condition in 2014 and restrictive management in 2015); 2066 tonnes were landed in 2015. Landings by Belgium and the Netherlands have only appeared in catch statistics since the 2000s as fisheries in the North Sea became established following the spatial expansion of the stock.

The bulk of the international landings was historically taken by French bottom trawlers and midwater (pelagic) pairtrawlers (Figure 10.1.1.1b). The midwater pairtrawl fleet targeted adult bass on or near spawning grounds in the Channel and Celtic Sea in late winter and spring. Since the mid-2000s, this fleet had shifted more of its activities from the Bay of Biscay to the Channel causing an increased fishing effort on adult bass in this area. In 2013, the fleet of around 40 French pair-trawlers and a small number of UK midwater trawlers accounted for 37% of the total international landings, but landings of this métier reduced from 1630 t in 2013 to only 243 t in 2014 due mainly to very bad weather conditions. The French pairtrawlers switched from sea bass to fishing for hake. In 2015 because of the restrictive measures taken by the European Commission and the ban of pelagic trawlers, trends in landings have changed significantly with an expected decrease observed. Almost 58% of the French landings in 2015 were also made by bottom trawlers, corresponding to a mix between sea bass targeted or caught as a bycatch.

Sea bass are targeted by relatively few UK inshore bottom trawlers, and are mainly a bycatch in that fleet. Total bottom-trawl landings of UK and French otter trawlers have been declining since the mid to late 2000s (Figure 10.1.1.1b,c). UK beam trawlers targeting flatfish and other benthic species in Area 7 also experienced a progressive decline in their normally small bycatches of sea bass over this period.

Some French vessels using Danish seines appeared in the offshore fisheries since 2009. Their catches are low but increased from 27 t in 2009 to 112 t in 2012, falling to 26 t in

2015. Seining has also become more prevalent in the UK fleet in recent years although it is a small contributor to total landings.

Around 28% of reported French landings and the bulk of the UK(E&W) reported landings in 2015 were made by a large fleet of artisanal liners, handliners and netters catching sea bass on inshore feeding grounds after the spawning season.

Despite the apparent decline in sea bass biomass indicated by the ICES assessment of the stock, reported landings of UK inshore <10 m vessels deploying fixed or drifting gillnets have been progressively increasing since the 2000s and reached their highest value in 2014 (Figure 10.1.1.1c), but returned to a "classical" level in 2015. Netting for bass, or taking bass as bycatch, takes place all around the coast of England and Wales, both in inshore waters and in some areas such as the eastern Channel where netting extends into deeper water to intercept migrating adult bass in autumn and early winter. It is not known to what extent the reduction in pelagic pairtrawl fishing in 2014 may have improved availability of bass to inshore fleets in subsequent months. An effect of this nature was not apparent in the French artisanal fleets.

In 2015, a total of 2066 tonnes were also landed.

10.1.2 Data

Commercial landings data

Landings series for use in the assessment are given in Table 10.1.2.1 for the six fleets for which selectivity is modelled: fleet 1- UK bottom trawls and nets; fleet 2- UK lines; fleet 3- UK midwater pairtrawls; fleet 4- French combined fleets; fleet 5- other countries plus UK gears not included in fleet 1, with selectivity based on fleet 4; and fleets 6- recreational fisheries (2012 is the reference year with selectivity based on fleet 2, UK lines. The time-series of recreation fisheries is calculated iteratively so that fishing mortality is constant and equal to fishing mortality in 2012). The landings figures are from census data (EU logbooks and/or sales slips) from several sources:

1) Official statistics recorded in the ICES official landings database since around the mid-1970s (data from 1985 are used in the assessment) plus preliminary data for 2015;
2) French landings for 2000–2015 from a separate analysis by Ifremer of logbook, auction data and VMS data (SACROIS database, now treated as official statistics from 2010);
3) Landings for Belgian vessels supplied directly by the national fisheries laboratory;
4) Landings for Netherlands recorded in ICES database "InterCatch;"
5) UK landings by gear type recorded in official UK landings databases.

Details of the methodology used to calculate French and UK historical landings can be found in the stock annex.

Length compositions: commercial landings

Fishery selectivity is modelled using age composition data for fleets 1 and 2, and length composition for fleet 3. The selectivity pattern of fleet 4, for which insufficient composition data were available, was assumed to be the same as for fleet 3.

Length and age compositions of sea bass landings, in a form suitable for inclusion in assessments, were available from sampling in the UK and France. Sampling design is described in the stock annex.

Sampling rates

UK(E&W) sampling rates for age compositions, by gear group, are given in Table 10.1.2.2. Although ALKs are derived by the UK for separate sea areas, the same ALK is applied to all gear groups in an area meaning that the age composition estimates for the different gears are not independent. This was a principal motivating factor for IBPBass (ICES, 2014) to combine UK trawls, nets and lines into a single fleet for estimation of selectivity in Stock Synthesis.

The UK midwater trawl fleet landings were not sampled in 1997, 2013, 2014 and 2015 due to the small number of trips targeting bass. The UK at-sea sampling programme selects vessels at random from stratified vessel lists, which includes midwater pairtrawlers in the same over 10 m vessel stratum as demersal otter trawlers, nets and lines. Similarly, port sampling is stratified by groups of ports, not métiers. The number of vessels and trips by midwater pairtrawlers is very low and therefore there is a high probability of low or zero numbers of samples. In Stock Synthesis, the missing age compositions for midwater trawls are imputed based on the selectivity parameters and the input landings figure. This has negligible impact on the assessment as this UK métier represented only 1% of total sea bass landings in 2013 and landed only 1 t in 2014 and less than 1 t in 2015.

Sampling of sea bass in France has also been very variable between areas and gears (Table 10.1.2.3). There has been a general increase in numbers of trips sampled for length since 2009, except in 2014 and 2015 which was mainly due to the exit of the French midwater pairtrawlers from the fishery.

Numbers of sampled trips for UK trawls, midwater trawls, nets and lines, and French all-gears, were used as proxies for effective sample size for initial development of the Stock Synthesis model for sea bass by ICES IBPNew, IBPBass and IBPBass2.

Based on those results, the input effective sample sizes were then iteratively adjusted using the Francis weight method weighting reducing the disproportionate effect of the different dataset used. The effective sample size which reflects the goodness-of-fit to the composition data are now fixed and additional data and associated sample sizes will require adjusting using the effective sample size multiplier for age and length compositions by fleet available in the stock annex.

Length composition estimates for landings

Table 10.1.2.4 gives fleet-raised length compositions for all French gears combined, updated to include 2015. Sampling levels are given in Table 10.1.2.3. French numbers at length are available from 2000 onwards. In the assessment (WGCSE 2015) a single fleet called "French fleet" is used. This fleet is the combination of several types of sub-fleets using various fishing gears: pelagic trawlers, bottom trawlers, netters, liners, Danish seiners and purse seiners.

Age composition estimates for landings

Fleet-raised age compositions were obtained for UK fleets from 1985 onwards by application of age–length keys developed for the Areas 4.bc, 7.d, 7.e&h, and 7.a,f,g. The annual age compositions for the combined otter and nets fleet and the line fleet are given in Table 10.1.2.5, and the age compositions for the UK midwater pairtrawl fleet since 1996 are given in Table 10.1.2.6a. During WGCSE 2015, French mixed gear landings by age class were made available (Table 10.1.2.6b) and were used for some exploratory assessment runs for comparison with the baseline Stock Synthesis run using French length data.

Following to the IBPBass2 (2016) age compositions for French commercial fishery landings of sea bass are used, derived from an annual age–length key (ALK) constructed for the whole area. It is applied to the total landings length frequency for the whole area (Tables XXX).

The age compositions for the trawls, nets and lines fleet show clear year-class signals and good tracking of year classes, and the year-class patterns appear similar in the constituent ICES division groups (Figure 10.1.2.1a). The impacts of strong year classes and periods of very weak year classes are clearly seen, particularly by standardising the annual catches at age to the mean of the time-series for that age (Figure 10.1.2.1b). The French data show some progression of year classes, for example a very weak 1996 year class and some stronger year classes after that (Figure 10.1.2.1.c.), observed also in the UK data. The UK and French data both show reduced landings of young bass from recent year classes which are indicated by surveys to be weak, though this is more apparent in the time-series standardised data in Figure 10.1.2.1b and c which also shows that sea bass over 20 years of age have become rarer in UK catches in each area. A direct comparison of the UK and French age-composition data (Figure 10.1.2.1.d) shows a relatively weak association, which is probably a reflection of very variable and often low sample sizes in each country (see Tables 10.1.2.2a,b and 10.1.2.3).

Commercial discards

Data sources for discards estimates, and sampling design, are described in the stock annex. Discarding of sea bass by commercial fisheries can occur where fishing takes place in areas with bass smaller than the minimum landing size (36 cm in most European countries), and where mesh sizes <100 mm are in use. Sampling rates and estimates of discards were provided to WGCSE from sampling in UK and France (Tables 10.1.2.7, 10.1.2.8 a,b,c, and 10.1.2.9. The annual estimated quantities discarded by UK and French vessels since 2009 has been less than 5% of total landings (Table 10.1.2.10). Addition of discards estimates from non-sampled fleets could alter the overall discard rate depending on their discard quantities and rates. Most discards are fish below the MLS of 36 cm, and mostly from otter trawlers using 80–99 mm mesh in areas such inshore regions of the English Channel where juvenile bass are most common.

England provided information to WGCSE on discards sampling design and achieved sampling in 2012–2014 using the discards quality tables supplied with the 2015 WGCSE data call. It was noted that the distribution of samples was not well reflected in spatial fishing effort in 2012, however spatial and temporal distribution of sampling relative to fleet effort improved annually from 2012–2014. However, out of 528 sampled trips on vessels and in areas where sea bass could potentially be caught, only 27 trips had discards of sea bass. This reflects the small proportion of trips where bass are caught. Sampling at sea on under 10 m vessels, which take the bulk of the UK sea bass catch, was very infrequent until 2007, and line gears have seldom been sampled (but mortality of discards for this gear can probably be considered as low). There is therefore a large potential for bias in the discards estimates. It was therefore recommended by England that the discards data for sea bass should be used with caution.

Information from France indicated that precision of discards estimates was poor due to the influence of occasional large catches by otter trawlers. This is responsible for the very variable estimates from year to year (Table 10.1.2.10). In 2014 and 2015 numbers of trip and fish sampled were higher. In 2015 in France, 49 tonnes of discards have been estimated, mainly due to bottom trawlers. Discards rates are also assume to be low (4% of the total catches for France).

IBPBass (ICES, 2012) considered that the series of discards estimates and length compositions required further development before incorporating them in the assessment, but noted that the overall discard rate is likely to be low given the large contribution of nets, lines offshore midwater trawls to the total international landings. An assessment including discards would be advantageous to support evaluation of methods to improve selectivity, of trawls in particular.

Recreational catches

Recreational marine fishery surveys covering different parts of the sea bass stock in the North Sea, Channel, Celtic Sea and Irish Sea have been developed in France, Netherlands, England and Belgium (ICES, 2012c). Methods and description of national surveys are described in the stock annex and in ICES (2012c).

The available estimates are summarised in Table 10.1.2.11. WGCSE 2014 concluded from these surveys that around 1500 t of sea bass was harvested by recreational fishing (mainly sea angling) in 2012. This estimate will have some bias because it is incomplete (no surveys in Wales, for example) and there was considerable uncertainty in the figure for England due to limitations in the data available for estimating sea angling effort and for estimating private boat catches. An additional survey result for the Netherlands was available to WGCSE for the period March 2012–March 2013 indicating an increase in recreational harvest from 138 t to 229 t (van der Hammen *et al*., 2015). However there is no additional information to allow any further estimates of total international recreational harvests.

From information available, the precision of combined international estimates is likely to be moderate, with relative standard errors of at least 20%. However, the ratio of recreational removals estimates in each country is a very consistent proportion of the combined recreational and reported commercial fishery landings (France: 25%; England: 28%; Netherlands: 26%; Belgium: 29%) giving greater confidence in the estimates, although the figure for the 2012 Netherlands survey is much higher at 38%. The recreational catch estimates exclude figures for Wales or any other European countries without surveys.

The proportion of fishery removals comprising recreational harvests has additional uncertainty due to unknown rates of post-release mortality, biases in reported commercial fishery landings, and unaccounted-for commercial (dead) discards. Extensive studies have been carried out to estimate post-release mortality in recreational fisheries for a wide range of species (see stock annex) but no information is available for European sea bass. For the purposes of the assessment, post release mortality of recreational caught fish has been assumed to be zero, but studies are needed to estimate the mortality. This will become more critical due to the imposition of bag limits and likely increases in MLS which will elevate the released rate further.

A bias in the proportion of total removals due to recreational fishing is unreported commercial fishery landings. For under 10 m vessels which do not have to submit EU logbooks, Article 65(2) of the EU Control regulation 1224/2009 allows disposal of up to 30 kg of fish for personal consumption without supplying sales slips. For small-scale, low-volume fisheries catching sea bass, this missing catch could be substantial but is poorly understood. French under 10 m vessels are all required to supply logbooks but this is currently not the case in all other countries including the UK. A separate logbook scheme for sea bass was developed in England by Cefas in the 1980s and indicated that total sea bass landings by commercial under 10 m boats using nets and lines could have been three or more times larger than reported landings (see results in stock annex). The scheme was terminated in 2010 so it is not known if the bias has continued at the same level.

It is concluded that recreational fishing may have accounted for up to 30% of total fishery removals and fishing mortality in 2012, and this represents a significant missing catch from the assessment. IBPBass (ICES, 2014b) developed a method to reflect this additional mortality in the Stock Synthesis model and this is described further in the stock assessment section and the stock annex. The historical trends in recreational catches and fishing mortality are unknown, but they are likely to differ from commercial catch trends. It is possible that, before the large growth in biomass of the stock in the 1990s, recreational fishing may have been a much larger proportion of total fishery removals than today.

Biological data

This section provides biological parameters of growth, maturity and natural mortality required for stock assessment of sea bass. Further information and plots of growth and maturity data can be found in the stock annex and WGCSE 2013, and detailed methods and results are given in IBPNew 2012 (ICES, 2012a) working documents by Armstrong (2012) and Armstrong and Walmsley (2012b,c).

Growth parameters

Growth parameters, standard deviations of length-at-age distributions, and an age error vector are input to the Stock Synthesis model. These are derived from more than 90 000 sea bass sampled by Cefas since 1985 from fishery catches around England and Wales as well as from trawls surveys of young bass in the Solent and Thames estuary.

The sampled sea bass show some sexual dimorphism of growth from about seven years of age onwards. It is currently not possible to implement a sex-disaggregated Stock Synthesis assessment as it is impossible to disaggregate commercial fishery catches and survey catches by sex. Therefore a combined-sex assessment using a combined-sex growth curve is adopted. Mean length-at-age has not shown any trend over time, and length-at-age is also very similar in strong and weak year classes (Armstrong and Walmsley, 2012b). Hence data have been combined over the full series to estimate growth parameters, and the estimated body weights-at-length and age in the Stock Synthesis assessment model are treated as being constant over time.

Von Bertalanffy model parameters were estimated by area using an absolute error model minimizing ∑(obs-exp)^2) in lengths-at-age:

Area	IVbc	7.d	7.e	7.afg	All areas
Linf (cm)	82.98	87.22	92.27	81.87	84.55
K	0.1104	0.09298	0.07697	0.09246	0.09699
t0 (years)	-0.608	-0.592	-1.693	-1.066	-0.730

The "all areas" VBGF parameters are used in the Stock Synthesis model.

Standard deviations of length-at-age

As expected, the standard deviation of length-at-age increased with length, and the trend could be described by the linear model SD = 0.1166 * age + 3.5609. The regression estimates of SD by age class are input to the assessment model to generate length-at-age distributions.

Age error parameters for Stock Synthesis

Inclusion of age error parameters in the Stock Synthesis model (CVs for ageing error by age class) were derived from results of the ICES sea bass scale exchange in 2002 (Mahé *et al*., 2012). CVs of 12% at-age were specified as increasing values per age class to give a standard error of ~1 year per age class. These are used in the SS3 observation submodel to derive expected values for observed data on age distributions. Further information on ageing precision and calibration between laboratories will become available from an ICES calibration study in 2015.

Weight-at-length

Weight-at-length and age was estimated within the Stock Synthesis model according to the following relationship derived from UK sampling:

W(kg) = 0.00001296 L(cm)^2.969

Maturity-at-length

In the Stock Synthesis model, maturity is modelled as a function of length. As the critical variable for management is reproductive potential of the stock, female maturity ogives are used rather than a combined-sex ogive.

Methods and results of estimating proportion mature at length for female sea bass, based on UK sampling from the 1980s up to 2003, are described in the Stock Annex, IBPNew 2012 (ICES, 2012a) and Armstrong and Walmsley (2012c). Sample numbers are relatively small.

Further details, and the fitted parameters of the model, are given in the stock annex. The estimated proportion mature converted to proportions-at-age by the Stock Synthesis assessment model can be seen later in the short-term forecast inputs. The maturation range for females during 1982–2003 occurred at ages 4 to 7, and for males at ages 3–6.

More recent sampling indicates the possibility that sea bass may be maturing at a smaller size and younger age than previously. Samples collected in the southern North Sea from 2005 to 2011 by the Netherlands (Quirijns and Bierman, 2012) indicate 50% maturity in female sea bass at-age 4. Estimates of proportion mature are needed from representative sampling of mature and immature bass across the geographic range of the population, using a robust, validated marker for maturity.

Natural mortality

A natural mortality rate of 0.15 yr^{-1} was adopted by WGCSE 2014 for all ages based on consideration of life-history parameters (see stock annex for further information).

Hooking mortality, and mortality of discarded bass from commercial vessels

Hooking mortality in recreational fisheries is discussed in the report section on recreational fish catches. Sea bass discarded from commercial line vessels and netters may survive depending on the extent of injury or stress. This will affect the calculation of fishing mortality reference points that are conditional on selectivity patterns. Trawl-caught undersized bass are less likely to survive. Unfortunately no estimates of survival rates of commercial bass discards are available.

Survey data used in assessment

Pre-recruit surveys

An inshore trawl survey in autumn in the vicinity of a major bass nursery area in the Solent (7.d English coast, Figure 10.1.2.3) provides abundance indices at-ages 2 to 4 for the stock assessment. Data are available from 1982, although there are intermittent years when the survey did not take place (Table 10.1.2.12). The stock annex provides details of this survey and of some other pre-recruit survey series not considered appropriate by previous WGs and IBPBass for inclusion in the assessment. A previous assessment of the stock by Pawson *et al*. (2007), using a statistical separable model, indicated that recruitment patterns in 7.afg, 7.eh, 7.d and 4.bc were similar to the trends in the Solent survey. This provides some justification for using the Solent survey in the current assessment despite its extremely localised coverage. Similar surveys, carried out by Ifremer, commenced on the coast of France from 2014. At this stage, this is not an established time-series and is in an initial period of testing the methodology until 2016.

Abundance indices for ages 2–4 in the Solent autumn survey have large interannual variability (Table 10.1.2.12; Figure10.1.2.4). Strong year classes are apparent in 1989, 1995 and 1997, but in the last decade, year-class strength has been less variable, a pattern also seen in the commercial fishery. The survey indicates a general trend of increasing recruitment since the early 1990s, but weak year classes from 2008 to 2012. There is only one pronounced year-effect, in 2007. The age-2 index appears less consistent than the age 3 and 4 indices.

Channel Groundfish survey

The Ifremer Channel Groundfish survey, carried out in October each year since 1988, provides swept-area indices of sea bass abundance in the eastern Channel (7.d) together with annual length compositions. Details of the survey are given in Coppin *et al.* (2002), which includes a full description of the GOV trawl used in October each year at the 82 stations in ICES Division 7.d shown in Figure 10.1.2.5. The majority of sea bass are caught in the coastal waters of England and France (Figure 10.1.2.5).

The abundance indices are calculated applying a stratified-random swept-area based estimator. Strata correspond to ICES statistical rectangles. Swept-area is calculated using wingspread. As this is a stratified swept-area based indicator, uncertainty is based on between haul variance within a strata and summation of variances across strata. Further details are in the stock annex.

The swept-area indices are given in Table 10.1.2.13. The trends in both the index and in the proportion of stations with sea bass showed similarities to the trend in total biomass estimates from the ICES, WGCSE 2013 update assessment using Stock Synthesis, before the survey data became available, lending *a priori* support to the use of the index in the assessment (Figure 10.1.2.6).

The precision of the swept-area indices appears unrealistically high in some years (e.g. 0.025 in 1991), which may indicate that the index trends are driven largely by the incidence of positive catches. Modelling of the data using delta lognormal models may provide more realistic precision. During trial Stock Synthesis runs, the use of the CVs in Table 10.1.2.13 resulted in poor fit to length frequencies in many years due to individual years with very low CVs being given far too much weight. Relaxing the CVs to 0.30 for all years except the first three years (set to 0.6 in preliminary runs given the very low incidence of positive stations) allowed the model to fit the length compositions more closely over the series. The final assessment excluded the composition data for 1988–1990 due to the very low sample sizes, but retained the overall index.

.***NB*** : The Channel Ground Fish Survey (CGFS) has been conducted since 1988 with a systematic fixed sampling program with a high opening (GOV) bottom trawl (20 mm meshsize codend), using the same Research Vessel Gwen Drez since 1988 to 2015. The RV Gwen Drez was decommissioned in 2015 and it was decided to continue the time-series using the RV Thalassa (a bigger vessel). An inter-calibration exercise was conducted in 2015 by using paired tows, simultaneously with both vessels (see Working Document in WGIBTS 2015 report for description of the inter-calibration results). The original index was calculated as numbers of fish per hour tow. The initial step in calculating the index was numbers per ICES square per hour tow (the stratum in this survey) and then raised to the whole Eastern Channel to compute a number of fish per age class per hour tow. As the surface trawled area differed between the two RVs (difference in trawling speed and width of the gear used) a density index (number of fish per km²) was also calculated in order to create a consistent index over the whole time-series.

The index is then computed using the formula:

$$\overline{N} = \frac{\sum_s A_s.\overline{N_s}}{\sum_s A_s}$$

With :

$\overline{N_s}$ mean abundance in the strata *s*, expressed in number/km²

A_s Surface of the strata *s*, in km²

As the vertical opening of the gear used by the RV Thalassa was higher than the previous one, and in order to take into account any vessel effect on catchability, the cpue were compared for all the species caught. Differences in cpues between the new and the old survey setting were found for nine species (mostly pelagic species) and a correction factor applied to continue the time-series. The correction coefficient for sea bass used to continue the time-series is R=1.707+/-0.091. In addition to the calculation of the new index a number of errors were found in the surface calculation of some strata. These errors where corrected and the new indices (expressed in number of fish per km² instead of number of fish per hour fished) take these corrections into account.

As the new index introduced significant changes that requires it to be reviewed and evaluated the WG decided not to use the new index, and to review and explore the use of it during the next benchmark in 2017.

Commercial landings per unit of effort

Abundance indices from commercial fishery catch rates are not included in the assessment. Previous inter-benchmark assessments of sea bass (IBPNew ICES, 2012) explored some landings per unit of effort (lpue) series for UK fleets and French trawlers. Fleets where sea bass are mainly a bycatch (e.g. otter trawlers and beam trawlers) showed lpue trends approximately similar to the biomass estimates from Stock Synthesis, whereas some UK inshore netting and line fishing fleets, where targeting of sea bass is more prevalent, showed recent sharp increases in lpue (Armstrong and Maxwell, 2012a). It was not clear if this reflected actual increases in abundance or the effects of increased targeting.

In 2015 for WGCSE, a study "French Logbook data analysis 2000–2013: possible contribution to the discussion of the sea bass stock(s) structure/annual abundance indices" (Laurec and Drogou, 2015) was presented in a Working Document to WGCSE 2015 (reference: Annex 3, WD07). The method uses a multiplicative model with a vessel effect (hull x gear group) and a stratum effect (area*month*year). A logarithmic transformation (in practice decimal logarithms are used) is provided, which excludes using zero catches, which transforms the multiplicative model in to an additive model. The vessel effect (in the multiplicative model "not transformed") is the relative fishing power, with a geometric mean of all the boats being forced to 1. The strata effects is reduced in apparent abundance expressed as landings by effort unit of a medium vessel, with zero logarithmic power and untransformed power. The adjustment is done by minimizing the sum of squared deviations, (logarithms), between predicted values (log10 of fishing power of a vessel + log10 of apparent abundance in the stratum) and observed value (log of capture/effort). It is possible to use not just the sum of squared deviations, but the sum of the weighted deviations for each datapoint given by the effort.

The apparent abundances correspond to the daily landings of an average standard vessel (effort data in hours in logbooks are not accurate enough).

The software uses a suitable algorithm, which, in contrast to common linearized model adjustments, avoids having to invert a matrix, and is therefore much faster. It thus offers limited reduction in computing time, which is very useful when processing large amounts of data, and / or when bootstrap techniques are used. Moreover the software used includes a possible data selection in order to conduct the analysis by eliminating (i) some individual vessels and/or some gears and (ii) some geographical areas or time periods.

The preliminary results of the study were considered promising by WGCSE. A comparison of the index using twelve months of data and with the spawning season excluded is given in Figure 10.1.2.7. The index for the reduced period showed more similar trends to the SSB estimates from Stock Synthesis, given the errors in both series. The method will be further developed for the next benchmark in 2017 assessment of sea bass.

Other relevant data

None.

10.1.3 Stock assessment

Model structure and input data / parameters for update assessment

The assessment was conducted using Stock Synthesis (Methot, 2000; 2011), using version 3.24f (Methot, 2011). The structure and input data / parameters of the SS3 model developed by IBPBass 2 are summarized below:

Model structure

- Temporal unit: annual based data (landings, survey indices, age–frequency and length–frequency);
- Spatial structure: One area;
- Sex: Both sexes combined.

Fleet definition

Six fleets defined: 1. UK bottom trawls, nets; 2. UK lines; 3. UK midwater pairtrawls; 4. French fleets (combined); 5. Other (other countries and other UK fleets combined); 6. Recreational fisheries.

Landed catches

Annual landings in tonnes from 1985 to final year for the Five fleets from ICES Subdivisions 4.b and c, 7.a, d–h. French data were as provided by Ifremer and the recreational catch was iteratively reconstructed conditioned on the 2012 estimated value of 1500 t.

Abundance indices

Channel Groundfish Survey in 7.d in autumn (France), 1988 to 2014: total swept-area abundance index and associated length composition data. Number of stations with sea bass is used as input effective sample size. Input CV for survey = 0.30 all years. First three years of composition data are excluded.

Cefas Solent Autumn bass survey (7.d), years 1986 to 2009; 2011, 2013 to 2015, for ages 2–4. Selection was fitted as a function of length using a double normal model, with minimum and maximum ages specified as 2 and 4 in the age selection function.

Fishery landings age composition data

Age bins: 0 to 15 with a plus group for ages 16 and over. Age compositions for fleets are expressed as fleet-raised numbers-at-age, although they are treated as relative compositions in SS3. Year range for UK trawls/nets: 1985 to present; UK lines; UK midwater pairtrawl: 1996 to 2012 (no samples for 1997, 2013-2015); French all fleets were input from 2000 to present.

Fishery landings length composition data

The length bin was set from 4 to 100 cm by 2 cm intervals. Length compositions for fleets are expressed as fleet-raised number-at-length. Year range for UK trawls/nets: 1985 to present; UK lines: 1985 to present; UK midwater pairtrawl: 1985 to 2012 (no samples for 1997, 2013–2015); French all fleets combined were input from 2000 to present.

Model assumptions and parameters

Table 10.1.3.1 summarises key model assumptions and parameters. Other parameter values and input data characteristics are defined in the SS3 control file BassIVVII.ctl, the forecast file Forecast.SS and the data file BassIVVII.dat.

Incorporation of recreational fishery landings estimates

A vector of recreational fishing landings values was generated using the selectivity for commercial UK line fisheries and a value of F for recreational fishing in 2012. For a given value of F, the recreational harvest was calculated based on landings in 2012 and the recreational F. The F and landings for recreational fishing was adjusted in successive SS3 runs until the recreational F for the time-series was close to the F giving 1500 t in 2012. The calculations for the final assessment run are given in Table 10.1.3.2.

Final update assessment: diagnostics

The likelihood components (log L * Lambda) for the update SS3 assessment are given below:

Likelihood components	Likelihood
TOTAL	542.032
Catch	2.6425e-012
Equilibrium catch	0.424307
Survey	-0.707472
Length compositions	195.63
Age compositions	318.996
Recruitment	27.6756
Parameter soft bounds	0.0136937

A range of model outputs and diagnostics are given in Figures 10.1.3.4–10.1.3.17.

Good correspondence was found between the observed and fitted length and age compositions for each fleet (Figures 10.1.3.6–10.1.3.14), although the fit to the French length compositions in 2014 was poorer than for preceding years. Some diagonal residual patterns are noted in the commercial age compositions indicating some problems in fitting extreme variations in recruitment.

Any smearing of age estimates from a strong year class into neighbouring weak ones could be responsible for year-class residuals in the UK age compositions that are apparent in the first half of the series. The age error vector included in the model helps to accommodate this in the fit to age compositions. The combined fit of the age and length composition data aggregated over the series was very close (Figure 10.1.3.8 and 14).

The survey abundance indices are fit reasonably well (Figure 10.1.3.15 and 16). The UK Solent autumn survey is characterised by a large variability with outliers present in the model fit (Figure 10.1.3.15). The model fits closely to the low indices for recent years because there are few fishery composition data for estimating these recent year classes.

The model is able to fit recruitment deviations with reasonable precision back to around the 1974 year class (Figure 10.1.3.17) allowing a longer-term perception of recruitment dynamics. Recruitment is highly variable with no evidence of a reduction in average recruitment at the lower SSB values (Figure 10.1.3.17) although this perception is affected by the imposition of a steepness value of 0.999 for the fitted Beverton–Holt stock–recruit curve. IBPBass and IBPBass 2 found that likelihoods progressively worsened as steepness value was reduced.

Retrospective analyses

Retrospective analysis with a five-year peel was carried out. For the runs with data up to 2012, 2013 and 2014, it was necessary to re-estimate the recreational F vector to give recreational landings of 1500 t in 2012. For runs with final data year 2011 or earlier, the recreational F vector for the run ending 2012 was adopted. There is no evidence of any retrospective pattern (Figure 10.1.3.18) although the WGCSE 2016 update assessment has lower SSB and higher F than the IBPBass 2 assessment (Figure 10.1.3.20).

Final update assessment: long-term trends

The time-series of estimates of numbers-at-age, combined recreational and commercial $F_{(5–11)}$, are given in Tables 10.1.3.2–10.1.3.3, and a summary of SSB, total stock biomass (TSB), recruitment and F are given in Table 10.1.3.4 and Figure 10.1.3.19. These series are based on the final SS3 update run with 2015 set as the final year. In order to obtain biomass estimates for 2016 and Fs for 2015 for the forecast the final year is set to 2016.

A sharp increase in F between 2010 and 2013 is generated because the assessment model interprets that landings were maintained despite a rapid decline in biomass. This may be a plausible scenario where aggregations or predictable migration routes of sea bass can be targeted and it is possible for fisheries to maintain landings as total stock size declines, and hence inflict an increasing fishing mortality rate. The F has however remained high despite the sharp reduction in landings in 2014. The most recent F estimates are the least precise, and it is therefore possible that the F estimate for 2014 could be revised downwards in future assessments.

WGCSE concludes that strong year classes in 1989 and some subsequent years caused a rapid increase in biomass throughout the stock area, and landings and fishing mortality in the commercial fishery also increased. The combined commercial and recreational fishery F is well above the F_{MSY} proxy. Recruitment has been declining since the mid-2000s, and has been very poor since 2008, however the recruitment estimated for 2013 is above the geometric mean. The combination of declining recruitment and increasing F is causing a rapid decline in biomass. Uncertainties in the assessment are explored in a subsequent section.

Comparison with previous assessments

The addition of catch and survey data for 2015 causes only a small change in historical biomass and fishing mortality compared with the IBPBass 2 assessment (Figure 10.1.3.20).

The state of the stock

The marked increase in biomass in the 1990s was driven by the very strong 1989 year class and a number of subsequent year classes. The biomass prior to this was declining during a period of poor recruitment, and the recent decline in biomass also coincides with a period of poor recruitment, but under conditions of higher F than estimated for the 1980s. The stock has been characterised by periods of poor recruitment in the 1980s and now again since 2008. These periods of poor recruitment have a major impact on biomass, which is exacerbated by any increase in F. Total biomass reacts more quickly than SSB due to the delayed maturity.

The period of increasing SSB in the 1990s and early 2000s also coincided with expansion of the stock in the North Sea. The enhanced productivity and geographic range of the stock at this time also coincided with a period of elevated sea temperatures (see WGCSE and stock annex for UK inshore sea temperature trends in relation to sea bass recruitment).

The assumption of a constant recreational fishing mortality over time implies that recreational harvests were a much larger fraction of total fishery removals in the 1980s compared with the 2000s onwards (Figure 10.1.3.19). It is likely that in the 1970s or earlier, sea bass were primarily the target of recreational fishing. Even at the relatively small natural mortality value of 0.15, removals due to natural deaths are a relatively large component of total removals. Consumption of sea bass by predators has not been estimated.

Sensitivity of the final update assessment to data and assumptions

Sensitivity of the assessment to the use of different estimates of recreational fishery harvest in 2012 was explored in IBPBass and IBPBass 2. Decreasing the assumed recreational harvest from 1500 t down to zero in steps had no effect on the relative trends in SSB and recruitment, but scales the overall biomass and recruitment downwards due the reduction in F. The assumption of constant recreational fishing mortality over time is an important potential source of bias in the assessment. WGCSE (2014) showed some historical UK estimates of sea angling participation that varied without clear trend, but the number of anglers and other recreational fishers targeting bass is likely to alter over time in response to changes in abundance.

IBPBass and IBPBass 2 also examined sensitivity to the use of different natural mortality estimates. The effect of this is to scale the biomass and recruitment throughout the series without altering the relative trend.

IBPBass considered the potential underestimate of UK commercial fishery landings due at least in part to the ability of fishermen to dispose of small catches below 25 kg or 30 kg depending on region, for personal consumption without supplying sales slips. Given the very many small-scale fishing activities of under 10 m vessels catching sea bass close inshore, this can amount to substantial quantities. IBPBass used separate landings estimates for UK nets and lines obtained by an independent bass logbook scheme and port census carried out since the 1980s by Cefas (UK) to increase the input landings of UK nets and lines by a factor of three throughout the series (see stock annex). This factor is approximate, as the logbook scheme has some unquantified biases. Again as expected, this acts to scale recruitment and biomass upwards without affecting the trend, and F stays the same. The assessment trends would be affected if the proportion of catch not reported changes over time, however the Cefas logbooks estimates are not good enough to accurately detect recent trends. The logbook scheme is no longer in operation due to a decline in numbers of fishermen participating in the scheme. However there is an urgent need to develop methods for more accurate recording to total catches of sea bass for these fleets, particularly for monitoring the effectiveness of any additional control measures to be implemented.

10.1.4 Biological reference points

The F_{MSY} and B_{lim} reference points defined by IBPBass 2 2016 have not been altered.

The YPR curve is flat topped and F_{MAX} is not definable (Figure 10.1.4.1). The estimates of $F_{0.1}$ (0.11) and $F_{35\%SPR}$ (0.13) are similar. WGCSE 2014 proposed $F_{35\%SPR}$ as a suitable candidate for an F_{MSY} proxy for sea bass, particularly in view of the delayed maturity, slow growth and inherent longevity (to ~30 years). The historical combined F for commercial and recreational fishing has exceeded $F_{35\%SPR}$ in all years since 1985 (Figure 10.1.3.16).

WGCSE 2015 noted that fishing at $F_{35\%SPR}$ would lead to a long-term average SSB of almost 21 kt if recruitment varied around the long-term average, above any SSB observed historically. However, the SSB achieved will vary according to periods of above-average or below-average recruitment as have been observed historically.

It was not possible to conduct MCMC runs of the Stock Synthesis model through to the forecast period in order to examine probabilities of falling below candidate reference points for biomass. WGCSE 2014 proposed that a B_{lim} could be set as B_{loss}, the lowest observed SSB, which the current assessment has revised B_{loss} to 7507 t (Figure 10.1.3.16) but it is not recommended to change the B_{lim} after only one year of additional data particularly as the revised B_{loss} lies within the confidence limits for the 1992 SSB estimate in the IBPBass 2 assessment.

The absence of a B_{pa} or $MSYB_{trigger}$ is problematic for reporting on stock status. In the absence of a full stochastic evaluation of risks, WGCSE 2015 suggests that B_{pa} and $MSYB_{trigger}$ could be set using the approach proposed by ICES (1992) where it was suggested that $B_{lim} = B_{pa} * \exp(-1.645\ \sigma)$ where σ is the relative standard error of the biomass estimate. The SS3 estimates of relative standard error and associated B_{pa} values given the IBPBass 2 B_{lim} value of 8075 t are as follows:

YEAR	Σ	B_{LIM}	B_{PA}
2012	0.1532	8075	10 389
2013	0.1981	8075	11 186
2014	0.274	8075	12 673

As the population numbers and biomass surviving at the start of 2015 is the metric of interest in relation to forecasts and management decisions, IBPBass 2 suggests that 12 673 t could be adopted as a value for B_{ps}, retaining 8075 t as B_{lim}). The stock summary Figure 10.1.3.19 shows that the point estimate of SSB in 2015 is just below this value of B_{pa}, whilst B_{lim} lies around 0.5 of a standard error below the point estimate for 2015.

The following table summarises what the reference points would be under this method of computing B_{pa}. Ranges for reference points will be evaluated by ICES later in 2017:

	TYPE	VALUE	TECHNICAL BASIS
$_{BPrecautionary}$ approach	B_{lim}	8075 t	Lowest observed SSB (IBPBass 2 2016)
	B_{pa}	12 673 t	$B_{lim} * \exp(1.645\ \sigma)$, σ = RSE of SSB(2015) estimate = 0.274
	F_{lim}	Undefined	
	F_{pa}	Undefined	
MSY approach	F_{MSY}	0.13	Based on F giving SSB per recruit 35% of value at zero F.
	$MSYB_{trigger}$	12 673 t	B_{pa}

F_{MAX} is not definable.

10.1.5 Short-term predictions

Inputs for a short-term forecast are given in Table 10.1.5.1, and their derivation is explained below.

Recruiting year-class strength

Recruitment estimates for sea bass are well below average from 2008 to 2012 (Table 10.1.3.4). SS3 does not estimate recruit deviations for years with no survey data for that year class. Hence, the model imputes a value from the stock–recruit curve at virgin biomass for year classes 2013 and after. This value (7321 thousand) differs slightly from the 1985 to 2013 geometric mean (6469 thousand) which was adopted for subsequent year classes for the forecast. This is summarised in the text table below:

Year class	SS3 (age 0)	LTGM 1985–2013
2013	10576 thousand	
2014		6469 thousand
2015		6469 thousand
2016		6469 thousand

WGCSE (2013 and 2014) reviewed some information on environmental influences on sea bass recruitment which supports the apparent recent reduction in recruitment from 2008–2012. Survival of 0-gp and 1-gp sea bass in nursery areas in estuaries and saltmarshes is thought to be enhanced by warmer conditions promoting survival through the first two winters, and increasing the growth rates (Pawson, 1992). Data on coastal sea temperatures in the south of the UK were presented by WGCSE to show that shifts between periods of poor recruitment and periods of above-average recruitment were associated with changes from cooler to warmer sea conditions, and that recent poor recruitment from 2008 onwards coincided with cooler conditions (see stock annex). During 2014, sea temperatures off southern England were exceptionally warm, which may have favoured survival and growth of young bass. The Solent survey in 2014 indicated that numbers of 1-gp bass (2013 year class) had returned to around the series average. Although the evidence is weak, it is not a critical assumption for short-term forecasts as these year classes have very little impact on the short-term forecast

Numbers of fish in 2016

These were derived from the update Stock Synthesis run with final year set at 2016. The numbers for ages 0–2 in 2016 were adjusted using the ratio of LTGM to SS3 values for 2014–2015 age 0 as explained above.

F-at-age vectors

Status quo F-at-age for the commercial fishery was taken as the 2015 estimates scaled to the previous three years derived from the update Stock Synthesis run with final year set at 2016. This approach was taken to allow for the change in selectivity associated with the large reduction in French pelagic trawl catch (Figure 10.1.5.1a), assuming that this will continue into 2015 and 2016 due to the emergency closure of that fishery and possible continuation of the closure. The recreational F vector was the same as input to the SS3 model in combination with the assumed M of 0.15. The imposition of a three-fish-per day bag limit part way through 2015 is intended to reduce the F due to recreational fishing, and an increase in MLS to 42 cm is expected to improve selectivity. WGCSE has no way to determine how the recreational F will be altered by these measures until survey information becomes available in future on recreational catches, releases and catch composition in European countries taking the bulk of the recreational catch, which may allow an evaluation of how recreational F has changed since 2012.

Weights-at-age

Mean weight-at-age in the stock was taken from the Stock Synthesis output. The commercial fishery weights for 2015 were derived as a weighted mean of the values for French and UK fleets given in the Stock Synthesis output, using the model estimates of catch numbers for the two fleets as weighting factors. The annual weights-at-age for any fleet are time-invariant as they are derived from length-at-age derived from von

Bertalanffy growth curve parameters, with selectivity applied where appropriate. Length at A_{MAX} (30 years) was estimated as 84.12 cm.

Maturity ogive

The proportion mature at-age is the length-based ogive applied to the length-at-age distributions around the input VB growth curve, calculated within Stock Synthesis.

Detailed short–term forecast output at *status quo* F

A detailed short-term forecast is given in Table 10.1.5.2 assuming that F in 2015 and 2016 is the 2015 values scaled to the average of the previous three years from the assessment. Fishing at the same fishing mortality as in 2015 (i.e. with continued reduction in pelagic pairtrawl catches) will result in a further decline in SSB from 7352 t in 2016 to 6219 t in 2017, and to 5845 t in 2018, below the B_{lim} of 8075 t. It is expected that the commercial fishery landings would decline from 2040 t in 2015 to 1633 t in 2016, then to 1475 t in 2017. The recreational fishery harvests would decline from 799 t in 2015 to 642 t in 2016 and to 560 t in 2017.

This forecast is highly uncertain, as the actual rate of decline in population abundance in recent years is likely to be more uncertain than indicated by the SS3 model confidence limits. Also, the final package of technical and other management measures for sea bass in 2015, 2016 and 2017 are not fully known at this stage, and information will be needed on their implementation and effectiveness before their impact on fishing mortality can be ascertained. The assumption of constant recreational F is also untested.

Management options

WGCSE provides management options in which F multipliers are applied equally to commercial and recreational F-at-age (Table 10.1.5.3). In reality, management may wish to allocate the combined forecasted landings in any way considered appropriate, and this would imply differing F-multipliers applied to each fishery.

The management options table includes options for F multipliers 0 to 2, including the multiplier giving the proposed F_{MSY} proxy of 0.13 for combined commercial and recreational fishing. With zero F in 2016, SSB is expected to increase from 6219 t in 2016 to 7583 t in 2017. At F_{MSY}, the combined commercial and recreational catch in 2016 is expected to be around 944 t. However, as SSB is predicted to be below MSY $B_{trigger}$ in 2017 F_{MSY} is adjusted accordingly and expected landings are thus reduced to 478 t. When compared with estimated landings for all fisheries of 2305 t in 2016, this represents an almost 80% reduction in combined commercial and recreational landings. The allocation between commercial and recreational fisheries depends on the balance of controls applied on recreational and commercial fishing in 2017.

10.1.6 Uncertainties and bias in assessment and forecast

Landings and discards data

The historical fishery catch data are subject to several biases. From 2000 to 2015, French landings data from the ICES commercial landings database are replaced by more accurate figures from a separate analysis of logbook, auction data and VMS. From 2011 onwards, the official and scientific French landings use the same analysis of logbook and auction data and VMS data. Prior to 2000 official French landings figures have had to be redistributed between ICES areas according to the average spatial pattern observed from 2000 onwards.

Historical landings of small-scale national fisheries not supplying EU logbooks or sales slips are known to be inaccurate. IBPBass ran the Stock Synthesis model with and without additional UK landings for nets and lines estimated from a separate Cefas logbook scheme, and found this had relatively little impact on stock trends or fishing mortality, but rescaled the biomass and recruitment due to the additional catch. However, if the extent of non-reporting is changing over time, for example to develop track record in the possible event of a future TAC, then bias will be introduced in the assessment trends.

Discard rates are low in most fisheries other than trawls. Estimates of discards are available only from the early 2000s, but do not cover all fisheries, are imprecise, and are not included in the assessment. The overall discard rate by weight is thought to be less than 5% due to the predominance of offshore fisheries from France targeting adult bass. Nonetheless, a time-series of discards at-length or -age is needed for all fleets if the impact of technical measures to improve selectivity is to be evaluated as part of any future bass management.

Fishery composition data

The ability to fit selectivity patterns for defined groups of fishery métiers, and to detect changes in selectivity, depends crucially on collection of adequate numbers of independent, representative samples of length and age to sufficiently characterise the length or age compositions of the selected métier groups. What constitutes "sufficient" is impossible to define without simulation studies to examine relationship between precision of input data and the precision of estimates required for management.

The absence of length composition data for French fisheries prior to 2000 is a serious deficiency in the model preventing any evaluation of changes in selectivity that may have occurred, for example due to changes in the mix of gear types. The numbers of trips of each métier group sampled on shore in France and the UK has varied widely over time, and in the UK has declined substantially since the 2000s. Currently there are no composition data supplied by Netherlands and Belgium.

ICES has developed extensive advice on establishing statistically-sound sampling designs for estimating fishery length and age compositions and discard quantities (see reports of ICES Workshops on Practical Implementation of Statistically Sound Catch Sampling Programmes (WKPICS1–3, available on ICES website). Stratified random sampling of fishing vessels or harbours may lead to low sample sizes for species such as sea bass for which large fractions of the total catches may be taken in relatively small numbers of fishing trips. The cost-benefit of expanding the sampling in vessel or harbour strata where most sea bass landings are recorded, without compromising statistical sampling design, should be investigated. The next benchmark should evaluate if sampling is currently sufficient to support continued application of Stock Synthesis fitting selection parameters to fishery composition data.

The comparative assessment using age compositions for French fleets showed that these data may improve the robustness of the assessment in future, and this should be subject to an inter-benchmark assessment and peer review.

Recreational fishery harvests

IBPBass 2 2016 accommodated an estimate of recreational fishery landings in the assessment and forecasts based on landing from 2012. This is however a crude approach based on surveys for only a year or two in France, UK, Netherlands and Belgium and leads to an assumption of constant recreational fishing mortality over time. This assumption is as unlikely to be correct as the assumption of a constant natural mortality (which is around 50% larger than the estimated recreational F). The estimate of recreational harvest in the Netherlands increased between 2010/2011 and 2012/2013.

Further survey data are needed to confirm the level of recreational catches and releases, and to develop a time-series to evaluate changes in recreational fishing mortality and any changes in selectivity.

More work is needed on post-release (e.g. hooking) mortality rates given the high incidence of catch-and-release practices in sea angling for sea bass. Release rates are expected to increase due to bag limits and increases in MLS that are in place or planned. WGCSE must collaborate closely with the ICES Working Group on Recreational Fishery Surveys to identify priorities for future surveys and hooking mortality studies.

Surveys

The surveys included in the assessment since 2014 include the Channel Groundfish Survey which provides data on a wider range of sizes and ages than the Cefas Solent survey, though with a steeply domed size selection pattern. From 2015 onwards, Ifremer will no longer use the scientific vessel "Gwen Drez" which will be replaced by the larger vessel "Thalassa". A calibration has been done in 2014. WGCSE is concerned that coverage of the coastal waters of 7.d could be altered by the use of this new vessel (the size of the vessel may prevent fishing as close to the coast as is possible with the previous vessel) and how the continuity of the Index could be kept. This could degrade the bass index due to the inshore distribution of the bulk of the fish caught. Statistically robust calibration data will be required to allow continuity of the index for 7.d pending establishment of a series for the larger area. If there are changes to the gear, size selectivity for sea bass may be altered, requiring a new year-block for selectivity estimation. These issues should be carefully considered by Ifremer in designing the new survey if the time-series for sea bass is to be continued.

The Cefas pre-recruit surveys are now reduced to just the Solent autumn survey, with the Solent spring and the Thames survey having been removed by previous benchmark assessments as being unsuitable. Recruitment estimates for the most recent years are heavily dependent on the Solent survey, and it is important to maintain this series. However, there is a need for information on recruitment trends in other areas as it cannot be assumed that the Solent index will in the long term represent overall recruitment patterns throughout Areas 4 and 7. A study by France under the EU Framework for Community actions in the field of water policy (Table 10.1.5.31) shows clearly that sea bass nurseries in the Channel have asynchronous patterns of abundance of young bass. In the UK, 37 sea bass nursery areas such as estuaries and saltmarshes are defined for implementing conservation measures, and there are others that may be added. Similar habitats for young bass also occur in France and the Netherlands. A more robust survey design would treat individual nursery grounds as strata or station clusters in an internationally coordinated, stratified survey design. The possibility for this, and the sampling effort and costs for a desired precision, could be considered as part of a long-term sea bass management plan.

Commercial lpue indices

The reliance of the assessment on the Solent and Channel trawl surveys is a potential source of bias because they cover only a part of the stock range, and the selectivity is heavily skewed towards young bass. This is of principle concern in establishing the current rate of decline in spawning–stock biomass and associated trends in fishing mortality. In the absence of relative abundance indices for older bass from surveys or commercial fishing vessels covering the range of the stock, it is difficult for the model to fix the recent stock trends and fishing mortality. Statistical modelling of French lpue data by vessel and rectangle by Laurec and Drogou (WGCSE 2015, Annex 3, WD 07) appears promising and should be further developed for the next benchmark assessment. In parallel a study on effect of vessel selection is done (Bissery, Mahevas and Drogou), but is still under development and cannot be evaluated yet.

Analyses of UK commercial fishery lpue, based on averaging across ICES rectangles where the bulk of sea bass catches have been recorded, was presented to IBPNEW in 2012. There were divergent trends between fleets where sea bass are typically a by-catch, and mainly under 10 m vessels where increased targeting has probably been occurring using lines and nets. Future development of UK lpue indices together with equivalent French data would require careful evaluation of potential for lpue of each fleet to track abundance.

Model formulation

Following from advice given by WGCSE in 2013, the Stock Synthesis model formulation was altered to include a more rational combination of fleets with more realistic selectivity patterns. It remains a complex model and further intersessional work would be beneficial to see if robustness can be further improved. A particular improvement may be conversion of the French commercial fishery length compositions, and the CGFS length compositions, to age compositions using age material collected by Ifremer. These data should be further investigated as part of a future benchmark or inter-benchmark assessment.

Stock structure and migrations

The assessment treats all sea bass in 4.b,c and 7.a,d–h as a single biological stock. Although there can be extensive migrations, for example between the south of the area and the Bay of Biscay (which is treated separately in the WGBIE group), or between the North Sea and the Channel, there is also strong site fidelity (Pawson *et al.*, 2008) resulting in a high proportion of tagged fish being recaptured at the same coastal location, even in subsequent years after migrations to offshore spawning sites. Immature sea bass may remain close inshore, and exploitation of young fish in coastal waters (<6 nautical miles offshore) may be predominantly by inshore fleets of that country. Mature fish originating from coastal waters of the UK, France or Netherlands or other countries may become increasingly vulnerable to offshore pelagic pairtrawlers fishing mainly on mature fish during December to April. These spatial, ontogenetic patterns may lead to complex responses of length and age compositions to previous fishery catches of each country and fleet. This could potentially be addressed using spatial structuring in Stock Synthesis, but the data demands would increase substantially. Both the UK (England) and France have embarked on major programmes of bass research involving electronic and conventional tagging, and modelling of larval drift patterns, to try and improve knowledge of spatial dynamics.

Biological parameters

The maturity ogive used in the assessment was derived from sampling from the 1980s onwards. There has been no coordinated sampling across the full range of the stock in recent years to determine if the current ogive is still valid. Sporadic recent sampling has suggested that sea bass may be spawning at sizes smaller than recorded historically (see stock annex). This would alter the F_{MSY} based on $F_{35\%spr}$, and could also be associated with changes in growth parameters. Mean length-at-age in UK samples remained more or less constant over several decades of sampling, but this analysis needs updating. Changes in growth, or inappropriate growth parameters, will lead to bias in fitting length-selectivity parameters to the French fishery and survey data.

Intermediate year fishing mortality and catch levels for forecasts

As the Measures introduced by the EU commission to reduce fishing mortality toward F_{MSY}, have the potential to affect the short-term forecast assumptions for this stock. The working group carried out two sensitivity runs adjusting the F_{bar} (ages 1 to 5) assumptions to 70% and 50% of F2015. It was agreed by the working group that given the measures, fishing mortality would likely correspond to a 30% reduction.

Tables 10.1.6.1 and 2 provide the management options from the two sensitivity runs. Given the 30% reduction F and catches in 2017 set to zero it is likely that the SSB in 2018 will be above B_{lim}, however it will remain below $MSYB_{trigger}$. The same is also true if the assumption for the intermediate year F is 50% lower than F_{2015}.

10.1.7 Recommendations for next benchmark assessment

Full benchmark of NE Atlantic sea bass stocks

WGCSE proposes a full benchmark for 2017, preferably in conjunction with the other stocks of sea bass particularly the Bay of Biscay stock. ICES, WGBIE 2015 encouraged documentation of the quality of the sea bass data for the Bay of Biscay, and studies to better understand the stock dynamics and movements between the current stock areas. In the longer term, Stock Synthesis could be configured to include spatially disaggregated data covering populations within Areas 4, 7 and 8, with estimates of exchange rates between the areas. New data on fish movements from electronic and conventional tagging, and modelling of egg/larva dispersal, will be available from the UK C-bass and French BarGip projects currently underway. New relative abundance indices for bass-47 based on commercial lpue data by rectangle and vessel trip are under development and will be available. The benchmark will allow a full evaluation and further development of the Stock Synthesis application and diagnostics as well as developing other simpler assessment approaches for comparison. The issues list for the proposed benchmark assessment is given in Table 10.1.7.2.

10.1.8 Management considerations

Sea bass in this stock are characterised by slow growth, late maturity and low natural mortality on adults, which imply the need for comparatively low rates of fishing mortality to avoid depletion of spawning potential in each year class. Productivity of the stock is affected by extended periods of enhanced or reduced recruitment which appear to be related to changes in sea temperature. Warm conditions facilitate northward penetration of sea bass in the North Sea and Northeast Atlantic, and enhance the growth and survival of young fish in estuarine and other coastal nursery habitats. A period of above-average sea temperatures and enhanced recruitment between 1989 and the mid-2000s generated a large increase in biomass and a geographic expansion. Increased abundance and a lack of a TAC or other means to control fishing outside of nursery areas stimulated a growth of fisheries and markets for sea bass. Many small-scale artisanal fisheries, especially line fishing and some forms of netting, have developed a high seasonal dependency on sea bass, and there is also a significant recreational fishing mortality in inshore waters. The behaviour of bass, forming predictable aggregations for spawning and moving close inshore to feed at other times of year, increase their vulnerability to exploitation by offshore and inshore fisheries. Increased targeting of sea bass has resulted in a progressive increase in fishing mortality above values considered appropriate to achieve F_{MSY}. The combination of increasing fishing mortality and environmental conditions causing poor recruitment since 2008 appears responsible for a continuous decline in biomass since 2010. Catches appear to be declining in fisheries where sea bass is mainly a bycatch, but some other fisheries such as netting in the UK appear to be expanding and may be exploiting known seasonal migration routes and local aggregations of fish despite a more widespread contraction of the population.

A reduction in fishing mortality on sea bass is needed to prevent SSB declining to such an extent that the stock's ability to produce strong recruitment in more favourable environmental conditions is impaired. Since 2013, the European Commission has been in dialogue with Member States to develop a package of management measures to promote recovery of the stock. This resulted in emergency measures to stop the offshore pelagic trawl fishery on spawning aggregations between January and April 2015, bag limits for recreational fishing, and proposals to increase the MLS to 42 cm. Further measures to restrict catches without resorting to a TAC are under consideration. Any management measures applied to commercial and recreational fisheries should take into account the need for collection of data to demonstrate the effectiveness of the measures, and the ability to enforce the measures adequately.

ICES advice in 2004 recommended that "implementation of 'input' controls, preferably through technical measures aimed at protecting juvenile fish, in conjunction with entry limitations into the offshore fishery in particular should be promoted", and that "any consideration of catch limitation (output control) would need to take into account that sea bass are a bycatch in mixed fisheries to a various extent, depending on gear and country; this incites discarding and should be avoided". This form of advice has reoccurred in subsequent ICES advice for sea bass.

WGCSE notes that protection of juvenile fish through technical measures is good to improve the fishery selectivity and increase the number of sea bass that are able to spawn at least once, but this is probably not enough to ensure a sufficient decrease in F. Protection of juveniles already exists to an extent already through designation of 37 UK sea bass nursery areas where certain types of fishing on sea bass is prevented annually or seasonally. However, catching and discarding of sea bass by trawlers fishing close to nursery areas remains an issue. Data available to WGCSE indicate that discarding is mainly by otter trawlers using 80–90 mm mesh in or near areas where juvenile bass are most abundant, for example in UK coastal waters of the eastern Channel. Improvements to fishery selectivity to successfully achieve a large reduction in fishing mortality on pre-spawning fish without increasing discarding would require changes to gear designs which could have a strong spatial management component.

Entry limitation can prevent an increase in effort but will not decrease F to the extent needed, unless existing licences are withdrawn. The occurrence of sea bass as a small bycatch in many fisheries raises the problem of this becoming a "choke species" if vessel catch limits are introduced under EU legislation and sea bass fall under the landings obligation.

ICES also previously advised that "Management of sea bass fisheries needs to take into account the distinctive characteristics and economic value of the different fisheries. Sea bass is of high social and economic value to the large inshore artisanal fleets and to sea angling and other recreational fishing that contribute substantially to local economies". Data from France indicate that the first sale value of the high-volume and lower quality catches of sea bass caught by pelagic trawlers targeting offshore spawning fish during December to March has been up to three times lower per kg than for smaller volume sales of higher-quality fish for métiers fishing inshore (Drogou *et al*., 2011). However, there is at present insufficient information to accurately evaluate the total economic value and impact of sea bass fisheries beyond just the first sale value, and covering direct incomes from sales and direct as well as indirect and induced costs, employment and added value generated downstream. The interrelationship between markets for wild caught and farmed sea bass also needs to be evaluated. A number of studies on the economic value of recreational sea fisheries have been conducted in recent years, and these demonstrate high levels of spend into national economies; for example the total direct, indirect and induced spend of sea angling in England in 2012 was estimated at £2 bn GBP (Anon., 2014) although this cannot be easily allocated to a spend per species.

No bio-economic scenarios are available at present to appreciate the effect of management measures for sea bass, based on economic considerations, and work is urgently needed in this area. The importance of sea bass to recreational fisheries, artisanal and other inshore commercial fisheries and large-scale offshore fisheries in different regions means that resource sharing is an important management consideration that has implications for the type of scientific evidence needed. WGCSE has estimated that up to 30% of total landings in France, England, the Netherlands and Belgium were attributable to the recreational fisheries in recent years.

The effects of targeting of offshore spawning aggregations of sea bass in the English Channel and Celtic Sea are poorly understood, particularly how the fishing effort is distributed in relation to mixing of fish from different nursery grounds or summer feeding grounds in the UK, France and other countries, given the strong site fidelity of sea bass. This is a subject of a new scientific study on sea bass in the UK.

The current stock structure assumptions are pragmatic, and need further evaluation. The sea bass population in coastal waters of the Republic of Ireland is currently considered as a separate stock, although it extends into at least one of the ICES divisions defining the 4.bc and 7.a,d–h stock. Further studies are needed to determine if the sea bass in Irish coastal waters are indeed functionally separate, or if they also mix with the other stock during spawning time and contribute to commercial catches on the offshore spawning grounds. Moreover, the Bay of Biscay is also currently considered as a separate stock although tagging program indicates some exchange with the Area 4 and 7 stock studied assessed by WGCSE.

As bass is, at present, a non-TAC species, there is potential for continued displacement of fishing effort from other species with limiting quotas. The effort of the pelagic fisheries during winter and spring can shift between the Bay of Biscay and the English Channel and approaches, and there is evidence for such a shift to the Channel in recent years which is likely to have increased the fishing mortality on sea bass in Area 7. The fisheries on sea bass have grown in the 1990s and 2000s due to good recruitment, and new markets have been established, competing with farmed bass. Fishing mortality has gradually increased over time and is above the F_{MSY} proxy for many years. With the stock in decline and no effective control on these fisheries, the risk of stock collapse is currently very high unless strong year classes are produced again. Therefore, in addition to technical measures to improve the fishery selection pattern, an overall limitation of total fishing mortality across all ages of sea bass is urgently needed through appropriate measures.

10.1.9 References

Anon. 2014. Sea Angling 2012: a survey of sea angling activity and economic value in England. http://www.marinemanagement.org.uk/seaangling/.

Armstrong, M.J. 2012. Life-history estimates of natural mortality of sea bass around the UK. Working Document: ICES IBPNew 2012; October 2012. 3 pp.

Armstrong and Walmsley. 2012b. Age and growth of sea bass sampled around the UK. Working Document: ICES IBPNew 2012; October 2012. 15 pp.

Armstrong and Walmsley. 2012c. Maturity of sea bass sampled around the UK. Working Document: ICES IBPNew 2012; October 2012. 14 pp.

Armstrong, M.J. and Maxwell, D. 2012. Commercial fleet lpue trends for sea bass around the UK. Working Document: ICES IBPNew 2012; October 2012. 29 pp.

Coppin, F., Le Roy, D., Schlaich, Y. 2002. Manuel des protocoles de campagne halieutique: Campagnes CGFS, Système d'information halieutiques - Campagnes à la mer. Ifremer, 09/2001. DRV/RH/DT/AN-NUMERO, 29pp. (in French).

Drogou, M., Biseau, A., Berthou, P., de Pontual, H., Habasque, J and le Grand, C. 2011. Synthèse des informations disponibles sur le Bar: flottilles, captures, marché. Reflexions autour de mesures degestion. http://archimer.ifremer.fr/doc/00035/14577/11879.pdf.

ICES. 1998. Report of the study group on the precautionary approach to fisheries management. ICES Copenhagen, 3–6 February 1998. ICES C.M. 1998/Assess:10.

ICES. 2003. Study Group on Precautionary Reference Points for Advice on Fishery Management. Copenhagen, 24–26 February 2003. ICES CM 2003/ACFM:15.

ICES. 2008. Report of the Working Group on the Assessment of New MoU Species (WGNEW). By correspondence, ICES CM 2008/ACOM:25. 77 pp.

ICES. 2012a. Report of the Inter-Benchmark Protocol on New Species (Turbot and Sea bass; IBPNew 2012). ICES CM. 2012/ACOM:45.

ICES. 2012b. Report of the Working Group on Assessment of New MoU Species (WGNEW), 5–9 March 2012, ICES CM 2012/ACOM:20. 258 pp.

ICES. 2012c. Report of the Working Group on Recreational Fisheries Surveys (WGRFS). ICES CM 2012/ACOM:23. 55 pp.

ICES. 2014. Report of the Working Group for Celtic Seas Ecoregion (WGCSE), 8–17 May 2013, Copenhagen, Denmark. ICES CM 2013/ACOM:12. 1986 pp.

ICES. 2014b. Report of the Inter-Benchmark Protocol for Sea Bass in the Irish Sea, Celtic Sea, English Channel, and Southern North Sea (IBPBass). By correspondence. ICES CM 2014/ ACOM:46.

ICES. 2014c. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 13–22 May 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:12.

Mahé, K., Holmes, A., Huet, J., Sévin, K., Elleboode, R. 2012. Report of the Sea bass (*Dicentrachuslabrax*) Otolith and Scale Exchange Scheme 2011, 16 pp.

Methot, R.D. 2000. Technical Description of the Stock Synthesis Assessment Program. National Marine Fisheries Service, Seattle, WA. NOAA Tech Memo. NMFS-NWFSC-43: 46 pp.

Methot, R.D. 2011. User Manual for Stock Synthesis, Model Version 3.23b. NOAA Fisheries Service, Seattle. 167 pp.

Pawson, M. G. 1992. Climatic influences on the spawning success, growth and recruitment of bass (*Dicentrarchus labrax* L.) in British Waters. ICES mar. Science Symp. 195: 388–392.

Pawson, M. G., Kupschus, S. and Pickett, G. D. 2007. The status of sea bass (*Dicentrarchuslabrax*) stocks around England and Wales, derived using a separable catch-at-age model, and implications for fisheries management. ICES Journal of Marine Science 64, 346–356.

Pawson, M.G., Brown, M., Leballeur, J. and Pickett, G.D. 2008. Will philopatry in sea bass, *Dicentrarchuslabrax*, facilitate the use of catch-restricted areas for management of recreational fisheries? Fisheries Research 93 (2008) 240–243.

Quirijns, F. and Bierman, S. 2012. Growth and maturity of sea bass sampled around the Netherlands. Working Document: ICES IBPNew 2012; October 2012. 9 pp.

Van der Hammen, T and de Graaf, M. 2012. Recreational fishery in the Netherlands: demographics and catch estimates in marine and freshwater. IMARES Wageningen UR, Report Number C147/13.

Van der Hammen T, and de Graaf, M. 2015. Recreational fisheries in the Netherlands: analyses of the 2012–2013 logbook survey, 2013 online screening survey and 2013 random digit dialing survey. IMARES C042/15, pp 55.

Table 10.1.1.1. Bass-47: Annual landings from 4.b,c and 7.d,e–h.

	Belgium	Denmark	Germany	France	UK	Netherlands	Channel Is.	Total	Total WG figures1
1985	0	0	0	620	105	0	18	743	994
1986	0	0	0	841	124	0	15	980	1319
1987	0	0	0	1226	123	0	14	1363	1980
1988	0	18	0	714	173	8	12	925	1239
1989	0	2	0	675	192	2	48	919	1161
1990	0	0	0	609	189	0	25	824	1063
1991	0	0	0	726	239	0	16	982	1227
1992	0	0	0	721	148	0	36	906	1186
1993	0	1	0	718	230	0	45	994	1255
1994	0	1	0	593	535	0	49	1178	1371
1995	0	1	0	801	708	0	69	1579	1835
1996	0	1	0	1703	563	8	56	2331	3022
1997	0	1	0	1429	561	1	74	2066	2620
1998	0	2	0	1363	488	48	79	1980	2390
1999	0	1	0	0	685	32	108	826	2670
2000	0	5	0	1522	407	60	130	2124	2407
2001	0	2	0	1619	458	77	80	2236	2500
2002	0	1	0	1580	627	96	73	2377	2622
2003	154	1	0	1903	586	163	84	2891	3458
2004	159	1	0	1883	617	191	159	3010	3731
2005	206	1	0	1937	512	327	220	3203	4430
2006	211	2	0	2033	574	308	162	3290	4377
2007	178	1	0	1975	713	376	142	3385	4064
2008	188	0	0	1420	791	380	123	2902	4107
2009	173	0	0	2732	697	395	91	4088	3889
2010	215	4	0	3294	736	399	120	4768	4563
2011	152	2	0	2566	793	395	90	3998	3858
2012	154	3	0	2399	892	376	55	3879	3987
2013	145	5	2	2786	803	370	37	4148	4136
2014	146	1	0	1309	1038	253	37	2784	2682
2015	40	0	0	1110	683	207	26	2066	2066

Source: Official Landings Statistics 1950–2013 and 2006–2013 datasets and 2015 provisional data, ICES, Copenhagen. [1] Includes figures supplied directly to WGCSE by France and Belgium.

Table. 10.1.2.1. Bass-47: Landings for the country / fleet components included separately in the assessment model.

Year	Fleet 1 : UK Trawls, nets	Fleet 2 : UK Lines	Fleet 3 : UK pelagic trawlers	Fleet 4 : France combined gears	Fleet 5: Other countries and gears	Fleet 6 : RecFish
1985	70	30	1	870	23	1222
1986	84	33	2	1180	19	1123
1987	96	18	0	1840	25	1062
1988	129	30	8	1028	44	1047
1989	141	29	7	917	67	988
1990	128	18	22	849	47	866
1991	152	60	14	971	29	761
1992	105	23	8	1001	49	749
1993	146	62	1	979	68	940
1994	354	154	0	786	76	1319
1995	424	169	4	1057	181	1524
1996	308	128	87	2395	104	1505
1997	335	119	71	1984	111	1407
1998	241	121	85	1773	170	1338
1999	274	148	220	1843	185	1372
2000	236	53	52	1805	261	1454
2001	263	58	97	1883	199	1505
2002	361	75	110	1825	251	1610
2003	353	65	127	2471	443	1703
2004	380	72	131	2604	544	1785
2005	353	59	68	3161	789	1778
2006	359	119	11	3259	629	1743
2007	413	166	37	2771	677	1805
2008	514	163	17	2750	663	1902
2009	486	147	9	2649	598	1921
2010	452	183	42	3236	649	1824
2011	462	143	98	2526	629	1678
2012	564	185	49	2610	579	1500
2013	530	191	39	2871	506	1246
2014	751	236	1	1303	391	998
2015*	440	199	0	1110	291	799

***Preliminary.**

[1].Preliminary.

Table 10.1.2.2. (a) Bass-47: Sampling of commercial fishery landings of otter and pelagic midwater trawls for length and age by area in the UK (England and Wales). Nsamp = number of landings sampled; Nfish = number of fish.

	UK Otter trawl					UK Pelagic/midwater				
	Age		Length		Landings (t)	Age		Length		Landings (t)
Year	Nsamp	Nfish	Nsamp	Nfish		Nsamp	Nfish	Nsamp	Nfish	
1985	45	235	15	225	27	3	44	2	43	1
1986	18	216	28	2591	24					2
1987	41	421	54	1181	41	4	42	1	589	0.02
1988	23	257	23	1298	65	2	64	2	1684	8
1989	63	531	44	1595	80	4	126	4	1451	7
1990	63	883	48	773	67	8	19			22
1991	92	983	32	731	39	12	125	1	1490	14
1992	69	699	17	398	41	2	50	2	220	8
1993	118	1219	38	836	80	9	39			1
1994	182	1927	113	3925	125			1	127	0.3
1995	28	529	66	1995	162			1	19	4
1996	49	660	39	1041	122	1	41	3	392	87
1997	59	1660	52	2445	140	1	49			71
1998	28	676	39	1442	133	20	95	4	167	85
1999	24	379	46	1216	138	12	382	9	770	220
2000	92	759	42	1814	133	23	847	14	2463	52
2001	45	851	49	2152	141	3	58	5	691	97
2002	54	523	47	1454	161			4	545	110
2003	48	512	45	1418	207	15	459	4	744	127
2004	33	361	31	1295	173	8	161	5	522	131
2005	35	498	31	2432	181	3	149	2	299	68
2006	15	252	17	810	160	1	43	1	100	11
2007	44	385	21	903	173	1	20	3	355	37
2008	37	580	32	2151	196	6	409	8	1283	17
2009	24	1184	13	807	175	8	317	6	625	9
2010	25	360	28	1312	150	7	153	3	376	42
2011	25	577	49	1903	137	3	103	4	463	98
2012	18	182	41	751	157			1	199	49
2013	15	289	23	859	125					39
2014	14	164	22	523	104					1
2015	28	377	39	1277	100	1	4	1	4	1

Table 10.1.2.2. (b) Bass-47: Sampling of commercial fishery landings of lines and net gears for length and age by area in the UK (England and Wales). Nsamp = number of landings sampled; Nfish = number of fish.

	UK Lines					UK Nets				
	Age		Length		Landings (t)	Age		Length		Landings (t)
Year	Nsamp	Nfish	Nsamp	Nfish		Nsamp	Nfish	Nsamp	Nfish	
1985	53	395	19	285	30	34	332	15	181	43
1986	60	496	31	894	33	18	251	18	1132	61
1987	92	313	69	557	18	37	528	44	1321	55
1988	66	538	53	1325	30	37	584	40	1397	64
1989	249	652	26	310	29	49	469	45	1248	60
1990	281	918	22	260	18	24	207	11	456	61
1991	346	1468	53	963	60	57	481	30	583	113
1992	418	2905	111	2077	23	40	281	28	1248	64
1993	287	1787	123	1426	62	127	1141	94	1686	66
1994	212	1616	155	3783	154	146	2846	157	5130	229
1995	160	1043	107	1493	169	95	1786	150	6248	262
1996	155	1326	106	1790	128	85	1371	113	3348	186
1997	141	1262	137	2072	119	73	1055	106	2747	195
1998	182	1215	111	2820	121	88	1119	82	2465	108
1999	237	1304	149	3793	148	127	1189	74	2966	137
2000	405	1395	65	1964	53	119	1719	104	5482	103
2001	451	2485	114	2935	58	140	2027	92	3309	122
2002	210	1286	146	3031	75	220	3800	206	6680	201
2003	151	1009	90	3108	65	171	1720	224	5899	146
2004	127	906	66	1980	72	83	974	150	3567	207
2005	87	380	25	921	59	73	768	33	1126	172
2006	54	359	67	989	119	56	598	47	1197	199
2007	94	713	31	1088	166	90	753	40	1811	239
2008	37	552	28	1325	163	100	1444	63	3361	318
2009	49	304	18	915	147	116	1571	100	3247	311
2010	34	418	40	970	183	63	1214	66	2350	302
2011	46	1091	55	2250	143	34	793	41	1433	324
2012	89	1295	100	2215	185	35	909	56	2809	407
2013	41	896	42	1236	191	42	1123	49	2342	405
2014	67	1247	73	1889	236	60	1161	71	2781	647
2015	72	1183	79	3055	199	48	776	67	3985	338

Table 10.1.2.3. Bass-47: Sampling of commercial fishery landings by area in France, giving numbers of fishing trips sampled, number of fish measured, and the total landings.

Year	FR_lines			FR_nets			FR_bottom trawl		
	No. Trips	No.fish	Landings	No. Trips	No.fish	Landings	No. Trips	No.fish	Landings
2000	53	1613	305	2	72	108	2	196	692
2001	101	2659	375	1	5	110	0	0	713
2002	79	2076	349	0	0	128	4	710	911
2003	78	1732	438	1	4	152	8	998	1087
2004	78	1748	381	6	84	150	12	887	1236
2005	34	949	439	4	110	148	14	689	1239
2006	73	1719	554	11	291	140	11	1240	1110
2007	69	2235	560	28	641	158	11	588	1187
2008	41	1280	425	25	496	128	18	1927	1145
2009	33	1339	251	25	159	94	93	1468	1052
2010	10	334	278	49	615	160	64	626	819
2011	17	540	359	156	278	129	151	1955	791
2012	10	681	295	60	408	142	87	1204	824
2013	16	309	291	26	512	126	73	2060	737
2014	10	299	285	29	218	163	137	2139	571
2015	16	326	210	35	242	109	76	1628	642

Year	FR_pelagic trawl			FR_danish seine			FR_other gears		
	No. Trips	No.fish	Landings	No. Trips	No.fish	Landings	No. Trips	No.fish	Landings
2000	2	629	681	0	0	0	0	0	20
2001	0	0	659	0	0	0	0	0	27
2002	3	680	415	0	0	0	0	0	22
2003	4	753	773	0	0	0	0	0	23
2004	6	938	820	0	0	0	0	0	17
2005	11	1239	1319	0	0	0	0	0	17
2006	16	2597	1420	0	0	0	0	0	35
2007	8	1800	841	0	0	0	0	0	24
2008	8	1065	1012	0	0	0	0	0	40
2009	55	899	1098	0	0	27	0	0	127
2010	28	1299	1828	0	0	61	2	2	90
2011	30	2309	1142	2	6	43	36	292	62
2012	9	1649	1143	6	370	112	7	154	91
2013	10	1253	1516	2	28	18	1	1	82
2014	23	455	242	12	23	9	1	1	25
2015	12	158	107	0	12	26	0	0	16

Table 10.1.2.4. Bass-47: Numbers-at-length in French commercial all-gears fishery landings (input to assessment at lengths 14–94 cm).

Length	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
20	0	0	0	0	0	0	0	0	0	0	717	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	3455	0	0	0	0	0	292	0	0	1219	0	0	291
30	0	0	1015	13054	14	0	15689	0	0	473	0	0	0	146	0	346
32	0	0	0	58717	13057	9903	32459	181	8250	2239	9811	1976	1583	0	3076	2678
34	9931	17962	12469	105655	78811	29872	179130	4715	28986	10714	28290	13885	6518	1504	3620	5102
36	34932	19809	38249	125326	127801	97890	285704	39335	229758	124925	169311	57121	85760	29667	33532	44175
38	85866	68920	46427	180475	124051	128022	217657	102714	263071	211881	177571	87842	172510	88507	68262	75546
40	126730	76594	62503	119495	227214	231750	178250	146272	266408	225545	182105	128838	140273	149070	74871	93273
42	102836	98008	82461	145456	282390	266905	196868	145122	237160	193030	283064	187586	147895	146130	82684	115713
44	80478	109595	91064	104545	243107	344681	289998	164011	270810	222613	251956	201447	162333	123170	51365	122460
46	93344	106857	86723	130023	188494	270532	285451	130859	228996	238849	230227	199487	180752	140677	61292	95208
48	80934	77694	62163	115806	126685	239265	263272	100043	142650	155222	188149	194697	158490	127136	39844	59668
50	55399	57055	55905	91915	72581	169478	200874	99210	112385	159658	186310	145447	130759	116842	38109	51436
52	52948	51658	46180	93878	82331	115269	119836	75929	74336	114530	109212	124239	107214	99156	29929	37860
54	42094	36737	35998	48742	50633	62106	99509	74405	66260	84649	120550	92526	90638	103818	39911	21406
56	26460	35839	26001	60839	60284	67741	99674	55147	48853	96257	71590	72471	78934	89197	32298	20681
58	27357	22762	19019	31614	31334	61132	54522	46087	39689	51578	62211	46869	54869	59004	30016	13591
60	23581	25834	14210	33688	19126	43591	45908	28056	29840	36547	31544	31690	35387	65851	21467	11946

Length	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
62	14295	18773	11129	30691	23996	35774	23763	23057	28335	57472	19076	19998	33085	64579	16797	11776
64	18044	13532	16771	18823	14799	25788	20607	18091	14420	24016	62005	17624	17714	53482	16261	9356
66	10773	11068	11011	13230	10650	12456	14969	8715	12694	21415	26388	14720	15170	37744	8387	6653
68	9903	9120	5447	7960	8569	13360	13976	8793	9039	27466	9340	7906	9374	23884	5579	2485
70	5709	11771	4795	5374	4880	8908	9653	4835	6821	20198	8541	6114	8114	32512	8995	1163
72	5721	5733	4559	5617	2974	8053	4521	2707	4714	12083	29128	2082	4147	14996	3027	660
74	2345	5345	1825	3275	2675	9811	3424	1962	1623	7551	1884	1163	2313	9001	642	628
76	2595	2782	1260	1356	2567	5020	2883	1010	1257	979	2114	1096	1540	2640	773	431
78	2102	1691	357	297	548	2378	731	399	534	1765	182	476	1134	2073	0	9
80	888	583	155	783	425	1365	201	158	261	264	5525	148	282	176	198	16
82	1021	296	109	112	149	107	261	37	8	1004	6097	104	451	1566	0	278
84	548	204	0	148	295	0	30	59	0	0	863	0	29	0	0	0
86	123	0	0	0	0	0	0	0	0	0	0	0	27	1115	0	0
88	0	61	0	0	149	0	0	0	0	0	1207	0	0	0	0	0

Table XXX. Bass-47: Numbers-at-age in French commercial all-gears fishery landings.

Age class	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2	0	0	0	2611	3	0	3138	0	1208	315	717	0	0		0	47
3	0	2651	8114	10800	4	24195	74600	5307	79917	23355	1962	0	406	36	603	1394
4	9440	55640	73892	364427	80483	77794	131099	73224	175402	119979	39409	6087	14357	491	6846	20917
5	222655	47734	125531	241694	627951	253455	564668	135809	545960	282754	221063	172404	65157	34169	11735	116939
6	273687	298773	90294	318445	438799	735235	361515	460583	401231	473020	515711	252236	262593	61973	123435	139446
7	139562	211740	236147	96562	297961	352182	841651	124606	456312	238022	411737	312186	346334	331051	149938	125305
8	79413	90962	86108	254050	65297	443765	146484	139879	143871	408951	437222	303804	308183	213427	133129	191220
9	47258	44742	31151	114829	131612	39104	253945	79978	147881	100487	200328	314164	264012	237503	143241	88543
10	43924	21074	23025	57883	77533	161572	13655	69214	40719	200417	172430	125800	214803	332529	39242	67528
11	49293	39908	17823	26223	25416	69617	132370	33191	57341	73570	109342	89188	83939	174544	39476	24658
12	20207	36007	14760	19879	14848	26314	84910	65868	17882	37114	75421	34465	50701	119858	12679	17551
13	10767	17787	15912	14232	14254	17996	22068	68599	35092	32657	46461	28352	24784	37411	7347	5046
14	4925	4394	9752	18088	13528	19238	6648	11131	12669	55506	21880	12942	8470	18454	3067	5387
15	4927	6838	3743	6600	7628	17974	6999	9034	5518	33537	4806	5585	3191	12343	198	431
16+	10901	8034	1553	4028	5270	22718	16069	5486	6091	23529	16480	337	1583	9852	0	428

Table 10.1.2.5. Bass-47: Numbers-at-age in UK(England and Wales) mixed bottom otter trawl, nets.

Age class	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	65	0	0	0	33394	0	1533	0	0	2	0	191	0	0	241
3	11844	15673	439	1930	5411	3035	6933	15982	657	1328	5599	11473	2490	1103	82
4	30828	20303	30263	20862	1223	2503	36938	55550	81429	30970	37064	43831	8501	44997	80414
5	6121	18759	58458	54472	7659	3770	2381	33557	65981	369416	81529	31632	64000	49461	146338
6	9692	3453	13753	41710	43911	16047	1283	1183	21858	41472	334815	64618	45238	69489	43841
7	1240	7662	2095	12803	26891	31459	6576	796	1351	16079	17932	173733	39229	25366	28582
8	3914	704	2437	1721	9002	21020	18064	1956	627	1130	6931	8235	145407	15136	9612
9	9713	3197	656	2315	3076	5042	16248	4750	1796	294	702	3622	8105	41057	6192
10	2454	10503	726	780	2901	2186	7033	4762	4803	2282	415	216	4456	2671	18072
11	2581	1833	5731	451	1878	1463	589	1230	3920	5842	1046	315	632	860	1112
12	1320	1403	2565	5503	2896	846	2617	451	1500	4387	3440	454	640	96	729
13	343	2889	1889	2024	8914	1100	2321	433	710	1596	3215	1881	294	96	40
14	841	1222	761	1312	1499	4837	480	139	735	650	1846	1688	2689	385	270
15	286	1688	817	801	1286	353	6659	497	475	646	2699	534	1712	623	97
16+	892	3595	2796	2589	3436	2703	3674	3202	2347	3717	2680	1784	2235	811	830

Age class	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2	0	614	338	0	0	0	0	0	0	0	0	0	0	0	0	0
3	9528	11085	11495	5698	4406	18910	20497	955	9338	2659	319	845	1620	0	6622	0
4	2584	92408	43605	75254	38270	135210	141335	33606	110875	73056	77100	28630	14135	45016	31923	50
5	151515	29064	240476	70415	214112	89202	144890	169272	296983	169969	155258	124625	166965	60547	107001	3716
6	72747	105169	16779	154267	76652	124422	54069	96625	139083	172602	118179	92582	219883	182858	58412	20172
7	11772	25329	67647	8719	95133	33796	56281	44423	47617	64997	78410	71094	61319	117821	114826	45807
8	11046	7388	16021	38901	2733	30175	17344	34061	19838	19002	28938	54338	39609	33448	78809	36830
9	4992	8742	7450	14072	12227	3112	24148	12877	17332	14443	11821	31775	31669	30222	38859	63272
10	4636	5811	8022	4789	4039	7357	2207	14366	8660	9064	6979	10438	15268	22727	27037	35025
11	8323	8136	2682	3196	1583	1390	3475	11530	6128	8631	6043	11227	9427	17473	30548	17302
12	818	7522	3842	2260	994	1123	2277	4527	852	3610	2645	6347	4092	11825	19853	12685
13	184	804	10166	1599	802	363	859	1621	793	2235	2083	2933	3864	2908	5152	10431
14	14	768	645	3937	263	173	210	11	988	1302	2273	2203	2546	2687	1776	2917
15	55	69	193	937	1029	650	188	254	317	0	534	675	538	2429	1857	7265
16+	643	759	568	756	221	842	1433	428	824	249	1663	1692	930	2133	1487	7308

Table 10.1.2.5. Bass-47: Numbers-at-age in UK(England and Wales) Lines.

Age class	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	0	0	0	0	22	0	0	0	16	0	0	0	59	0	479
3	9225	577	108	33	0	305	131	1195	526	71	486	210	454	3676	255
4	11491	8939	1052	1751	538	82	8420	5473	11652	4059	6943	8804	3102	8366	25158
5	3441	3343	3719	13389	8171	185	471	5267	11776	119784	21979	12487	15613	10920	37306
6	5902	933	2132	5067	36046	1284	177	294	7569	18540	97509	15338	11415	22630	13589
7	891	2354	581	2398	1842	3456	792	269	590	9393	7380	57127	8287	10485	13697
8	1113	358	477	551	371	2407	4927	518	289	943	5313	4566	50819	6452	5288
9	5133	758	432	1014	104	897	4024	1193	931	173	480	4979	2853	28231	5001
10	1176	5428	523	209	208	357	1842	1633	3941	1754	699	127	1635	2949	20522
11	694	960	1578	456	58	369	89	563	3344	5414	831	510	557	1091	1669
12	913	871	845	1863	215	193	1229	130	1367	5570	5684	364	354	138	2038
13	46	953	211	895	1040	242	1685	195	663	1205	3696	2521	243	196	247
14	122	573	167	715	115	1261	367	169	703	639	1936	1573	2195	793	777
15	134	645	179	523	87	81	4831	143	643	274	840	1300	1065	1381	315
16+	936	1307	1187	977	334	828	2887	1411	3789	2790	4733	2346	1570	1254	3314

Age class	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2	0	54	30	0	0	0	0	0	0	0	0	0	0	0	0	0
3	421	471	729	80	279	621	44	22	199	315	814	8	91	0	980	1834
4	294	7385	2609	7166	1697	2669	16121	6611	5010	8415	7029	5209	1695	1187	4985	5941
5	19380	1392	14173	7917	13884	5059	35990	31578	27319	19843	45515	11538	18362	6979	26081	23369
6	12402	17864	2686	25014	8601	14699	13714	28396	42071	33661	54766	24667	28593	35135	20743	22221
7	2696	7702	17358	2167	17310	5529	22306	14511	21561	25695	39716	19293	23507	32251	39548	31442
8	3285	2027	7757	10164	2398	6985	5794	17834	12265	12017	15835	16668	22946	18057	28357	19014
9	1476	3239	2621	3262	6365	589	12717	8499	12566	9320	5147	13032	17909	14762	15323	10344
10	1248	1685	5179	1473	3626	5697	1644	10951	5458	5021	2395	4947	10199	10333	12440	8210
11	4697	1761	1463	982	1181	1845	3135	5163	4960	5371	2910	6066	7725	10543	12413	7036
12	330	3774	1766	796	1189	236	1258	3121	1372	4748	706	2695	2994	6106	8018	2504
13	258	440	3687	681	1172	1307	305	5119	1032	811	522	1941	2672	3730	4889	3136
14	16	301	322	1704	406	33	358	85	3431	1075	359	2187	2158	2886	1976	744
15	88	27	101	186	2243	189	1016	344	198	0	81	522	596	1957	1673	408
16+	559	420	180	166	143	606	734	485	992	0	277	657	820	1938	1322	798

Table 10.1.2.6a. Bass-47: Numbers-at-age in UK(England and Wales) midwater pairtrawl fleet (no samples for 1997, 2013 and 2014).

Age class	1996	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	15	0	3	0	7	0	0	0	45	0	9	0	0
4	289	245	2983	60	179	37	2689	1254	114	227	385	445	90	36	255	391
5	796	5979	18409	2476	899	2380	10619	12502	2103	567	2517	1540	635	1741	4397	4461
6	3892	11845	15106	7587	19777	1578	39257	14372	15321	608	7038	3279	2175	5546	10231	10776
7	71666	8553	27147	3270	20290	24087	7971	48109	14397	4076	5387	1787	2596	8261	13640	10016
8	5583	8135	13818	4497	7042	9693	40551	3199	17408	1423	6833	1412	843	6678	15909	8757
9	1648	25138	18060	1459	5268	6297	10293	20694	1907	3085	2795	1557	784	4755	13642	5789
10	21	2517	43097	2830	3124	5978	3162	8010	5182	254	1900	755	168	403	4424	2741
11	334	345	4389	7077	2845	450	3254	353	0	176	631	960	298	3786	4233	1134
12	154	93	1686	634	9666	5664	618	1797	1831	111	807	30	173	152	2773	290
13	622	53	324	174	857	9215	169	1141	99	0	12	183	11	294	1688	433
14	485	119	387	39	636	0	4043	91	0	0	37	490	169	313	1003	143
15	199	893	308	96	123	0	77	968	40	0	19	0	0	551	264	127
16+	559	569	2689	420	261	530	281	18	599	53	121	40	0	50	423	226

Table 10.1.2.6b. Bass-47: Numbers-at-age in French commercial fishery landings, 2000–2015, all gears combined.

Age class	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2	0	0	0	2611	3	0	3138	0	1208	315	717	0	0	0	0	47
3	0	2651	8114	10800	4	24195	74600	5307	79917	23355	1962	0	406	60	603	1394
4	9440	55640	73892	364427	80483	77794	131099	73224	175402	119979	39409	6087	14357	569	6846	20917
5	222655	47734	125531	241694	627951	253455	564668	135809	545960	282754	221063	172404	65157	52216	11735	116939
6	273687	298773	90294	318445	438799	735235	361515	460583	401231	473020	515711	252236	262593	96064	123435	139446
7	139562	211740	236147	96562	297961	352182	841651	124606	456312	238022	411737	312186	346334	609903	149938	125305
8	79413	90962	86108	254050	65297	443765	146484	139879	143871	408951	437222	303804	308183	377156	133129	191220
9	47258	44742	31151	114829	131612	39104	253945	79978	147881	100487	200328	314164	264012	367869	143241	88543
10	43924	21074	23025	57883	77533	161572	13655	69214	40719	200417	172430	125800	214803	481247	39242	67528
11	49293	39908	17823	26223	25416	69617	132370	33191	57341	73570	109342	89188	83939	245982	39476	24658
12	20207	36007	14760	19879	14848	26314	84910	65868	17882	37114	75421	34465	50701	158757	12679	17551
13	10767	17787	15912	14232	14254	17996	22068	68599	35092	32657	46461	28352	24784	43008	7347	5046
14	4925	4394	9752	18088	13528	19238	6648	11131	12669	55506	21880	12942	8470	21825	3067	5387
15	4927	6838	3743	6600	7628	17974	6999	9034	5518	33537	4806	5585	3191	14812	198	431
16+	10901	8034	1553	4028	5270	22718	16069	5486	6091	23529	16480	337	1583	11520	0	428

Table 10.1.2.7. Numbers of trips sampled for discards by Cefas (UK): 2002–2015, by gear group and area.

a) bottom otter trawls

Division	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
IV	16	34	56	37	41	85	58	49	46	42	54	30	53	45
7.afg	8	15	23	8	11	43	50	28	22	22	22	12	14	16
7.d	1	2	4	3	1	2	1	6	7	9	4	5	7	3
7.eh	9	24	37	31	49	90	87	38	29	32	29	45	73	68
total	34	75	120	79	102	220	196	121	104	105	109	92	147	132

(b) Fixed/driftnets

Division	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
IV	0	0	2	1	11	31	15	20	15	11	13	18	10	7
7.afg	3	7	5	3	7	8	9	10	7	16	22	16	25	12
7.d	0	0	1	0	0	17	6	4	1	7	10	42	25	17
7.eh	1	5	9	2	3	16	10	14	19	17	25	24	24	15
total	4	12	17	6	21	72	40	48	42	51	70	100	84	51

(c) Lines

Division	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
IV	0	1	0	0	0	1	2	0	0	0	0	0	1	1
7.afg	0	0	0	0	0	0	0	0	0	0	1	1	0	0
7.d	0	0	0	0	0	0	0	0	0	0	0	0	1	0
7.eh	0	0	1	0	0	0	0	0	0	0	1	0	8	5

Division	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
total	0	1	1	0	0	1	2	0	0	0	2	1	10	6

(d) Midwater trawls

Division	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
IV	1	0	0	1	0	0	0	0	0	0	0	0	0	0
7.afg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.d	0	0	0	1	0	0	0	0	0	0	0	0	0	0
7.eh	0	1	1	1	2	1	0	0	0	0	0	2	1	0
total	1	1	1	3	2	1	0	0	0	0	0	2		0

(e) Other gears

Division	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
IV	8	5	10	1	2	1	1	7	6	8	4	10		0
7.afg	4	11	8	4	9	1	2	3	3	1	4	8		0
7.d	0	1	5	2	3	1	1	2	4	1	2	3	1	2
7.eh	10	17	27	16	24	32	18	13	17	27	22	21	14	15
total	22	34	50	23	38	35	22	25	30	37	32	42	15	17

(f) Summary

total all gears	61	123	189	111	163	329	260	194	176	193	213	237	256	206

Table 10.1.2.8a. Estimated annual numbers and weight of sea bass retained and discarded by UK otter trawl fleets in Areas 4, 7.d, 7.eh and 7.afg, based on at-sea sampling, and raised from landings in sampled strata to landings in all strata. Numbers of sampled trips are shown.

	2002	2002	2003	2003	2004	2004	2005	2005	2006	2006	2007	2007
Length cm	Discarded	Retained	Discarded	Retained	Discarded	Retained	Discarded	Retained	Discarded	Retained	Discarded	Retained
14	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	47	0	0	0	0	0	0	0
22	0	0	0	385	0	0	0	0	0	0	0	0
24	0	0	483	0	505	0	0	0	970	0	16070	0
26	0	0	1450	0	2709	0	0	0	105	0	38812	0
28	0	0	38	22	23767	0	1761	0	5975	0	34687	0
30	27949	0	1161	0	63941	0	3638	0	5907	0	52326	0
32	10487	0	19658	109	53293	1391	2873	0	59795	0	15258	617
34	5244	37005	14442	31602	13974	25288	5890	16348	9769	113212	4990	20183
36	0	13239	0	60910	0	47799	0	28948	132	35742	0	46242
38	0	7995	0	37258	78	39442	0	48654	0	37900	0	39243
40	0	32057	0	35014	0	32367	0	36648	0	19782	0	40557
42	0	18482	0	25754	0	26099	0	11515	0	14197	0	27516
44	0	5502	0	12919	0	12245	0	11480	0	7224	0	16021
46	0	17165	0	9501	0	9276	0	6078	0	3456	0	6645
48	0	32315	0	5777	0	3737	0	1100	0	2692	0	4050
50	0	3668	0	9530	0	3185	0	31620	0	948	0	5221
52	0	0	0	2716	0	1878	0	4310	0	2377	0	4099
54	0	2751	0	3128	0	1762	0	3301	0	446	0	770
56	0	2751	0	1245	0	1184	0	0	0	484	0	591
58	0	0	0	2350	0	704	0	0	0	672	0	553
60	0	0	0	454	0	639	0	0	0	369	0	0
62	0	0	0	1004	0	314	0	0	0	0	0	0
64	0	0	0	1933	0	801	0	0	0	0	0	0
66	0	0	0	0	0	314	0	0	0	105	0	52
68	0	0	0	0	0	262	0	0	0	0	0	378
70	0	0	0	0	0	651	0	0	0	0	0	0
72	0	0	0	0	0	105	0	0	0	485	0	154
74	0	0	0	0	0	52	0	0	0	0	0	0
76	0	0	0	385	0	52	0	0	0	0	0	0
Total	43680	172931	37231	241996	158315	209549	14162	200004	82653	240091	162143	212890
Trips sampled	34		75		120		79		102		220	
Weight(t)	17	161	16	207	59	173	6	181	34	160	49	173

	2008	2008	2009	2009	2010	2010	2011	2011	2012	2012	2013	2013	2014	2014
Length cm	Discarded	Retained	Discarded	Retained	Discarded	Retained	Discarded	Retained	Discarded	Retained	Discarded	Retained	Discarded	Retained
14	0	0	12159	0	0	0	0	0	0	0	0	0	0	0
16	0	0	12159	0	0	0	0	0	0	0	0	0	0	0
18	0	0	133744	0	0	0	0	0	0	0	0	0	0	0
20	0	0	206695	0	0	0	0	0	0	0	0	0	0	0
22	0	0	147671	0	0	0	0	0	410	0	0	0	0	0
24	0	0	36655	0	10295	0	0	0	553	0	0	0	0	0
26	0	0	26049	0	23448	0	229	0	1275	0	0	14563	0	0
28	588	0	2813	0	23056	0	2580	0	1823	0	332	16442	0	0
30	4964	528	6865	0	29348	78	5681	0	18434	0	2753	10667	0	0
32	4442	15	29651	807	47848	68	9919	0	25801	2889	3676	5500	1024	0
34	2919	16603	2177	5279	9498	11058	2832	10659	18545	50932	2196	9618	1461	1200
36	0	24149	29	28304	262	27019	71	34852	173	67439	0	35148	0	3897
38	0	37773	0	34820	0	30340	0	40046	0	24568	0	34006	0	15166
40	0	44594	0	21333	0	24963	0	10915	0	28182	0	23764	0	18682
42	0	35555	0	28484	0	23169	0	16195	0	7916	0	12229	0	20350
44	0	28083	0	12398	0	12607	0	10755	0	7761	0	5768	0	14602
46	0	8715	0	5819	0	8002	0	5939	0	11416	0	3050	0	17128
48	0	9306	0	6336	0	4229	0	6619	0	4595	0	4190	0	6431
50	0	4247	0	14499	0	3500	0	5423	0	316	0	1720	0	939
52	0	3038	0	4329	0	4764	0	1025	0	2460	0	470	0	3742
54	24	3402	0	1679	0	2803	0	2968	0	331	0	1675	0	674
56	0	793	0	2379	0	84	0	1536	0	2340	0	2479	0	0
58	0	369	0	403	0	207	0	737	0	764	0	664	0	0
60	0	1623	0	782	0	2129	0	2748	0	341	0	470	0	512
62	0	528	0	0	0	1922	0	1128	0	385	0	0	0	301
64	0	0	0	77	0	1486	0	669	0	606	0	0	0	0
66	0	125	0	38	0	79	0	57	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	807	0	0	0	0	0	0	0	0	0	301
72	0	14	0	705	0	640	0	0	0	0	0	0	0	0
74	0	0	0	807	0	0	0	0	0	0	0	403	0	0
76	0	0	0	1615	0	0	0	0	0	0	0	0	0	0
Total	12937	219461	616664	171701	143756	159145	21311	152272	67014	213243	8957	182826	2486	103925
Trips sampled	196		121		104		105		109		92		147	
Weight(t)	5	196	85	175	49	150	8	137	27	157	4	125	1	104

Table 10.1.2.8b. Estimated annual numbers and weight of sea bass retained and discarded by UK vessels using fixed or driftnets in Areas 4, 7.d, 7.eh and 7.afg, based on at-sea sampling, and raised from landings in sampled strata to landings in all strata. Numbers of sampled trips are shown. Results for 2002–2006 are omitted due to insufficient coverage of area strata.

	2007	2007	2008	2008	2009	2009	2010	2010	2011	2011	2012	2012	2013	2013	2014	2014
Length cm	Discardec	Retained	Discardec	Retained	Discardec	Retained	Discardec	Retained	Discardec	Retained	Discardec	Retained	Discardec	Retained	Discarded	Retained
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	1655	0	0	0
20	0	0	0	0	0	0	8736	0	0	0	0	0	1655	0	0	0
22	139	0	0	0	357	0	0	0	0	0	0	0	0	0	0	0
24	139	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	139	0	0	0	357	0	0	0	0	0	0	0	0	0	0	0
28	139	0	0	0	0	0	0	0	0	0	586	0	0	0	2163	0
30	312	0	0	0	357	0	0	0	0	0	0	0	0	0	1082	0
32	1109	555	0	0	0	0	0	0	33702	1064	0	785	3359	0	1082	0
34	416	3743	4585	1467	357	357	0	0	0	240	3533	17270	0	7648	0	802
36	0	5142	0	4889	0	714	0	0	0	1183	0	29438	0	22013	0	39868
38	0	9011	0	17413	0	103722	0	8736	0	1064	0	31202	0	49160	0	84999
40	0	12502	0	43277	0	2857	0	0	0	1183	0	16485	0	26302	2827	238863
42	0	9301	0	3544	0	57486	0	0	0	1199	0	24639	0	33539	0	117053
44	0	6906	0	21504	0	55611	0	17472	0	407	0	23069	0	18751	0	83924
46	0	4540	0	27187	0	6607	0	0	0	7216	0	3518	0	15840	0	54778
48	0	1149	0	36052	0	5446	0	17472	0	52251	0	30686	0	11454	0	4407
50	0	3630	0	16655	0	17669	0	22965	0	20312	0	17206	0	35087	0	4431
52	0	10746	0	16092	0	10665	0	39239	0	13545	0	14657	0	37140	0	8462
54	0	5656	0	5319	0	9593	0	19093	0	44827	0	17003	0	25566	0	2005
56	0	7344	0	19965	0	1786	0	14230	0	40552	0	23114	0	11852	0	0
58	0	11339	207	5686	0	3214	0	18549	0	3253	0	25211	0	5413	0	12015
60	0	10815	0	7204	0	2143	0	0	0	1220	0	9043	0	7745	0	5654
62	0	9313	0	2917	0	7718	0	4411	0	1335	0	8794	0	4386	802	991
64	0	17576	0	696	0	0	0	0	0	136	0	2931	0	0	0	2827
66	0	655	0	829	0	357	0	8736	0	0	0	0	0	1027	0	0
68	0	277	0	415	0	0	0	0	0	136	0	0	0	1027	0	0
70	0	451	0	489	0	357	0	0	0	0	0	1173	0	0	0	2827
72	0	757	0	489	0	357	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	357	0	0	0	0	0	0	0	0	0	0
76	0	139	0	978	0	0	0	0	0	0	0	0	0	1027	0	0
78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2827
82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
84	0	0	0	0	0	357	0	0	0	0	0	0	0	0	0	0
Total	2391	131546	4792	233068	1429	287374	8736	170902	33702	191122	4119	296226	6669	314975	7955	666733
Trips sampled	72		40		48		42		51		70		100		84	
Weight (t)	1	239	3	318	0	311	1	302	14	324	2	407	2	405	6	647

Table 10.1.2.8c. Estimated annual weight of sea bass retained and discarded by UK vessels using trawls, nets and beam trawls, and percentage discarded by weight.

	Otter trawl			Nets			Beam trawl			Total OTB, nets and BTS		
	discards	retained	rate (%)	discards	retained	rate %	discards	retained	rate %	discards	retained	rate%
2002	17	161	9				0.2	24	0.7			
2003	16	207	7				1.9	21	8.1			
2004	59	173	25				0.3	24	1.3			
2005	6	181	3				2.4	15	13.7			
2006	34	160	17				0.4	14	2.5			
2007	49	173	22	1	239	0.4	0.0	19	0.0	50	432	10
2008	5	196	3	3	318	0.9	1.2	21	5.6	9	535	2
2009	85	175	33	0	311	0.1	0.2	10	2.1	86	495	15
2010	49	150	25	1	302	0.3	1.3	6	17.9	51	458	10
2011	8	137	6	14	324	4.2	0.0	5	0.0	22	467	5
2012	27	157	15	2	407	0.5	0.0	5	0.0	29	569	5
2013	4	125	3	2	405	0.4	1.2	4	22.7	7	534	1
2014	1	104	1	6	647	0.9	0.8	8	9.1	8	758	1
2015	2	77	2.5	0	340	0	0.0	8	0	2	425	0.5
Mean	26	155	14	3	366	0.8	1	13	7	29	519	5

Table 10.1.2.9. Number of fishing trips sampled for retained and discarded weight of sea bass on French vessels using different gear types: 2009–2015.

(a) 2009 - 2012 analysis

		No. samples	weight of discards (t) estimated	total weight landings (t)	%discarded by weight
2009	Bottom trawl	54	121	1027	11.8%
	Long line	17	1	71	1.4%
	Nets	41	1	94	1.1%
	pelagic trawl	23	16	1098	1.5%
2010	Bottom trawl	45	143	797	17.9%
	Nets	25	0	159	0.0%
	pelagic trawl	20	12	1824	0.7%
2011	Bottom trawl	123	8	791	1.0%
	Danish seine	2	NA	43	NA
	nets	150	0	129	0.2%
	other	24	NA	57	NA
	long line	4	0	117	0.1%
	pelagic trawl	23	6	1142	0.5%
	Purse seine	6	NA	6	NA
2012	Bottom trawl	54	115	824	14.0%
	Danish seine	6	NA	112	NA
	long lines	7	0	83	0.3%
	nets	31	7	142	5.0%
	Pelagic trawl	6	3	1143	0.2%

(b) 2013 analysis

Discards estimates 2013, by metier

Zone	Metier	Number of trips	Discards (t), seabass, 95% CI	Landings (t)	Total catch (t)	% discarded by weight
27.4.c	GTR_DEF	4	0.3[0.0-0.7]	15	15	1.9
27.4.c	OTB_DEF	4	0.1[0.0-0.9]	35	35	0.4
27.7.d	GTR_DEF	12	0.5[0.0-1.8]	43	43	1.1
27.7.d	OTB_DEF	28	23.7[14.3-64.1]	470	494	4.8
27.7.d	OTB_SPF	9	0.9[0.0-2.2]	7	8	11.4
27.7.e	PTM_DEF	3	0.0 [0.0-0.0]	716	716	0
27.7.g	SDN_DEF	2	0.0 [0.0-0.0]	1	1	0
27.7.h	OTT_DEF	4	0.0 [0.0-0.0]	17	17	0

(b) 2014 analysis

Discards estimates 2014, by metier area

Zone	Metier	Number of trips	Discards (t), seabass, 95% CI	Landings (t)	Total catch (t)	% discarded by weight
27.4.c	GTR_DEF	13	0.0[0.0-0.0]	18.4	18.4	0
27.4.c	OTB_DEF	7	0.0[0.0-0.0]	63.1	63.1	0
27.7.d	GTR_DEF	77	0.0[0.0-0.0]	45.7	45.7	0
27.7.d	OTB_DEF	74	8.8[0.0-58.1]	229.3	238.1	3.7
27.7.d	OTB_SPF	24	5.1[0.0-22.2]	4.7	9.8	52
27.7.e	PTM_DEF	4	0.0[0.0-0.0]	182.3	182.3	0
27.7.g	SDN_DEF	4	0.0[0.0-0.0]	1	1	0
27.7.h	OTT_DEF	14	0.0[0.0-0.0]	14.5	14.5	0

	French discards 2015 estimates			French landings 2015 estimates			
gear	Nb trips	Nb fish	Discards (t)	gear	Nb trips	Nb fish	Landings (t)
Bottom trawl	23	356	48	Bottom trawl	76	1628	642
Danish	0	0	0	Danish	12	157	26
Nets	6	8	1	Nets	35	242	109
Handline	2	2	0	Handline	7	129	147
Longline	4	19	0	Longline	9	197	63
others	0	0	0	others	0	0	5
Pelagic	1	5	0	Pelagic	12	158	107
Purse seine	0	0	0	Purse seine	0	0	11
Total	36	390	49	Total	151	2511	1110

Table 10.1.2.10. Bass-47: Summary of estimated UK and France commercial discards in relation to total landings (note that sampling rates in individual years may be low).

	Discard weight			UK& Fr	
	UK	France	total	Landings	discard rate (%)
2009	86	139	225	3346	6
2010	51	155	206	3972	5
2011	22	14	36	3319	1
2012	29	125	154	3502	4
2013	7	25	32	3674	1
2014	8	186	194	2342	8
2015	29	49	78	1749	4
total	232	693	925	21903	4

Table 10.1.2.11. Estimates of annual recreational fishery catches of sea bass in France, Netherlands and UK (England) from surveys in recent years. RSE = relative standard error. An additional 60 t of removals was estimated by Belgium in 2013. Estimates are by weight except for Netherlands where weight and numbers are given.

(a) France		Kept	RSE	Released	RSE	Total	RSE	Release rate
2009-2011	NE Atlantic	2,343t		830t		3,173t	26%	26%
	ICES IV & VII	940t		332t		1,272t	>26%	26%
2011-2012	NE Atlantic	3,146t		776t		3,922t		20%

RSE was 26% for area VII and VIII combined; area VII represented 40% of total.

~ 80% by weight in 2009/11 was recreational sea angling

(b) Netherlands			Kept	RSE	Released	RSE	Total	RSE	Release rate
March 2010-Feb 2011	Southern North Sea	By number	234000	38%	131000	27%	365000	26%	64%
		By weight	138t	37%					
March 2012-Feb 2013	Southern North Sea	By number	335000	26%	332000	21%	667000	17%	50%
		By weight	229t	26%					

93% by weight in 2010/11 was recreational sea angling. 2012/13 figure is angling only

(c) England		Kept	RSE	Released	RSE	Total	RSE	Release rate
2012	ICES IVbc, VIIa,d,e,f	230– 440t		150-250t		380 – 690t	26-38%	36-39%

Survey covered only recreational sea angling

Range of values is for different effort estimation procedures

Table 10.1.2.12. Updated time-series of Cefas Solent autumn survey of juvenile sea bass, including 2013 survey results. Indices for 2000 are revised. A change in trawl design took place in 1993, and calibration factors are applied.

Year	Solent Index
1986	5.84
1987	2.6
1989	7.05
1990	3.98
1991	3.32
1992	19.7
1993	14.63
1994	5.46
1995	10.24
1996	6.06
1997	38.2
1998	7.34
1999	20.91
2000	17.46
2001	39.91
2002	11.7
2003	13.55
2005	21.93
2006	19.73
2007	5.5
2008	25.52
2009	19.83
2011	4.05
2013	1.52
2014	2.3
2015	11.29

Table 10.1.2.13. Sea bass indices of abundance 2000-2014 (swept area) from the Channel Groundfish Survey. The relative standard error CV is the log-transformed value used in SS3 (sqrt(loge (1+CV^2)).2015 not updated (Intercalibration need to be reviewed during benchmark 2017).

year	Total hauls	No. hauls with seabass	Percentage of hauls with seabass	Mean no. seabass per positive haul	Swept-area abundance index	CV
1988	68	6	9	2	245776	0.15
1989	61	3	5	1	77716	0.58
1990	75	8	11	8	1129914	0.12
1991	79	19	24	9	4250636	0.03
1992	60	23	38	13	2617986	0.11
1993	65	21	32	8	2299919	0.10
1994	86	19	22	5	1097828	0.11
1995	166	17	10	5	1021741	0.09
1996	134	26	19	3	1224238	0.13
1997	169	31	18	6	1817599	0.12
1998	82	38	46	8	2531043	0.08
1999	102	37	36	8	1642271	0.12
2000	100	36	36	9	2570994	0.08
2001	109	39	36	9	3150674	0.14
2002	100	44	44	12	3872427	0.11
2003	94	41	44	20	8739056	0.11
2004	94	44	47	8	3598436	0.10
2005	105	40	38	7	3005315	0.08
2006	110	36	33	14	5518000	0.12
2007	103	33	32	8	3661314	0.14
2008	105	40	38	10	6468839	0.15
2009	102	26	26	7	2564694	0.09
2010	101	30	30	4	1804538	0.10
2011	108	27	25	4	1513742	0.12
2012	96	25	26	5	2034552	0.11
2013	96	19	20	4	995987	0.13
2014	98	20	20	3	669931	0.13

Numbers-at-age in Solent Survey1986–2015: updated time-series of Cefas Solent autumn survey of juvenile sea bass

Age class	1986	1987	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	0.27	0.05	6.68	2.81	3.08	0.95	6.65	3.33	4.83	5.52	33.62	1.22	19.37
3	4.26	0.28	0.37	1.15	0.21	18.59	3.59	1.84	4.69	0.43	4.52	5.5	0.67
4	1.31	2.27	0	0.02	0.03	0.16	4.39	0.29	0.72	0.11	0.06	0.61	0.87
5	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0
16+	0	0	0	0	0	0	0	0	0	0	0	0	0

Age class	2000	2001	2002	2003	2005	2006	2007	2008	2009	2011	2013	2014	2015
2	6.07	34.42	7.42	8.37	13.12	9.51	3.42	18.52	13.25	2.25	1.34	1.17	10.374
3	11.35	3.92	3.87	4.6	7.98	9.21	1.78	6.66	6.25	1.39	0.08	1.02	0.661
4	0.03	1.57	0.4	0.59	0.84	1.02	0.3	0.34	0.33	0.42	0.1	0.11	0.253
5	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0
16+	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 10.1.3.1. Key model assumptions and parameters from the WGCSE 2014 update assessment.

Characteristic	Settings
Starting year	1985
Ending year	2013
Equilibrium catch for starting year	0.82* landings in 1985 by fleet.
Number of areas	1
Number of seasons	1
Number of fishing fleets	4
Number of surveys	two surveys: CGFS; Solent autumn survey (Solent spring and Thames survey removed).
Individual growth	von Bertalanffy, parameters fixed, combined sex
Number of active parameters	70
Population characteristics	
Maximum age	30
Genders	1
Population length bins	4–100, 2 cm bins
Ages for summary total biomass	0–30
Data characteristics	
Data length bins (for length structured fleets)	14–94, 2 cm bins
Data age bins (for age structured fleets)	0–16+
Minimum age for growth model	2
Maximum age for growth model	30
Maturity	Logistic 2-parameter – females; L50 = 40.65 cm
Fishery characteristics	
Fishery timing	-1 (whole year)
Fishing mortality method	Hybrid
Maximum F	2.9
Fleet 1: UK Trawl/nets/lines selectivity	Double normal, age-based
Fleet 2: UK Midwater trawl selectivity	Asymptotic, age-based
Fleet 3: Combined French fleet selectivity	Asymptotic, length-based
Fleet 4: Other fleets/gears selectivity	Asymptotic: mirrors French fleet
Year-invariant recreational fishing mortality vector (F(5–11) = 0.10;	Asymptotic, age-based (fixed, not estimated). Fs from age 0 to 8 = 0,0,0,0.002,0.013, 0.059, 0.097, 0.106, 0.107; ages 9+ = 0.107.) added to M=0.15 at each age and entered in CTL file as M vector.
Survey characteristics	
Solent autumn survey timing (yr)	0.83
CGFS survey timing (yr)	0.75
Catchabilities (all surveys)	Analytical solution
Survey selectivities: Solent autumn:	[all survey data entered as single ages; sel = 1]
Survey selectivities: CGFS	Double normal, length-based
Fixed biological characteristics	
Natural mortality	0.15 (fixed)
Beverton–Holt steepness	0.999 (fixed)
Recruitment variability (σR)	0.9 (fixed)

Characteristic	Settings
Geometric mean recruitment –virgin stock	8.9832 (estimated with soft bounds)
Weight–length coefficient	0.00001296 (fixed)
Weight–length exponent	2.969 (fixed)
Maturity inflection (L50%)	40.649 cm (fixed)
Maturity slope	-0.33349 (fixed)
Length-at-age Amin	19.6 cm at Amin=2[1] (fixed)
Length-at-Amax	84.119 cm (estimate with soft bounds; starting value 80.26 cm)
von Bertalanffy k	0.09699 (fixed)
von Bertalanffy Linf	84.55 cm (fixed)
von Bertalanffy t0	-0.730 yr (fixed)
Std. Deviation length-at-age (cm)	SD = 0.1166 * age + 3.5609
Age error matrix	CV 12% at-age
Other model settings	
First year for main recruitment deviations for burn-in period	1965
Last year for recruit deviations	2012 (last year class with survey indices)

[1] **as recommended by R. Methot after scrutinizing earlier SS3 runs during IBPNew 2012, and used by IBPNew and WGCSE.**

Table 10.1.3.2. Final sea bass update assessment: stock numbers-at-age (thousands of fish). Shaded figures for 2013–2015 year classes are values over-written at age 0 by the long-term geometric mean, decremented by natural mortality to give numbers-at-ages 1 and 2.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1985	355	505	9 429	3 588	2 756	764	756	617	879	2 518	631	397	298	236	188	145	584
1986	686	306	434	8 115	3 079	2 297	597	564	453	642	1 839	461	290	218	172	137	532
1987	7 868	590	263	374	6 960	2 554	1 766	433	400	320	454	1 298	325	205	154	122	473
1988	6 188	6 772	508	226	320	5 723	1 903	1 215	289	265	211	299	856	214	135	101	392
1989	37 654	5 326	5 828	437	194	265	4 387	1 377	862	204	187	149	211	604	151	95	348
1990	3 213	32 409	4 584	5 015	375	161	203	3 175	978	610	144	132	105	149	427	107	314
1991	6 106	2 765	27 892	3 944	4 300	310	123	146	2 244	689	430	102	93	74	105	301	297
1992	9 044	5 256	2 380	24 000	3 380	3 528	231	85	100	1 526	469	292	69	63	51	72	407
1993	4 163	7 784	4 523	2 048	20 571	2 784	2 653	162	58	68	1 035	318	198	47	43	34	324
1994	13 202	3 584	6 700	3 892	1 756	16 998	2 115	1 891	113	40	47	716	220	137	32	30	248
1995	20 048	11 363	3 084	5 765	3 338	1 453	13 055	1 546	1 363	81	29	34	516	158	99	23	200
1996	1 024	17 255	9 779	2 654	4 942	2 753	1 105	9 411	1 098	967	58	21	24	366	112	70	159
1997	23 272	882	14 850	8 414	2 273	4 043	2 027	751	6 216	721	634	38	14	16	240	74	150
1998	8 440	20 030	759	12 778	7 208	1 860	2 986	1 390	502	4 136	479	422	25	9	10	160	149
1999	22 970	7 264	17 238	653	10 948	5 916	1 384	2 064	935	336	2 764	320	282	17	6	7	206
2000	11 067	19 771	6 252	14 834	559	8 975	4 378	945	1 366	614	220	1 811	210	185	11	4	140
2001	12 605	9 525	17 015	5 380	12 714	460	6 732	3 057	643	923	414	149	1 222	142	125	7	97
2002	20 114	10 850	8 198	14 642	4 611	10 463	345	4 701	2 078	434	623	280	100	824	96	84	70
2003	21 068	17 312	9 337	7 054	12 548	3 791	7 836	241	3 205	1 410	294	422	190	68	559	65	105

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
2004	13 829	18 134	14 899	8 034	6 043	10 272	2 793	5 315	159	2 091	918	192	275	123	44	364	110
2005	10 283	11 903	15 606	12 821	6 882	4 943	7 545	1 885	3 475	103	1 354	595	124	178	80	29	307
2006	11 175	8 850	10 243	13 428	10 977	5 602	3 567	4 946	1 190	2 174	64	845	371	77	111	50	210
2007	8 606	9 619	7 617	8 814	11 496	8 924	4 031	2 331	3 114	743	1 354	40	526	231	48	69	162
2008	5 362	7 407	8 278	6 554	7 548	9 371	6 488	2 682	1 500	1 989	474	864	26	336	147	31	147
2009	4 508	4 615	6 375	7 123	5 612	6 152	6 827	4 345	1 744	969	1 284	306	558	16	217	95	115
2010	865	3 880	3 972	5 485	6 100	4 583	4 511	4 623	2 862	1 142	635	841	200	365	11	142	138
2011	2 845	745	3 339	3 418	4 695	4 951	3 290	2 948	2 918	1 793	715	397	526	125	228	7	175
2012	1 595	2 449	641	2 873	2 926	3 817	3 580	2 180	1 894	1 864	1 144	456	253	336	80	146	116
2013	10 576	1 373	2 107	551	2 458	2 358	2 693	2 297	1 356	1 173	1 154	709	283	157	208	50	162
2014	6 469	9 103	1 181	1 813	471	1 959	1 607	1 639	1 347	791	684	673	414	165	92	121	124
2015	6 469	11 108	7 831	1 016	1 548	373	1 329	1 002	1 009	835	492	427	420	258	103	57	153

Table 10.1.3.3. Final sea bass update assessment: fishing mortality-at-age.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1985	0.000	0.000	0.000	0.003	0.032	0.096	0.143	0.160	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164
1986	0.000	0.000	0.000	0.004	0.037	0.113	0.171	0.192	0.197	0.198	0.198	0.198	0.198	0.198	0.198	0.198	0.198
1987	0.000	0.000	0.000	0.004	0.046	0.144	0.224	0.255	0.264	0.265	0.266	0.266	0.266	0.266	0.266	0.266	0.266
1988	0.000	0.000	0.000	0.004	0.038	0.116	0.173	0.194	0.198	0.199	0.199	0.199	0.199	0.199	0.199	0.199	0.199
1989	0.000	0.000	0.000	0.004	0.039	0.117	0.173	0.192	0.196	0.196	0.196	0.196	0.196	0.196	0.196	0.196	0.196
1990	0.000	0.000	0.000	0.004	0.041	0.121	0.178	0.197	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1991	0.000	0.000	0.000	0.005	0.048	0.143	0.210	0.232	0.236	0.236	0.236	0.235	0.235	0.235	0.235	0.235	0.235
1992	0.000	0.000	0.000	0.004	0.044	0.135	0.205	0.231	0.237	0.238	0.238	0.238	0.238	0.238	0.238	0.238	0.238
1993	0.000	0.000	0.000	0.004	0.041	0.125	0.188	0.212	0.217	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218
1994	0.000	0.000	0.000	0.004	0.039	0.114	0.163	0.178	0.179	0.179	0.179	0.179	0.179	0.179	0.178	0.178	0.178
1995	0.000	0.000	0.000	0.004	0.043	0.124	0.177	0.192	0.194	0.193	0.193	0.192	0.192	0.192	0.192	0.192	0.192
1996	0.000	0.000	0.000	0.005	0.051	0.156	0.236	0.265	0.271	0.272	0.272	0.272	0.272	0.272	0.272	0.272	0.272
1997	0.000	0.000	0.000	0.005	0.051	0.153	0.227	0.253	0.257	0.258	0.258	0.257	0.257	0.257	0.257	0.257	0.257
1998	0.000	0.000	0.000	0.004	0.048	0.145	0.219	0.246	0.252	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253
1999	0.000	0.000	0.000	0.005	0.049	0.151	0.231	0.263	0.271	0.272	0.272	0.272	0.272	0.272	0.272	0.272	0.272
2000	0.000	0.000	0.000	0.004	0.045	0.137	0.209	0.236	0.242	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244
2001	0.000	0.000	0.000	0.004	0.045	0.138	0.209	0.236	0.242	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.243
2002	0.000	0.000	0.000	0.004	0.046	0.139	0.208	0.233	0.238	0.239	0.239	0.239	0.239	0.239	0.239	0.239	0.239
2003	0.000	0.000	0.000	0.005	0.050	0.156	0.238	0.270	0.277	0.279	0.279	0.279	0.279	0.279	0.279	0.279	0.279
2004	0.000	0.000	0.000	0.005	0.051	0.159	0.243	0.275	0.283	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
2005	0.000	0.000	0.000	0.005	0.056	0.176	0.272	0.310	0.319	0.321	0.321	0.322	0.322	0.322	0.322	0.322	0.322
2006	0.000	0.000	0.000	0.005	0.057	0.179	0.276	0.313	0.322	0.323	0.324	0.324	0.324	0.324	0.324	0.324	0.324
2007	0.000	0.000	0.000	0.005	0.054	0.169	0.257	0.290	0.298	0.299	0.300	0.300	0.300	0.300	0.300	0.300	0.300
2008	0.000	0.000	0.000	0.005	0.054	0.167	0.251	0.281	0.287	0.288	0.288	0.288	0.288	0.288	0.288	0.288	0.288
2009	0.000	0.000	0.000	0.005	0.053	0.160	0.240	0.268	0.273	0.274	0.274	0.274	0.274	0.274	0.274	0.274	0.274
2010	0.000	0.000	0.000	0.006	0.059	0.182	0.276	0.310	0.317	0.319	0.319	0.319	0.319	0.319	0.319	0.319	0.319
2011	0.000	0.000	0.000	0.005	0.057	0.174	0.262	0.292	0.298	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299
2012	0.000	0.000	0.000	0.006	0.066	0.199	0.294	0.324	0.329	0.329	0.329	0.329	0.329	0.329	0.328	0.328	0.328
2013	0.000	0.000	0.000	0.007	0.077	0.233	0.346	0.384	0.390	0.390	0.389	0.389	0.389	0.389	0.389	0.389	0.389
2014	0.000	0.001	0.001	0.008	0.085	0.238	0.323	0.335	0.328	0.323	0.321	0.321	0.320	0.320	0.320	0.320	0.320

Table 10.1.3.4. Final sea bass update assessment: stock summary table.

	Recruitment (age 0)			SSB (t)			TSB (t)		Landings	
Year	Estimate ('000)	lower	upper	Estimate	lower	upper	Estimate	F(5–11)	Commercial	Recreational
1985	355	22	688	13 506	11 095	15 916	17 078	0.151	994	1 222
1986	686	68	1 304	12 242	10 029	14 455	16 432	0.181	1 318	1 123
1987	7 868	5 717	10 019	11 155	9 140	13 170	15 461	0.241	1 979	1 062
1988	6 188	3 395	8 980	10 154	8 332	11 975	13 821	0.183	1 239	1 047
1989	37 654	32 655	42 653	10 054	8 340	11 767	13 024	0.181	1 161	988
1990	3 213	750	5 675	9 481	7 783	11 179	12 846	0.185	1 064	866
1991	6 106	3 527	8 685	8 497	6 794	10 200	14 035	0.218	1 226	761
1992	9 044	6 265	11 823	7 507	5 827	9 186	15 673	0.217	1 186	749
1993	4 163	2 030	6 297	7 738	6 104	9 372	17 811	0.200	1 256	940
1994	13 202	9 593	16 811	9 710	8 160	11 260	19 886	0.167	1 370	1 319
1995	20 048	16 249	23 846	12 825	11 286	14 363	21 312	0.181	1 835	1 524
1996	1 024	65	1 984	14 725	13 087	16 362	22 003	0.249	3 022	1 505
1997	23 272	18 885	27 659	14 309	12 601	16 016	21 611	0.238	2 620	1 407
1998	8 440	3 975	12 906	13 592	11 842	15 343	21 643	0.232	2 390	1 338
1999	22 970	17 514	28 426	13 219	11 437	15 001	22 438	0.248	2 670	1 372
2000	11 067	6 906	15 228	13 313	11 503	15 122	23 240	0.222	2 407	1 454
2001	12 605	7 250	17 961	14 090	12 195	15 985	24 672	0.222	2 500	1 505
2002	20 114	13 357	26 871	14 768	12 767	16 768	26 121	0.219	2 622	1 610

	Recruitment (age 0)			SSB (t)			TSB (t)		Landings	
Year	Estimate ('000)	lower	upper	Estimate	lower	upper	Estimate	F(5–11)	Commercial	Recreational
2003	21 068	14 869	27 267	15 807	13 714	17 900	27 582	0.254	3 459	1 703
2004	13 829	8 772	18 886	16 458	14 294	18 622	28 477	0.259	3 731	1 785
2005	10 283	6 288	14 278	17 024	14 802	19 247	29 255	0.292	4 430	1 778
2006	11 175	7 147	15 204	16 759	14 455	19 062	29 305	0.294	4 377	1 743
2007	8 606	4 796	12 416	16 619	14 236	19 001	29 231	0.273	4 064	1 805
2008	5 362	2 150	8 575	17 294	14 810	19 779	29 074	0.264	4 107	1 902
2009	4 508	2 094	6 922	18 021	15 331	20 710	28 186	0.252	3 889	1 921
2010	865	0	1 739	18 215	15 213	21 217	26 712	0.291	4 562	1 824
2011	2 845	1 158	4 533	17 001	13 616	20 386	23 876	0.275	3 858	1 678
2012	1 595	378	2 812	15 738	11 899	19 578	21 055	0.305	3 987	1 500
2013	10 576	1 046	20 107	13 781	9 438	18 125	17 630	0.360	4 137	1 246
2014	6 469			11 057	6 219	15 896	13 870	0.313	2 682	998
2015	6 469			9 084	3 820	14 348	11 708		2 040	799
2016				7 330						

Table 10.1.5.1. Inputs for short-term forecast. Fishing mortality is the estimates for 2015, which takes into account a change in overall selectivity due to the reduction in French landings. Numbers-at-ages 0–2 in 2015 are adjusted by replacing Stock Synthesis values for 0-group in 2014–2015 (years with no recruit deviations estimated) with the long-term GM, adjusted for natural mortality.

AGE	2015	WEIGHT IN STOCK	PROPORTION MATURE (FEMALE)	H.CONS MEAN F (2014)	H.CONS MEAN WEIGHTS	RECREATIONAL F	RECREATIONAL REMOVALS MEAN WEIGHT	M
0	6 469	0.003	0.000	0.000	0.000	0.000	0.000	0.15
1	5 568	0.023	0.000	0.000	0.055	0.000	0.120	0.15
2	4 791	0.096	0.000	0.000	0.273	0.000	0.282	0.15
3	6 736	0.209	0.000	0.005	0.471	0.002	0.467	0.15
4	868	0.369	0.186	0.053	0.644	0.018	0.620	0.15
5	1 234	0.570	0.419	0.154	0.809	0.053	0.777	0.15
6	257	0.807	0.638	0.220	1.003	0.078	0.977	0.15
7	843	1.073	0.792	0.235	1.242	0.088	1.227	0.15
8	624	1.359	0.885	0.233	1.518	0.091	1.512	0.15
9	630	1.659	0.937	0.231	1.817	0.092	1.814	0.15
10	523	1.968	0.965	0.229	2.125	0.092	2.123	0.15
11	309	2.279	0.980	0.229	2.435	0.092	2.434	0.15
12	268	2.588	0.989	0.229	2.742	0.092	2.741	0.15
13	264	2.893	0.993	0.229	3.042	0.092	3.042	0.15
14	162	3.190	0.996	0.229	3.334	0.092	3.334	0.15
15	65	3.476	0.998	0.229	3.615	0.092	3.615	0.15
16+	132	4.181	0.998	0.229	4.222	0.092	3.884	0.15

Age 0,1,2 over-written as follows:

2016 yc 2016 age 0 replaced by 1985–2013 LTGM (6469);

2015 yc 2016 age 1 from SS3 survivor estimate at-age 1, 2016 * LTGM / SS3 estimate of age 0 in 2014;

2014 yc 2016 age 2 from SS3 survivor estimate at-age 2, 2016 * LTGM / SS3 estimate of age 0 in 2013.

Table 10.1.5.2. Bass-47: Detailed short-term *status quo* forecast. The F-at-age in 2015, when the French pelagic fishery was substantially reduced, was assumed as *status quo* for 2016 when the pelagic fishery was closed in spring.

Year: 2016
H.cons F mult: 1 F(5-11): 0.219
Recreational F mult 1 F(5-11): 0.084

Age	F(5-11): Commercial	F(5-11): Recreational	Catch Nos: Commercial	Yield: Commercial	Catch Nos: Recreational	Yield: Recreational	Stock Nos	Biomass	SSB nos. Jan 1	SSB tonnes Jan 1
0	0.000	0.000	0.0	0.0	0.0	0.0	6469	18	0	0
1	0.000	0.000	1.8	0.1	0.0	0.0	5568	130	0	0
2	0.000	0.000	2.1	0.6	0.2	0.1	4791	458	0	0
3	0.005	0.002	29.5	13.9	11.2	5.2	6736	1407	0	0
4	0.053	0.018	40.9	26.4	14.0	8.7	868	320	162	60
5	0.154	0.053	160.3	129.6	54.8	42.6	1234	704	517	295
6	0.220	0.078	45.6	45.8	16.2	15.9	257	208	164	133
7	0.235	0.088	157.6	195.7	59.2	72.6	843	904	667	716
8	0.233	0.091	115.8	175.8	45.3	68.5	624	848	552	750
9	0.231	0.092	115.8	210.4	46.2	83.8	630	1046	591	980
10	0.229	0.092	95.7	203.3	38.5	81.7	523	1029	505	993
11	0.229	0.092	56.4	137.4	22.7	55.4	309	704	303	690
12	0.229	0.092	48.9	134.0	19.7	54.1	268	693	265	686
13	0.229	0.092	48.2	146.6	19.4	59.1	264	764	262	759
14	0.229	0.092	29.6	98.7	11.9	39.8	162	517	162	515
15	0.229	0.092	11.8	42.7	4.8	17.2	65	225	65	224
16+	0.229	0.092	24.1	101.7	9.7	37.8	132	552	132	551
Total			984	1663	374	642	29745	10529	4346	7352

Year: 2017
H.cons F mult: 1 F(5-11): 0.219
Recreational F mult 1 F(5-11): 0.084

Age	F(5-11): Commercial	F(5-11): Recreational	Catch Nos: Commercial	Yield: Commercial	Catch Nos: Recreational	Yield: Recreational	Stock Nos	Biomass	SSB nos. Jan 1	SSB tonnes Jan 1
0	0.000	0.000	0.0	0.0	0.0	0.0	0	0	0	0
1	0.000	0.000	1.8	0.1	0.0	0.0	5568	130	0	0
2	0.000	0.000	2.1	0.6	0.2	0.1	4791	459	0	0
3	0.005	0.002	18.0	8.5	6.8	3.2	4121	861	0	0
4	0.053	0.018	271.4	174.9	92.8	57.6	5760	2123	1073	396
5	0.154	0.053	90.4	73.2	30.9	24.0	696	397	292	166
6	0.220	0.078	153.0	153.4	54.5	53.2	863	697	551	445
7	0.235	0.088	30.8	38.2	11.6	14.2	164	176	130	140
8	0.233	0.091	97.5	148.0	38.1	57.6	525	714	465	631
9	0.231	0.092	71.4	129.6	28.5	51.6	388	644	364	604
10	0.229	0.092	71.9	152.7	28.9	61.4	393	773	379	746
11	0.229	0.092	59.6	145.1	24.0	58.5	326	744	320	729
12	0.229	0.092	35.2	96.5	14.2	38.9	193	499	191	494
13	0.229	0.092	30.5	92.8	12.3	37.5	167	484	166	481
14	0.229	0.092	30.1	100.3	12.1	40.5	165	526	164	524
15	0.229	0.092	18.5	66.8	7.5	27.0	101	352	101	351
16+	0.229	0.092	22.4	94.6	9.0	35.1	123	514	123	513
Total			1004	1475	372	560	24347	10094	4319	6219

Year: 2018
H.cons F mult: 1 F(5-11): 0.219
Recreational F mult 1 F(5-11): 0.084

Age	F(5-11): Commercial	F(5-11): Recreational	Catch Nos: Commercial	Yield: Commercial	Catch Nos: Recreational	Yield: Recreational	Stock Nos	Biomass	SSB nos. Jan 1	SSB tonnes Jan 1
0	0.000	0.000	0.0	0.0	0.0	0.0	0	0	0	0
1	0.000	0.000	0.0	0.0	0.0	0.0	0	0	0	0
2	0.000	0.000	2.1	0.6	0.2	0.1	4791	459	0	0
3	0.005	0.002	18.0	8.5	6.8	3.2	4122	861	0	0
4	0.053	0.018	166.1	107.0	56.8	35.2	3524	1299	657	242
5	0.154	0.053	600.0	485.3	205.2	159.5	4620	2635	1937	1104
6	0.220	0.078	86.3	86.6	30.7	30.0	487	393	311	251
7	0.235	0.088	103.1	128.1	38.7	47.5	552	592	437	468
8	0.233	0.091	19.0	28.9	7.4	11.2	103	139	91	123
9	0.231	0.092	60.1	109.1	24.0	43.5	327	543	306	508
10	0.229	0.092	44.3	94.1	17.8	37.8	242	476	234	460
11	0.229	0.092	44.8	109.0	18.1	43.9	245	559	240	548
12	0.229	0.092	37.2	102.0	15.0	41.1	204	527	201	521
13	0.229	0.092	22.0	66.8	8.9	27.0	120	348	120	346
14	0.229	0.092	19.0	63.5	7.7	25.6	104	333	104	332
15	0.229	0.092	18.8	67.9	7.6	27.4	103	358	103	357
16+	0.229	0.092	25.5	107.8	10.3	40.0	140	585	140	584
Total			1266	1565	455	573	19684	10107	4880	5845

Table 10.1.5.3. Management options table. The F-at-age in 2015, when the French pelagic fishery was substantially reduced, was assumed as *status quo* for 2016 when the pelagic fishery was closed in spring, and assumed to continue in 2017. F-Multipliers for 2017 are applied to both the commercial and recreational fishery. Note that the combined total commercial and recreational forecasted catch could be allocated in different ways.

2016		Commercial fishery			Recreational fishery			Total fishery	
Biomass	SSB	Fmult	Fbar	Landings	Fmult	Fbar	Landings	Total Fbar	Total landings
10529	7352	1	0.219	1663	1	0.084	642	0.303	2305

2017		Commercial fishery			Recreational fishery			Total fishery		2018	
Biomass	SSB	Fmult	Fbar	Landings	Fmult	Fbar	Landings	Total Fbar	Total landings	Biomass	SSB
10094	6219	0	0.000	0	0	0.000	0	0.000	0	12074	7583
		0	0.000	0	0	0.000	0	0.000	0	12074	7583
		0.2	0.044	328	0.2	0.017	125	0.061	453	11634	7192
		0.211	0.046	346	0.211	0.018	132	0.064	478	11610	7171
		0.335	0.073	540	0.335	0.028	205	0.101	745	11351	6941
		0.4	0.087	639	0.4	0.034	243	0.121	882	11218	6824
	F_{MSY}	0.430	0.094	684	0.430	0.036	260	0.130	944	11159	6771
		0.6	0.131	933	0.6	0.050	355	0.182	1288	10827	6478
		0.7	0.153	1074	0.7	0.059	408	0.212	1483	10639	6312
		0.8	0.175	1212	0.8	0.067	460	0.242	1672	10457	6152
		1	0.219	1475	1	0.084	560	0.303	2036	10107	5845
		1.2	0.262	1725	1.2	0.101	655	0.363	2380	9777	5556
		1.4	0.306	1962	1.4	0.117	745	0.424	2707	9465	5285
		1.4264	0.312	1992	1.4264	0.120	756	0.432	2748	9425	5250
		1.6	0.350	2187	1.6	0.134	829	0.484	3016	9170	5029
		1.8	0.394	2399	1.8	0.151	910	0.545	3309	8892	4788
		2	0.437	2601	2	0.168	986	0.605	3587	8628	4561

Table 10.1.5.31. Annual average cpue bars Group 0 (1000 minutes trawling) and annual deviations from the time-series average per site. The sites are listed from north to south.

	annual LPUE (number of age 0 for 1000minutes of trawling								average annual deviation					
	area	2005	2006	2007	2009	2010	2011	average per area	2005	2006	2007	2009	2010	2011
East Channel	seine aval		4			133	15	51		-91			161	-70
	Ome		206			164	268	213		-3			-23	26
	Baie des Veys	0	167			96	4	89	-100	88			7	-95
West Channel	Mont St Michel		567			836	252	551		3			52	-54
	Morlaix			664	182	535	456	459			45	-60	16	-1
South Britanny	Laita			0	2	278	17	74			-100	-98	275	-78
	Blavet			25	42	19	58	36			-32	17	-46	61
	Vilaine			301	19	23	101	111			171	-83	-79	-9
Bay of Biscay	Loire		151		192	0	30	93		62		106	-100	-68
	Sevre Niortaise			3772	2133	460	74	1610			134	32	-71	-95
	Charente				28	14	6	16				76	-12	-65
	Seudre	0			127	0	11	35	-100			268	-100	-68
	Gironde aval					87	7	47					86	-86
	Gironde	3			72			38	-91			91		
	Adour aval	4	22		12	0	0	8	-45	191		54	-100	-100
								mean	-84	42	44	40	5	-50
SD >-20%								SD	26.2	96	112.6	108.1	109.6	49.8
-20%<SD>20%														
SD >+20%														

Table 10.1.6.1. Alternative management options table. Assuming an F *status quo* for 2016 = F_{2015}*0.7. F-Multipliers for 2017 are applied to both the commercial and recreational fishery. Note that the combined total commercial and recreational forecasted catch could be allocated in different ways.

2016		Commercial fishery			Recreational fishery			Total fishery	
Biomass	SSB	Fmult	Fbar	Landings	Fmult	Fbar	Landings	Total Fbar	Total landings
10529	7352	0.7	0.153	1215	0.7	0.059	469	0.212	1684

2017		Commercial fishery			Recreational fishery			Total fishery		2018	
Biomass	SSB	Fmult	Fbar	Landings	Fmult	Fbar	Landings	Total Fbar	Total landings	Biomass	SSB
10700	6779	0	0.000	0	0	0.000	0	0.000	0	12681	8160
		0.2	0.031	355	0.2	0.012	136	0.042	491	12204	7733
		0.22975	0.035	407	0.22975	0.013	155	0.049	562	12135	7672
		0.4	0.061	691	0.4	0.023	264	0.085	955	11754	7332
		0.614	0.094	1031	0.614	0.036	393	0.130	1424	11300	6929
		0.6	0.092	1009	0.6	0.035	385	0.127	1394	11329	6954
		0.8	0.122	1310	0.8	0.047	499	0.169	1809	10928	6599
		1	0.153	1162	1	0.059	443	0.212	1604	11126	6774
		1.2	0.184	1864	1.2	0.070	709	0.254	2574	10193	5951
		1.4	0.214	2120	1.4	0.082	806	0.296	2926	9856	5655
		0.0387	0.006	70	0.0387	0.002	27	0.008	97	12586	8075
		1.6	0.245	2362	1.6	0.094	898	0.339	3260	9537	5376
		1.8	0.276	2591	1.8	0.106	985	0.381	3576	9236	5114
		2	0.306	2809	2	0.117	1067	0.424	3876	8952	4866

Table 10.1.6.2. Alternative management options table. Assuming an F *status quo* for 2016 = F_{2015}*0.5. F-Multipliers for 2017 are applied to both the commercial and recreational fishery. Note that the combined total commercial and recreational forecasted catch could be allocated in different ways.

2016		Commercial fishery			Recreational fishery			Total fishery	
Biomass	SSB	Fmult	Fbar	Landings	Fmult	Fbar	Landings	Total Fbar	Total landings
10529	7352	1	0.109	893	1	0.042	345	0.151	1238

2017		Commercial fishery			Recreational fishery			Total fishery		2018	
Biomass	SSB	Fmult	Fbar	Landings	Fmult	Fbar	Landings	Total Fbar	Total landings	Biomass	SSB
11137	7183	0	0.000	0	0	0.000	0	0.000	0	13118	8575
		0.2	0.022	190	0.2	0.008	73	0.030	263	12862	8346
		0.4	0.044	375	0.4	0.017	143	0.061	518	12614	8123
		0.6	0.066	554	0.6	0.025	212	0.091	766	12373	7907
		0.444	0.049	415	0.444	0.019	158	0.067	573	12560	8075
		0.487	0.053	453	0.487	0.020	173	0.074	627	12508	8028
		0.859	0.094	780	0.859	0.036	298	0.130	1078	12070	7637
		0.8	0.087	729	0.8	0.034	278	0.121	1007	12139	7698
		1	0.109	899	1	0.042	343	0.151	1242	11911	7495
		1.2	0.131	1064	1.2	0.050	406	0.182	1470	11691	7298
		1.4	0.153	1225	1.4	0.059	467	0.212	1692	11476	7107
		1.6	0.175	1381	1.6	0.067	527	0.242	1908	11268	6921
		1.8	0.197	1533	1.8	0.075	585	0.272	2118	11065	6742
		2	0.219	1681	2	0.084	641	0.303	2322	10869	6567

Table 10.1.7.1. Proposed Inter-benchmark assessment amendment to IBPBass assessment procedure by correspondence, February 2016.

STOCK	SEA BASS IN 4.BC AND 7.A,D–H

ISSUE	PROBLEM/AIM	WORK NEEDED / POSSIBLE DIRECTION OF SOLUTION	DATA NEEDED TO BE ABLE TO DO THIS: ARE THESE AVAILABLE / WHERE SHOULD THESE COME FROM?	EXTERNAL EXPERTISE NEEDED AT BENCHMARK TYPE OF EXPERTISE / PROPOSED NAMES
Validation of use of French fishery age compositions in the assessment	WGCSE 2015 carried out a Stock Synthesis run using French age compositions from 2000–2014 rather than length compositions. This removed an unusual sharp increase in F in recent years, and the fit to the data, though noisy, showed no residual patterns which are apparent in the residuals to the fit of the length data. A change to the agreed methods from IBPBass needs to be agreed to allow use of the age data in the 2016 update assessment.	Evaluation of the French landings-at-age data. Review outcome of 2015 age calibration study between UK and France. Develop input data including empirical weights at age for French and UK fleets. More detailed comparison of model performance using age rather than length data. Establish the most appropriate selection pattern and input priors/soft bounds. Explore methods of deriving age compositions for the Channel groundfish surveys from the length data and evaluate performance in the assessment.	All data are available.	Stock assessment expert. For continuity, external review by one of the IBPBass benchmark meeting would be valuable. E.g. Chris Legault, NOAA.

Suggested ToRs: (a) Review quality and performance of age composition data for French fishery landings in the Stock Synthesis model formulated by IBPBass; (b) Develop input data including empirical weights-at-age; (c) Develop age compositions for the Channel groundfish survey and test in SS3 model.

Table 10.1.7.2. Proposed full benchmark to be done together with WGBIE bass stocks in ICES 8, 9, 10. Benchmark assessment around March 2017, data compilation / evaluation late 2016 or January 2017.

STOCK	SEA BASS IN 4.BC AND 7.A,D–H

ISSUE	PROBLEM/AIM	WORK NEEDED/ POSSIBLE DIRECTION OF SOLUTION	DATA NEEDED TO BE ABLE TO DO THIS: ARE THESE AVAILABLE / WHERE SHOULD THESE COME FROM?	EXTERNAL EXPERTISE NEEDED AT BENCHMARK TYPE OF EXPERTISE / PROPOSED NAMES
Fishery landings data	The assessment is heavily driven by fishery landings data and age/length compositions. Historical landings are subject to several biases, and this will bias the assessment trends.	Review the French landings prior to 2000. Develop more accurate series of UK small scale national fisheries landings. Develop plausible alternative scenarios for landings series for testing in SS3 including pre-1985 data..	Historical national landings data (available). Cefas sea bass logbook data (available) plus other regional observations (to be sourced)	
Fishery composition data and selectivity	SS3 model relies on fitting selectivity by fleet, and this needs sufficiently accurate data on age/length composition and to properly account for any changes in selectivity whilst minimising numbers of parameters to estimate. Current implementation of age and length selectivity could be a source of bias in estimating stock trends.	Review quality and amount of sampling for length and age composition by fleet; examine evidence for shapes of selectivity curves and for changes in selectivity over time; identify minimum sufficient disaggregation of fleets; evaluate parameter correlations and minimise numbers of parameters to estimate; review availability of French sampling data prior to 2000; evaluate sampling data by métier from other countries (Netherlands; Belgium). Identify leverage of individual fleet data on final results.	Sample and fleet data held nationally. Available	

Issue	Problem/Aim	Work needed/ possible direction of solution	Data needed to be able to do this: are these available / where should these come from?	External expertise needed at benchmark type of expertise / proposed names
Recreational catches and selectivity	Recreational fishery catches are considered to be around quarter of total removals but current assessment uses only one annual estimate to provide a crude value for recreational fishing mortality to apply to all years. This assumption is almost certainly incorrect and it will be necessary to account for changes in recreational catches based on successive survey estimates as they become available. Selectivity of recreational catches is based on limited data and is likely to change over time.	Update results of new surveys conducted since WGCSE 2015, if available. Develop and test alternative methods for accounting for recreational fishery catches in the assessment. Liaise with ICES WGRFS to develop inputs and methods.	Recreational survey estimates available nationally and from submissions to ICES WGRFS.	
Relative abundance indices	The assessment currently includes the French Channel Groundfish Survey and the UK Solent pre-recruit survey. These are restricted to 7.d and not the full stock area, and are mainly focused on young bass. They show similar trends to analysis of commercial landings-at-age/length data without the surveys included, and appear to have limited influence on the model fit. The design of the Channel GFS is expected to change in 2015 and this may render it unsuitable for inclusion in the assessment. Relative abundance indices are needed that cover the full age range and stock area.	Evaluate the calibration and the area covered by the new vessel for the redesigned CGFS survey. Collate and evaluate information on changes in abundance of young bass in nursery areas in the UK and France, and evaluate the need for a more coordinated pre-recruit survey in terms of potential benefits vs costs. A study modelling French commercial fishery lpue is available and should be further developed and tested in the assessment. Evaluate UK data for inclusion in the lpue analysis.	Ifremer data for the CGFS calibration (available); UK and French pre-recruit dataseries for as many nursery areas as possible (mostly available). UK and French landings and effort data by rectangle and trip, with vessel/gear data (available). Data from the Netherlands and Belgium should be requested also.	

Issue	Problem/Aim	Work needed/ possible direction of solution	Data needed to be able to do this: are these available / where should these come from?	External expertise needed at benchmark type of expertise / proposed names
Discards	Discards estimates are imprecise due to small numbers of sampled trips with sea bass catches, are available only for a recent period, and are not included in assessment though considered low. However absence of data in assessment could cause some bias, and prevents correct estimation of selectivity to allow evaluation of technical conservation measures such as minimum conservation reference size	Compile historical estimates; evaluate precision and bias; test some scenarios for including data in the assessment	Discards data are held nationally and are available	
Post release mortality	Inclusion of discards estimates in the assessment needs an evaluation of potential survival rates of released fish. Post release mortality in recreational fisheries needs to be accounted for. Increases in MLS and recreational bag limits will lead to more releases.	Provide updated review of studies on post release mortality in liaison with WGRFS. Test sensitivity of assessment and advice to assumptions regarding post release mortality.	Literature review.	
Stock structure and migration	Stock structure remains uncertain. Trends in recruitment could vary between areas whilst current surveys are spatially limited. Movements between 4/7 and 8, particularly if changing over time, would bias the assessment trends.	Review findings of the UK C-Bass and French BarGip projects which have carried out tagging studies and hydrographic modelling of egg and larval dispersal. SS3 could potentially be configured to include spatially disaggregated data covering population within area 4, 7 and 8, as an exploratory exercise and to see if this could improve the advice for both areas.	Results of UK and French studies should be available; assessment input data for Bass-47 and Bass-8ab needed and will be available.	

Issue	Problem/Aim	Work needed/ possible direction of solution	Data needed to be able to do this: are these available / where should these come from?	External expertise needed at benchmark type of expertise / proposed names
Biological Parameters	Natural mortality is considered as constant over time at a relatively low value of 0.15, set for all ages. Maturity ogives are based on long-term historical UK sampling data and do not account for any trends that may have occurred. Inappropriate treatment of growth and M could bias the assessment and reference points, whilst not accounting for changes in maturity would bias SSB trends and reference points.	Review evidence for spatio-temporal variation in growth and maturity, and age-dependent M. Examine sensitivity of assessment and advice to this. Develop parameter inputs for future assessments.	Historical and recent sampling data for growth and maturity. Available nationally. Review methods for identifying appropriate M values and plausible ranges.	
Assessment method	Stock Synthesis 3 is complex, highly parameterised and requires considerable expertise to fully understand how to set up the model and interpret the diagnostics. If age data become available for French fishery and survey data, alternative models could be explored more easily. If SS3 is retained, more comprehensive evaluation of model performance is needed, e.g. jitter analysis, and this needs to be developed.	Comparison of performance of alternative assessment models of differing structure and complexity including very simple approaches. Further development of SS3 and presentation / interpretation of diagnostics, forecasts and MCMC evaluation of confidence intervals.	Will be done with available data.	Expertise in Stock Synthesis and other statistical and simpler assessment methods. Suggest: Neil Klaer (CSIRO, Hobart), Chris Legault (NOAA),
Biological Reference Points	Current reference point is F_{MSY} proxy = F35%spr. This is driven by the choice of M. The assessment forces stock-recruit steepness as 1.0 as there is little information in the stock-recruit data to define steepness.	Review of choice of M as discussed above. Further evaluation of S/R steepness including S/R data from alternative assessment models.	Agreed stock assessment inputs.	As for assessment methods

Proposed Terms of Reference for Data Compilation and Evaluation meeting:

a) Evaluate quality of historical fishery landings data and develop series by country, area and gear including plausible alternative scenarios where biases are known or suspected. Develop scenarios for pre-1985 landings.

b) Compile and evaluate historical estimates of discards by fleet and provide indicators of precision and bias.

c) Compile and evaluate length and age composition by fleet for landings and discards, and weights-at-length or -age, and provide indicators of precision and bias.

d) Compile historical estimates of recreational catches and length–age compositions by country and area, for retained and released components, and provide indicators of precision and bias.

e) Provide updated review of studies on post release mortality in commercial and recreational fisheries, and propose candidate ranges of values for sea bass.

f) Review findings of the UK C-Bass and French BarGip projects and identify if any changes to stock areas are needed based on connectivity of populations in neighbouring areas shown by tagging and hydrographic modelling of egg/larva dispersal.

g) Compile and evaluate available series of fishery-independent and fishery-dependent indices of abundance, and propose series for use in assessment together with quality indicators that could guide relative weightings in the assessment.

h) Update previous review of methods to establish the value of natural mortality, and propose any changes needed including age-dependent values if appropriate.

i) Review evidence for spatio-temporal variation in growth and maturity and develop parameter inputs for the benchmark assessment.

ToRs for benchmark assessment meeting to be decided.

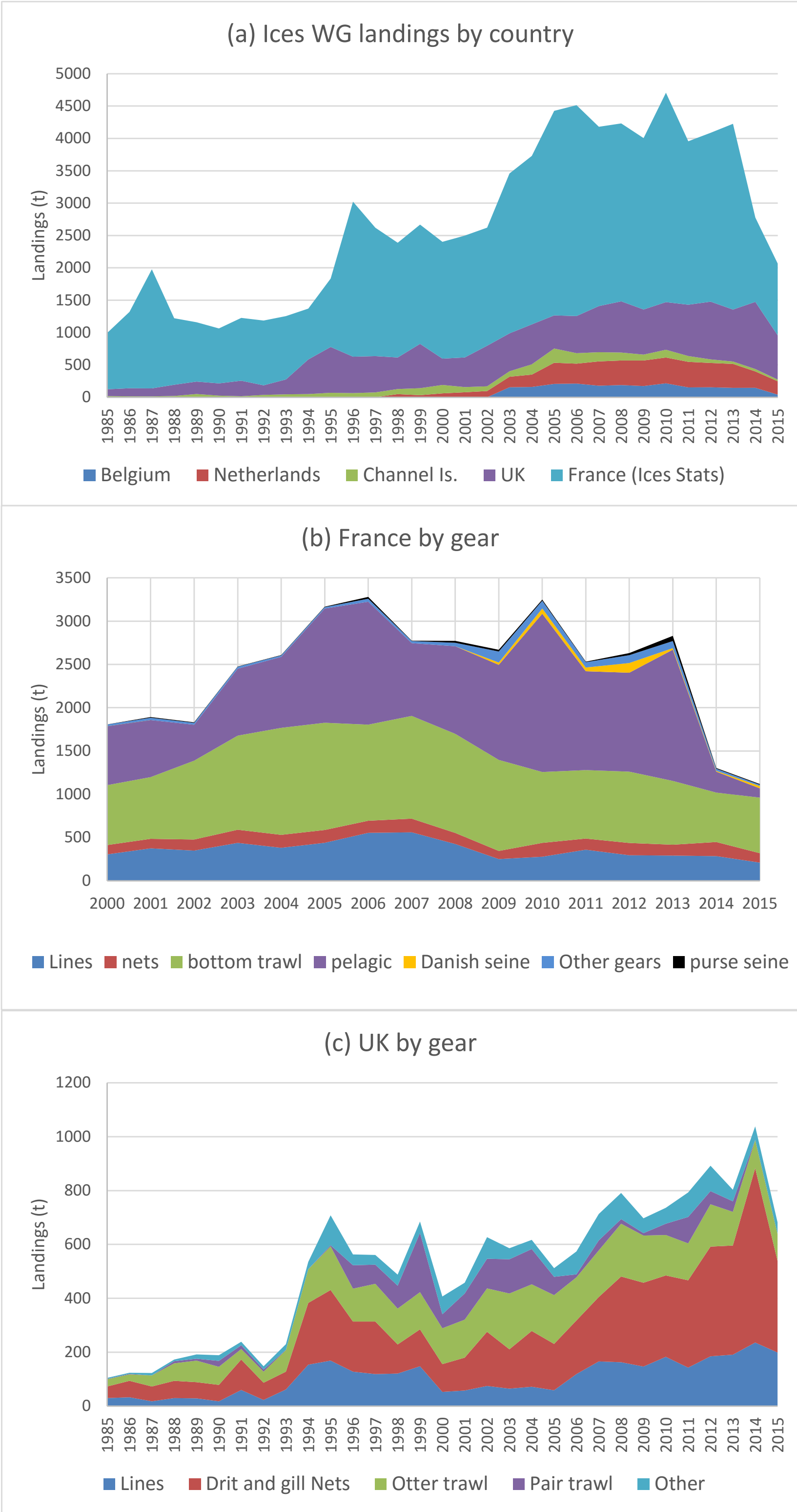


Figure 10.1.1.1. Bass-47: Trends in ICES Working Group landings by (a) country and (b, c) by gear group in France and the UK (Source: Official Catch Statistics 1985–2015 and data supplied by national laboratories).

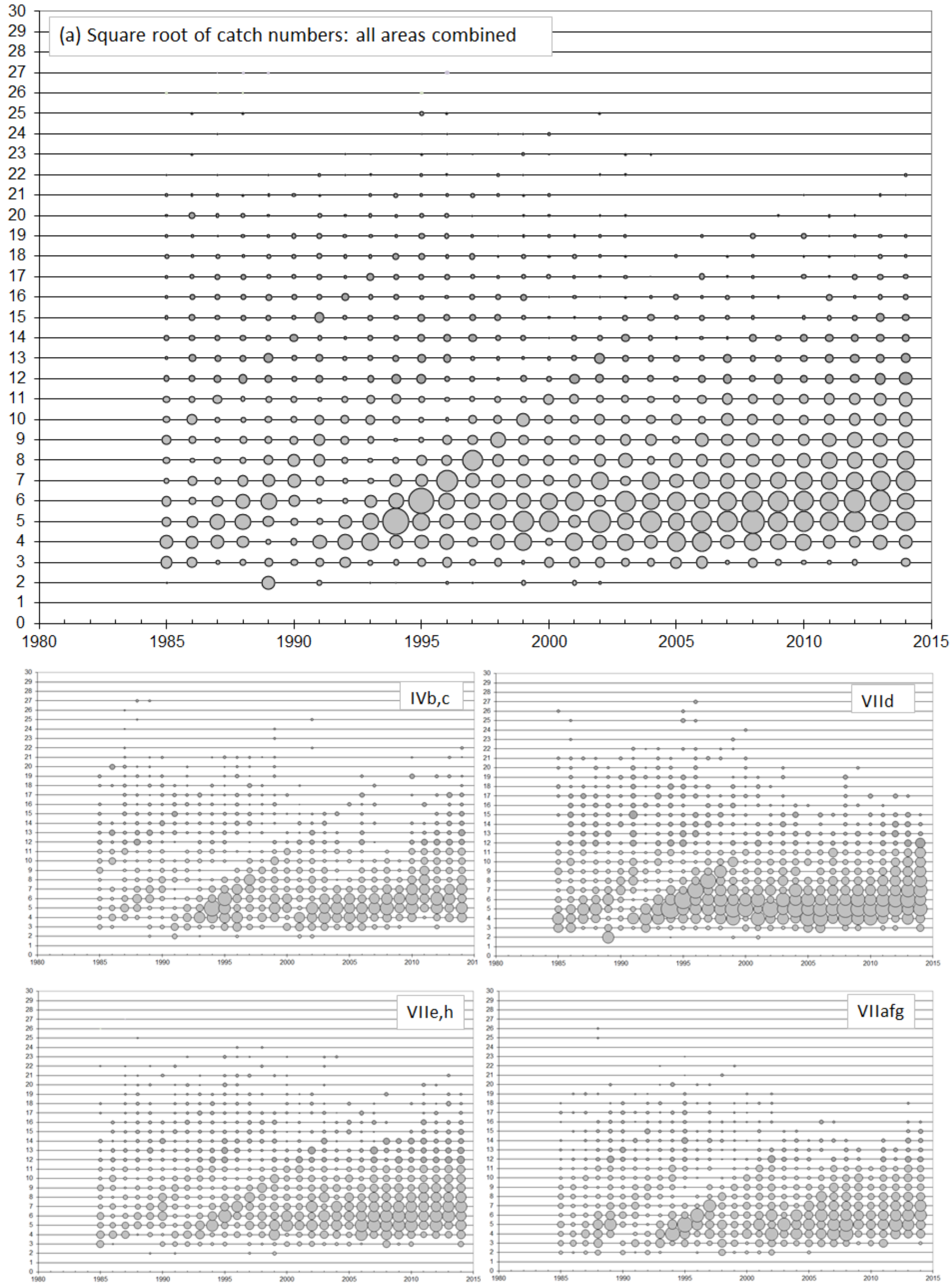


Figure 10.1.2.1. (a) Annual landings-at-age in the combined UK(E&W) trawls, nets and lines fleet. Bubble diameter is proportional to the square root of the catch number. Data for the four separate regions with independent length compositions and age–length keys are shown below. All plots are standardised so will not show actual differences in catches between regions.

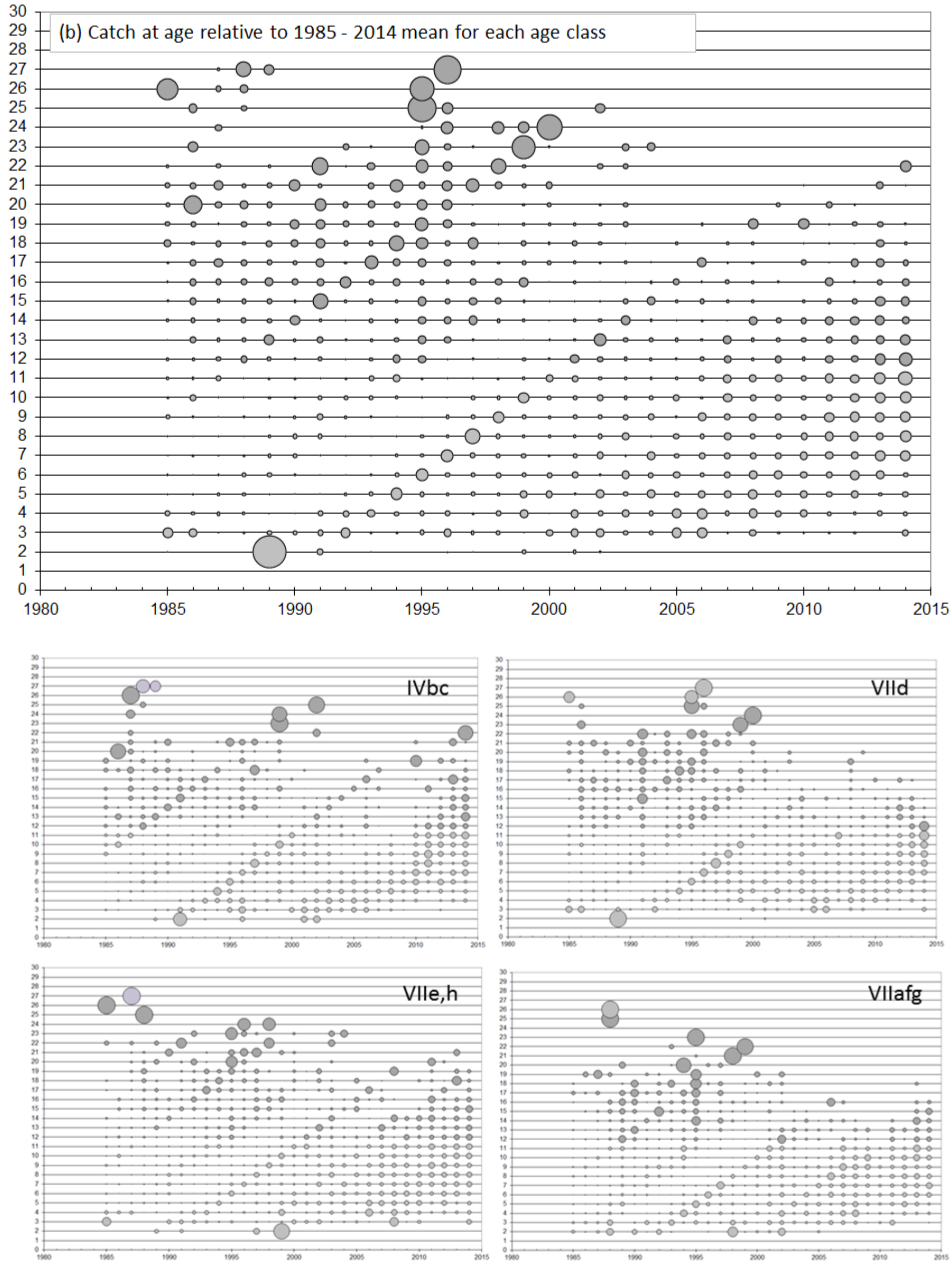


Figure 10.1.2.1. (b) Annual landings-at-age in the combined UK(E&W) trawls, nets and lines fleet, standardised at each age class by dividing by the 1985–2014 mean catch numbers for the age class. Data for the four separate regions with independent length compositions and age–length keys are shown below.

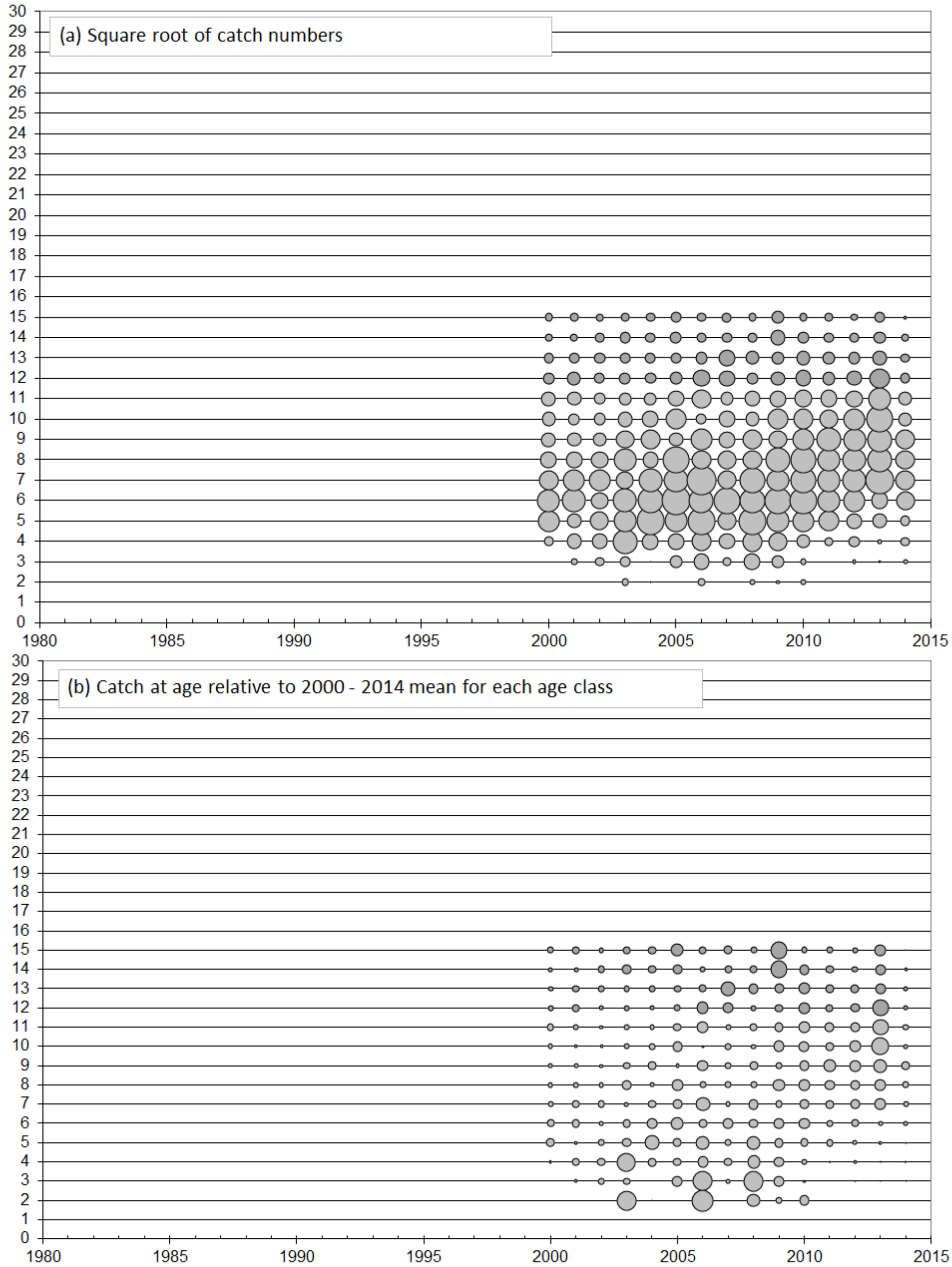


Figure 10.1.2.1. (c) Annual landings-at-age in the combined French fleets, as (top) square root of catch numbers, and (bottom) standardised at each age class by dividing by the 2000–2014 mean catch numbers for the age class.

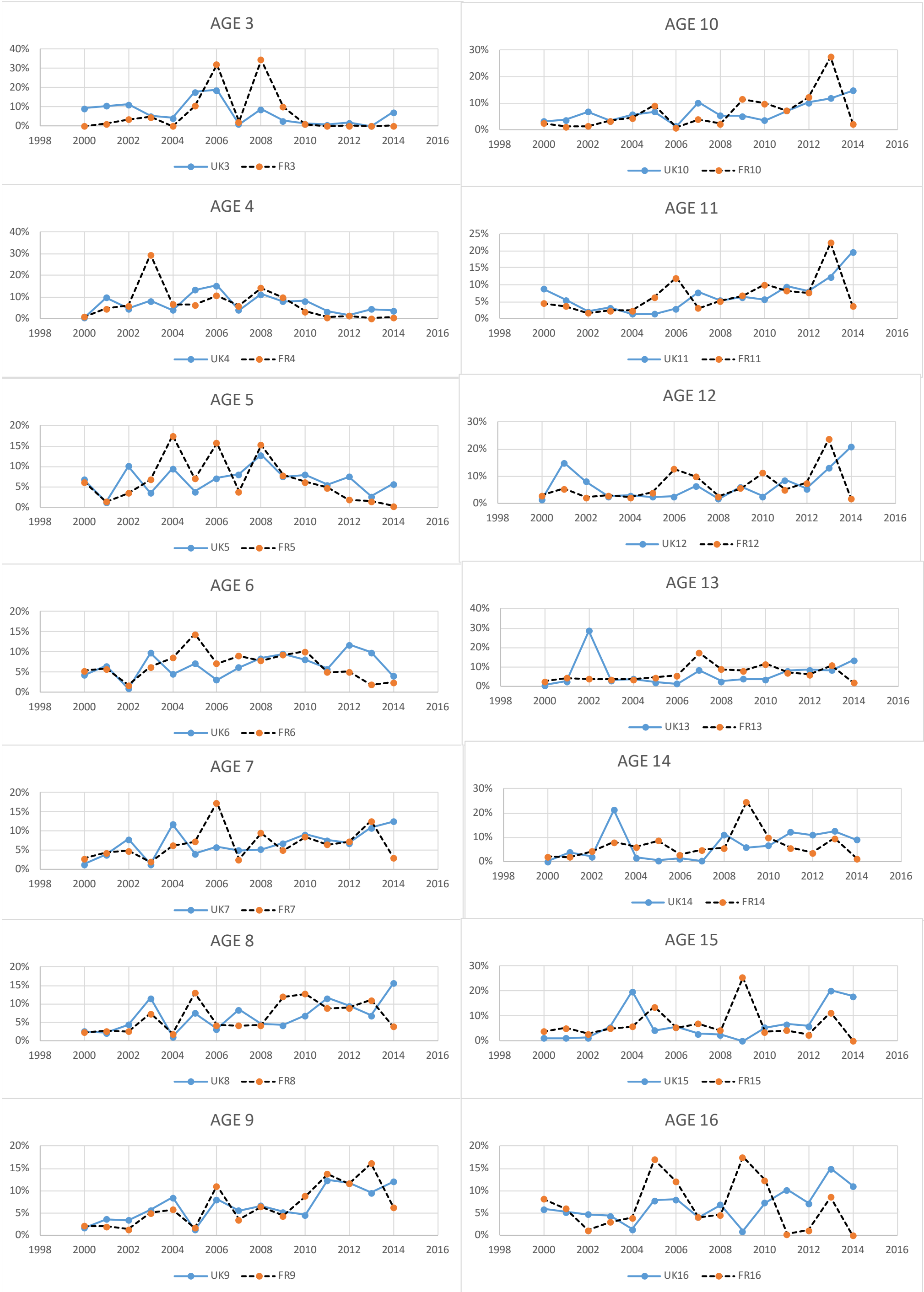


Figure 10.1.2.1. (d) Comparison of UK and French landings numbers-at-age from 2000 to 2014. Data for each age class are shown as percentage of 2000–2014 mean.

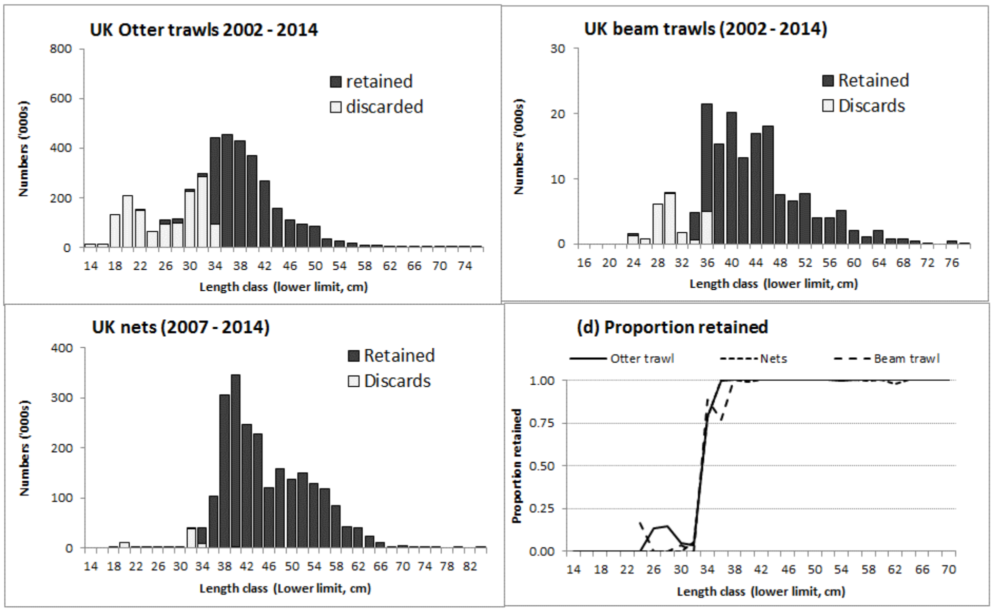


Figure 10.1.2.2. Numbers of bass retained and discarded, summed over the period 2002–2014 for otter trawls and beam trawls, and 2007–2014 for fixed and driftnets. The retention ogives for the three gears are shown at right.

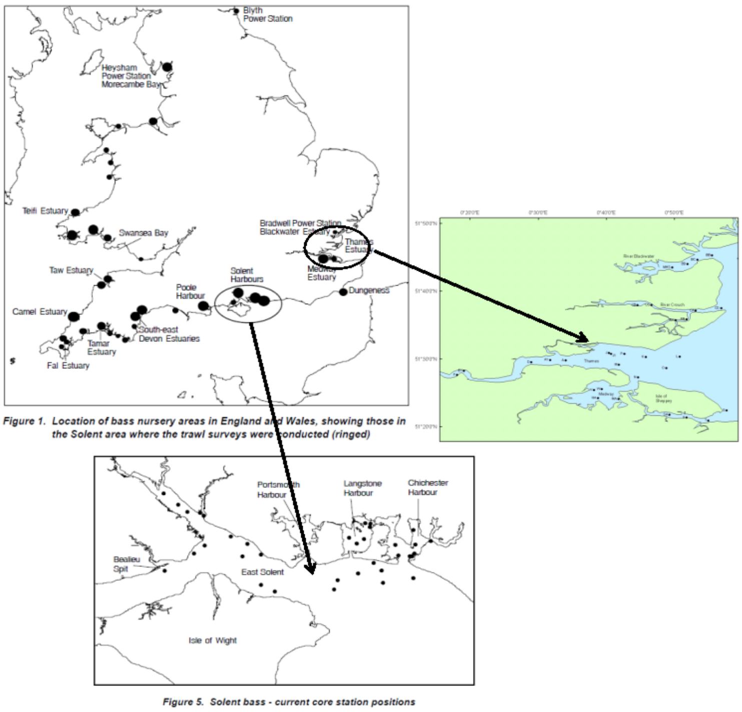
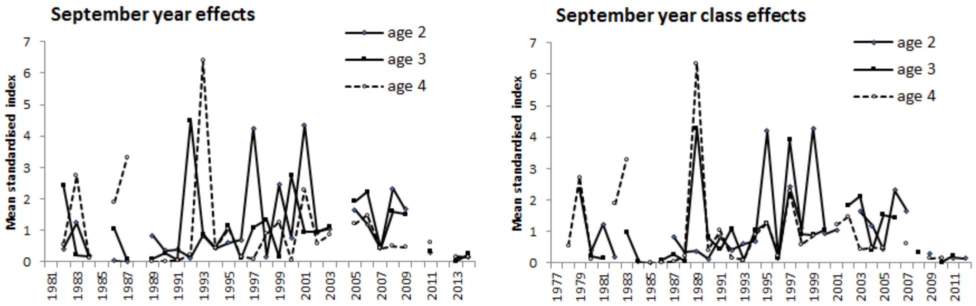


Figure 10.1.2.3. Location of Cefas Solent and Thames juvenile sea bass surveys.

(a) Year and year-class effects



(b) Solent 1-gp index

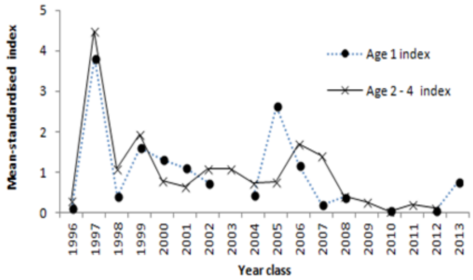


Figure 10.1.2.4. Cefas Solent survey in autumn: (a) year and year-class effects in indices; (b) 1-gp index from 1996 onwards compared with a composite year-class index derived from the age 2–4 indices.

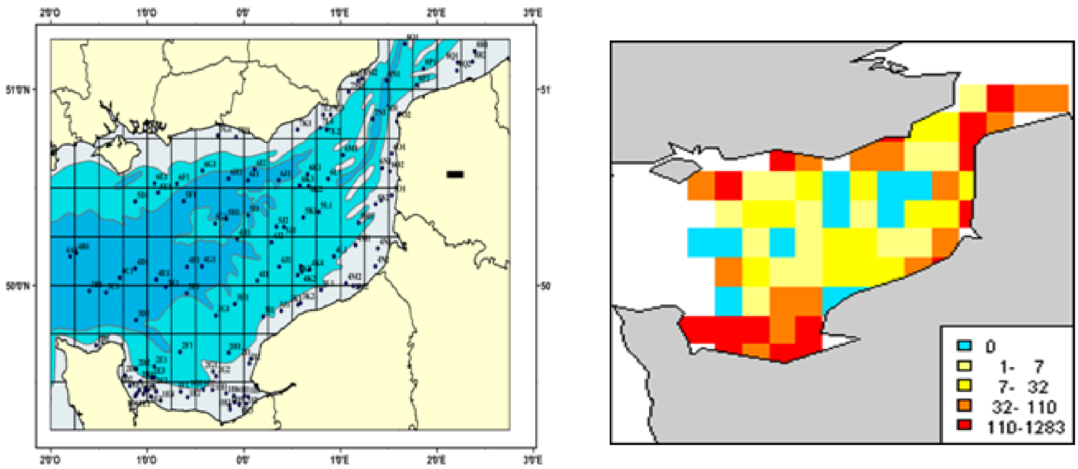


Figure 10.1.2.5. Left: stations fished during the Channel Groundfish Survey carried out annually by France. Right: distribution of total catches of sea bass over the survey series.

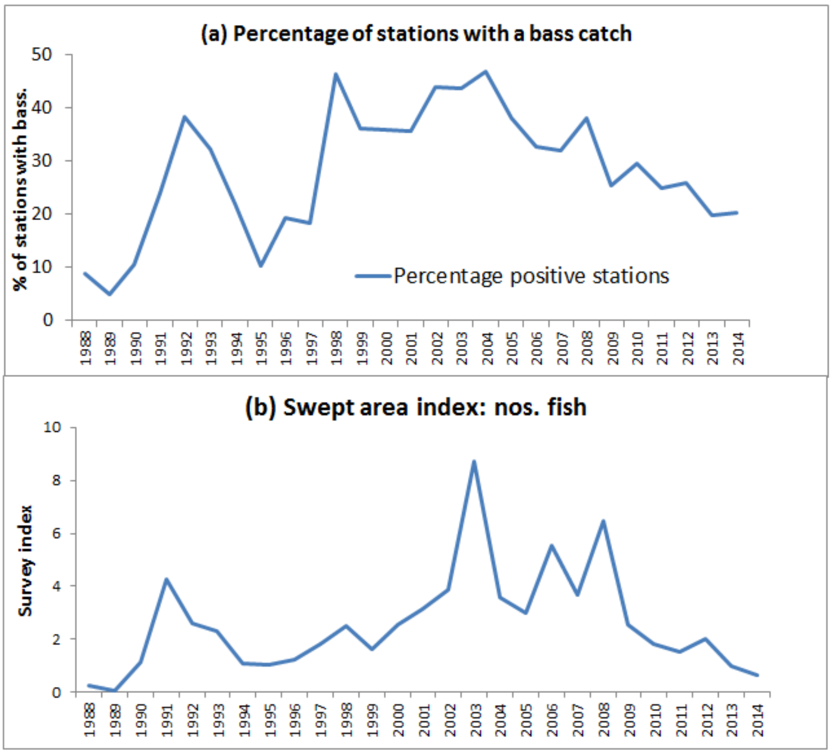


Figure 10.1.2.6. Mean standardised time-series of (a) percentage of stations with sea bass, and (b) swept-area abundance indices (millions of fish) from the Ifremer Channel Groundfish Survey.

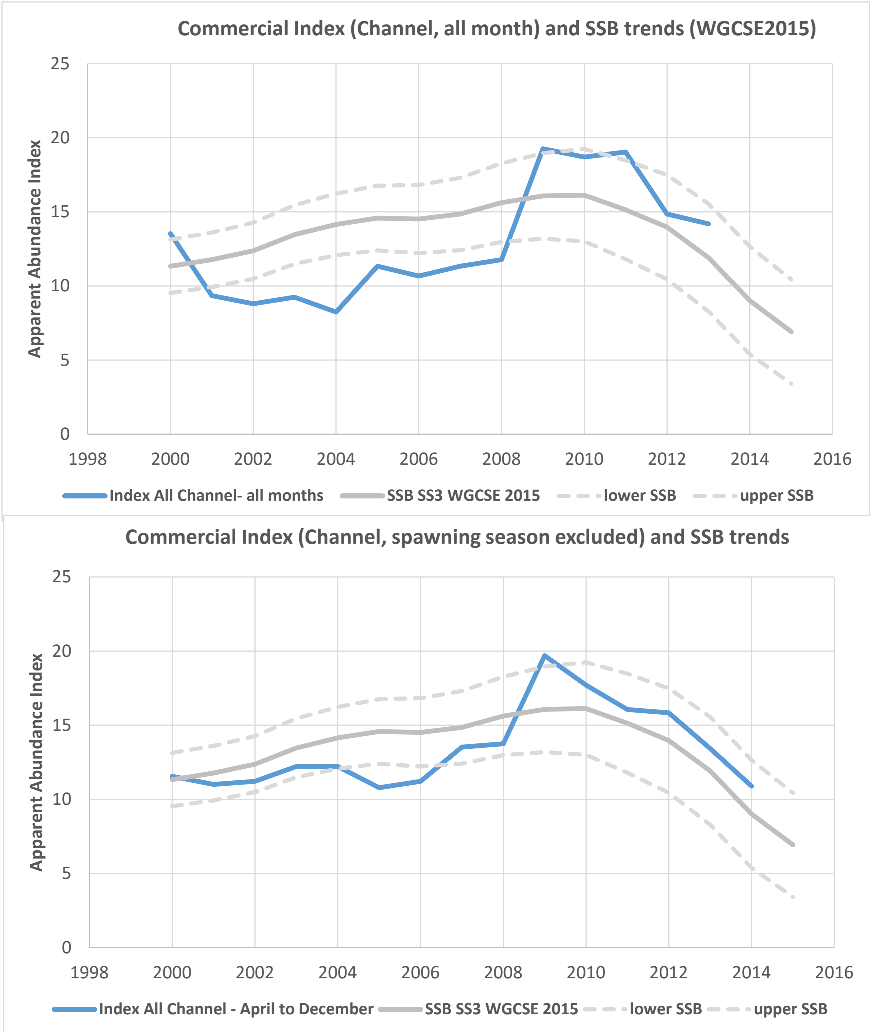


Figure 10.1.2.7. Bass-47: Trends in commercial lpue index for French fleets overlaid on this year's update assessment estimates of spawning–stock biomass (+/- 2 standard errors). Top: index based on data from all 12 months; bottom: index excluding fishing trips during spring spawning season.

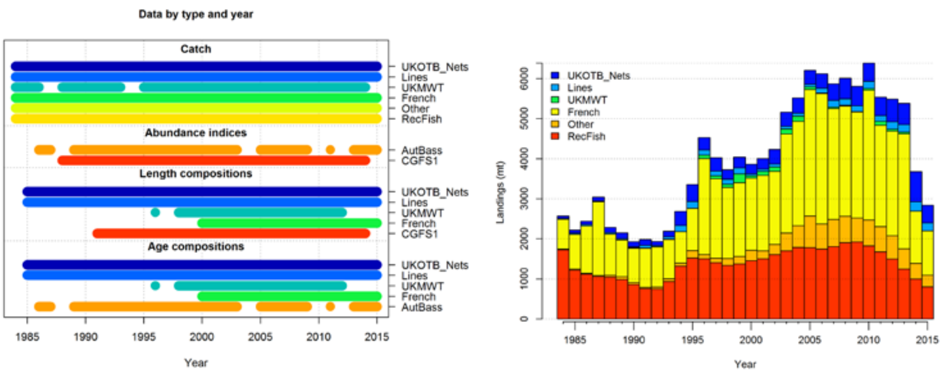


Figure 10.1.3.4. Left: Datasets used in the final sea bass update assessment. Right: landings series for the six fleets.

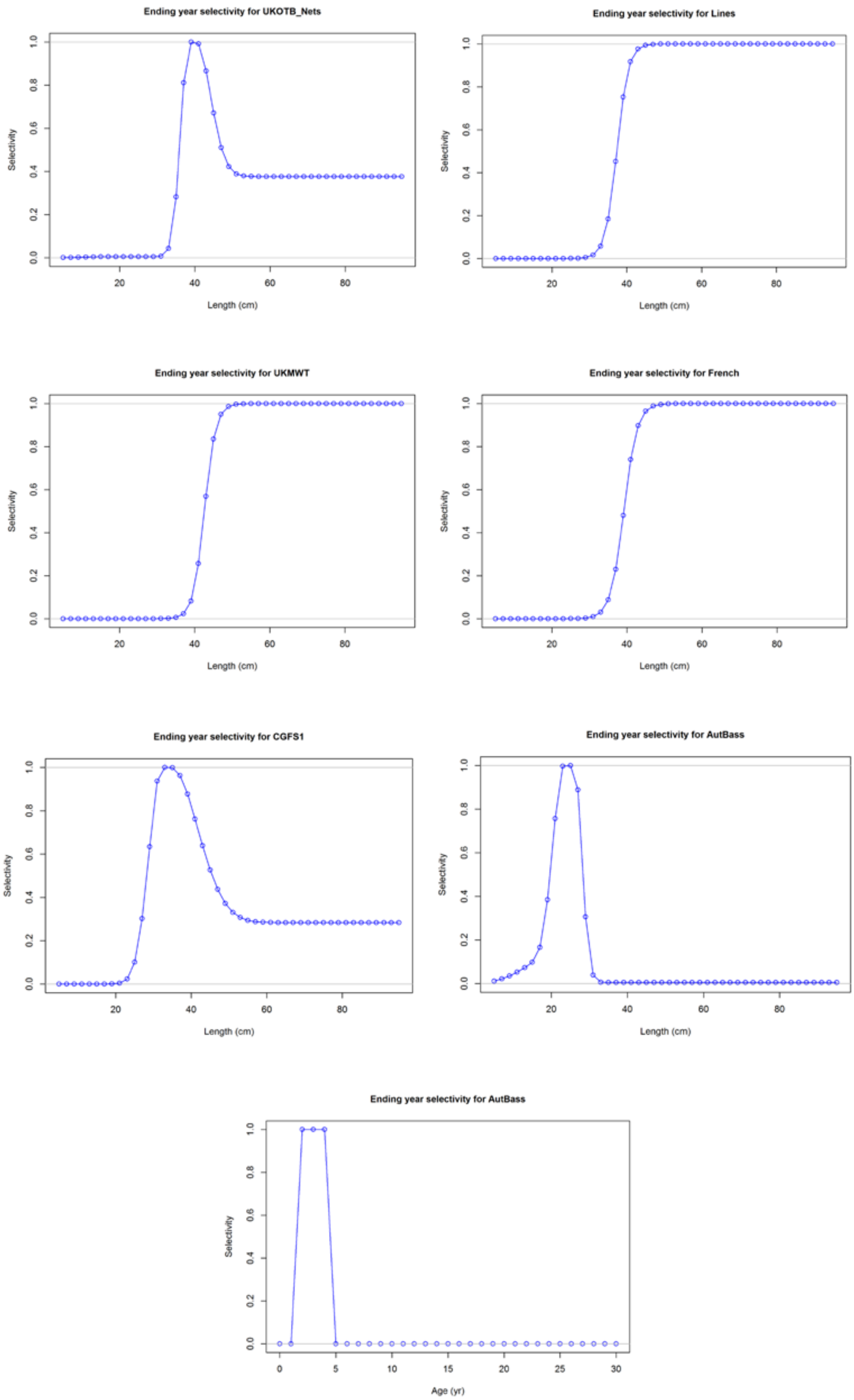
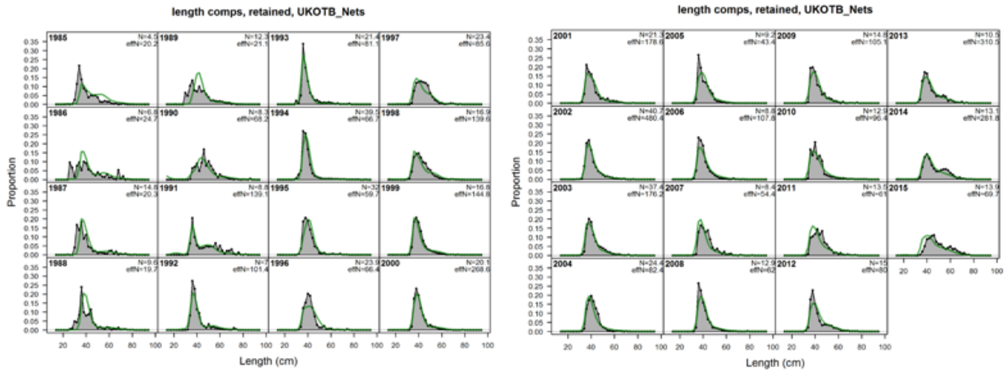


Figure 10.1.3.5. Final sea bass update assessment: Fitted length-based and age-based selectivity curves.



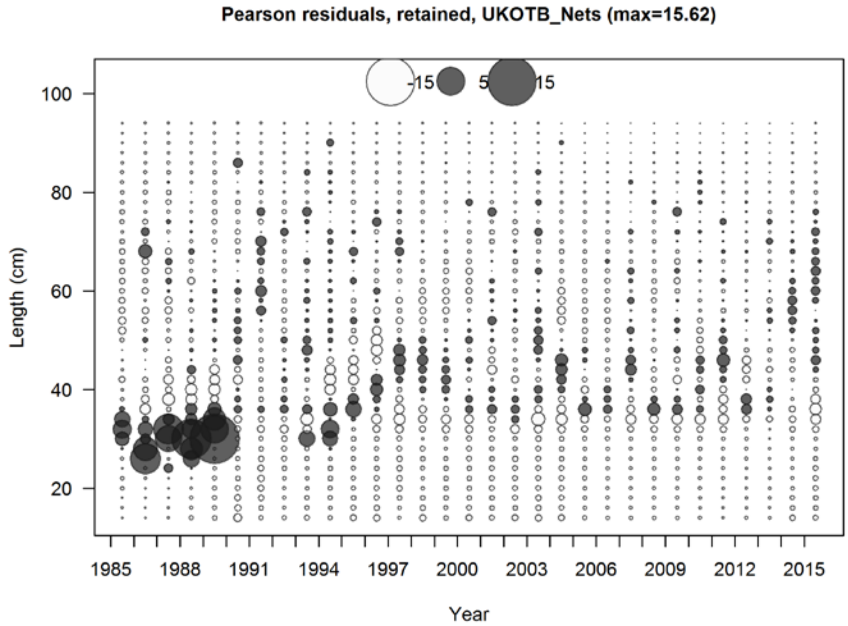


Figure 10.1.3.6. Final sea bass update assessment: fit to UK trawl and net fishery length composition data.

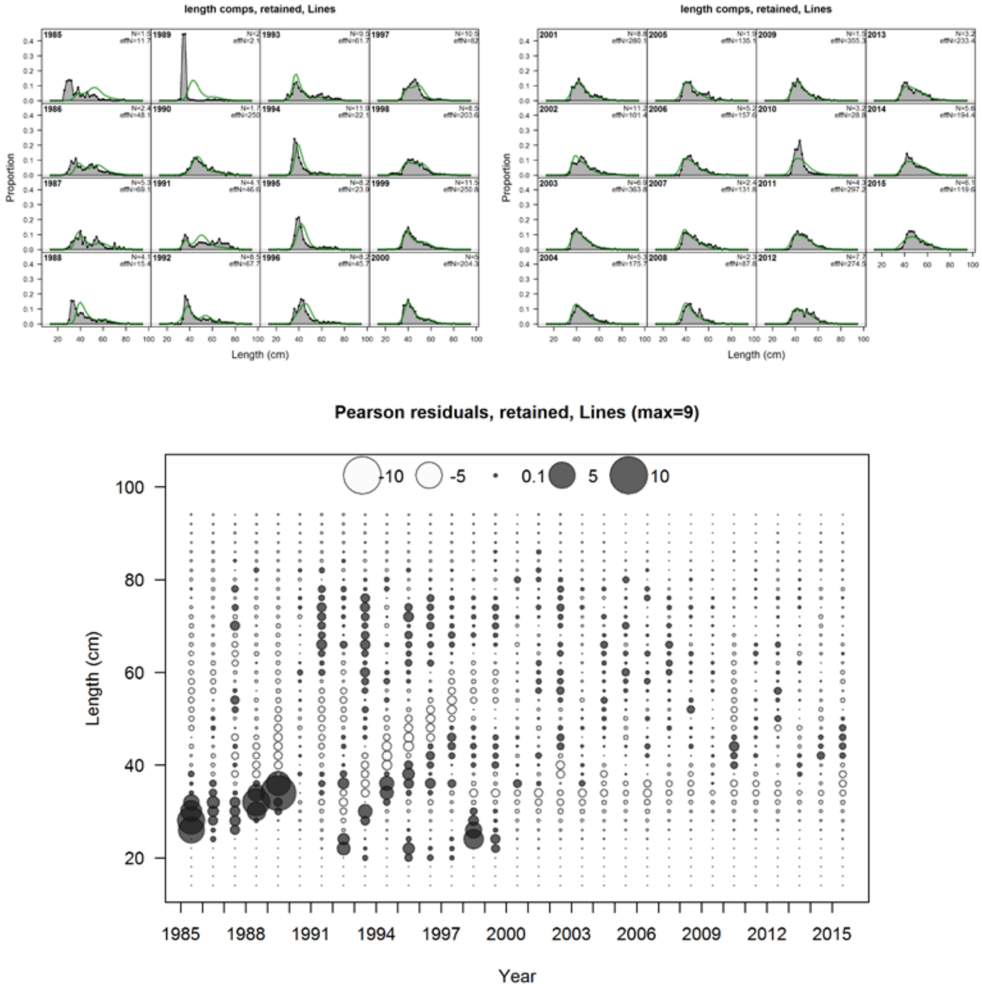
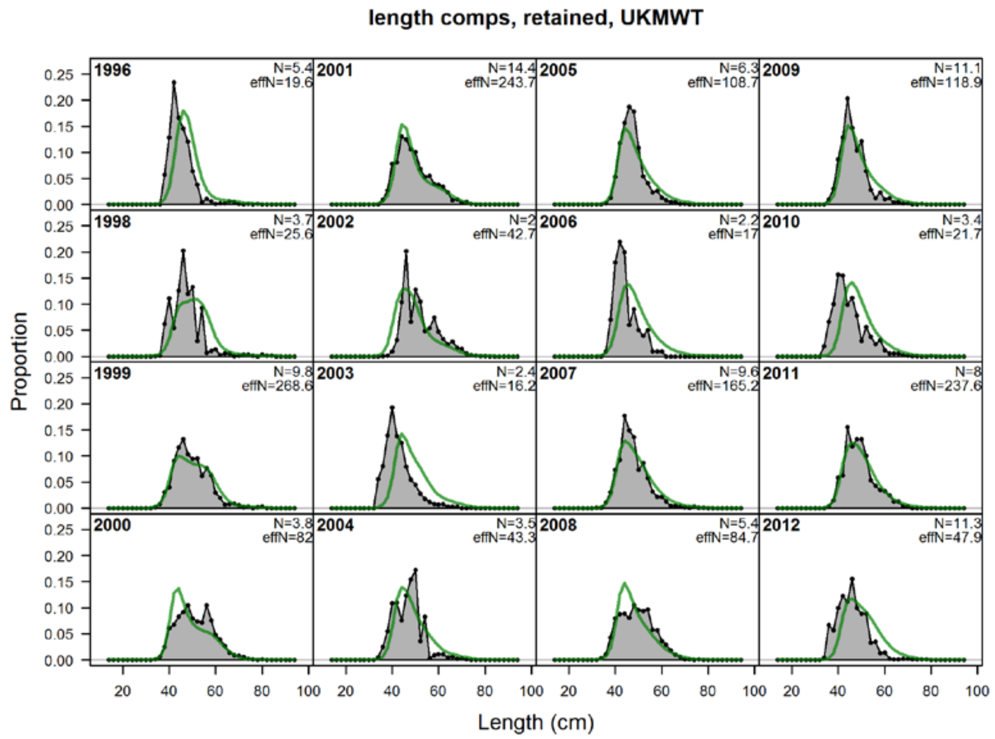


Figure 10.1.3.6. Final sea bass update assessment: fit to UK lines length composition data.



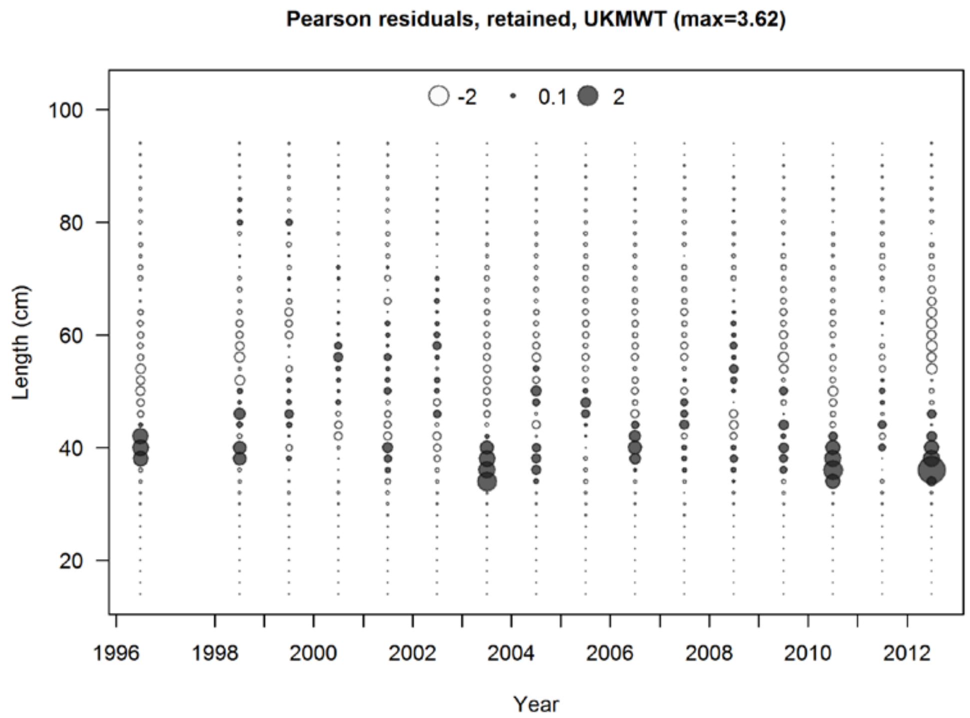
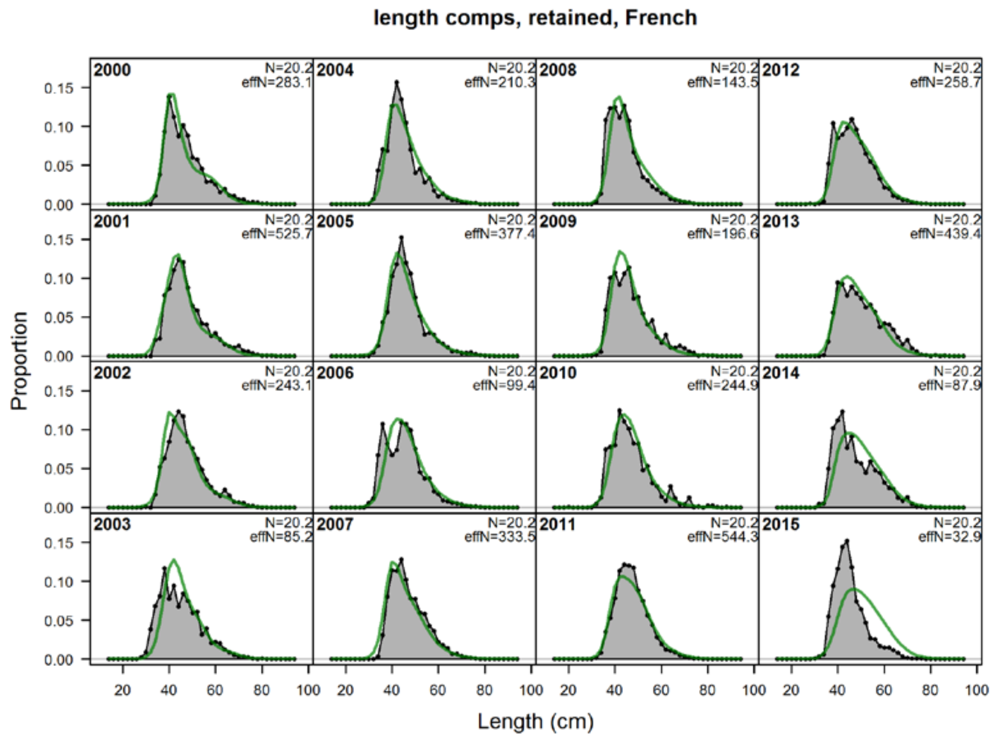


Figure 10.1.3.6. Final sea bass update assessment: fit to UK midwater trawl fishery length composition data.



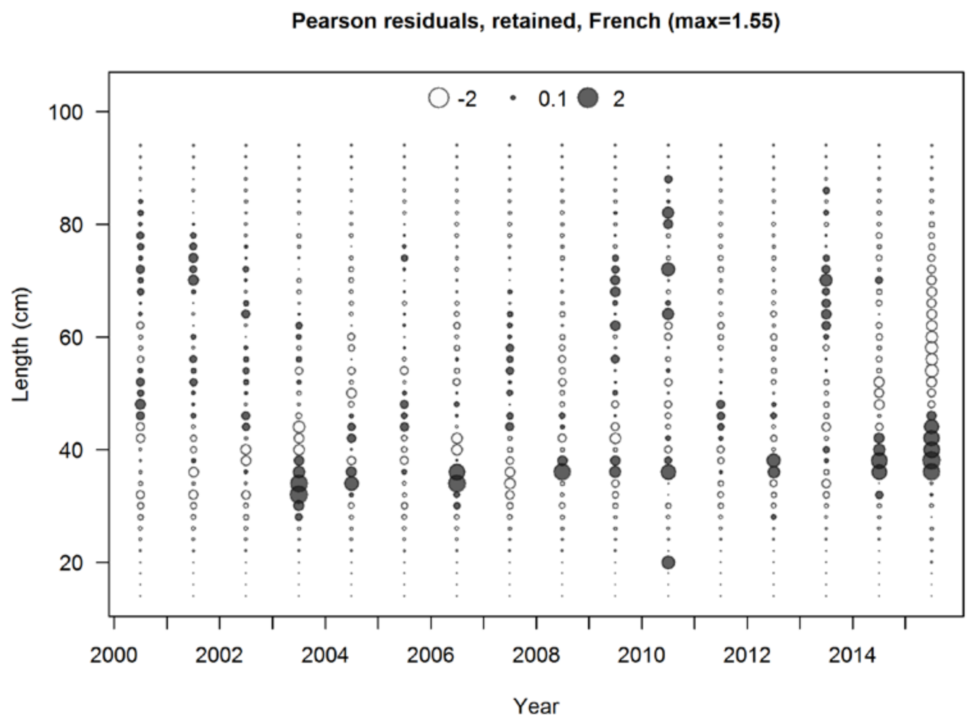


Figure 10.1.3.6. Final sea bass update assessment: fit to French fishery length composition data.

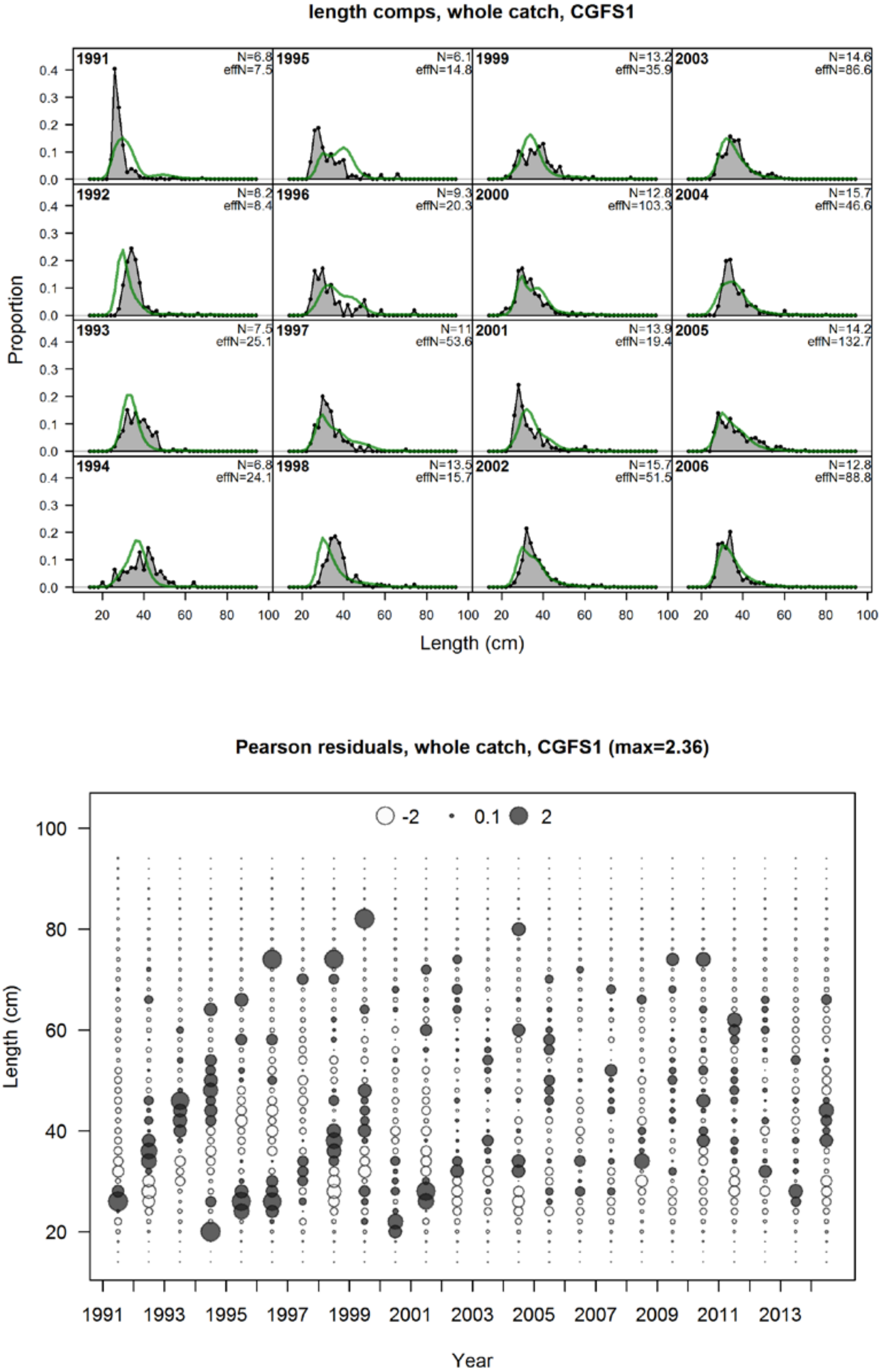
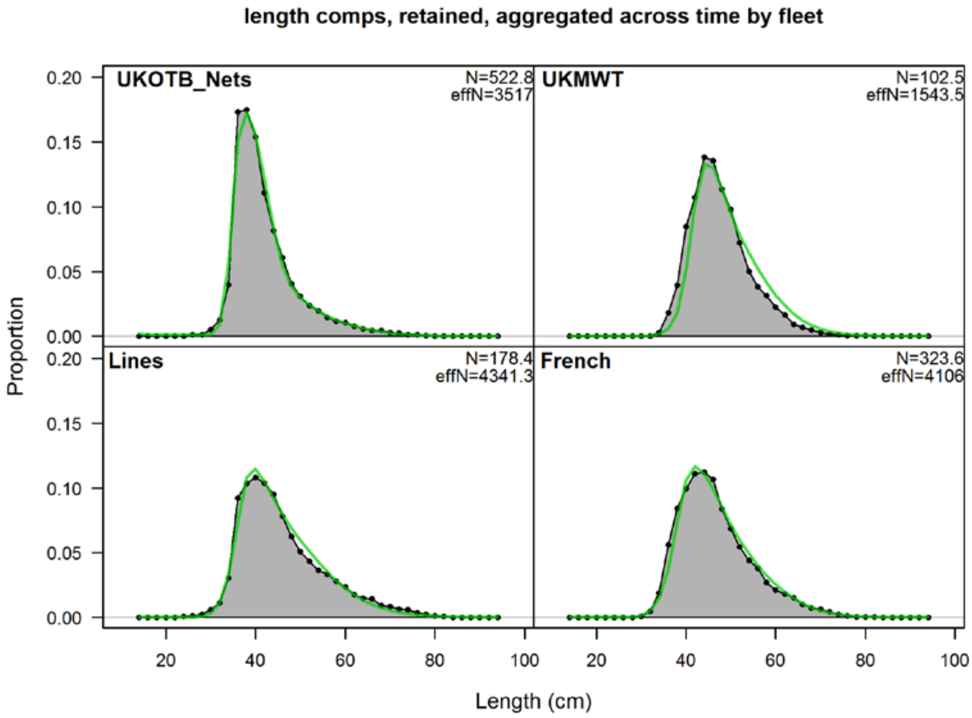


Figure 10.1.3.7. Final sea bass update assessment: Fit to Channel groundfish survey length compositions.



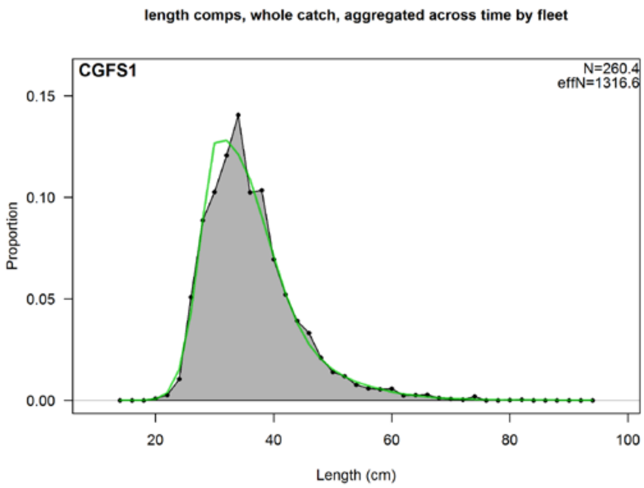
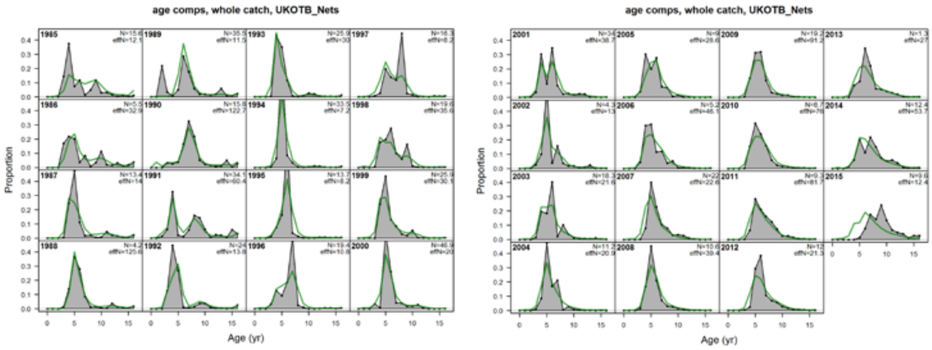


Figure 10.1.3.8. Final sea bass update assessment: Fit to the commercial fisheries and Channel groundfish survey length compositions, aggregated across time.



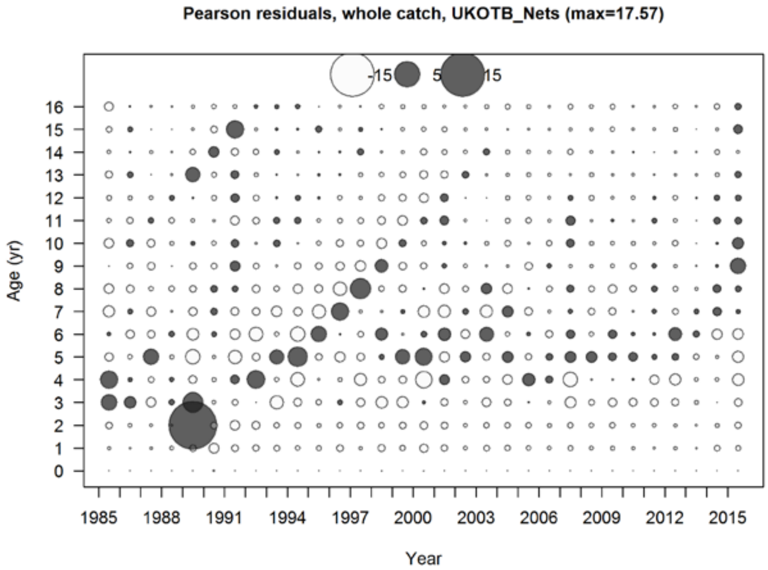


Figure 10.1.3.9. Final sea bass update assessment: Fit to age composition data for the combined UK otter trawl and nets fleets.

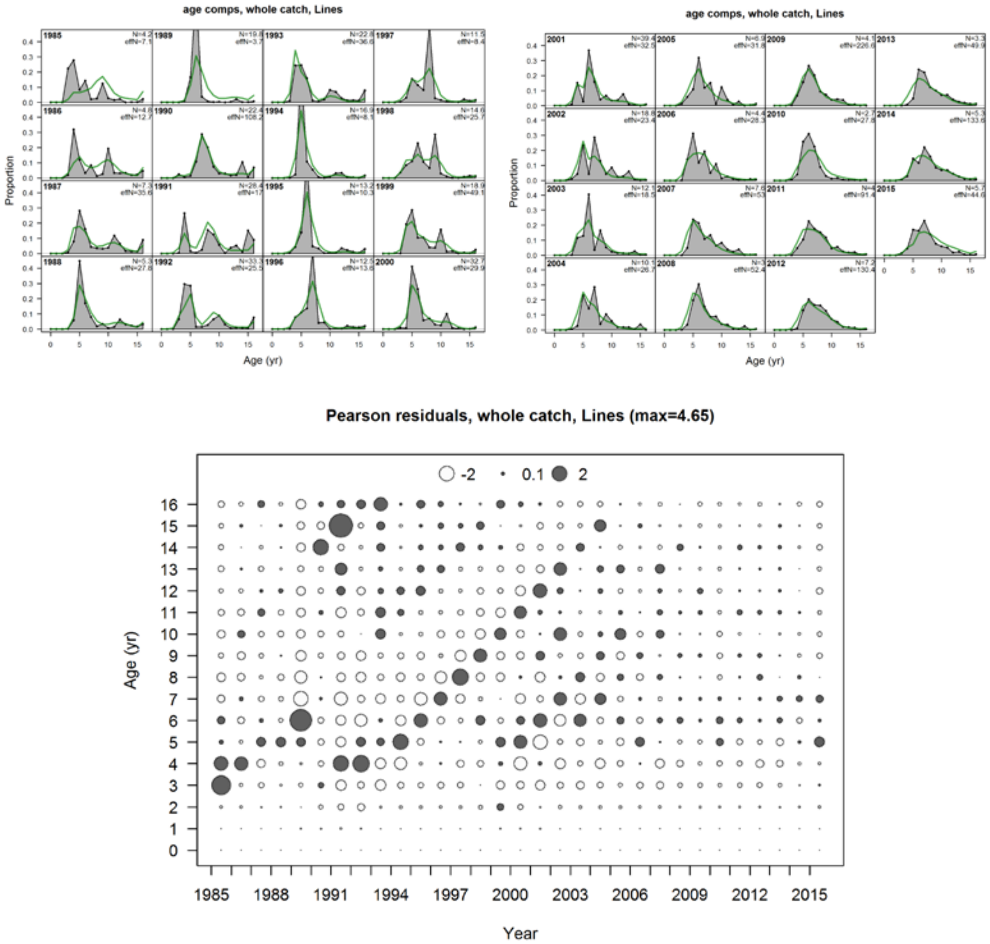
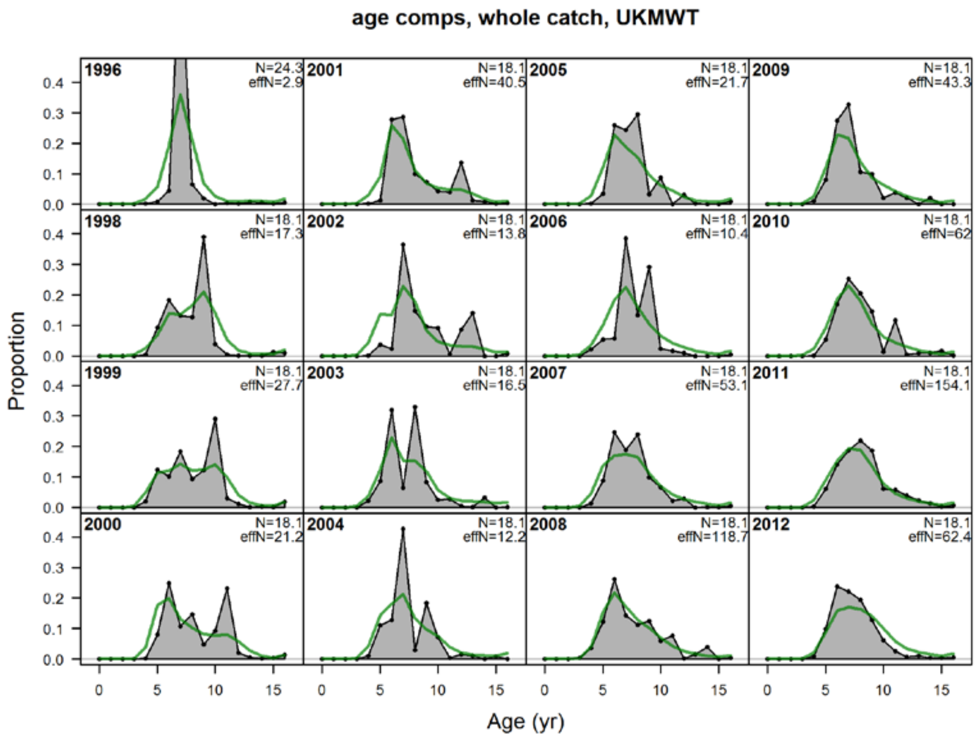


Figure 10.1.3.10. Final sea bass update assessment: Fit to age composition data for the combined UK otter trawl and nets fleets.



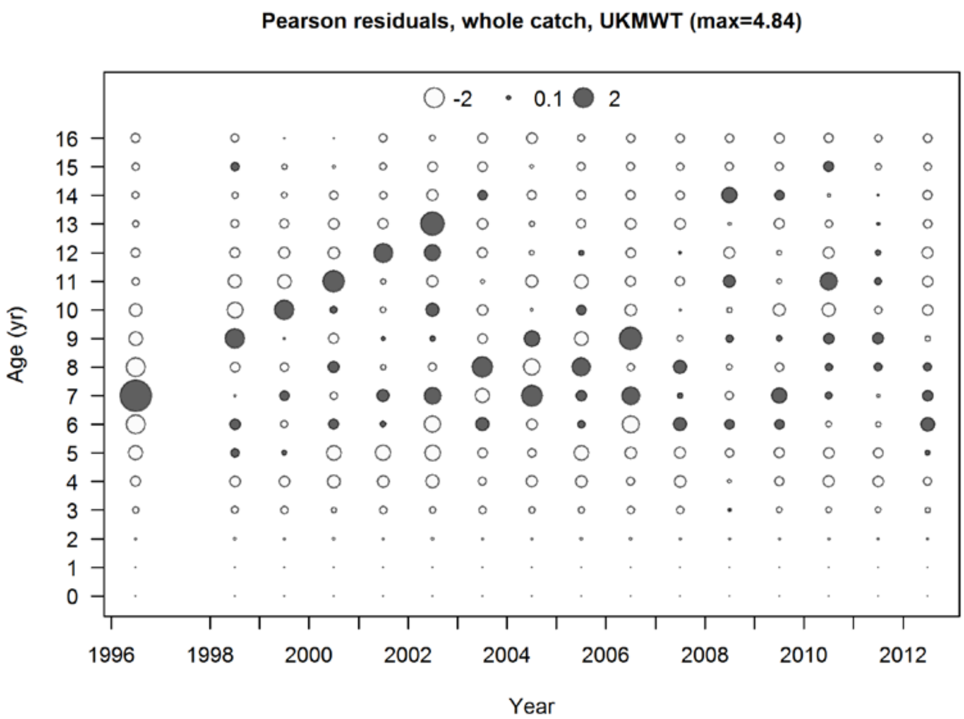
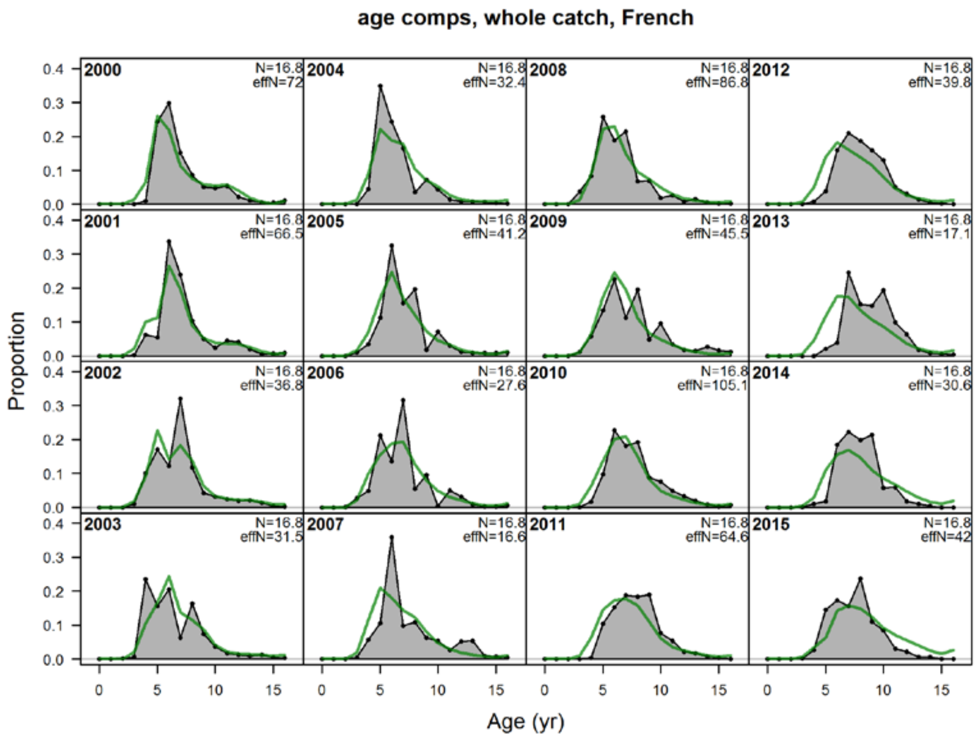


Figure 10.1.3.11. Final sea bass update assessment: Fit to age composition data for the UK midwater trawl fleet.



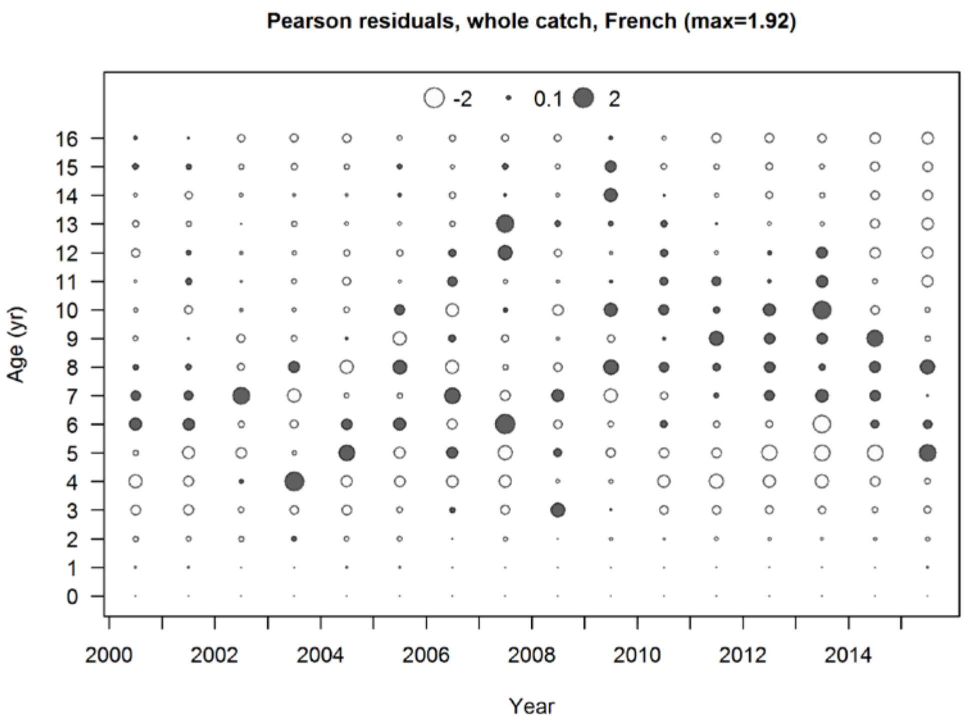


Figure 10.1.3.12. Final sea bass update assessment: Fit to age composition data for the combined French fleets.

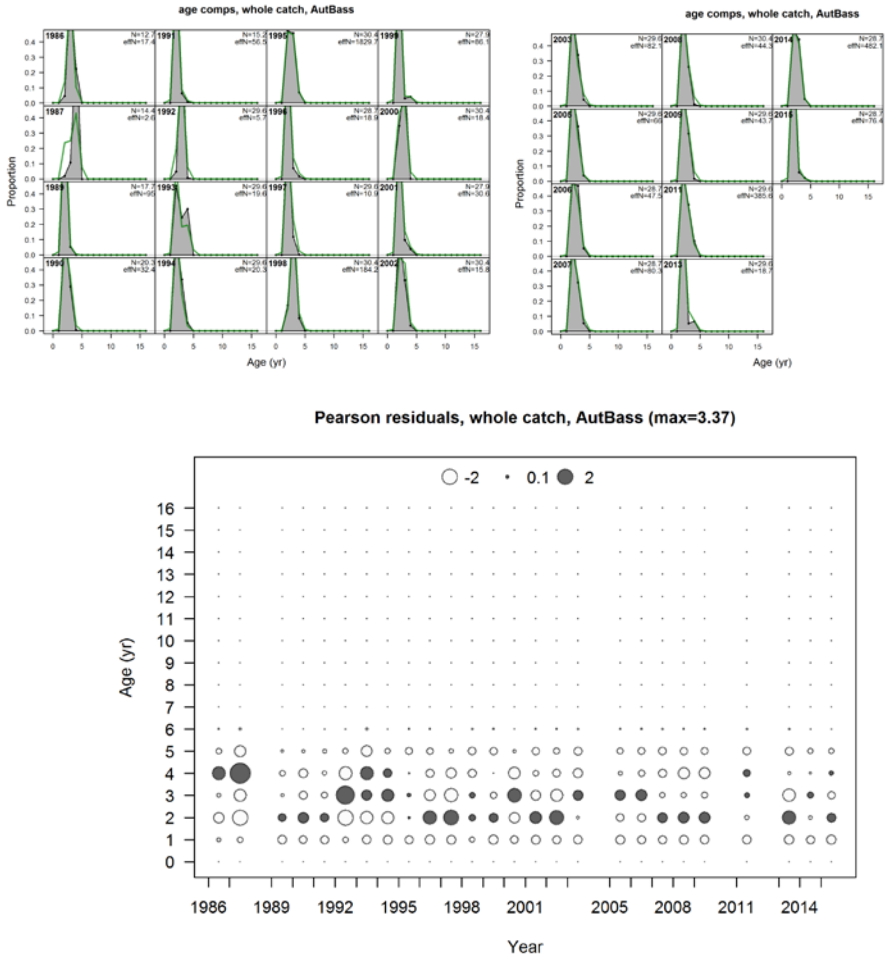


Figure 10.1.3.13. Final sea bass update assessment: Fit to age composition data for the Solent Autumn bass survey.

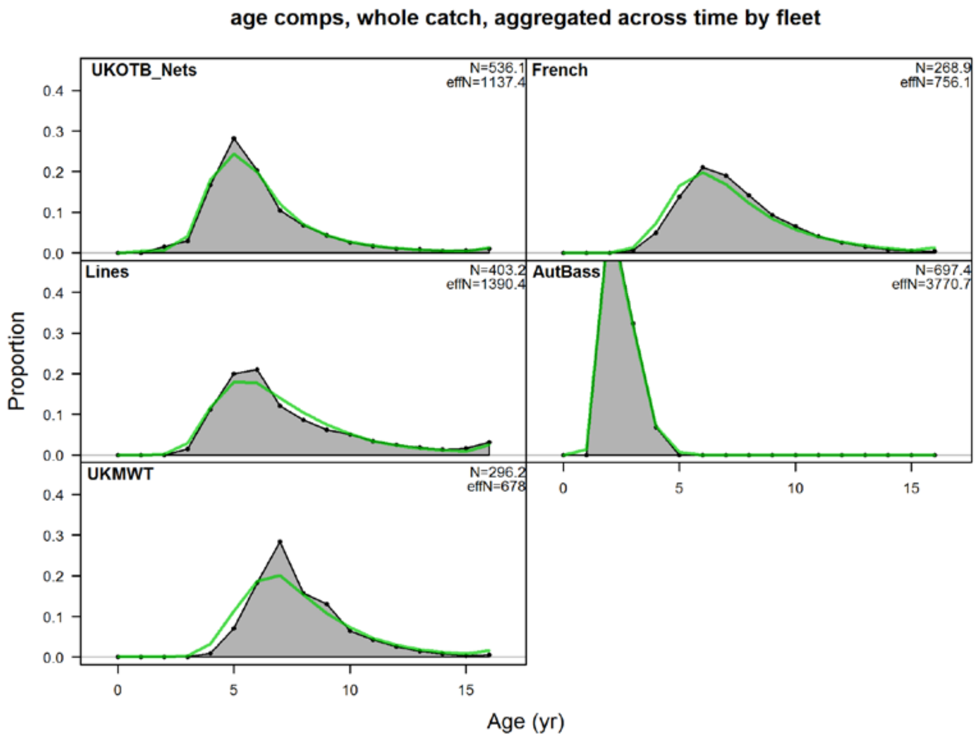


Figure 10.1.3.14. Final sea bass update assessment: Fit to UK fleets age compositions, aggregated across time.

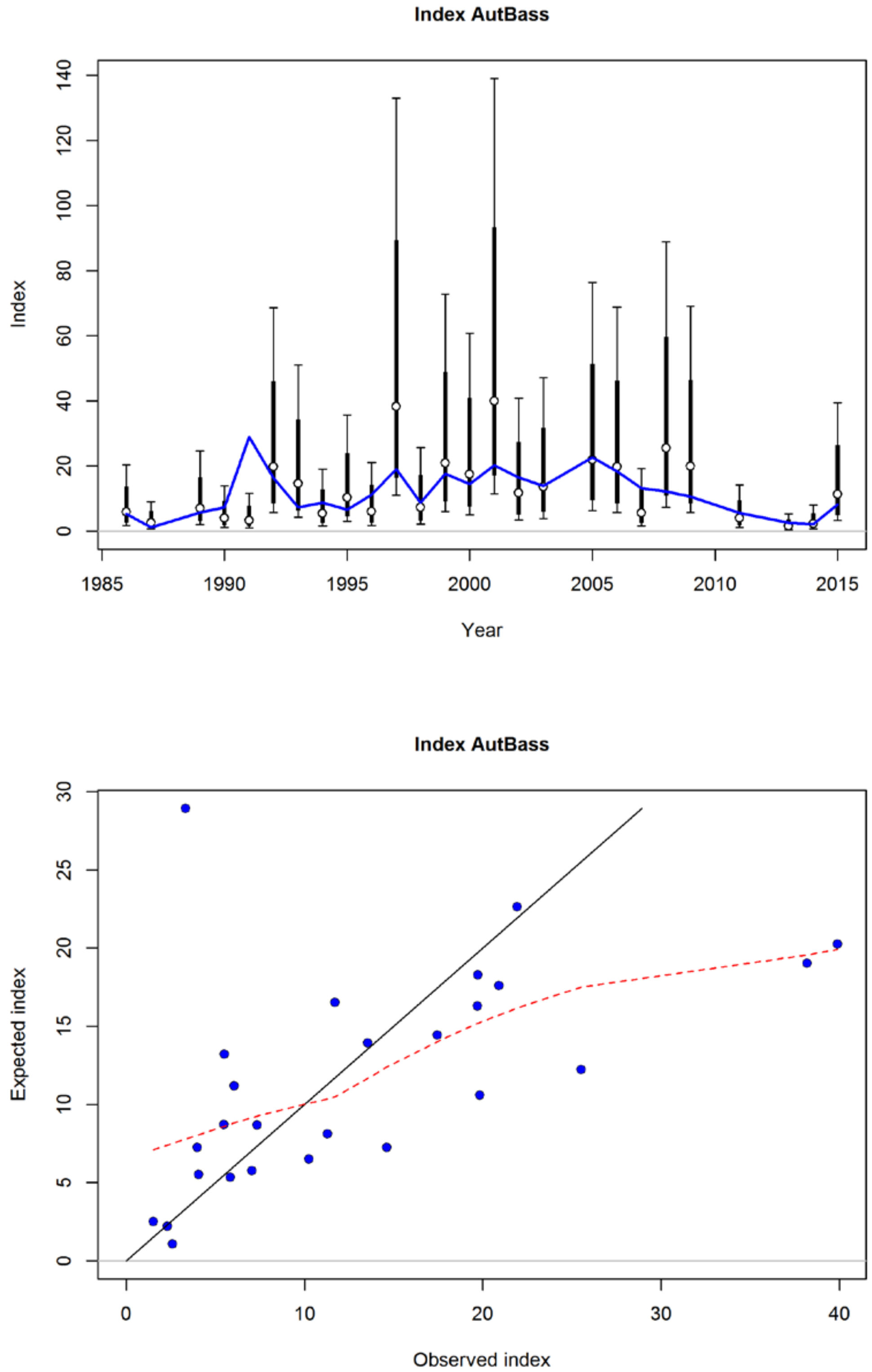
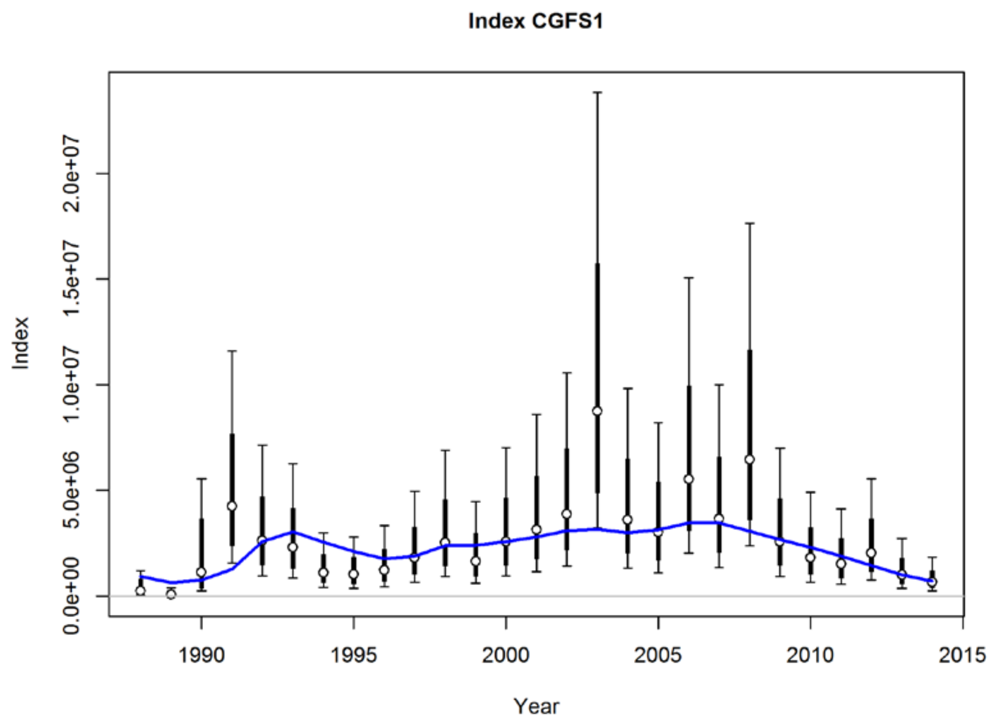


Figure 10.1.3.15. Final sea bass update assessment: Fit to Solent Autumn bass survey total abundance index, accounting for age and length-based selectivity.



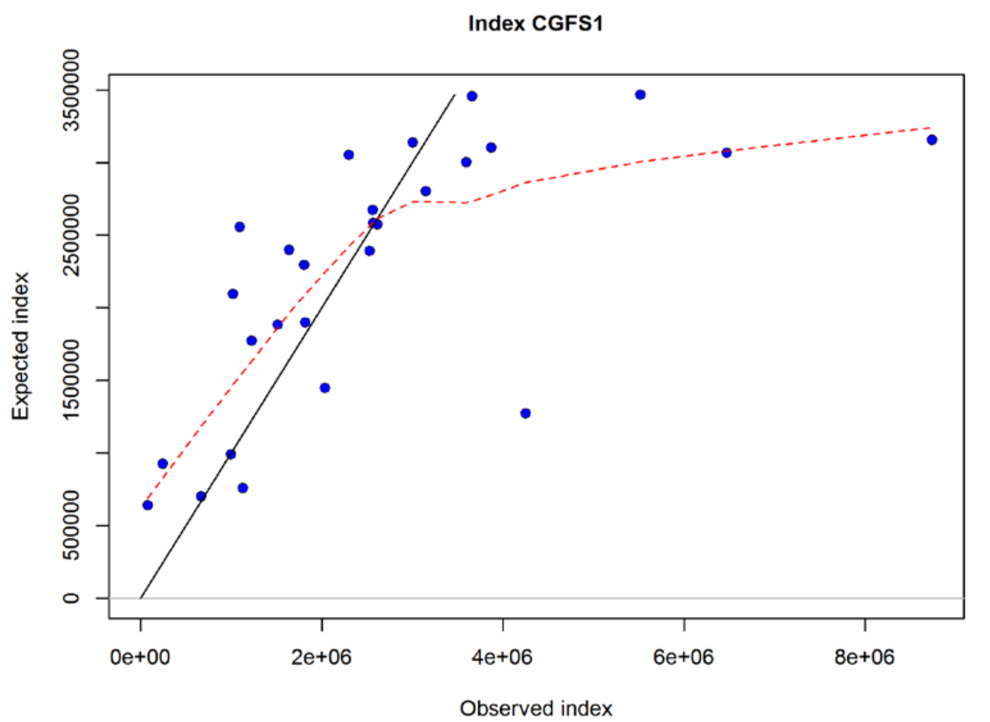
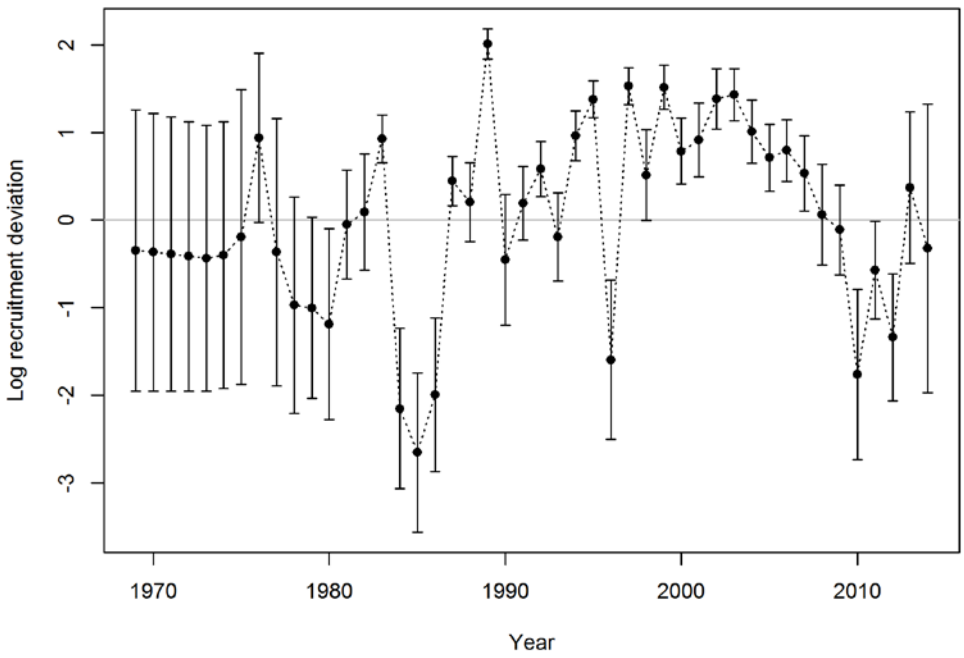
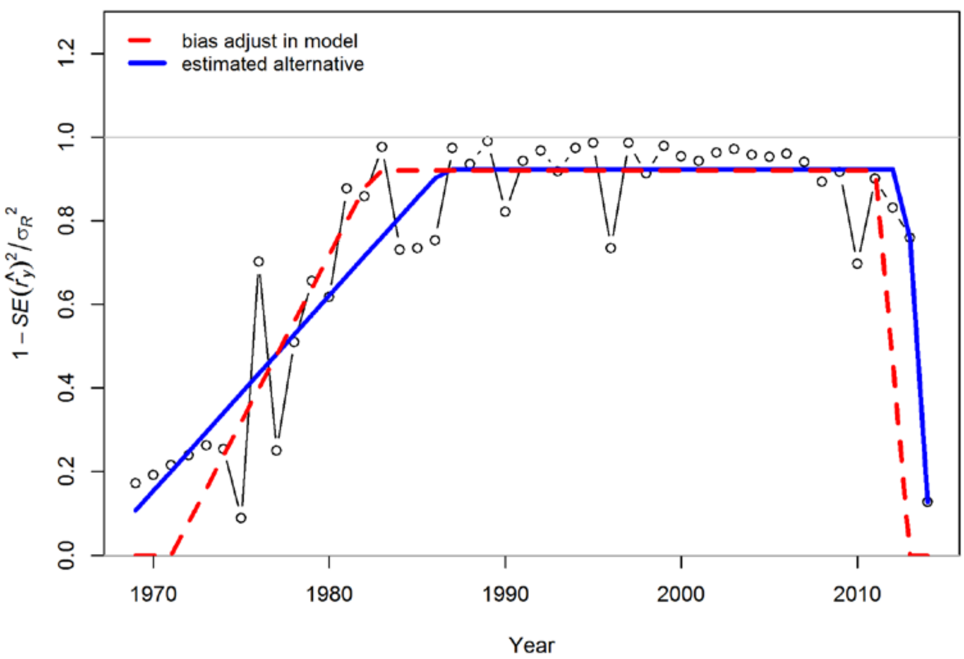


Figure 10.1.3.16. Final sea bass update assessment: Fit to Channel groundfish survey total abundance index, accounting for length-based selectivity.


Log recruitment deviation
2
1
0
-1
-2
-3
1970
1980
1990
2000
2010
Year


bias adjust in model
estimated alternative
$1 - SE(\hat{r}_y)^2/\sigma_R^2$
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1970
1980
1990
2000
2010
Year

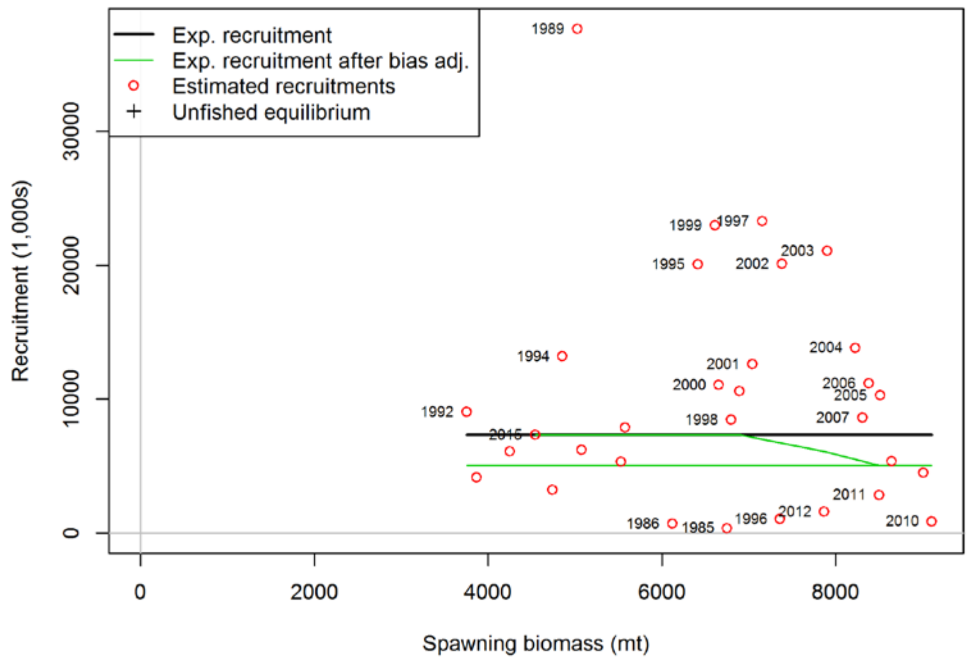


Figure 10.1.3.17. Final sea bass update assessment: Top: time-series of log-recruit deviations (deviations for 1965–1984 precede the period of input catch data). Below: stock–recruit scatter (model is fitted assuming Beverton–Holt stock–recruit model and steepness = 0.999.)

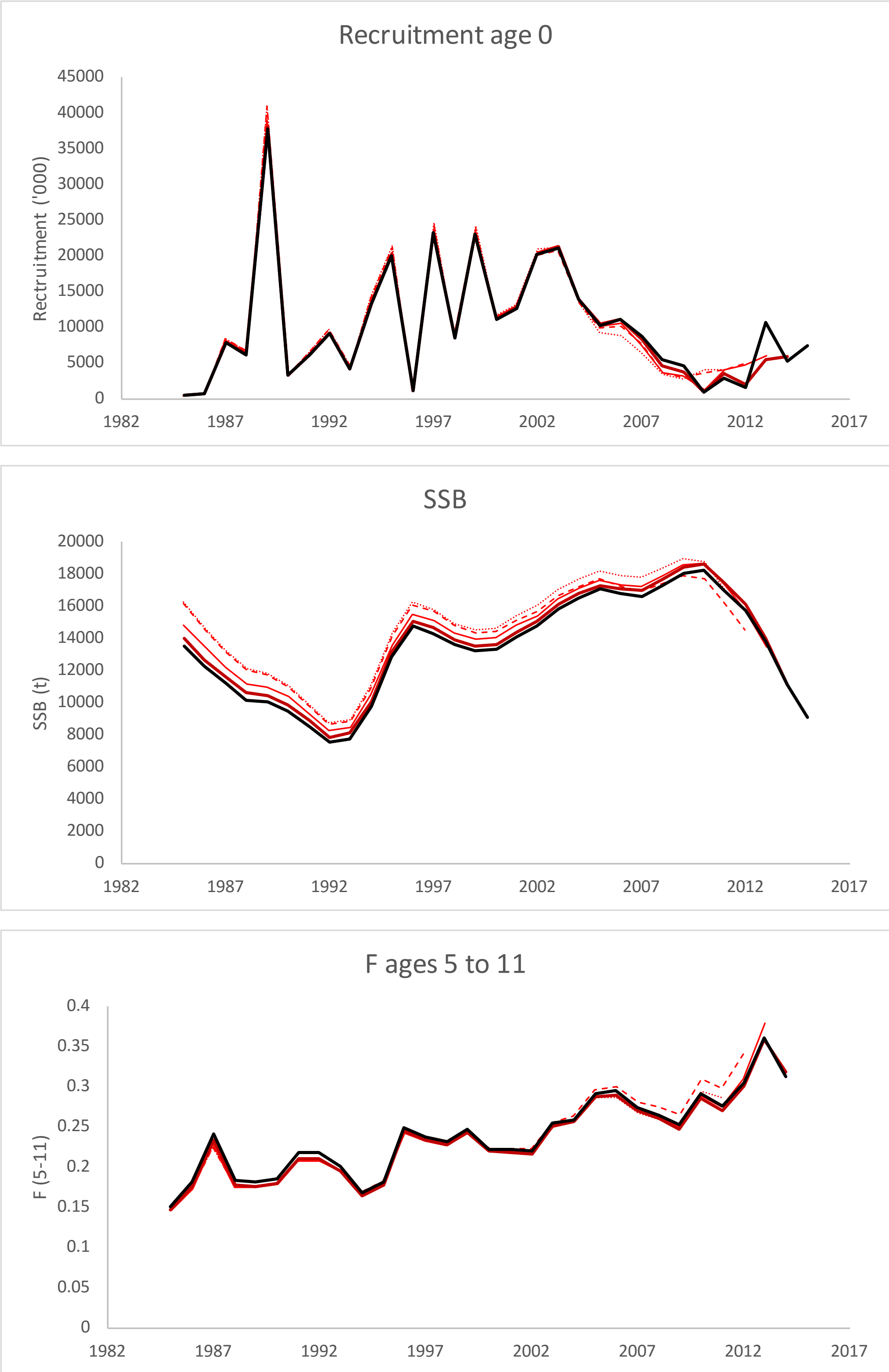


Figure 10.1.3.18. Retrospective analysis of stock trends from final update assessment, based on Stock Synthesis run final year set to 2015 and peeling back five years (for the final run, terminal F is for 2014 and SSB and total biomass terminate in 2015).

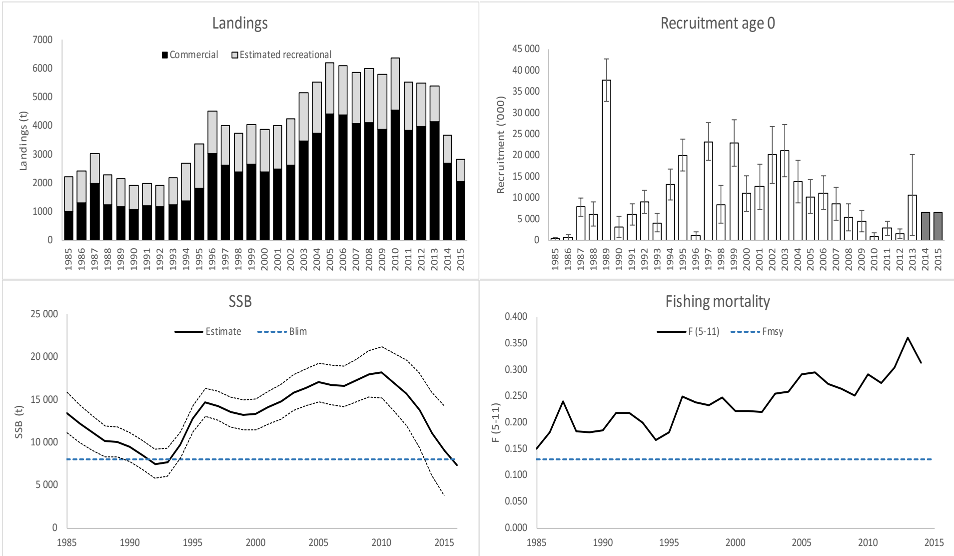


Figure 10.1.3.19. Stock trends from final update assessment, based on Stock Synthesis run final year set at 2016 to give 2016 numbers and biomass and 2014 F. Recruitment in 2014 and 2015 is the long-term geometric mean. The F_{MSY} proxy is $F_{35\%SPR}$ = 0.13. Error bars on recruitment plot and dotted lines on SSB plot are ± 2 standard errors.

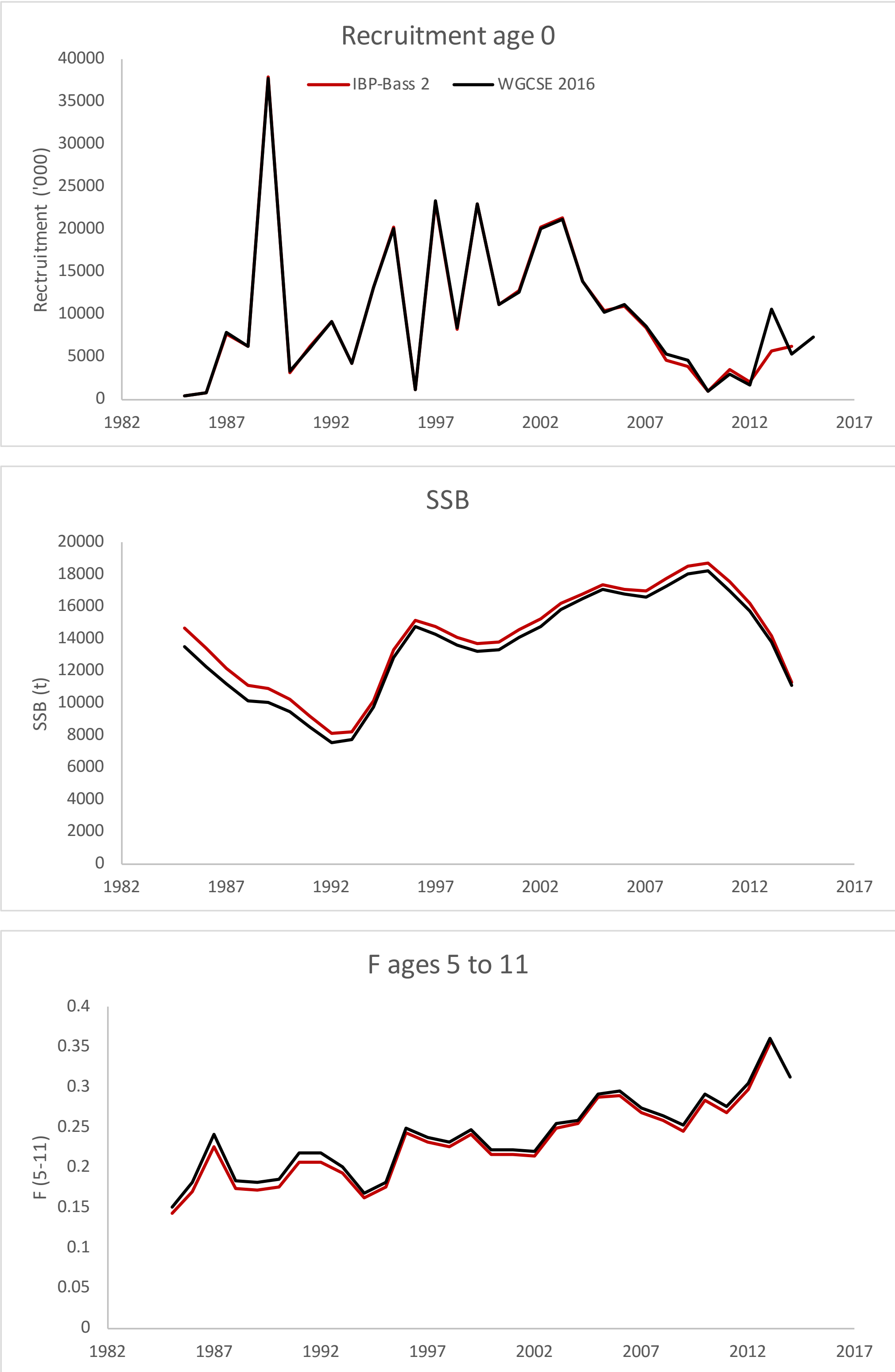


Figure 10.1.3.20. Comparison between stock trends from this year's final update assessment and the 2016 IBPBass assessment.

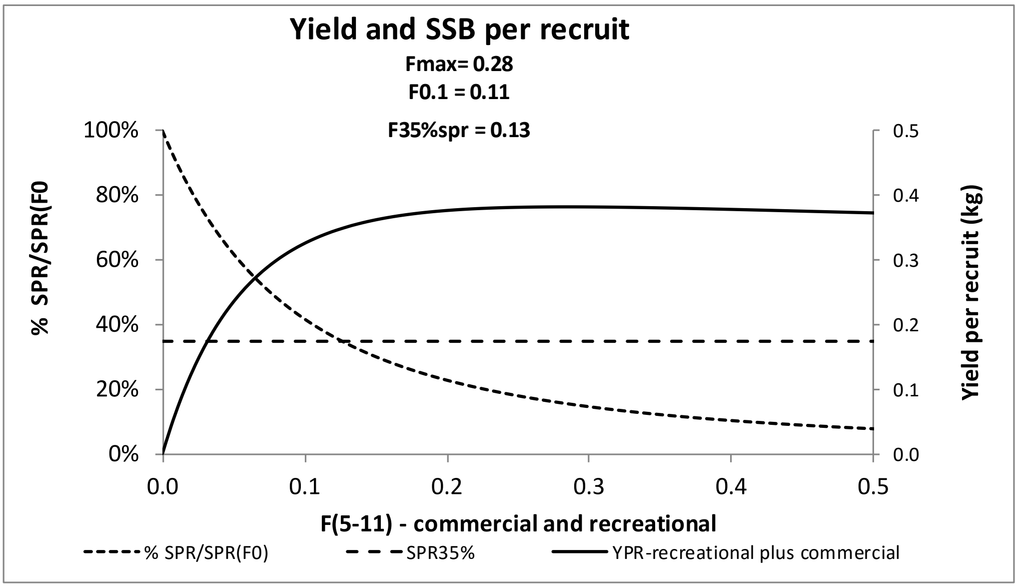


Figure 10.1.4.1. Bass-47: Yield and biomass per recruit analysis from 2016 IBPBass 2 conditional on mean pattern of F-at-age for 2012–2014 for the combined commercial and recreational fishing.

10.2 European sea bass in Divisions 6a, 7b and 7j (West of Scotland and Ireland)

Type of assessment

There is no assessment for this stock component.

ICES advice applicable to 2016 & 2017

"Based on ICES approach to data-limited stocks, ICES advises that when the precautionary approach is applied, commercial landings should be no more than 5 tonnes in each of the years 2016 and 2017. ICES cannot quantify total catches.No information on discards is available, therefore it is not possible to provide commercial catch advice. Also, recreational catches cannot be quantified. Therefore total catches cannot be calculated.

Currently there is no TAC for this species in this area, and it is not clear whether this should constitute a separate management unit. ICES does not necessarily advocate the introduction of a TAC for sea bass in this area."

ICES advice applicable to 2015

"The revised landings data do not change the perception of the stock but result in a revision of the advised landings. Therefore, ICES advises based on the data-limited stocks approach, but cannot quantify the resulting catches. The implied commercial landings should be no more than 5 tonnes.

Currently there is no TAC for this species in this area, and it is not clear whether this should constitute a separate management unit. ICES does not necessarily advocate the introduction of a TAC for sea bass in this area."

10.2.1 General

Stock description and management units

At IBP-NEW (2012a), it was agreed that sea bass in the North Sea (4b&c) and in the Irish Sea, Channel and Celtic Sea (7a,d,e,f,g&h) would be treated as a functional stock unit as there is no clear basis from fishery data, tagging and genetics studies to subdivide the populations in the Irish Sea, Celtic Sea, Channel and North Sea into independent stock units. It was proposed based on previous ICES bass study group reports to allocate sea bass in 6a, 7b and 7j to a separate stock, although it is recognised that sea bass in Irish coastal waters of 7g and 7a are likely to be from the same stock as in VIIj. As there are negligible commercial fishery catches of sea bass in Irish coastal waters due to the moratorium on commercial fishing for bass by Irish vessels, the splitting of the stock between 7g and is not likely to have any impact on the bass assessment in 4b,c and 7 a,d–h. Supporting information can be found in the IBP-NEW (ICES, 2012a) report.

Management applicable to 2015and 2016

Sea bass are not subject to EU TACs and quotas. A moratorium on commercial fishing for sea bass has been in place for Irish vessels fishing in Areas 6 and 7 since 1990, and a minimum landing size of 40 cm applies to Irish fisheries. The official minimum landing size for non-Irish vessels is 36 cm (EC regulation 850/98). In addition, a variety of national restrictions on commercial sea bass fishing are also in place for non-

Irish commercial vessels, including licensing, individual landings limitations, larger MLS and seasonal/ area closures. Recreational fishing for sea bass in Ireland is prohibited from 15 May to 15 June, and a bag limit of two fish per 24 hours is in place.

Previous advice from ICES, showing a rapid decline in sea bass biomass in the North Sea, Channel, Celtic Sea and Irish Sea caused by poor recruitment and over-fishing, has resulted in the European Commission working with Member States to identify more effective control measures to reduce fishing mortality towards F_{MSY}. It shall be prohibited for Union fishing vessels to fish for sea bass in ICES Divisions 7b, 7c, 7j and 7k, as well as in the waters of ICES divisions 7a and 7g that are more than 12 nautical miles from the baseline under the sovereignty of the UK. It shall be prohibited for Union fishing vessels to retain on board, tranship, relocate or land sea bass caught in that area. Depending on the true stock structure of sea bass in Area 6 and 7, very restrictive measures introduced in 2016 may have some effect on sea bass in 6a, 7b and 7j: .see Article 10 « Measures on Sea bass fisheries » COUNCIL REGULATION (EU) 2016/72 of 22 January 2016 which consist in catch limits (from 0 to 1300 kg/month depending of the period and gear used).

Fishery in 2015

Landings data used by the WG are given in Table 10.2.1. Due to the Irish sea bass moratorium, official landings reports are by other countries, historically mainly by France, although the landings are less than 10 tonnes per year and only 2 tonnes or less since 2012. In 2015, only UK gillnet catches are reported (3.2 tonnes).

10.2.2 Data

Commercial landings data

Landings data are given in Table 10.2.1. No other data for sea bass in this area were provided to WGCSE.

Commercial discards

No estimates of sea bass discards are available.

Recreational catches

Recreational marine fishery surveys in Europe are still at an early stage in development and are described by the ICES Working Group on Recreational Fishery Surveys (ICES, 2012b). A survey was conducted in Ireland in 2010 and 2011 (O'Reilly and Roche, 2012). Domestic shore bass anglers are estimated at 11 600 individuals and these anglers harvested and estimates of 30 t and 44 t of bass in 2010 and 2011. The 2010 estimate was considered to be more robust. In addition between 75% and 80% of bass caught were returned to the water. The survey doesn't disaggregate the angling catch estimates by ICES division.

The IBP-NEW meeting report (ICES, 2012a) includes some data supplied by a stakeholder on trends in recreational catch rates from an angling club on the southern Irish coast, as well as age compositions of sea bass caught by anglers, which may be applicable also to trends in VIIj.

Biological data

Data on growth and maturity for this stock component were not reviewed by WGCSE.

Survey data

No survey data were available to WGCSE for this stock.

Other relevant data

None.

10.2.3 Historical stock development

No information is available for this stock area.

10.2.4 Management plans

There are no existing management plans for European sea bass.

10.2.5 Management considerations

Sea bass grow slowly, do not mature until 4–7 years of age, and have been recorded up to 28 years of age. Juvenile bass up to three years of age occupy nursery areas in estuaries whilst adults undertake seasonal migrations from inshore habitats to offshore spawning sites. It is not known to what extent adults from the stock in 7b,j and 6a are caught by pelagic trawlers targeting mature sea bass on spawning sites in Divisions 7e–h. After spawning, sea bass tend to return to the same coastal sites each year. The combination of slow growth, late maturity, spawning aggregation and strong site fidelity, increase the vulnerability of sea bass to over-exploitation and localized depletion.

ICES advice sheets for sea bass in the Northeast Atlantic have previously recommended that "implementation of 'input' controls (preferably through technical measures aimed at protecting juvenile fish, in conjunction with entry limitations into the offshore fishery in particular) should be promoted (ICES, 2004)" and that "Any consideration of catch limitation (output control) would need to take into account that sea bass are a bycatch in mixed fisheries to a various extent, depending on gear and country; this incites discarding and should be avoided".

Management of sea bass fisheries needs to take into account the distinctive characteristics and economic value of the different fisheries. Sea bass is of high social and economic value to sea angling in Ireland which contributes substantially to local economies.

The current stock structure assumptions are pragmatic, and need further evaluation. Further studies are needed to determine if the sea bass in Irish coastal waters are indeed functionally separate, or if they also mix with the other stock during spawning time and contribute to commercial catches on the offshore spawning grounds.

As bass is, at present, a non-TAC species, there is potential for displacement of fishing effort by non-Irish fleets from other species with limiting quotas. The effort of the pelagic fisheries during winter and spring can shift between the Bay of Biscay and the English Channel and approaches, and there is evidence for such a shift to the Channel in recent years which is likely to have increased the fishing mortality on sea bass in Area 7.

10.2.6 Data needs

Time-series of relative abundance indices need to be developed throughout the range of the stock, for both the adult and pre-recruit components of the stock.

There is a need to develop a time-series of recreational fishery catch, effort, and catch composition.

Catch locations and composition of significant commercial landings should be monitored to help establish the stock affiliation.

Further studies using tagging, genetics, and other stock and individual markers are needed to more accurately define stock boundaries suitable for assessment and management purposes.

Studies are needed to document the survival of recreationally caught and released sea bass. IBP-NEW (ICES, 2012a) noted that a range of studies on striped bass in the USA indicated hooking mortalities of around 20% on average, although a lower value of around 9% from one specific study is currently considered most appropriate for inclusion in the assessments.

10.2.7 References

ICES. 2012a. Report of the Inter-Benchmark Protocol on New Species (Turbot and Sea bass; IBPNew 2012). ICES CM 2012/ACOM:45.

ICES. 2012b. Report of the Working Group on Recreational Fisheries Surveys (WGRFS). ICES CM 2012/ACOM:23. 55 pp.

O'Reilly, S. and Roche, W. 2012. Pilot study to estimate recreational angling landings of bass in Ireland. Inland Fisheries Ireland report IFI/2012/1-4099. http://www.miextranet.ie/fss/sites/DCMAP/Annual%20Report/Annex_2_DCF_Bass_Landings_2010_11.pdf .

Table 10.2.1. European sea bass in Divisions VIa, VIIb and VIIj. Official landings: all countries (predominantly France). Source: ICES official catch statistics.

Year	Official landings
2000	1
2001	4
2002	4
2003	2
2004	8
2005	4
2006	2
2007	5
2008	5
2009	4
2010	9
2011	7
2012	1
2013	0
2014	2*
2015	3

* **Preliminary.**

Annex 1: Participants list

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Annex 2: WGCSE Stock Annexes

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

STOCK ID	STOCK NAME	LAST UPDATED	LINK
Ang-iwi_SA	Anglerfish (Northern Shelf, Division 3.a, Subarea 4 and Subarea 6, and Norwegian Sea, Division 2.a)	May 2016	Anglerfish 3.a46
Bss-47_SA	European sea bass (*Dicentrarchus labrax*) in Subarea 4.b,c and 7.a, d–h	May 2015	Sea bass 47
Cod-7e–k_SA	Celtic Sea Cod in Divisions 7.e–k	March 2016	Cod 7.e–k
Cod-iris_SA	Irish Sea Cod in Division 7.a	May 2013	Cod VIIa
Cod-rock_SA	Rockall Plateau Cod in 6.b	May 2013	Cod VIb
Cod-scow_SA	West of Scotland Cod (Division 6.a)	March 2016	Cod 6.a
Gug-celt_SA	Grey gurnard in Subarea 6 and Divisions 7.a–c and e–k	March 2014	Grey gurnard
Had-7b–k_SA	Haddock 7.b,c,e–k	May 2015	Haddock VIIbc,e–k
Had-iris_SA	Irish Sea Haddock (Division 7.a)	May 2014	Haddock VIIa
Had-rock_SA	Rockall Plateau Haddock in Division 6.b	May 2015	Haddock VIb
Had-scow_SA	West of Scotland Haddock (Division 6.a)	May 2009	Haddock VIa

Stock ID	Stock name	Last updated	Link
Meg-4a6a_SA	Megrim in Divisions 4.a and 6.a	May 2016	Megrim 4a6a
Nep-11_SA	North Minch *Nephrops* (FU11)	May 2016	*Nephrops* FU11
Nep-12_SA	South Minch *Nephrops* (FU12)	May 2016	*Nephrops* FU12
Nep-13_SA	Clyde *Nephrops* (FU13)	May 2016	*Nephrops* FU13
Nep-14_SA	Irish Sea East *Nephrops* (FU14)	September 2015	*Nephrops* FU14
Nep-15_SA	Irish Sea West *Nephrops* (FU15)	March 2009	*Nephrops* FU15
Nep-16_SA	Porcupine Bank *Nephrops* (FU16)	March 2013	*Nephrops* FU16
Nep-17_SA	Aran Grounds *Nephrops* (FU17)	May 2016	*Nephrops* FU17
Nep-19_SA	South and Southwest Ireland, *Nephrops* (FU19)	May 2016	*Nephrops* FU19
Nep-2021_SA	*Nephrops* FU 20 (Labadie, Baltimore and Galley) and FU 21 (Jones and Cockburn)	February 2014	*Nephrops* FU2021
Nep-2022_SA	*Nephrops* (*Nephrops norvegicus*) Division 7.fgh	May 2009	*Nephrops* VIIfgh
Nep-22_SA	Smalls *Nephrops* (FU22)	May 2015	*Nephrops* FU22
Ple-7b–c_SA	Plaice in Division 7.b,c (West of Ireland)	April 2013	Plaice VIIbc
Ple-7h–k_SA	Plaice in Divisions 7.h–k (Southwest of Ireland)	May 2014	Plaice VIIh–k

Stock ID	Stock name	Last updated	Link
Ple-celt_SA	Celtic Sea Plaice (Division 7.f&g)	May 2016	Plaice 7.fg
Ple-echw_SA	Western Channel Plaice (7.e)	April 2016	Plaice 7.e
Ple-iris_SA	Irish Sea Plaice (Division 7.a)	May 2013	Plaice VIIa
Sol-7b–c_SA	Sole in Division 7.b, c (West of Ireland)	April 2013	Sole VIIbc
Sol-7h–k_SA	Sole in Divisions 7.h–k (Southwest of Ireland)	May 2014	Sole VIIh–k
Sol-celt_SA	Celtic Sea Sole (Division 7.fg)	May 2016	Sole 7.fg
Sol-echw_SA	Sole in Division 7.e (Western English Channel)	May 2016	Sole 7.e
Sol-iris_SA	Irish Sea Sole (Division 7.a)	May 2016	Sole 7.a
Whg-7e–k_SA	Whiting 7.bc & e–k	February 2014	Whiting VIIbc,e–k
Whg-iris_SA	Irish Sea Whiting (Division 7.a)	May 2016	Whiting 7.a
Whg-rock_SA	Whiting 6.b Rockall Plateau	May 2013	Whiting VIb
Whg-scow_SA	West of Scotland Whiting (Subarea 6.a)	May 2016	Whiting 6.a

Annex 3: Working Documents presented to WGCSE 2016

The following seven working documents were presented to WGCSE in 2016. They are found below on the following pages:

Results of Russian Research of Demersal Fish on the Rockall Bank in 2015; Khlivnoy V.N. and T.N. Gavrilik.

Maturity-at-age estimates for Irish Demersal Stocks in VIa and VIIabgj 2004–2015; Hans Gerritsen.

Cod (*Gadus morhua*) in the Celtic Sea otolith exchange 2016; Mahé K., Dufour J.L., Brown D., Smith J., Beattie, S., Woods F.

Channel GroundFish SURVEY; Mickael Drogou.

Intercalibration of research survey vessels: "GWEN DREZ" and "THALASSA;" Arnaud Auber, Bruno Ernande, Franck Coppin, Morgane Travers-Trolet.

French Logbook data analysis 2000–2013: possible contribution to the discussion of the sea bass stock(s) structure/annual abundance indices; Alain Laurec, M.Drogou and Sih-Ifremer staff.

EqSim Analysis for West of Scotland whiting; Helen Dobby.

Working Group on the Celtic Seas Ecoregion and the area west of Scotland (WGCSE)
2016
Working Document
by
Khlivnoy V.N. and T.N. Gavrilik

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Results of Russian Research of Demersal Fish on the Rockall Bank in 2015

Introduction

In 2015, on the Rockall Bank, Russian researches were continued. In the course of the research activities, new scientific and fisheries data on biology, distribution and abundance dynamics of haddock (*Melanogrammus aeglefinus*), grey gurnard (*Eutrigla gurnardus*) and other demersal fish were obtained.

Material and methods

Russian catch statistics and data on biology and distribution of haddock and grey gurnard collected by PINRO's specialists during a cruise aboard Russian fishery vessel in the March third ten-day period – April first ten-day period and second ten-day period of May 2015 were used as baseline data. Also, the data on fishery statistics derived from the results of the short-term fishery (one day) in October 2015 were taken into consideration.

Maturity of demersal fish was estimated using the following scale: juvenile, II – immature, III – maturing, IV – prespawning, V – spawning, VI – postspawning, VI-II – postspawning recovery. Maturity of haddock and gurnard was identified using the following scale with an additional stage VI-IV extruded one or several portions of sexual products but having not finished spawning (Filina, Khlivnoy and Vinnichenko, 2009).

Age was read from the central break of otoliths poured over with alcohol and glycerin solution and scanned in the incident light of a binocular (8x 2 magnifications).

Mean stomach fullness was used as an indicator of feeding intensity. To study the stomach fullness the following scale was used:

0 – no food;
1 – very little food, traces of food in stomachs;
2 – little food, contents do not fill all stomach cavity;
3 - stomach is full with food and has folds on the walls;
4 – very much food, stomach walls are stretched, no folds;
5 – stomach is everted.

Haddock fatness was estimated from hepatosomatic index as the ratio of liver weight to the total weight of a fish body expressed as a percentage.

Fatness of grey gurnard was determined by fat content on the viscera by a four point scale: 0 – no fat on the viscera; 1 – minor fat deposit as a thin strip attached to intestine; 2 – moderate fatness, a wide strip of fat which almost covers viscera; 3 – much fat, the fat completely covers viscera, no lumens observed.

The condition factor (fatness) of haddock was estimated using the Fulton's method and calculated from the formula (1):

$$K=\frac{Qx100,}{L^3} \qquad (1)$$

where Q=total weight of fish (with viscera) and L=length of fish, cm.

Results

Review of fishery

In the March third ten-day period-April first ten-day period, May second ten-day period and October 2015 (1 hauling was in October), 136 t of haddock were caught by the trawler of 9 tonnage class. Other demersal fish species were caught in small numbers as bycatch (Table 1). The vessel operated in the international waters outside the areas closed for fishing.

Biological characteristic of haddock

Length-age composition

In 2015, haddock 19-67 cm long occurred in the bottom trawl catches, mature individuals 25-35 cm in length prevailed (Fig. 1). Mean length of haddock amounted to 31.1 cm. The weight of one individual varied from 62.5 g to 2.3 kg and mainly was132-325 g, mean weight equalled to 284 g. Individuals aged from 1 to 10 years were found in the catches. Individuals aged 2-4 from 2011-2013 year-classes with the prevalence of 2012 year-class were predominant (Fig. 2).

Maturity

In late March-early April, the bulk of catches was made up by maturing and prespawning individuals. The number of immature haddock occurred in catches was minor and accounted to about 2% (Fig. 3).

In March-May 2015, as opposed to the previous two years, males predominated over females in number. In March, the sex ratio was 1.0:0.7, in April – 1.0:0.5 (Table 2).

Feeding, fatness and hepatosomatic index

In March, April and May 2015, haddock fed with low intensity. However, as compared to the previous years (2004-2014), feeding intensity estimated by the stomach fullness was at one of the highest levels. The mean stomach fullness was higher only in March 2010 and May 2014 (Table 3).

In 2015, the hepatosomatic index and condition factor were at one of the lowest levels (since 2004) (Table 4).

In March-early May 2015, benthic organisms prevailed in haddock stomachs. Ophiurans, gastropods and bivalves, worms and fish are also included in the diet (Table 5).

Biological characteristic of grey gurnard

Length-age composition

In March-May, the grey gurnard seldom occurred in bottom trawls. The fish length varied from 24 to 38 cm. Iindividuals 28-33 cm long were predominant. The mean length was 30.6 cm (Fig. 4).

Maturity

In March, in near bottom layers, grey gurnards with maturing (56%) and prespawning (44%) gonads were predominant. Among the prespawning fish males were more abundant (93,2 %). Females predominated in number. The sex ratio was 1.0:1.3 (Fig.5).

In May 2015, in catches, small amounts of spawning and postspawning females as well as maturing males were found.

Feeding

In March-May 2015, the feeding intensity of grey gurnard was high, the mean stomach fullness was 1.7. About 26% of stomachs were empty. Euphausids and fish objects (mainly blue whiting) occurred in stomachs.

Conclusion

1. In 2015, individuals of the 2011-2013 year-classes aged 2-4 (with the prevalence of 2012 year-class) were predominant in the trawl catches of haddock on the Rockall Bank.
2. Haddock of the 2007-2010 year-classes occurred in catches in small numbers indicating their small number.
3. In April 2015, haddock spawning was at the highest level, in early May, spawning was finished by more than half of the individuals.
4. In Marchl-May 2015, the feeding intensity of haddock was at one of the highest levels for 2004-2014.
5. In April-May, in near bottom layers, small numbers of big mature grey gurnards were caught. In March, primarily, individuals with maturing and prespawning gonads were found. In May, primarily, spawning and postspawning individuals were caught.

References

Filina, E.A., Khlivnoy V.N. and Vinnichenko V.I. 2009. The reproductive biology of haddock (*Mellanogrammus aeglefinus*) at the Rockall Bank. J. Northw. Atl. Fish. Sci., Vol. 40: p. 59–73.

Khlivnoy V.N., Gavrilik T.N., 2014. Results of Russian Research and Fishery of Demersal Fish on the Rockall Bank in 2013. Working Document for ICES Working Group on the Celtic Seas Ecoregion (WGCSE), 12 p.

Khlivnoy V.N., 2015. Results of Russian Research of Demersal Fish on the Rockall Bank in 2014. Working Document for ICES Working Group on the Celtic Seas Ecoregion (WGCSE), 8 p.

Table 1

Fleet performance in the Russian fishery of demersal fish on the Rockall bank in 2015 (provisional data)

Month	Ton-nage class	Number of fishing days	Number of trawling hours	Catch, t						
				had-dock	grey gurnard	angler	saithe	ling	silvery pout	others
March	9	7	67,5	33	<1		<1	<1		
April	9	8	111	74	<1	<1	<1			
May	9	9	119,5	27		1	<1	2	8	1
October	9	1	6	2						
Total		25	304	136	1	2	1	2	8	1

Table 2

Sex ratio of haddock on the southwestern slope of the Rockall Bank in 2013***, 2014 and 2015

Years	Sex	Month		
		April	May	September
2013	Males*	1,0	1,0	1,0
	Females	1,7	3,5	1,0
	N, ind.**	108	50	335
	Males*	1,0	1,0	1,0
2014	Females	1,2	1,7	1,1
	N, ind.**	300	30	1848

**number of individuals examined.

***data on 2013 according to Khlivnoy, Gavrilik (2014), on 2014 according to Khlivnoy (2015)

Table 2

Sex ratio of haddock on the southwestern slope of the Rockall Bank in 2013***, 2014 and 2015

Years	Sex	Month			
		Match	April	May	September
2013	Males*		1,0	1,0	1,0
	Females		1,7	3,5	1,0
	N, ind.**		108	50	335
2014	Males*		1,0	1,0	1,0
	Females		1,2	1,7	1,1
	N, ind.**		300	30	1848
2015	Males*	1,0	1,0	1,0	
	Females	0,7	0,7	0,5	
	N, ind.	111	40	150	

** number of individuals examined

***- data on 2013 according to Khlivnoy, Gavrilik (2014), on 2014 according to Khlivnoy (2015)

Table 3

Feeding intensity and fatness of haddock on the Rockall Bank in 2004-2010, 2012-2013*, 2014 and 2015

Year	March		April		May		September	
	Fulton's condition factor**	Mean stomach fullness	Fulton's condition factor**	Mean stomach fullness	Fulton's condition factor**	Mean stomach fullness	Fulton's condition factor**	Mean stomach fullness
2004		0,6	0,84	0,7		1,3		
2005	0,93	0,4	0,87	0,7		1,0	0,95	1,1
2006			0,87	0,6		1,1	0,98	1,3
2007							0,92	1,2
2008	0,93	0,3	0,92	0,2		0,3	0,92	1,1
2010	1,00	0,9	0,97	0,7				
2012							0,89	2,0
2013			0,94	0,6		0,8		
2014			0,95	0,7		2,4		1,2
2015	0,90	0,8	0,60	0,7	0,73	1,5	0,73	

*- data for 2004-2010 and 2012-2014 according to Khlivnoy (2015)

**- average value

Table 4

Hepatosomatic index in Rockall haddock in 2004-2006, 2008, 2010, 2012-2013*, 2014 and 2015

Year	Sex	Month						
		March	April	May	June	July	August	September
2004	Males	-	3,4	2,2	2,4	3,8	4,8	4,6
	Females	-	3,8	2,4	2,7	3,9	4,6	4,8
	Juveniles	-	-	-	-	-	-	2,3
2005	Males	5,5	3,8	2,8	-	-	5,6	5,3
	Females	5,0	4,3	3,4	-	-	6,1	5,7
	Juveniles	-	-	-	-	-	-	3,1
2006	Males	-	2,9	1,9	2,0	-	5,1	4,9
	Females	-	3,4	3,0	2,9	-	5,1	5,5
	Juveniles	-	-	-	-	-	-	-
2008	Males	-	-	-	-	-	-	3,3
	Females	-	-	-	-	-	-	3,4
	Juveniles	-	-	-	-	-	-	3,2
2010	Males	3,8	3,9	-	-	-	-	-
	Females	3,4	3,4	-	-	-	-	-
	Juveniles	-	-	-	-	-	-	-
2012	Males	-	-	-	-	-	-	5,2
	Females	-	-	-	-	-	-	4,9
	Juveniles	-	-	-	-	-	-	2,8
2013	Males	-	2,9	5,3	-	-	-	-
	Females	-	3,4	3,7	-	-	-	-
	Juveniles	-	-	-	-	-	-	-
2014	Males	-	3,9	-	-	-	-	2,9
	Females	-	4,8	-	-	-	-	3,1
	Juveniles	-	-	-	-	-	-	1,8
2015	Males	3,3	-	1,2	-	-	-	-
	Females	3,5	3,4	1,4	-	-	-	-
	Juveniles	-	-	-	-	-	-	-

*- data for 2005-2006, 2008, 2010 and 2012-2013 according to Khlivnoy, Gavrilik (2014), for 2014 according to Khlivnoy (2015)

Table 5

Frequency of occurrence of food items in the haddock stomachs on the Rockall Bank in 2006, 2008, 2010, 2012-2015, % of total number of prey species

Food items	2006**					2008*				2010*		2012*	2013		2014		2015		
	April	May	June	August	September	March	April	May	September	March	April	September	April	May	April	May	March	April	May
Euphausiids		0.5	0.6	31.5	12.4	1.79	4.55	4.35	12.92	16.77	27.78				10.00		2.06	0.98	2.72
Amphipods	0.3				1.1				1.3										
Shrimps	0.5	0.4	0.1		1.1	1.79	1.14	4.35		8.07	3.70	20.65			4.17	10.87			
Crustaceans	4.8	1.2	0.8	1.9	1.5		1.14		0.46	12.42	0.93	0.25			0.83		1.03	0.98	
Jellyfish	0.5	1.0	0.3				1.14		0.28	4.97	0.93	24.18							
Other plankton									1.2			1.51							
Worms	1.8	4.8	5.4	1.9	6.7	16.07	5.68		6.32					4.35	0.83	4.35	2.58	4.90	0.34
Polychaetes	1.0	0.3	0.6		0.8				0.09	4.35		3.27	2.44		3.33	13.04			
Echinoderms	13.5	8.0	8.4	3.7	14.6	1.79	2.27	4.35	7.53			0.25	41.46	4.35			1.03	4.90	
Holothurians									0.09	0.62			4.88						
Ophiurans	5.1	3.9	4.1		10.9	7.14	3.41	4.35	4.09	5.59	12.96	1.76	14.63	43.48	17.50	15.22	7.22	3.92	1.70
Other benthos	1.3	8.9	12.8	22.2	15.0		1.14	8.7	0.19	1.86	4.63	1.01	2.44		22.50	21.74	63.92	73.53	92.52
Molluscs	2.5	2.2	2.2	5.6	5.6	5.36	2.27	8.7	7.05	9.31	8.34	1.51	2.44	43.48	1.67	4.35	2.58	3.92	
Pteropods	15.2	43.8	49.1	1.9			1.14		1.02										
Detritus	12.4	3.0	0.1	1.9	0.4	28.57	10.23		0.1										
Fish eggs	0.3														3.33	2.17			
Haddock juvenile	0.5											0.25	2.44						
Blue whiting	2.0	0.4	0.1	1.9			1.14			0.62	0.93				20.00		1.55		
Long rough dab											0.93								
Other fish.objects	17.0	11.4	11.1	22.2	10.9	8.93	1.14	26.109	6.2	0.62	3.71	4.54	19.51		6.67		1.55		1.36
Squids	0.8	0.1	0.1			1.79	2.27	8.7	0.55	4.97	5.56	1.51			1.67	4.35	1.55	0.98	
Crabs	0.8	2.7	2.3		0.8	3.57	5.68		8.27	1.86	3.70	36.29			0.83				
Octopuses	0.5				0.4					1.24	0.93	0.25							
Algae												0.25							
Other species	0.3				0.4	19.64	44.32	21.74	1.12	3.1	6.48		4.88	4.35	0.83	19.57	8.76	2.94	1.02
Digested fish										13.66	11.11	2.27			5.83	4.35	3.61	1.96	0.34
Digested food	19.0	7.3	2.0	5.6	17.6	3.57	11.36	8.7	41.64	9.94	7.41	0.25	4.88				2.58	0.98	
Stomachs examined	1250	2506	1450	100	458	400	1150	200	650	161	108	178	108	50	300	30	194	102	294

*- данные за 2006, 2008, 2010 и 2012-2013 гг. приведены по Khlivnoy, Gavrilik (2014)

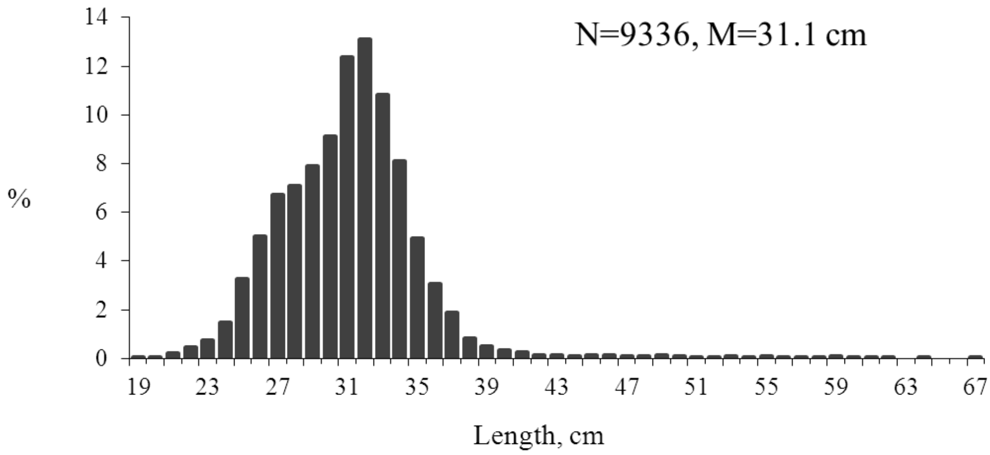

Fig. 1. Length composition of haddock catches on the Rockall Bank according to data collected by observers onboard Russian fishery vessels by bottom trawlings in March-May 2015

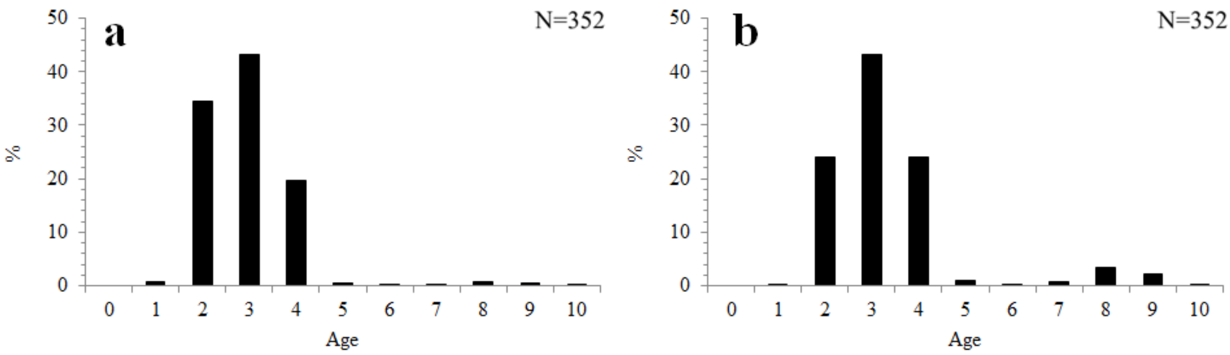

Fig. 2. Age composition of haddock catches according to number (a) and weight (b) on the Rockall Bank in March-May 2015 (collected by observers aboard Russian vessels)

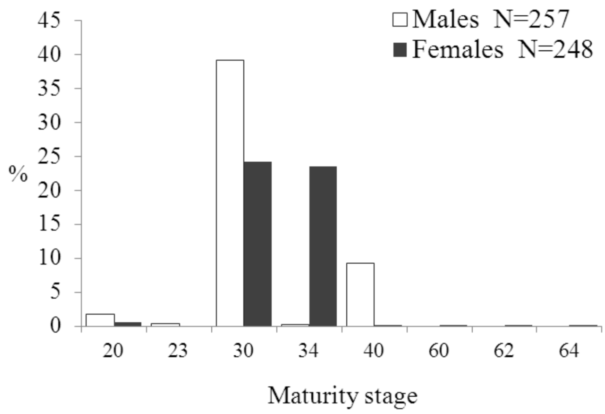

Fig.3 Maturity of haddock on the Rockall Bank in March-April 2015

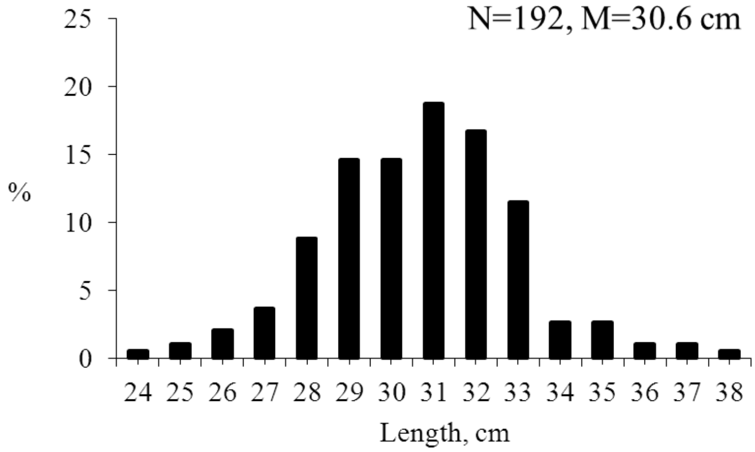

Fig. 4. Length composition of grey gurnard on the Rockall Bank in March-May 2015

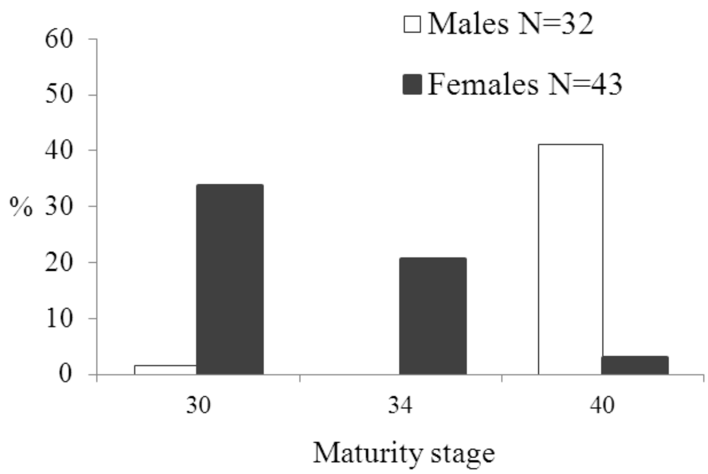

Fig. 5. Maturity of grey gurnard on the Rockall Bank in March 2015

Working document X

ICES Working Group for the Celtic Seas Ecoregion
4–13 May 2016
Copenhagen, Denmark

ICES Working Group for the Assessment of the Bay of Biscay and the Iberic waters Ecoregion
13–19 May 2016
Copenhagen, Denmark

Maturity-at-age estimates for Irish Demersal Stocks in VIa and VIIabgj 2004-15

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Introduction

This document provides maturity-at-age estimates for stocks assessed by the WGCSE and WGBIE. All data are obtained on surveys and commercial sampling carried out by the Marine Institute.

Methods

Between 2004 and 2009, the Marine Institute carried out annual Q1 groundfish surveys in the waters around Ireland, primarily to assess the maturity ogives of stocks that require sampling under the Data Collection Framework. The surveys covered the ICES divisions around Ireland (VIa and VIIabgj) with the aim to cover all divisions at least every 3 years. From 2010 onwards, maturity sampling was carried out by on-board commercial sampling and port sampling. During Q1, maturity stages were recorded for all discard fish that are brought back to the lab for age sampling. Additionally, samples of small landed cod and sole were purchased in the ports (with the guts in situ) to increase the sample size and length range for these species.
A two-stage sampling scheme was applied whereby the total catch length distribution is quantified and length-stratified samples of the target species are taken for further biological analysis (age, sex and maturity).
Maturity stages were assessed using a 7-stage maturity scale whereby stages 1-2 are considered immature while stages 3-7 are considered mature (e.g. Gerritsen et al., 2003). Stages 3-7 are characterised by the appearance of vitellogenesis or hydrated cells or clear signs of recent spawning.
The length at 50% maturity was estimated for females only by fitting a binomial model to the maturity-at-length data. Confidence limits were estimated by bootstrapping the observations on individual fish.
Proportions mature-at-age were estimated by constructing a matrix containing the sample numbers by age, sex and maturity state (mature/immature) at each length class. Unsexed

individuals (usually small fish with undeveloped gonads) were assigned in equal numbers to both sexes. This Age-Sex-Maturity-Length Key (ASMLK) was applied to the length-frequency data to estimate the proportions mature-at-age for either sex and both sexes combined. Any gaps in the ASMLK were filled in using a multinomial model (Gerritsen et al., 2006).

Results

Figure 1 shows that for most stocks there are no clear trends in the L50 over time. Estimates for cod in area VII (cod 7) varied from around 40cm to 60cm, however the sample sizes for this stock were generally very low at the start of the time-series; in recent years the estimates are more precise and less variable (around 40cm). Plaice in area VII (ple 7) had an outlying estimate for 2013 but this was estimated with low precision. Because overall there was no clear evidence of trends in maturity over time for any stock, data from all years (2004-2015) were combined. Table 1. Shows the estimated proportions mature-at-age. For the cod stocks, the proportion of mature 2-year-olds is somewhat higher than that the proportions used by the working group. For other ages the estimates are very similar. For haddock in VIIbk and VIIa, the Irish estimates are slightly lower for 2-year-olds and in agreement for the other ages. For haddock in VIa the Irish estimates for age 1 and 2 were higher than the proportions used by the working group. For megrim, the Irish estimates were very close for females of ages 2 to 4, for ages 5 to 8 the Irish estimates were somewhat lower than those used by the working group. It should be noted that sampling took place after the peak of spawning and it is possible that the gonads of some fish had recovered to the extent that they could not reliably be distinguished from immature fish. Estimated proportions mature for plaice and sole were also slightly lower than those used by the working group, possibly for the same reasons. For whiting in 7b-k, the Irish maturity estimates are broadly in agreement with the ogives used by the working group, for the other whiting stocks the Irish estimates are considerably higher for the 0-group and similar for older fish.

Discussion

Some (relatively minor) differences were found between the ogives used by the working groups and the current findings. Because Irish sampling generally does not cover the full extent of the stocks, it is difficult to determine whether the Irish estimates are unbiased. It is possible that the lack of full spatial coverage can explain some of the differences.

References

Gerritsen, H.D., Armstrong, M.J., Allen, M., McCurdy, W.J. and Peel, J.A.D., 2003. Variability in maturity and growth in a heavily exploited stock: whiting (Merlangius merlangus L.) in the Irish Sea. J. Sea Res., 49(1): 69-82.

Gerritsen, H.D., McGrath, D. and Lordan, C., 2006. A simple method for comparing age-length keys reveals significant regional differences within a single stock of haddock (Melanogrammus aeglefinus). ICES J. Mar. Sci., 63(3): 1096-1100.

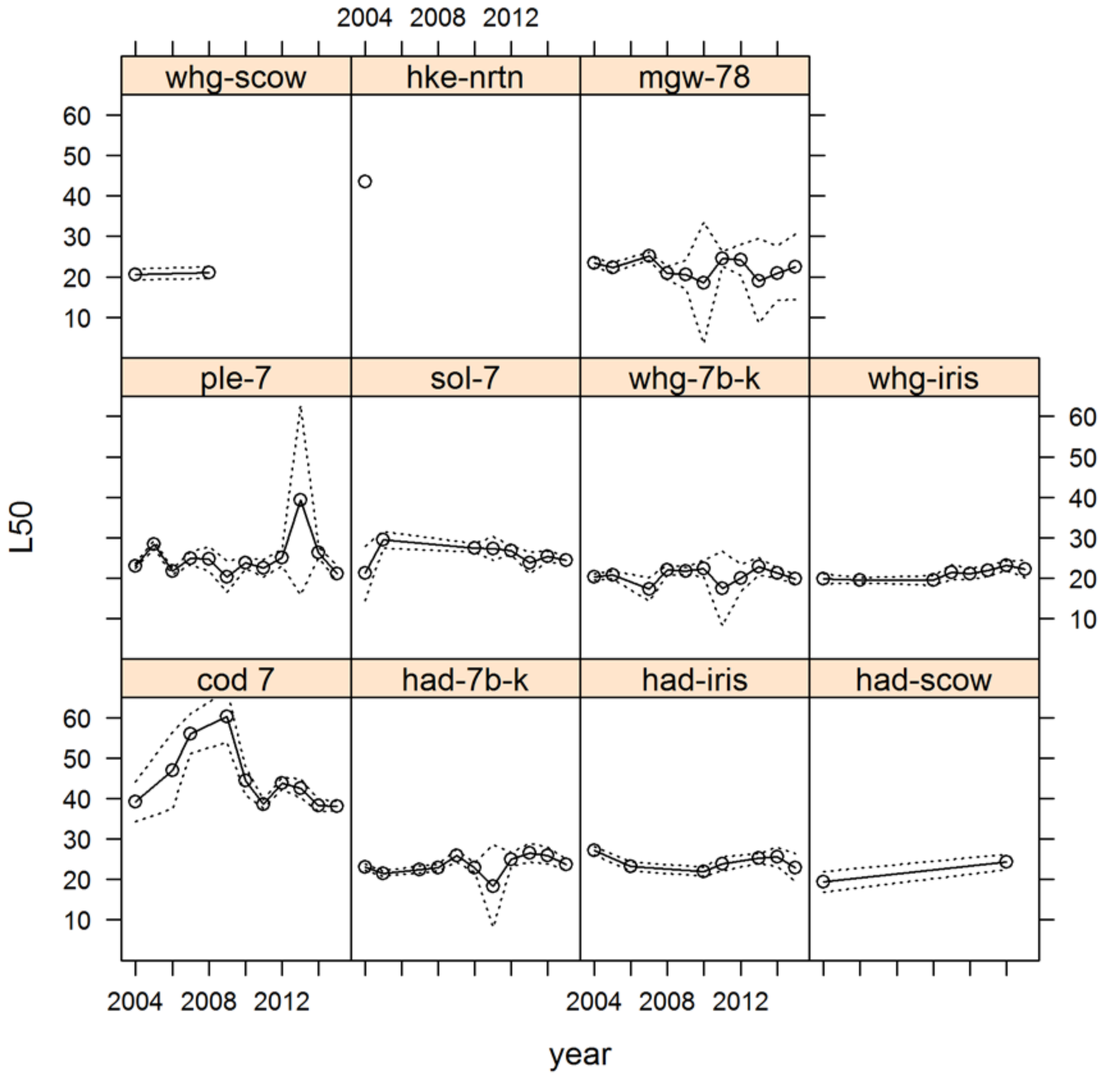

Figure 1. Length at 50% maturity (L50; cm) for females by stock and year.

Table 1. Estimated proportions mature (sample numbers in brackets) by stock, sex and age. Maturity ogives used by the WG are also given.

Stock	Sex/WG	1	2	3	4	5	6	7	8	9	10+
cod 7	**F**	0.01 (484)	0.58 (793)	0.99 (78)	1.00 (19)	1.00 (2)					
	M	0.01 (632)	0.76 (1196)	1.00 (72)	1.00 (11)	1.00 (2)					
cod-7a	**WGCSE**	0.00	0.38	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
cod-7e-k	**WGCSE**	0.00	0.39	0.87	0.93	1.00	1.00	1.00	1.00	1.00	1.00
had-7b-k	**F**	0.01 (268)	0.90 (675)	0.98 (442)	0.99 (126)	1.00 (60)	1.00 (20)	1.00 (5)	1.00 (1)		
	M	0.29 (380)	0.80 (570)	0.92 (312)	0.89 (77)	1.00 (39)	1.00 (8)	1.00 (2)	1.00 (1)	1.00 (1)	
	WGCSE	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
had-iris	**F**	0.01 (154)	0.78 (196)	1.00 (123)	1.00 (5)	1.00 (5)					
	M	0.14 (112)	0.72 (182)	0.97 (113)	1.00 (3)	1.00 (1)					
	WGCSE	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
had-scow	**F**	0.10 (9)	0.97 (66)	0.99 (44)	1.00 (47)	1.00 (16)	1.00 (1)				
	M	0.05 (32)	0.92 (68)	0.98 (25)	1.00 (31)	1.00 (9)	1.00 (1)				
	WGCSE	0.00	0.57	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
mgw-78	**F**	0.18 (7)	0.28 (96)	0.62 (237)	0.83 (255)	0.87 (212)	0.87 (159)	0.79 (66)	0.89 (31)	1.00 (17)	1.00 (8)
	M	0.64 (14)	0.46 (146)	0.45 (235)	0.66 (191)	0.50 (99)	0.69 (67)	0.74 (21)	1.00 (5)	1.00 (1)	1.00 (2)
	WGHMM	0.04	0.21	0.60	0.90	0.98	1.00	1.00	1.00	1.00	1.00
ple-7	**F**	0.00 (13)	0.15 (199)	0.45 (604)	0.64 (458)	0.80 (339)	0.97 (116)	0.94 (75)	0.93 (35)	1.00 (10)	0.97 (21)
	M	0.00 (13)	0.30 (226)	0.53 (438)	0.72 (314)	0.80 (168)	0.85 (86)	0.88 (44)	0.89 (34)	0.76 (10)	1.00 (5)
ple-7a	**WGCSE**	0.00	0.24	0.57	0.74	0.93	1.00	1.00	1.00	1.00	1.00
ple-7fg	**WGCSE**	0.00	0.26	0.52	0.86	1.00	1.00	1.00	1.00	1.00	1.00
sol-7	**F**		0.12 (27)	0.36 (312)	0.58 (499)	0.85 (333)	0.92 (172)	0.97 (118)	0.97 (73)	0.90 (35)	0.95 (84)
	M		0.20 (8)	0.30 (55)	0.46 (87)	0.59 (68)	0.68 (92)	0.74 (94)	0.76 (83)	0.69 (44)	0.87 (100)
sol-7fg	**WGCSE**	0.00	0.14	0.45	0.88	0.98	1.00	1.00	1.00	1.00	1.00
whg-7b-k	**F**	0.29 (512)	0.96 (547)	0.98 (294)	0.98 (116)	1.00 (40)	1.00 (5)	1.00 (2)			
	M	0.51 (557)	0.84 (446)	0.95 (291)	0.78 (122)	0.76 (49)	1.00 (9)	1.00 (1)			
	WGCSE?	0.39	0.90	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00
whg-iris	**F**	0.11 (295)	0.91 (281)	0.99 (144)	1.00 (22)	1.00 (4)					
	M	0.23 (239)	0.77 (146)	0.74 (48)	1.00 (9)	1.00 (5)					
	WGCSE	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
whg-scow	**F**	0.52 (49)	0.99 (74)	1.00 (19)	1.00 (9)	1.00 (6)					
	M	0.61 (66)	0.88 (54)	1.00 (15)	1.00 (23)	1.00 (5)	1.00 (2)				
	WGCSE	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Working paper

Cod (*Gadus morhua*) in the Celtic Sea otolith exchange 2016

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1. SUMMARY

In this working document, the results of an otolith exchange on Cod (*Gadus morhua*) in the Celtic Sea are presented. Each year, stock assessment of cod in the Celtic Sea requires data to be compiled and compared. For example the age distribution from this year's assessment is compared to historical data. In 2016, there has been a small number of one year olds. Consequently, the three main countries (France, Ireland and UK England) which contribute to the cod landings in Celtic Sea organised a small otolith exchange to verify the precision of age data between four readers. Mean precision of age estimate for individual fish had a coefficient of variation (CV) of 0.2% and percent agreement to modal age of 99.5%. There was only one image where two readers identified three growth rings and the other identified four growth rings.

2. BACKGROUND INFORMATIONS

This small exchange was organized following the data preparation to stock assessment group in 2016. This is not a recommendation from the WGBIOP 2015 (ICES, 2015).

The last workshop on cod otoliths was organized in 2008 but this focused on the North Sea stock (ICES, 2008).

3. PARTICIPANTS

Four readers from five institutes participated in this exchange (Tab. 1).

Table 1: List of the readers.

Readers	Institute	Country
Fiona Woods	Marine Institute	Ireland
Susan Beattie	Marine Institute	Ireland
Dave Brown	CEFAS	UK England
Jean Louis Dufour	IFREMER	France

4. SAMPLING COLLECTION

A total of 99 fish were sampled in 2015 by Ifremer from EVHOE survey and from fish markets (Fig. 1):

- 24 fish during Quarter 1
- 25 fish during Quarter 2
- 25 fish during Quarter 3
- 25 fish during Quarter 4

The length range of the fish was between 37 and 96 cm, with mean 60 cm (Fig. 1).

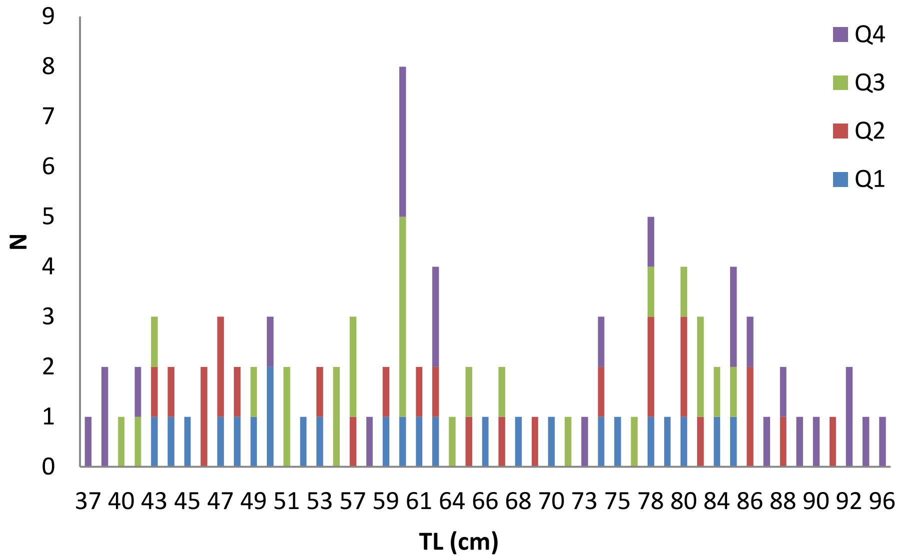


Figure 1: Histograms of the cod samples.

5. RESULTS

One exercise was realized on the same set of otoliths (n=99) to compare the readings with blind readings for each reader. The spreadsheet (Eltink, 2000) was completed according to the instructions contained in Guidelines and Tools for Age Reading Comparisons by Eltink *et al.* (2000). Modal ages were calculated for each otolith read, with percentage agreement, mean age and precision coefficient of variation as a definition (for each otolith):

- Percentage agreement = 100.(no. of readers agreeing with modal age/total no. of readers).
- Coefficient of variation (CV) = 100.(standard deviation of age readings/mean of age readings).

The modal age was from one to five years old. Mean precision of age estimate for individual fish were coefficient of variation (CV) of 0.2% and percent agreement to modal age of 99.5%. There was only one image where two readers identified three growth rings and the other identified four growth rings. These results showed that the precision of age estimation from the Celtic Sea was very high. Consequently, the ageing data were usable for stock assessment of Celtic Sea cod.

The minimal requirement for age readings consistency is the absence of bias among readers and through time. The hypothesis of an absence of bias between two readers or between a reader and the modal age estimated can be tested non-parametrically with a one-sample Wilcoxon signed rank test (Tab. 2).

Table 2 : Inter-reader bias test and reader against modal age bias test (-: no sign of bias (p>0.05); *: possibility of bias (0.01<p<0.05); **: certainty of bias (p<0.01)) .

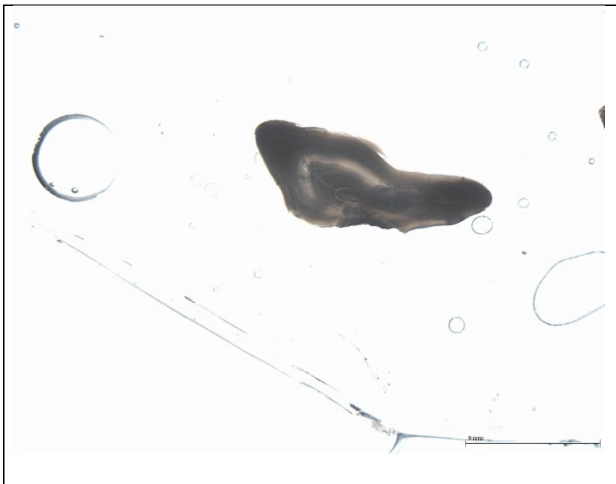
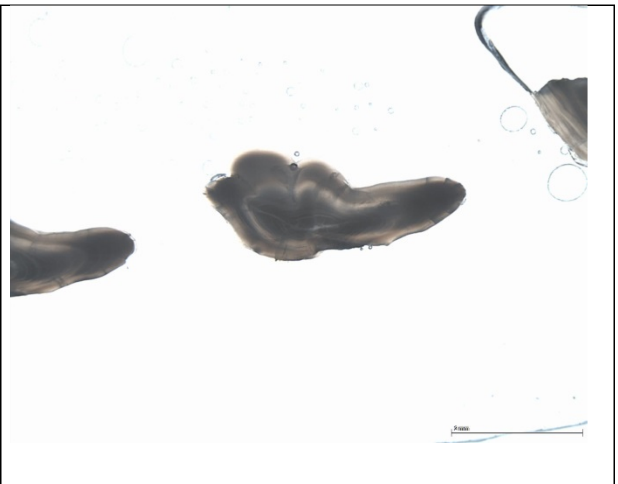
	Fiona Ireland	Susan Ireland	Jean Louis France	Dave UK England
Ireland		–	–	–
Ireland	–		–	–
France	–	–		–
UK England	–	–	–	

modal age	–	–	–	–

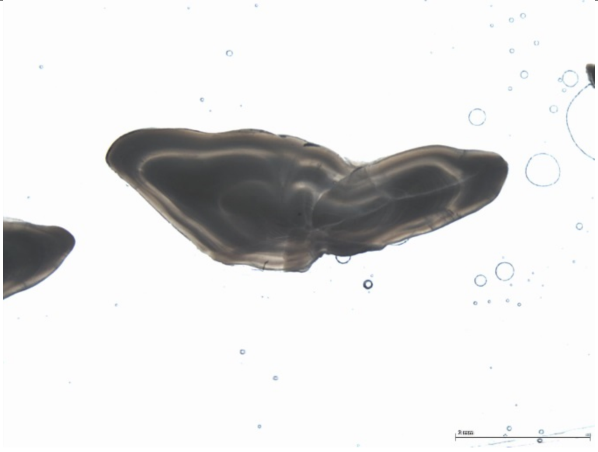
6. EXAMPLES

Quarter 4 : Otoliths from survey at sea (EVHOE)

Age group 1

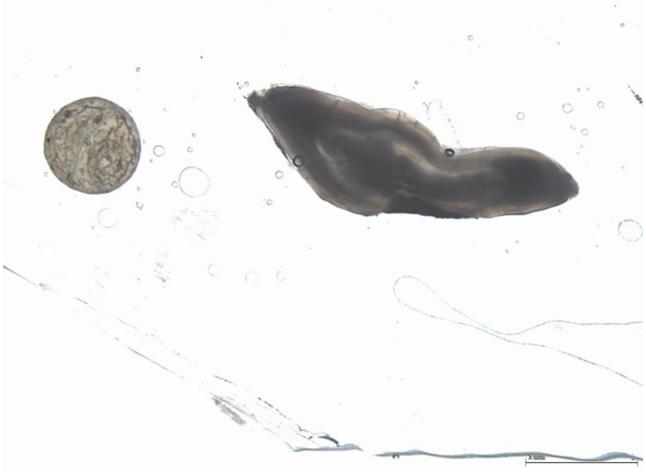
	
Male TL=37 cm	Female TL=41 cm

Age group 2

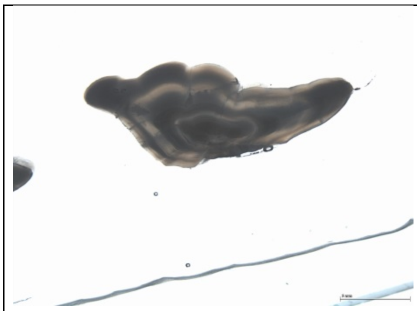
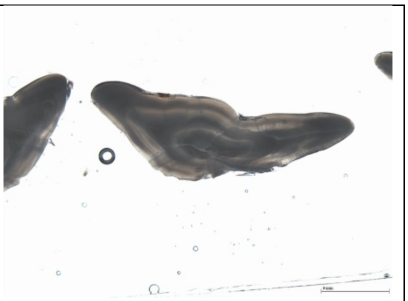
	
FemaleTL= 81 cm	Male TL= 51 cm

Quarter 3 : Otoliths from fish market (Lorient)

Age group 1

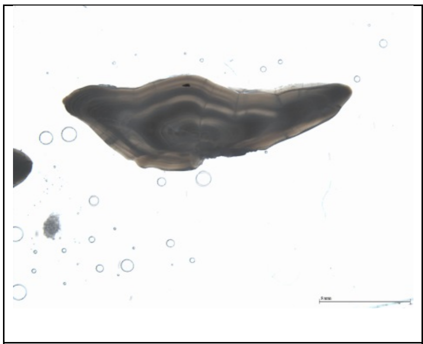
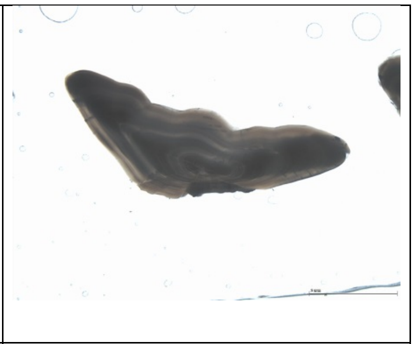

TL=43 cm

Age group 2

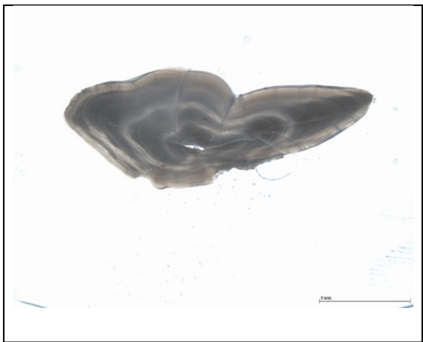
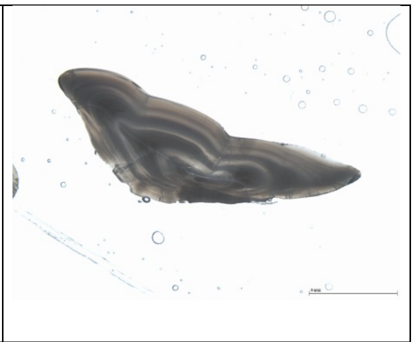
	

TL=63 cm	TL=74 cm

Age group 3

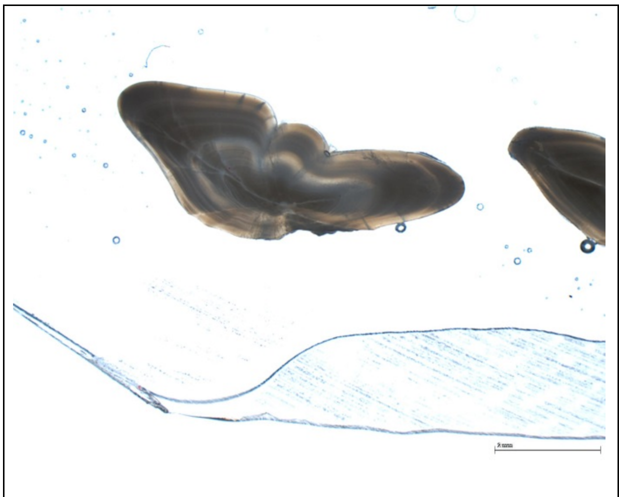
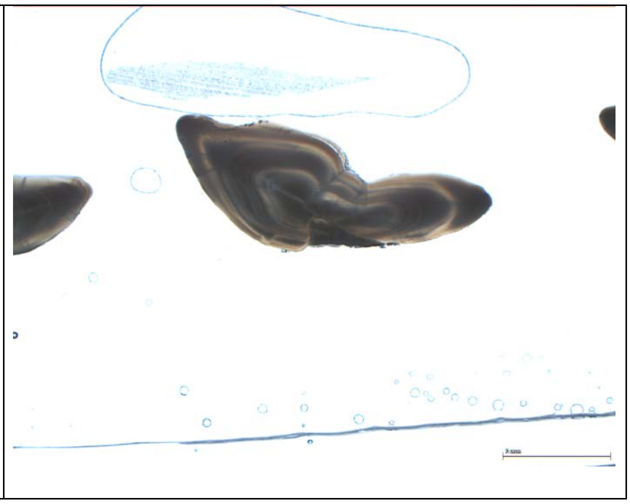
	
TL=78 cm	TL = 88 cm

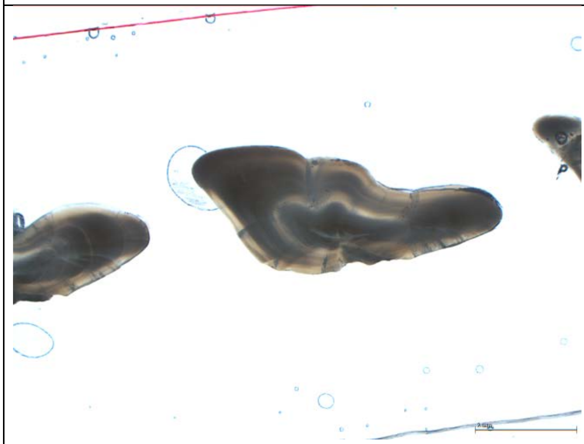
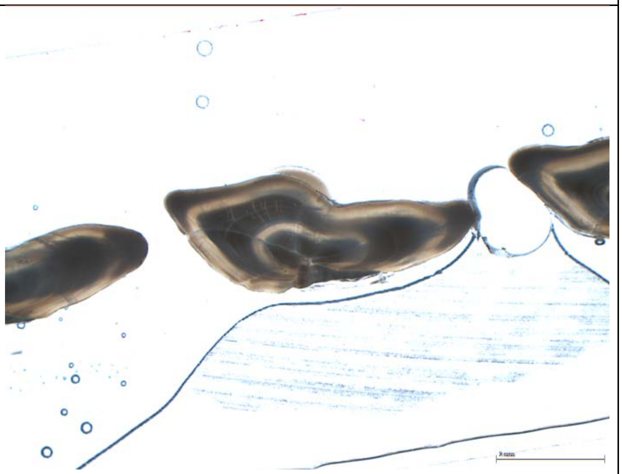
Age group 4

	
TL=92 cm	TL=86 cm

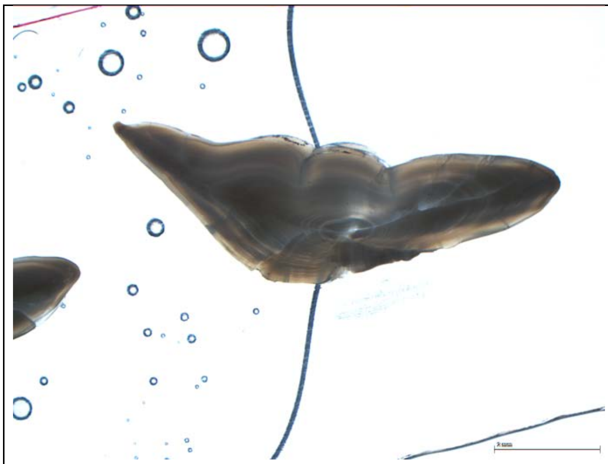
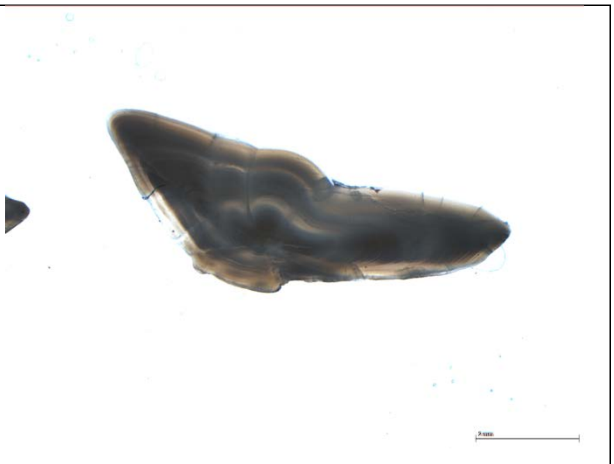
Quarter 2 : Otoliths from fish market (Lorient)

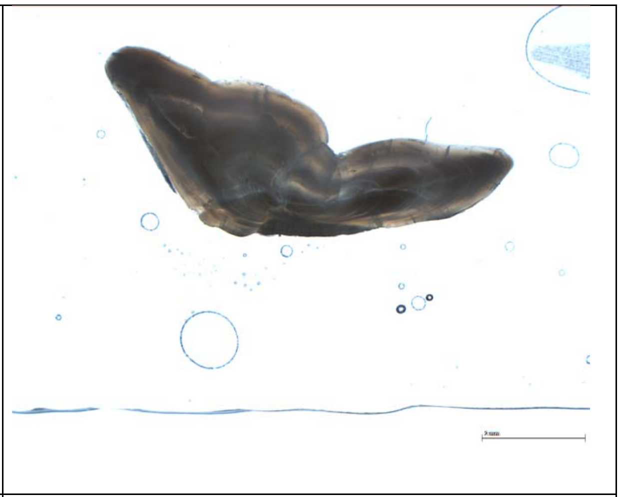
Age group 2

TL=65 cm	TL=44 cm
	
TL=57 cm	TL=39 cm

Age group 3

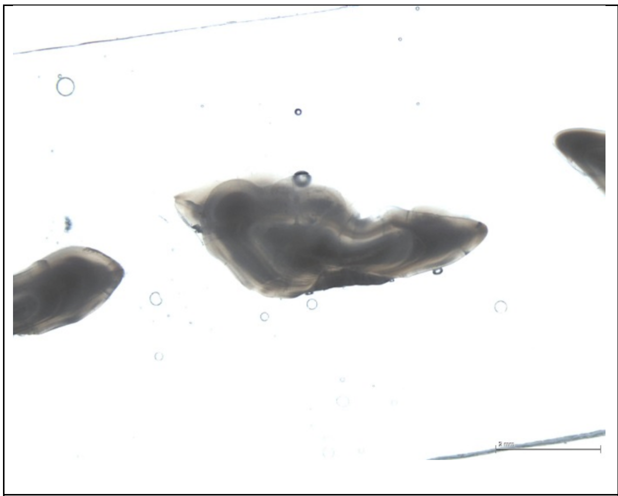
	
TL=76 cm	TL=78 cm



TL= 88 cm	TL=78 cm

Quarter 1 : Otoliths from fish market (Lorient)

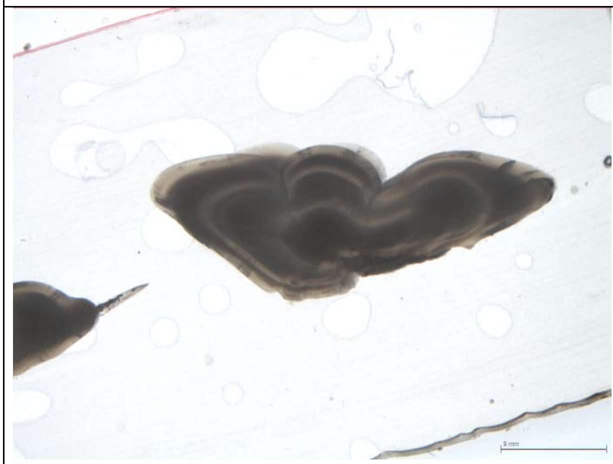
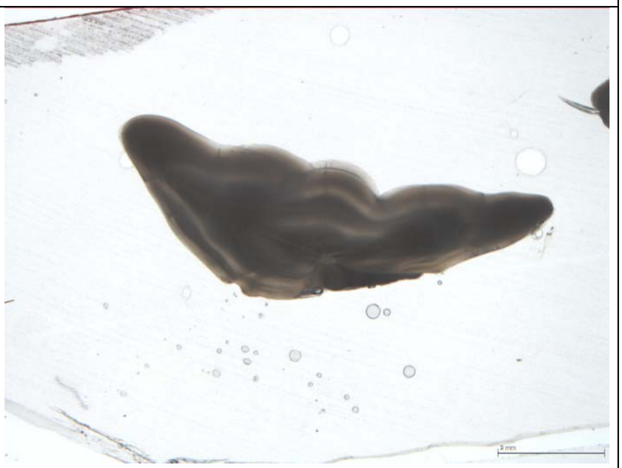
Age group 2



TL= 45 cm	TL = 56 cm

	
TL = 41 cm	TL = 46 cm

Age group 3

	
TL= 78 cm	TL = 84 cm
	

TL = 63 cm	TL = 70 cm

7. REFERENCES

Eltink, A. T. G. W., 2000. Age reading comparisons. (MS Excel workbook version 1.0 October 2000) Internet : http://www.efan.no

Eltink, A. T. G. W., Newton, A. W., Morgado, C., Santamaria, M. T. G., Modin, J., 2000. Guidelines and Tools for Age Reading. (PDF document version 1.0 October 2000) Internet : http://www.efan.no

ICES. 2008. Report of the Workshop on Age Reading of North Sea Cod (WKARNSC), 5-7 August 2008, Hirsthals, Denmark. ICES CM 2008/ACOM:39. 71 pp.

ICES. 2015. First Interim Report of the Working Group on Working Group on Biological Parameters (WGBIOP), 7-11 September 2015, Malaga, Spain. ICES CM 2015/SSGIEOM:08. 67 pp.

Morgane Travers-Trolet, Raphaël Girardin, Franck Coppin, Ifremer France, Boulogne/Mer

1. Sampling scheme Channel Groundfish Survey

The CGFS follows a fixed stratified sampling design, composed initially of 88 stations. When changing vessel in 2015 (passage of the Gwen Drez used since 1988 to Thalassa used from 2015), the number of stations making up the sampling plan has been slightly decreased. It now consists of 74 stations as shown in Figure 1. The impact of the ship change on overall abundance indices was studied through comparative analysis of CPUE of the two vessels during the intercalibration carried out in 2014.

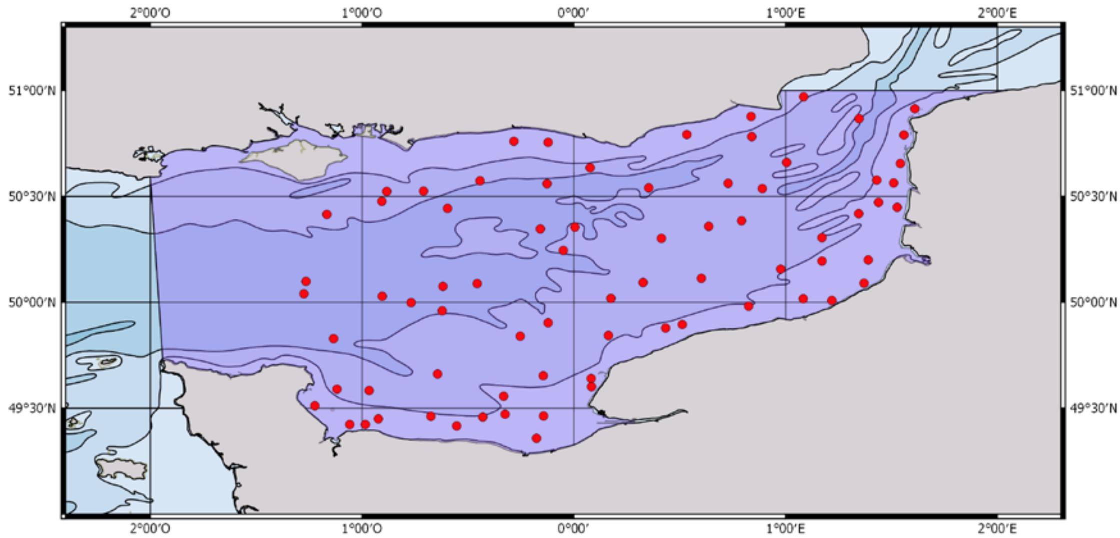


Figure 1 : Sample design of the CGFS conducted on the R / V Thalassa from 2015, consisting of 74 stations (red) spread over the layers corresponding to the statistical rectangles of VIId (purple)

2. Calculation of the overall abundance indices

2.1. Introduction

Data collected during the campaigns CGFS are used annually to contribute to the evaluation of different stocks, and are also used regularly as part of various research projects. This section describes the methodology used to calculate the overall abundance indices, i.e. without taking into account the size and / or age, and changes related to the ship change made in 2015. Following the change of vessel and gear used to make the CGFS campaign (see previous section), it becomes necessary to have the abundance per area and not per hour trawled. Indeed, while the NO Gwen Drez was trawling averaged 0.029 km² for half an hour (average conducted between 1988 and 2014), NO Thalassa trawls 0.052 km² (average in 2015) : almost two surface larger. Expressing abundance indices per km², it becomes possible to ensure the continuity of the time series despite the ship change. Use of conversion factors may however be necessary if a difference in CPUE between the two vessels is observed.

2.2. Méthod

The overall abundance indices are calculated for each species as follows:

$$\overline{N} = \frac{\sum_s A_s.\overline{N_s}}{\sum_s A_s}$$

$\overline{N_s}$ the average abundance in stratum s, expressed in number / km²

A_s the surface of the stratum s, expressed in km²

To calculate these indices, only the layers that were actually sampled are taken into account. Thus, if in a year is not a stratum sampled (eg because of bad weather), its surface is not taken into account in the denominator of the previous formula.

2.3. Results : Seabass (*Dicentrarchus labrax*)

3. Possible causes of differences from previous years

Because the vessel has changed and therefore the unit in which abundance indices are expressed, there may be differences between the time series presented here and those obtained in previous years. In addition, during this comparative study, an error was found on the surfaces of the strata. These various sources of variation, valid both for the global indices and the indices at ages are presented here.

3.1. Correction in surface strata

The surfaces of statistical rectangles provided were erroneous for some strata, and were therefore recalculated from geographic layers provided by ICES. The effect of this correction on global indexes is studied by comparing the time series of global indices expressed by trawling time using the wrong strata surfaces with the time series of the indices using the corrected surfaces (Figure 4).

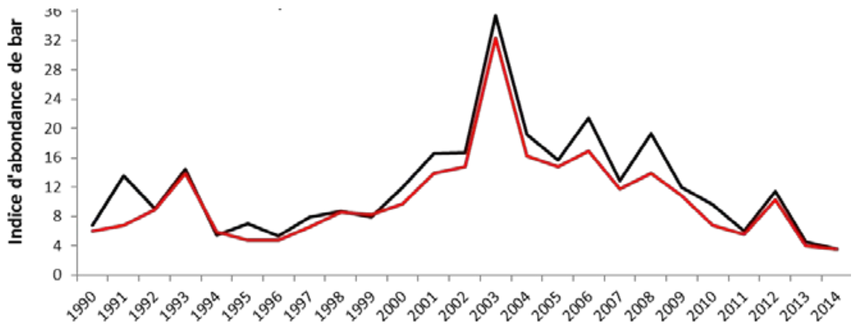


Figure 2 : Seabass abundance index by time based on surfaces of strata used (black: Wrong surfaces, red, corrected surfaces)

The correction of surfaces strata slightly changes the value of the indices, but does not lead to change in the temporal dynamics of bass populations.

3.2. Unit change: abundance per km²

By the change of ship operated in 2015, and increased the size of the cod that goes, it is necessary to express the indices km² and not trawled per hour. This unit change can lead to differences in index series because although the length and trawling speed does not change the protocol, speed on the base observed for Gwen Drez could be lower than the protocol if high current (trawled the surface is then less). This effect is studied by comparing the abundance indices per hour with abundance indices per km², both calculated with the surfaces of the corrected strata (Figure 5).

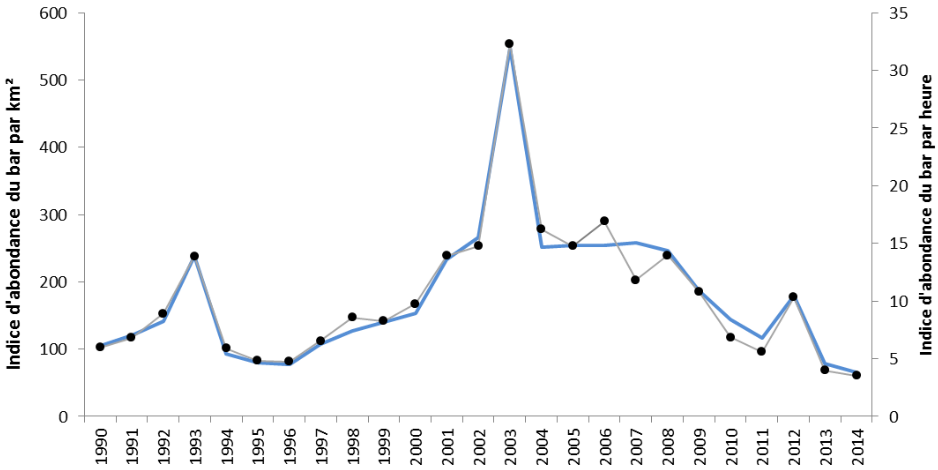


Figure 3 : Seabass abundance index per hour trawled (black lines and dots) and km² trawled (blue line)

Logically, the value of the index is greater when the abundance is expressed in km², but the trends are not affected by the change of the unit. It may be noted that the change in units seems to mitigate the variations in seabass abundance for the period 2005-2008.

3.3. Reducing the sampling plan

The number of stations sampled in CGFS decreased slightly from 2015 due to vessel change (water draft and number of days at sea available to the campaign). The effect of this reduction in the number of station has been quantified for the consistency of the indices for seabass (Figure 6).

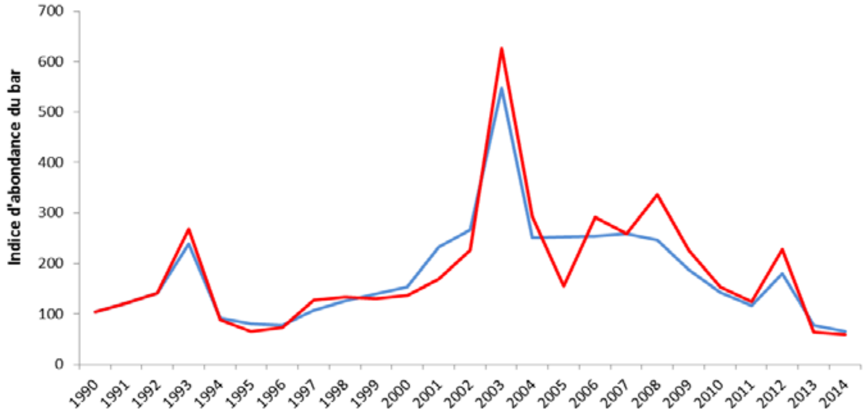


Figure 4 : Abundance index of seabass according to the stations included in the calculation (in blue: all stations; red: only 74 stations of the reduced sampling plan)

Some differences exist between the time series, but in the same way as before, the trends are maintained. A note in the sampling plan reduced use since 2015, the 27F0 stratum is not sampled.

RBE / HMMN

Arnaud Auber
Bruno Ernande
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Morgane Travers-Trolet

March 2015

Intercalibration of research survey vessels: "GWEN DREZ" and "THALASSA"

Intercalibration of research survey vessels: “GWEN DREZ” and “THALASSA”

Ifremer

novembre 2015

sommaire

Contents

1. Context of the study

1.1. CGFS survey and need for intercalibration

The Channel Ground Fish Survey (CGFS) has been carried out on the R/V Gwen Drez annually in October since 1988 in the eastern English Channel. This bottom trawl survey provides information on the demersal community used for stock assessment, and more precisely indices for plaice, red mullet, sea bass, cuttlefish, but also biological parameters relative to age and size structure as well as maturity for several other species (dab, lemon sole, gurnards, pouting, turbot, brill). From 2015 onwards, the R/V Gwen Drez is reformed and can no longer be used, thus the CGFS survey will be carried out on another scientific vessel, the R/V Thalassa. In order to ensure a continuity of time series, if possible, an intercalibration between both vessels has been realized in October 2014.

1.2. Sampling design

The inter-calibration survey was based on paired hauls at selected sampling sites as recommended by numerous authors (e.g. Pelletier 1998; Wilderbuer et al. 1998). 32 sampling sites (see Figure 1) were selected based on catch rates information available from the CGFS time series since 1988. Site selection was based on a 3-step procedure:

1. Identify species with an average frequency of occurrence in the survey area above 10% during the last 10 years;
2. Among these species, select those that are (i) subject to European monitoring, (ii) well captured by the GOV trawl, and (iii) ecologically and economically important;
3. Identify a few geographical areas were the selected species are found at high abundance and the specific composition of capture relatively similar between sampling sites using hierarchical agglomerative clustering on the abundance of selected species.

Given that no single geographical area combined all selected species, two complementary areas in terms of specific composition of the catch were identified with 16 sampling sites each (Figure 1): the bay of Seine (red) and the central English Channel (green).

Pairs haul were carried out at each sampling site with the two vessels towing simultaneously during 30 min at the same speed and as closely as possible (average distance between vessels around 300m). Because the two GOV gears differ in their opening width, catch data were standardized to trawled-surface unit before statistical analyzes (CPUE, in number of individuals per km²) using the distance between shooting and hauling positions and the wing spread measured during each tow.

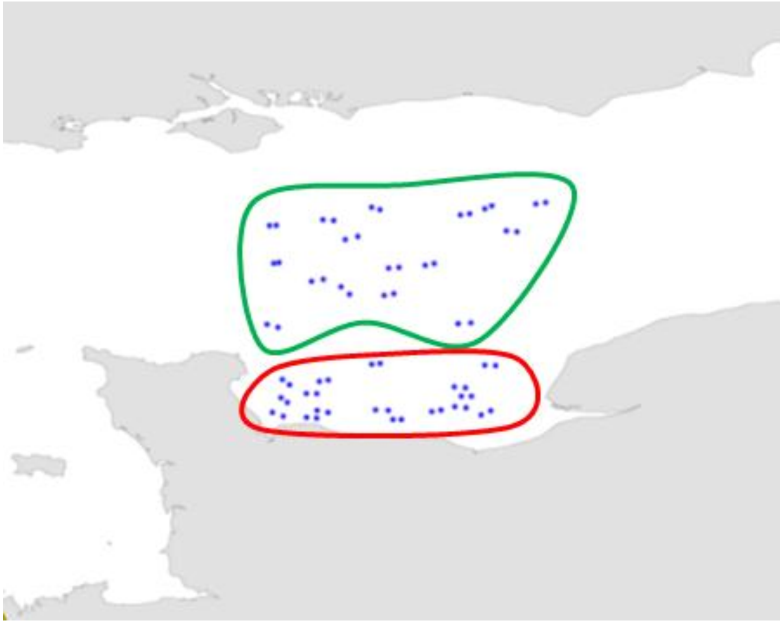

Figure 1. Spatial distribution of the 32 sampling sites (paired hauls) during the inter-calibration survey and identification of the two complementary areas in terms of specific composition of the fish community.

1.3. Gears characteristics and measured geometry

On the R/V Gwen Drez, a 19.7/25.9 GOV is deployed, with groundrope composed of rubber discs of 110mm of diameter, 6 bobins of 250mm in the square (bosom section of 5.90m), and 2 bobins of 150 and 2 bobins of 200mm in the quarter section. The trawl shows an average vertical opening of 3.21m, and an average wing spread of 10.34m which increases with increasing depth (Figure 2).

On the R/V Thalassa, a 36/47 GOV is deployed, similar to the gear used during the EVHOE survey, with groundrope composed of rubber discs of 110mm of diameter, bobins of 400mm in the square (bosom section of 5m), and bobins of 300mm and 400mm in the quarter section. The trawl shows an average vertical opening of 4.35m, and an average wing spread of 15 (Figure 3)

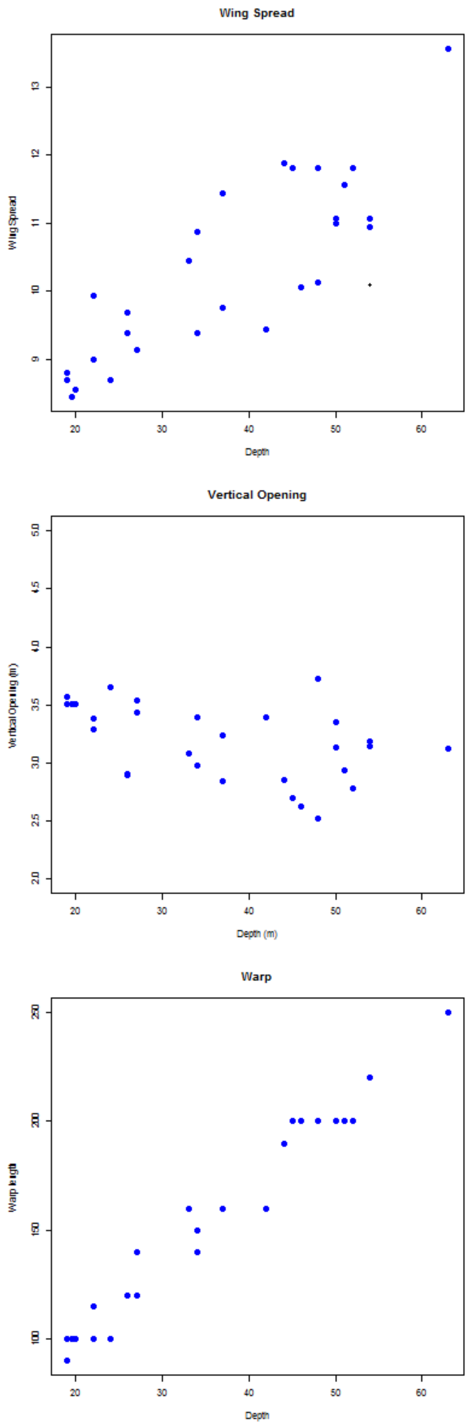

Figure 2. Measurements of trawl geometry on the R/V Gwen Drez using SCANMAR sensors: wing spread (top), vertical opening (middle) and warp length (bottom) with depth.

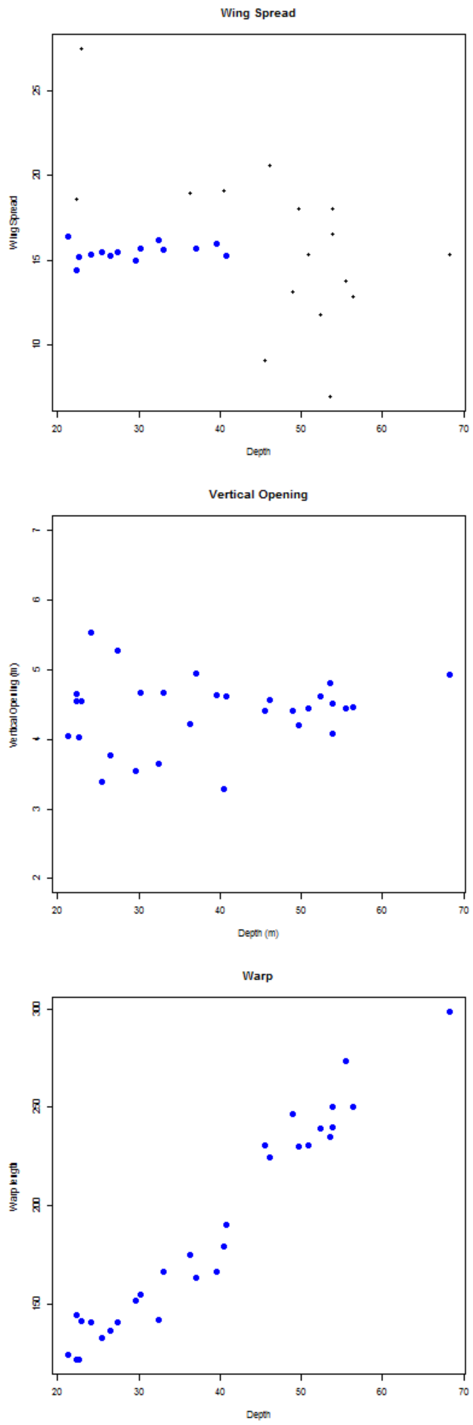

Figure 3. Measurements of trawl geometry on the R/V Thalassa using MARPORT sensors: wing spread (top), vertical opening (middle) and warp length (bottom) with depth. Note that the sensors recording wing spread produced some erroneous values (small dots).

2. Fish population-level analyses

2.1. Testing for difference in species' CPUEs

2.1.1. Methods

For each species, sampling sites for which the two vessels captured no individual were excluded from the analyses. Indeed, the simultaneous absence of a species (so-called 'double zeros') in the two vessels' catches at a given sampling site is uninformative about CPUE similarity (Legendre and Legendre 2012). The inclusion of double zeros in the analyses may thus lead to erroneous conclusions about vessels' catch similarity and consequently on correction coefficients.

Because of the large numbers of zeros (even when removing double zeros), CPUE data did not conform to the normality and homoscedasticity assumptions required to perform paired Student's t test nor was any transformation able to solve this problem. Therefore, CPUE data of each species were compared between vessels by a paired permutation test. The identity of vessels was switched at each sampling site (hence the paired aspect of the permutation) either so as to produce the 2^n possible permutations when the number of paired hauls n was below 10 or randomly 1000 times when $n > 10$. The average difference between vessels' CPUE across sampling sites was computed for each permutation to produce its distribution under the null hypothesis of similar vessels' catches. The quantile of the null distribution corresponding to the observed average CPUE was then taken as the probability p of a significant difference between vessels' CPUEs.

Because of multiple testing (same comparison test carried out for each species), the familywise type 1 error rate α_{F} is increased to a level that varies according to the dependence between tests with a maximum in case of total independence of $\alpha_{\mathrm{F,max}}(k) = 1-(1-0.05)^k$ where k is the number of tests, i.e., the number species in our case. A second series of p-values, p_{cor}, accounting for multiple comparisons was therefore computed using two nested permutation tests based on the max-statistic method (Groppe et al. 2011). The identity of vessels was again switched at each sampling (in the same way as above) but while keeping the original species composition of the catch (outer permutation). This randomized any potential association between the CPUE of each species and vessel while preserving any correlative structure between species CPUEs themselves. The first permutation test described above was then performed on each species' CPUE in the permuted dataset (inner permutation) and the minimum p value across species was recorded. This procedure was repeated 1000 times and the resulting distribution of minimum p values was used as the empirical null distribution against which observed p values computed through the first permutation test on the real CPUE dataset were tested. For each species, p_{cor} was taken as the quantile in the empirical null distribution of minimum p values corresponding to the observed p value.

The minimum number of non-double-zero paired hauls $n_{\min}$ required to perform CPUE comparison tests was defined as follows. p_{cor} was computed for each species with an increasing minimum number of non-double-zero paired hauls starting at 3. $n_{\min}$ was set at the value for which p_{cor} stabilized for all species. All species having less than $n_{\min}$ non-double-zero paired hauls were excluded from the analyses and correction coefficient computation.

2.1.2. Results

The stability analysis of p_{cor} values revealed that a minimum of $n_{\min} = 9$ paired hauls was required to perform CPUE comparisons between the two vessels.

For most captured species (43/65; 66%) during the intercalibration survey, CPUE comparison tests could not be carried out because of a number of non-double-zero paired hauls inferior to $n_{\min}$ (see 'NA' items in Table 1). Only 22 species were considered for statistical tests (see their names and CPUEs in Figure 2). However, these species represent 80% of the total abundance of all fish collected during the whole CGFS time series (i.e., since 1988) (Table 1).

According to simple permutation tests (uncorrected p-values p), the CPUE of 9 species (*Callionymus lyra, Chelidonichthys cuculus, Dicentrarchus labrax, Loligo forbesi, Raja clavata, Sardina pilchardus, Scomber scombrus, Scyliorhinus canicula, Trachurus trachurus*) was significantly different between the two vessels (Table 1) and thus, required the computation of a correction coefficient (see red arrows in Figure 4).

According to nested permutation tests (corrected p-values p_{cor}), the CPUE of 6 species (*Callionymus lyra, Chelidonichthys cuculus, Dicentrarchus labrax, Loligo forbesi, Sardina pilchardus, Scomber scombrus*) was significantly different between the two vessels (Table 1).

In order to be as conservative as possible, the computation of a correction coefficient was performed for each of the 9 species listed above.

2.2. Correction coefficients

2.2.1. Methods

Following Pelletier et al. (1998) and Wilderbuer et al. (1998), the correction coefficient of each species was estimated as the ratio of the mean CPUE of the 'Gwen Drez' vessel to the mean CPUE of the 'Thalassa' vessel, which is equivalent to taking the ratio between the total CPUEs of the two vessels:

$$\hat{R} = \frac{\sum_{j=1}^{n} Y_j}{\sum_{j=1}^{n} X_j} \qquad (1)$$

$\hat{R}$ is the ratio estimate or correction coefficient, *n* is the number of haul pairs, *j* indexes haul pairs, Y_j is the CPUE of the considered species from the *j*th haul by the 'Gwen Drez' vessel, and X_j is the CPUE of the same species from the corresponding haul by the 'Thalassa' vessel.

The 95% confidence intervals of the correction coefficients were calculated based on their variance computed according to the equation given by Cochran (1977) (in Wilderbuer et al., 1998):

$$Var(\hat{R}) = \frac{\dfrac{\sum_{j=1}^{n}(Yj - \hat{R}Xj)^2}{n-1}}{n\bar{X}^2} \qquad (2)$$

where $\hat{R}$, *n, j,* Y_j, and X_j are defined as in equation (1), and $\bar{X}$ is the mean CPUE of the considered species across all hauls by the 'Thalassa' vessel.

2.2.2. Results

According to correction coefficients (Table 1), the difference of CPUE between vessels was particularly important for (in decreasing order): *Callionymus lyra* (7.055 ± 0.647), *Chelidonichthys cuculus* (3.502 ± 0.574), *Raja clavata* (2.541 ± 0.296), *Scyliorhinus canicula* (2.537 ± 0.460), *Dicentrarchus labrax* (1.707 ± 0.091), *Loligo forbesi* (0.491 ± 0.009), *Trachurus trachurus* (0.389 ± 0.015), *Scomber scombrus* (0.127 ± 0.002) and *Sardina pilchardus* (0.056 ± 0.002). In contrast, based on permutation tests (see section II.1.2) 13 species did not necessitate correction and their coefficient was set equal to 1 (Table 1).

Table 1. Correction coefficient values, standard errors and 95% confidence intervals. 'NA' items correspond to species for which statistical tests could not be performed. Green cells correspond to significant difference of density means between vessels.

Species	Rubbin code		Correction coefficient	Standard error	95% confidence interval	Relative abundance on the overall CGFS time serie (%)	Permutation test pvalues (uncorrected)	Permutation test pvalues (corrected)	Number of traits (which are not 'double-zero')	Number of traits where none individuals were collected by the 'Gwen Drez' vessel	Number of traits where none individuals were collected by the 'Thalassa' vessel
Agonus cataphractus	AGONCAT		NA	NA	NA	0.045	NA	NA	3	30	30
Alosa fallax	ALOSFAL		NA	NA	NA	0.003	NA	NA	3	32	29
Ammodytes tobianus	AMMOTOB		NA	NA	NA	0.008	NA	NA	1	31	31
Arnoglossus laterna	ARNOLAT		NA	NA	NA	0.003	NA	NA	1	31	32
Blennius ocellaris	BLENOCE		NA	NA	NA	0.000	NA	NA	4	29	31
Buglossidium luteum	BUGLLUT		NA	NA	NA	0.060	NA	NA	1	31	31
Callionymus lyra	CALMLYR		7.055	0.804	[6.251-7.859]	0.801	<0.001	0.049	15	18	18
Chelidonichthys cuculus	CHELCUC		3.502	0.758	[2.744-4.259]	0.817	<0.001	0.033	28	5	11
Trigla lucerna	CHELLUC		1	0	[1-1]	0.078	0.74	1	10	29	24
Chelon labrosus	CHEOLAB		NA	NA	NA	0.000	NA	NA	1	32	31
Ciliata mustela	CILIMUS		NA	NA	NA	0.001	NA	NA	1	32	31
Clupea harengus	CLUPHAR		NA	NA	NA	1.579	NA	NA	1	31	32
Conger conger	CONGCON		NA	NA	NA	0.002	NA	NA	4	29	31
Ctenolabrus rupestris	CTELRUP		NA	NA	NA	0.002	NA	NA	2	31	30
Dasyatis pastinaca	DASYPAS		NA	NA	NA	0.006	NA	NA	1	32	31
Dicentrarchus labrax	DICELAB		1.707	0.30166206	[1.405-2.009]	0.178	0.002	0.041	9	24	24
Trachinus vipera	ECITVIP		NA	NA	NA	0.231	NA	NA	5	29	28
Engraulis encrasicolus	ENGRENC		1	0	[1-1]	0.642	0.109	0.922	23	16	10
Gobiidae	FMGOBII		NA	NA	NA	0.062	NA	NA	2	30	31
Gadus morhua	GADUMOR		NA	NA	NA	0.194	NA	NA	5	29	29
Galeorhinus galeus	GALOGAL		1	0	[1-1]	0.026	0.789	1	10	26	24
Gobius niger	GOBINIG		NA	NA	NA	0.000	NA	NA	6	30	28
Hippocampus	HIPP		NA	NA	NA	0.000	NA	NA	1	32	31
Hyperoplus	HIPPHIP	FMAMMOD	NA	NA	NA	0.340	NA	NA	6	28	29
	HYPEIMM		NA	NA	NA		NA	NA	1	32	31
	HYPELAN		NA	NA	NA		NA	NA	6	28	28
Labrus bergylta	LABSBER		NA	NA	NA	0.001	NA	NA	2	31	30
Labrus mixtus	LABSMIX		NA	NA	NA	0.000	NA	NA	3	31	29
Lepadogaster lepadogaste	LEPALEP		NA	NA	NA	NA	NA	NA	1	31	32
Limanda limanda	LIMDLIM		NA	NA	NA	1.034	NA	NA	4	30	28
Liza aurata	LIZAAUR		NA	NA	NA	0.026	NA	NA	2	32	30
Loligo forbesi	LOLIFOR	LOLI	0.491	0.093	[0.398-0.584]	1.993	<0.001	0.049	23	15	10
Loligo vulgaris	LOLIVUL		1	0	[1-1]		0.312	1	32	3	0
Lophius piscatorius	LOPHPIS		NA	NA	NA	0.002	NA	NA	1	32	31
Melanogrammus aeglefinu	MELAAEG		NA	NA	NA	0.000	NA	NA	1	31	32
Merlanguis merlangus	MERNMER		NA	NA	NA	1.581	NA	NA	3	30	30
Microstomus kitt	MICTKIT		NA	NA	NA	0.166	NA	NA	3	30	30
Microchirus variegatus	MICUVAR		NA	NA	NA	0.012	NA	NA	3	31	30
Mullus surmuletus	MULLSUR		1	0	[1-1]	0.590	0.228	0.997	25	14	9
Mustelus	MUST		1	0	[1-1]	0.159	0.82	1	14	19	22
Pagellus erythrinus	PAGEERY		NA	NA	NA	0.000	NA	NA	5	28	30
Palaemon serratus	PALOSER		NA	NA	NA	0.027	NA	NA	1	32	31
Pleuronectes platessa	PLEUPLA		1	0	[1-1]	0.644	0.072	0.789	9	24	23
Raja brachyura	RAJABRA		NA	NA	NA	0.006	NA	NA	2	30	32
Raja clavata	RAJACLA		2.541	0.544	[1.997-3.085]	0.122	0.004	0.108	22	15	13
Raja undulata	RAJAUND		NA	NA	NA	0.008	NA	NA	8	29	26
Sardina pilchardus	SARDPIL		0.056	0.041	[0.015-0.097]	1.830	<0.001	0.033	22	23	10
Scomber scombrus	SCOMSCO		0.127	0.043	[0.084-0.17]	1.841	<0.001	0.033	28	23	4
Scophthalmus maximus	SCOPMAX		NA	NA	NA	NA	NA	NA	1	32	31
Scophthalmus rhombus	SCOPRHO		NA	NA	NA	0.007	NA	NA	4	29	31
Scyliorhinus canicula	SCYOCAN		2.537	0.678	[1.859-3.216]	1.536	0.003	0.085	27	7	9
Scyliorhinus stellaris	SCYOSTE		1	0	[1-1]	0.079	0.817	1	15	20	18
Sepia officinalis	SEPIOFF		1	0	[1-1]	0.277	0.467	1	22	16	14
Solea solea	SOLESOL		NA	NA	NA	0.117	NA	NA	4	30	28
Sparus aurata	SPARAUR		NA	NA	NA	0.001	NA	NA	2	32	30
Spondyliosoma cantharus	SPONCAN		1	0	[1-1]	1.545	0.204	0.995	29	11	4
Sprattus sprattus	SPRASPR		NA	NA	NA	7.533	NA	NA	2	30	31
Symphodus bailloni	SYMPBAI		NA	NA	NA	NA	NA	NA	2	30	32
Syngnathus acus	SYNGACU		NA	NA	NA	0.000	NA	NA	1	32	31
Trachurus trachurus	TRACTRA		0.389	0.121	[0.269-0.51]	37.655	0.003	0.085	32	0	0
Trachinus draco	TRAHDRA		NA	NA	NA	0.009	NA	NA	5	30	28
Trisopterus luscus	TRISLUS		1	0	[1-1]	5.437	0.221	0.997	13	22	23
Trisopterus minutus	TRISMIN		1	0	[1-1]	23.796	0.065	0.778	24	14	12
Zeugopterus punctatus	ZEUGPUN		NA	NA	NA	0.001	NA	NA	1	32	31
Zeus faber	ZEUSFAB		1	0	[1-1]	0.050	0.097	0.895	30	9	3

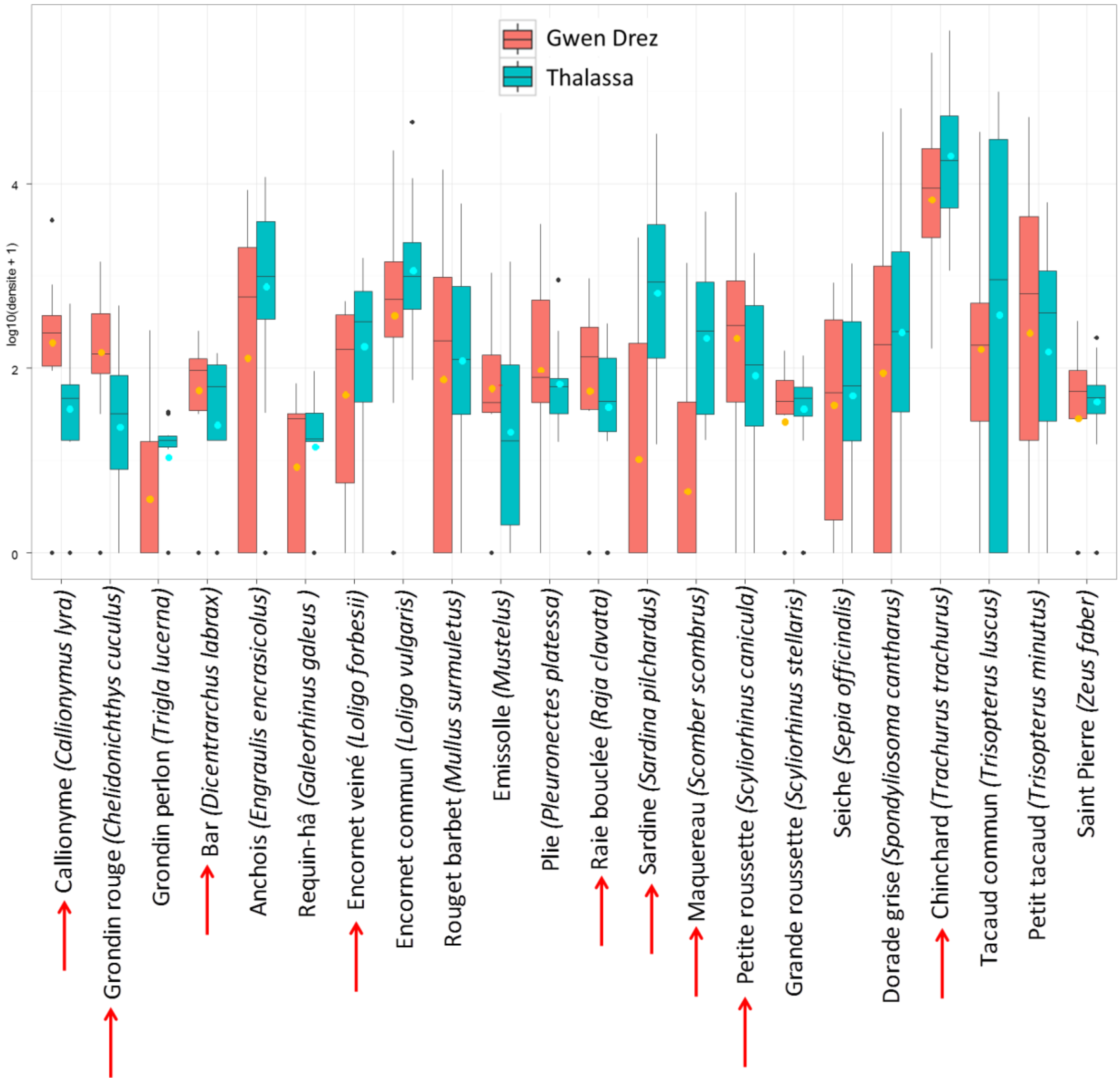

Figure 4. Boxplot representing log-transformed species CPUEs (nb. ind./km²) of the 'Gwen Drez' (red) and 'Thalassa' (blue) vessels. Only species for which the number of non-double-zero paired hauls is greater or equal to the minimum number of traits $n_{\min} = 9$, and thus for which statistical tests could be performed, are presented. Red arrows indicated species for which a correction is required according to simple permutation tests (uncorrected p-values p). Orange and blue circles correspond to the mean CPUE on 'Gwen Drez' and 'Thalassa', respectively. Horizontal lines within boxes give the median of the distribution, boxes' limits give the first and last quartile, whiskers extend to the most extreme data point which is no more than 1.5 times the interquartile range from the corresponding boxes, dots are data points outside the whiskers' limits.

3. Fish community-level analyses

3.1. Multivariate description of the data

In order to describe and compare the structure of communities captured by the two vessels, a non-metric Multidimensional Scaling (nmMDS) was first performed on the matrix of catch composition (CPUE organized by species as columns and by combinations of sampling sites and vessels as lines). Only species with CPUE representing more than 0.1% of the total CPUE were included in this analysis (Kortsch *et al.*, 2012).

According to the biplot of the nmMDS on its 2 first axes (Figure 5), the structure of communities collected by the 'Gwen Drez' vessel were relatively different to those collected by the 'Thalassa' vessel.

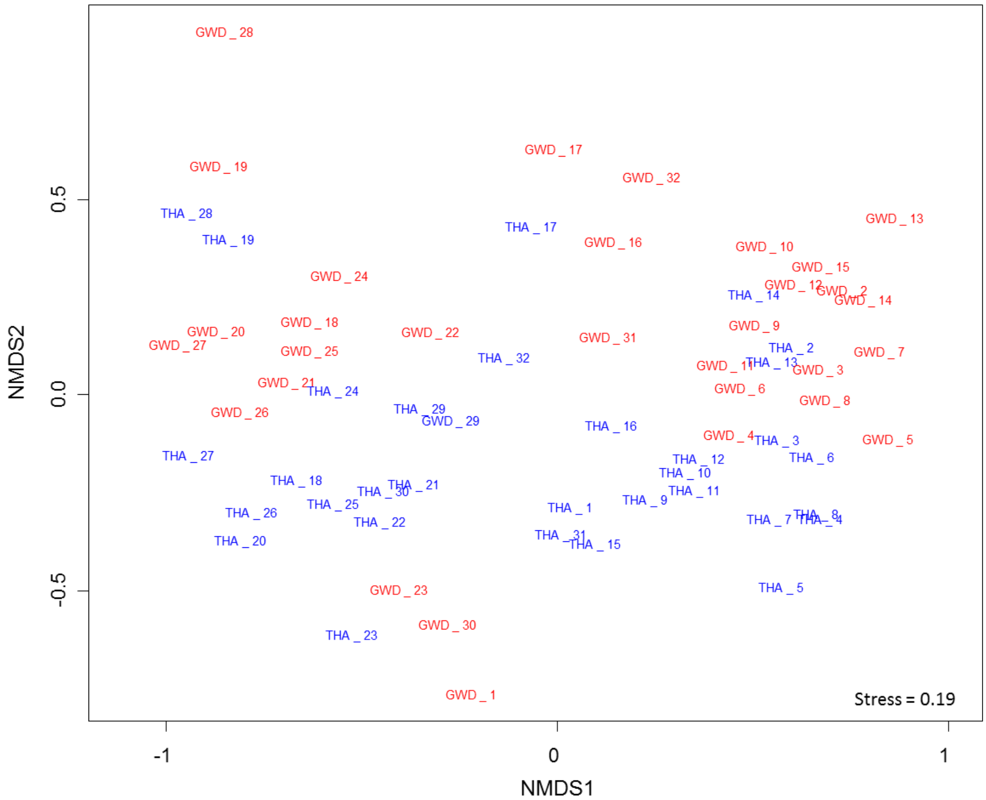

Figure 5. Non-metric Multidimensional Scaling biplot representing fish community structure collected by each vessel at each sampling site (graph items: 'Name of the vessel_site number'; 'GWD': 'Gwen Drez' in red, 'THA': 'Thalassa' in blue).

3.2. Testing for difference in community structure

Because of spatial variation in the structure of communities, the vessel effect on the composition of the catch was assessed by performing a 'Partial Redundancy Analysis' (pRDA) with the matrix of catch composition as explained matrix, the vector of vessel identity as explanatory variable, and the vector of sampling sites as condition variable in order to remove any spatial effect. The pRDA revealed a significant difference of community structure between the two vessels (p=0.012) based on post-pRDA permutation tests (Legendre & Legendre 2012).

In order to mimic the procedure used for species-level analyses, difference of community structure between the two vessels was also tested by performing a permuted-based paired Hotelling's T^2 test. As for species-level analyses, the identity of vessels was switched randomly at each sampling 1000 times while keeping the original species composition of the catch. This randomized any potential association between catch composition and vessel. The T^2 statistics was then computed for the 1000 permuted datasets to obtain its empirical distribution under the null hypothesis of similar catch composition between the two vessels. The quantile of the null distribution corresponding to the observed T^2 statistic was then taken as the probability of a significant difference between vessels' catch compositions. Only species with a number of non-double-zero paired hauls superior or equal to $n_{\min} = 9$ were considered in this test. The permutation-based paired Hotelling's T^2 test detected a significant difference of community structure between the two vessels at a probability of 0.0483.

3.3. Assessing the efficiency of correction coefficients at community level

In order to assess the efficiency of correction coefficients at community level, a second pRDA was performed on the corrected catch composition matrix, i.e. after correcting Thalassa CPUEs according to correction coefficients, with the same model as in section III.2. After correction, no significant difference was detected between the two vessels (post-pRDA permutation test: p=0.408; Figure 6), which means that the proposed inter-calibration procedure allows assessing the Gwen Drez's trawl contents from those collected on the 'Thalassa' vessel.

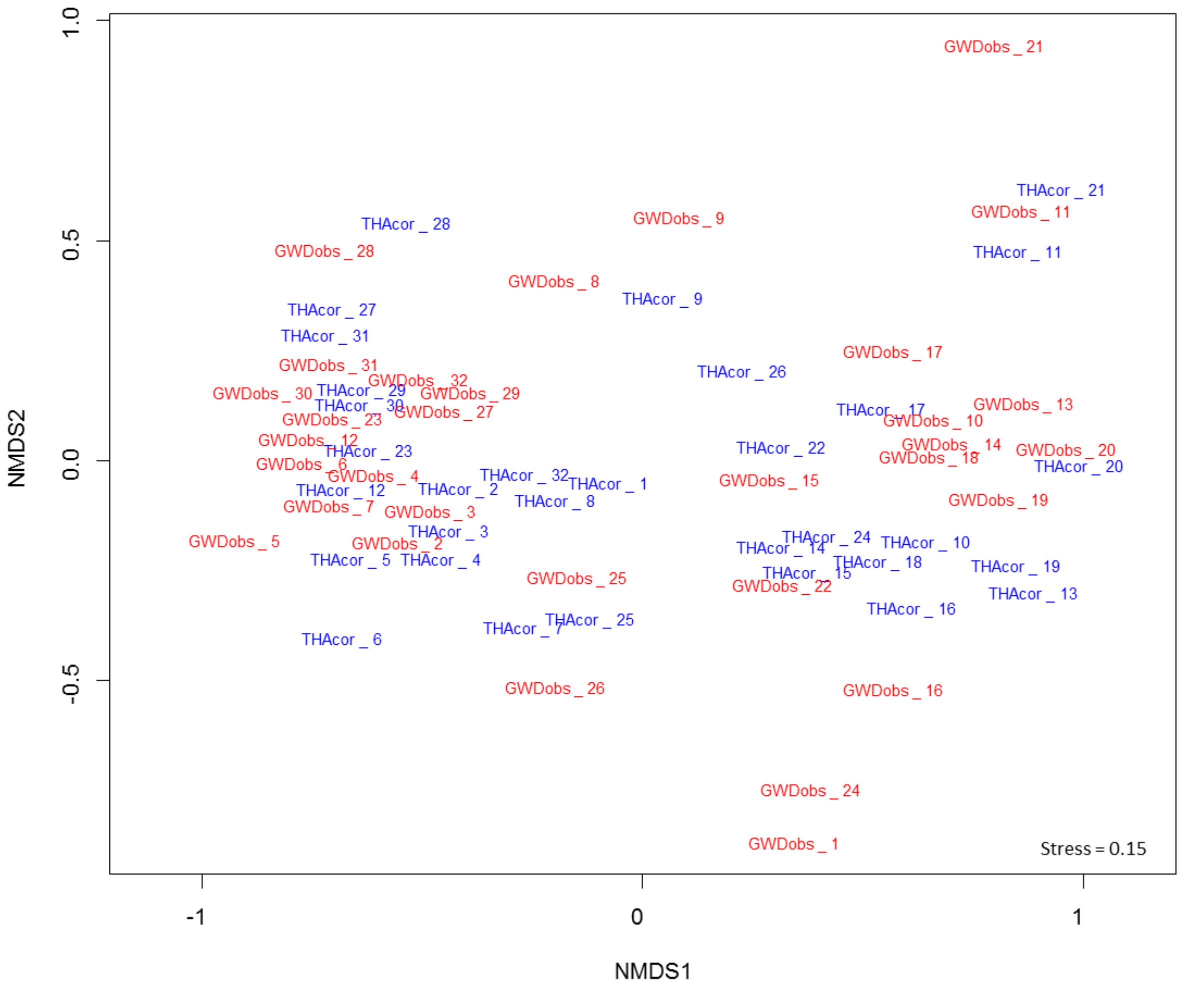

Figure 6. Non-metric Multidimensional Scaling biplot representing fish community structure collected by the 'Gwen Drez' vessel ('GWDobs' red items) and corrected fish community data of the 'Thalassa' vessel ('THAcor' blue items).

4. Synthesis & Conclusions

Based on data collected during the inter-calibration survey conducted in October 2014, the CPUE of 22 species could be statistically compared between the vessels, the other species being too rarely caught to allow rigorous analysis. The CPUE of 9 species differed significantly between the two vessels and will therefore necessitate a correction for maintaining the CPUE time series (Figure 7). In contrast, the CPUE of 13 species did not differ significantly between vessels and thus do not require any correction (correction coefficient set equal to 1). Unfortunately, CPUE comparison tests could not be carried out for the 43 remaining rare fish species because of an insufficient number of paired hauls with at least one positive CPUE (too many ‘double zeros’). Such comparison will have to be done at a more aggregated taxonomic level, for instance by grouping all gadoids, assuming a similar catchability between grouped species. However, the 22 species for which a comparison was possible represent most (80%) of total fish abundance collected across the whole Eastern English Channel on the overall CGFS period (i.e. since 1988). It is also important to note that CPUE of flatfish species and notably plaice does not significantly differ between both vessels, confirming that the two gears used during the intercalibration survey have a similar contact with the sea floor.

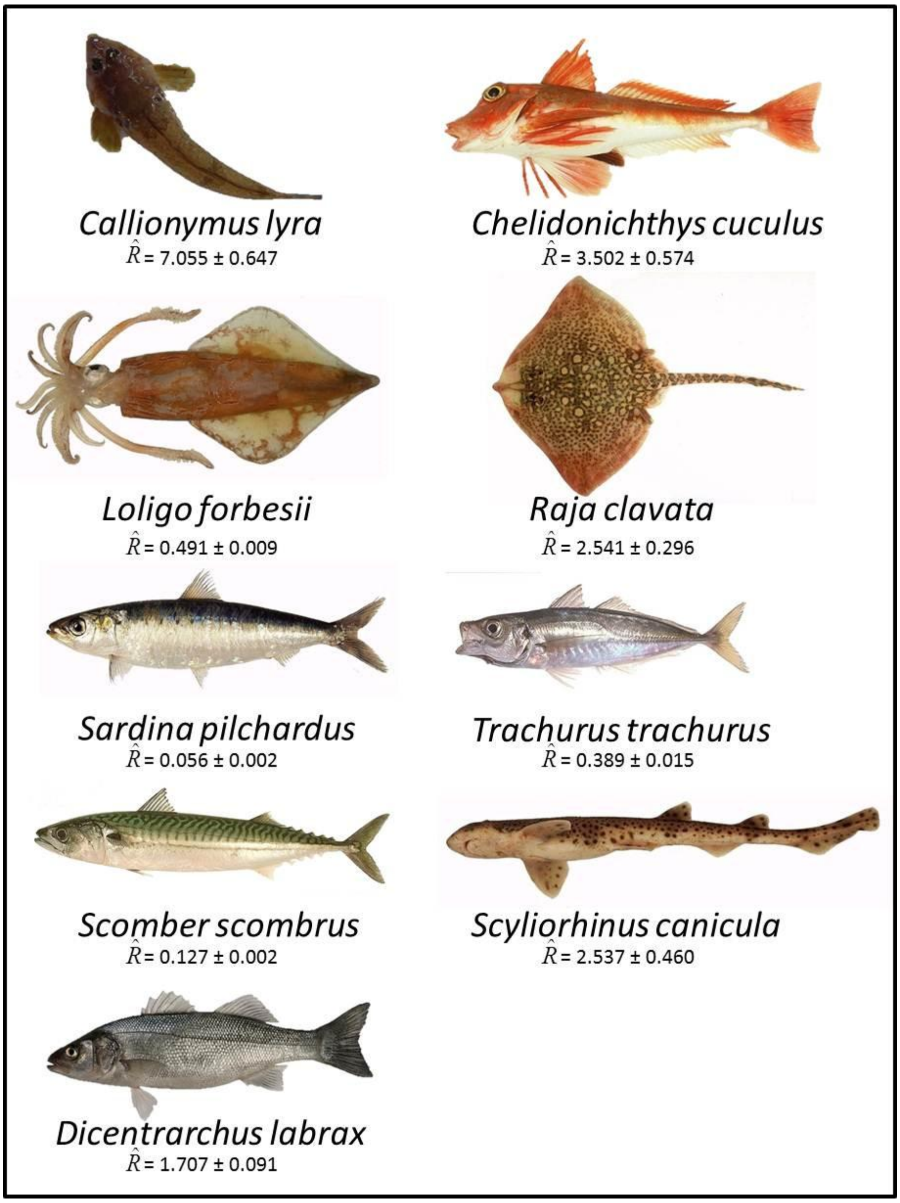

Figure 7. Pictures of the species for which a correction is needed and their respective correction coefficient.

At the community-level, statistical analyzes showed that the correction of CPUE values from the 'Thalassa' was both necessary and effective since it allowed an acceptable assessment of the community structure collected by the 'Gwen Drez' vessel. Concerning the values of the correction coefficients, for 4 species (sardine, horse mackerel, mackerel and veined squid), the R/V Thalassa catches significantly more individuals than the R/V Gwen Drez. It is worth noting that the former has a higher vertical opening (4.35m versus 3.21m) which typically allows for higher catch of these pelagic species. For the 5 other species requiring a correction coefficient, the R/V Thalassa catches less individuals than the R/V Gwen Drez.

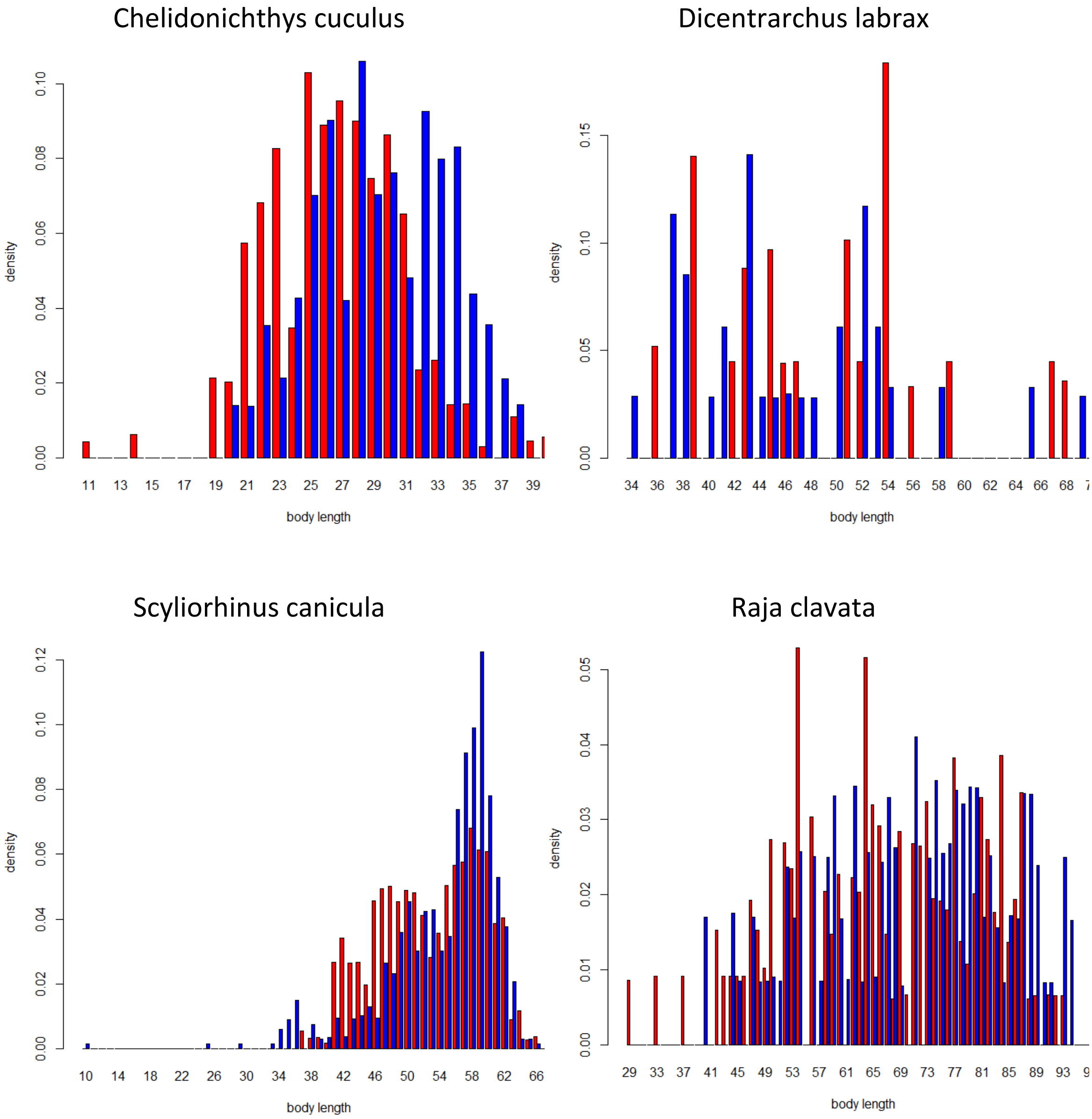

Figure 8. Comparison of size structures of the 4 species caught more on the R/V Gwen Drez than on the R/V Thalassa. The comparison cannot be made for dragonet as this species was not measured on R/V Gwen Drez. In red: relative size structure of species caught on the Gwen Drez, in blue: relative size structure of species caught on Thalassa.

While the size range sampled by each vessel is similar for these species (Figure 8), for *Chelidonichthys cuculus* there seem to be a higher proportion of large fish caught by the Thalassa compared to the Gwen Drez vessel. The size distribution is similar between the vessels for *Scyliorhinus canicula*, and for the 2 other species requiring correction coefficients (*Dicentrarchus labrax* and *Raja clavata*) the size distribution does not show any mode but does not seem to differ from one vessel to the other (Figure 8).

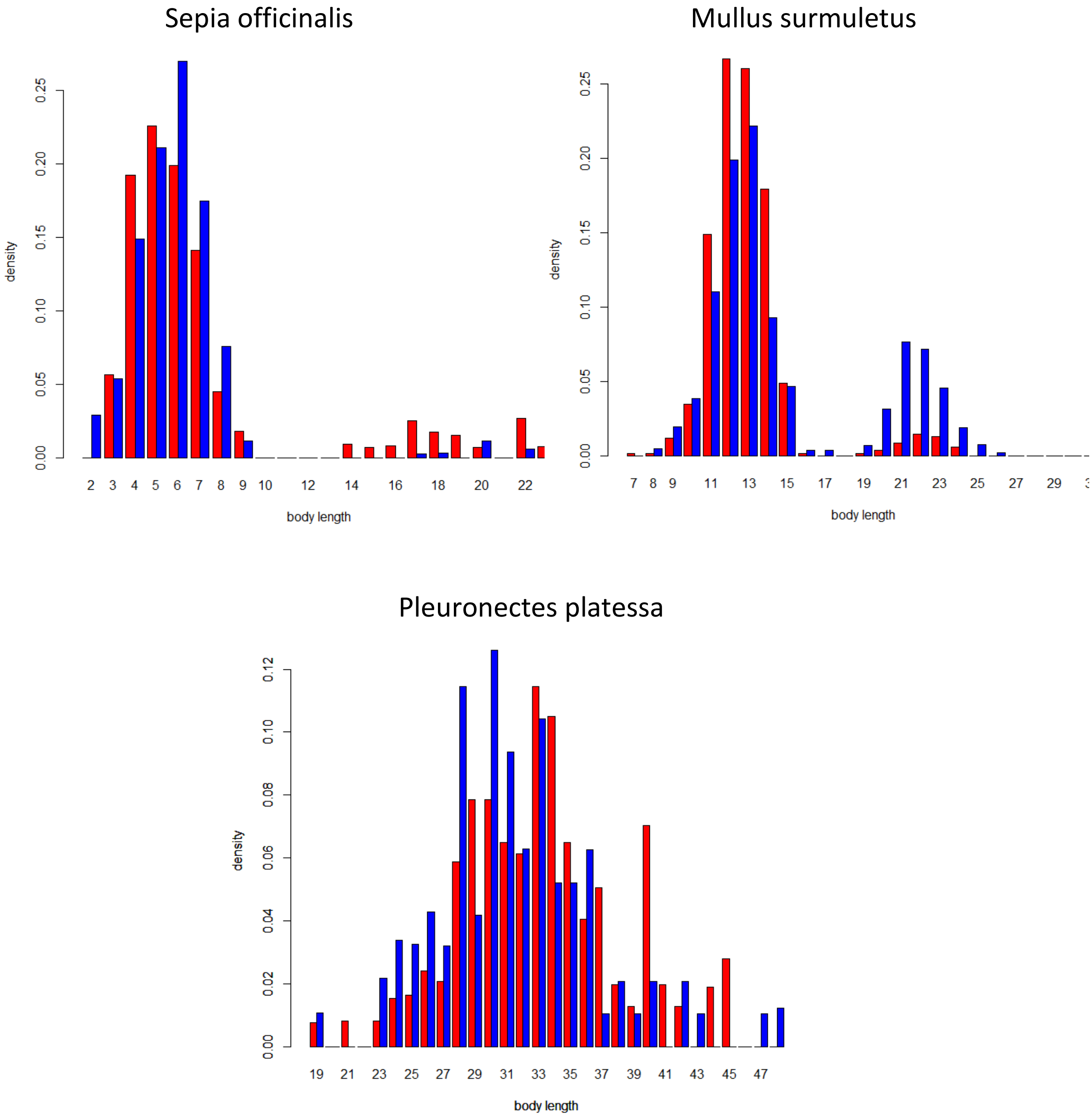

Figure 9. Comparison of size structures of the 3 species assessed base on CGFS species (the 4th species assessed, seabass, is represented on Figure 8). In red: relative size structure of species caught on the Gwen Drez, in blue: relative size structure of species caught on Thalassa.

It is important to note that for the stocks assessed using CGFS data (plaice, cuttlefish, red mullet and sea bass), the CPUE (except for sea bass) and size structure do not differ much between the vessels (Figure 9). Concerning red mullet (*Mullus surmuletus*), there might be more large fish caught by the Thalassa than by the Gwen Drez, but the bi-modal size distribution can be clearly derived from both vessels. For the flatfish plaice (*Pleuronectes platessa*), the size distribution appears to be identical between vessels.

In conclusion, the analysis of the catches realized by both vessels during paired tows shows qualitatively the same compositions of species and size structure, illustrating a similar behavior of the gears deployed. Furthermore, after comparison of the CPUE of the 22 non rare fish species, 13 species show no differences of CPUE between Thalassa and Gwen Drez, and time series regarding their abundance and biomass can be continue using the R/V Thalassa from 2015 onwards. For the 9 remaining species, the difference of CPUE has been quantified, so the time series can continue assuming a correction using the coefficients determined in the present study. The analysis of the community structure using the corrected CPUE when needed clearly illustrates the usefulness of using such correction coefficients, and will allow a continuity of analyses regarding community dynamics as well.

5. References

Cochran, W. G. 1977. Sampling techniques. Wiley, New York.

Groppe DM, Urbach TP, Kutas M. 2011. Mass univariate analysis of event-related brain potentials/fields I: A critical tutorial review. Psychophysiology 48: 1711–1725.

Kortsch S, Primicerio R, Beuchel F, Renaud PE, Rodrigues J, Lønne Ole Jø, et al., 2012. Climate-driven regime shifts in Arctic marine benthos. Proceedings of the National Academy of Sciences. 109: 14052–7.

Legendre, P. & Legendre, L. 2012. Numerical Ecology, 3rd ed. Elsevier, Amsterdam.

Pelletier, D. 1998. Intercalibration of research survey vessels in fisheries: a review and an application. Canadian Journal of Fisheries and Aquatic Sciences, 55, 2672–2690

Wilderbuer T.K., Kappenman R.F., & Gunderson, D.R. 1998. Analysis of Fishing Power Correction Factor Estimates from a Trawl Comparison Experiment. North American Journal of Fisheries Management. 18: 11-18.

French Logbook data analysis 2000-2013: possible contribution to the discussion of the sea bass stock(s) structure/annual abundance indices. Alain Laurec, M.Drogou and Sih-Ifremer staff.

Working document for WGBIE 2015 and WGCSE 2015-Provisional version, April 2015

Introduction

Why logbook data

The main aims of the analysis (combing catch rates of the various individual vessels in order to analyse changes in space and time of apparent abundance).

Stock structure / annual abundance indices

I Material and method

I-1 Material

Basic logbook data (all vessels <10m and >10m) from the French fleet have been used, on the basis of daily declared catches, mostly sea-bass catches, but also total catches for some calculations. In the data base results cover a period that extends from January 2000 to December 2013. Although these logbooks may contain within a day detailed information (e.g. fishing time) it has been preferred to simply consider catches per day, and the associated ICES squares, as well as the fishing technique used (see Appendix A). In fact what is called a vessel in the text is a combination of a real vessel and a group of fishing techniques, so that when a vessel shifts for a gear from another group, she becomes for us another vessel.
Because logarithmic transformations of the daily catches will be systematically used, zero values will be ignored. Changes in the proportion of zero will be discussed in another paper.
Strata have been defined in order to simplify the basic set of daily catches. A stratum corresponds to a so-called ICES square, a month and a year. In fact only strata where catches have been documented often enough have been considered.

I-2 Method(s)

Fishing powers and apparent abundances time series within each ICES square

Daily catch rates per vessel, grouped within months and ICES squares, have been analysed basically through a multiplicative two factors model. The two factors, namely the fishing vessel effect and the stratum effect. Eliminating at a first stage null catches, and using a logarithmic transformation, the multiplicative model has been changed into an additive one , coming back to the basic, which brings back to the basic Abramson(19?6?) analysis . For a first data survey it has been preferred not to use more sophisticated models (Generalized linear model), in order to take into account possible interactions which are not a simple nuisance preventing the use of additive three or four factors simple models, they contain key information in order to better understand sea bass stocks changes.

Calculated fishing powers are relative ones, and a reference vessel (or a set of vessels) must be chosen, the fishing power of which (or the geometric average within the set) being set to one (or zero for the log fishing powers or their arithmetic average over the group).

The stratum effects within and individual ICES square correspond to a time series (with possibly missing data) of apparent abundance, expressed as the daily catch rate of the standard vessel (or the standard average).

Analysis of the time series of apparent abundance related to the individual ICES square

Any visual check of such time series reveals the combination of a strong seasonal effect, a multiannual trend and apparent added noise. The strongest seasonal effect corresponds to what will be interpreted as spawning migrations and concentrations which take place in late autumn and winter. This is why it has been decided not to use[1] the usual calendar year from January to December, but 12 months period from July to the following June month, the apparent abundance being for most squares low in June-July, without major changes between June and the following July month.

Within each square second stage processing of the associated time series have been based on a multiplicative[2] (or additive after logarithmic transformations) two factors model (the year effect and the month (seasonal) effect. In fact there are not only between squares changes in the seasonal patterns, but also within a square between years changes in the seasonal patterns (which can be for instance stronger and/or delayed from year to year). Such interactions between years and months will be studied later on, so that for the time being only averaged seasonal patterns will be considered. Such a seasonal pattern is associated to a set of 12 monthly values. On a logarithmic scale these monthly values, the arithmetic average of which is zero,

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[1] In fact calculations have also been made using the basic calendar year. They lead to the same seasonal patterns which are simply more difficult to follow between december and january, at a key moment for the spawning seasons.

[2] It would also be possible to use a slightly more complicated model than the twor factors one, and to fit a model where for ICES squares associated to the same stock (e.G. the Bay of Biscaye one the time series of a apparent abundance would be constrained so that they have a common year effect, and/or to keep the same seasonal pattern over years. This will be done at a later stage but is not likely to lead to conclusions in terms of stock structure and between years changes.

must be added to the annual apparent abundance index. On a re-transformed scale (through exponential transformation) the monthly coefficients are multiplicative ones. They will be called the modulation coefficients, associated to the (average) seasonal modulation curve. The geometric mean of the twelve coefficients is by definition equal to one. They can for instance fluctuate between 0.5 and 2, which implies that between the lowest and highest apparent abundance months variations range from 1 to 4.

Series of year effects offer a description of the multiannual trends.
Seasonal patterns will be compared between squares, either by direct comparisons of the seasonal modulation curves, or through mapping of (i) some key numbers related to each curve such as the month of the highest value, or seasonal variances calculated on the logarithmic coefficients, and (ii) average (over years) abundance by month. The so called apparent average abundance for a given month is given by the average (over years) within a square multiplied by the seasonal modulation factor[3].

Possible variants

It is in theory possible to describe the multiannual trend using a regular curve such as a polynomial curve. It is however difficult with such models to avoid misbehaviours of the curve on both ends of the series, which is a major problem because of the importance of the last yearsô figures for real time stock assessment.
If a group of Ices squares can be related to the same stock, it is possible to use a slightly more complex model than the two factors one, in order to impose a common year effect to those squares. This will be done later.
It is possible not to use all vessels, but a selection of vessels more likely to show simpler relationships between catch rates and real abundance. It must however be kept in mind that using only selected vessels limits the information taken into account, making it more difficult to extract meaningful signals from the noise associated to between vessels variability. Various selections of vessels will in fact be used.
It is also possible not to refer to the calendar years (January to December), which implies an abrupt change in the annual trend in the middle of the spawning season which is also a key fishing seasons associated for most vessels and many squares to high catch rates. Also calculations have also been performed on the basis of the basic calendar years, priority will be given to years running from July to the following month of June.
It is also possible not to consider all months within a year, in order for instance to focus on the spawning seasons, in order to get indices of apparent changes of the spawning stock. In such a case it is also legitimate to consider only the spawning grounds. Such an approach will lead to more useful estimates of relative fishing powers than the estimates using all year round data: mid water trawls are more efficient during the spawning seasons than when the fish do not aggregate. On the other hand here again the number of observations taken into account will be reduces, and the results will be more sensitive to noises, and first of all to between vessels variability.

[3] Problems if for some squares some annual values are missing.

Specific targets and the choice of options in the analyses

The first exploratory treatments have revealed that the analysis could give important elements on the stock(s) structure, and time series of annual abundance for a set of squares which could be related to specific stocks. The key arguments about stock structures and migrations will be taken from the compared seasonal modulations, in relation with spawning concentrations and migrations. Priority will so be given in the treatment of time series per squares to results obtained using shifted years, from July to June. Priority will also be given to analyses which take into account all available vessels, regardless of the gear they use. In order to detect in a square months where the apparent abundance is very low, using all vessels and gears offer more guarantees that low catch rates are not due to a catchability problem for specific gears.

In terms of stock structure consistent seasonal patterns within a set of squares suggest that they could be related to a single stock. This will even be more likely if they show similar between years variations. In order to compare variations, regardless of the fact that the apparent abundance is systematically higher in some squares, for all squares or sets of squares ratio between a yearly index abundance and the corresponding geometric mean over years 2006 and 2007 will be calculated. Seasonal patterns related to specific gears can also lead to interesting details. This will however be discussed in a future document.

Beyond their contributions to the stocks structure debate time series of year effects can contribute to the definition of annual indices of abundance at the scale of a stock, which could as usual contribute to the fine tuning of stock assessments, especially for the more recent years. This will be done through averages over sets of squares, and more specifically through arithmetic means of log apparent abundance. Other techniques for combining time series from the different squares could later be considered.

It must also be kept in mind that seasonal effects are in most cases much stronger than the year effects. This makes year effects estimations more sensitive to between vessels variability than their counterpart about seasonal effects, at least in this later case for average (over years) of the seasonal effects. This is why for estimates of yearly abundance priority will be given to averages over sets of neighbouring squares. In the analysis of year to year changes results for the final year (in our case 2013) are of paramount importance. Priority will so be given in the corresponding discussion to analyses based upon the basic calendar year (January to December) in order to get a final year fully comparable to the previous ones, since the available data end in December 2013. The discussion about yearly indices of abundance will compare results obtained using all gears with those obtained using specific gears, namely bottom trawling and Danish seine, which are likely to show simpler relationships between real abundance and catch per unit of effort. Analyses have also been performed after elimination of the vessels which seem to target[4] sea-bass, and using only data from an enlarged spawning season, from December to March, in order to get indices of spawning areas, in which case only squares which

[4] Log fishing powers have been calculated for both total catch and sea-bass catch. The difference between values obtained (1) for sea-bass and (2) for total catch is an index of sea-bass targeting. Among vessels using bottom trawl or Danish seine, vessels associated with the 100 highest values of the sea-bass target index have been eliminated in some analyses

are related to what seem to be the main spawning areas are taken into account. One must however keep in mind that selecting vessels and months taken into account leads to a decrease in the amount of information utilized, making results more sensitive to ñnoisesò, and first of all to between vessels taken into account. Such statistical questions will be analysed in a future specific document, based upon bootstrapping within the sets of vessels used for each specific analysis. For the time being discussion will focus on analyses which use a large set of data, but results obtained using other options are available as additional material (See appendix B)

II Results

Apparent abundances are expressed as caches per day (Kg) of an average trawler, the average being calculateted over CF1 vessels more than 15 meters long.

Three ICES squares, ranging from North to South, have been selected as examples of time series : 28E9 (center of the Eastern Channel), 25E5 (West of Britanny), and 18E8 (South of the Bay of Biscay). Figure 1-a below uses an arithmetic scale, and figure 1-b a logarithmic one. Each point on the x axis is associated to a month and a year. For practical reasons it is not possible to specify both the month and the year. On figure 1-a year only are indicated, while on figure 1-b January and July monthes are reported, in order to hihgligt seasonal changes.

Figure 1-a

Apparent abundance (Kg/day) for the three squares of the basic example arithmetic scale

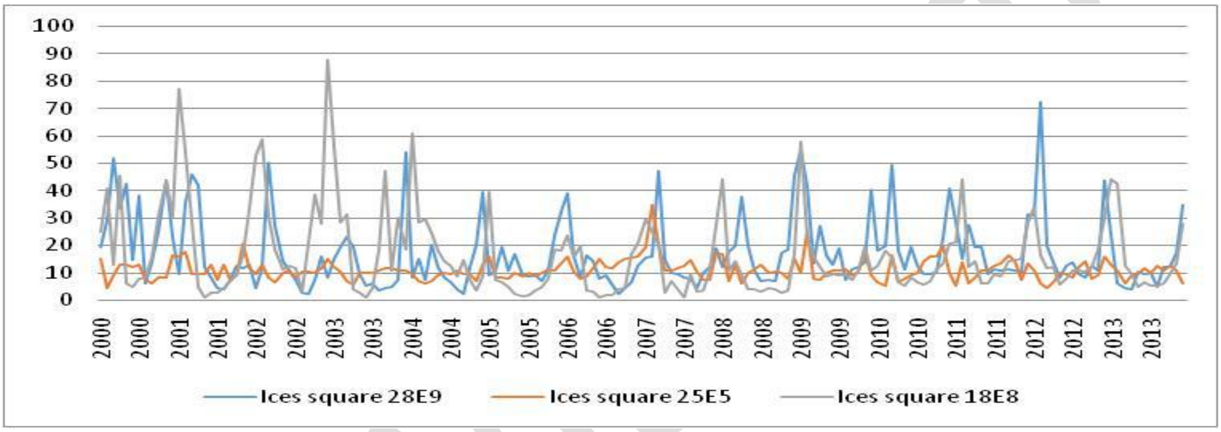


Figure 1-b

Apparent abundance (Kg/day) for the three squares of the basic example logarithmic scale

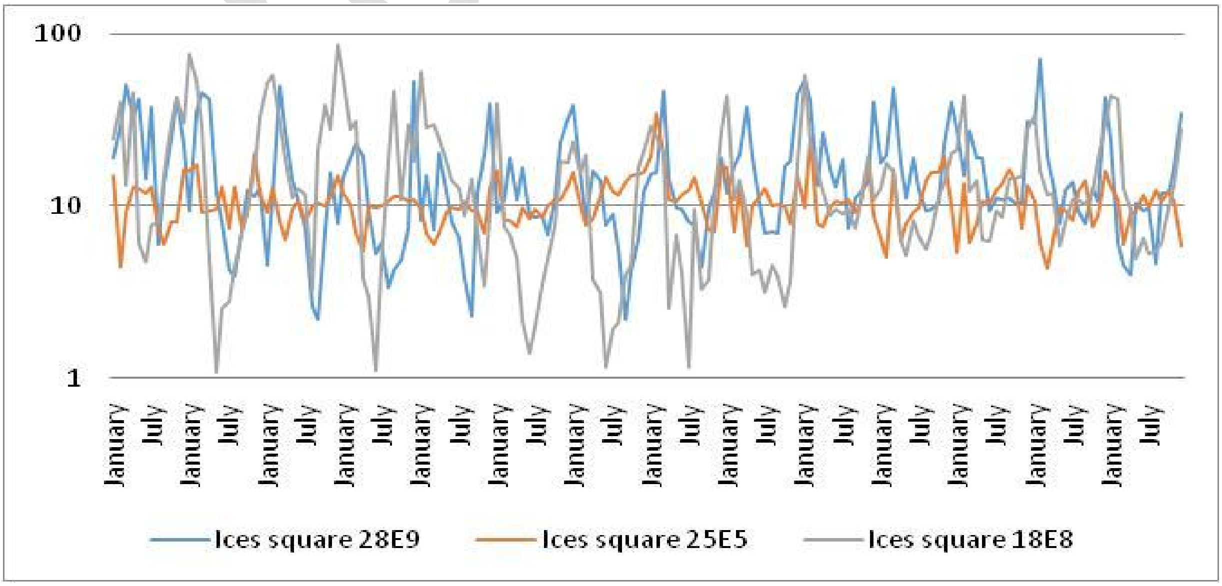


Figure 1-b is easier to read, and makes it possible to appreciate the preeminence of seasonal changes, which are hovever highly variable from one ICES square to another (square x month interactions), but also varies from year to year (month x year interactions).
Square 25E5 is in fact a special one, since for most of the squares seasonal variations are higher. If there are obvious differences between geographically distant squares such as the three ones referred to in figures 1-a and 1-b, neigbhouring squares can lead to similar patterns, as illustrated on Figure 2, or not as shown on figure 3.

Figure 2 :
Example of similarities between neigbhouring squares
Squares from the South of the Bay of Biscay

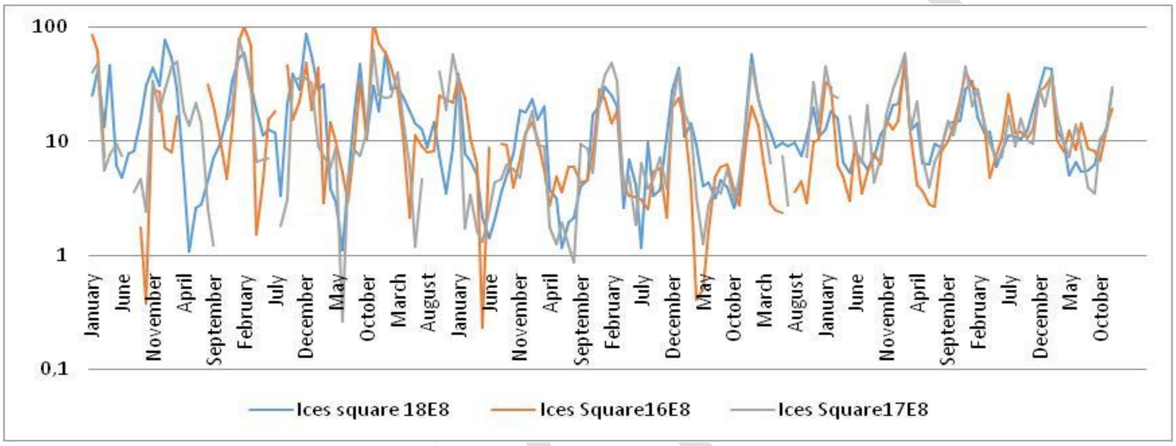
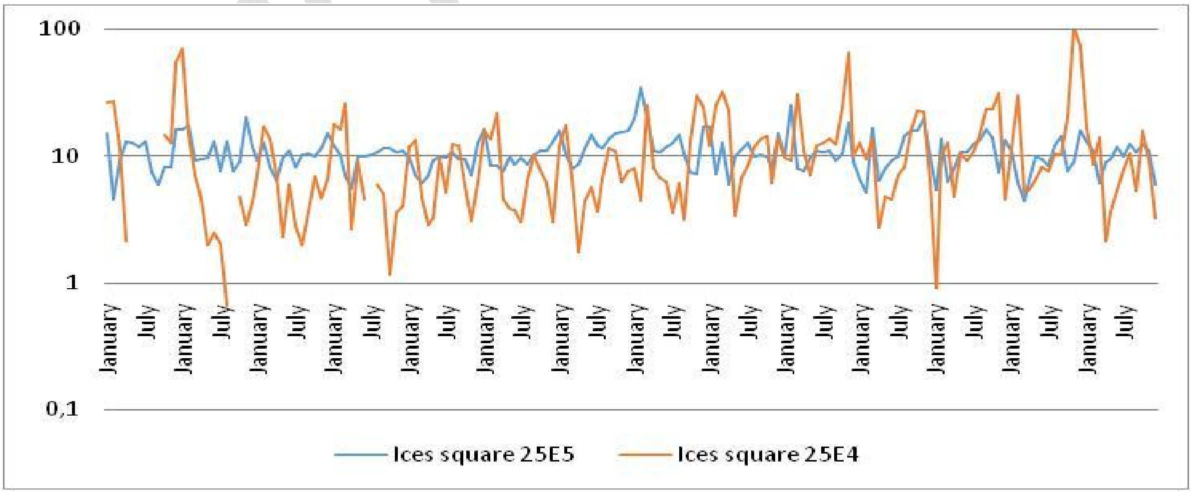


Figure 3:
Example of discrepancies between neigbouring squares
Squares off western Brittany



A detailed analysis of the set of time series is so necessary.

II - 2 Stock(s) structure and migrations

On the basis of the outputs of a multiplicative two factors model (year x month) fitting in the various ICES squares, for each month and each square the average (over years) apparent abundances (see footnote) have been calculated. Apparent abundances are expressed as catches per day of a standard vessel (average over CF1 trawlers more than 15 meters long). This leads to a set of 12 simplified, which use the following shading code.

	Shading	Code	
		<	4.99
	5	to	9.99
	10	to	19.99
	20	to	29.99
		>	30

Figures 4 (1) to 4(12)
Monthly maps of average apparent abundance per square

July

	E4	E5	E6	E7	E8	E9	F0	F1	F2
31								15.1	11.8
30							8.4	9	
29			4.5	5.6	11.3	6.1	9.4	8.2	
28		1.2	1.7	2.8	12.5	10.3	11.5		
27	0.9	1	1.6	4.5		11.2			
26		8.2	5.3	6.6					
25		10.4							
24		9.3	6.5	5					
23			5.7	5.9					
22				7.1					
21				5	7.5				
20				6.2	4.9				
19				7.9	6.5				
18					5.2				
17					5.6				
16					6.3				
15					12				

August

	E4	E5	E6	E7	E8	E9	F0	F1	F2
31								10	8.8
30							6	8.1	
29			4.9	3.7	10.3	4.3	5.3	6.7	
28		1.1	1.7	1.9	13.8	6.3	9.6		
27	1.2	1.6	2	4.9		9.9			
26		8.6	5.3	5.5					
25		11.3							
24		9	7.2	5.3					
23			6.1	5.3					
22			6.1	5.3					
21			6.1	5.3	8.5				
20			6.1	5.3	8.1				
19			6.1	14.1	7.5				
18					6.5				
17					4.3				
16					7.7				
15					13.1				

September

	E4	E5	E6	E7	E8	E9	F0	F1	F2
31								11.7	13.5
30							4.7	11.4	
29			3.5	3.4	10.7	5.6	4.8	7.3	
28		1.5	2.2	2.5	15.9	6.4	9.7		
27	1.8	2.1	1.9	4.1		12.3			
26		7.3	4.7	5.2					
25		10.8							
24		8.9	7.1	5.6					
23			6.7	7.6					
22				10.3					
21				11.6	10.5				
20				14.6	11.1				
19				18.3	12.2				
18					9.1				
17					5.4				
16					9.3				
15					12.6				

October

	E4	E5	E6	E7	E8	E9	F0	F1	F2
31								24.3	17.9
30							7.6	17.4	
29			10.2	4.4	19.3	10	8.6	11	
28		2.4	4	4.1	20	11	15.2		
27	3.8	2.4	4.6	2.8		17.4			
26		7	4.2	5					
25		10.6							
24		10.2	8	6.3					
23			10.4	10.1					
22				12.6					
21				15.3	14.6				
20				24.8	15				
19				9.8	15				
18					10				
17					9.3				
16					6.4				
15					8.4				

November

	E4	E5	E6	E7	E8	E9	F0	F1	F2
31								37	24.8
30							15.8	22.2	
29			14	7	13.7	22.6	16.3	15.4	
28		4.8	4.1	9.7	23.5	15.4	25.7		
27	4.9	5	2.5	6.5		15.4			
26		8.6	4.2	5.9					
25		11							
24		12.8	8.9	10.6					
23			9.1	9.6					
22				12.3					
21				13.5	15.5				
20				25.6	17.6				
19				40	19.4				
18					15.3				
17					14.4				
16					12.6				
15					12.5				

	E4	E5	E6	E7	E8	E9	F0	F1	F2
31								23.1	14.8
30							13.3	20.5	
29			12.8	11.7	20.5	40.2	17.1	17.8	
28		18.3	9.9	10.2	20.4	28.5	22.4		
27	16	4.8	5.8	11.8		16.4			
26		10.4	6.1	4.8					
25		12.6							
24		14.4	8.9	10.5					
23			8.7	10.4					
22				14.9					
21				19	20.5				
20				21.9	22.1				
19				35	36				
18					23.9				
17					24.5				
16					22.7				
15					15.7				

January

	E4	E5	E6	E7	E8	E9	F0	F1	F2
31								11.5	9.1
30							11.7	9.9	
29			26.3	18.6	26.8	20.8	12.7	10.7	
28		27.4	20.3	16.8	14.2	17	17.4		
27	15.7	25.4	19	17.9		8.3			
26		7.3	6.7	2.9					
25		11.8							
24		16.1	10.8	7.5					
23			8.5	8.9					
22				12.8					
21				16.9	16.6				
20				17.2	20				
19				17.9	39.6				
18					37.1				
17					33.6				
16					28.2				
15					12.4				

February

	E4	E5	E6	E7	E8	E9	F0	F1	F2
31								8.3	6.9
30							14.9	8.1	
29			20	30.8	33.8	23	13.2	10.2	
28		29.8	29.2	22.7	12.7	19.4	19.1		
27	23.4	33.8	21.9	14.7		15.6			
26		9.9	5.3	3.6					
25		10.4							
24		11.5	7.5	7.8					
23			7.7	9.2					
22				10.6					
21				15.6	12.3				
20				19.4	16.3				
19				26.8	32				
18					25.2				
17					23.4				
16					27.5				
15					10.9				

March

	E4	E5	E6	E7	E8	E9	F0	F1	F2
31								8.3	7
30							25.2	11.4	
29			26.8	32.7	39.5	29.7	22.8	11.9	
28		30.9	41	29.9	14	21.8	18.1		
27	17.7	26.1	25.7	16.9		6.3			
26		8.8	3.9	4.2					
25		8.5							
24		10.1	5.3	6.1					
23			8.2	9.2					
22				10.7					
21				10.9	12.7				
20				12.9	14.6				
19				11.9	22.8				
18					17.1				
17					15.2				
16					10.6				
15					6.8				

April

	E4	E5	E6	E7	E8	E9	F0	F1	F2
31								16.2	18.3
30							24.8	15.6	
29			15.1	22.7	20.2	27.1	19.9	13.2	
28		12.9	17.2	11.7	9.4	19.2	20.3		
27	3.3	3.7	6.3	11.1		9.3			
26		7.6	6.5	2.9					
25		7.7							
24		6.5	4.5	3.4					
23			5.1	4.7					
22				6.4					
21				6	9.1				
20				5	8.9				
19				2.3	13.6				
18					9				
17					6.6				
16					3.9				
15					5.6				

May

	E4	E5	E6	E7	E8	E9	F0	F1	F2
31								20.6	23.2
30							13	12	
29			2.2	7.1	8	12.9	13.7	9.4	
28		5.2	3.5	6.6	9	14.2	16		
27	2.2	2.5	3.2	5.1		14.3			
26		8.8	7.4	4.9					
25		10							
24		9.1	5.4	5					
23			4.5	5.8					
22				6.2					
21				4.7	9				
20				2.3	6.4				
19				4.6	8.5				
18					5				
17					5.3				
16					2.9				
15					6.6				

June

	E4	E5	E6	E7	E8	E9	F0	F1	F2
31								14.4	13.4
30							9.2	9.5	
29			5.6	5	11.2	8.1	11.3	8.1	
28		2.1	1.8	2.3	9.5	10.2	13.4		
27	1.3	1.6	1.9	6.4		12.6			
26		10.3	6.4	7					
25		10.8							
24		10.9	6.6	5.6					
23			5.1	6					
22				7.7					
21				4.6	7				
20				3.6	5.7				
19				2.9	5.9				
18					4.6				
17					3.9				
16					5.5				
15					5				

These maps suggest first of all two major spawning areas located respectively in the North West of the English Channel, and in the south of the bay of Biscay. Over an average year apparent abundance is low in summer for almost all squares.

- In the Channel and the North Sea squares covered in the data set, apparent abundance increases progressively between October and December, following an apparent East to West move. Apparent abundance is high in a set of northern squares, which defines what will be later on the Channel major Spawning ground. A rapid decrease then takes place, which even starts in March for the more western squares, so that in June apparent abundance is low in all squares in the Channel.
- In the Bay of Biscay apparent abundance first increases around latitude 21 in October/November, and becomes very high in the southern part (south of latitude 21), which correspond to what will be considered as the Bay of Biscay major spawning grounds. The apparent abundance then decreases sooner than on the Channel major spawning grounds, since in March it is significantly lower than in the previous months.

Changes in apparent abundance cannot be due only to horizontal migrations. It seems for instance that even at low densities there are sea-bass of commercial size in most squares all year long. Changes in apparent abundance result from a combination of (1) real horizontal migrations, confirmed by tagging programs results (X pers. Com.) and observations from the industry, and (2) changes in "local" catchability, including schooling behaviour and changes in vertical distribution within the water column.. The analysis of seasonal patterns according to the fishing techniques can give some insight about such local changes, and this will be discussed later on. The basic model of two distinct stocks (Channel + North sea ; Bay of Biscay) associated to the previously mentioned major spawning grounds will deserve further discussions. If sea bass in the North is very likely to be related to a component of the Channel stock, relationships between the Channel and the Celtic Sea and adjacent areas cannot be discussed on the basis of the available information. A detailed analysis of the coastal squares around Brittany also reveals that they do not fit for most of them this basic scheme. West of Brittany apparent abundance seem almost stable over the year, which could be consistent with local spawning grounds related to neighbouring coastal nurseries.

The bulk of the catches in the Channel, the North Sea and the Bay of Biscay are likely to be related to the previously mentioned major spawning areas. Available data on sea water temperature show that these areas are compatible with the available literature about sea bass spawning (Ref???=), and that they can be connected to well-known nursery areas along the south west coast of England, and in coastal areas of the Bay of Biscay. This is also true for possible local spawning areas off western Brittany.

Remarks above about stock structure can be, at least partly, confirmed by a comparison of seasonal patterns in the different squares as described by the plotting of the twelve monthly modulation coefficient (see appendix C). The basic suggested stock structure is also consistent with between years changes in the different squares. Figures 5 (1) and 5 (2) below are based upon changes between (geometric) means over years 2000 to 2004 , then 2005 to 2009 and finally years 2010 to 2013. Using averages over years range simplifies the discussion, and limits the influence of "noise"(mainly between vessels variability) on the year effects which are as pointed out more difficult to assess than the stronger seasonal effects. Complete sets of annual effects per square are anyway available as supplementary material (see Appendix D). Figures below are expressed as percentage of change per year between two periods.

Figure 5(a)

Changes between the first (2000-2004) and the second (2005-2009) years ranges

	E4	E5	E6	E7	E8	E9	F0	F1	F2
31								9.2	6.6
30							10.7	10.5	
29			-2.5	2.3	6.6	6.1	11.1	12.2	
28		12.5	4.6	7.1	-6.8	1.3	3.1		
27	7.7	7.3	7.3	11.1		1.3			
26		3	5.8	-3.5					
25		2.7							
24		-1.9	1.6	19.5					
23			-0.9	4.6					
22				-6.9					
21				-13	-4.1				
20				-7.6	-7				
19				-11	0.7				
18					-12				
17					-14				
16					-14				
15					-24				

Figure 5(b)

Changes between the second (2004-2009) and the third (2010-2013) years ranges

	E4	E5	E6	E7	E8	E9	F0	F1	F2
31								11.2	10.7
30							18.4	9.8	
29			-5.2	-2.3	-2.1	4.4	15.6	11.1	
28		4.2	17.7	-2.3	-4.6	2.2	6.9		
27	31.4	14.7	8	14.5		6.2			
26		-1.7	-5.4	7.8					
25		-2.9							
24		-0.9	1.5	-2.6					
23			2.2	2.9					
22				6.9					
21				9.7	3.3				
20				11.9	9.2				
19				6.8	9.3				
18					10.5				
17					18.9				
16					17				
15					14.7				

Shading convention

	<		-20%	
-20.00%	<	<	-10%	
-9.99%	<	<	0%	
0%	<	<	10%	
10%	<	<	20%	
20%	<			

Figures 5(a) and (b) show that apart from the more northern squares (coastal ones south of Brittany) changes are consistent within the bay of Biscay, mostly negative between periods 1 and 3, then positive between periods 2 and 3, even if in both cases changes are stronger in the southern part.

Within the Channel and Dover straight changes between periods 1 and 2 are positive in most squares. As for changes between periods 2 and 3 they are positive in most cases. This is not true however for squares immediately north of Brittany, which is consistent with previous remarks, but also, which is more difficult to explain for central squares (e.g. 29E7). It cannot also be excluded that even fish issued from neighbouring spawning areas should be considered as being related to different stocks in terms of yield per recruit if they grew up on distinct nursery areas, and if fish remain “faithful” to their feeding areas including since their nursery months.

This being said we do believe that the basic scheme based upon two major spawning areas and a likely secondary one off Brittany is a strong basis for future discussions, and should be considered in future tagging programs.

II-3 Could annual indices of apparent abundance be used for tuning stock assessment

This question is directly related to the discussion about stock structure. This is why analyses below are just preliminary ones and cover various options. Annual indices have in fact been calculated for various areas. Averages over sets of squares have been calculated for statistical reasons over logarithm, then retransformed in kg/day.

Various areas have been considered.

For the channel four combinations have been used:

Splitting between east (1) and west (2), using all individual squares (3), and eventually only squares which correspond to the major spawning area as previously defined (4). The spawning area in question groups seven squares: 29E9, 26E7, 28E7, 29E7, 27E6, 28E6, 27E5.

West of Brittany a set of two squares (24E5/25E5) has been considered.

Within the Bay of Biscay four combinations, mainly based upon latitude ranges have been considered:

- 24E7 / 24E6 / 23E7 (North)
- 23E6 / 22E7 / 21E7 (Central)
- 19E7/19E8/18E8/17E8/15E8 (South which almost coincides with the so-called spawning area)
- All squares from the Bay of Biscay, but the extreme ones (24E7 and 15E8).

Calculations have also been performed using all vessels, gear groups CF1, CF2 and SND, only the less bass selective (see above definition of the 100 vessels targeting more sea bass).

Other analyses have also been performed using only groups of fishing techniques such as fixed gears or mid water trawls. Results are not discussed here, but can be found in the supplementary material (appendix D).

Finally the possibility of using only ñspawning period monthsò,i.e. December to March has been considered.

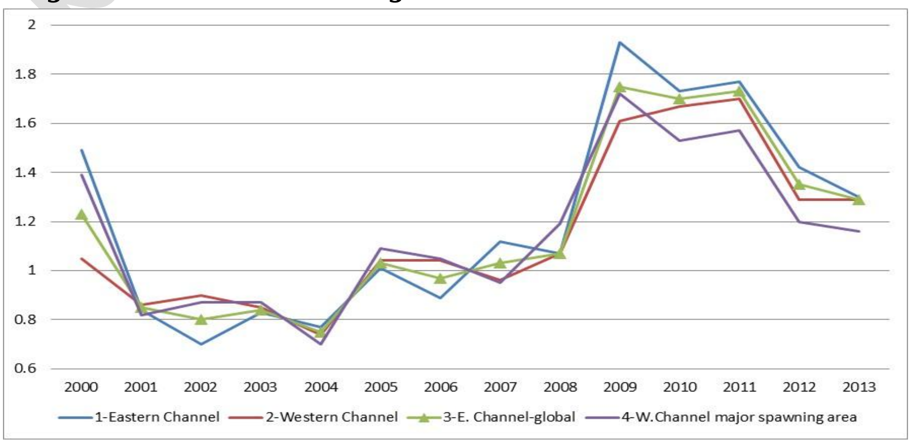
All annual indices are expressed as a ratio, using the geometric mean over years 2006 and 2007 as the denominator. They so vary around one, and close to one for years 2006 and 2007.

For the Channel, using al gears and all months leads to promising results, which do not vary very much according to the square selection, which would back up the idea of a single stock, and seem consistent with previous assessment results.

Figure 6

Annual indices of abundance for various groups of squares

All gears and all months being taken into account



It would seem preferable to select vessels which are more likely to provide simpler relationships between catch rates and real abundance, such as bottom trawls.

Figure 7 a

Annual indices of abundance
for various groups of squares all months
Bottom trawl + SND and all months

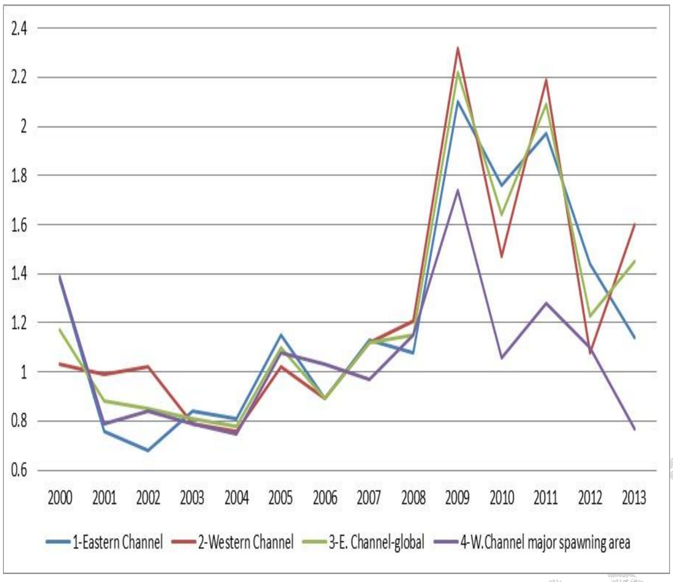
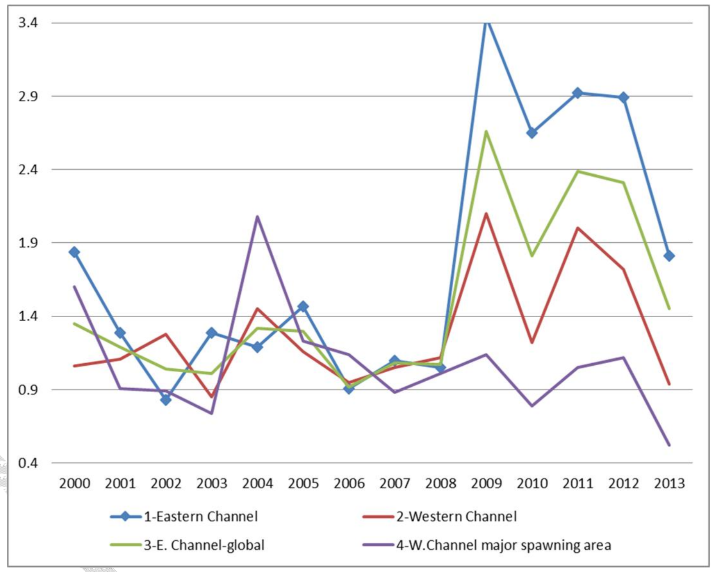


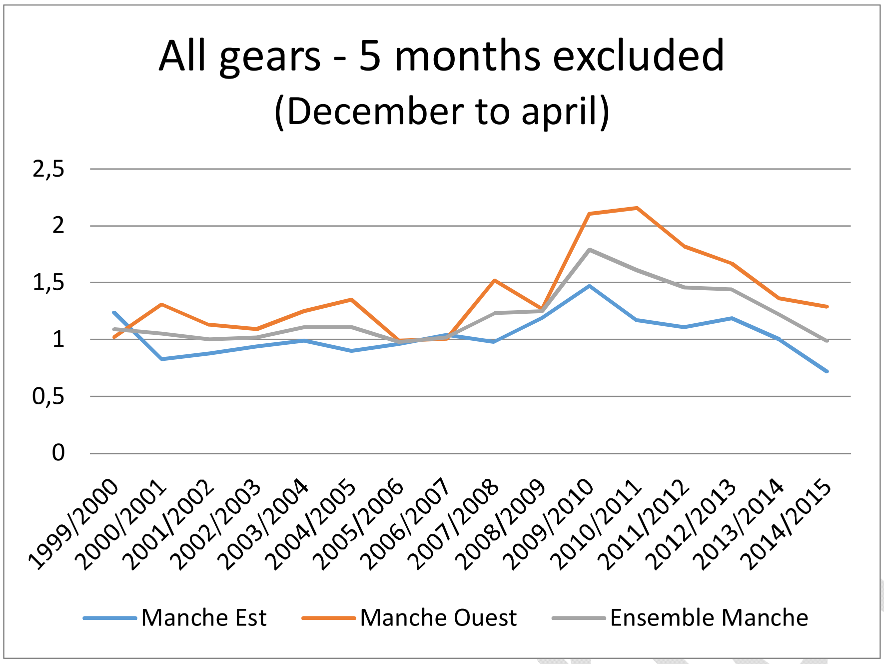
Figure 7 b

Annual indices of abundance
for various groups of squares December to March
Bottom trawl + SND without the more selective vessels



Results seem more chaotic for recent years (strong year to year changes) and less consistent from one area to another one. The option which corresponds to spawning areas on Figure 7-b, which only takes into account vessels which would appear as the more reliable ones (bottom trawl + SND without the more bass oriented vessels) for the more relevant combination of squares and months (spawning ground squares during the spawning season) does not seem to detect a trend consistent with previous stock assessments. This could be due to the fact that this option only takes into account a limited number of observations, making it more difficult to extract the signal from the noise. In other words selecting the best vessels for the best period in the best area is not necessarily fruitful. Further analyses will be conducted on this issue. In the mean time if one cannot expect that indices calculated with all vessels and all months are simply proportional to real abundance, it would be useful to compare them to estimates of stock abundance issued from integrated stock assessment.

Some preliminary calculation including 2014, excluding the spawning period (December to April) to avoid problems related to aggregations around the spawning period, including interference with the efficiency gains of the pelagic trawlers during this season have been tested and results are presented in Figure 8.



It would be however premature to draw conclusions valid for all stocks, since in the Bay of Biscay results are more robust, as illustrated on figures 8-a and 8-b

Figure 8-a
Bay of Biscay ï analysis for the **global area** using various sets of vessels and months

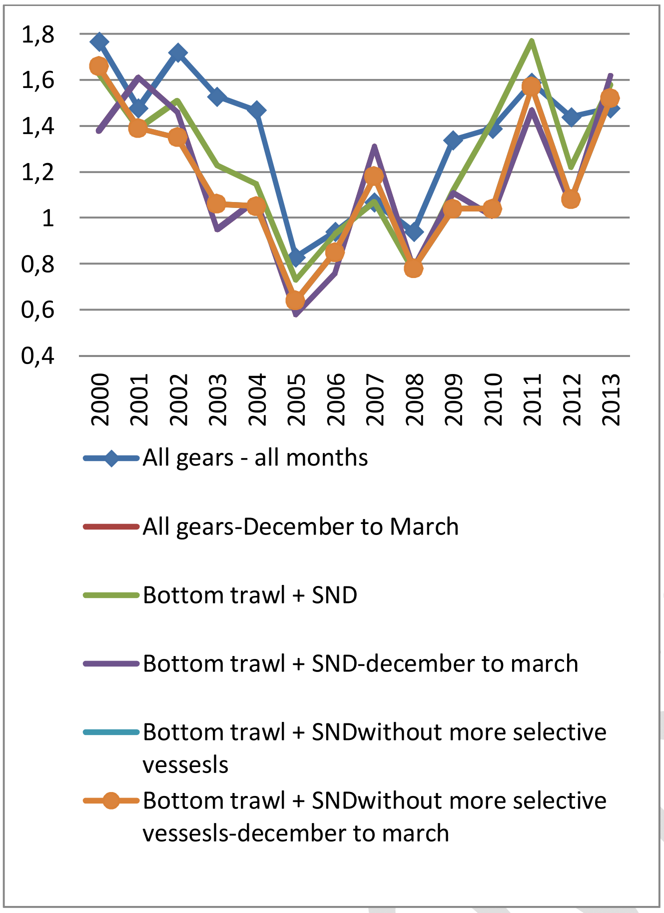
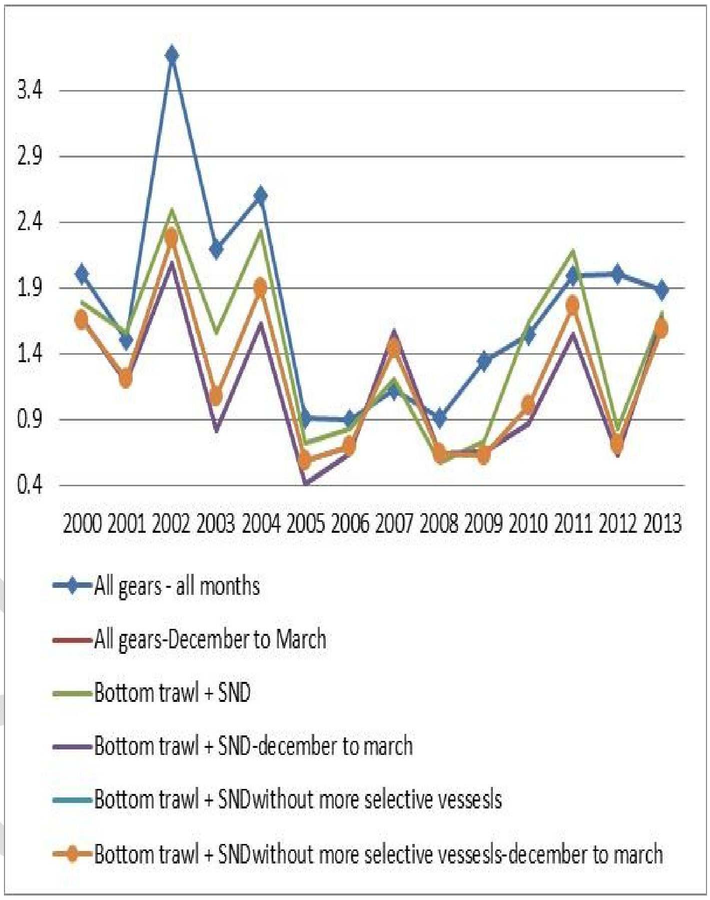


Figure 8-b
Bay of Biscay ï analysis for the **<u>southern part</u>** (spawning grounds) using various sets of vessels and months



The two more important series, because they correspond to extreme options, have been highlighted: all gears all months and Bootom trawl + Snd without the more selective vessels keeping only December to March data. Time series which only cover the southern part are as could be anticipated more noisy. Isolated peaks in 2007 and 2011 would require some specific check of the data base. It seems however possible to conclude that the abundance has decreased severely up to 2005, and has recovered in the following years. This could be considered in connexion with the available catch and effort figures.

Conclusions/Discussion

Very useful material within logbooks. Key results can be obtained using simple techniques (two factors models, averages and least squares).

First conclusions provide a basic hypothesis about stock structures and spawning migrations which will deserve future work in combination with other sources of data.

More work has yet to be done (including the more recent data, assessing uncertainties due to between vessels variability, combination with integrated assessment methods as possible indices of abundance which could reduce uncertainties for the more recent years…).

Appendices

(A) Fishing techniques and groups of fishing techniques

Gears categories	Included gears codes	Gears description
FL1	GN	
	GNC	
	GNS	
FL2	GTR	
HMC	LH	
	LHM	
	LHP	
	LTL	
PLG	LL	
	LLD	
	LLF	
	LLS	
	LVD	
	LVS	
CF1	OT	
	OTB	
	TB	
CF2	OTT	
CFC	TBS	
SND	SDN	
	SSC	
CPS	OTM	
CPB	PT	
	PTB	
	PTM	
	TM	
BLC	PS	
	PS1	

EqSim Analysis for West of Scotland whiting (WGCSE 2016)

Helen Dobby

Tue May 10 07:22:54 2016

This is an R script which can be compiled to produce a 'report' on the EqSim analysis for West of Scotland whiting based on the results of the assessment carried out at WGCSE in 2016. Alternatively the script can just be run from R.
First of all set up the environment. Load the required libraries

```
rm(list=ls(pos=1))
graphics.off()

library(devtools)

## Warning: package 'devtools' was built under R version 3.2.5

library(msy)

##
## Attaching package: 'msy'

## The following object is masked from 'package:base':
##
##     paste0

library(xtable)

## Warning: package 'xtable' was built under R version 3.2.5

library(gplots)

## Warning: package 'gplots' was built under R version 3.2.5

##
## Attaching package: 'gplots'

## The following object is masked from 'package:stats':
##
##     lowess

library(FLCore)

## Warning: package 'FLCore' was built under R version 3.2.3

## Loading required package: lattice

## Loading required package: MASS

## Loading required package: Matrix
```

```
## FLCore (Version 2.5.20160107, packaged: 2016-02-16 12:15:57 UTC)

##
## Attaching package: 'FLCore'

## The following object is masked from 'package:msy':
##
##     initial

## The following objects are masked from 'package:base':
##
##     cbind, rbind

library(ggplot2)

## Warning: package 'ggplot2' was built under R version 3.2.3

##
## Attaching package: 'ggplot2'

## The following object is masked from 'package:FLCore':
##
##     %+%

sessionInfo()

## R version 3.2.2 (2015-08-14)
## Platform: i386-w64-mingw32/i386 (32-bit)
## Running under: Windows 7 x64 (build 7601) Service Pack 1
##
## locale:
## [1] LC_COLLATE=English_United Kingdom.1252
## [2] LC_CTYPE=English_United Kingdom.1252
## [3] LC_MONETARY=English_United Kingdom.1252
## [4] LC_NUMERIC=C
## [5] LC_TIME=English_United Kingdom.1252
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
## [1] ggplot2_2.1.0       FLCore_2.5.20160107 Matrix_1.2-2
## [4] MASS_7.3-43         lattice_0.20-33     gplots_3.0.1
## [7] xtable_1.8-2        msy_0.1.16          devtools_1.11.1
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_0.12.4        knitr_1.12.3       magrittr_1.5
##  [4] munsell_0.4.3      colorspace_1.2-6   plyr_1.8.3
##  [7] stringr_1.0.0      caTools_1.17.1     tools_3.2.2
## [10] grid_3.2.2         gtable_0.2.0       KernSmooth_2.23-15
## [13] withr_1.0.1        htmltools_0.3.5    gtools_3.5.0
## [16] yaml_2.1.13        digest_0.6.9       bitops_1.0-6
```

```
## [19] memoise_1.0.0      evaluate_0.8.3     rmarkdown_0.9.5
## [22] gdata_2.17.0       stringi_1.0-1      scales_0.4.0
## [25] stats4_3.2.2
```

Set up some directories and source some of the scripts.

```
Rdir <-"C:/MyFiles/Meetings/WGCSE/2016/cod-scow/R scripts/"
EqSimdir <-"C:/MyFiles/Meetings/WKMSYREF/WKMSYREF4/"
datadir <-"C:/MyFiles/Meetings/WGCSE/2016/whi-scow/"
wkdir <-"C:/MyFiles/Meetings/WGCSE/2016/whi-scow/MSY Ref Pts"

source(file.path(Rdir,"tsa_conversion_functions.R"))
source(file.path(EqSimdir,"Calculate Flim and 5percentonBMSY.r"))
```

Input Data

Load the final TSA run, convert it to an FLR stock object.

```
runname <-"whiting fit new plus retro.Rdata"
load(file.path(datadir,runname))

whg6a <-tsa.output.to.flr.stock.object(whiting_fit,"whi6a.final.2016")
save(whg6a,file=file.path(wkdir,"whi.6a.flr.rdata"))
```

Restrict stock data to end in 2015

```
stk <- window(whg6a, end = 2015)
```

The results from the TSA stock assessment conducted at ICES WGCSE 2016 were used to create an FL Stock object which was used in the MSY analysis.

```
pname <-"stock.summary.png"
plot(stk)
```

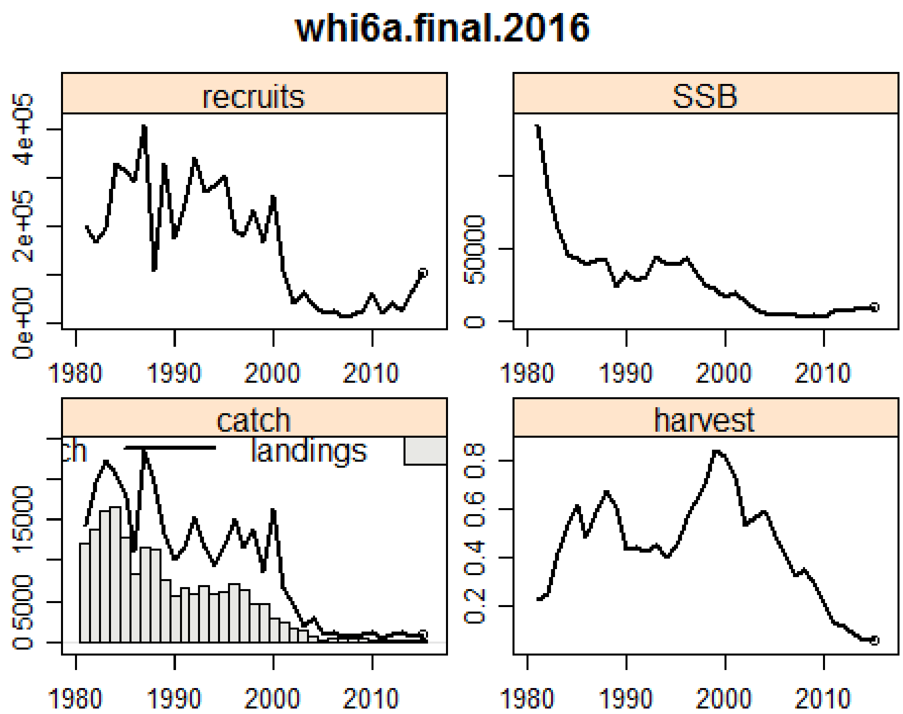


Figure 1: Whiting 6.a: Stock summary

```
dev.copy(png,pname, width=600, height=400)

## png
##   3

dev.off()

## png
##   2
```

The base run largely uses the default settings for the input parameters (10 year window) with the exception of the selection pattern. Although there is some evidence of a downward trend in mean weight in the youngest age class, other ages appear to exhibit periodic variation with high variability in recnet years (See below). The standard ten year window is therefore used for the mean stock/catch weights at age. The introduction of large square mesh panels in the TR2 fleet which has bee responsible for a large proportion of whiting discards should have resulted in a change in selelction pattern in recent years and therefore a shorter period is used for the selectivity pattern year window (last fiver years). (Note that the expected selectivity changes are not particularly apparent in the F at age pattern from the TSA stock assessment)

```
pname <-"selection.pattern.png"

f <-as.data.frame(stk@harvest)
f$year <-as.character(f$year)
```

```
ggplot(subset(f,year %in% c(1995,2000,2005,2010,2015)),
aes(age,data,group=year,colour=year)) +
  ylab("F")+
  geom_line()
```

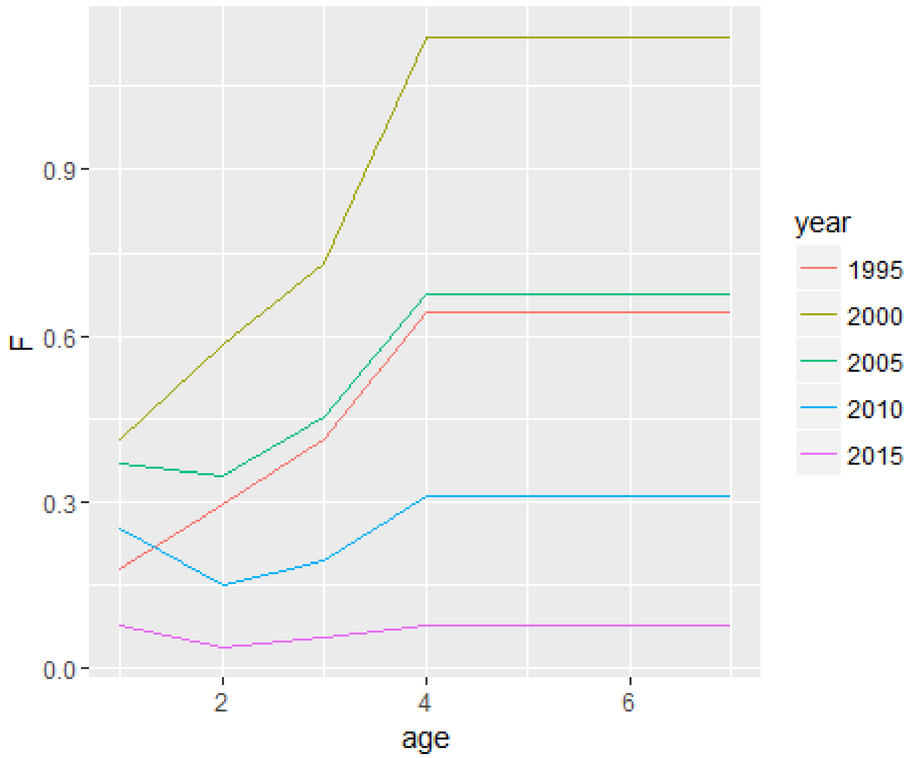


Figure 2: Whiting in 6.a. Selection pattern over time.

```
dev.copy(png,pname, width=600, height=400)

## png
##   3

dev.off()

## png
##   2

pname <-"F.at.age.png"

f <-as.data.frame(stk@harvest)
f$year <-as.numeric(f$year)
f$age <-as.character(f$age)
ggplot(f, aes(year,data,group=age,colour=age)) +
  ylab("F")+
  geom_line()
```

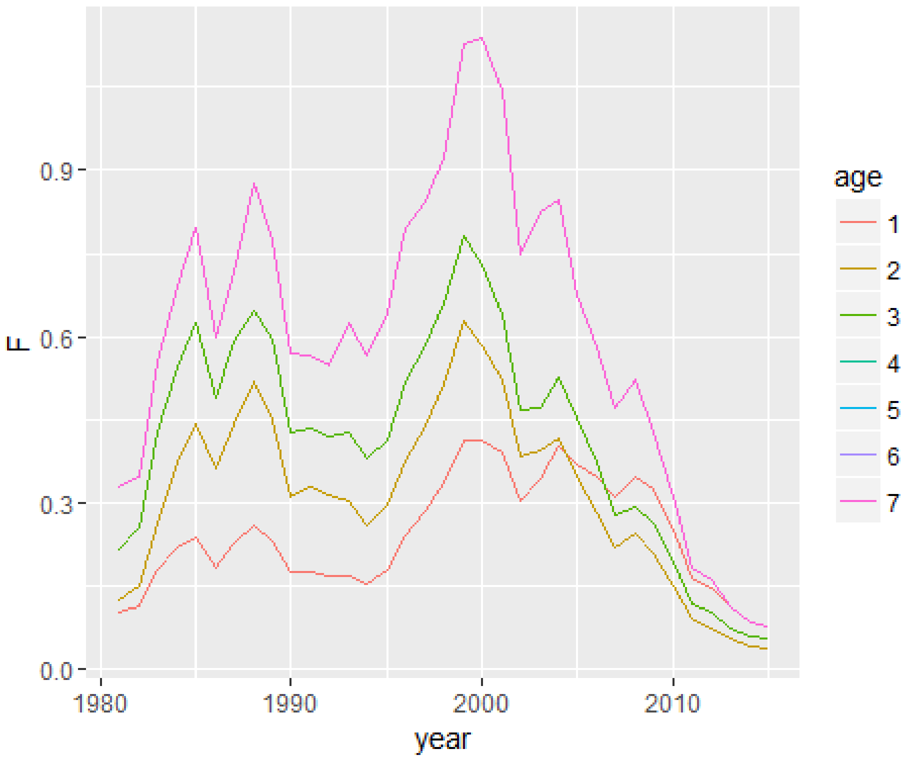


Figure 3: Whiting in 6.a. F at age over time.

```
dev.copy(png,pname, width=600, height=400)

## png
##   3

dev.off()

## png
##   2

pname <-"weights.at.age.png"

wts <-as.data.frame(stk@stock.wt)
wts$year <-as.numeric(wts$year)
wts$age <-as.character(wts$age)
ggplot(wts, aes(year,data,group=age,colour=age)) +
  ylab("weight (kg)")+
  geom_line()
```

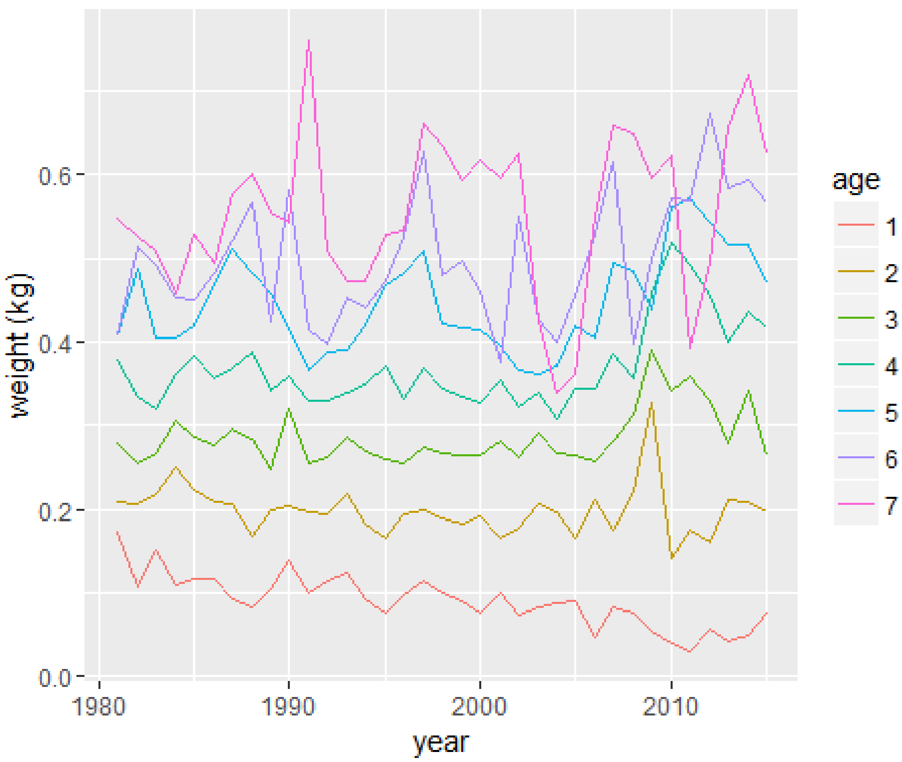


Figure 4: Whiting in 6.a. Mean stock/catch weight at age.

```
dev.copy(png,pname, width=600, height=400)

## png
##   3

dev.off()

## png
##   2
```

Set up some of the some of input parameters which are required for the EqSim. We use the standard values for err.cv & err.phi.

```
b.yrs <-c(2006,2015)
s.yrs <-c(2011,2015)
err.cv <-0.212
err.phi <-0.423
tsa.brk.pt <-31880
```

Stock Recruit Model

Two different approaches were considered for the stock recruit model: 1) fixing the breakpoint in the segmented regression at the value estimated by the TSA, and 2) the default 'Buckland' method estimating the proportion of fits with Ricker, Beverton-Holt and Segmented regression. The plots look quite similar.

```
pname <-"fixed.brk.segreg.sr.png"
fixed.brk.pt <-tsa.brk.pt
segreg3  <- function(ab, ssb){
  log(ifelse(ssb >= fixed.brk.pt, ab$a * fixed.brk.pt, ab$a * ssb))
}
fit <-eqsr_fit(stk,nsamp=1000,models="segreg3")
eqsr_plot(fit,ggPlot=FALSE)
```

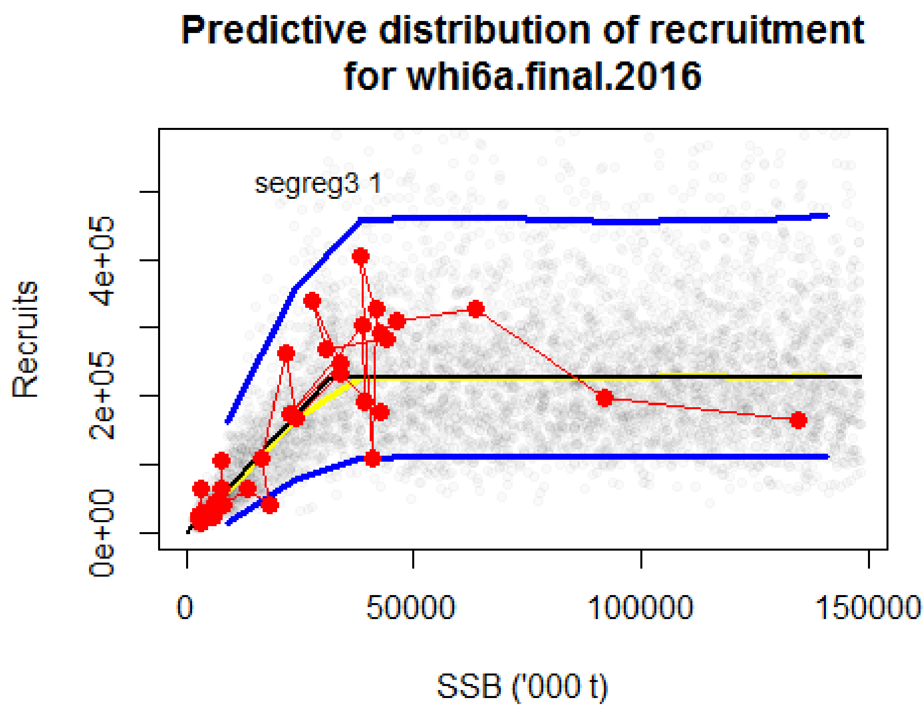


Figure 5: Whiting 6.a: S-R fit with fixed breakpoint in the Segmented Regression

```
dev.copy(png,pname, width=600, height=400)

## png
##   3

dev.off()

## png
##   2

pname <-"default.sr.png"
fit <-eqsr_fit(stk,nsamp=1000,models = c("Ricker", "Bevholt", "Segreg"))
eqsr_plot(fit,ggPlot=FALSE)
```

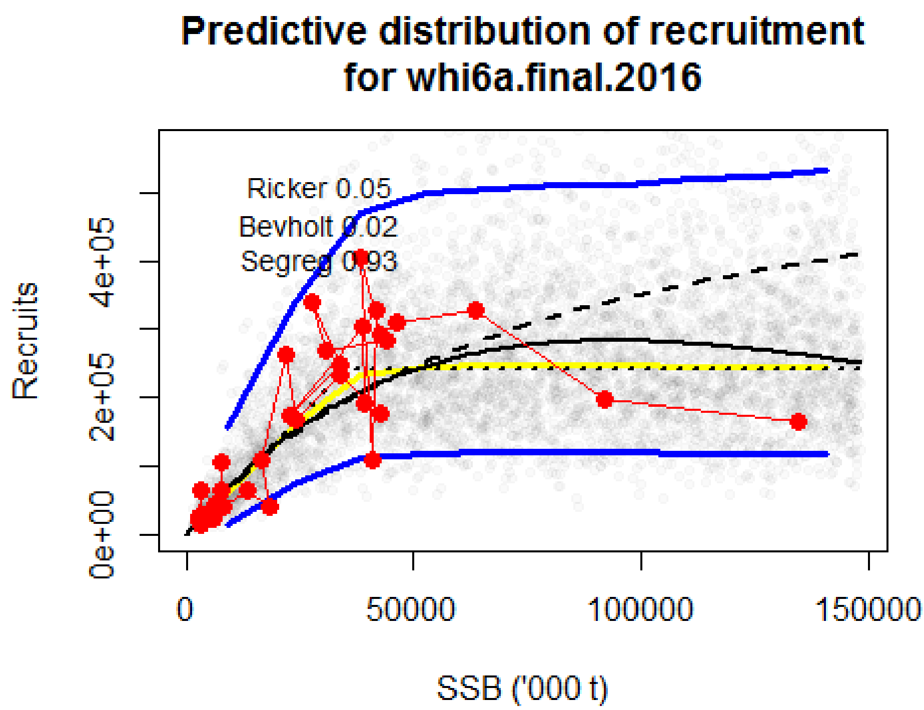


Figure 6: Whiting 6.a: S-R fit using the default 'Buckland' method (Ricker, Beverton-Holt and segmented regression).

```
dev.copy(png,pname, width=600, height=400)

## png
##   3

dev.off()

## png
##   2
```

The S-R function with fixed breakpoint was used in all further runs and Blim chosen equal to the breakpoint. Bpa was set at 1.4 x Blim.

Run 1

A number of runs of EqSim have to be carried out to estimate all the reference points. First run is with the standard error assumptions, but without the Btrigger

```
rname <-"baseline.no.Btrigger"
fixed.brk.pt <-tsa.brk.pt
segreg3  <- function(ab, ssb){
  log(ifelse(ssb >= fixed.brk.pt, ab$a * fixed.brk.pt, ab$a * ssb))
}
stk.indat <-list(data=stk,
```

```
              bio.yrs <-b.yrs,
              sel.yrs <-s.yrs,
              Fscan <-seq(0,1.0,by=0.02),
              Fcv=err.cv,
              Fphi=err.phi,
              Blim=tsa.brk.pt,
              Bpa=tsa.brk.pt*1.4,
              Btrigger=0
)

stk.res <-within(stk.indat,
{
  fit <-eqsr_fit(data,nsamp=1000,models="segreg3")
  sim <-eqsim_run(fit,bio.years=bio.yrs,sel.years=sel.yrs,
                  Fscan = Fscan, Fcv = Fcv, Fphi = Fphi,
                  Blim=Blim, Bpa=Bpa, Btrigger=Btrigger,verbose=FALSE)
})
save(stk.res,file=paste(rname,".results.rdata",sep=""))
write.csv(t(stk.res$sim$Refs2),file=paste(rname,".summary.csv",sep=""))

knitr::kable(stk.res$sim$Refs2,digits=2,row.names=TRUE)
```

	F05	F10	F50	median MSY	mean MSY	Medlo wer	Meanlo wer	Medup per	Meanup per
catF	0.15	0.18	0.26	NA	0.22	NA	NA	NA	NA
lanF	NA	NA	NA	0.20	0.20	0.15	0.15	0.24	0.24
catch	7121.85	7666.45	7854.64	NA	8180.79	NA	NA	NA	NA
landings	NA	NA	NA	3292.68	3274.19	3116.07	3343.28	3122.32	3339.85
catB	48393.34	44873.77	31787.10	NA	39289.37	NA	NA	NA	NA
lanB	NA	NA	NA	41811.90	42061.99	49364.00	NA	35879.53	NA

```
eqsim_plot(stk.res$sim,catch=FALSE)
```

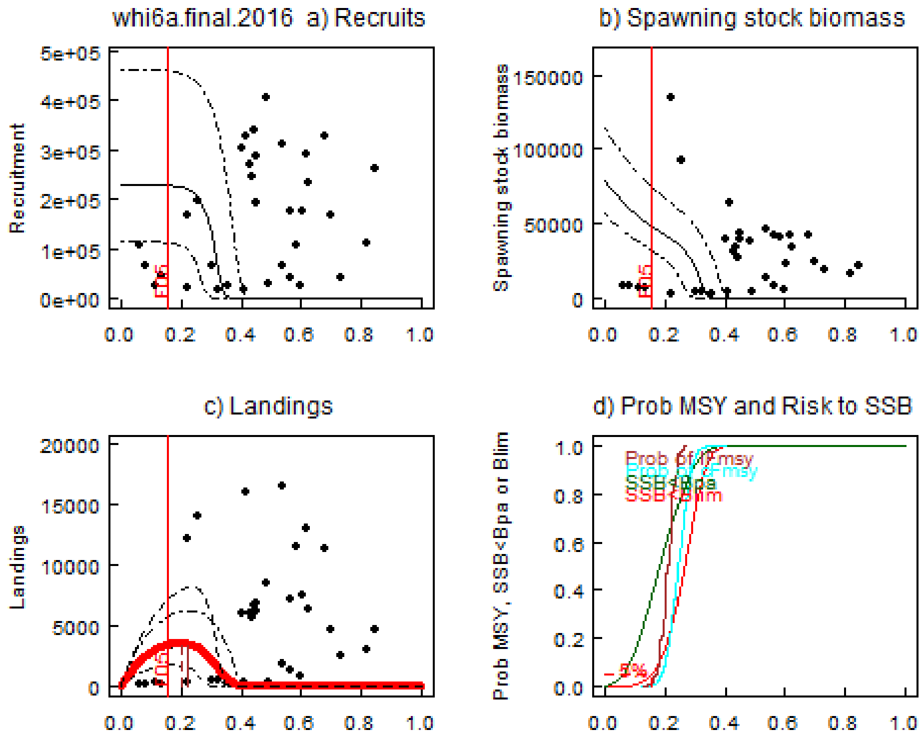


Figure 7: Whiting 6.a.EqSim summary (without Btrigger). Panels a-c: Recruitment, SSB & landings at fixed values of F - median plus 90 % intervals and historical values. Panel d shows the probability of SSB<Blim (red), SSB<Bpa (green) and cumulative distribution of FMSY based on yield as landings (brown) and catch (cyan).

```
dev.copy(png,file=paste(rname,".summary.png",sep=""), width=600, height=400)

## png
##   3

dev.off()

## png
##   2

eqsim_plot_range(stk.res$sim,type="median")
```

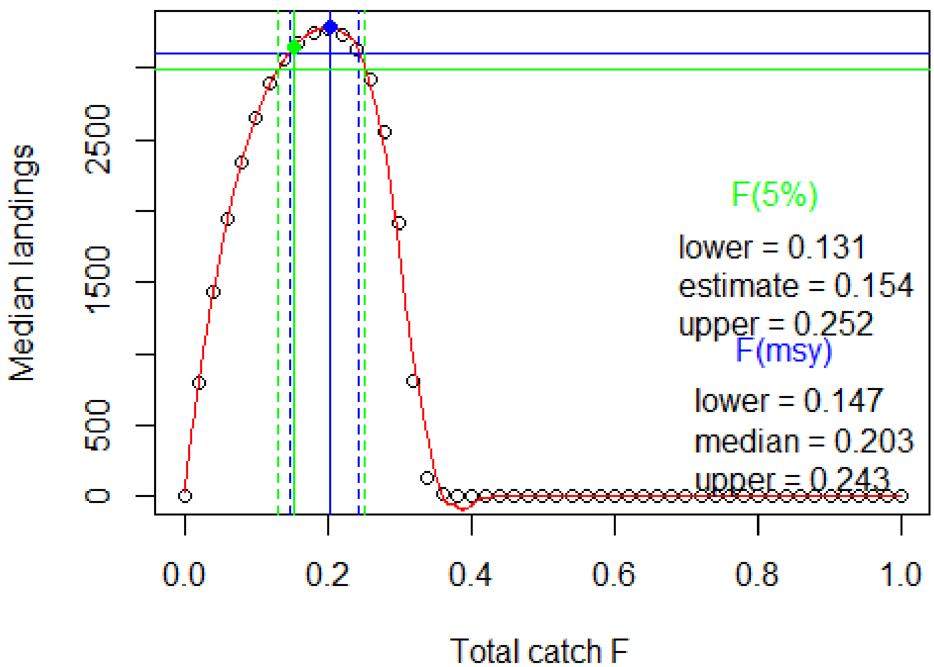


Figure 8: Whiting 6.a. Median landings yield curve with estimated reference points (without Btrigter). Blue lines: FMSY estimate (solid) and range at 95 % of maximum yield (dotted). Green lines: FP.05 estimate (solid) and range at 95 % yield implied by FP.05 (dotted).

```
dev.copy(png,file=paste(rname,".med.land.png",sep=""), width=600, height=400)

## png
##   3

dev.off()

## png
##   2

eqsim_plot_range(stk.res$sim,type="ssb")
```

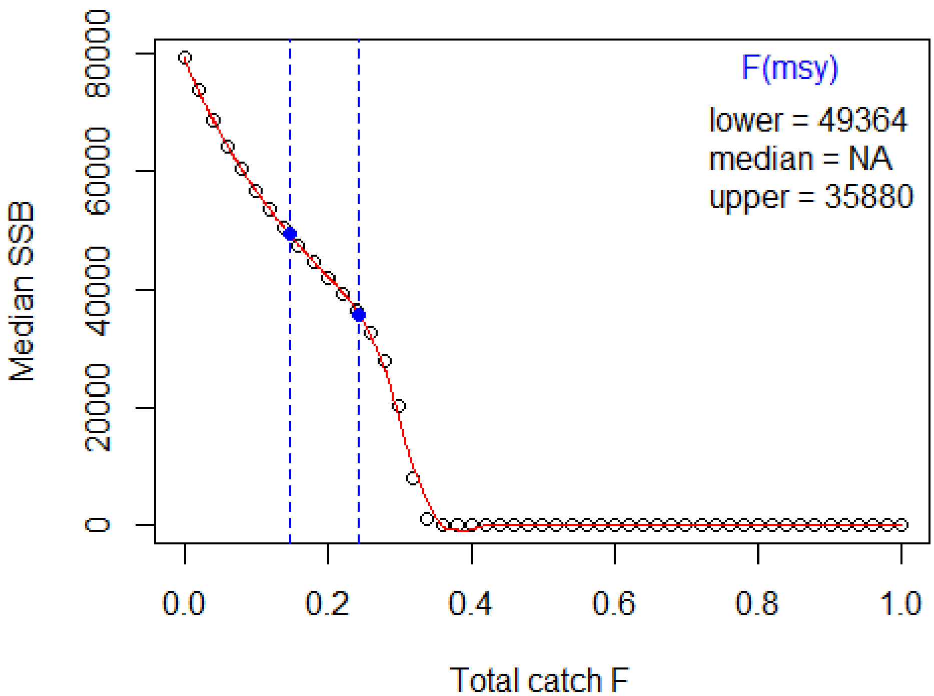


Figure 9: Whiting 6.a. Median SSB curve over a range of targer F values (without Btrigger). Blue lines: FMSY estimate (solid) and range at 95 % of maximum yield(dotted).

```
dev.copy(png,file=paste(rname,".med.ssb.png",sep=""), width=600, height=400)

## png
##   3

dev.off()

## png
##   2

med.FMSY.no.Btrigger <-stk.res$sim$Refs2["lanF","medianMSY"]
med.FMSY.no.Btrigger

## [1] 0.2032032
```

Run2

A run with no error in the advice was carried out to estimate MSY Btrigger using the fifth percentile of the distribution of SSB when fishing at Fmsy (calculated from the previous run)

```
rname <-"no.error.no.Btrigger"
fixed.brk.pt <-tsa.brk.pt
segreg3  <- function(ab, ssb){
```

```
  log(ifelse(ssb >= fixed.brk.pt, ab$a * fixed.brk.pt, ab$a * ssb))
}

stk.indat <-list(data=stk,
                 bio.yrs <-b.yrs,
                 sel.yrs <-s.yrs,
                 Fscan <-seq(0,1.0,by=0.02),
                 Fcv=0,
                 Fphi=0,
                 Blim=tsa.brk.pt,
                 Bpa=tsa.brk.pt*1.4,
                 Btrigger=0)

stk.res <-within(stk.indat,
{
  fit <-eqsr_fit(data,nsamp=1000,models="segreg3")
  sim <-eqsim_run(fit,bio.years=bio.yrs,sel.years=sel.yrs,
                  Fscan = Fscan, Fcv = Fcv, Fphi = Fphi,
                  Blim=Blim, Bpa=Bpa, Btrigger=Btrigger,verbose=FALSE)
})
save(stk.res,file=paste(rname,".results.rdata",sep=""))
write.csv(t(stk.res$sim$Refs2),file=paste(rname,".summary.csv",sep=""))

knitr::kable(stk.res$sim$Refs2,digits=2,row.names=TRUE)
```

	F05	F10	F50	median MSY	mean MSY	Medlo wer	Meanlo wer	Medup per	Meanup per
catF	0.16	0.19	0.27	NA	0.24	NA	NA	NA	NA
lanF	NA	NA	NA	0.21	0.20	0.15	0.15	0.26	0.25
catch	7416.19	7922.14	8245.02	NA	8502.95	NA	NA	NA	NA
landings	NA	NA	NA	3352.47	3333.55	3168.81	3348.14	3174.74	3348.36
catB	47138.52	43868.81	31825.47	NA	37246.26	NA	NA	NA	NA
lanB	NA	NA	NA	41625.76	42539.30	48847.06	NA	35047.39	NA

```
eqsim_plot(stk.res$sim,catch=FALSE)
```

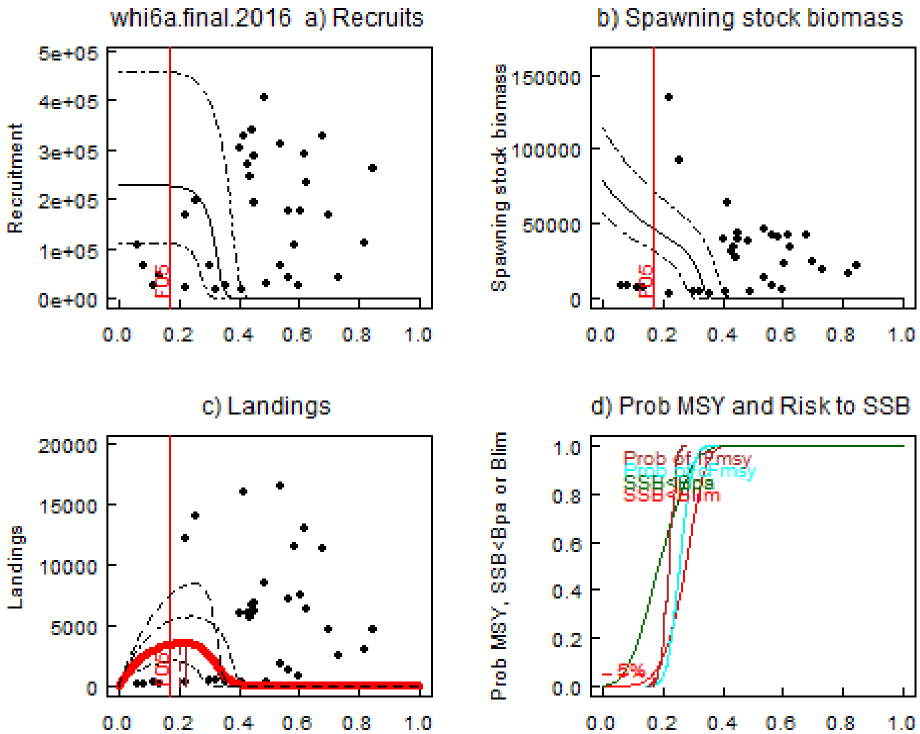


Figure 10: Whiting 6.a.EqSim summary (without Btrigger and error). Panels a-c: Recruitment, SSB & landings at fixed values of F - median plus 90 % intervals and historical values. Panel d shows the probability of SSB<Blim (red), SSB<Bpa (green) and cumulative distribution of FMSY based on yield as landings (brown) and catch (cyan).

```
dev.copy(png,file=paste(rname,".summary.png",sep=""), width=600, height=400)

## png
##   3

dev.off()

## png
##   2

eqsim_plot_range(stk.res$sim,type="median")
```

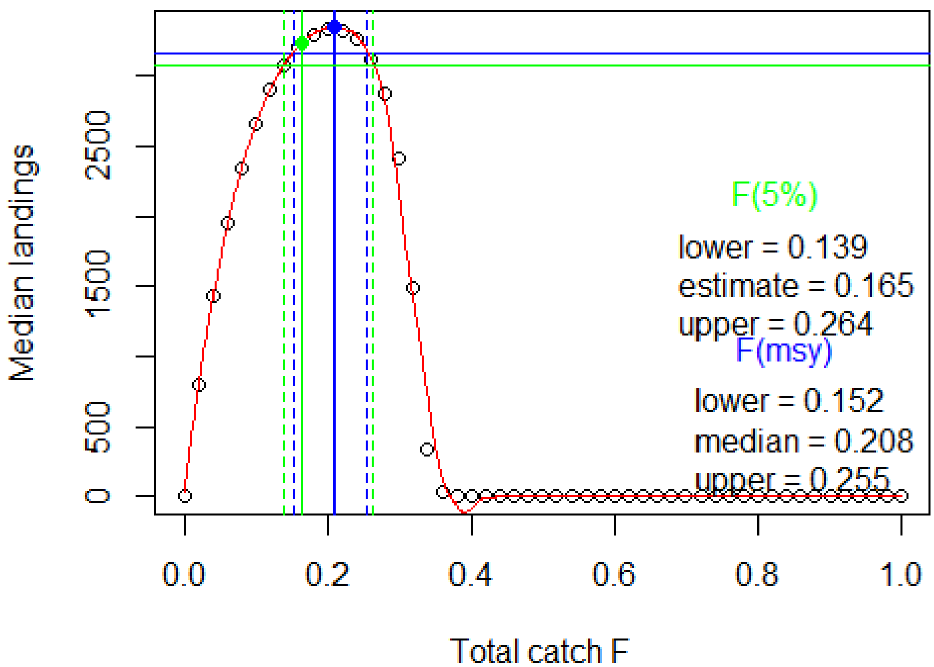


Figure 11: Whiting 6.a. Median landings yield curve with estimated reference points (without Btrigger or error). Blue lines: FMSY estimate (solid) and range at 95 % of maximum yield (dotted). Green lines: FP.05 estimate (solid) and range at 95 % yield implied by FP.05 (dotted).

```
dev.copy(png,file=paste(rname,".med.land.png",sep=""), width=600, height=400)

## png
##   3

dev.off()

## png
##   2

eqsim_plot_range(stk.res$sim,type="ssb")
```

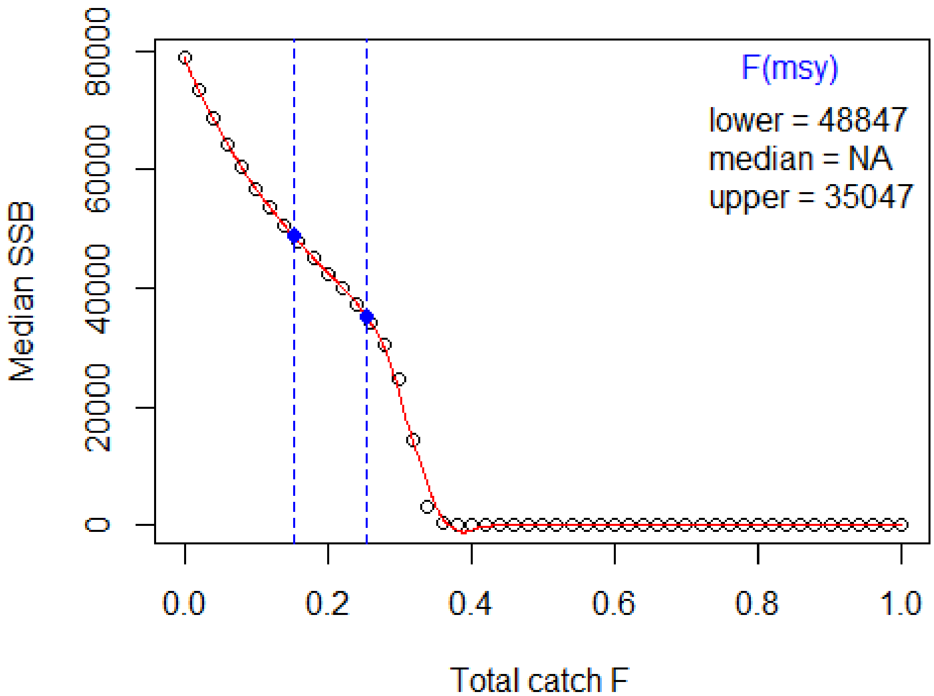
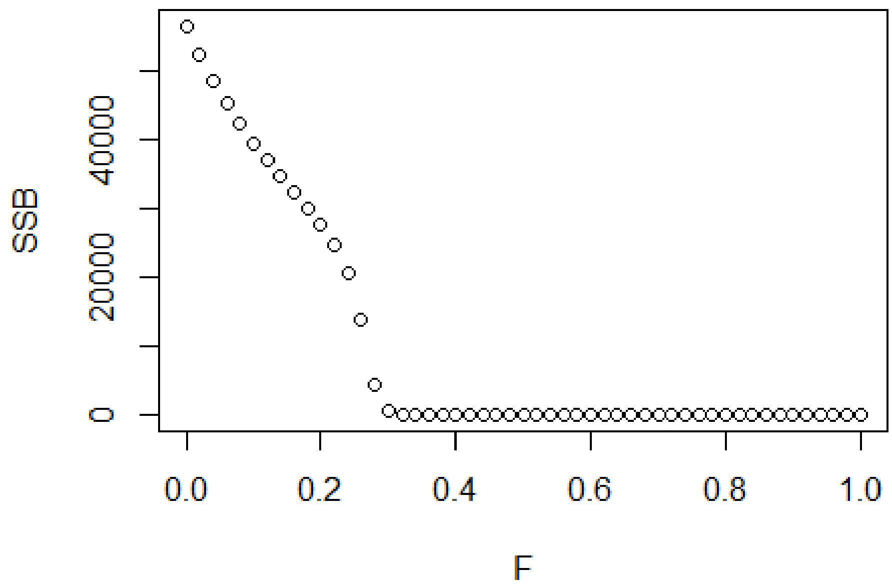


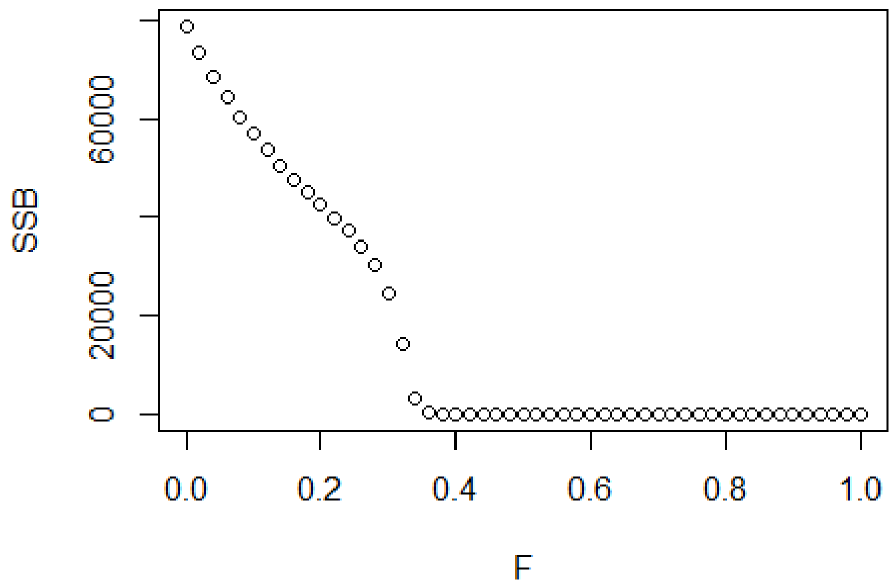
Figure 12: Whiting 6.a. Median SSB curve over a range of targer F values (without Btrigger or error). Blue lines: FMSY estimate (solid) and range at 95 % of maximum yield(dotted).

```
dev.copy(png,file=paste(rname,".med.ssb.png",sep=""), width=600, height=400)

## png
##   3

dev.off()

## png
##   2

Btrig <-get.btrigger(stk.res$sim,med.FMSY.no.Btrigger)
```



If Btrigger is estimated to be less than Bpa then the Btrigger for use in the ICES advice rule is set at Bpa. This run was also used to calculate Flim as the equilibrium F that gives a 50 % probability that SSB>Blim and Fpa is defined as Flim/1.4. The results are shown below.

```
Btrig.AR <-max(Btrig,1.4*tsa.brk.pt)

Flim <-get.flim(stk.res$sim,tsa.brk.pt) #

## Warning in simpleLoess(y, x, w, span, degree, parametric, drop.square,
## normalize, : at -394.07

## Warning in simpleLoess(y, x, w, span, degree, parametric, drop.square,
## normalize, : radius 1.5529e+005

## Warning in simpleLoess(y, x, w, span, degree, parametric, drop.square,
## normalize, : all data on boundary of neighborhood. make span bigger

## Warning in simpleLoess(y, x, w, span, degree, parametric, drop.square,
## normalize, : pseudoinverse used at -394.07

## Warning in simpleLoess(y, x, w, span, degree, parametric, drop.square,
## normalize, : neighborhood radius 394.07

## Warning in simpleLoess(y, x, w, span, degree, parametric, drop.square,
## normalize, : reciprocal condition number 1
```




```
print(list(MSY.Btrigger=Btrig,MSY.Btrigger.AR=Btrig.AR,Flim=Flim,Fpa=Flim/1.4
))
```

```
## $MSY.Btrigger
## [1] 27397.8
##
## $MSY.Btrigger.AR
## [1] 44632
##
## $Flim
## [1] 0.2712956
##
## $Fpa
## [1] 0.1937826
```

Run3

The final run uses both the advice error plus Btrigger to calculate the FMSY values under the ICES advice rule.

```
rname <-"run.with.error.and.Btrigger"
fixed.brk.pt <-tsa.brk.pt
segreg3  <- function(ab, ssb){
  log(ifelse(ssb >= fixed.brk.pt, ab$a * fixed.brk.pt, ab$a * ssb))
}

stk.indat <-list(data=stk,
```

```
                 bio.yrs <-b.yrs,
                 sel.yrs <-s.yrs,
                 Fscan <-seq(0,1.0,by=0.02),
                 Fcv=err.cv,
                 Fphi=err.phi,
                 Blim=tsa.brk.pt,
                 Bpa=1.4*tsa.brk.pt,
                 Btrigger=Btrig.AR)

stk.res <-within(stk.indat,
{
  fit <-eqsr_fit(data,nsamp=1000,models="segreg3")
  sim <-eqsim_run(fit,bio.years=bio.yrs,sel.years=sel.yrs,
                  Fscan = Fscan, Fcv = Fcv, Fphi = Fphi,
                  Blim=Blim, Bpa=Bpa,Btrigger=Btrigger,verbose=FALSE
                  )
})
save(stk.res,file=paste(rname,".results.rdata",sep=""))
write.csv(t(stk.res$sim$Refs2),file=paste(rname,".summary.csv",sep=""))

knitr::kable(stk.res$sim$Refs2,digits=2,row.names=TRUE)
```

	F05	F10	F50	median MSY	mean MSY	Medlo wer	Meanlo wer	Medup per	Meanup per
catF	0.18	0.22	0.38	NA	0.34	NA	NA	NA	NA
lanF	NA	NA	NA	0.23	0.26	0.16	0.17	0.34	0.36
catch	7586.53	8082.34	8397.78	NA	8549.25	NA	NA	NA	NA
landings	NA	NA	NA	3298.04	3285.78	3131.88	3407.16	3134.19	3408.79
catB	45763.30	42392.91	31878.57	NA	34135.99	NA	NA	NA	NA
lanB	NA	NA	NA	41416.55	39239.41	48697.02	NA	34061.21	NA

```
eqsim_plot(stk.res$sim,catch=FALSE)
```

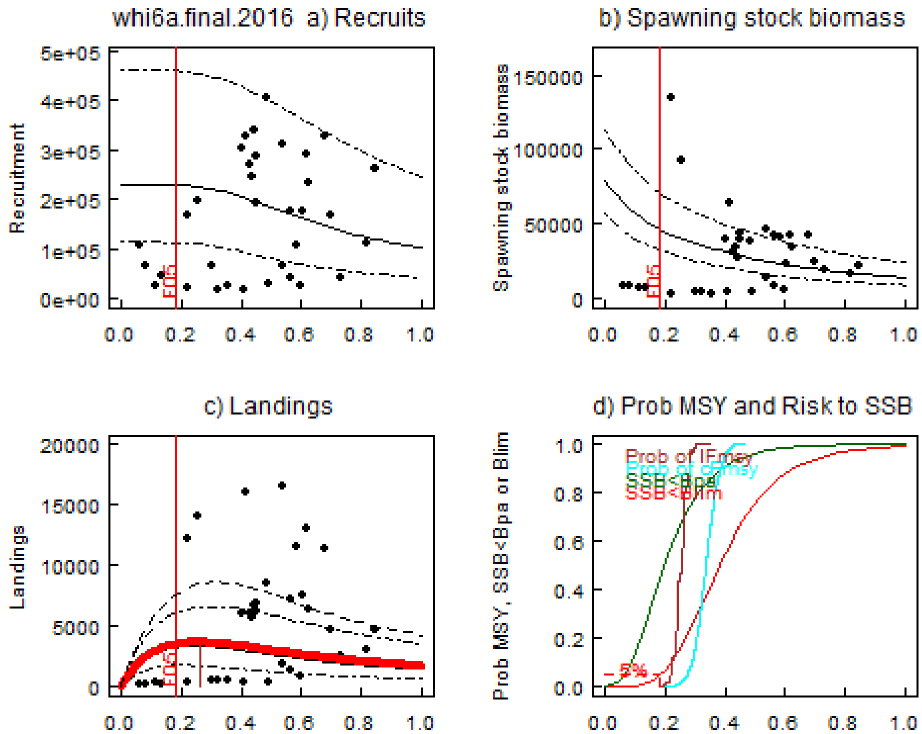


Figure 13: Whiting 6.a.EqSim summary (with Btrigger and error). Panels a-c: Recruitment, SSB & landings at fixed values of F - median plus 90 % intervals and historical values. Panel d shows the probability of SSB<Blim (red), SSB<Bpa (green) and cumulative distribution of FMSY based on yield as landings (brown) and catch (cyan).

```
dev.copy(png,file=paste(rname,".summary.png",sep=""), width=600, height=400)

## png
##   3

dev.off()

## png
##   2

eqsim_plot_range(stk.res$sim,type="median")
```

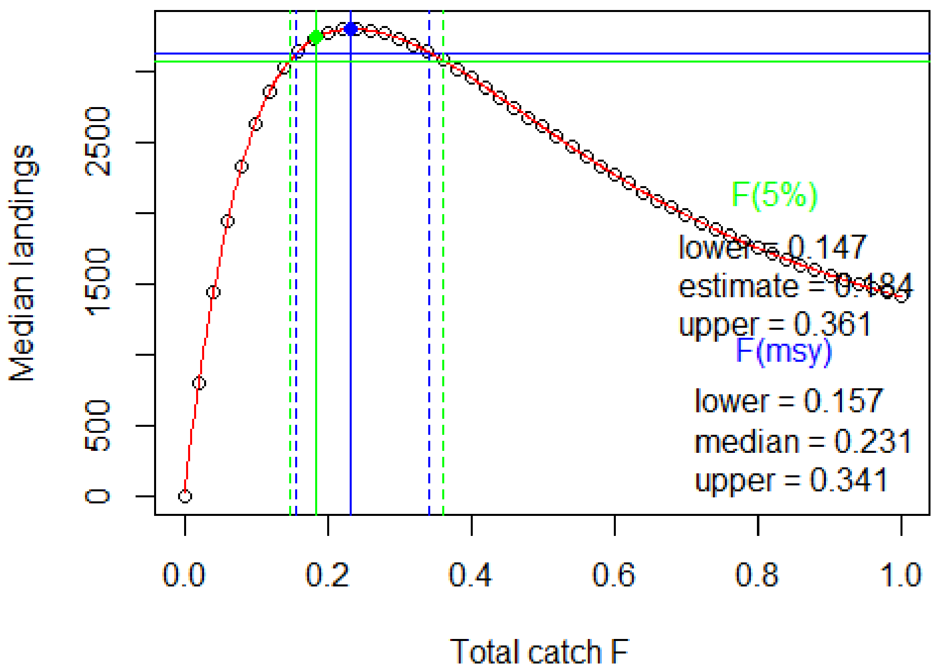


Figure 14: Whiting 6.a. Median landings yield curve with estimated reference points (with Btrigger or error). Blue lines: FMSY estimate (solid) and range at 95 % of maximum yield (dotted). Green lines: FP.05 estimate (solid) and range at 95 % yield implied by FP.05 (dotted).

```
dev.copy(png,file=paste(rname,".med.land.png",sep=""), width=600, height=400)

## png
##   3

dev.off()

## png
##   2

eqsim_plot_range(stk.res$sim,type="ssb")
```

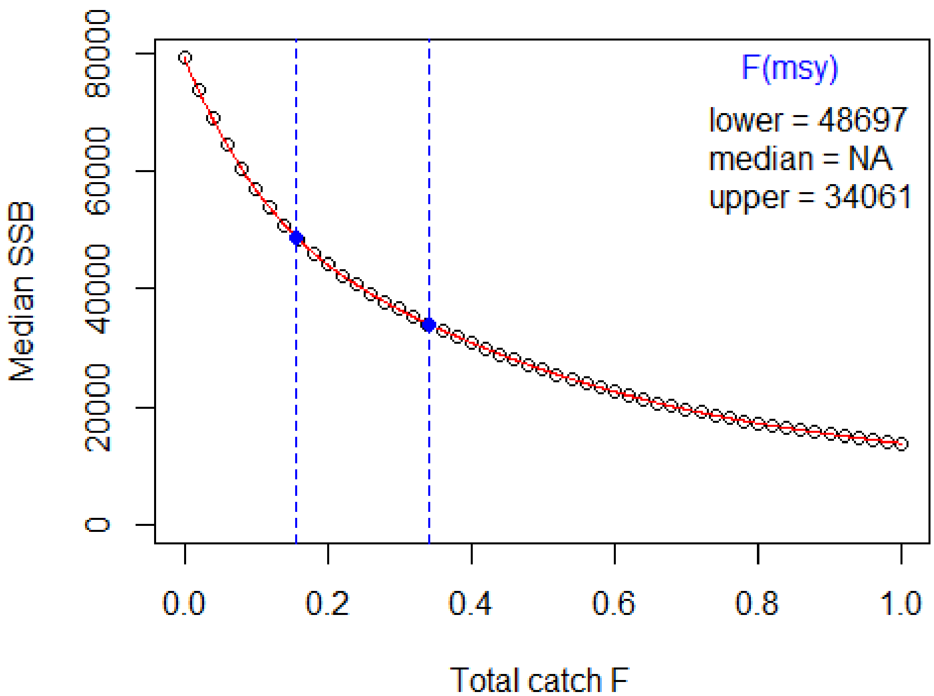


Figure 15: Whiting 6.a. Median SSB curve over a range of targer F values (with Btrigger or error). Blue lines: FMSY estimate (solid) and range at 95 % of maximum yield(dotted).

```
dev.copy(png,file=paste(rname,".med.ssb.png",sep=""), width=600, height=400)

## png
##   3

dev.off()

## png
##   2
```

Stock	WGCSE 2016	WKMSYREF4	
MSY Reference point		Value	Rational
Blim	31880	28500 t	Breakpoint from the stock assessment (TSA) segmented regresstion stock recruitment relationship
Bpa	44632	39900 t	1.4 x Blim
Flim	0.27	0.25	Based on segmented regression simulation of recruitment with Blim as the breakpoint
Fpa	0.19	0.18	Blim/1.4
MSY Reference point		Value	
FMSY without Btrigger	0.20	0.19	
FMSY lower without Btrigger	0.15	0.14	
FMSY upper without Btrigger	0.24	0.22	
MSY Btrigger	44632	39900 t	
$F_{P.05}$ (5% risk to Blim without Btrigger)	0.15	0.14	
FMSY upper precautionary without Btrigger	0.15	0.14	
$F_{P.05}$ (5% risk to Blim with Btrigger (= Bpa)	0.18	0.16	
FMSY with Btrigger(= Bpa)	0.23	0.22	
FMSY lower with Btrigger(=Bpa)	0.16	0.15	
FMSY upper with Btrigger(=Bpa)	0.34	0.32	
FMSY upper precautionary with Btrigger(=Bpa)	0.18	0.16	
MSY	3293	2852 t	
Median SSB at FMSY		36552 t	
Median SSB lower precautionary (median at FMSY upper precautionary)		31970 t	

Median SSB upper (median at FMSY lower)	44429 t

Annex 4: Technical Minutes of the Review Group of Precautionary Approach Reference Points estimation

- RGPA
- 12 May–14 June 2016
- Reviewers: Chris Legault (chair), Arni Magnusson and Colin Millar
- Chair WG: Colm Lordan (Ireland)- Review of ICES WGCSE Report 2016
- Secretariat: Cristina Morgado

General

The Review Group considered estimation of PA reference points for the following stocks:

- Whiting in Division 6.a
- Sea bass in Divisions 4.b–c, 7.a, and 7.d–h

The RG focus was on the PA reference points but in this case also the MSY and the respective MSY ranges were addressed.

Whiting in Division 6.a (report Section 3.4.6)

General comments

According to the advice sheet, B_{lim}=31 900 t and B_{pa}=44 600 t based on the relationship B_{pa}=B_{lim}*1.4 which implicitly assumes σ_B=0.20.

According to the advice sheet, F_{lim}=0.27 based on segmented regression with B_{lim} as breakpoint and F_{pa}=0.19 based on the relationship F_{pa}=F_{lim}/1.4 which implicitly assumes σ_F=0.20.

When using the value 1.4 to derive PA reference points, the underlying logic is an assumption of σ=0.20. For consistency with the guidelines on PA reference points, the value of σ_B and σ_F should be made explicit in the advice sheet along with the equation $B_{pa} = B_{lim} * \exp(1.645\ \sigma_B)$ or $F_{pa} = F_{lim} * \exp(-1.645\ \sigma_F)$.

The F_{MSY} value is defined in the advice sheet as the "upper precautionary with $B_{trigger}$(=B_{pa})", perhaps it could be clearer that F_{MSY} was defined as $F_{p.05}$ to ensure that B > B_{lim} with 95% probability.

Technical comments

	Basis of underlying limit refpt is clear	Right approach to derive PA refpt from limit refpt	PA refpt looks correct	Basis and value of Σ is clear
B_{pa}	OK, B_{lim} is the changepoint in the stock recruitment function (type=2)	Please state the equation $B_{pa}=B_{lim}*\exp(1.645\sigma_B)$ and the value of $\sigma_B=0.20$ in the refpt table of the advice sheet.	Almost, but $B_{lim}*\exp(1.645*0.20)$ will give a slightly different value.	Please state the value of $\sigma_B=0.20$ in the refpt table of the advice sheet.
F_{pa}	Almost, the approach is defined, but the description is insufficient. Is F_{lim} the F that gives a 50% probability of falling below B_{lim} in the long term?	Please state the equation $F_{pa}=F_{lim}*\exp(-1.645\sigma_F)$ and the value of σ_F in the refpt table of the advice sheet.	OK	Please state the value of $\sigma_F=0.20$ in the refpt table of the advice sheet.

Conclusions

2/8 cells in the above matrix are OK. The remaining six should be improved.

Sea bass in Divisions 4.b–c, 7.a and 7.d–h (report Section 10.1)

General comments

According to the advice sheet, B_{lim}=8075 and B_{pa}=12 673. The basis of B_{lim} is B_{loss} and the basis of B_{pa} is $B_{lim}*\exp(1.645\sigma_B)$, where σ_B=0.274.

According to the advice sheet, F_{lim} and F_{pa} are not defined.

According to the advice sheet, MSY $B_{trigger}$=12673 and F_{MSY}=0.13. The basis of MSY $B_{trigger}$ is B_{pa} and the basis of F_{MSY} is a proxy based on $F_{35\%SPR}$.

Technical comments

	Basis of underlying limit refpt is clear	Right approach to derive PA refpt from limit refpt	PA refpt looks correct	Basis and value of Σ is clear
B_{pa}	OK, $B_{lim}=B_{loss}$ (type 5)	OK	OK	OK
F_{pa}	Limit ref pt F_{lim} is not defined.	F_{pa} is not defined.	F_{pa} is not defined.	Value of σ_F is not reported in the advice sheet.

The definition of F_{MSY} in the ICES guidelines is the F that maximizes the long-term yield (using stochastic simulations) while also making sure that $F_{MSY} \leq F_{p.05}$. Since the F_{MSY} specified in the bss-47 advice sheet is based on a proxy $F_{35\%SPR}$ it is not according to the ICES guidelines.

Conclusions

4/8 cells in the above matrix are OK. The remaining four should be improved.

Also, the basis of the F_{MSY} reference point is not according to the ICES guidelines.