ICES WGCSE REPORT 2012

ICES ADVISORY COMMITTEE

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

9–18 May 2012

Copenhagen, Denmark

International Council for the Exploration of the Sea
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 9th–18th May 2012 at ICES Headquarters in Copenhagen. There were 22 participants from six countries (Belgium, France, Ireland, Norway, the Russian Federation and the UK) present at the meeting and an additional six who contributed by correspondence. The WG was also attended by three members of the ICES secretariat (who assisted the WG with their advice drafting tasks) and by a European Commission observer. The meeting was chaired by Helen Dobby (UK) and Joël Vigneau (France).

In total the WG provided assessments and draft advice for 37 demersal fish and *Nephrops* stocks across ICES Subareas VI and VII (with the distribution of megrim extending into Division IVa and anglerfish into Subarea IV and Division IIIa). This includes four cod, haddock and whiting stocks, five sole and plaice stocks, two megrim stocks, one anglerfish, ten *Nephrops* stocks, one of pollock and one of grey gurnard which was a new addition to the WG this year.

Seven stocks within the remit of the WG went through the benchmarking process in 2012 and one through an Inter-benchmark Protocol. Of these, analytical assessments were agreed for cod-scow, cod-7e–k, had-7b–k, meg-46a, sol-echw and whi-scow. An interim assessment was agreed for cod-iris (while further work is being carried out) to be used to provide advice on stock status and total mortality. Little progress was made on ang-46.

For those stocks with an agreed full analytical assessment, an update assessment was carried out according to the stock annex (with some deviations detailed in the stock sections). For some of the more data limited stocks (without agreed approaches) a more exploratory approach was taken often using new methods, and the WG presented the results of these investigations. The type of final assessments presented at the WG are summarised as follows:

- Full analytical age-based assessments and forecasts were conducted for cod-scow, had-scow, whi-scow, had-rock, cod-7e–k, had-7b–k, whi-7e–k, sol-iris, sol-celt, sol-echw, ple-echw;
- Bayesian surplus production model for meg-46a;
- Catch-at-age based assessments with caveats i.e. used for trends only/without forecasts for cod-iris, ple-iris, ple-celt;
- Assessments based on survey data were presented for ang-46, meg-rock, had-iris, whi-iris;
- The UWTV survey approach was used for nep-11, nep-12, nep-13, nep-14, nep-15, nep-17, nep-19 and nep-22;
- The *Nephrops* data limited approach was applied to nep-20–21;
- Analysis of catch data only was presented for pol-celt, nep-16, ple-7bc, sol-7bc (DCAC), sol-7h–k, ple-7h–k (catch curves);
- No assessments were carried out for cod-rock, gug-celt, whi-rock.

The WGs conclusions on stock status across the ecoregion were mixed. With the exception of had-scow and had-iris, the outlook for gadoids in the northern part of the Celtic Seas ecoregion is assessed as being extremely poor with many stocks suffering a series of particularly low recruitments. In addition, the mortality of both cod-scow and cod-iris shows little sign of significant decline. In contrast the northern *Nephrops* stocks are at relatively high levels and are being fished sustainably (or only slightly above sustainable levels). The assessment of megrim in Divisions IVa and VIa showed that the stock is exploited well below F_{MSY} and has a biomass well above $B_{trigger}$. Northern Shelf anglerfish stock has declined and uncertainties in catch data and general biological parameters still prevent the estimation of exploitation rate.

Further south in the Celtic Sea and West of Ireland areas, the biomass of gadoid stocks has increased substantially in recent years following some high or moderate recruitments. Cod and whiting are assessed as being fished at or below F_{MSY} while the exploitation rate of haddock is still above this level. The *Nephrops* stocks in this area which are assessed using the UWTV survey method appear at stable levels and are fished at harvest rates below the F_{MSY} proxy. Although nep-16 remains a data limited stock, there was sufficient information available to the WG to conclude that stock biomass has increased from the very low levels of a number of years ago following recent good recruitment and a reduction in exploitation rate.

Three of the four major sole stocks in the region are assessed as being exploited at or below F_{MSY}. The exception is Irish Sea sole which has also seen a continuous decline in biomass over the last decade following a series of low recruitments and F remaining above the precautionary value.

Plaice in the Irish Sea are estimated to be fished below possible reference points and have a biomass above possible reference points (no quantitative estimates). The other major plaice stocks assessed by the WG are all fished at rates above F_{MSY}. Despite this, a single particularly high year class has meant that plaice in the western Channel have recovered from the lowest observed SSB to near the highest abundance in 2011. The assessment of plaice stocks is typically more uncertain that those for sole due the lack of precise discard data which represents a substantial component of the catch and only plaice in the western Channel have a full analytical assessment.

1.1 General

1.2 Terms of reference

2011/2/ACOM12 The **Working Group for the Celtic Seas Ecoregion** (WGCSE), chaired by Joel Vigneau (France) and Helen Dobby, UK, will meet at ICES Headquarters, 9–18 May 2012 to:

a) Address generic ToRs for Fish Stock Assessment Working Groups (see table below);

b) Assess the progress on the benchmark preparation of haddock and whiting in Division VIa and plaice in Divison VIIa.

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

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

WGCSE will report by 28 May 2012 for the attention of ACOM.

Fish Stock	Stock Name	Stock Coord.	Assessment Coord. 1	Assessment Coord. 2	Advice
ang-ivvi	Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Division IIa, IIIa, Subarea IV, VI	UK (Scotland)	UK (Scotland)	Denmark, Norway	Update

Fish Stock	Stock Name	Stock Coord.	Assessment Coord. 1	Assessment Coord. 2	Advice
cod-iris	Cod in Division VIIa (Irish Sea)	UK (England)	UK (England)		Update
cod-rock	Cod in Division VIb (Rockall)	UK (Scotland)	UK (Scotland)		Update
cod-scow	Cod in Division VIa (West of Scotland)	UK (Scotland)	UK (Scotland)		Update
cod VIIe–k	Cod in Division VIIe–k (Celtic Sea)	France	France	Ireland	Update
gug-celt	Grey gurnard in Subarea VI and Divisions VIIa–c and e–k (Celtic Sea and West of Scotland)				Regional update
had-7b–k	Haddock in Divisions VIIb–k	Ireland	Ireland	France	Update
had-iris	Haddock in Division VIIa (Irish Sea)	UK (Scotland)	UK (Scotland)		Update
had-rock	Haddock in Division VIb (Rockall)	Russia	Russia	UK (Scotland)	Update
had-scow	Haddock in Division VIa (West of Scotland)	UK (Scotland)	UK (Scotland)		Update
meg-scrk	Megrim (*Lepidorhombus* spp) in Subarea VI (West of Scotland and Rockall) and Subarea IV (North Sea)	Ireland	Ireland	UK (Scotland)	Update
nep-11	*Nephrops* in Division VIa (North Minch, FU11)	UK (Scotland)	UK (Scotland)		Update
nep-12	*Nephrops* in Division VIa (South Minch, FU12)	UK (Scotland)	UK (Scotland)		Update
nep-13	*Nephrops* in Division VIa (Firth of Clyde and Sound of Jura, FU13)	UK (Scotland)	UK (Scotland)		Update
nep-14	*Nephrops* in Division VIIa (Irish Sea East, FU14)	UK (England)			Update
nep-15	*Nephrops* in Division VIIa (Irish Sea West, FU15)	UK (Northern Ireland)	UK (Northern Ireland)	Ireland	Update
nep-16	*Nephrops* in Division VIIb,c,j,k (Porcupine Bank, FU16)	Ireland	Ireland		Biennial 1st year
nep-17	*Nephrops* in Division VIIb (Aran Grounds, FU17)	Ireland	Ireland		Update
nep-19	*Nephrops* in Division VIIa,g,j (South East and West of IRL, FU19)	Ireland	Ireland		Biennial 1st year
nep-20–22	*Nephrops* in Divisions VIIfgh (Celtic Sea, FU 20–22)	France	France	Ireland	Update
ple-7b–c	Plaice in Division VIIb,c (West of Ireland)	Ireland			Update
ple-7h–k	Plaice in Divisions VIIh,k (Southwest of Ireland)	Ireland	Ireland	Belgium	Update
ple-celt	Plaice in Divisions VIIf,g (Celtic Sea)	UK (England)	UK (England)	Belgium	Update
ple-echw	Plaice in Division VIIe (Western Channel)	UK (England)	UK (England)	France	Update
ple-iris	Plaice in Division VIIa (Irish Sea)	UK (England)	UK (England)		Update

Fish Stock	Stock Name	Stock Coord.	Assessment Coord. 1	Assessment Coord. 2	Advice
pol-celt	Pollack in Subareas VI and VII (Celtic Sea and West of Scotland)				Regional update
sol-7b–c	Sole in Division VIIb, c (West of Ireland)	Ireland			Update
sol-7h–k	Sole in Divisions VIIh–k (Southwest of Ireland)	Ireland			Update
sol-celt	Sole in Divisions VIIf,g (Celtic Sea)	Belgium	Belgium	UK (England)	Update
sol-echw	Sole in Division VIIe (Western Channel)	UK (England)	UK (England)	France	Update
sol-iris	Sole in Division VIIa (Irish Sea)	Belgium	Belgium		Update
whg-7e–k	Whiting in Divisions VIIe–k	Ireland	Ireland	France	Update
whg-iris	Whiting in Division VIIa (Irish Sea)	Ireland	Ireland	UK (Northern Ireland)	Update
whg-rock	Whiting in Division VIb (Rockall)	Ireland			Update
whg-scow	Whiting in Division VIa (West of Scotland)	UK (Scotland)	UK (Scotland)		Update

1.3 Overview sections

The overviews sections have been missing from the WGCSE report since 2009, as a consequence of an overloaded working group focusing exclusively on stock assessment and preparation of advice. The group is willing to resume reporting on overviews if these are not simply a summary of information contained in the stock sections, but an added value to the single-stock analysis. It is also considered that it would be an ineffective use of time for assessment experts to be required to provide information on topics outside their competence area (mainly biology and modelling). Conversely, assessment experts may interpret other fields of expertise and put the findings in relation with their knowledge and current analysis. In order to draft overviews according to these ideas, the group proposed to divide the overview sections as follows:

- Subsection on ecosystem, using indicators and comments from ICES ecosystem expert groups (WGECO …);
- Subsection on changes in fishing technology and fishing patterns, using the conclusions of the ICES WGFTFB;
- Subsection on fisheries to be drafted by WGCSE, including, spatial distribution of fisheries, mixed fisheries considerations, integrated indicators (effort, …) and surveys;
- Subsection on regulations and their effects to be drafted by WGCSE.

The group believes that the overview sections deserve a special attention and would benefit from confronting broader views. Therefore, the group would welcome a dedicated workshop to share its proposal with other opinions.

1.4 General considerations

It is long known that assessing 37 stocks in an assessment working group is a difficult challenge, and solutions are sought to decrease the workload. Reading the working group report could lead to thinking that the challenge was successfully addressed in 2012. This has been done, thanks to the high commitment of the experts participating in the group. However the quantity of analysis was achieved only at the expense of thorough internal reviews, likely resulting in poorer quality assessments.

The challenge is also to address the extending demands of advice with dwindling resources in the European fisheries institutes, and the need to make room for new inexperienced experts in assessment working groups (rotating the assessments between experts, thorough reviews …). This cannot be achieved by splitting the group in smaller units as this would likely lead to a diluting of expertise, or by expanding the use of work by correspondence. Additionally, the unconditional need for a normal preparation of the working group is to have the data compiled and sent to stock coordinators well in advance of the working group (see also Section 2 on data).

The WGCSE is of the opinion that the ecoregion entity must remain, and that other means to address the overload must be implemented. WGCSE has proposed for each of the stocks a duration of the advice, when drafting the advice summary sheet, choosing to start with a two-year period. In line with the conclusions of WKFREQ (ICES, 2012) the stocks concerned with a biennial advice were those where the status is unlikely to change in the very near future. These include stocks where current F and SSB are far from the MSY reference estimates, and stocks for which it is unlikely that more information will be available in the near future (data poor). For the WGCSE to gain time and expertise for focusing on more demanding stocks the group **recommends that ICES details the specific procedure to deal with stocks where no new advice will be proposed and draft terms of references accordingly**.

Work by correspondence has led to difficulties in exchanging views between the group and the remote expert. Lessons should be learnt from this experience, and **the group recommends that each expert participating by correspondence should be represented by one expert in the group** who is able to present the assessment and answer questions and has final responsibility for ensuring that the report and draft advice are available at the WG.

Assessment and advice for the new stocks (pollack and grey gurnard in 2012) are challenging. These assessments are meant to be prepared by WGNEW before being transferred to ecoregion working group. WGCSE tried to provide additional value to the WGNEW advices, but discovered that the main sources of information for these stocks were not fully utilised. These are, not exclusively, lpue series and maps of international effort and catches for pollack, survey indexes from the whole area and quantified discards information for grey gurnards. **The group recommends that a stock coordinator and a stock assessor be formally named to WGCSE for pollack**. For grey gurnards and all other bycatch species, **the group recommends WGISDAA to compile and process data from merged surveys, and ICES to propose simplified method to evaluate the status of stocks caught as bycatch and heavily discarded, by means of e.g. standard indicators**.

2 Data and methods

2.1 Data tables

As requested by ICES in recent years, this year the WG stock coordinators were asked to fill Data Tables concerning data transmitted to the WG for assessment purposes. These tables have been filled during the WG meeting and are available on the WGCSE 2012 SharePoint site, under the "Data Tables" folder.

2.2 Biological sampling

Table 2.1. Biological sampling levels by stock and country.

		Cod					Whiting				Nephrops										Plaice					Sole					Haddock				Megrim		Anglerfish			
		VIa	VIb	VIIa	VIIb,c	VIIe–k	VIIb,c	VIIe–k	VIa	VIIa	FU11	FU12	FU13	FU14	FU15	FU16	FU17	FU19	FU 20-22	VIIa	VIIb,c	VIIe	VIIf,g	VII h-k	VIIa	VIIb,c	VIIe	VIIf,g	VII h-k	VIIb–k	VIa	VIb	VIIa	VIa	VIb	IIa	IVa & IIIa	VIa	VIb
Belgium	No. lengths (landings)			622		631		5,590		663										17,288		2,395	2,516		22,747		3,376	21,323		3,394			1,497				337		
	No. ages (landings)			401		422		750		249										772		0	390		1,327		0	830		799			282						
	No. samples (landings)*			6		17		17		6										9		4	17		9		4	17		17			6				8		
	No. lengths (discards)			1,733		2,489		14,141		15,260										39,110		642	3,920		4,414		5	2,736		25,659			6,245				6		
	No. ages (discards)			606		732		694		403										400		83	360		143		4	183		850			421						
	No. samples (discards)**			6		17		17		6										9		4	13		9		4	13		17			6				8		
E & W (UK)	No. lengths (landings)			305		6,426		5,125		0										3,522		16,281	2,615	1,831	1,136		13,601	6,809	4,603	6,627			0				0		
	No. ages (landings)			115		1,214		654		0										602		1,881	804	0	357		1,480	1,183	555	630			0				0		
	No. samples (landings)*			8		193		102		0										24		119	26	14	20		109	31	30	82			0				0		
	No. lengths (discards)			0		2,886		7,248		199										1,476		7,947	7,122	29	1		717	308	5	8,221			3				12		
	No. ages (discards)			0		48		69		27										51		184	49	0	0		1	1	1	98			0				0		
	No. samples (discards)**			13		979		979		13										13		566	182	231	13		566	182	231	979			7				57		
Northern Ireland	No. lengths (landings)																																						
	No. ages (landings)																																						
	No. samples (landings)*																																						
	No. lengths (discards)																																						
	No. ages (discards)																																						
	No. samples (discards)**																																						
France	No. lengths (landings)					5,850		4,233											8,636			774	328				1,739	1,007	189	9,909									
	No. ages (landings)					1,034		1,148											0			0	0				477	0	0	1,142									
	No. samples (landings)*					331		105											56			98	14				132	12	11	288									
	No. lengths (discards)					289		1,982														60	22				23	17	0	3,412									
	No. ages (discards)					0		0														0	0				0	0		0									
	No. samples (discards)**					118		63														129	6				129	8	0	200									
Spain	No. lengths (landings)																																						
	No. ages (landings)																																						
	No. samples (landings)*																																						
	No. lengths (discards)																																						
	No. ages (discards)																																						
	No. samples (discards)**																																						

Table 2.1. Continued.

Ireland	No. lengths (landings)	1,096	10	3,303	54	7,570	2,555	10,370	5070	873						6,783				2,861	378		3,253	1,905	2,075	808		2,861	2,307	17,725	7,229	1,963	1,442	11,650				4,019	
	No. ages (landings)	1,004	0	2,038	0	2,504	943	2,093	1115	156										1,088	0		1,050	963	825	486		1,092	977	3,191	1,915	423	1,397	1,132				450	
	No. samples (landings)*	19	2	46	9	102	26	80	20	7						1				27	10		39	27	30	14		44	30	111	26	3	27	32				46	
	No. lengths (discards)	21		178	6	1,463	1,580	5,436	808	8,737					14,002		14,811		10,278	3,345	118		653	154	5	4		14	1	23,023	2,437		2,943	418	362			331	219
	No. ages (discards)	16		33	0	306	145	378	121	395										402	49		119	56	1					714	181		361	108	34			97	37
	No. samples (discards)**	234		483	192	690	192	690	234	483					22		21		31	483	192		379	311	483	192		379	311	882	234		483	234				234	
	No. lengths (catches)														11,787		17,125	7,864	10,968																				
	No. ages (catches)																																						
	No. samples (catches)														23		23	15	34																				
UK Scotland	No. lengths (landings)	158							1,437		36,497	34,389	30,664																		4,518	1,964		1,222	combined with V		8,290	2,943	combined with VIa
	No. ages (landings)	123							224																						455	250		132	combined with V		771	298	combined with VIa
	No. samples (landings)*	12							15		58	54	31																		21	7		6	combined with V		147	22	combined with VIa
	No. lengths (discards)	892							1,837		2,441	2,258	4,594																		2,973	43		2,307	combined with V		1	0	combined with VIa
	No. ages (discards)	551							278																						363	22		0	combined with V		0	0	combined with VIa
	No. samples (discards)**	15 trips							12 trips		14	16	23																		14 trips	3 trips		21 trips	combined with V		41 trips	21 trips	combined with VIa
Norway	No. lengths (landings)																																			2,580	957		
	No. ages (landings)																																						
	No. samples (landings)*																																			316	156		
	No. lengths (discards)																																						
	No. ages (discards)																																						
	No. samples (discards)**																																						
Russian Federatio	No. lengths (landings)																																						
	No. ages (landings)																																						
	No. samples (landings)*																																						
	No. lengths (discards)																																						
	No. ages (discards)																																						
	No. samples (discards)**																																						
Denmark	No. lengths (landings)																																						
	No. ages (landings)																																						
	No. samples (landings)*																																						
	No. lengths (discards)																																						
	No. ages (discards)																																						
	No. samples (discards)**																																						

* Number of vessels sampled
** Number of hauls sampled

2.3 Survey information

Survey	WG name	DCF name
EVHOE Groundfish Survey	EVHOE-WIBTS-Q4	IBTS Q4
Irish groundfish survey-Q4	IGFS-WIBTS-Q4	IBTS Q4
Joint science/industry survey anglerfish megrim Scottish survey	SAMISS-Q2	
Joint science/industry survey Irish anglefish survey	IAMISS-Q2	
Quarter 1 South West Beam Trawl Survey	Q1SWBeam	
Rockall haddock survey	ROCK-IBTS-Q3	
Scottish west coast groundfish survey - 1Q	ScoGFS-WIBTS-Q1	IBTS Q1
Scottish west coast groundfish survey – 1Q (2011 onwards)	UKSGFS-WIBTS-Q1	IBTS Q1
Scottish west coast groundfish survey - 4Q	ScoGFS-WIBTS-Q4	IBTS Q4
Scottish west coast groundfish survey – 4Q (2011 onwards)	UKSGFS-WIBTS-Q4	IBTS Q4
Spanish Porcupine groundfish survey	SpPGFS-WIBTS-Q4	IBTS Q4
UK (England and Wales) beam trawl survey - 3Q	UK (E&W)-BTS-Q3	ISBCBTS
UK (Northern Ireland) groundfish survey - March	NIGFS-WIBTS-Q1	IBTS Q1
UK (Northern Ireland) groundfish survey - October	NIGFS-WIBTS-Q4	IBTS Q4
UK (Northern Ireland) Methot-Isaacs–Kidd survey	NIMIK	
UK (Northern Ireland) Nephrops trawl survey - Summer	NI-NEP-Trawl-Summer	
UK Fishery Science Partnership western Irish Sea pelagic trawl survey		
Underwater TV survey	UWTV (FU 11–13)	UWTV (FU 11-13)
Underwater TV survey	UWTV (FU 14 & 15)	UWTV (FU 15)
Underwater TV survey	UWTV (FU 17)	UWTV (FU 17)
Underwater TV survey	UWTV (FU 20–22)	UWTV (FU 20-2
Western Channel Plaice and Sole Fisheries Science Partnership	FSP-7e (UK-FSP)	
Western English Channel beam trawl survey	UK-WEC-BTS	VIIe BTS

2.4 InterCatch

The InterCatch database has historically not been widely used by the WGCSE, and the table below shows little improvement in 2012. Some institutes expressed irritation about the time needed to upload and modify entries in the database, and were not willing to reiterate the process as long as step changes were made to the web service.

During the WG, WGNSSK kindly shared their experience and proposals for improvement with WGCSE. In view of using InterCatch for the mixed fisheries analysis, ICES WGNSSK adopted the principle of joined data call for WGMIXFISH and WGNSSK, in order to define the minimum aggregation (metier) level that individual countries could deliver, and ICES InterCatch was chosen as the most appropriate tool to use. All details of the process followed and proposals made by WGNSSK can be found in their 2012 report in Section 1.2 (ICES WGNSSK, 2012). ICES InterCatch leader committed to work on these proposals so that a renewed service is proposed in 2013. **WGCSE fully supports the recommendations made by WGNSSK, and is also willing to launch a full scale data call in preparation of the 2013 meeting**. During its August 2012 meeting, WGMIXFISH will consider West of Scotland fisheries in their analysis and define relevant métier aggregation. These métiers will then serve as the basis for the 2013 WGCSE data call. Based on the WGNSSK experience and WGMIXFISH findings, the WGCSE chairs will propose a detailed draft of a data call to be approved by correspondence by the WGCSE participants.

2.4.1 Acceptance test and status of the use of InterCatch

All stock coordinators should make sure that catch data are imported into InterCatch and use InterCatch, following the Generic Terms of Reference. InterCatch is the standardised documentation system for stock assessment expert groups and a part of the ICES Quality Assurance Program. Therefore it is suggested that stock coordinators request national data submitters to import catch data into InterCatch over the internet in the InterCatch format to ease the stock coordinators work. All stock coordinators should fill in the table below, to give a status of the use of InterCatch, also if the table was filled in last year. If stock coordinators have not used, tested and compared the output from InterCatch with the so far used system, it is suggested that it is done this year. If InterCatch outputs were compared last year the 'Comparison made previous year' can be selected in the 'Discrepancy'-column, but the 'Acceptance test'-column should still be filled in. Stock coordinators should verify that InterCatch fulfils the needs of their stocks and gives the expected output. Hereby the stock coordinator can also approve InterCatch as the system, which can be use in the future.

Table of Use and Acceptance of InterCatch.

Stock code for each stock of the expert group	InterCatch used as the: 'Only tool' 'In parallel with another tool' 'Partly used' 'Not used'	If InterCatch have not been used what is the reason? Is there a reason why InterCatch cannot be used? Please specify it shortly. For a more detailed description please write it in the 'The use of InterCatch' section.	Discrepancy between output from InterCatch and the so far used tool: Non or insignificant Small and acceptable significant and not acceptable Comparison not made Comparison made previous year	Acceptance test. InterCatch has been fully tested with at full data set, and the discrepancy between the output from InterCatch and the so far used system is acceptable. Therefore InterCatch can be used in the future.
Cod-scow	In parallel with another tool	InterCatch was used	Non or insignificant	Can be used
Sol-iris	Not used	InterCatch was not used, as it is not possible to make a combined age distribution from the raw data. Furthermore, there is no option to upload a combined age distribution as "international" because an international code is not available. Moreover, also codes for e.g. Isle of Man are not available.	Non or insignificant	Cannot be used
Sol-celt	Not used	Last year it was used and proved to be suitable. This year not used due to no upload by all countries	Non or insignificant	Can be used
Had7b–k	Partly used	Landings data were uploaded, but intercatch was not used to extract data because the number of required allocation rules is very high, making it impractical to use.	Comparison made previous year	Could be used
Ple7h–k	Partly used	Assessment is based on Irish CNAA only, so the only purpose is documentation of the data	Comparison not made	Not relevant

Sol7h–k	Partly used	Assessment is based on Irish CNAA only, so the only purpose is documentation of the data	Comparison not made	Not relevant
Sol-Echw	Not used	Few national datasets were uploaded to Intercatch by stock co-ordinators.	Comparison not made, but 2009 and earlier years were Non or insignificant	Can be used
Ple-Echw	Not used	Few national datasets were uploaded to Intercatch by stock co-ordinators.	Comparison not made, but 2009 and earlier years were Non or insignificant	Can be used
Ple-Celt	Not used	Few national datasets were uploaded to Intercatch by stock co-ordinators.	Comparison not made, but 2009 and earlier years were Non or insignificant	Can be used to international landings level – discards estimates are now included in the assessment and this may be problematic.
Ple-Iris	Not used	Few national datasets were uploaded to Intercatch by stock co-ordinators.	Comparison not made, but 2009 and earlier years were Non or insignificant	Can be used to international landings level – discards estimates are now included in the assessment and this may be problematic.
Cod-Iris	Not used	Few national datasets were uploaded to Intercatch by stock co-ordinators.	Comparison not made, but 2009 and earlier years were Non or insignificant	Can be used
Ang-ivvi	Partly used	Few national datasets were uploaded to Intercatch	Comparison not made.	Can be used
NEP FU14	Partly used	InterCatch was used	Non or insignificant	Can be used
NEP FU11	In parallel with another tool	InterCatch was used	Non or insignificant	Can be used
NEP FU12	In parallel with another tool	InterCatch was used	Non or insignificant	Can be used
NEP FU13	In parallel with another tool	InterCatch was used	Non or insignificant	Can be used
NEP FU15	Partly used	Not all data uploaded	Comparison not made	.
NEP FU16	Partly used	Not all data uploaded	Comparison not made	

NEP FU17	Partly used	Not all data uploaded	Comparison not made
NEP FU19	Partly used	Not all data uploaded	Comparison not made
NEP FU20–21	Partly used	Not all data uploaded	Comparison not made
NEP 22	Partly used	Not all data uploaded	Comparison not made

2.5 Working Documents

The following working documents were submitted to WGCSE in 2012 and are cited in particular stock sections. A short summary of each working document can be found in Annex 3 to this report.

WD01 Fisheries Science Partnership 2011. Final report Programme 8: Western Channel Sole and Plaice. Robert Bush and Rob Phillips, Cefas, UK.

WD02 A potential assessment method for Northern Shelf megrim (*Lepidorhombus whiffiagonis*) ICES Divisions Via–IVa using a Bayesian state–space biomass dynamic model; post review. Norman Graham, Marine Institute, Ireland.

WD03 Maturity-at-age estimates for Irish Demersal Stocks in VIa and VIIabgj 2004–2011. Hans Gerritsen (Marine Institute, Ireland).

WD04 Western Irish Sea *Nephrops* Grounds (FU15) 2011 UWTV Survey Report. Colm Lordan, Matthew Service, Jennifer Doyle (Marine Institute, Ireland) and Ross Fiztgerald (AFBI, N Ireland).

WD05 Aran, Galway Bay and Slyne Head *Nephrops* Grounds (FU17) 2011 UWTV Survey Report. Colm Lordan, Jennifer Doyle, Robert Bunn, Dermot Fee, and Chris Allsop (Marine Institute, Ireland).

WD06 Celtic Sea *Nephrops* Grounds 2011 UWTV Survey Report. Jennifer Doyle, Colm Lordan, Ross Fitzgerald, Sean O'Connor, Dermot Fee, Cormac Nolan and Joan Hayes (Marine Institute, Ireland).

WD07 Re-examination of the Western Channel Plaice Reference Points following a change in the perceived stock recruitment relationships. Sven Kupschus, Ian Holmes, Cefas, UK.

WD08 Trawl survey based assessment of haddock (*Melanogrammus aeglefinus*) at Rockall. Khlivnoy V.N., Gavrilik T.N. (PINRO, Russia).

WD09 FU19 *Nephrops* Grounds 2011 UWTV Survey Report. Colm Lordan, Matthew Service, Jennifer Doyle (Marine Institute, Ireland) and Ross Fiztgerald (AFBI, N Ireland).

2.6 Summary of benchmarks in 2012

In 2012, seven stocks within the remit of WGCSE went through the benchmarking process and one was reviewed through the inter-benchmark protocol (IBP). Of these, six resulted in agreed full analytical assessments, one was considered sufficient for advice provision but still a work in progress and one made little progress. A summary of the outcomes is given here.

Anglerfish (*Lophius* spp) in Division IIIa, Subarea IV and VI (Northern Shelf): Limited progress was made at WKFLAT on this stock. It was agreed that a survey based assessment was a likely way forward. However, given the uncertainties associated with ageing this species, WKFLAT advised that the use of age-structured survey data should be accompanied by thorough sensitivity testing to the age readings and alternative growth assumptions. This year's assessment is again based on trends in survey biomass.

Cod (*Gadus morhua*) in VIIe–k (Celtic Sea): Major revisions of the assessment input data were carried out at WKROUND, leaving only a merged French/Irish bottom trawl survey and a French cpue series as tuning data. Natural mortality was revised according to Lorenzen (1996) which links natural mortality to body weight resulting in higher natural mortalities at younger ages. Both ASAP and XSA were considered suitable assessment methods for this stock, but XSA was preferred due to the greater experience of using XSA within WGCSE.

Cod (*G. morhua*) in VIIa (Irish Sea): WKROUND agreed to use the SAM assessment model which provides robust estimates of unallocated mortality when fitted to noisy survey data. Additional survey-series were used in the assessment including SSB estimates from egg surveys as well as data from the Fisheries Science Partnership roundfish surveys. Although it was agreed that the results of the SAM assessment could be used to give advice on the status of the stock and total mortality, the model still estimates substantial unallocated mortality and until the source of this mortality can be determined WKROUND considered that the assessment should still be viewed as a work in progress.

Cod (*G. morhua*) in VIa (West of Scotland): A modified version of TSA was implemented to estimate underreporting of catches in the period 1995–2005, while still using the age structure of the sampled catches in that period. Natural mortality was revised according to Lorenzen (1996) which links natural mortality to body weight resulting in higher natural mortalities at younger ages. Predation by seals was considered, but it was recommended not to include this source of mortality in the final assessment and instead to provide an additional TSA run incorporating the best available estimate of seal consumption for comparison.

Haddock (*Melanogrammus aeglefinus*) in VIIb–k: The ASAP model was proposed by WKROUND as the main assessment tool (and XSA run in comparison) as it allows for uncertainty in both the catches and age composition and therefore addresses the concern surrounding the uncertainty of the discard estimates for this stock. As for other stocks at WKROUND, natural mortality was revised according to Lorenzen (1996) which links natural mortality to body weight resulting in higher natural mortalities at younger ages. In addition, a combined French/Irish bottom trawl survey index was derived for use as a tuning fleet.

Megrim (*Lepidorhombus whiffiagonis*) in VI and VIa: A Bayesian surplus production model incorporating six surveys covering the full stock area was agreed by IBP-Meg as the final assessment. A full time-series of historical raised discard data is not available for the stock so the final assessment, which assumes a linear trend in discard rate, is accompanied by a sensitivity analysis of this assumption. The model estimates MSY reference points which have been used to define precautionary reference points.

Sole (*Solea solea*) in VIIe (Western English Channel): XSA was retained as the assessment method for this stock. The changes to the previous assessment included splitting a commercial tuning index into two time periods (on the basis of changes in the fishery) and the addition of two new surveys with greater spatial coverage and greater age range. In addition a thorough sensitivity testing was conducted to investigate appropriate XSA settings (such as q-plateau and shrinkage).

Whiting (*Merlangius merlangus*) in VIa (West of Scotland): As in the West of Scotland cod assessment, a modified version of TSA was implemented to estimate underreporting of catches in the period 1995–2005, while still using the age structure of the sampled catches in that period. Natural mortality was revised according to Lorenzen (1996) which links natural mortality to body weight resulting in higher natural mortalities at younger ages. In addition to two Scottish surveys, the Irish groundfish survey has also been included in the assessment. Despite the problem of a divergence of historical trends in survey and commercial data, WKROUND considered the final assessment with this model as adequate for the provision of advice.

2.7 Proposals for future benchmarks

In 2013 four finfish stocks within the remit of WGCSE are scheduled to be benchmarked. These stocks are:

Cod in VIIa (Irish Sea);

Haddock in VIIa (Irish Sea);

Haddock in VIa (West of Scotland);

Plaice in Division VIIa (Irish Sea).

A *Nephrops* benchmark meeting is also planned by ICES for 2013. A full benchmark is planned for a number of functional units while for others with more minor assessment issues (such as agreement of forecast inputs or spatial distribution for stocks not benchmarked at WK*NEPH* in 2009) it is planned to review them by IBP. The procedure envisaged for the *Nephrops* IBP is that a working document will be submitted to, and subsequently reviewed by the benchmark meeting. The *Nephrops* stocks proposed for full benchmark are:

Nephrops FU11;

Nephrops FU16.

Nephrops stocks proposed for IBP:

Nephrops FU14;

Nephrops FU17;

Nephrops FU19;

Nephrops FU22.

The proposed benchmarks for 2014 are the following stocks:

Sole in Divisions VIIf, g (Celtic Sea);

Whiting in Division VIIe–k (Celtic Sea);

Nephrops FU2–21.

2.7.1 Planning table [used for preparing the ACOM proposal of upcoming benchmarks]

Stock	Ass status	Latest benchmark	Benchmark next year	Planning Year +2	Further planning	Comments
Ang-ivvi	Survey trends	2012 (little progress made)			Further benchmark required following completion of additional work.	See Section 5.2
Cod-7e–k	Update deviating from benchmark	2012				Work needs to be continued on commercial tuning-series. See Sec. 7.2
cod-iris	Update	2012 (interim assessment agreed)	2013		Further benchmark required to deal with unallocated mortality issues.	See Section 6.2
cod-rock	Data limited – no assessment	-				
cod-scow	Update	2012				
Had-7b–k	Update	2012				
Had-iris	Survey trends		2013			See Section 6.3.
Had-rock	update				Benchmark pending improvement in model input data.	See Section 4.3.
Had-scow	Update, but surveys discontinued		2013			See Section 3.3.
Meg-46a	update	2012				
Meg-rock	Survey trends	2011			Work ongoing on surplus production model – will require benchmark when completed.	See Section 5.3.

Stock	Ass status	Latest benchmark	Benchmark next year	Planning Year +2	Further planning	Comments
Nep-11	update	2009	2013			Additional areas surveyed using new UWTV survey techniques. See Sec. 3.5.
Nep-12	Update	2009				
Nep-13	Update	2009				
Nep-14	Update	UWTV survey method only in 2009	2013 (IBP)			See Section 6.4
Nep-15	Update	2009				
Nep-16	Data limited – DCAC & trends in lpue	-	2013			See Section 7.6
Nep-17	update	2009	2013 (IBP)			See Section 7.5
Nep-19		UWTV survey method only in 2009	2013 (IBP)			See Section 7.8
Nep-20-21	Data limited	-		2014		See Section 7.7
Nep-22	update	UWTV survey method only in 2009	2013 (IBP)			See Section 7.7
Ple-7b–c	Data limited - DCAC	-				
Ple-7h–k	Catch curves & separable VPA	-				
Ple-celt	Update for trends only	2011				
Ple-echw	update	2010				
Ple-iris	Update for trends in biomass	2011 (temporary trends based assessment agreed)	2013			Highly uncertain discard estimates. needs further work. See Section 6.7.

Stock	Ass status	Latest benchmark	Benchmark next year	Planning Year +2	Further planning	Comments
Sol-7b–c	Data limited - DCAC	-				
Sol-7h–k	Catch curves	-				
Sol-celt	update			2014		Conflicting signals in tuning-series. Potential inclusion of alternative surveys. See Section 7.13
Sol-echw	update	2012				
Sol-iris	update	2011				
Whg-7e–k	Update (XSA) considered full analytical assessment in 2012	-		2014		See Section 7.15
Whg-iris	Survey trends (update)	-			No benchmark likely until international catch-at-age data time-series constructed	See Section 6.6
Whg-rock	Data limited – no assessment	-				
Whg-scow	update	2012				

2.7.2 Issue lists for stocks with upcoming benchmarks

Stock	Cod-iris			
Benchmark	Year:2013			
Stock coordinator	Ian Holmes			
Stock assessor	Chris Darby			
Data contact	Ian Holmes			
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
Tuning series				
Discards	Partition a forecast into landings, discards & unallocated	Estimates of annual discards at age	Discard data from main fleets (UK & Irish)	Knowledge of discard sampling & work up procedures
Landings				
Biological Parameters	Update M Update maturity ogive	Use Lorenzen weight-based natural mortality constant over time Re-estimate maturity at age 2 from survey data	Survey data	
Ecosystem/mixed fisheries considerations				
Assessment method				
Forecast method				
Biological Reference Points	May require updating on basis of new maturity ogive			

Stock	**Had-iris**			
Benchmark	Year:2013			
Stock coordinator	Pieter-Jan Schön			Pieter-Jan.Schon@afbini.gov.uk
Stock assessor	Pieter-Jan Schön			Pieter-Jan.Schon@afbini.gov.uk
Data contact	Pieter-Jan Schön			Pieter-Jan.Schon@afbini.gov.uk
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
Tuning series	Choose most appropriate of survey indices including estimates from egg production	Survey data analysis;	Survey data	Knowledge of survey data analysis
Discards	Potential bias and uncertainty in estimates due to poor sampling levels in some years	Explore uncertainty issues and create reliable discards-at-age matrix for as full a time-series as possible	Discard data from main fleets (UK & Irish)	Knowledge of discard sampling & work up procedures
Landings	Bias due to misreporting	Use estimates of misreporting to provide unbiased landings estimates where possible	Estimates of misreporting	
Biological Parameters	Apparent density dependent effects in growth	Ensure appropriate models for weight at age	Survey weight/length at age data	Knowledge of growth modelling
Ecosystem/mixed fisheries considerations				
Assessment method	Incomplete time series of reliable catch-at-age data	Explore assessment models which can deal with missing/uncertain commercial data and potentially both age-structured and biomass based abundance indices	Assessment input data	Expertise in a range of assessment methods
Forecast method	Potentially overoptimistic forecast estimates unless growth correctly predicted	Growth modelling could help with forecasts of mean weights at age (see above).		

Stock	**Had-iris**			
Benchmark	Year:2013			
Stock coordinator	Pieter-Jan Schön			Pieter-Jan.Schon@afbini.gov.uk
Stock assessor	Pieter-Jan Schön			Pieter-Jan.Schon@afbini.gov.uk
Data contact	Pieter-Jan Schön			Pieter-Jan.Schon@afbini.gov.uk
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
Biological Reference Points	No SSB reference points due to rapid expansion of stock; Fpa set by analogy with other haddock stocks; No MSY reference points;	Dependent on outcomes of assessment		

Stock	Had-scow			
Benchmark	Year:2013			
Stock coordinator	Rui Catarino		r.catarino@marlab.ac.uk	
Stock assessor	Rui Catarino		r.catarino@marlab.ac.uk	
Data contact	Rui Catarino		r.catarino@marlab.ac.uk	
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
Tuning series	End of ScoGFS-WIBTS-Q1 & ScoGFS-WIBTS-Q4, possible inclusion of IGFS-WIBTS-Q4	Investigate IGFS-WIBTS-Q4 as index for this stock & compare with Scottish indices	Survey data	Knowledge of survey data analysis
Catch at age data	Bias due to misreporting	Analysis of area misreporting estimates & adjustment of assessment input data to account for this if required	Estimated area misreporting data from Marine Scotland Compliance	
Biological Parameters	Variable growth results in highly variable weights at age which appear strongly linked to cohort strength	Develop improved models of growth accounting for cohort effects to be used in forecast Consideration of stock weights from survey, instead of estimated weights-at-age in catch	Survey weight at age data	Knowledge of growth modelling
Ecosystem/mixed fisheries				
Assessment method	To use commercial age composition data for years when total catch excluded (due to misreporting)	Alternative TSA model to be fitted	Assessment input data	Expertise in TSA
Forecast method		Growth modelling could help with forecasts of mean weights at age.		
Biological Reference Points				

Stock	Ple-iris			
Benchmark	Year:2013			
Stock coordinator	Ian Holmes			
Stock assessor	Chris Lynam			
Data contact	Ian Holmes			
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
Tuning series	Potential use of UK (E & W)-BTS-Q1 Lack of information at older ages	Exploration of survey data Explore commercial indices & HP corrections	Appropriate survey/commercial tuning data	
Discards	Quantify variability in discard estimates	Work on discard raising procedure; Historic data collected by N Ireland require further evaluation	Discard data from all nations involved in the fishery	Familiarity with discard sampling & raising procedures
Biological Parameters	Maturity ogives have changed Trends in weights at length and age	Use of annual maturity ogive in survey index (NIGFS-WIBTS) calculation Explore growth models accounting for cohort/year effects to be used in forecast	Survey maturity at age data Survey length and weight at age data	Knowledge of growth modelling
Ecosystem/mixed fisheries				
Assessment method	Greater reliability of discards at length than age; Evidence of substock structure	Investigation of length structured assessment models Consider evidence of stock structure & explore potential changes to spatial units for assessment	Assessment data appropriately formatted, estimates of growth parameters Data on substock mixing, spatial distribution; Survey & catch data appropriately partitioned	Expertise in length based assessments
Biological Reference Points				

Stock	Nep-FU11			
Benchmark	Year:2013			
Stock coordinator	Carlos Mesquita		c.mesquita@marlab.ac.uk	
Stock assessor	Carlos Mesquita		c.mesquita@marlab.ac.uk	
Data contact	Carlos Mesquita		c.mesquita@marlab.ac.uk	
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
Tuning series				
Discards	Potential inclusion of creel discard data	Review of creel discard survival literature to investigate whether these are likely to be an important component of removals	Creel discard data	
Biological Parameters	To be reviewed	Review of recent data analysis & potentially analysis of additional biological data	Biological data collected on surveys	To be concluded ahead of benchmark
Ecosystem/mixed fisheries considerations				
Assessment method	Revision of stock area to include sea lochs	Data on spatial distribution of sediment/presence of Nephrops in sea lochs	UWTV surveys to define edges of suitable habitat	To be worked up in GIS/R ahead of the benchmark
Assessment method	Review of burrow density estimates using drop frame methodolgy	Counts and workup procedure to be available for scrutiny	UWTV surveys using the drop frame	Knowledge of UWTV survey methods
Forecast method	Review of forecast inputs and their precision estimates	Analysis of available data & sensitivity testing	Available commercial data	Familiarity with Nephrops forecast methods
Biological Reference Points	MSY reference points may be updated			

Stock	**Nep-FU16**			
Benchmark	Year:2013			
Stock coordinator	Colm Lordan		clordan@marine.ie	
Stock assessor	Colm Lordan		clordan@marine.ie	
Data contact	Colm Lordan		clordan@marine.ie	
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
Tuning series				
Landings	Improvement to landings size distribution information	Use of commercial landings grade information to reconstruct historical size distributions	Quantities of landings & size composition by commercial grade category	
Biological Parameters	To be reviewed with consideration to potential spatial differences	Spatial analysis of survey and biological data	Survey and biological data	Knowledge of *Nephrops* biology
Ecosystem/mixed fisheries considerations	Linking recruitment to ecosystem drivers	Collation & analysis of environmental & recruitment data	Environmental & recruitment proxy information	Knowledge of *Nephrops* biology
Assessment method	Use of new UWTV survey as basis for assessment	Work up of June 2012 survey data to provide abundance estimate;	Completed UWTV survey June 2012;	UWTV survey methods & spatial analysis of survey data
Assessment method	Alternative assessment models: biomass, age or length structured	Exploratory assessments set up ahead of benchmark	Commercial/survey data as required by assessment method	Expertise in alternative assessment methods
Forecast method	Use of new UWTV survey as basis for advice	Review of bias correction factors for FU 16 Agree forecast inputs	Relative camera field of view/burrow size, other burrowing fauna Recent commercial sampling data	Knowledge of UWTV survey methods for *Nephrops* Familiarity with *Nephrops* forecast methods
Biological Reference Points	MSY reference points to be agreed dependent on above			

Stock	Nep-FU14			
Benchmark	Year:2013 (Inter benchmark protocol)			
Stock coordinator	Ana Leocadio		Ana.leocadio@cefas.co.uk	
Stock assessor	Ana Leocadio		Ana.leocadio@cefas.co.uk	
Data contact	Ana Leocadio		Ana.leocadio@cefas.co.uk	
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
Tuning series				
Discards				
Biological Parameters				
Ecosystem/mixed fisheries considerations				
Assessment method				
Forecast method	Use of UWTV survey as basis for advice (FU 14 not previously benchmarked at WKNEPH, 2009)	Review of bias correction factors	Relative camera field of view/burrow size, other burrowing fauna	Knowledge of UWTV survey methods for *Nephrops*
	Review of forecast inputs and their precision estimates	Analysis of available data & sensitivity testing	Available commercial data	To be worked up ahead of the benchmark
Biological Reference Points	MSY reference points may be updated	Dependent on above		

Stock	**Nep-FU17**			
Benchmark	Year:2013 (Inter benchmark protocol)			
Stock coordinator	Jennifer Doyle			
Stock assessor	Jennifer Doyle			
Data contact	Jennifer Doyle			
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
Tuning series				
Discards				
Biological Parameters	Poor fit to separable cohort analysis	Review of inputs including biological parameters	Length frequency data to estimate growth parameters; Comparison of stock characteristics with other FUs	To be worked up ahead of the benchmark
Ecosystem/mixed fisheries considerations				
Assessment method	Revise spatial extent of *Nephrops* population	Integrate Galway Bay & Slyne head estimates Consider accuracy of current Aran ground boundary	Data defining spatial extent of *Nephrops*: VMS, sediment distribution or *Nephrops* presence	To be worked up ahead of the benchmark
Forecast method	Review of forecast inputs and their precision estimates	Analysis of available data & sensitivity testing	Available commercial data	To be worked up ahead of the benchmark
Biological Reference Points	MSY reference points may be updated	Dependent on above		

Stock	Nep-FU19			
Benchmark	Year:2013 (Inter benchmark protocol)			
Stock coordinator	Jennifer Doyle			
Stock assessor	Jennifer Doyle			
Data contact	Jennifer Doyle			
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
Tuning series				
Discards				
Biological Parameters				
Ecosystem/mixed fisheries considerations				
Assessment method	Stock consists of large number of discrete patches	Exploration of spatial distribution & area estimate to enable calculation of absolute abundance	Data defining spatial extent of Nephrops: VMS or sediment distribution	To be worked up ahead of the benchmark
Forecast method	Use of UWTV survey as basis for advice (FU 19 not previously benchmarked at WKNEPH, 2009)	Review of bias correction factors	Relative camera field of view/burrow size, other burrowing fauna	Knowledge of UWTV survey methods for *Nephrops*
	Review of forecast inputs and their precision estimates	Analysis of available data & sensitivity testing	Available commercial data	To be worked up ahead of the benchmark
Biological Reference Points	MSY reference points may be updated	Dependent on above		

Stock	Nep-FU22			
Benchmark	Year:2013 (Inter benchmark protocol)			
Stock coordinator	Jennifer Doyle			
Stock assessor	Jennifer Doyle			
Data contact	Jennifer Doyle			
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
Tuning series	Disaggregation of FU22 & FU20–21 data	Trends in groundfish surveys by FU	Spatial survey data	To be worked up ahead of the benchmark
Landings	Disaggregation of FU22 & FU20–21 data	Collation of historical landings by rectangle; Recreation of trends in commercial data by separate FU	Spatially resolved sampling data	To be worked up ahead of the benchmark
Biological Parameters				
Ecosystem/mixed fisheries considerations				
Assessment method				
Forecast method	Use of UWTV survey as basis for advice (FU22 not previously benchmarked at WKNEPH, 2009) Review of forecast inputs and their precision estimates	Review of bias correction factors Analysis of available data & sensitivity testing	Relative camera field of view/burrow size, other burrowing fauna Available commercial data	Knowledge of UWTV survey methods for *Nephrops* To be worked up ahead of the benchmark
Biological Reference Points	MSY reference points may be updated	Dependent on above		

2.8 Methodology and software

2.8.1 Standard assessment methods and software

For the stocks for which a full analytical assessment was possible, the WG typically used either Extended Survivor's Analysis (XSA) or Time-Series Analysis (TSA), methods which have a long history of use at this WG. These approaches and procedures for using them are discussed in further detail in the relevant stock annexes and in Section 2 of WGNSDS 2008. At WKROUND and IBP-Meg this year, a number of new methods were agreed for use with WGCSE stocks:

- A new implementation of TSA (for VIa cod and whiting) such that the Kalman filter no longer uses linear approximations during the maximum likelihood parameter estimation and also has the ability to account for catch composition data where total landings are not available.
- Use of the State–space Assessment Model SAM (implemented in AD Model Builder) for VIIa cod.
- Age-Structured Assessment Program (ASAP, Legault and Restrepo, 1998) for haddock in VIIe–k which is a statistical catch-at-age analysis which allows for uncertainty in both catches and age composition.
- A Bayesian state–space biomass dynamic model for megrim in VI and VIa (IBP-Meg 2012).

Pre-screening of age structured survey data (investigating within and between survey consistency) was carried out using SURBA, which was also one of the methods used for those data limited stocks falling into WKLIFE category 4.

Short-term forecasts from the analytical age-base assessments were conducted using either the Marine Laboratory Aberdeen (MLA) programmes or the MFDP/MFYPR software. Assumptions regarding future recruitment and intermediate year fishing mortality (for the forecast) are documented in the specific stock sections.

Eight of the ten *Nephrops* FUs were assessed using the UWTV survey method (the other two were data limited) which is more fully described in the reports of WKNEPHTV (ICES, 2007) and WKNEPH (ICES, 2009).

2.8.2 MSY estimation for *Nephrops* stocks

A wide range of fisheries exploit the *Nephrops* stocks (Functional Units, FUs) for which ICES delivers advice. These include single, twin, triple and even quadruple trawls and creeling (potting), with activity covering inshore and offshore grounds. The timing of these fisheries varies; which due to the different emergence patterns of the different sexes due to moulting and egg-brooding, leads to very different relative exploitation rates (between the sexes) in different FUs. Local ecosystem type is also highly variable with a range of *Nephrops* densities, different composition and density of organisms competing for space as well as different assemblages of predators. Ground types also cover a wide range including large contiguous sediment beds, fragmented patches of suitable sediment in rocky areas, sea-lochs and patches of mud on relatively deep shelf edges.

Given these differences in fishery and ecology it is inevitable that estimates of the exploitation rate leading to long-term MSY will vary between the FUs, the difficulty for scientists is how to estimate these rates given the inherent difficulty in assessing crustacean stocks, for which no practical method routine of age determination is available. Some assessments take the observed length–frequency data and slice it into age classes according to the von Bertalanffy growth parameters. These numbers-at-age are then taken forward into standard stock assessment packages. This practice was ceased in 2005 within this Group due to concerns over both the reliability of reported landings in some FUs (particularly the UK fisheries) and the use of the 'pseudo' age-structured data in an age-based assessment. As a result of this, no dynamic population model is fitted to the data and consequently there are no estimates of spawning–stock and recruitment which are fundamental to the determination of F_{MSY}.

Proxies for F_{MSY} must therefore be sought. WKFrame (ICES 2010) made several recommendations for defining F_{MSY} proxies where no direct estimation of F_{MSY} was possible (i.e. for stocks for which there is no analytic assessment, but length- or age-structured catch data are available). The suggested approach focused on per-recruit analysis with the following guidelines:

- Use input parameters which reflect the current situation (selection and discard ogive, maturity and weight-at-age/length).
- If there is clear peak at low F in the YPR analysis and no evidence of recruitment dependence on biomass, then F_{MAX} may be an appropriate proxy.
- Where $F_{MAX,}$ is undefined then $F_{0.1}$ might be considered as a 'lower bound' to the range of F suitable for F_{MSY}, as it is assumed to be low risk.
- Spawning biomass per recruit analysis should be routinely evaluated in addition to YPR. There is not a single level of % SPR that is optimal for all stocks and the proposal for F_{MSY} should include some consideration of life history. Further studies by Clark (1991; 1993) concluded that $F_{35\%}$ and higher were robust proxies for F_{MSY}, considering uncertainty in stock–recruitment functions and or recruitment variability.
- Conduct a sensitivity analysis to the input parameters and consider the variability of estimates over time.

Within the Celtic Sea areas, assessment of *Nephrops* stocks falls into two categories, those with TV surveys and data limited stocks which typically have landings data and indicators of lpue or cpue/mean size. Only for those stocks with TV surveys is the catch advice determined by an exploitation rate, advice for the other stocks is based on the data limited approach (see below on WKLIFE approach).

For those stocks with a TV survey, the harvest rates (removals divided by abundance as estimated by the TV survey) associated with fishing at $F_{0.1}$ and F_{MAX} were first estimated at the 2009 benchmark meeting WK*NEPH* (ICES 2009). The inputs of which were derived from a separable length based cohort analysis of recent commercial length composition data. Since then, some of these have been updated (and also calculated for additional FUs not considered at WK*NEPH*) in response to significant changes in the separable cohort analysis input data and results. In addition, in response to the recommendations of WKFrame, estimates of $F_{35\%SpR}$ and the corresponding harvest rate have also been determined and these estimates typically lie between the estimates of $F_{0.1}$ and F_{MAX}.

Suggestions for a TV-abundance based proxy for $B_{trigger}$ have been made on the basis of the lowest observed TV-abundance (median survey value) unless the stock has shown signs of stress at a higher TV-abundance in which case this value becomes $B_{trigger}$.

The remaining challenge is determining which F_{MSY} proxy is appropriate to which stock and this becomes an exercise in expert judgment based upon knowledge of the fishery and the ecosystem. The implications for exploitation rate can vary considerably depending upon which proxy is chosen ($F_{0.1}$, $F_{35\%SpR}$ or F_{MAX}) and whether to account for the differences in relative exploitation rate between the sexes. Given that there is often a distinct difference in the exploitation rate between the two sexes (males>females) it is usually impossible to simultaneously achieve the target fishing mortality on both sexes (i.e. the stock cannot be fished such that both the male and female YPRs are maximized simultaneously). The following text table shows the F-multipliers required to achieve various F_{MSY} proxies for both sexes of a typical

Nephrops stock (FU8 in this example), the harvest rates which correspond to those F multi-pliers and the resulting level of spawner-per-recruit expressed as a percentage of the virgin level.

			Fbar (20–40 mm)			SPR (%)		
		Fmult	Male	Female	HR (%)	Male	Female	Combined
	Male	0.2	0.13	0.06	7.47	42.33	64.5	51.72
$F_{0.1}$	Female	0.43	0.29	0.13	14.23	22.96	44.8	32.21
	Combined	0.24	0.16	0.07	8.75	37.29	60.04	46.92
	Male	0.36	0.24	0.11	12.31	26.94	49.5	36.49
F_{MAX}	Female	0.81	0.54	0.24	23.38	12.11	28.95	19.24
	Combined	0.46	0.31	0.14	15.03	21.55	43.02	30.64
$F_{35\%SpR}$	Male	0.27	0.18	0.08	9.67	34.13	57.04	43.83
	Female	0.63	0.42	0.19	19.28	15.79	34.96	23.91
	Combined	0.39	0.26	0.12	13.15	25.1	47.38	34.53

The yield-per-recruit and spawner-per-recruit plots for this stock are shown in Figure 2, emphasizing the disparity in F-multipliers required to achieve F_{MAX}. The general tradition in fisheries science is to concentrate on the mortality on females because in a freely distributing population, one male should be able to fertilize several females and therefore a higher exploitation rate on males should not affect spawning potential. *Nephrops* are slightly different in that the adults have a fairly limited range of movement (100s of metres) and therefore very low densities of males could result in sperm limitation. Ensuring that the fishing mortality target on males is not exceeded will usually result in an underutilization of the females, but due to the faster growth rate of males the underutilization of total yield is not likely to be large. The alternative of trying to achieve F_{MSY} on females carries a potentially serious risk to the production of future recruits and may result in very high exploitation of males. The use of a combined F_{MSY} (or proxy thereof) would obviously deliver higher long-term yield than either of the two separate sex values but the implication for male stock level should be noted. The Working Group suggested that a combined sex F_{MSY} proxy should be considered appropriate provided that the resulting percentage of virgin spawner-per-recruit for males does not fall below 20%. In such a case the male F_{MSY} proxy should be picked over the combined proxy.

In cases where recruitment rates are typically low and/or highly variable then a more cautious F_{MSY} proxy would be appropriate as the stock may have reduced resilience to periods of poor recruitment and in this case $F_{0.1}$ is recommended. Conversely where recruitment rates are considered to be regularly high and the stock appears to have supported a harvest rate at or above F_{MAX}, (or in the case of a short TV time-series a particular landing level) without showing signs of recruitment overfishing, then F_{MAX} is recommended. In all other cases $F_{35\%SpR}$ should deliver high long-term yield with a low probability of recruitment overfishing and is recommended as the "default" value.

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

- Describe the absolute density. Is it high (i.e. >1 m^{-2}), medium (i.e. 1.0–0.2 m^2) or low (i.e. <0.2 per m^{-2});

- Variability of density. Is there large interannual variability, spatial complexity?
- Understanding of biological parameters. Is the growth rate particularly fast or slow, high or low estimates of natural mortality?
- Fishery timing and operation. Is there a strong seasonal pattern leading to different exploitation rates on the sexes, does this pattern vary much between years?
- Observed Harvest Rate or landings compared to stock status. Is the harvest rate consistently around or above F_{MAX}? Have landings been stable? Have the indicators of stock status shown signs of difficulty?

Accompanying this text should be a table listing the F_{MSY} proxies F_{MAX}, $F_{35\%SpR}$ and $F_{0.1}$ for males and females, their corresponding harvest rates and the implied % spawner-per-recruit for males and females.

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

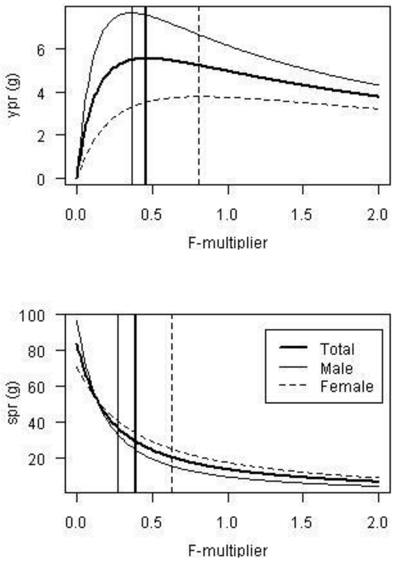


Figure 2.1. Yield-per-recruit and spawning–stock biomass-per recruit for males, females (dotted line) and combined (bold) with F_{MAX} and $F_{35\%spr}$ reference points.

2.8.3 Data limited stocks

2.8.3.1 WKLIFE considerations

ICES' WKLIFE met in Lisbon in 2012 to examine the information available for the stocks currently classified as data poor which are currently lacking in quantitative advice from ICES. The idea is to distinguish among those stocks for which quantitative forecasts are not available, as they are not all equally 'data poor'. For each of the categories, new approaches were proposed to derive reference points and stock status, in order to help drafting the most appropriate advice.

WKLIFE defined the following categories of stocks and categorised each stock according to these:

Category 1: Data rich stocks (quantitative assessment);

Category 2: Negligible landings stocks in comparison to discards;

Category 3: Stocks with analytical assessments and forecasts that are only treated qualitatively;

Category 4: Stocks for which survey-based assessments indicate trends;

Category 5: Stocks for which reliable catch data are available for short time-series;

Category 6: Data-limited stocks;

Category 7: Stocks caught in minor amount as bycatch.

The WG's initial review of WKLIFE's stock classification is given in the table below. As the WG progressed and assessment results became available some categorisations were subsequently revised (and are described in more detail in specific stock sections).

WKLIFE proposed a variety of methods which could be applied to stocks in the data limited categories but without specific guidance of how advice should be derived from the results of these analyses which is still considered a 'work in progress' by

WKLIFE. On the basis of their suggestions, the WG agreed an approach for each type of stock in terms of analysis for the WG assessment report and results that should be carried over to the draft advice.

For the category 3 stocks, the agreed approach was to continue the trends estimation in the assessment forecast, and to include the forecast relative changes in the advisory sheet. If the trends only situation is due to missing discards and that discards mainly occurs in the first ages, outside the mean F age range, F reference points should be estimated and used in the advice. Alternatively, neighbouring stocks could be investigated as a potential source of biological reference points. In terms of summary sheets for this category, the standard graphs are used without y-axis numbering and it was proposed that a catch option table with % changes could be produced.

A number of stocks at the WG fell into the WKLIFE category 4 (survey based analysis). For these, the WG proposed the use of surplus production models where possible, to comment on recent trends (according to the Annex IV rule) and to explore per-recruit analysis or reference points from neighbouring stocks. Survey trends standard graphs were updated for the advice sheet for these stocks.

For category 5 stocks (catch data and potentially catch-at-age data), the WG proposed conducting catch curve and per-recruit analysis (when age structured data available) and otherwise investigating Depletion Corrected Average Catch (DCAC) to provide some insight on likely sustainable catch levels. For plaice in Southwest Ireland (VIIh–k), a stock with a time-series of catch-at-age data, the WG extended its usual analysis (catch curves) and considered a separable VPA. The results were sufficiently stable that it was considered that it could be used as a final assessment and formally quantify our understanding of the stock dynamics. In addition, neighbouring stocks could be investigated as a potential source of biological reference points. For the advice sheet the WG considered that the standard graphs could include a time-series of Z and that catch options could be based on transitions to F_{MSY}.

For the truly data limited stocks and those caught as minor bycatch (categories 6 and 7), the WG considered that DCAC should be used where possible for stocks with a time-series of reliable landings data and limited discarding.

The extent to which this guidance was followed and the range of methods explored for each stock was dependent on time available at the WG for analysis of that stock.

In addition, WKLIFE proposed initial proxies for sustainable fishing mortalities based on life-history parameters and asked the WG to consider these proxies (using L_{MAX} values). Given the differences between these proxies and stock-specific values estimated for some data rich stocks, the WG did not further pursue this life-history based approach.

Category	Stocks (WKLIFE categorisation)	Stock (WG categorisation)	Agreed WG approach for assessment WG report	WG suggestions for draft advice
2	Whg-iris			
3 – Analytical assessment treated as trends only	Had-7b–k Meg-4–6a Ple-celt Ple-iris	Cod-iris (zero catch) Ple-celt Ple-iris Whg-7e–k	Provide forecast Per recruit analysis & neighbouring stocks for possible reference points	Catch options table with % changes Standard graphs without y axis labels
4 – Survey based analysis	Ang-ivvi Cod-rock Had-iris Nep-19 Nep-20–22 Whg-7e–k Whg-scow	Ang-ivvi Had-iris Meg-rock Nep-FU16 Whg-iris Gug-67	Surplus production model if possible Trends in abundance index Per recruit analysis & neighbouring stocks for possible reference points	Survey trends standard graphs
5 – Catch data available (possibly catch-at-age)	Ple-7h–k Sol-7h–k	Ple-7h–k Sol-7h–k Nep-FU20–21	Catch curves	Standard graph could include Z trend Catch options based on transition to F_{MSY}
6 – Data limited stocks	Nep-16 Ple-7b–c Sol-7b-c Whg-rock Pol-67 Meg-rock	Pol-67	DCAC analysis	
7 – Stocks caught in minor amount as bycatch		Ple-7b–c Sol-7b–c Whg-rock Cod-rock	DCAC analysis	

2.8.3.2 *Nephrops* data limited approach

Not all Functional Units areas are covered by TV surveys and in some cases the biological data are also sparse which has resulted in qualitative advice based on trends in catch rates and size composition. For 2012, the basis for advice has been developed from the TV survey methodology in order to provide a quantitative estimate of fishing opportunity likely to be compliant with MSY considerations. This approach was explored at the WG for *Nephrops* on the Labadie and other banks in the Celtic Sea (FU 20–21) and on the Porcupine Bank (FU 16).

The approach is based on habitat extent and population characteristics. The physical area of the FU has been determined either through knowledge of the sediment type, or from the fishery itself (e.g. VMS positions). Estimates of total abundance are calculated by taking the physical area and multiplying by potential values of *Nephrops* density which are drawn either from neighbouring FUs with existing TV surveys or from preliminary TV surveys of the specific FU. The numbers removed corresponding to the average (ten years) and maximum observed landings were estimated using mean weights and appropriate discard rates. Finally, the harvest rates for these removal numbers were calculated for each of the possible density values and these are laid down in a table:

Basis: Surface area FU 20–21: 3710 km^2, Mean weight: 34 grams, Discards: 25% in number.

		Range of potential densities (Nephrops per m2)						
Basis	Landings	0.2	0.25	0.3	0.35	0.4*	0.45	0.5
average (3yr)	2058	10.3%	8.3%	6.9%	5.9%	5.2%	4.6%	4.1%
average (10yr)	2464	12.4%	9.9%	8.3%	7.1%	6.2%	5.5%	5.0%
maximum	3145	15.8%	12.6%	10.5%	9.0%	7.9%	7.0%	6.3%
Minimum	1152	5.8%	4.6%	3.9%	3.3%	2.9%	2.6%	2.3%

Shaded areas indicate harvest rates > 7.5 % (lowest F_{MSY} proxy of *Nephrops* across the Celtic Seas Ecoregion).

*** Most recent density estimate (preliminary TV survey results).**

In order to give advice, average landings of the last ten years are considered together with the relevant densities in the area (gathered through preliminary surveys or assumed based on neighbouring FUs). The resulting harvest rate is compared to harvest rates commensurate with F_{MSY} for other *Nephrops* stocks in the Celtic Seas Ecoregion, which are in the region 7.5% (FU19) to 17.1% (FU 15) and on average 12.4%. Based on this table and these reference points, if in any FU average landings result in a harvest rate below the minimum F_{MSY} harvest rate calculated for this ecoregion, this is considered a precautionary state and advice is given on the basis of landings at the average of the last ten years. Where the harvest rate resulting from the average landings are higher or there is particular uncertainty surrounding the appropriate density estimates, additional precautionary reductions are considered.

3 West of Scotland

3.1 Area overview

3.2 Cod in Subarea VIa

Cod in Division VIa 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). In general the assessment carried out at the WG follows the procedure outlined in the stock annex developed at the benchmark. Any deviations are outlined in this section.

ICES advice applicable to 2011

MANAGEMENT OBJECTIVE(S)	CATCHES IN 2011
Transition to an MSY approach with caution at low stock size	Zero catch
Cautiously avoid impaired recruitment (Precautionary Approach)	Zero catch
Cautiously avoid impaired recruitment and achieve other objective(s) of a management plan (e.g., catch stability)	n/a

ICES advice applicable to 2012

ICES advises on the basis of the precautionary considerations that catches in 2012 should be reduced to the lowest possible level.

3.2.1 General

Stock definition and the management unit

General information about the stock can be found in the stock annex and an overview of the fisheries West of Scotland can be found in Section 3.1. The assessment unit is VIa and up to 2011 a TAC was set for ICES Areas VIa and Vb (EC waters). The 2011 TAC for cod in the management unit was 182 t. For 2012 the TAC has been set to zero but a bycatch of cod is allowed so long as it comprises no more than 1.5% of landings by live weight.

Management applicable to 2010 and 2011

The minimum landing size of cod in the human consumption fishery in this area is 35 cm. Before 2009 a TAC was set for ICES Subarea VI and EC and international waters of ICES Subareas XII and XIV and Subdivision Vb1. From 2009 a TAC advice for VIa and Vb1 has been given.

TAC for 2011

Species: Cod *Gadus morhua*		**Zone:** VIa; EU and international waters of Vb east of 12° 00′ W (COD/5BE6A)
Belgium	0	
Germany	3	
France	29	
Ireland	40	
United Kingdom	110	
EU	182	
TAC	182	Analytical TAC

TAC for 2012

Species: Cod *Gadus morhua*		**Zone:** VIa; EU 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.

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 the Restrictions on fishing for cod, haddock and whiting in ICES zone VI contained in Council Regulation No. 43/2009 (Annex III paragraph 6), are described in Section 3.1.

The fishery in 2011

Cod is believed to be no longer targeted in any fisheries now operating in ICES Division VIa. The table of official landings statistics is given in Table 3.2.1. This indicates the full TAC was taken in 2011.

Because of restrictive TACs, seasonal/spatial closures of the fishery, and effort restrictions based on bycatch composition the probability of misreporting and underreporting of cod in the past is considered to have been high. From 2006 the Registration of Buyers and Sellers legislation in the UK and Sales Notes management system in Ireland are considered to have reduced to low levels under reporting (see Section 3.1) and Figure 3.2.1. Area misreporting, however, is believed to take place in the UK and Figure 3.2.1 shows results compiled by Marine Scotland Compliance. Area misreporting will, for example, see cod caught in VIa declared as taken from the Faroe region or ICES Area IVa. The UK and Irish legislation introduced in 2006 is also believed responsible for a significant increase in discards starting in 2006. Since 2006, the estimated weight of discards has exceeded landings (Table 3.2.2), and discarding has taken place over an increased range of age groups (Tables 3.2.6 and 3.2.7 and Figure 3.2.2). Discard numbers as a percentage of catch numbers-at-age for 2006–2011 are shown in the following text table.

AGE YEAR	1	2	3	4	5	6	7+
2006	98.7	34.5	25.4	7.8	17.5	34.5	11.3
2007	99.1	90.9	47.6	56.4	51.8	5.0	0.0
2008	99.9	85.3	81.0	6.0	2.5	0.0	0.0
2009	99.8	95.7	94.8	82.1	0.0	88.0	0.0
2010	100	96.9	75.6	42.3	27.8	0.0	0.0
2011	100	98.4	97.5	79.4	6.5	29.5	0.0

The absolute level of numbers discarded from the 2005 year class at age 1 in 2006 through to age 4 in 2009 were high relatively to the same age class from adjacent cohorts (Table 3.2.6). A similar pattern is evident for the 2008 year class, with numbers of fish discarded at age 3 exceptionally high in 2011.

Tables and figures of total effort by the fleets operating in Division VIa can be found in Section 3.1.

3.2.2 Data

An overview of the data provided and used by the WG is provided in the following text table.

	COMMERCIAL DATA			
	Landings		Discards	
	No.-at-age	Wght.-at-age	No.-at-age	Wght.-at-age
Available	1978–2011 Ages : 1–7+	1978–2011 Ages : 1–7+	1978–2011 Ages : 1–7+	1978–2011 Ages : 1–7+
Used	1981–1990 & 2006–2011 Ages : 1–7+	1981–2011 Ages : 1–7+	1981–1990 & 2006–2011 Ages : 1–7+	1981–2011 Ages : 1–7+

From 1991 to 2005, only the age composition information from the commercial data was used in the assessment. This is because of concerns over bias in the data caused by under and misreporting. The problem of biased data is considered to have become serious from 1995. WKROUND 2012 considered that landings subject to underreporting could still be expected to yield unbiased age structures when sampled. Therefore, rather than exclude landings and discards data completely from 1995 it was agreed to make use of the information on age structure from the landings and discards data. The survey tuning data is then used to estimate a correction factor on overall catch amounts in these years. To allow the model an overlap with a period considered to contain relatively unbiased commercial data the ‘age structure only’ period was started in 1991.

SURVEY DATA						
	cpue at age					
	ScoGFS-WIBTS-Q1	ScoGFS-WIBTS-Q4	IreGFS	IRGFS-WIBTS-Q4	UKSGFS-WIBTS-Q1	UKSGFS-WIBTS-Q4
Available	1985–2010 Ages: 1–7	1996–2009 Ages: 0–8	1993–2002 Ages: 0–3	2003–2011 Ages: 0–3	2011–2012 Ages: 1–7	2011 Ages: 0–8
Used	1985–2011 Ages: 1–6	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED

Catch data

A plot of log catch curve gradient derived from commercial catch data (landings plus discards) is shown in Figure 3.2.3. The trend in gradients over time appear fairly consistent between the age ranges considered (2–5, 2–4 and 3–5) except for the most recent cohorts. The implication from the figure is of an increasing rate of mortality for cohorts spawned during the 1990s, a considerable reduction in mortality for the 2002, 2003 and 2004 cohorts, but a return to a higher mortality rate for the cohorts from 2005 onwards. The final value (estimated over age range 2–5) is comparable to those for cohorts from the start of the time-series through to the early 1990s.

Annual mean weights-at-age in landings, discards and catch are given in Tables 3.2.5, 3.2.7 and 3.2.9. In years where landings and discards data are not used fully, weights-at-age for the stock are still required to obtain biomass estimates and so the full series of stock weights are used. Figure 3.2.2 shows the mean weights-at-age in the landings and discards. The figure indicates an increase in mean weight of landed fish at ages 2 and 3 in recent years. Mean weight-at-age of discarded fish at age 2 has increased in recent years. These results combined with the high discarding rates of recent years suggest increasing levels of highgrading.

Raised discard numbers-at-age are given in Table 3.2.6. Discard data including age distributions were supplied by Scotland and Ireland and bulk discard weights by France and Northern Ireland. Discard rates at age for the Irish fleet were very low and considerably different to those of the Scottish fleet. The Scottish offshore fleet discard ratio was applied to the one fleet with no discard information (Norway) on the grounds both are offshore large mesh otter trawl fisheries. Age distributions were assigned within InterCatch using Scottish finfish (TR1) trawl, Scottish *Nephrops* trawl (TR2) or Irish trawl data as appropriate. Observer coverage 2008–2011 (number of trips) is detailed in the following text table.

AREA VI					
	Scotland			Ireland	
Year	Other trawlers	*Nephrops* trawlers	Total	OTB trawlers	Total
2008	9	8	17		
2009	10	22	32		
2010	5	6	11	9	9
2011	8	7	15	?	?

Increased discards from 2006 are considered an indicator of the combined effect of restrictive quotas and new regulation. The larger 2005 cohort can be tracked through the discards.

Scottish landings and discards data (numbers-at-age) were adjusted for misreporting using

$$\hat{N}_{a,y} = N_{a,y} * \frac{L_y + Lm_y}{L_y},$$

where $N_{a,y}$ is number-at-age a in year y, Ly is total weight of landings in year y and Lm_y is weight of landings misreported in year y. Landings and discards were adjusted in the same way. The adjusted totals were then submitted to InterCatch and the aggregated international data compiled. This is different to the dataset used at WKROUND which adjusted the international aggregated data using international landings totals for the Ly term. WGCSE considered the change of approach necessary because the misreporting data only relates to Scottish fleet landings. Analysis of Irish fleet behaviour (provided to WKROUND) indicated little likelihood of misreporting and the type of fishing conducted by other fleets in the area was also thought to lead to little area misreporting.

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.

For 2011 the rig and sampling design of the ScoGFS-WIBTS-Q1 survey was changed. A new groundgear was introduced broadly modelled around the rig used by Ireland for the IRGFS-WIBTS-Q4. The move to a more robust gear also allowed a move to a random stratified survey (which is again consistent with the IRGFS-WIBTS-Q4). It is hoped the greater compatibility between Scottish and Irish surveys will facilitate both being used to assess gadoids west of Scotland. WGCSE 2011 concluded the changes constituted a new abundance series. The ScoGFS-WIBTS-Q1 survey data therefore finishes in 2010. There are insufficient years of data from the new survey UKSGFS-WIBTS-Q1 to be used in the current assessment. The same changes to groundgear and survey design occurred for the ScoGFS-WIBTS-Q4 and the final year of data from the ScoGFS-WIBTS-Q4 series is 2009 (the survey did not take place in 2010).

Figure 3.2.4 shows cpue by survey haul from 2010 and 2011 for the IRGFS-WIBTS-Q4 survey, from 2011 for the UKSGFS-WIBTS-Q4 and from 2011 and 2012 for the UKSGFS-WIBTS-Q1 survey. The data from the Scottish surveys show cpue for ages 1+, that from the Irish survey a proxy for fish at ages 1+ (fish at lengths >23 cm).

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 strongest cpue north of 58.5 degrees N. The Q1 surveys return positive cpue from the Clyde region and the Q4 surveys show relatively high cpue just north of Northern Ireland. From the IRGFS-WIBTS-Q4 survey there is also evidence of stronger abundance along the shelf edge in the southern part of Division VIa.

Figures 3.2.5 and 3.2.6 show the log mean standardised indices from the ScoGFS-WIBTS-Q1 survey by year and by cohort respectively. Figure 3.2.5 does not exhibit any exceptional year effects. Figure 3.2.6 shows the survey is able to track cohorts to some extent at younger ages.

Figure 3.2.7 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. The index of the 2005 and 2008 year classes also increased from age 2 to age 3 and the survey’s ability to track recent cohorts seems poor relative to the 1990s and early 2000s.

A plot of log catch curve gradient derived from the ScoGFS-WIBTS-Q1 data is shown in Figure 3.2.8. For cohorts after 1995 index values of zero have sometimes been recorded at age five. For the age ranges considered (2–5, 2–4 and 3–5) this means the slope has not always been fitted to data from all the ages indicated. There is little consistancy in results between age ranges chosen and this appears to worsen after the 1995 or 1996 cohort. The series for ages 2–5 seems more stable than the others in this later period although large variations in the final years occur over all age ranges. There is no evidence of a long-term trend in catch curve gradient. In contrast to the commercial data the result for the 2005 cohort shows a large decline in mortality rate on this cohort. Overall, information on mortality trends from all survey-series (including the ScoGFS-WIBTS-Q1) appears weak.

Biological data

Values for natural mortality-at-age (previously 0.2 for all ages and years) have changed based on a new approach agreed at WKROUND 2012. Natural mortality-at-age (M) is assumed weight-dependent after Lorenzen (1996) with mortality assumed to be time invariant, M is calculated by finding the time-series means for stock weights-at-age before applying the Lorenzen parameters, i.e.

$$M_a = 3\overline{W}_a \exp(-0.29)$$

Where M_a is natural mortality-at-age a, $\overline{W_a}$ is the time averaged stock weight-at-age a (in grammes) and the numbers are the Lorenzen parameters for fish in natural ecosystems. Figure 3.2.9 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.

Age	1	2	3	4+
Proportion mature-at-age	0.0	0.52	0.86	1.0

The proportion of F and M acting before spawning is set to zero.

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 are available 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 VIa 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 Historical stock development

This assessment uses a TSA run as outlined in the stock annex.

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. Standardised prediction errors at age from the update assessment run (which can be interpreted as residuals) are shown in Figure 3.2.10 (landings), Figure 3.2.11 (discards) and Figure 3.2.12 (ScoGFS-WIBTS-Q1). Errors within ±2 are considered reasonable. A large prediction error is observed for discards at age 3 in 2011. Such a result can indicate a large departure from previous values because of sampling error, in which case that datapoint can be down-weighted. In this instance, however, a stronger 2008 year class combined with very low TAC provides supporting evidence for the rise in discards at age 3 in 2011 and WGCSE agreed the datapoint should not be down-weighted.

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 3.2.13.

From Figure 3.2.13 there is a noticeable long-term downward trend in recruitment although the values for the 2005 and 2008 year classes are the highest since the 2001 year class. There has been a modest increase in SSB since 2006 and the estimate for 2011 and 2012 are the highest since 2003. The value is still well below B_{lim} however. Mean F is above F_{lim} and within the confidence limits of the estimate for the majority of the time-series.

Retrospectives for the final assessment run are shown in Figure 3.2.14. This figure also shows lines at ± 2 se (approximate 95% confidence limits) around the run using all years of data. Retrospective bias is small with respect to SSB. With respect to recruitment all results sit within the confidence limits of this year's run. .This is also true for mean F but the confidence interval for mean F is 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).

The TSA estimated stock–recruit relationship is shown in Figure 3.2.15. It includes the datapoint of the 1986 year class which from inspection of Figure 3.2.11 appears an outlier. The relatively high strength of the 2005, 2008 and 2009 year classes (considering the size of SSB) can also be seen.

The precautionary approach plot for this stock is given in Figure 3.2.16. It shows clearly how the stock has moved and remained in the zone indicating reduced reproductive capacity and unsustainable removals.

Comparison with last year's assessment

Recent assessments (to 2011) removed commercial data from 1995 onwards. The 2011 assessment was not accepted (because of change in survey indices-series) but assessments for several years showed a clear disparity between the estimated removals compared to the supplied commercial catch data. This assessment re-introduces landings and discards data from 2006 onwards and adjusts Scottish landings and discards for estimates of misreporting. Figure 3.2.17 shows the ratio between the estimated removals and observed catch from a) the 2010 assessment and b) this year's assessment. The pattern of increasing disparity between modelled removals and submitted data up to the mid 2000s has remained the same but in this year's assessment the ratios peak at a smaller value and in the last three years modelled catch is lower than input catch. This is because the model does not reproduce the steeply increasing trend in discards seen in the input data (see also Figure 3.2.13).

Figure 3.2.18 shows a comparison of SSB, recruitment-at-age one and mean F estimates produced by final run assessments between this year's assessment and assessments going back to 2001.

Compared to the 2010 assessment SSB in 2009 has been revised down from 5166 t to 2727 t while the estimate of mean F has remained virtually unchanged (0.88 against 0.89 previously). The estimate of recruitment in 2009 is revised down considerably from 10.4 million to 5.39 million. The estimate of SSB in 2010 from this year's assessment is 3498 t with a s.e. of 411 t. The short-term forecast from the 2010 assessment predicted SSB in 2010 at 6230 t or 2000t more than the current estimate plus 2 s.e.

Comparison with supplementary (seal predation) assessment

Figure 3.2.19 shows the summary plot of the assessment run including seal predation. Visual inspection shows the trajectories of the metrics to be very similar to those from the final assessment. For comparison to the final assessment and that from 2010 the estimates of SSB in 2009 and 2010 from the model including seal predation are 4412 t and 6008 t.

3.2.4 Short-term stock projections

A short-term projection was made using WGFRANSW following the procedure outlined in the stock annex.

Estimating recruiting year-class abundance

The recruitment values (000 fish) used in the forecast are given in the following table:

YEAR	TSA	STF
2012	4124	4124
2013		3604 (GM 01-10)
2014		3604 (GM 01-10)

Three-year means of the F estimates were taken to represent *status quo* mortality. The cod long-term management plan introduced in 2009 (Council Regulation No. 1342/2008, article 6, paragraph 4), directs that forecasts "assume that in the year prior to the year of application of the TAC the stock is fished with an adjustment in fishing mortality equal to the reduction in maximum allowable fishing effort that applies in that year." At WGCSE 2010 and 2011 the F value was reduced by 25% for the intermediate year to reflect reductions in maximum allowed fishing effort (kWdays) or incorporation of vessels in schemes designed to achieve a 25% reduction in mortality.

Effort reductions were again applied in 2012. Analysis by STECF, however, show that in past years effort (kWdays) for those fleet categories controlled under the cod management plan have reduced effort by amounts less than the annual reductions in overall effort allowance, (STECF 2011). There are also exemptions and special conditions allowing 'buy back' of fishing effort. The discard data made available to ICES and the assessment also indicate little or no trend in fishing mortality. Therefore a *status quo* fishing mortality was used in the projections.

Input data to the short-term projection are shown in Table 3.2.17. Management options from the forecast are shown in Table 3.2.18 and detailed tables of catch numbers-at-age are shown in Table 3.2.19.

A plot of the short-term forecast is shown in Figure 3.2.20. Results from sensitivity analysis from this forecast are shown in Figure 3.2.21 and probability profiles in Figure 3.2.22.

From Table 3.2.18 it can be seen that an assumption of zero removals in 2013 gives an estimate of SSB in 2014 below B_{lim}.

3.2.5 MSY Explorations

Prior to 2010 ICES defined the following PA reference points:

Reference point	Technical basis
B_{pa} = 22 000 t	Previously set at 25 000 t, which was considered a level at which good recruitment is probable. This has since been reduced to 22 000 t due to an extended period of stock decline.
B_{lim} = 14 000 t	Smoothed estimate of B_{loss} (as estimated in 1998).
F_{pa} = 0.6	Consistent with B_{pa}.
F_{lim} = 0.8	*F* values above 0.8 led to stock decline in the early 1980s.

WKROUND 2012 concluded these reference points were still valid.

In 2010 WGCSE derived an F_{MSY} estimate using the srmsymc package. Mortalities from removals in the range 0.17 to 0.33 were concluded as consistent with F_{MSY}. A description of the runs performed is given in the stock annex. The current level of F is higher than the median F_{crash} value for all three stock–recruit relationships tested.

3.2.6 Management plans

Cod in VIa 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 is discussed in Section 9.

3.2.7 Uncertainties and bias in assessment and forecast

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 and directly affects the perception of the stock. Scottish landings and discards (from 2006) are adjusted by estimates of misreporting. The misreporting estimates will have uncertainty associated with them.

Effort

Commercial effort data for Division VIa from the Scottish fleets is considered very uncertain and is not supplied to this working group.

Discards

The current assessment model removes discard information for the same years for which landings data is removed (although age composition data are included from both). Catch of this stock has been dominated by discards in recent years. Discard information is imprecise compared to landings data because of lower sampling coverage.

Surveys

The survey used for this assessment changed vessel and tow duration in 1999. Although a correction has been made based on comparative tows, there will be an additional variance associated with this correction factor which will affect the survey index. The spatial aggregation of the ScoGFS-WIBTS-Q1 survey (weighted arithmetic mean) can result in hauls catching large numbers of fish having a strong influence on index values (as was the case in 2008). This in turn has added noise to the indices leading to high prediction errors from TSA (residuals from other models) and downweighting of data points.

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 VIa 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.

Forecasts

Short-term forecasts are sensitive to the estimation of *status quo* mean fishing mortality. The WG considers mortality estimates arising from an assessment heavily based on discard data are poorly estimated and therefore noisy.

3.2.8 Recommendation for next Benchmark

problem	solution	expertise necessary	suggested time
Misreporting of landings – does not take account of fleet components.	Further analysis of misreporting data supplied by Scotland.	Can be performed in house by MSS.	?

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 25% effort reduction imposed as part of the cod long-term management plan in 2011 and landings composition rules have not been reflected in the latest estimate of F.

For 2012 the fishing opportunities regulation has explicitly made the stock a bycatch species. Allowing landings up to a given percentage 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. The number of RTCs west of Scotland and the % of all RTCs this represents are shown in the text table below.

YEAR	2008	2009	2010	2011
No RTC	4	17	27	4[a]
% of total	27%	12%	10%	2%

[a)] Three further RTCs straddled ICES Divisions VIa and IVa.

RTCs are determined by lpue, based on fine scale VMS data and daily logbook records and also by onboard inspections. The low number of RTCs west of Scotland result from few instances of high lpue in the area. Estimates of continuing high discard rates in Division VIa indicate the scheme has not been as effective as in the North Sea. Figure 3.2.23 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. This explains the relatively constant overall fishing mortality seen in Figure 3.2.13. 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 give area misreporting estimates considerably in excess of recent TACs. The assessment indicates the 2005 and 2008 year classes to be the biggest within the last decade. Both discards at higher ages and area misreporting reduce the potential for these year classes to contribute to increases in SSB. It is important good observer coverage is conducted in Division VIa to record discard trends in future.

Cod is taken in mixed demersal fisheries, and in Division VIa 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). The STECF report (STECF 11) assessing effort and catch of fishing regimes subject to fishing effort limitations shows trawl gear vessels targeting finfish (TR1 gear) to take roughly 96% of cod catch and the *Nephrops* fleet (TR2 gear) to take 4% of cod catch in ICES Area VIa.

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. For vessels of length 15 m and over operating west of a management line shown in Figure 3.2.24 effort is restricted to a lesser degree. Figure 3.2.24 also shows locations of fishing activity (2009 data) using TR1 gear (from VMS data) linked to cod landings. It can be seen a large proportion of the effort falls outside of the cod management area. The landings composition restrictions do not restrict discards.

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 and 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. 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.

Sources

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.

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).

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

Table 3.2.1. Cod in Division VIa. Official catch statistics in 1985–2009, as reported to ICES.

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Belgium	48	88	33	44	28	-	6	-	22	1	2	+	11	1	+	+	2	+
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*	236	391	208
Germany	66	53	12	25	281	586	60	5	94	100	18	63	5	6	8	6	4	+
Ireland	2,564	1,704	2,442	2,551	1,642	1,200	761	761	645	825	1,054	1,286	708	478	223	357	319	210
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-
Norway	204	174	77	186	207	150	40	171	72	51	61	137	36	36	79	114*	40*	88
Spain	28	-	-	-	85	-	-	-	-	-	16	+	6	42	45	14	3	11
UK (E., W., N.I.)	260	160	444	230	278	230	511	577	524	419	450	457	779	474	381	280	138	195
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	2,057	1,544	1,519
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	2,767	2,439	2,231

COUNTRY	2003	2004	2005	2006	2007	2008	2009	2010	2011*
Belgium								0	0
Denmark									
Faroe Islands		2	0	0.8	12	1		0.2	0
France	172	91	107	100.7	92	82	74	60.3	58.5
Germany	+			2	2	1	0	0	
Ireland	120	34	27.9	18	70	58.2	24.4	48.7	41.3
Netherlands	-						0		0
Norway	45	10	17	30	30	65	18	20.7	8.3
Spain	3								
UK (E., W., N.I.)	79	46	25		21	6	14		
UK (Scotland)	879	413	243		260	232			
UK				332.1			104	118.6	109.1
Total landings	1,298	596	419.9	483.6	487	445.2	234.4	248.5	217.2

* Preliminary.

Table 3.2.2. Cod in Division VIa. Landings, discards and catch estimates 1978–2011, 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	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	478	504	940	992
2007	525	595	2104	2363	2629	2957
2008	451	682	909	1363	1360	2045
2009	222	408	1401	2538	1623	2946
2010	239	559	1183	2881	1422	3440
2011		523		5840		6363

Table 3.2.3. Cod in Division VIa. Survey data made available to the WG. Data used in assessment are highlighted in bold. For ScoGFS-WIBTS-Q1, numbers are standardised to catch-rate per 10 hours. Survey from 2011 conducted according to new design and ground gear.

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 cont. Cod in Division VIa. Survey data made available to the WG. Data used in assessment are highlighted in bold. UKSGFS-WIBTS-Q1; numbers are standardised to catch-rate per 10 hours.

2011	2012							
1	1	0	0.25					
1	7							
10	0.60	33.89	20.80	0.94	0.99	0.97	0	2011
10	12.13	25.30	23.51	4.26	4.03	2.53	4.84	2012

Table 3.2.3 cont. Cod in Division VIa. Survey data made available to the WG. For IreGFS, effort is given as minutes towed, 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

Table 3.2.3 cont. Cod in Division VIa. Survey data made available to the WG. Data used in assessment are highlighted in bold. For ScoGFS-WIBTS-Q4, numbers are standardised to catch-rate per 10 hours. "+" indicates value less than 0.5 after standardising. No survey was conducted in 2010. Survey from 2011 conducted according to new design and ground gear.

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

1996	**2010**									
1	1	0.75	1.00							
0	8									
10	0	1	14	5	3	1	0	0	0	1996
10	1	11	2	1	1	1	0	0	0	1997
10	+	15	9	1	0	0	0	0	0	1998
10	2	4	6	9	1	0	0	0	0	1999
10	0	16	3	0	0	0	0	0	0	2000
10	1	2	9	1	1	0	0	0	0	2001
10	1	10	3	7	1	0	0	0	0	2002
10	1	2	11	3	1	0	0	0	0	2003
10	0	5	4	0	+	0	0	0	0	2004
10	+	2	3	0	1	+	0	0	0	2005
10	0	17	6	1	1	0	0	0	0	2006
10	0	12.0	20.0	1.3	0.6	0	0.3	0	0	2007
10	2	8	5	7	1	0	0	0	0	2008
10	2	14	4	1	1	+	0	0	0	2009
10	na	na	na	na	na	na	na	na	na	2010

Table 3.2.3 cont. Cod in Division VIa. Survey data made available to the WG. Data used in assessment are highlighted in bold. UKSGFS-WIBTS-Q4; numbers are standardised to catch-rate per 10 hours.

2011	**2011**									
1	1	0.75	1.0							
0	8									
10	0.66	11.18	31.13	11.08	0.98	1.52	2.03	0	0	2011

Table 3.2.3 cont. Cod in Division VIa. Survey data made available to the WG. Data used in assessment are highlighted in bold. For IRGFS-WIBTS-Q4, effort is given as minutes towed, numbers are in units.

IRGFS- WIBTS-Q4 Irish West Coast groundfish

2003	**2011**					
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

Table 3.2.4. Cod in Division VIa. 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
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	0.1
2010[1]	0	43	61	38	32	1	0.4
2011[1]	0	16	47	39	14	15	2

[1] Values include adjustment for misreporting.

Table 3.2.5. Cod in Division VIa. 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
2007[1]	0.476	0.976	2.512	4.285	6.491	7.733	8.810
2008[1]	0.557	1.183	2.992	4.826	6.330	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	1.437	3.181	4.064	5.832	6.528	9.884

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

Table 3.2.6. Cod in Division VIa. Discard dataset from Scottish & Irish sampling programmes, ages 1–7, years 1978–2011. Data from 1978–2001 raised from Scottish sampling only; later data raised from Scottish sampling and Irish sampling when available (2004 & 2005 to date).

Discards at age (thousands)							
	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[2]	1310	50	26	2	3	1	0.1
2007[2]	711	1872	63	48	3	4	0
2008[2]	133	199	552	2	0	0	0
2009[2]	1624	402	293	254	0	13	0
2010[2]	1289	1441	240	26	11	0	0
2011[2]	1081	976	1873	149	1	6	0

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

[2] Values include adjustment for misreporting.

Table 3.2.7. Cod in Division VIa. Discard dataset from Scottish & Irish sampling programmes, ages 1–7, years 1978–2011. Data from 1978–2001 raised from Scottish sampling only; later data raised from Scottish sampling and Irish sampling when available (2004 & 2005 to date).

Mean weight-at-age in discards (kg)							
	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[1]	0.259	1.291	2.649	3.499	6.24	5.581	11.122
2007[1]	0.198	0.940	3.016	4.453	5.018	10.627	0
2008[1]	0.220	0.976	2.046	4.047	7.937	0	0
2009[1]	0.261	1.312	2.248	3.324	0	6.448	0
2010[1]	0.252	1.312	2.268	3.218	3.245	0	0
2011[1]	0.212	1.026	2.207	2.993	4.891	4.168	0

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

Table 3.2.8. Cod in Division VIa. Total catch-at-age (thousands).

	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	276	113	85	11	26	2	1
2005	139	141	43	37	7	6	0.5
2006[2]	1328	146	102	24	16	3	1
2007[2]	717	2060	133	85	6	8	3
2008[2]	133	233	682	27	16	1	3
2009[2]	1627	415	304	313	8	15	0.3
2010[2]	1289	1485	301	64	43	1	0.4
2011[2]	1081	992	1921	187	14	21	2

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

[2] Values include adjustment for misreporting.

Table 3.2.9. Cod in Division VIa. Mean weight-at-age (kg) in total catch.

	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]	0.264	1.211	2.341	3.797	6.184	7.031	11.103
2007[2]	0.200	0.943	2.752	4.380	5.729	9.166	8.810
2008[2]	0.220	1.006	2.226	4.779	6.371	7.957	8.471
2009[2]	0.262	1.332	2.280	3.595	5.904	6.677	8.646
2010[2]	0.252	1.318	2.349	3.565	4.750	6.144	7.974
2011[2]	0.212	1.033	2.231	3.214	5.771	5.833	9.884

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

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

Table 3.2.10. Cod in Division VIa. 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 data points.	Landings: Age 2 in 1987 age 6 in 1982 and 2009, age 7 in 1982,1983,1989. 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 mins.
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 $\eta_1 S \exp(-\eta_2 S)$, 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 $5\eta_1 S \exp(-\eta_2 S)$. The factor of 5 was chosen by comparing maximum recruitment to median recruitment from 1966–1996 for VIa 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 VIa. TSA parameter estimates for final assessment presented this year.

PARAMETER	NOTATION	DESCRIPTION	2012 WG
Initial fishing mortality	$F(1, 1981)$	Fishing mortality-at-age *a* in year *y*	0.3056
	$F(2, 1981)$		0.6263
	$F(4, 1981)$		0.9764
Fishing mortality standard deviations	σ_F	Transitory changes in overall fishing mortality	0.0706
	σ_U	Persistent changes in selection (age effect in F)	0.0334
	σ_V	Transitory changes in the year effect in fishing mortality	0.1088
	σ_Y	Persistent changes in the year effect in fishing mortality	0.0009
Measurement CVs	$CV_{landings}$	CV of landings-at-age data	0.1295
	$CV_{discards}$	CV of discards-at-age data	0.7262
Recruitment	η_1	Ricker parameter (slope at the origin)	1.0053
	η_2	Ricker parameter (curve dome occurs at 1/ç2)	0.0139
	CV_{rec}	Coefficient of variation of recruitment data	0.4779
Discards	$\sigma_{logit\ p}$	Transitory trends in discarding	0.7079
	$\sigma_{persistent}$	Persistent trends in discarding	0.3199
	Step fn age 1	Amount by which discards increase in 2006	4.3109
	Step fn age 2		6.1439
	Step fn age 3		1.1598
	Step fn age 4		0.3955
Survey selectivities	$\Phi(1)$	Survey selectivity at age *a*	0.5300
	$\Phi(2)$		2.5736
	$\Phi(3)$		6.4396
	$\Phi(4)$		10.8097
	$\Phi(5)$		14.9578
	$\Phi(6)$		21.8590
	σ_{survey}	Standard error of survey data	0.2784
	???	???	1.0606
Survey catchability standard deviations	σ_Ω	Transitory changes in survey catchability	Na
	σ_β	Persistent changes in survey catchability	Na
Misreporting		Transitory changes in misreporting	0.0
		Persistent changes in misreporting	0.1605

Table 3.2.11. Cod in Division VIa. TSA parameter estimates for 2002–2004, 2006–2009 assessments and final assessment presented this year. No final assessment using TSA was conducted in 2005. Run 3 from 2004 used a similar approach to this year's assessment.

Parameter	Notation	Description	2002 WG	2003 WG	2004 WG Run 3	2006 WG	2007 WG	2008 WG	2009 WG	2010 WG	2011 WG
Initial fishing mortality	*F*(1, 1978)	Fishing mortality-at-age *a* in year *y*	0.03	0.64	0.64	0.6378	0.6337	0.6366	0.6373	0.6334	0.6329
	F(2, 1978)		0.25	0.62	0.57	0.5333	0.5889	0.5803	0.5797	0.5853	0.5978
	F(4, 1978)		0.67	0.82	0.66	0.5743	0.6879	0.5888	0.5886	0.5955	0.6241
Survey selectivities	$\Phi(1)$	Survey selectivity-at-age *a*	0.83	0.33	0.47	0.6275	0.5425	0.4746	0.4809	0.4791	0.4530
	$\Phi(2)$		4.41	1.98	3.19	3.5857	3.7292	3.2855	3.3317	3.3463	3.3290
	$\Phi(4)$		18.28	10.65	14.92	15.9096	14.1997	14.0472	13.7891	13.6507	13.9381
Fishing mortality standard deviations	σ_F	Transitory changes in overall fishing mortality	0.10	0.04	0.07	0.0947	0.0741	0.0846	0.0850	0.0834	0.0819
	σ_U	Persistent changes in selection (age effect in F)	0.10	0.06	0.03	0.0242	0.0507	0.00	0.00	0.0057	0.0129
	σ_V	Transitory changes in the year effect in fishing mortality	0.00	0.07	0.10	0.0844	0.0984	0.1120	0.1117	0.1144	0.1143
	σ_Y	Persistent changes in the year effect in fishing mortality	0.16	0.07	0.00	0.0425	0.00	0.00	0.00	0.00	0.00
Survey catchability standard deviations	σ_Ω	Transitory changes in survey catchability	0.24	0.00	0.00	0.1224	0.2374	0.2276	0.2498	0.2275	0.1990
	σ_β	Persistent changes in survey catchability	0.00	0.45	0.00 (f)	0.00 (f)	0.00 (f)	0.00 (f)	0.00(f)	0.00(f)	0.00(f)
Measurement standard deviations	$\sigma_{landings}$	Standard error of landings-at-age data	0.12	0.13	0.10	0.0935	0.0891	0.0892	0.0889	0.0897	0.0904
	$\sigma_{discards}$	Standard error of discards-at-age data	n/a	0.94	1.42	1.2669	1.367	1.3756	1.3681	1.3819	1.4102
	σ_{survey}	Standard error of survey data	0.36	0.56	0.35	0.3887	0.364	0.3875	0.3930	0.3926	0.3999
Discards	$\sigma_{logit\ p}$	Transitory trends in discarding	n/a	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	$\sigma_{persistent}$	Persistent trends in discarding	n/a	0.16	0.68	0.5735	0.6742	0.7032	0.6959	0.7112	0.7429
Recruitment	η_1	Ricker parameter (slope at the origin)	0.82	0.62	0.80	0.6584	0.7882	0.9634	0.8913	1.0233	1.0986
	η_2	Ricker parameter (curve dome occurs at 1/ç2)	0.03	0.003	0.01	0.0049	0.0124	0.0203	0.0177	0.0223	0.0251
	CV_{rec}	Coefficient of variation of recruitment data	0.36	0.56	0.49	0.4184	0.5116	0.5627	0.5530	0.5671	0.6224

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

	Age						
Year	1	2	3	4	5	6	7+
1978							
1979							
1980							
1981	11.34812	19.09072	6.897182	1.886227	0.3418	0.053027	0.04367
1982	26.24653	5.049945	7.477498	2.50271	0.642595	0.115349	0.033323
1983	14.58462	12.28908	2.166543	2.854757	0.877482	0.227608	0.054096
1984	26.87302	6.451253	4.849152	0.756994	0.897556	0.281996	0.0909
1985	12.29306	12.14372	2.438401	1.587327	0.219447	0.252228	0.110442
1986	21.93922	4.893376	4.113029	0.714861	0.358039	0.054884	0.087601
1987	51.72579	10.13116	1.974291	1.447136	0.224233	0.11451	0.047196
1988	6.615108	19.62398	3.694834	0.598068	0.36504	0.060502	0.044419
1989	23.05178	2.904582	6.529125	1.143436	0.178588	0.10558	0.031412
1990	7.504155	10.01382	1.044694	1.749048	0.317673	0.050154	0.038786
1991	12.54891	3.443532	3.757631	0.366924	0.553329	0.105472	0.030161
1992	24.09728	5.58965	1.202938	1.200322	0.118024	0.173966	0.042744
1993	9.555528	10.93608	2.069691	0.372735	0.350632	0.036811	0.069738
1994	18.44467	4.366643	4.118067	0.626564	0.118157	0.106395	0.034267
1995	15.29575	8.527512	1.682323	1.376062	0.187106	0.037185	0.04459
1996	6.588183	7.123536	3.011704	0.544772	0.433971	0.060839	0.027133
1997	24.36114	3.013374	2.299453	0.826537	0.157426	0.126374	0.025738
1998	7.003158	10.96891	0.871644	0.58211	0.229661	0.045009	0.043536
1999	5.11322	3.169927	3.273451	0.221298	0.16442	0.071363	0.027307
2000	18.98193	2.375659	0.921804	0.824768	0.05943	0.046307	0.029181
2001	4.253511	8.372126	0.731498	0.254133	0.227109	0.017082	0.021754
2002	8.206441	1.944314	2.568608	0.190241	0.06296	0.060439	0.011228
2003	1.827117	3.489312	0.546838	0.628541	0.043359	0.013967	0.015604
2004	2.69943	0.7471	0.854109	0.128728	0.147048	0.010118	0.006447
2005	1.969237	1.164763	0.195422	0.196149	0.034223	0.031079	0.003228
2006	7.197788	0.881616	0.353934	0.030342	0.033605	0.006242	0.005877
2007	2.124812	3.383427	0.306721	0.105903	0.007464	0.01021	0.003702
2008	2.957665	0.945848	1.082563	0.071573	0.023947	0.001595	0.003269
2009	5.392126	1.371983	0.300534	0.290863	0.016024	0.005705	0.001129
2010	4.470036	2.546514	0.487717	0.08722	0.084311	0.00491	0.00207
2011	3.290714	2.157449	0.966402	0.157331	0.028201	0.027783	0.002238
2012	4.123587	1.535531	0.737306	0.263548	0.042443	0.008059	0.008392
GM(81-11)	8.8167	4.2829	1.5569	0.4751	0.1401	0.0421	0.0199

***2012 values are TSA-derived projections of population numbers.**

Table 3.2.13. Cod in Division VIa. Standard errors on TSA population numbers-at-age (millions).

	Age						
Year	1	2	3	4	5	6	7+
1978							
1979							
1980							
1981	1.334331	1.84567	0.573788	0.135058	0.033668	0.009837	0.009135
1982	2.106655	0.2798	0.621667	0.195046	0.050057	0.015317	0.005148
1983	2.069512	0.769148	0.126597	0.210578	0.071398	0.022341	0.006569
1984	1.829877	0.587641	0.304754	0.046896	0.072954	0.030231	0.01007
1985	2.206325	0.691967	0.197126	0.115137	0.018282	0.032021	0.014293
1986	2.312734	0.536429	0.294116	0.058292	0.03792	0.007421	0.013754
1987	10.96245	0.819187	0.174706	0.116737	0.022209	0.01631	0.007456
1988	1.285631	3.19852	0.257703	0.05364	0.041625	0.009799	0.008076
1989	2.640965	0.310176	0.925137	0.087543	0.015963	0.014854	0.005439
1990	1.823943	0.869645	0.095748	0.228313	0.02975	0.006368	0.005858
1991	2.294114	0.558159	0.394363	0.035372	0.075871	0.012852	0.00395
1992	2.342739	0.69889	0.176869	0.138682	0.012831	0.028179	0.00639
1993	1.124471	0.893899	0.237264	0.048387	0.045565	0.005088	0.010904
1994	2.705461	0.4023	0.382207	0.077265	0.014903	0.017138	0.005501
1995	2.162236	1.023962	0.168092	0.137425	0.026058	0.005812	0.007701
1996	1.415956	0.795771	0.393826	0.060056	0.048324	0.009289	0.004246
1997	3.102241	0.467471	0.309462	0.120691	0.019989	0.01846	0.004469
1998	1.617577	1.214198	0.16063	0.092631	0.036417	0.007655	0.007917
1999	1.140879	0.544063	0.467847	0.041437	0.028231	0.012306	0.004899
2000	2.693188	0.353501	0.1547	0.126808	0.011567	0.009796	0.005498
2001	1.070254	1.110053	0.113001	0.042027	0.039962	0.003981	0.00471
2002	1.942196	0.356955	0.379975	0.034183	0.014235	0.014868	0.002845
2003	1.163956	0.740037	0.106006	0.11044	0.010765	0.00506	0.005822
2004	1.365358	0.345413	0.233724	0.028958	0.036282	0.003812	0.003303
2005	1.288313	0.444602	0.087425	0.049206	0.007892	0.011392	0.002124
2006	1.483822	0.335651	0.093156	0.011621	0.008539	0.002251	0.00299
2007	0.685376	0.634718	0.092541	0.017337	0.002164	0.002479	0.001181
2008	0.795165	0.271261	0.185326	0.015045	0.004739	0.000698	0.000903
2009	1.125494	0.257688	0.077761	0.036962	0.002863	0.001552	0.000422
2010	0.904041	0.498855	0.079777	0.015264	0.008088	0.000734	0.000469
2011	1.454341	0.448576	0.187003	0.026667	0.003934	0.00339	0.000263
2012	2.201394	0.692892	0.174888	0.065954	0.010214	0.002031	0.001914
GM(81-11)	1.7022	0.5972	0.2089	0.0608	0.0193	0.0076	0.0040

***2012 values are standard errors on TSA-derived projections of population numbers.**

Table 3.2.14: Cod in Division VIa. TSA estimates for mortality-at-age.

	Age						
Year	1	2	3	4	5	6	7+
1978							
1979							
1980							
1981	0.233993	0.560446	0.71431	0.805062	0.854456	0.855615	0.851656
1982	0.206481	0.446653	0.661265	0.783583	0.793181	0.788242	0.790401
1983	0.298293	0.533522	0.73108	0.893191	0.898247	0.912628	0.91149
1984	0.234133	0.591369	0.812701	0.97863	1.045277	1.010505	1.008125
1985	0.39178	0.701508	0.931041	1.238117	1.164933	1.219458	1.207917
1986	0.224601	0.532669	0.746547	0.911651	0.91922	0.920251	0.900929
1987	0.368141	0.631337	0.889282	1.112333	1.08146	1.081863	1.080903
1988	0.300768	0.655735	0.873352	0.951757	1.019434	1.009254	0.998372
1989	0.30679	0.647769	0.960524	1.028114	1.04423	1.058984	1.04702
1990	0.270645	0.599642	0.740219	0.910037	0.863022	0.859055	0.852307
1991	0.288331	0.667066	0.841998	0.872868	0.932568	0.945212	0.95479
1992	0.243306	0.613464	0.869723	0.976404	0.936125	0.92035	0.938748
1993	0.246106	0.593453	0.896756	0.896014	0.9676	0.942299	0.929181
1994	0.250595	0.569905	0.792308	0.9519	0.929543	0.940241	0.935966
1995	0.235933	0.651492	0.827461	0.898575	0.895627	0.901316	0.890374
1996	0.264183	0.743785	0.974431	0.98832	1.009078	1.02857	1.016581
1997	0.271068	0.811959	1.040062	1.014434	1.022273	1.041732	1.01684
1998	0.26824	0.810266	1.019498	0.995057	0.944129	0.982097	0.968394
1999	0.266294	0.828692	1.058976	1.039427	1.032158	1.016501	1.02774
2000	0.288921	0.798822	0.990638	1.031417	1.019765	1.02317	1.046052
2001	0.254653	0.784841	1.01501	1.08079	1.055485	1.021503	1.019898
2002	0.310101	0.859767	1.079734	1.142377	1.146049	1.15789	1.166242
2003	0.278482	0.878305	1.072537	1.11959	1.105625	1.12035	1.118456
2004	0.262543	0.794306	1.015629	1.005995	1.115586	1.100688	1.085414
2005	0.267787	0.785913	1.1215	1.191876	1.229136	1.181732	1.163121
2006	0.228762	0.677189	0.920556	1.021303	0.981755	0.991274	0.989227
2007	0.273013	0.768679	1.094986	1.191877	1.194583	1.190536	1.183913
2008	0.247058	0.752189	1.038706	1.152723	1.160709	1.152058	1.164008
2009	0.225489	0.64315	0.935691	0.983882	0.976228	1.007673	0.982187
2010	0.201549	0.577338	0.826061	0.91988	0.848726	0.841645	0.850519
2011	0.237978	0.694288	1.006461	1.064055	1.038851	1.073129	1.078154
2012	0.233308	0.675671	0.967374	1.02609	1.02609	1.026091	1.026091
GM(81-11)	0.2632	0.6753	0.9106	0.9988	1.0015	1.0038	0.9999

*Estimates for 2012 are TSA projections.

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

	Age						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1981	0.028204	0.050915	0.06298	0.0702	0.085228	0.08757	0.087237
1982	0.025301	0.043517	0.060207	0.071662	0.079431	0.08503	0.085352
1983	0.038593	0.050501	0.064509	0.080598	0.089542	0.094056	0.097537
1984	0.030479	0.054152	0.070415	0.085648	0.101296	0.103256	0.106035
1985	0.054249	0.070911	0.087662	0.114144	0.118438	0.129834	0.131766
1986	0.037992	0.056403	0.076181	0.092444	0.101313	0.108097	0.104921
1987	0.057666	0.069547	0.082379	0.101488	0.108691	0.113987	0.116999
1988	0.051882	0.06254	0.076888	0.089054	0.103181	0.112193	0.111572
1989	0.050219	0.061416	0.088591	0.092052	0.103915	0.109684	0.112788
1990	0.046491	0.063116	0.074137	0.091197	0.091956	0.096073	0.096265
1991	0.051224	0.072465	0.089357	0.093849	0.106068	0.111039	0.114928
1992	0.044072	0.067662	0.094776	0.105296	0.10794	0.108758	0.113723
1993	0.044394	0.06639	0.095369	0.099614	0.112018	0.114036	0.11141
1994	0.044936	0.063209	0.084337	0.104751	0.108523	0.112577	0.114602
1995	0.043385	0.071588	0.087337	0.095551	0.102089	0.106889	0.105584
1996	0.049146	0.082012	0.103932	0.105833	0.114647	0.12093	0.121947
1997	0.049728	0.089063	0.111019	0.112304	0.119161	0.124303	0.124597
1998	0.049629	0.088173	0.111593	0.110326	0.10956	0.118259	0.117042
1999	0.049733	0.090956	0.114013	0.117477	0.121437	0.122946	0.126872
2000	0.052561	0.086873	0.110707	0.117186	0.120974	0.125113	0.129426
2001	0.047422	0.08674	0.111244	0.121128	0.124385	0.124801	0.124654
2002	0.057075	0.094349	0.116909	0.129475	0.136464	0.140913	0.145654
2003	0.05195	0.097663	0.11761	0.125357	0.130557	0.136795	0.136603
2004	0.048825	0.089486	0.113661	0.114907	0.132435	0.134957	0.13426
2005	0.052277	0.102786	0.141655	0.142547	0.15211	0.149244	0.150848
2006	0.045111	0.089789	0.1182	0.117854	0.104531	0.114163	0.113853
2007	0.0535	0.102573	0.14173	0.134258	0.129596	0.13673	0.140458
2008	0.04897	0.105945	0.137965	0.139893	0.144138	0.143046	0.142555
2009	0.044916	0.091101	0.127044	0.113667	0.107012	0.119339	0.118573
2010	0.040349	0.083474	0.112659	0.102597	0.09192	0.0956	0.099582
2011	0.049755	0.111706	0.159368	0.158031	0.153964	0.160404	0.162252
2012	0.050897	0.112883	0.158734	0.158967	0.158965	0.158974	0.158976
GM(81-11)	0.0457	0.0758	0.0984	0.1062	0.1119	0.1168	0.1180

***Estimates for 2012 are standard errors of TSA projections of log *F*.**

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

Year	Landings (000 tonnes)			Discards (000 tonnes)			Total catch (000 tonnes)			Mean F (2–5)		SSB (000 tonnes)		TSB (000 tonnes)		Recruitment at age 1 (millions)	
	Obs.	Pred.	SE	Obs.	Pred.	SE	Obs.	Pred.	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
1981	23.865	23.76	1.494	0.303	0.121	0.082	24.168	23.881	1.497	0.734	0.051	40.261	2.139	58.553	3.16	11.348	1.334
1982	21.511	20.586	1.294	0.571	0.555	0.233	22.082	21.141	1.279	0.671	0.048	38.418	2.033	58.057	2.68	26.247	2.107
1983	21.305	20.389	1.039	0.197	0.213	0.115	21.503	20.601	1.044	0.764	0.052	34.088	1.463	49.539	2.173	14.585	2.07
1984	21.272	20.072	1.044	0.329	0.713	0.269	21.601	20.785	1.019	0.857	0.056	31.261	1.357	53.536	2.105	26.873	1.83
1985	18.607	18.061	0.876	0.963	0.384	0.137	19.57	18.444	0.87	1.009	0.074	25.256	1.138	36.265	1.696	12.293	2.206
1986	11.82	11.688	0.775	0.263	0.676	0.197	12.083	12.364	0.813	0.778	0.063	19.789	1.025	34.445	1.73	21.939	2.313
1987	18.971	17.342	1.146	2.388	0.963	0.476	21.358	18.305	1.282	0.929	0.065	21.015	1.047	43.426	3.667	51.726	10.962
1988	20.413	19.043	1.813	0.368	0.221	0.095	20.781	19.264	1.824	0.875	0.059	26.751	2.063	43.125	3.881	6.615	1.286
1989	17.169	15.95	1.492	2.076	0.976	0.346	19.246	16.926	1.546	0.92	0.061	23.338	2.075	37.106	2.797	23.052	2.641
1990	12.175	12.178	0.867	0.571	0.125	0.051	12.746	12.303	0.875	0.778	0.061	19.806	1.394	27.692	1.916	7.504	1.824
1991	10.927	10.716	1.166	0.622	0.293	0.129	11.549	11.009	1.198	0.829	0.071	16.74	1.532	24.855	2.394	12.549	2.294
1992	9.086	9.356	1.1	1.779	0.699	0.213	10.865	10.055	1.14	0.849	0.075	14.071	1.411	25.027	2.216	24.097	2.343
1993	10.314	11.476	1.194	0.139	0.37	0.132	10.453	11.846	1.208	0.838	0.074	17.447	1.45	30.198	2.362	9.556	1.124
1994	8.928	11.128	1.159	0.661	0.528	0.183	9.588	11.656	1.201	0.811	0.072	18.081	1.514	28.782	2.396	18.445	2.705
1995	9.439	11.475	1.235	0.141	0.354	0.118	9.58	11.829	1.261	0.818	0.071	17.973	1.568	29.745	2.614	15.296	2.162
1996	9.427	12.276	1.376	0.063	0.215	0.076	9.489	12.492	1.396	0.929	0.08	18.079	1.728	26.699	2.632	6.588	1.416
1997	7.034	9.883	1.226	0.499	0.822	0.307	7.533	10.705	1.308	0.972	0.086	13.24	1.486	26.814	2.708	24.361	3.102
1998	5.714	9.447	1.204	0.538	0.236	0.098	6.252	9.683	1.221	0.942	0.083	11.656	1.291	19.043	2.105	7.003	1.618
1999	4.201	7.61	1.115	0.069	0.198	0.073	4.27	7.808	1.14	0.99	0.089	10.833	1.394	15.656	2.042	5.113	1.141
2000	2.977	6.175	0.855	0.821	0.648	0.238	3.798	6.823	0.918	0.96	0.087	7.856	1.038	16.497	1.931	18.982	2.693
2001	2.347	6.596	0.931	0.092	0.19	0.077	2.439	6.785	0.948	0.984	0.089	8.604	1.054	14.316	1.786	4.254	1.07
2002	2.243	6.259	0.969	0.48	0.265	0.12	2.722	6.524	1.006	1.057	0.096	8.107	1.134	12.932	1.84	8.206	1.942
2003	1.241	4.304	0.802	0.034	0.094	0.056	1.275	4.398	0.826	1.044	0.094	5.824	0.967	8.508	1.654	1.827	1.164
2004	0.54	2.435	0.634	0.072	0.1	0.057	0.612	2.534	0.665	0.983	0.09	3.574	0.848	5.023	1.33	2.699	1.365
2005	0.511	1.738	0.477	0.041	0.093	0.059	0.552	1.832	0.497	1.082	0.109	2.312	0.555	3.764	0.986	1.969	1.288
2006	0.488	0.402	0.069	0.504	1.092	0.251	0.992	1.494	0.288	0.9	0.081	1.7	0.317	4.231	0.667	7.198	1.484
2007	0.595	0.516	0.071	2.363	1.925	0.378	2.957	2.441	0.396	1.063	0.093	3.018	0.418	5.094	0.722	2.125	0.685
2008	0.682	0.564	0.082	1.363	1.644	0.317	2.045	2.208	0.322	1.026	0.098	3.102	0.413	4.548	0.583	2.958	0.795
2009	0.408	0.435	0.052	2.538	1.602	0.258	2.946	2.037	0.263	0.885	0.078	2.727	0.3	5.113	0.566	5.392	1.125
2010	0.559	0.543	0.057	2.881	1.831	0.327	3.44	2.375	0.338	0.793	0.068	3.498	0.411	6.396	0.779	4.47	0.904
2011	0.523	0.496	0.052	5.84	2.302	0.376	6.364	2.798	0.378	0.951	0.114	3.865	0.48	5.934	0.791	3.291	1.454
2012	NA	0.764	0.244	NA	1.901	0.494	NA	2.665	0.557	0.924	0.114	3.707	0.708	5.846	1.246	4.124	2.201
Min	0.4080	0.4020	0.0520	0.0340	0.0930	0.0510	0.5520	1.4940	0.2630	0.6710	0.0480	1.7000	0.3000	3.7640	0.5660	1.8270	0.6850
GM	4.3710	5.6630	0.6099	0.4449	0.4329	0.1541	6.3049	7.7961	0.8576	0.8977	0.0753	10.8724	1.0454	17.9048	1.7389	8.8167	1.7021
AM	8.8804	9.7709	0.8925	0.9538	0.6596	0.1885	9.8342	10.4305	0.9667	0.9039	0.0770	15.2352	1.1949	24.5458	1.9648	12.5342	2.0144
Max	23.8650	23.7600	1.8130	5.8400	2.3020	0.4760	24.1680	23.8810	1.8240	1.0820	0.1140	40.2610	2.1390	58.5530	3.8810	51.7260	10.9620

*** Estimates for 2012 are TSA projections.**

Table 3.2.17. Cod in Division VIa. Inputs to short-term predictions from TSA run. Mean weights assumed from final three years.

Table_____Cod,,,VIa,,

input data for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	4123	0.53	WS1	0.24	0.11
N2	1535	0.45	WS2	1.23	0.14
N3	737	0.24	WS3	2.29	0.03
N4	263	0.25	WS4	3.49	0.07
N5	42	0.24	WS5	5.48	0.12
N6	8	0.25	WS6	6.22	0.07
N7	8	0.23	WS7	8.83	0.11
H.cons selectivity			Weight in the HC catch		
sH1	0.00	1.73	WH1	0.33	1.73
sH2	0.02	0.32	WH2	1.64	0.17
sH3	0.08	1.13	WH3	2.99	0.09
sH4	0.32	0.69	WH4	4.27	0.10
sH5	0.85	0.15	WH5	5.67	0.06
sH6	0.60	0.72	WH6	6.95	0.15
sH7	0.97	0.12	WH7	8.83	0.11
Discard selectivity			Weight in the discards		
sD1	0.22	1.73	WD1	0.24	0.11
sD2	0.62	0.32	WD2	1.22	0.14
sD3	0.84	1.13	WD3	2.24	0.01
sD4	0.66	0.69	WD4	3.18	0.05
sD5	0.10	0.15	WD5	2.71	0.92
sD6	0.38	0.72	WD6	3.54	0.92
sD7	0.00	0.12	WD7	0.00	0.00
Natural mortality			Proportion mature		
M1	0.53	0.10	MT1	0.00	0.10
M2	0.39	0.10	MT2	0.52	0.10
M3	0.31	0.10	MT3	0.86	0.10
M4	0.26	0.10	MT4	1.00	0.10

```
M5          0.24   0.10     MT5         1.00   0.00
M6          0.22   0.10     MT6         1.00   0.00
M7          0.21   0.10     MT7         1.00   0.00

Relative effort             Year effect for natural mortality
in HC fishery
HF12        1.00   0.05     K12         1.00   0.10
HF13        1.00   0.05     K13         1.00   0.10
HF14        1.00   0.05     K14         1.00   0.10

Recruitment in 2013 and 2014
R13         3603   0.54
R14         3603   0.54



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

Stock numbers in 2012 are TSA survivors.,,
```

Table 3.2.18. Cod in Division VIa. Results of short-term forecasts from TSA run. Management options.

Table_____.Cod,,,VIa,,

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

		Year						
	2012	2013						
Mean F Ages								
H.cons 2 to 5	0.88	0.00	0.18	0.35	0.53	0.70	0.88	1.05
Effort relative to 2011								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Biomass								
Total 1 January	5.85	5.82	5.82	5.82	5.82	5.82	5.82	5.82
SSB at spawning time	3.71	3.62	3.62	3.62	3.62	3.62	3.62	3.62
Catch weight (,000t)								
H.cons	0.518	0.000	0.152	0.279	0.386	0.475	0.549	0.612
Discards	2.015	0.000	0.504	0.941	1.321	1.652	1.940	2.193
Total Catch	2.533	0.000	0.656	1.220	1.706	2.126	2.490	2.805
Biomass in year.... 2014								
Total 1 January		9.34	8.37	7.54	6.82	6.20	5.65	5.18
SSB at spawning time		6.79	5.93	5.19	4.56	4.02	3.56	3.15

		Year						
	2012	2013						
Effort relative to 2011								
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	0.20	0.34	0.34	0.34	0.34	0.34	0.34	0.34
SSB at spawning time	0.18	0.36	0.36	0.36	0.36	0.36	0.36	0.36
Catch weight								

H.cons	0.37	0.00	0.49	0.46	0.47	0.48	0.48	0.49
Discards	0.40	0.00	0.45	0.39	0.37	0.35	0.35	0.34
Biomass in year.... 2014								
Total 1 January		0.30	0.32	0.35	0.37	0.39	0.42	0.44
SSB at spawning time		0.34	0.36	0.39	0.42	0.45	0.48	0.51

Table 3.2.19. Cod in Division VIa. Results of short-term forecasts from TSA run. Detailed tables.

Table_____.Cod,,,VIa,,

Detailed forecast tables.

Forecast for year 2012

F multiplier H.cons=1.00

Populations		Catch number		
Age	Stock No.	H.Cons	Discards	Total
1	4124	0	643	643
2	1536	15	598	613
3	737	34	357	392
4	264	49	100	149
5	42	21	3	24
6	8	3	2	5
7	8	5	0	5
Wt	6	1	2	3

Forecast for year 2013

F multiplier H.cons=1.00

Populations		Catch number		
Age	Stock No.	H.Cons	Discards	Total

1	3604	0	562	562
2	1948	20	759	778
3	551	26	267	293
4	216	40	82	122
5	75	38	5	42
6	13	4	3	7
7	5	3	0	3
Wt	6	1	2	2

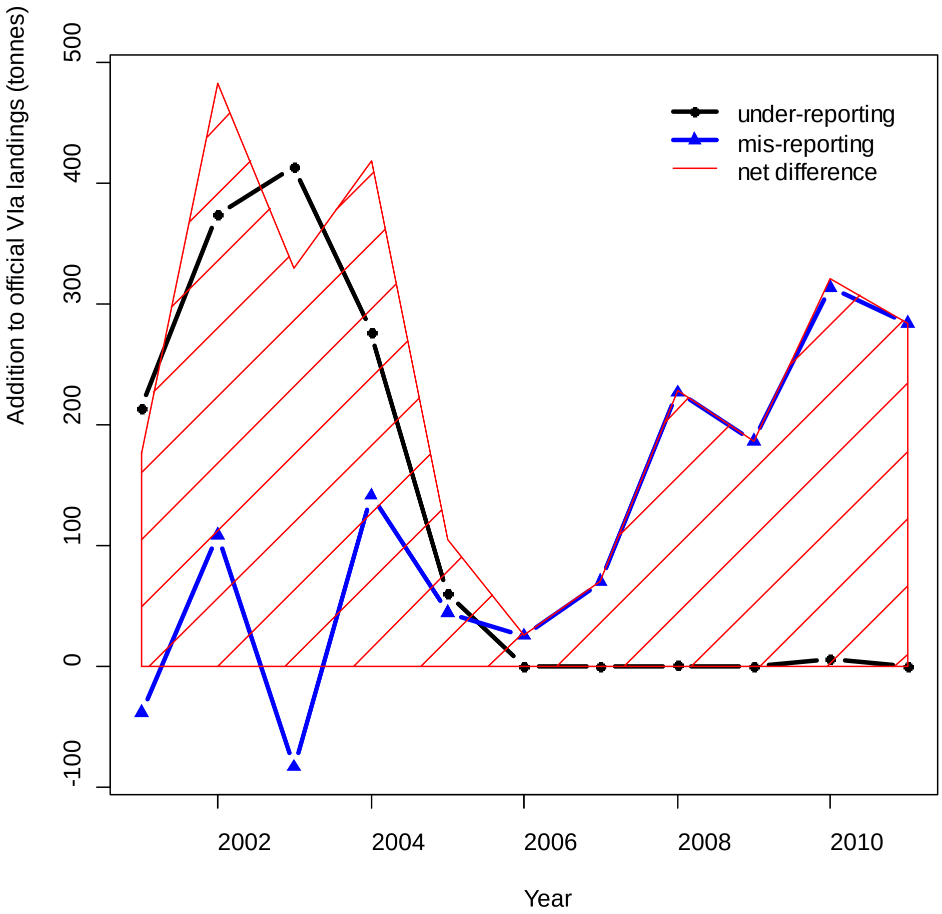


Figure 3.2.1. Cod in Division VIa. Estimates of underreporting and area misreporting of cod caught in ICES Division VIa by Scottish vessels. Negative values of area misreporting indicate a net balance of misreporting into Division VIa from other areas.

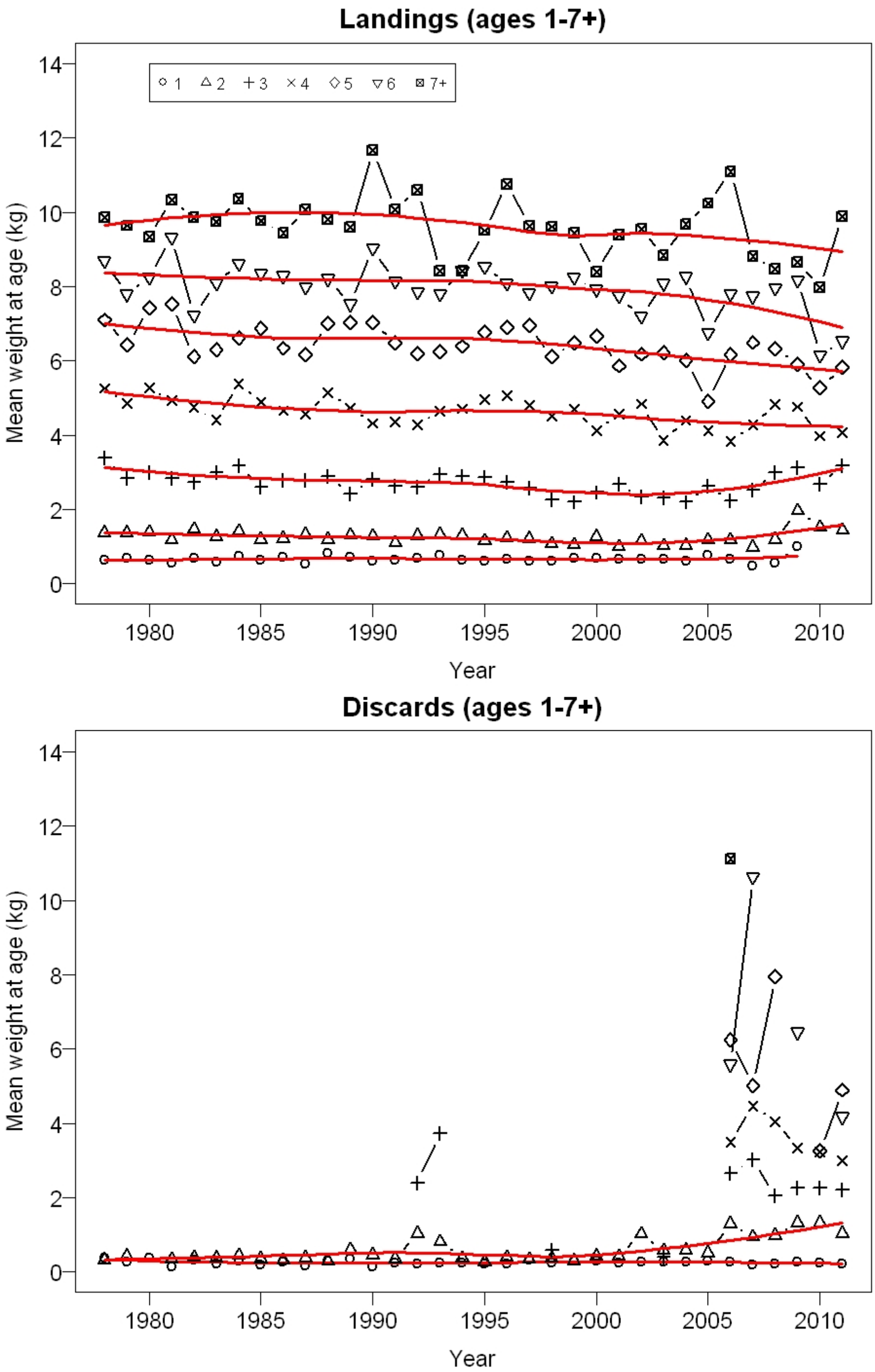


Figure 3.2.2. Cod in Division VIa. Mean weights-at-age in landings and discards. A loess smooth has been fitted to the data at each age, with a span including three quarters of the datapoints.

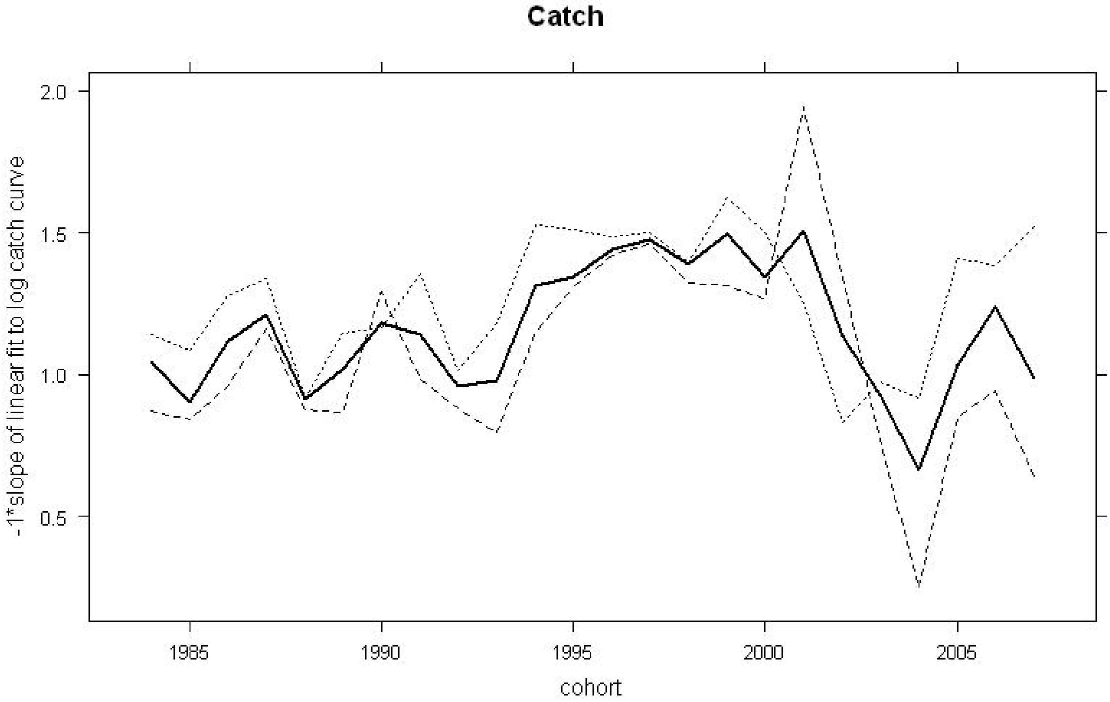


Figure 3.2.3. Cod in Division VIa. Log catch (landings + discards) curve gradient plot using WG commercial catch-at-age data. Solid line shows time-series of gradient of linear fit to curve over the age range 2–5, dashed line over the ages 2–4 and dotted line over the ages 3–5. An increasing value indicates increasing mortality.

2010 2011

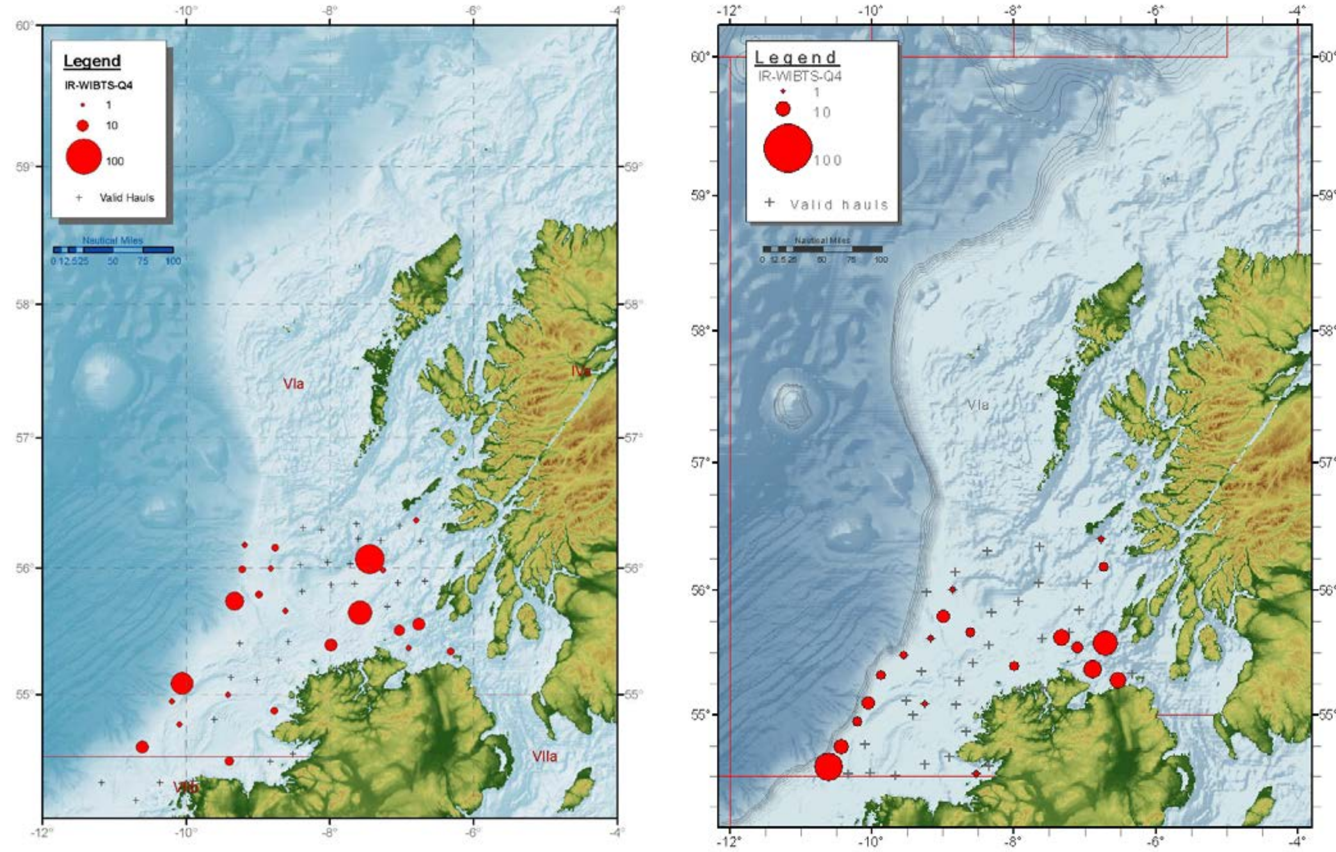
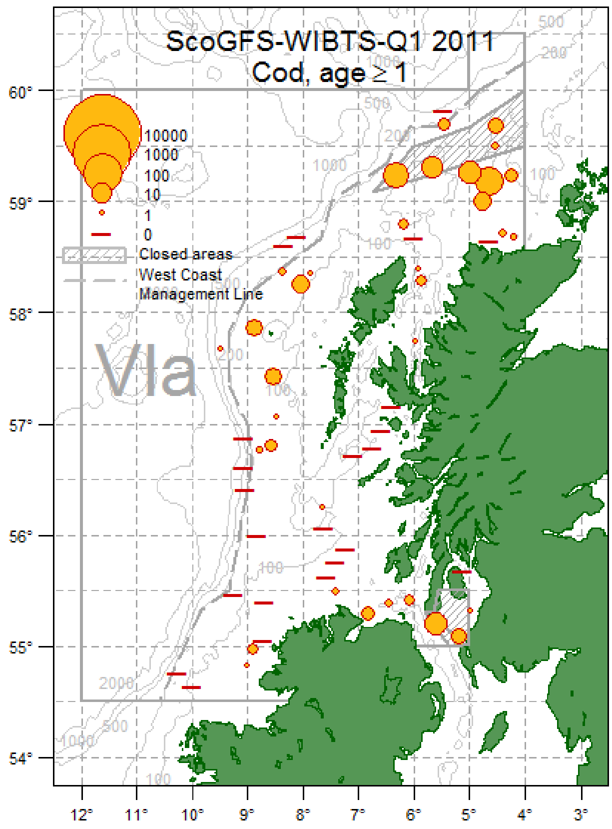


Figure 3.2.4. Cod in Division VIa. Cpue numbers for fish aged at 1+ per haul resulting from quarter four Irish ground fish survey (IRGFS-WIBTS-Q4). Irish Survey values are for fish >23cm in length (proxy for age 1+) and numbers are standardised to 60 minutes towing.

2011



2012

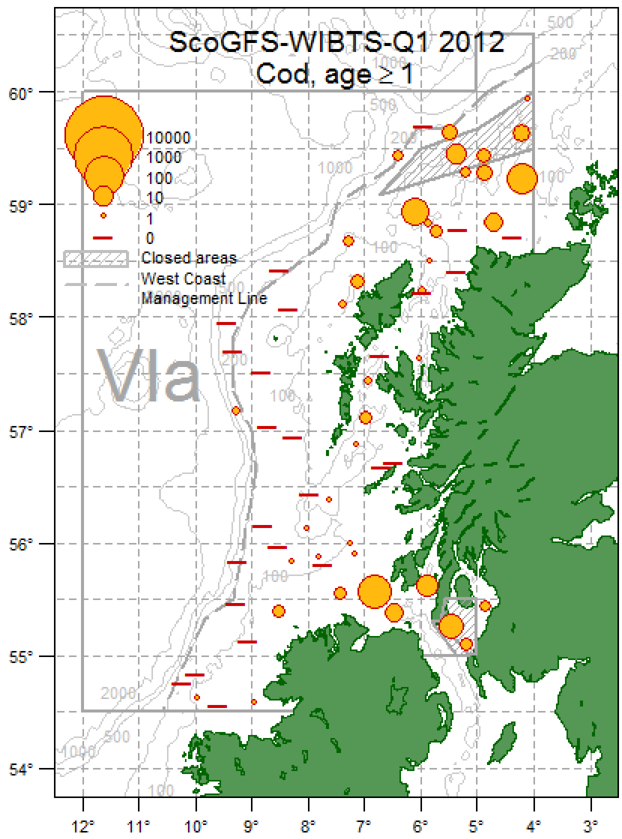


Figure 3.2.4 cont. Cod in Division VIa. Cpue numbers for fish aged at 1+ per haul resulting from Scottish quarter one survey (UKSGFS-WIBTS-Q1). Numbers are standardised to 60 minutes towing.

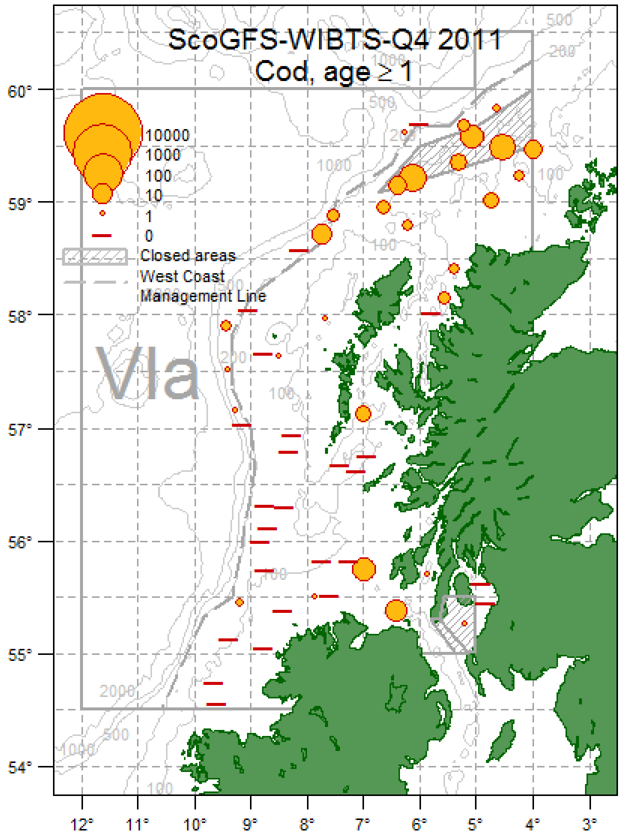


Figure 3.2.4 cont. Cod in Division VIa. Cpue numbers for fish aged at 1+ per tow resulting from Scottish quarter four survey (UKSGFS-WIBTS-Q4). Numbers are standardised to 60 minutes towing. Note that no Scottish quarter four ground fish survey (ScoGFS-WIBTS-Q4) took place in 2010.

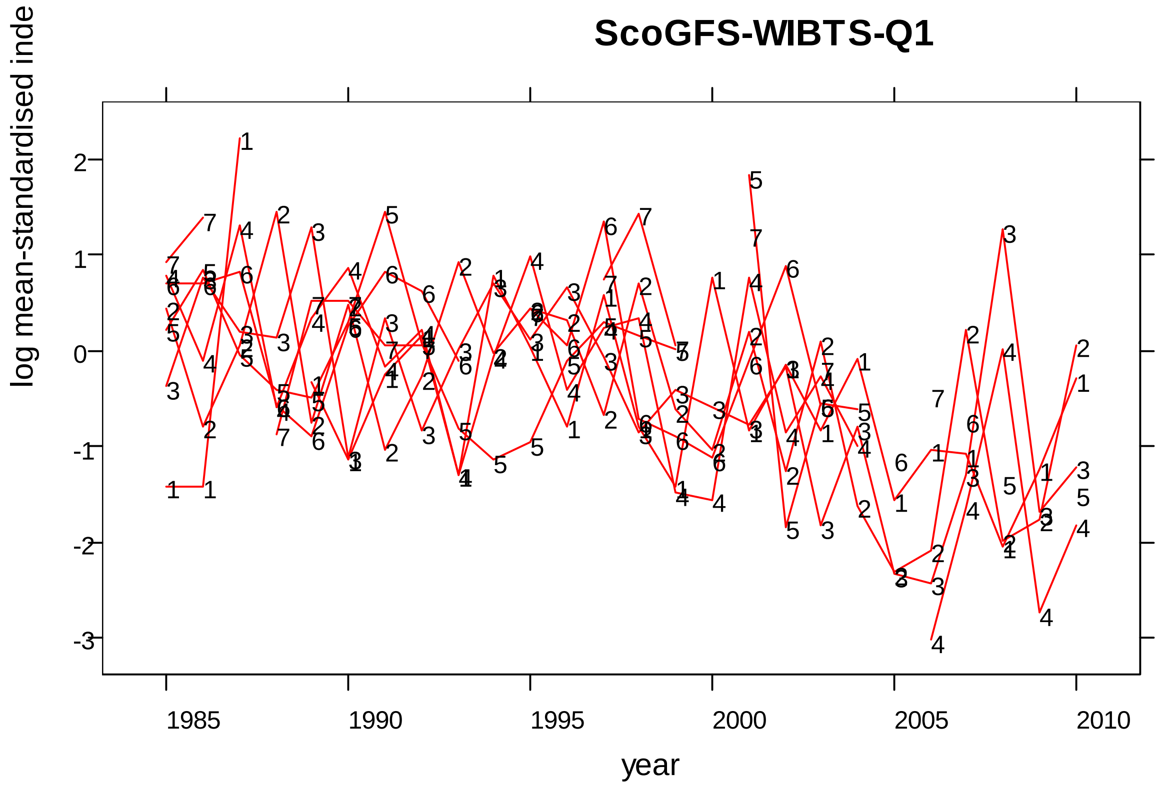


Figure 3.2.5. Cod in Division VIa. Log mean standardised index values -by year- from Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1); ages 1–6. Survey finished in 2010.

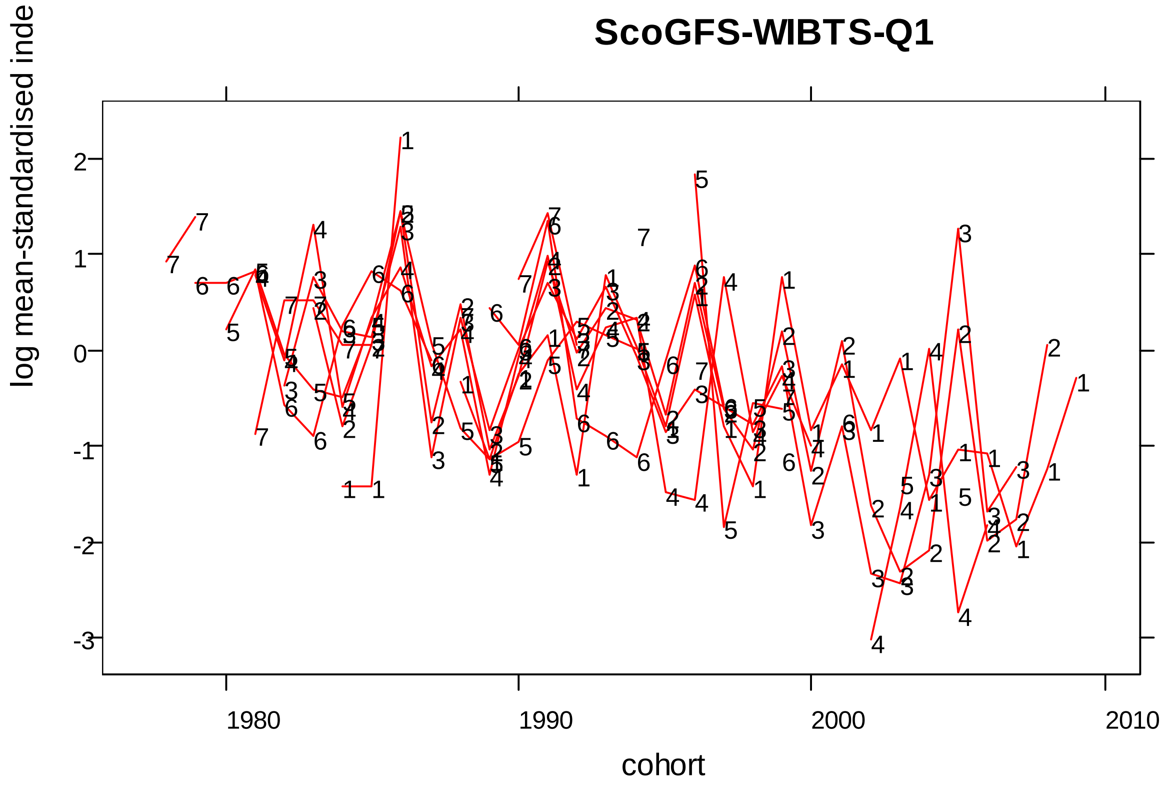


Figure 3.2.6. Cod in Division VIa. Log mean standardised index values -by cohort- from Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1); ages 1–6. Survey finished in 2010.

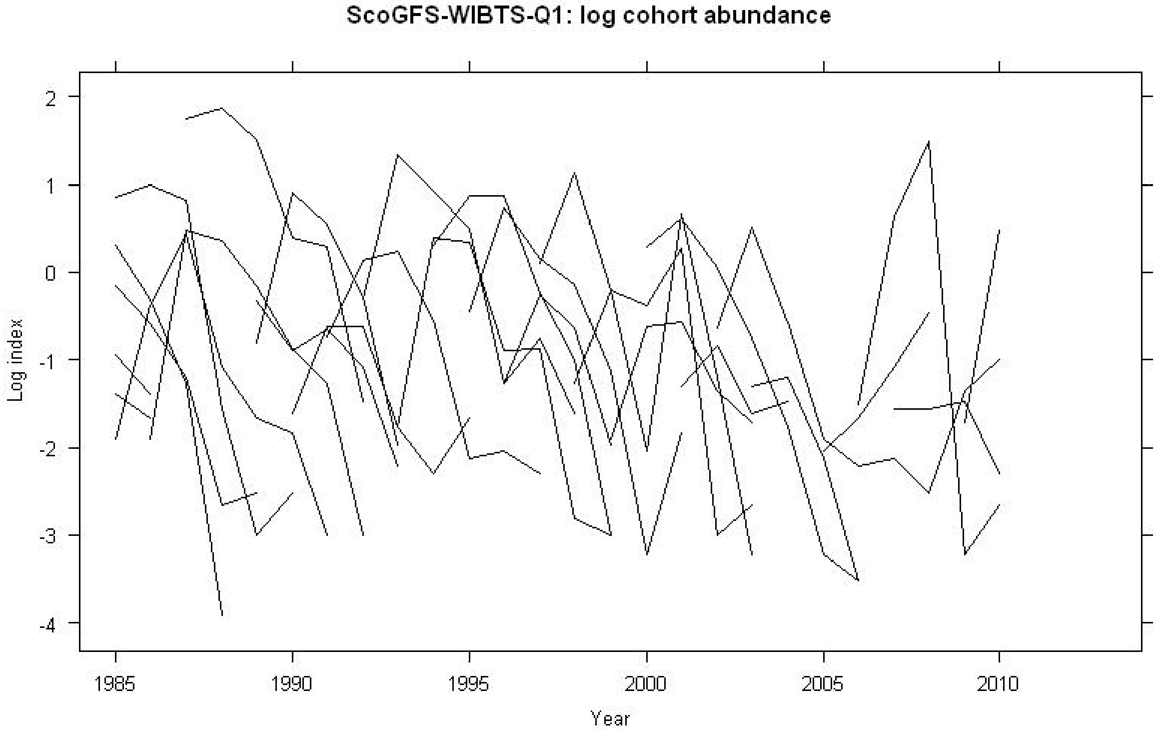


Figure 3.2.7. Cod in Division VIa. Log catch curves from Scottish quarter one ground fish survey (ScoGFS-WIBTS-Q1); ages 1–6. Survey finished in 2010.

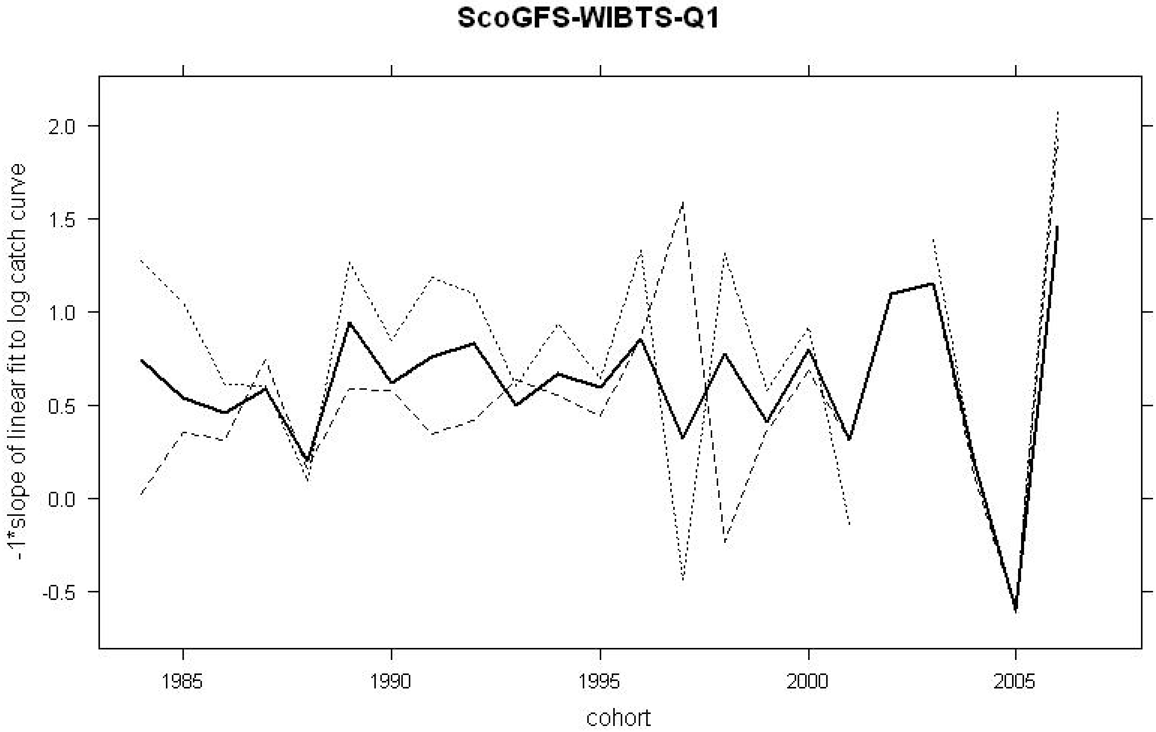


Figure 3.2.8. Cod in Division VIa. Log catch curve gradient plot using ScoGFS-WIBTS-Q1 index data. Solid line shows time-series of gradient of linear fit to curve over the age range 2–5, dashed line over the ages 2–4 and dotted line over the ages 3–5. An increasing value indicates increasing mortality. Last cohort shown was at age 5 in 2010, the last year of the ScoGFS-WIBTS-Q1 survey.

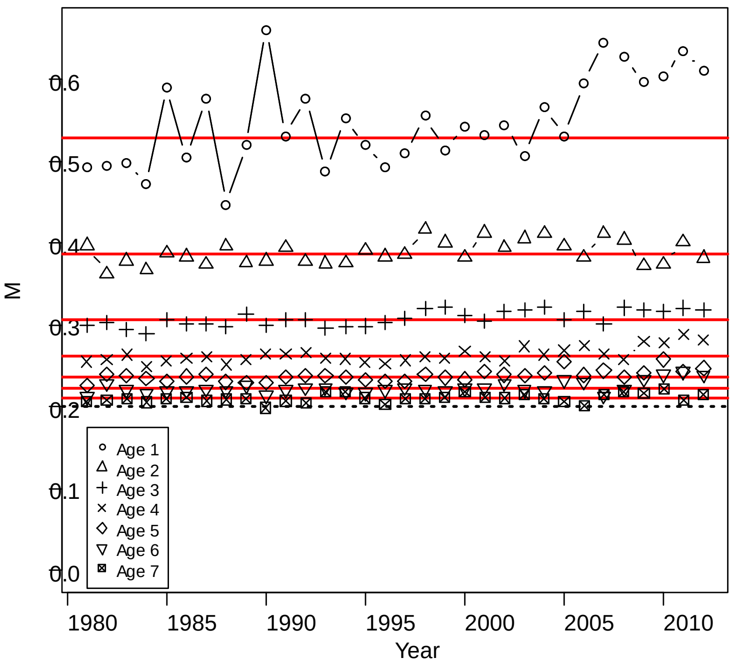


Figure 3.2.09. Cod in Division VIa. Natural mortality-at-age based on mean weight-at-age and mortality–weight relationship. Solid horizontal lines show the time averaged values at each age used in the assessment. Dotted horizontal line shows value of 0.2 previously used at all ages in all years.

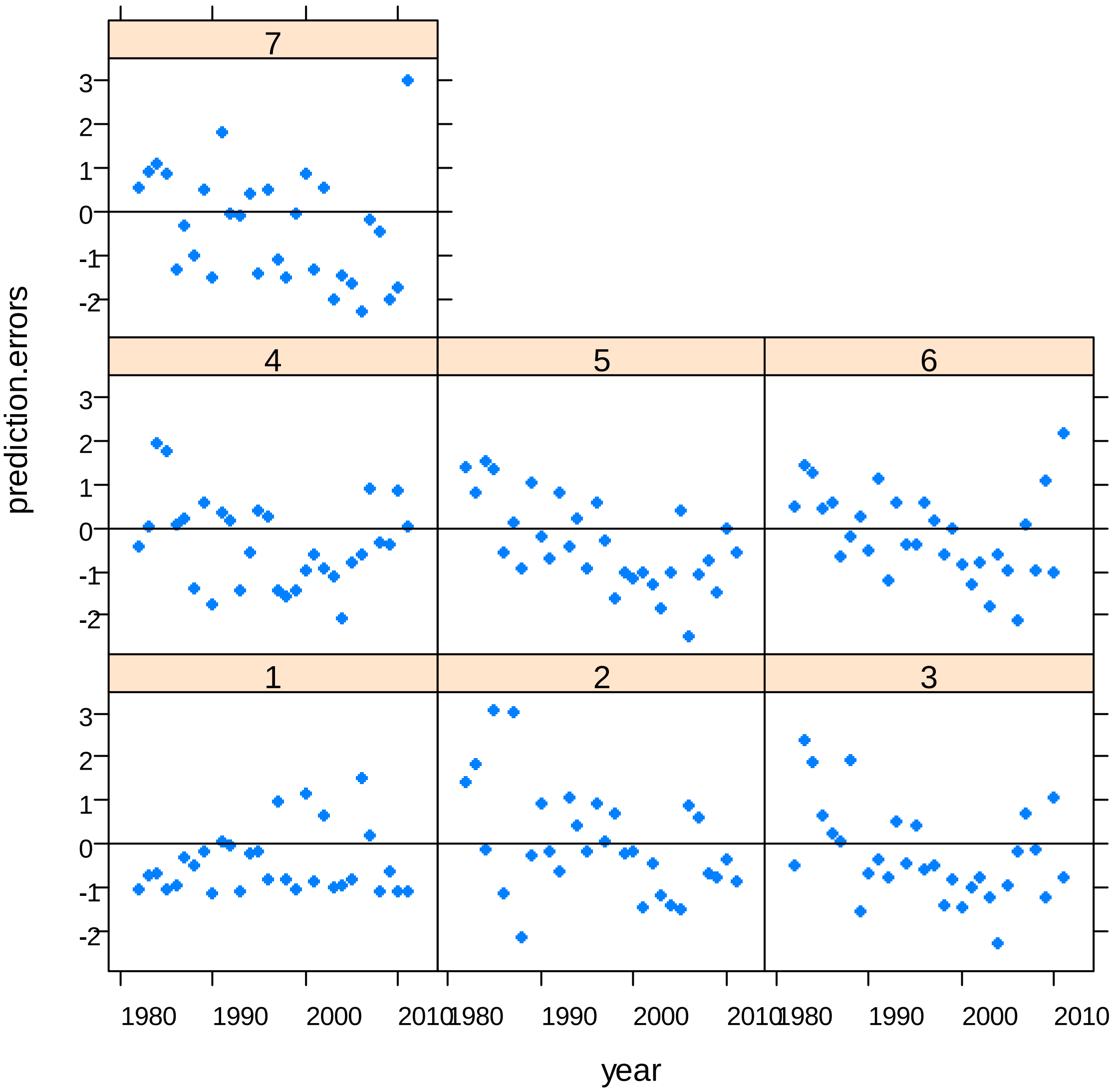


Figure 3.2.10. Cod in Division VIa. TSA final run. Standardised prediction errors at age plots for landings.

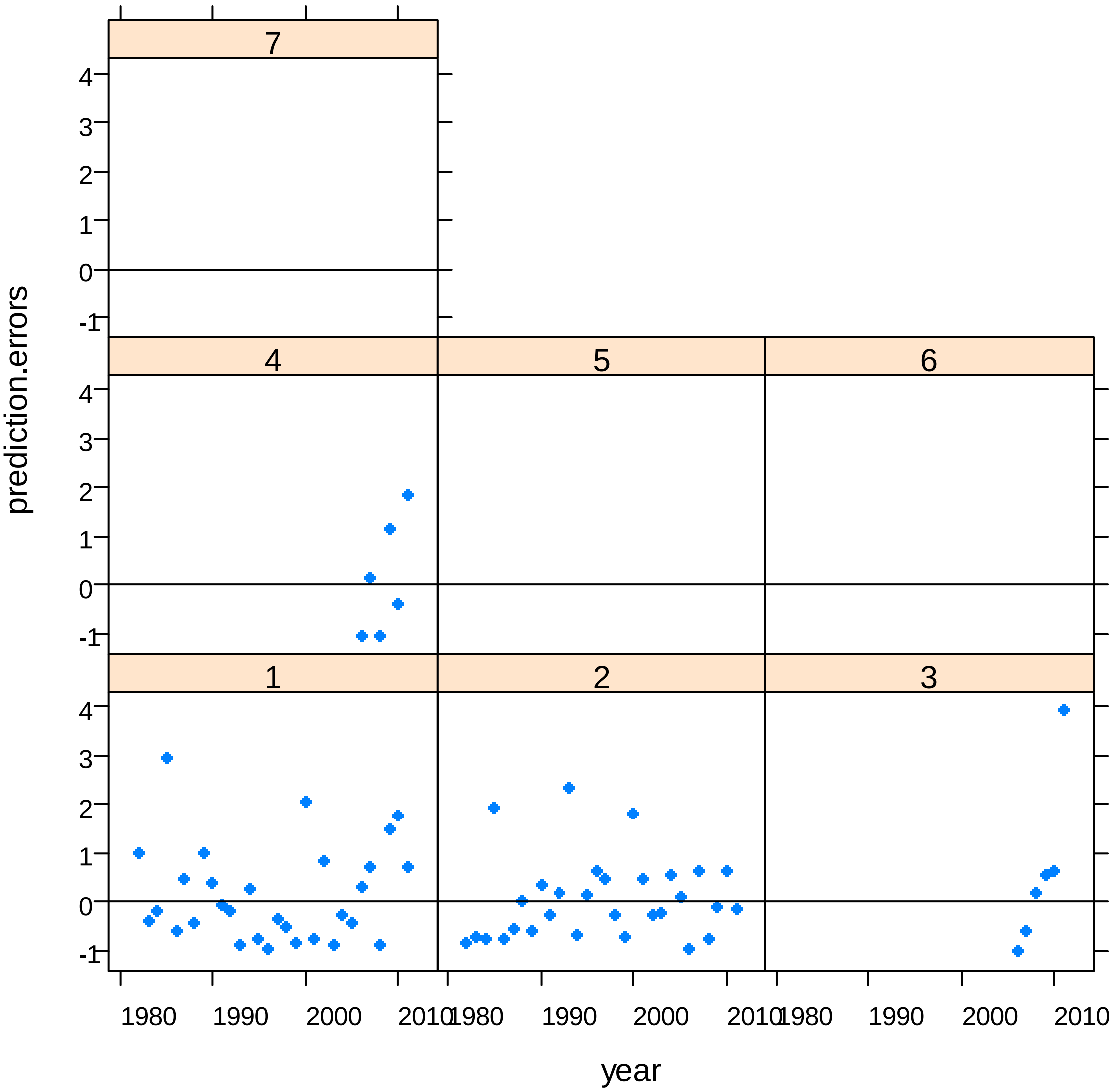


Figure 3.2.11. Cod in Division VIa. TSA final run. Standardised prediction errors at age plots for discards.

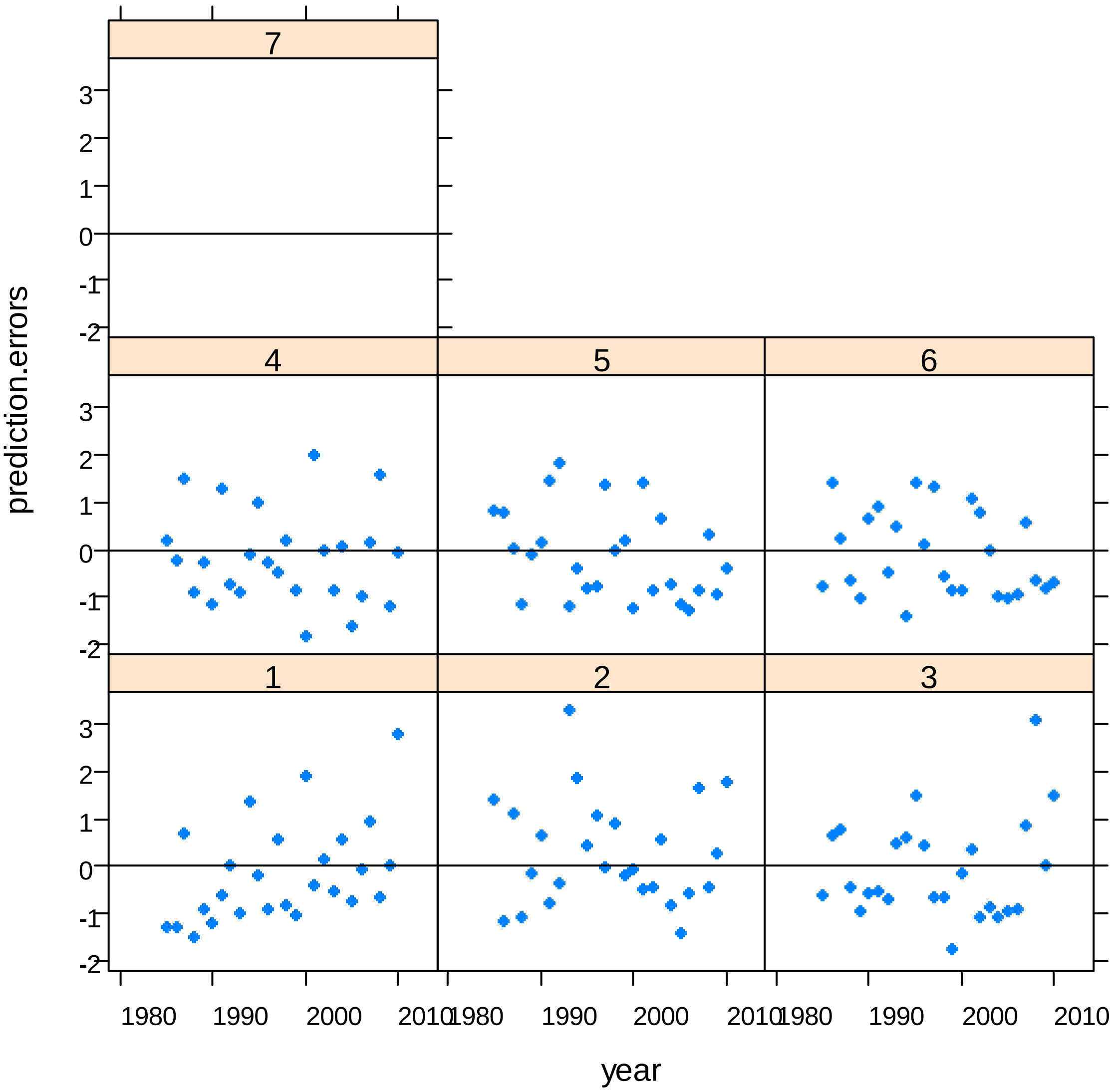


Figure 3.2.12. Cod in Division VIa. TSA run. Standardised prediction errors at age plots for ScoGFS-WIBTS-Q1.

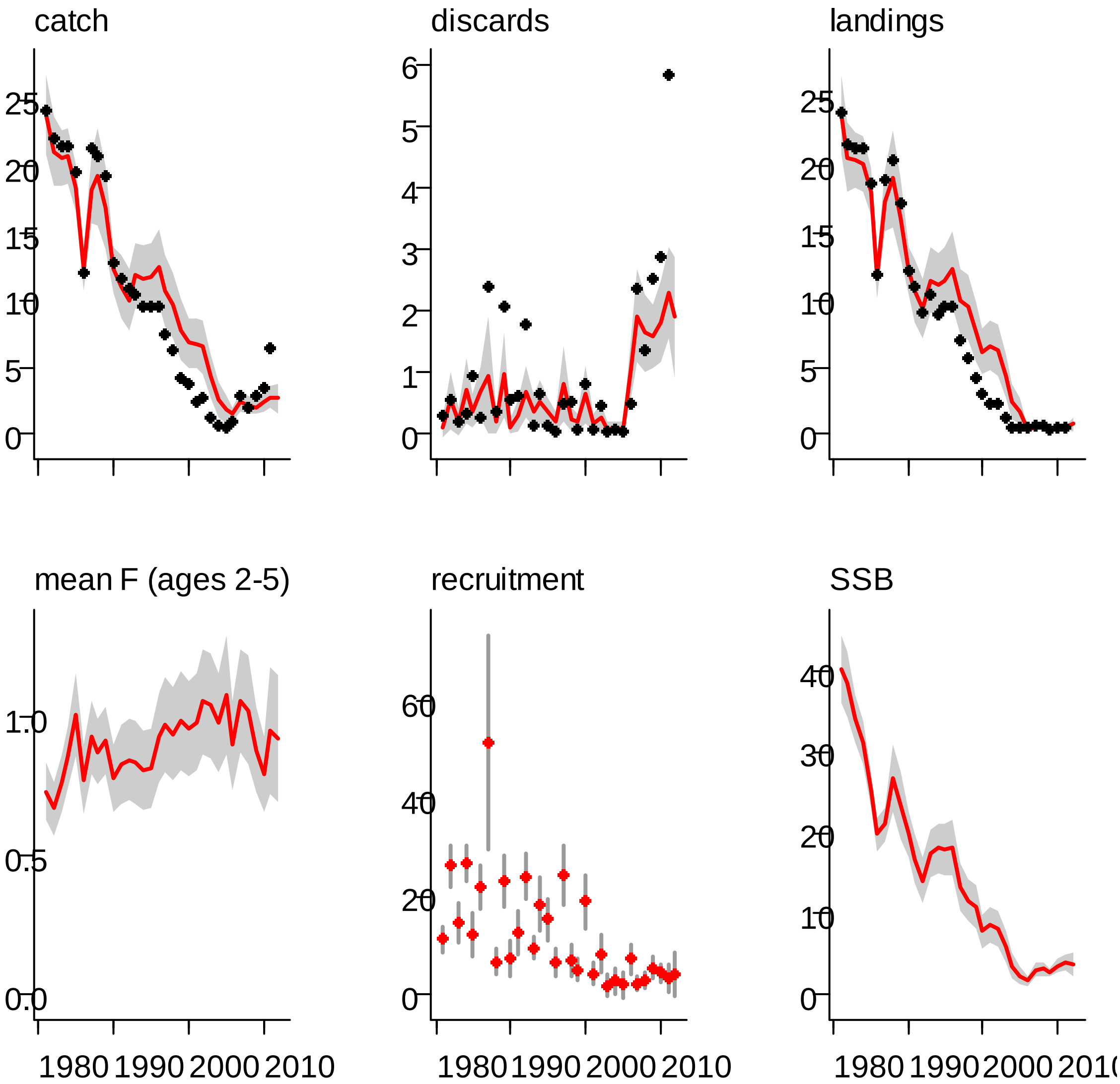


Figure 3.2.13. Cod in Division VIa. Summary plot of final TSA run.

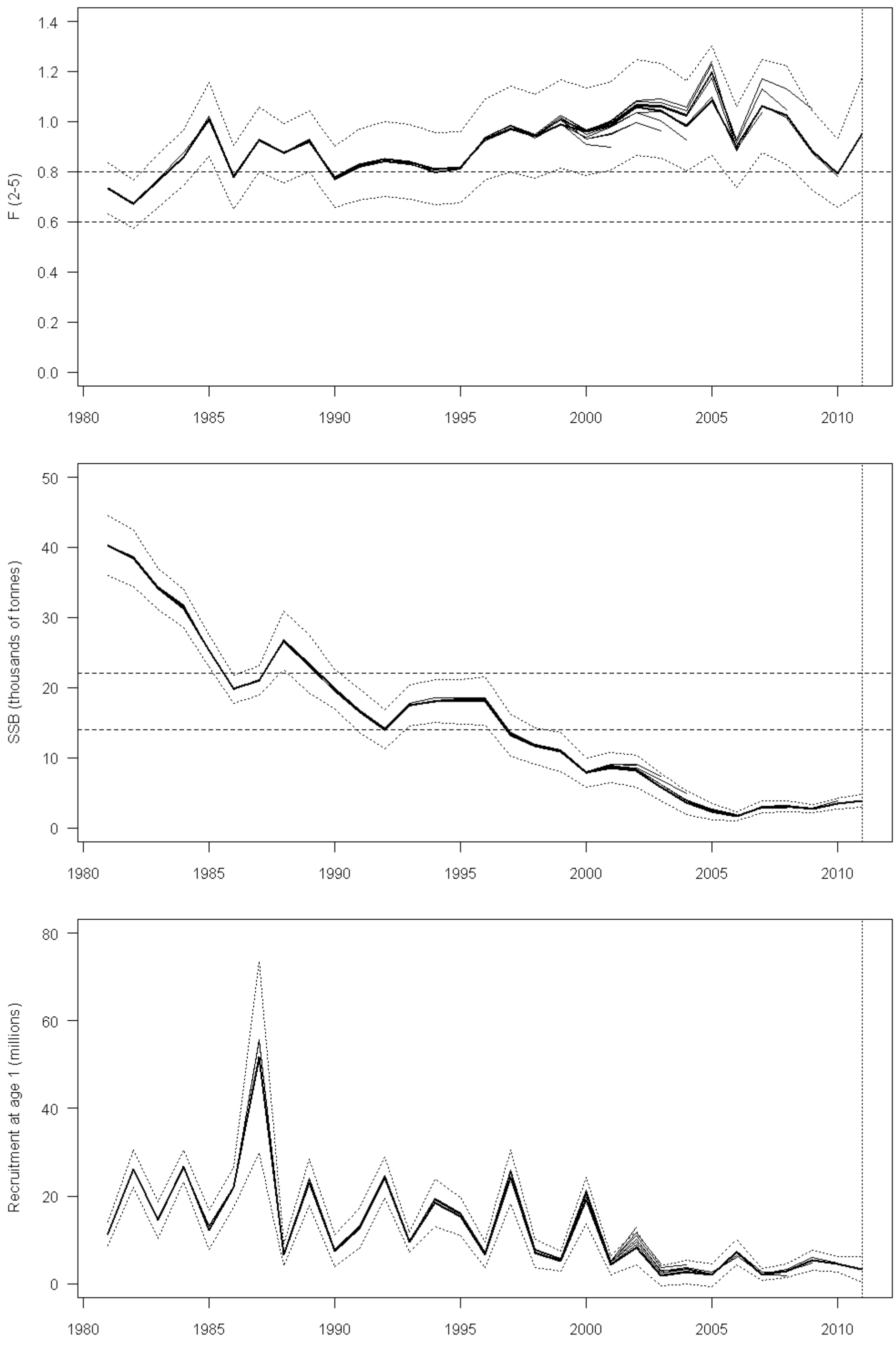


Figure 3.2.14. Cod in Division VIa. Retrospective plots of TSA run. Biological reference points are given by horizontal dashed lines. Confidence intervals for the run using all years of data are shown by dotted lines.

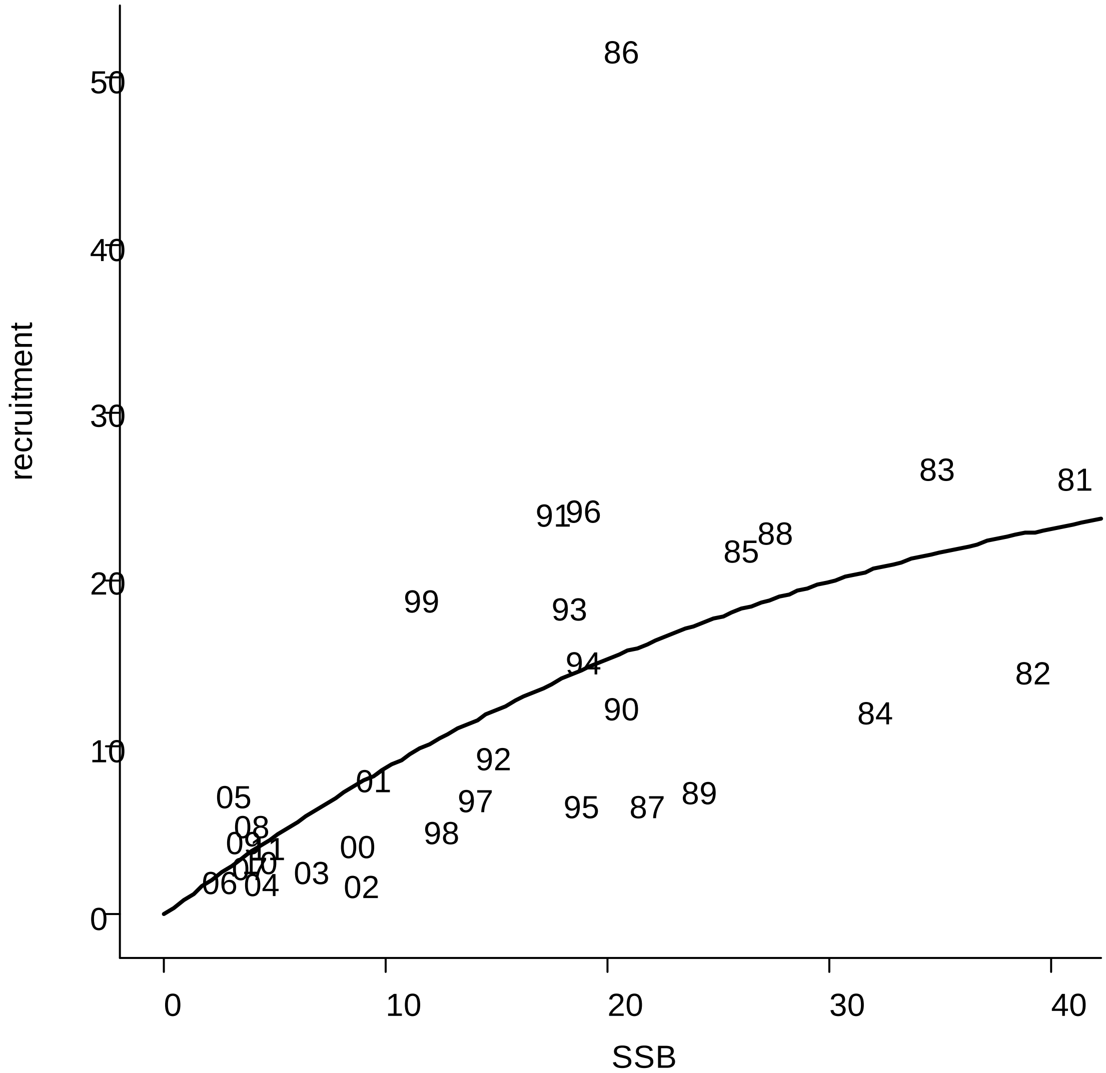


Figure 3.2.15. Cod in Division VIa. TSA final run. Stock–recruit relationship. Numbers indicate year class.

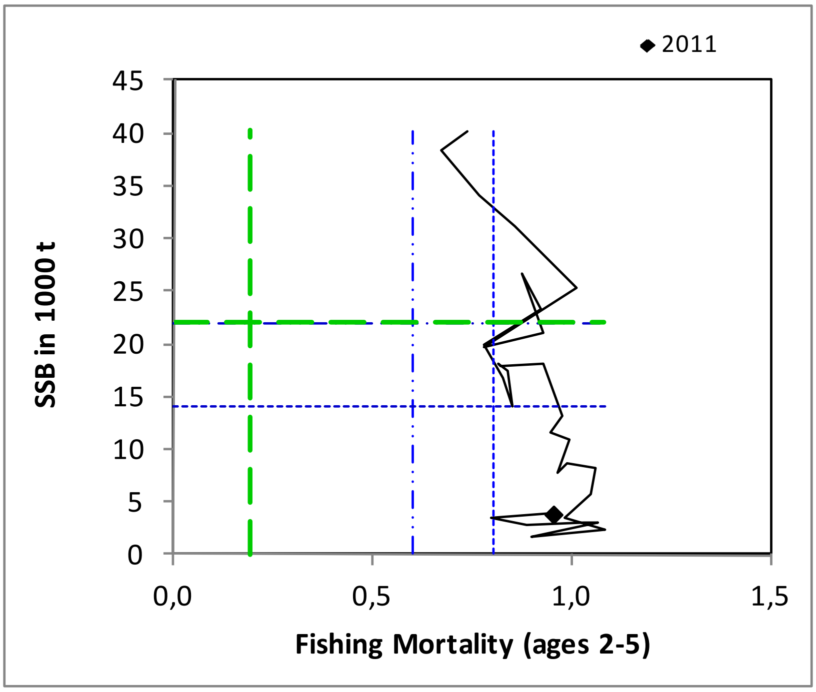
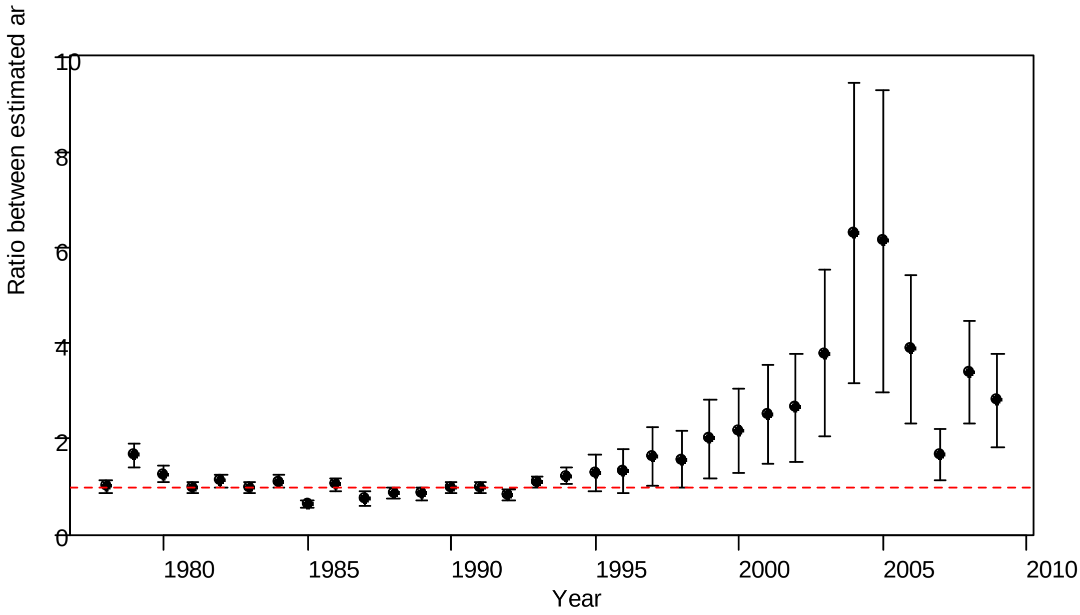


Figure 3.2.16. Cod in Division VIa. Precautionary approach plot.

a)



b)

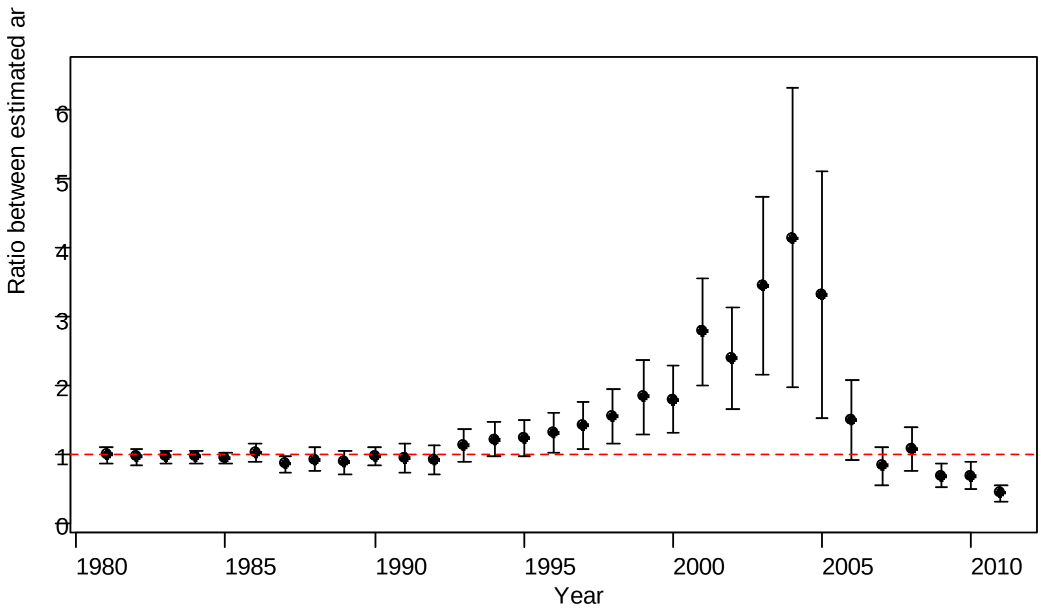


Figure 3.2.17. Cod in Division VIa. Ratio of estimated to observed catch using TSA, a) result from 2010 when catch was estimated using survey data for all years from 1995; b) 2012 assessment. Bars show ± 2 s.e.

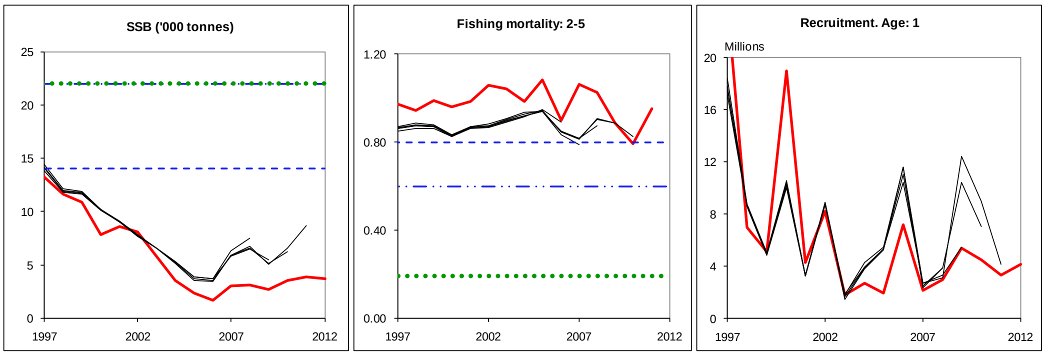


Figure 3.2.18. Cod in Division VIa. Comparison of SSB, mean F (2–5) estimates and recruitment-at-age one produced by final run assessments between this year's assessment and assessments going back to 1997.

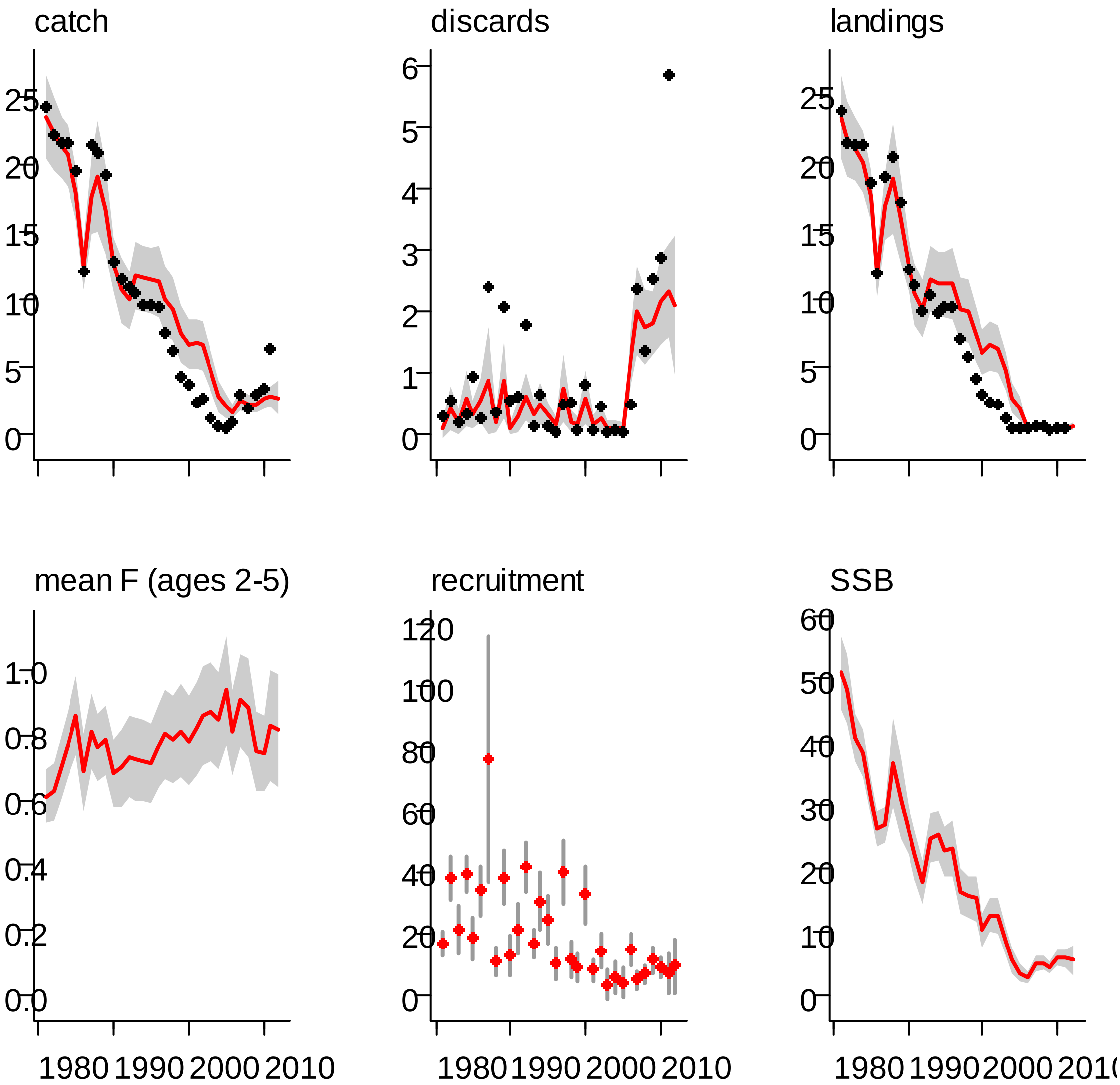


Figure 3.2.19. Cod in Division VIa. Summary plot of supplementary TSA run. Run includes a seal predation model within the assessment.

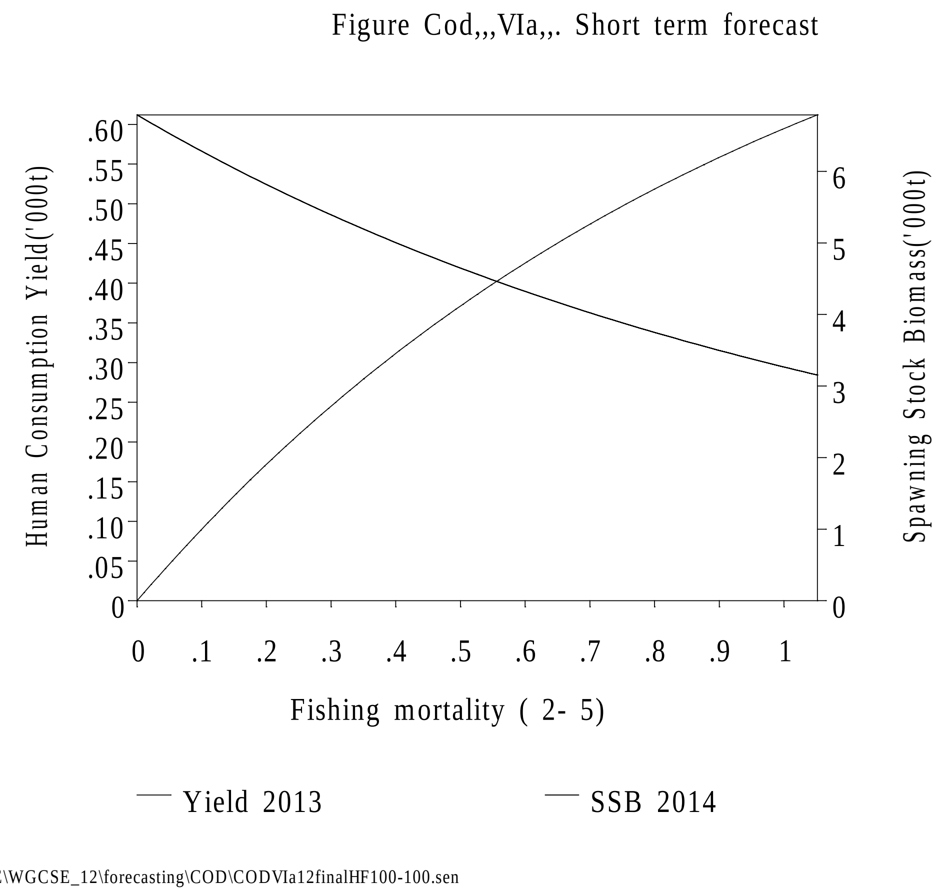


Figure 3.2.20. Cod in Division VIa. Short-term forecast.

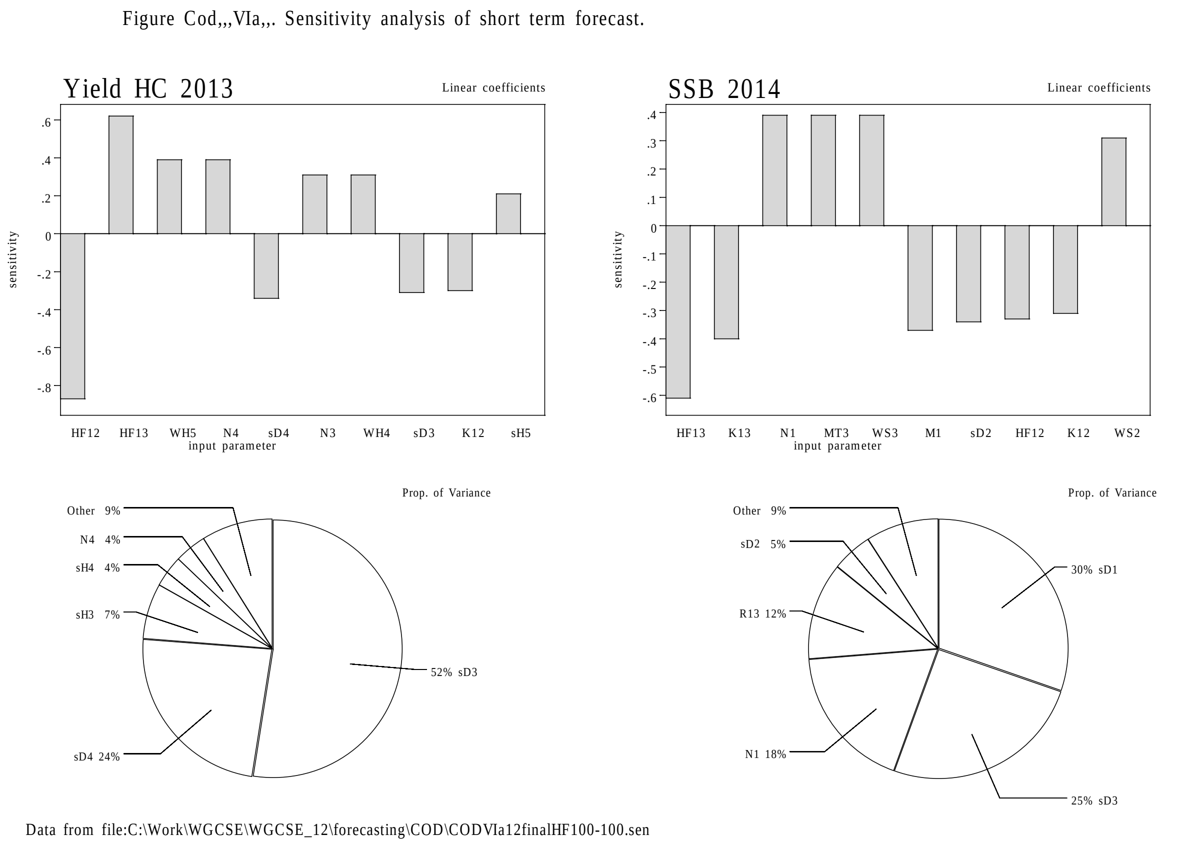


Figure 3.2.21. Cod in Division VIa. Sensitivity analysis of short-term forecast.

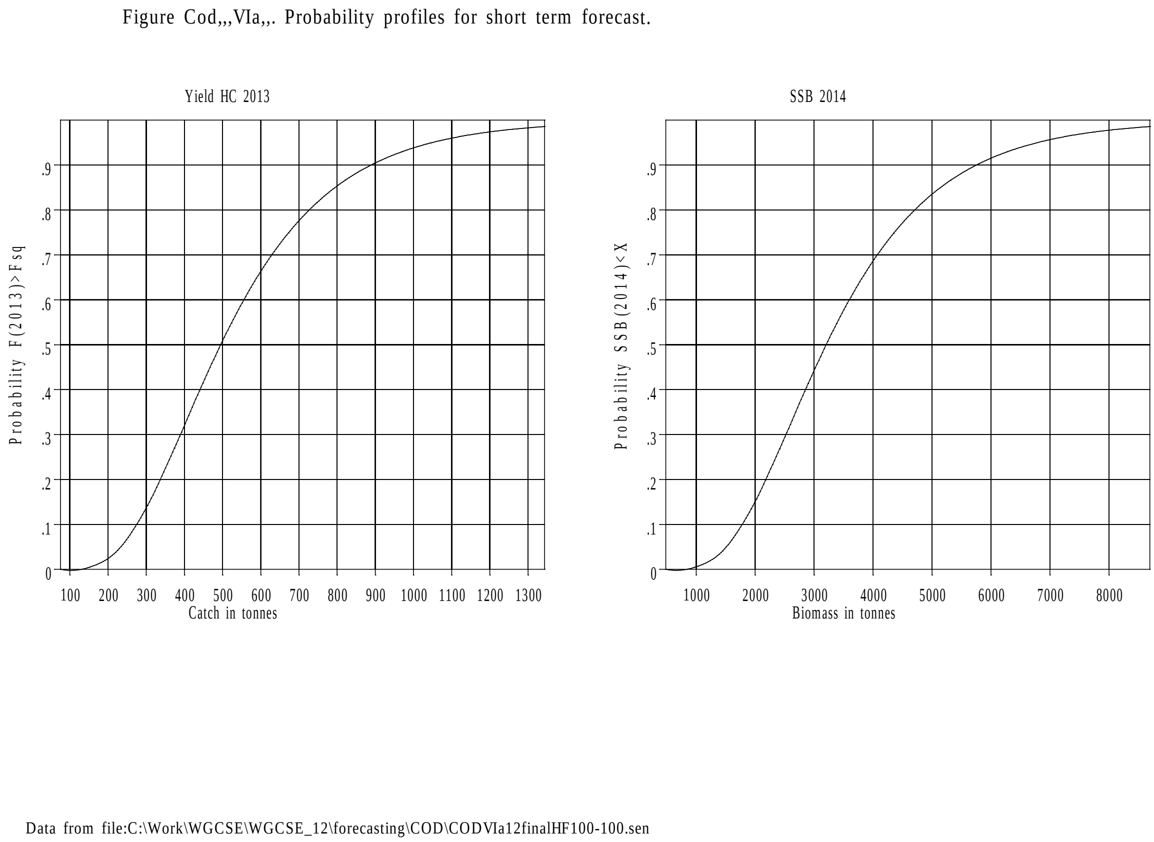


Figure 3.2.22. Cod in Division VIa. Probability profiles for short-term forecast.

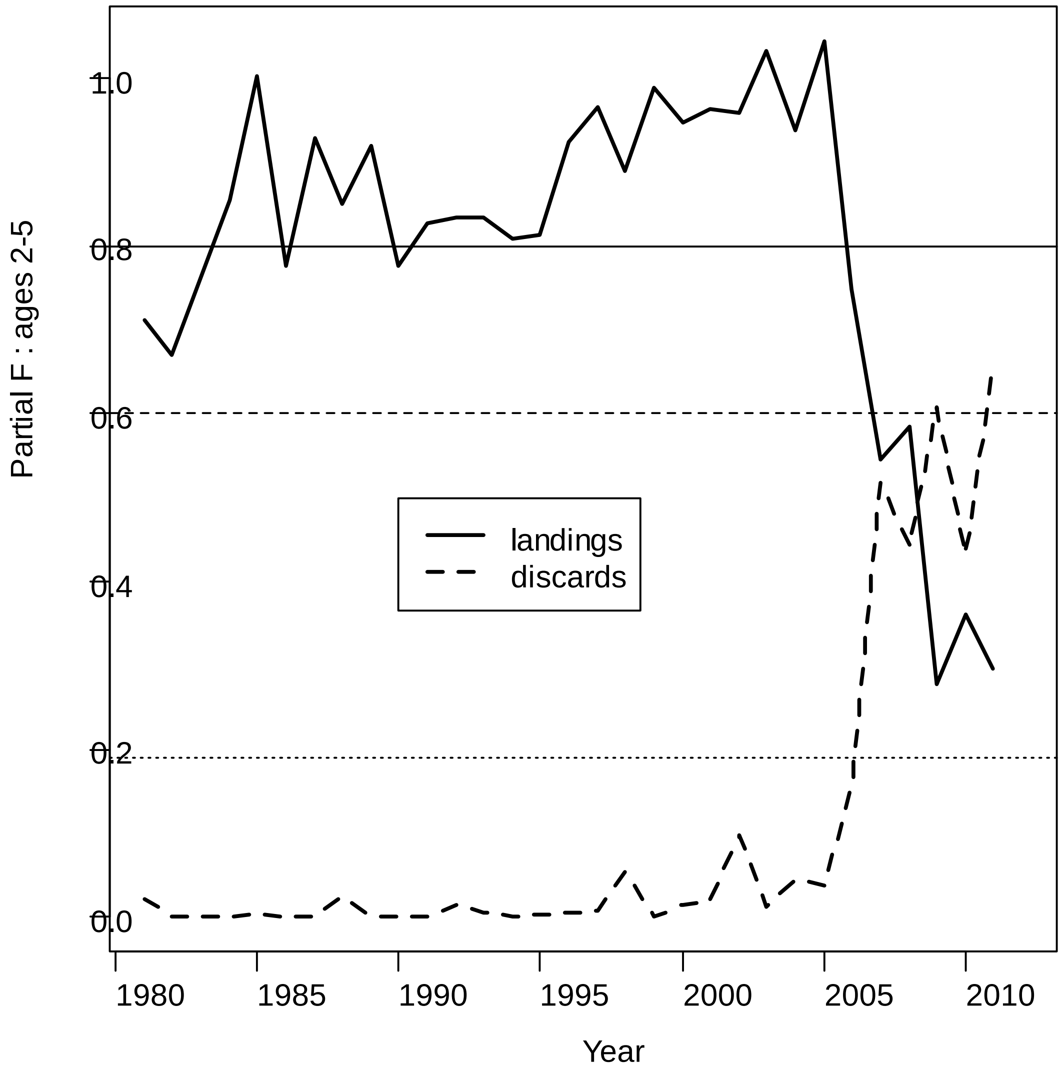


Figure 3.2.23. Cod in Division VIa. Partial mean F attributed to landings and discards. Horizontal lines represent F_{lim} (solid), F_{pa} (dashed) and F_{MSY} (dotted) values for the stock.

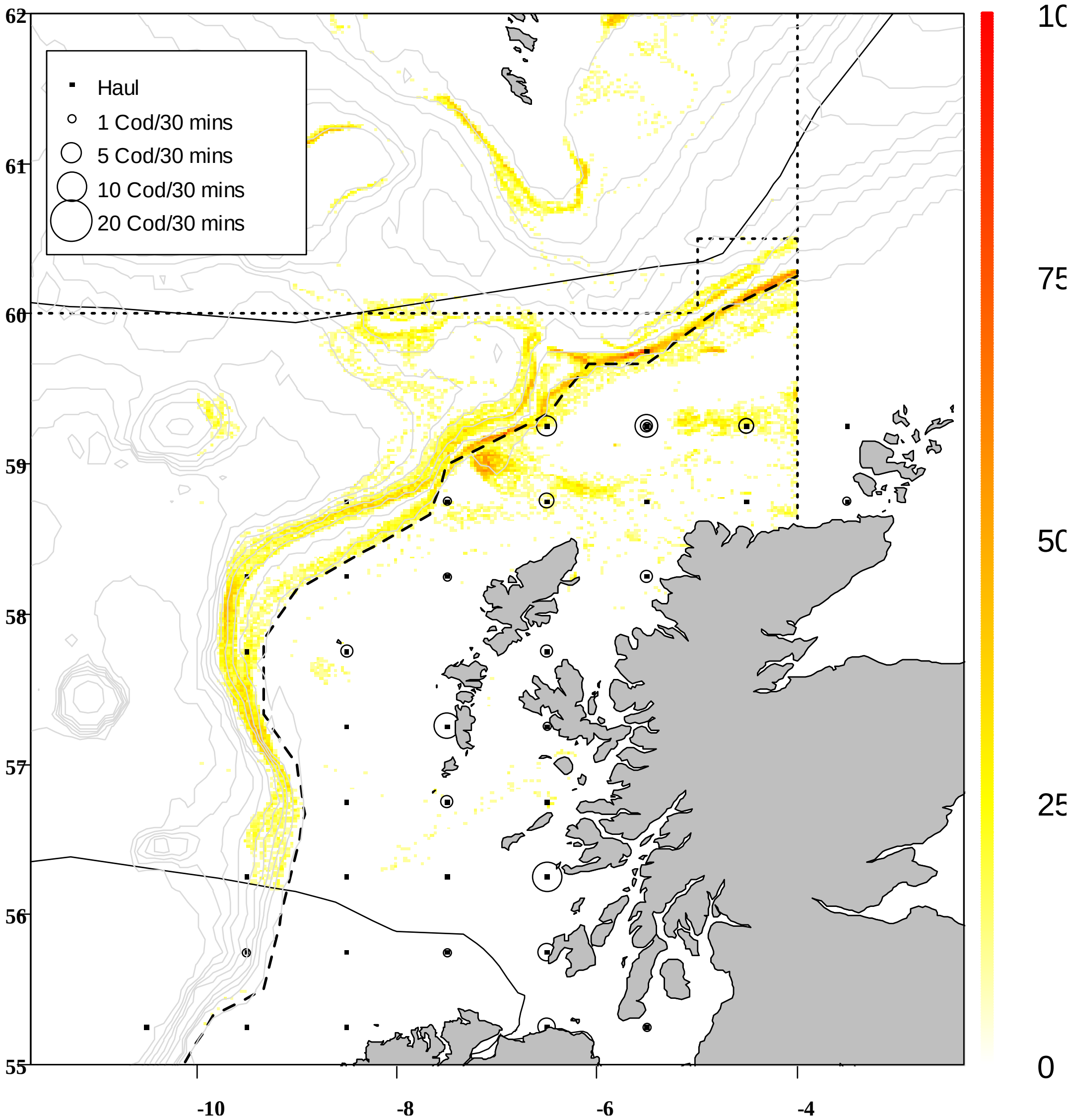


Figure 3.2.24. Scottish Q1 2010 Survey cpues of Cod plotted over Scottish (and other EU landing into Scotland) VMS data (2009 data) on fishing activity (annual VMS pings per square n.m.) associated with TR1 gear and trips with cod landings. Scottish survey results are centred on the statistical rectangle sampled. Dashed lines show ICES divisions, the broken line represents the cod management line and the solid line shows the limits of the UK EEZ, highlighting the extent of EU waters in Subdivision Vb. Depth contours are at 200 m intervals.

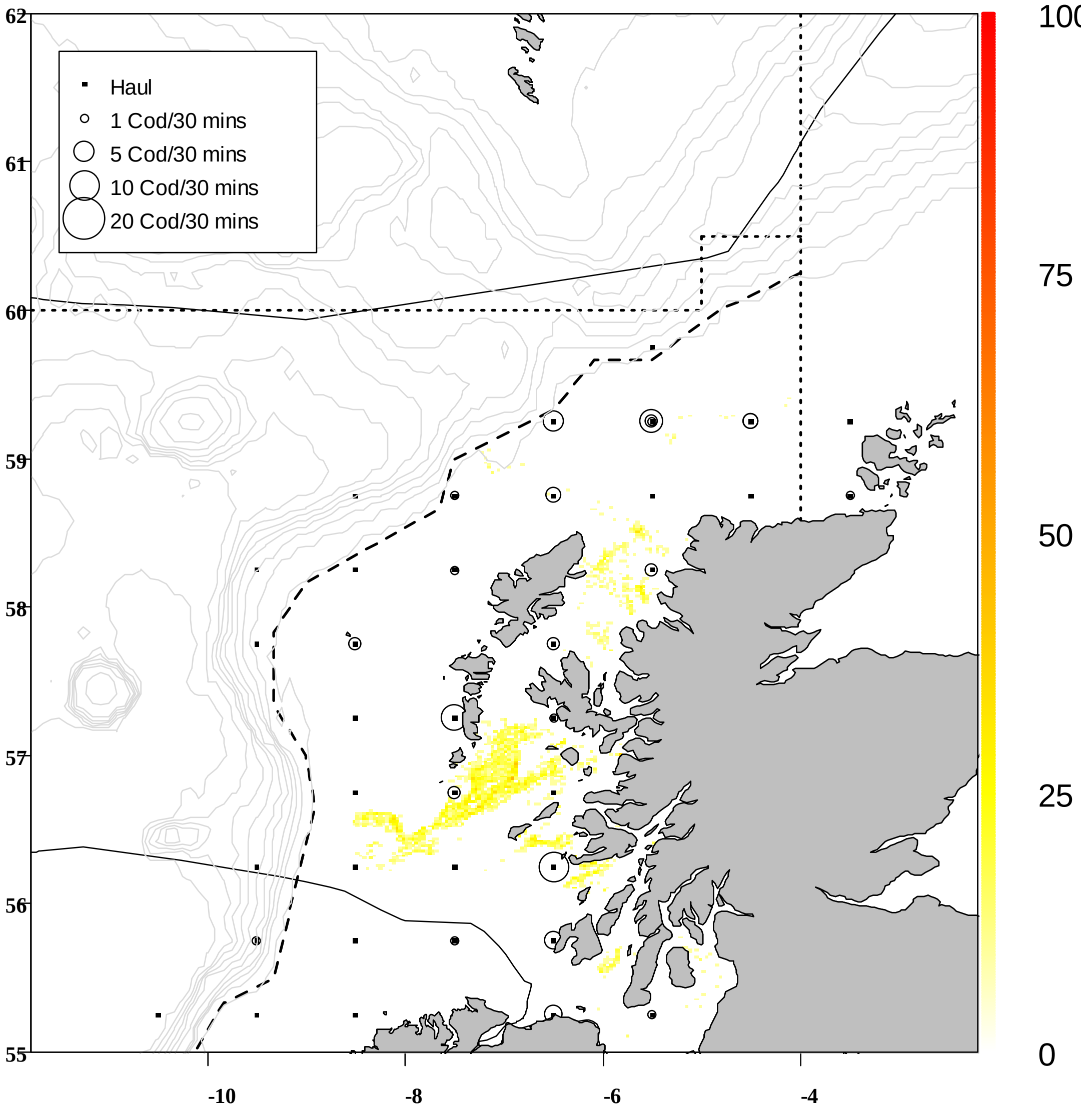


Figure 3.2.24 cont. Scottish Q1 2010 Survey cpues of Cod plotted over Scottish (and other EU landing into Scotland) VMS data (2009 data) on fishing activity (annual VMS pings per square n.m.) associated with TR2 gear and trips with cod landings. Scottish survey results are centred on the statistical rectangle sampled. Dashed lines show ICES divisions, the broken line represents the cod management line and the solid line shows the limits of the UK EEZ, highlighting the extent of EU waters in Subdivision Vb. Depth contours are at 200 m intervals.

3.3 Haddock in Division VIa

Type of assessment in 2012

The stock assessment of VIa haddock in 2012 is an update of last year's assessment using a TSA model. The model uses catch data from 1978 to 1994 and 2006 to 2011. Two Scottish groundfish surveys are used for tuning: the ScoGFS-WIBTS Q1 (1985–2010) and ScoGFS-WIBTS Q4 (1996–2009). Due to changes in survey design, trawl groundgear and adjusted sweep lengths in waters >80 m, new data (2011 onwards) from these surveys was not used in the current assessment. See Section 3.3.2 for further explanation.

ICES advice applicable to 2011

MSY approach

Following the ICES MSY transition framework implies fishing mortality to be reduced to 0.33, resulting in human consumption landings of less than 2800 t in 2011. This is expected to lead to an SSB of 20 700 t in 2012.

ICES advice applicable to 2012

MSY approach

Following the ICES MSY framework implies fishing mortality less than 0.3, resulting in human consumption landings of less than 10 200 t in 2012. This is expected to lead to an SSB of 40 700 t in 2013.

3.3.1 General

Stock description and management units

A TAC relating to this stock is in place for EU and international waters of ICES management Areas Vb and VIa and the assessment is carried out using data from VIa. The basis for the stock assessment area is described in the Stock Annex.

The agreed minimum landing size for haddock in Division VIa is 30 cm. There is no formal management plan currently in place although one has been evaluated and considered precautionary by ICES. Further regulations implemented for the west of Scotland include technical measures associated with the cod recovery plan (EC regulation 1342/2008) and emergency measures introduced with EC regulation 43/2009. The EU Registration of Buyers and Sellers regulation has reduced bias in commercial landings data. The regulations are described in the overview section for this management area (Section 3.1).

The following table summarizes EC TACs applied for haddock in Division VIa during 2011.

Species: Haddock *Melanogrammus aeglefinus*		Zone: EU and international waters of Vb and VIa (HAD/5BC6A.)
Belgium	2	
Germany	3	
France	111	
Ireland	328	
United Kingdom	1 561	
EU	2 005	
TAC	2 005	Analytical TAC

Values are in tonnes.

The following table summarizes EC TACs applied for haddock in Division VIa during 2012.

Species: Haddock *Melanogrammus aeglefinus*		Zone: EU and international waters of Vb and VIa (HAD/5BC6A.)
Belgium	7	
Germany	8	
France	332	
Ireland	985	
United Kingdom	4 683	
Union	6 015	
TAC	6 015	Analytical TAC

Values are tonnes.

Fishery in 2011

Official (reported) landings for each country participating in the fishery are given in Table 3.3.1. Vessels operating in the fishery are mainly Scottish and Irish and the amount of quota allocated to different countries reflects this.

Uptake of quota is given here and is calculated from the official landings as a proportion of the EC allocated quota for each country. None of the countries used their entire quota, which led to a total uptake of ~87%. This uptake is in line with recent years values (e.g. ~73% in 2006; ~51% in 2007; ~45% in 2008 and ~79% in 2009) where the odd value was 2010 were the quota uptake reached the 109%. Discards data that are reported are dealt with in the following section.

Country	TAC 2011	Official landings*	% uptake of quota
Belgium	2	0	0.0%
Germany	3	0	0.0%
France	111	75	68%
Ireland	328	290	88%
Norway	0	4	NA
UK	1561	1373	88%
EC	2005	1743	87%

Values of TAC (Total Allowable Catch) and landings are in tonnes.

*** The official landings provided to the WG for 2011 are preliminary at time of writing in 2012.**

3.3.2 Data

An overview of the data that have been provided to the WG is given in Section 2, including sampling levels by country for this stock. The reliability of catch data for this stock was a concern for several years, due to issues such as misreporting or underreporting and associated unaccounted discarding. It became impossible to quantify the extent of unallocated removals, leading to the use at the 2006 meeting of a modified TSA assessment method which did not use catch data after 1994.

Recent changes in regulations and fleet behaviour have improved the quality of catch data, which is now thought to be more representative of the true catch. The UK Registration of Buyers and Sellers Regulations introduced in 2006 are likely to have reduced or largely eliminated underreported landings. Nevertheless, information from the Compliance section of Marine Scotland suggests that approximately 19 tonnes of haddock were suspected of misreported out of Area VIa in 2010 (~1% of the officially reported UK(Scotland) landings). At the same time 302 tonnes were suspected of misreported in to Area VIa (~22% of the officially reported UK (Scotland) landings). The TAC in recent years (exception in 2010) was not restrictive; The values of misreporting are quite high and its inclusion on the assessment is a possibility that should be considered on next year benchmark.

Official landings as reported to ICES and estimated by the WG are provided in Table 3.3.1.

Catch-at-age data

Total catch-at-age data (landings and discards) are given in Table 3.3.2., while catch-at-age data and mean weights-at-age for each catch component (landings and discards) are given in Tables 3.3.3–3.3.7. The full available year and age range are given for completeness: however, it should be noted that commercial catch data before 1978 are not used in the assessment. The year of 1978 was the start year of the discard observer programme and for that reason data collected from that year onwards is reliable allowing the split of total catch into landings and discards.

Discards

WG estimates of discards are based on data collected in the Scottish and Irish discard programmes; raised by weighted average to the level of the total international discards (Table 3.3.4.). The 2011 discard data from Scotland and Ireland was raised based on respectively 14 and 15 sample observer trips, spread across 2011.

Biological

Weights-at-age

The estimated weights-at-age for the total catch in Division VIa are given in Table 3.3.5. These are calculated as weighted averages of the corresponding weights-at-age in landings and discards: the latter are given in Tables 3.3.6.and 3.3.7. Weights-at-age in the stock are assumed to be equal to the weights-at-age in the total catch, in the absence of a sufficiently long time-series of survey-based weight measurements. The weights-at-age time-series are also plotted in Figures 3.3.1–3.3.3. These show that weights-at-age in landings (and, by extension, catch and stock) for fish aged 4 and older have declined considerably over the last ~20 years. Weights-at-age in discards are relatively constant but since 2010 the weight for fish at age 1 has decreased. In 2011 there were no fish samples at age 1 in the Scottish and Irish landings. Also the age 1 discard samples show a decrease in weight in relation to the long-term average which is 134 grammes; age 1 discarded fish weighed on average 54 grammes in Scottish data and 81 grammes for the Irish. According to Dickey-Collas *et al*., 2003, haddock tends to grow faster in the southern area of Division VIa, where the mean temperature is higher than the west of Scotland (1°C less than the Irish Sea and 2°C less than Celtic Sea) which is where the Irish fishing vessels are most likely to operate. This might explain the differences between Scottish and Irish values but does not explain the difference with the long-term average.

Natural mortality and maturity

Natural mortality was assumed to be 0.2 for all ages and years, and maturity was assumed to be as follows:

Age	1	2	3+
Proportion mature	0.00	0.57	1.0

Proportions of F and M before spawning were both set to 0.0, in order to generate abundance (and hence SSB) estimates dated to January 1st.

Surveys

Research vessel surveys

Four research-vessel survey-series are available for the assessment of haddock in Division VIa as given in the following table:

Survey	Years available	Ages available	Ages used
ScoGFS-WIBTS Q1	1985–2010	1–8	1–7
ScoGFS-WIBTS Q4	1996–2009	0–7	1–7
IGFS-WIBTS-Q4	1993–2002	0–8	-
New IGFS-WIBTS-Q4	2003–2010	0–10	-

The reports of the 2006 meeting of the WG (WGNSDS 2006) and the 2007 meeting of the IBTS WG (IBTSWG 2007) explored available survey data in detail. Both ScoGFS-WIBTS-Q1 and Q4 were first accepted for use in the 2006 assessment, and this practice has been continued in subsequent years. The IGFS-WIBTS-Q4 series was not considered further due to problems with internal consistency (ICES-WGNSDS 2006). The new IGFS-WIBTS-Q4 series has eight years of data and can be considered for tuning purposes at the next benchmark assessment.

All survey-series available for tuning the assessment are given in Table 3.3.8, with the data that were used in the final assessment indicated in bold type. Plots of the spatial distribution of the ScoGFS-WIBTS-Q1 and Q4 survey mean catch rates per ICES statistical rectangle by age class are given in the Stock Annex.

Commercial catch–effort series

The available commercial effort and lpue data for this stock are indicated in the Stock Annex.

3.3.3 Historical stock development

The model used for this assessment is the state space model TSA, with data from two research vessel surveys (1985–2010) and with catch data included 1978–1994 and

2006–2011, corresponding to the time periods when catch data are thought to be reliable. The model is run using R. Outputs from the TSA assessment are shown in Figures 3.3.4–3.3.10 and Tables 3.3.10–3.3.14.

The reliability of landings data for haddock was a concern for several years, and because it was not possible to quantify the extent of unallocated removals, this lead, at the 2006 meeting, to the use of a modified TSA assessment method which did not use catch data after 1994. This remained the accepted assessment method for the 2007–2009 meetings. In 2010, measurable improvements in the reliability of catch data (Section 3.3.2) led the WG to question the continued discrepancy between the prediction of landings by the model and the reported catches after 2005. Furthermore, while the assessment was primarily survey based, the uncertainty around estimates of F was appreciable, and the estimate was not coming down in years when evidence of reduced effort indicated a probable reduction in F.

The re-inclusion of catch data has been implemented with TSA in other assessments for which this model is used. For example, catch data were re-included in the assessment of VIa cod at the 1997 meeting of the Working Group for the Assessment of Northern Shelf Demersal Stocks (WGNSDS, 1997). The catch data for cod were re-included in following assessments, but were removed again subsequently because of more recent concerns over reported landings for that stock. See Section 3.2.

Final update assessment

The assessment in 2011 was an update, including data indicated in the table below, which summarizes the data ranges used in recent assessments.

Data	2007 assessment	2008 assessment	2009 assessment	2010 Assessment	2011 assessment	2012 assessment
Catch data	Years: 1978–1994 Ages: 1–8+	Years: 1978–1994 Ages: 1–8+	Years: 1978–1994 Ages: 1–8+	Years: 1978–1994 and 2006–2009 Ages: 1–8+	Years: 1978–1994 and 2006–2010 Ages: 1–8+	Years: 1978–1994 and 2006–2011 Ages: 1–8+
Survey: ScoGFS Q1	Years: 1985–2007 Ages 1–7	Years: 1985–2008 Ages 1–7	Years: 1985–2009 Ages 1–7	Years: 1985–2010 Ages 1–7	Years: 1985–2010 Ages 1–7	Years: 1985–2010 Ages 1–7
Survey: ScoGFS Q4	Years: 1996–2006 Ages 1–7	Years: 1996–2007 Ages 1–7	Years: 1996–2008 Ages 1–7	Years: 1996–2009 Ages 1–7	Years: 1996–2009 Ages 1–7	Years: 1996–2009 Ages 1–7
Survey: IGFS	Not used	Not used	Not used	Not used	Not used	Not used

Table 3.3.9 shows the evolution of the corresponding TSA parameter estimates since 2003.

Standardized prediction errors from the assessment model are shown in Figures 3.3.5 (landings), 3.3.6 (discards), 3.3.7 (ScoGFS-WIBTS-Q1) and 3.3.8 (ScoGFS-WIBTS Q4). TSA is a state–space model, and these prediction errors are an analogous (but not completely equivalent) diagnostic tool to residuals of fits from other stock assessment models. The small, negative prediction errors for the landings and discards in the period 2006–2010 at various ages show that the model is predicting landings and discards to be slightly higher than observed data. Generally the prediction errors do not show a pattern persisting for longer than five years. The only cases where this occurs are for age 1 of the ScoGFS-WIBTS-Q1 index (Figure 3.3.7). The magnitude of these (age 1 ScoGFS) prediction errors is relatively small (ranging from -0.9 to -1.6). A similar, inconsequential, pattern is seen in the fit to the ScoGFS-WIBTS-Q4 index (Figure 3.3.8). None of the prediction errors are of a magnitude or show a pattern which would invalidate the model fit. Negative prediction errors in the survey indices at age 1 indicate lower than expected recruitments in recent years.

Previous assessments have applied a down-weighting to certain data points, based on the TSA prediction errors. High values of prediction errors do occur and the procedure to deal with this high values is to down weight them in order to decrease the influence of this extreme values (an adjustment recommended in Fryer, 2001 which has been applied previously to several age/year data points). The values down weighted are not changed in future assessments and tend to only be revised at benchmarks.

There is a poor relationship between stock size (SSB) and recruitment for this stock, with large values for recruitment possible at small stock sizes and small recruitments possible at large stock sizes (Figure 3.3.9). The TSA stock–recruit plot is shown in Figure 3.3.9.

Estimated and observed discard rates (proportions-at-age) are shown in Figure 3.3.10. The discard model fits are good for the years when catch data are included (1978–1994 and 2006–2011) and also most other years. The observed proportions deviate slightly in 2003–2005.

TSA estimates a discard ogive for every year. However, when there are no catch data, the estimated ogive will simply be some weighted average of the discard ogives in neighbouring years. So, when several years of catch data are omitted, the estimated discard ogives in this period will hardly change at all because there are no new data included from which to produce a new estimate. From 2006, when the catch data are re-included, the model is able to much better estimate the discard ogive (Figure 3.3.10).

Retrospective analysis

Most retrospective bias in this stock assessment (see Figure 3.3.11) is thought to be caused by mismatch between catch and survey data (WGMG 2007), and as only survey data are used in the TSA model between 1995 and 2005 causing the retrospective pattern observed in F and SSB over the period of 1995–2005 to be irregular.

Comparison with previous year's assessment

The 2011 VIa haddock assessment estimated F in 2010 at 0.29 and SSB (January 1st 2010) at 15 868 tonnes. The current assessment has revised these figures, to a fishing mortality of 0.32 in 2010 and an SSB (January 2010) as 13 890 tonnes (12% decrease). Recruitment in 2010 has been revised from 8.1 million to 6.9 million (~15% decrease).

The estimate of SSB in January 2011 from this assessment is 18 624 tonnes with a standard error of 3719 tonnes (~20%). Last year's assessment put this figure at 21 303 tonnes.

The current assessment's estimate of SSB (for January 2012) used in the forecast (output from MFDP1a) is 23 616 tonnes. The short-term forecast from last year's assessment predicted SSB in 2012 to be at 31 300 tonnes. This is a difference of 7684 tonnes (~33% decrease in the estimate).

State of the stock

The state of the stock is summarized in Figure 3.3.4 and Table 3.3.14.

The final estimates for the stock in 2011 are:

$F_{(2\text{-}6)}$ = 0.22

SSB = 18 624 t

Based on the most recent estimates of SSB in 2012 (B_{pa} > 23 600 tonnes, >$B_{lim,}$) ICES classifies the stock as being at increased risk.

Based on the most recent estimate of fishing mortality in 2011 (0.22, <F_{pa}) ICES classifies the stock as being harvested sustainably.

Based on fishing mortality being estimated to be less that F_{MSYHCR} and SSB greater than MSY $B_{trigger}$; In relation to the MSY reference points, ICES classifies the stock as being harvested appropriately.

Summaries from the final assessment, including, total removals, landings, discards, recruitment, mean F and SSB are given in Figure 3.3.4, while corresponding estimates and standard errors are presented in Tables 3.3.10 and 3.3.11 (population abundance), Tables 3.3.12 and 3.3.13 (fishing mortality), and Table 3.3.14 (stock summary). Mean $F_{2\text{-}6}$ is estimated to have risen to just above F_{pa} (0.5) during 2003–2007, subsequently falling below 0.5 in 2008, and remaining below F_{pa} since. A sequence of low recruitments led to a fall in SSB from the peak in 2003. The assessment estimates that SSB has been below B_{pa} since 2005.

Uncertainty in fitted and observed catches increases from 1995–2005 (Figure 3.3.4), which is the period when the landings and discards are excluded from the model and the survey data are used for estimation. Catch data tend to have more precision than survey data and although both surveys used in the assessment have been seen to track year-class strength well, the survey data are more "noisy" (show greater variability) than the catch data. Therefore, when the catch is included in the later part of the time-series (2006–2011) the confidence intervals of the estimates are seen to reduce.

The difference between observed and predicted catch represents unaccounted removals, amounting to about 8% of the landings by 2009–2011. The reported catch in 2011 is not within the bounds of error of the estimated catch. This is thought to reflect the exclusion of surveys since 2010. Information from the Compliance section of Marine Scotland put estimates of misreporting out of and in to VIa at approximately ~290 tonnes in 2011 (table below). The misreporting seems to occur mainly between Areas VIa and IVa.

Recorded in	IVa (EU)	VIa (EU)
Suspected from	VIa (EU)	IVa (EU)
Tonnes	287.4	3.4

3.3.4 Short-term projections

Recruitment estimates

The TSA assessment model provides estimates of recruitment for the forecast years 2012 and 2013. Since 2011 these values are based on a Ricker stock–recruit model (Figure 3.3.9) as the the ScoGFS-WIBTS-Q1 survey was last used in 2010 assessment. In this year's assessment it was decided by the WG to use a more conservative approach, after a closer look at the recruitment values shown in both IGFS and the new ScoGFS-WIBTS-Q1 surveys. So the preferred method to calculate recruitment forecasts was a geometric mean for the last six years were the ScoGFS-WIBTS-Q1 was used to assess the recruitment. The recruitment values used in the forecast are ~24.8 million for both 2012 and 2013.

TSA produces short-term forecasts as part of every standard model run. The model will also forecast fishing mortality rates. It does so by iterating forward the time-series model that had been fitted to historical data. These forecast mortalities therefore retain the time-series characteristics of the preceding data. Although the TSA estimates are likely to follow a pattern of damped oscillation towards an eventual steady state, the WG preferred to use standard tools (i.e. MFDP) as the basis for the forecast. The MFDP procedure is described below.

The time-series of fishing mortality-at-age estimates is shown in Figure 3.3.12, along with the mean F over ages 2–6. As with last year's assessment, a three-year mean fishing mortality selection pattern was used in the forecast. Figure 3.3.13 compares a simple three-year mean, the most recent estimate (2011), and TSA-generated selection patterns.

The forecasts presented in this Section have been given as forecasts of total removals, split subsequently into removals due to landings, discards and unallocated removals (other than those assumed to be due to current estimates of natural mortality) respectively. As highlighted previously, the assessment is survey-based from 1995 to 2005 and can only estimate total removals during this period. The difference between reported and estimated catches represents unallocated removals, reflecting our uncertainty in natural mortality and a certain amount of likely area-misreporting. In the period when the assessment is survey based only the estimated amount of unallocated removals is appreciable. The 1999 year class of haddock was strong, and survey estimates of that year class would have contributed to high model estimates of predicted catch between 2002 and 2005 (Figure 3.3.4).

The WG considered that the most appropriate level of discarding to use in the forecast was a mean of the last three years. It is not possible to know what discarding practices will be in the immediate future, although since the incoming of the 2009 year class has been estimated to be at appreciable numbers by the Scottish and Irish groundfish surveys in Q4 2009 and by the Scottish groundfish survey in Q1 2010 led to an increase in discard numbers going from ~1.8 thousand to ~2.8 thousand tonnes in 2010. The discard behaviour in the last three years changed in largely due to the 2009 large year class which made haddock more abundant and part due to the poor selectivity in the fleet component fishing for *Nephrops* (TR2). The total catch for haddock is estimated to be ~3152 tonnes; of these 46% are discards. Splitting discards by fleet shows that TR2 vessels are responsible for ~80% of all discards while landing only 80 tonnes, less than 5% of total landings (1713 tonnes).

Nevertheless, taking a 3-year mean is still the most unbiased approach. For the short-term forecast, the assumption is that this input F remains constant.

The final key issue for the forecast is that of weights-at-age, and in particular, the slow growth observed in recent year classes. Figure 3.3.14 demonstrates this with linear models fitted to cohort-based mean weights-at-age data. A number of recent year classes appear to be growing more slowly than has been the case in the more distant past. As with last year, linear models were used as the basis for predictions for those cohorts with sufficient data (Table 3.3.15), with the small change that the models were fit using data from age 0–8+, as this slightly improved precision (Jaworski, WD12 in 2010).

Short-term projections are presented here for reference only; they are not considered reliable because recruitment of haddock is characterized by sporadic events. Therefore this year following suggestion of the WG a geometric mean recruitment (2004–2009) was used for 2012–2014 estimates providing a very uncertain but precautionary estimate of future recruitment. The time frame was chosen in order to include the most six recent years were both surveys were used as indicators for recruitment.

Short-term projections were performed using MFDP1a software.

Results of the forecast at *status quo* F are summarized in the following table:

Year	Removals (000 t)	SSB (000 t)
2012	10.9	23.6
2013	12.4	31.6
2014	-	36.2

At the *status quo* rate of removals, and given assumptions about growth and recruitment, the most recent estimate of SSB (2011) is greater than B_{lim} and is forecast to increase in 2012 and 2013, primarily due to the most recent estimate of recruitment in 2010 being relatively high compared to the last nine years.

3.3.5 MSY evaluations

No estimates of MSY reference points were presented at the WG this year.

Biological reference points

ICES has defined the following reference points for this stock.

Reference point	Technical basis
B_{pa} = 30 000 t	B_{lim}*1.4
B_{lim} = 22 000 t	Lowest observed SSB when reference point was established (1998)
F_{pa} = 0.38	High probablity of avoiding SSB falling below B_{pa} in the long term
F_{lim}	Not defined

3.3.6 Management plans

There is a management plan evaluated by ICES as being precautionary, details of which can be found at:

http://www.ices.dk/committe/acom/comwork/report/2010/Special%20Requests/EC%20haddock%20management%20plan.pdf

However, this management plan is not implemented, waiting to be sign off by all parts.

3.3.7 Uncertainties and bias in assessment and forecast

Quality of the assessment

Landings and discards

Quotas for haddock in Division VIa appear to have started to become restrictive in or around 1995. Anecdotal evidence suggests that these and other restrictive management measures led to increasing unreliability of landings data from the commercial fleets prosecuting the fishery from 1995 to 2005. The approach taken by this WG from

2006 onwards was to assess the stock using a modified TSA model which did not include catch data from 1995 onwards, and which thus modelled removals rather than catches. During the period when the catch is not included (1994–2005) the discard ogives estimated by the model are weighted averages of those of neighbouring years. This results in little change in the estimated discard ogive in the years when the catch is excluded and an observable discrepancy between the model's discard ogive and the reported discards proportions in 2003–2005. In 2009 catch data from 2006 onwards were included again in the model; being 2006 the year in which the buyers and sellers registration was implemented increasing the reliability of the data.

Effort

In 2009 assessment, catch data from 2006 onwards was reincorporated into the assessment as confidence levels rose due to the implementation of the UK Registration of Buyers and Sellers legislation. Due to the "lost" of two surveys in the last two years at the moment the assessment is driven by catch data.

Surveys

A survey-based assessment can only be as good as the surveys on which it is based. The Scottish groundfish survey-series appear to have good internal consistency and to track cohorts reasonably well, with the exception of a period during the mid-1990s. Concerns remain over the apparent differences in catchability of young fish between the Scottish and Irish components of IBTS (ICES-IBTSWG 2007). These concerns will extend in to the GFS WCIBTS Q1 as this survey adopted the same gear and design as the Irish. Any survey is likely to become less reliable when stock abundance declines, and this issue needs to be revisited in the near future for haddock and many other stocks.

This assessment is survey based for the years 1995–2005. Re-including catch data for 2006–2011 has resulted in narrower confidence intervals for estimates of F, SSB, and catch components (landings, discards and total removals). Some uncertainty remains over the unallocated component of removals and how this could be divided between removals caused by natural mortality and removals related to fishing (for example, escape mortality and area misreporting).

For 2011 the rigging and sampling design of the ScoGFS-WIBTS-Q1 and ScoGFS-WIBTS-Q4 surveys was changed and these data are not used in the assessment. A new groundgear capable of tackling challenging terrain was introduced broadly modelled around the rig used by Ireland for the IGFS-WIBTS-Q4. The move to a more robust groundgear also allowed a move to a random stratified survey (which is again consistent with the IRGFS-WIBTS-Q4) as 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 was considered to be prone to bias. It is hoped the greater compatibility between Scottish and Irish surveys will facilitate both being used to assess gadoids west of Scotland. New survey strata were designed using cluster analysis on aggregated data from the previous ScoGFS-WIBTS-Q1 data (1999–2010) as well as the data collected from a dedicated gadoid survey which took place during quarter 1 of 2010. Species considered were cod, haddock, whiting, saithe and hake. Cluster analysis yielded four specific clusters. Two additional strata were added; the Clyde area and the 'windsock' which is an area that has been designated as a recovery zone since 2002 and has therefore experienced no mobile gear exploitation during this time. Each individual polygon was treated as a separate stratum and the number of survey stations for each was allocated according to polygon size and the variability of indices within each stratum. Strata were weighted by surface area to build the final indices. Due to vessel breakdown, the ScoGFS-WIBTS-Q4 did not take place in 2010. However, due to the introduction of catch-at-age data this has less affect on the quality of the assessment than previously when the recent catch was excluded.

Weights-at-age

In this assessment, simple linear growth models have been fitted to cohort weights-at-age data and used to generate weights-at-age in the forecast. These models fit reasonably well, but this approach is quite simplistic and may be missing important growth characteristics such as variable growth within a cohort. This may lead to greater uncertainty in the forecast.

Model formulation

Models such as the modified TSA used this year, based largely on survey data, are becoming the standard in several ICES assessments for which problems have existed with commercial catch data (see this report, and also WGNSSK 2006). Other examples include BADAPT and SURBA. While these types of models are essential in order to address data problems, it needs to be borne in mind that there are two main problems with such approaches. Firstly, survey data are based on far fewer samples, and are therefore more variable than catch data. It is therefore likely that precision is sacrificed to reduce bias. Secondly, a survey-based assessment estimates removals from the stock and total mortality, rather than landings and fishing mortality, and is therefore more difficult to use as the basis of quota advice than corresponding catch-based approaches. It is therefore thought that the re-inclusion of catch data was appropriate, and investigations have indicated that this has been the case in the years 2006–2011.

Stock connectivity

There is uncertainty concerning the stock definition and hence the degree of connectivity between the VIa haddock stock and the North Sea haddock stock. Since these stocks are currently assessed separately, it is possible that the two stock assessments are both affected by uncertainties in catch data relating to area misreporting.

3.3.8 Recommendations for next benchmark

Some ways of addressing these issues are proposed here. All aspects are considered important and the proposed time frame would be to work on these in order to prepare for the next benchmark (2013).

Landings and discards

There should be a full analysis of the precision and bias of catch-at-age data. Although catch data between 2006–2011 are thought to represent a large proportion of the true catch, further analysis would help to put a clearer estimate on the uncertainty of this. Measures such as the UK Registration of Buyers and Sellers legislation seem to have greatly improved the reliability of commercial landings data for the last three years. Also, the landings misreporting; in, out and within Area VIa should be addressed in the next benchmark and assess their impact in the assessment. Marine Scotland- Compliance provides every year estimative of misreporting. The process of calculating it should be investigated and considered for integration in the assessment.

Surveys

There are now eight years of data from the IGFS-WIBTS-Q4 and the benchmark should evaluate its inclusion as a tuning survey. Also the new UKScoGFS-WIBTS Q1 will have reached three years by the next benchmark so a re-inclusion of this survey should be also investigated.

Weights-at-age

The growth characteristics of this haddock stock are very variable, and seem to be strongly driven by cohort effects rather than year effects: that is, early life-history events determine the subsequent growth potential of each cohort. Work is underway at Marine Scotland (Aberdeen) and elsewhere to develop improved models of growth, and it is hoped that these will improve stock forecasts in future. Consideration of using stock weights from the survey, instead of the estimated weights-at-age could also be addressed at a benchmark assessment.

Other modelling

Growth modelling could help with forecasts of mean weights-at-age. It may also be of interest to use bioeconomic models to address questions to do with feedbacks between quota, uptake of quota and strong drivers of quota uptake and fishers' behaviour, for example, fuel price.

Other assessment models could be considered where information from the age structure of the catch data could be incorporated in the assessment for the years where the catch data are currently excluded (1995–2005).

3.3.9 Management considerations

This stock is at a low level of biomass, but a good recruitment (age 1) in 2010 is moving into the population and is estimated to elevate the biomass to more safe levels. An agreed long-term management plan, which takes into account the recruitment characteristics of this stock, has been evaluated by ICES in 2010 and for the last two years has been waiting to be signed off.

Discard rates, in recent years have been high, in 2010 they represented 51% of the total catch and in 2011 ~47%. In 2011 the majority of these discards ~80% (1156 tonnes) happen in the *Nephrops* fishery landing only 80 of the 1713 tonnes landed, which shows having a poor selectivity for young haddock. Any measure to reduce discarding and to improve the fishing pattern should be actively encouraged. Such measures should include the adoption of a sorting grid as well as appropriately located square mesh panels.

The expansion of the Catch Quota scheme in the North Sea from 17 vessels in 2010 to 23 vessels in 2011 and with potential to grow might during the year "force" some vessels to redirect their effort to VIa or VIb. Vessels within this scheme are not allowed to fish in the North Sea if they reach the annual cod quota, but as an alternative they can fish west of the 4 degree line.

Table 3.3.1. Haddock in Division VIa. Nominal landings[2], as officially reported to ICES and estimated by the WG.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Belgium	9	-	9	1	7	1	-	1	3	2	2	1
Denmark	+	+	+	+	1	-	1	1	-	-	-	-
Faroe Islands	13	-	1	-	-	-	-	-	-	-	-	-
France	1335	863	761	762	1132	753	671	455	270	394	-	282
Germany	-	-	1	2	9	19	14	2	1	1	2	1
Germany	4	15	-	-	-	-	-	-	-	-	-	-
Ireland	2171	773	710	700	911	746	1406	1399	1447	1352	1054	677
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-
Norway	74	46	12	72	40	7	13	16	21	28	18	70
Spain	-	-	-	-	-	-	1	-	-	2	4	+
UK – (E&W)[3]	235	164	137	132	155	254	322	448	493	458	315	199
UK - Scotland	19 940	10 964	8434	5263	10 423	7421	10 367	10 790	10 352	12 125	8630	5933
Un. Sov. Soc. Rep.	-	-	59	-	-	-	-	-	-	-	-	-
Total reported	23 781	12 825	10 124	6932	12 678	9201	12 795	13 112	12 587	14 362	10 025	7163
WG estimates	16 691	10 141	10 557	11 351	19 068	14 272	12 368	13 466	12 883	14 401	10 464	6958

1) Preliminary.

2) Includes Divisions Vb(EC) and VIb.

3) 1989–2005 N. Ireland included with England and Wales.

WG estimates refer to the sum-of-products of landings and weights-at-age provided to the WG, rather than the estimated removals produced in the final assessment.

Table 3.3.1. Continued. Haddock in Division VIa. Nominal landings[2], as officially reported to ICES and estimated by the WG.

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Belgium	2	-	-	<0.5	-	-	-	-	.	.	.
Denmark	-	-	<0.5	<0.5	-	-	.	.	.	.	.
Faroe Islands	-	-	-	4	-	1	2	<0.5	-	-	.
France	160	151	183	173	273	291	211	151	136	89	74.83
Germany	1	-	-	-	1	7	-	1	-	1	
Germany, F.R.	.	.	.	.	.	.	.	.	.	.	
Ireland	744	672	497	194	152	526	759	879	297	396	290.39
Netherlands	-	-	-	1	-	-	-	-	.	.	
Norway	32	30	23	4	21	17	16	28	18	11	4.109
Spain	4	4	5	-	47	44	5	10	21	28	
UK – (E&W)[3]	201	237	107	93	42	19	193	32	14	7	
Belgium	2	-	-	<0.5	-	-	-	-	.	.	.
Denmark	-	-	<0.5	<0.5	-	-	.	.	.	.	.
Total reported	7030	7082	5397	3378	2561	5833	3773	2845	2852	2939	1743
WG estimates	6762	7115	5337	3874	3792	6266	3777	2848	2851	3016	1737

[1]) Preliminary.

[2]) Includes Divisions Vb(EC) and VIb.

[3]) 1989–2005 N. Ireland included with England and Wales.

WG estimates refer to the sum-of-products of landings and weights-at-age provided to the WG, rather than the estimated removals produced in the final assessment.

Table 3.3.2. Haddock in Division VIa. Total catch-at-age numbers (000s). Values used in the final assessment are boxed.

Year	Age								
	0	1	2	3	4	5	6	7	8
1965	451	1059	1341	72461	6816	294	274	174	11
1966	5953	1595	529	1113	47431	1926	64	32	57
1967	40122	19185	19332	951	265	24979	400	9	14
1968	27	129418	38393	3079	356	681	14063	727	43
1969	2742	84	160706	10260	1434	268	379	4576	191
1970	17189	6317	519	95114	2770	173	89	145	585
1971	6604	71481	3915	3328	79966	545	127	7	20
1972	14215	20713	85141	2718	2336	53823	504	50	19
1973	19589	47387	16907	19477	258	1222	33193	150	32
1974	63698	68837	11562	10757	6317	83	447	11463	104
1975	6849	179349	34957	3339	3350	1882	95	98	3454
1976	4227	24337	72330	15224	1588	1491	868	21	7
1977	4552	13109	3468	35948	5705	680	495	308	28
1978	57	**15942**	**2095**	**971**	**24357**	**2938**	**351**	**247**	338
1979	5697	**70070**	**17282**	**1865**	**470**	**9863**	**833**	**114**	145
1980	13	**22729**	**21927**	**5636**	**922**	**143**	**3082**	**229**	22
1981	764	**251**	**83911**	**20697**	**1768**	**194**	**39**	**822**	39
1982	136	**15492**	**5019**	**73676**	**8167**	**898**	**108**	**272**	288
1983	2084	**14524**	**20233**	**6040**	**36122**	**3398**	**597**	**41**	194
1984	269	**98976**	**8626**	**12910**	**6242**	**22790**	**2449**	**371**	43
1985	155	**22820**	**78922**	**4667**	**4184**	**1789**	**11189**	**964**	84
1986	2979	**8127**	**11235**	**45367**	**1823**	**916**	**449**	**2611**	344
1987	1498	**89021**	**16824**	**10150**	**23857**	**1452**	**1116**	**642**	1818
1988	7582	**10007**	**58414**	**7598**	**4185**	**9255**	**428**	**235**	177
1989	3773	**5010**	**3420**	**25724**	**2755**	**1556**	**3634**	**255**	84
1990	437	**37247**	**5856**	**1884**	**12158**	**871**	**279**	**519**	48
1991	8921	**36924**	**21991**	**1259**	**834**	**5132**	**412**	**283**	410
1992	4332	**51840**	**18971**	**11331**	**565**	**236**	**1577**	**157**	37
1993	2196	**43659**	**60785**	**20763**	**4669**	**306**	**219**	**915**	70
1994	2843	**19484**	**32638**	**21527**	**5671**	**1579**	**76**	**175**	237
1995	7692	17580	15759	23599	6865	1472	387	34	111
1996	10249	33344	39812	6641	10225	3663	1007	324	23
1997	2984	23843	10507	21550	2178	2668	870	259	59
1998	2058	11421	18001	8032	15116	1352	1036	377	124
1999	6898	6179	18055	11569	3004	4919	579	452	96
2000	5709	50142	6642	8596	4213	1055	1104	205	133
2001	11818	11023	33496	2432	3666	1521	533	314	65
2002	1362	16427	12394	32248	833	714	549	238	144
2003	3861	6972	5592	6848	12830	222	209	70	34
2004	2727	15159	6506	2384	3839	6706	286	101	26
2005	3965	7190	6202	3700	2116	2669	2704	57	42
2006	817	**16031**	**4831**	**3844**	**3801**	**3109**	**2731**	**2750**	33
2007	257	**1777**	**15850**	**2897**	**1725**	**2428**	**811**	**904**	478
2008	1840	**2409**	**2330**	**4421**	**587**	**609**	**868**	**255**	185
2009	2021	**4999**	**434**	**429**	**6681**	**512**	**335**	**254**	79
2010	1373	**37370**	**1936**	**422**	**580**	**4633**	**258**	**158**	64
2011	63	**1721**	**6187**	**402**	**289**	**319**	**1625**	**88**	57

Table 3.3.2. Continued. Haddock in Division VIa. Total catch-at-age numbers (000s). Values used in the final assessment are boxed.

Year	Age						
	9	10	11	12	13	14	15+	8+
1965	6	6	0	0	0	0	0	24
1966	0	0	0	0	0	0	0	57
1967	4	0	0	0	0	0	0	19
1968	9	0	0	0	0	0	0	52
1969	9	0	0	0	0	0	0	200
1970	13	2	0	0	0	0	0	600
1971	175	16	0	0	0	0	0	212
1972	0	67	0	0	0	0	0	86
1973	6	125	0	0	0	0	0	163
1974	34	31	0	1	4	0	0	174
1975	72	8	0	0	0	0	0	3534
1976	1103	4	0	5	0	0	0	1119
1977	11	259	5	0	0	0	0	304
1978	7	17	211	3	0	0	0	**575**
1979	28	3	1	42	1	0	0	**221**
1980	5	21	3	0	4	0	0	**54**
1981	14	2	2	1	0	1	0	**60**
1982	31	12	1	0	0	0	0	**332**
1983	195	40	15	0	0	0	0	**444**
1984	44	73	3	0	0	0	0	**162**
1985	4	8	56	4	0	0	1	**157**
1986	38	7	15	1	3	0	0	**409**
1987	326	20	15	9	3	12	0	**2203**
1988	935	45	3	1	3	2	0	**1167**
1989	87	437	56	1	1	0	0	**666**
1990	22	12	2	0	0	0	0	**85**
1991	24	11	5	6	0	0	1	**457**
1992	108	25	0	0	0	0	0	**169**
1993	107	44	25	1	2	0	0	**250**
1994	17	16	9	1	0	0	0	**279**
1995	90	2	0	0	0	0	0	203
1996	40	12	4	0	0	0	0	80
1997	1	7	1	0	0	0	0	67
1998	45	2	4	1	0	0	0	175
1999	12	2	1	2	1	0	0	115
2000	21	1	0	0	0	0	0	156
2001	25	11	0	3	0	0	0	104
2002	18	9	0	0	0	0	0	172
2003	12	10	0	0	0	0	0	56
2004	6	2	2	0	0	0	0	37
2005	5	1	1	0	0	0	0	48
2006	26	5	0	0	1	0	0	**65**
2007	6	0	0	0	0	0	0	**485**
2008	122	0	0	0	0	0	0	**307**
2009	41	32	0	0	0	0	0	**152**
2010	39	26	24	0	0	0	0	**153**
2011	0	0	0	0	0	0	0	**57**

Table 3.3.3. Haddock in Division VIa. Landings-at-age numbers (000s). Values used in the final assessment are boxed.

Year	Age								
	0	1	2	3	4	5	6	7	8
1965	0	33	463	60967	6753	294	274	174	11
1966	0	58	175	1082	46902	1926	64	32	57
1967	0	595	6136	782	262	24979	400	9	14
1968	0	3665	12439	2573	354	681	14063	727	43
1969	0	3	45819	8766	1423	268	379	4576	191
1970	0	169	170	78402	2747	173	89	145	585
1971	0	1925	1149	2665	78909	545	127	7	20
1972	0	576	26700	2225	2312	53823	504	50	19
1973	0	1252	5301	16109	256	1222	33193	150	32
1974	0	1706	3318	8625	6261	83	447	11463	104
1975	0	4629	10534	2735	3315	1882	95	98	3454
1976	0	745	22563	12358	1571	1491	868	21	7
1977	0	451	1317	29456	5645	680	495	308	28
1978	0	**1030**	**1006**	**813**	**23620**	**2912**	**344**	**247**	338
1979	0	**2068**	**10448**	**1761**	**468**	**9810**	**833**	**114**	145
1980	0	**2505**	**12871**	**5341**	**915**	**143**	**3082**	**229**	22
1981	0	**200**	**20553**	**15695**	**1768**	**194**	**39**	**822**	39
1982	0	**250**	**1342**	**46283**	**8004**	**898**	**108**	**272**	288
1983	0	**568**	**4917**	**4585**	**34659**	**3387**	**597**	**41**	194
1984	0	**3341**	**4386**	**10754**	**5959**	**20352**	**2449**	**371**	43
1985	0	**939**	**19434**	**4437**	**4112**	**1782**	**11031**	**964**	84
1986	0	**603**	**4812**	**26770**	**1823**	**916**	**449**	**2611**	344
1987	0	**4254**	**7388**	**9206**	**23551**	**1452**	**1116**	**642**	1818
1988	0	**847**	**20687**	**6873**	**4091**	**9205**	**428**	**235**	177
1989	0	**927**	**1414**	**18417**	**2744**	**1556**	**3633**	**255**	84
1990	0	**787**	**3198**	**1342**	**9450**	**848**	**279**	**519**	48
1991	0	**2145**	**10578**	**1217**	**834**	**5131**	**412**	**283**	410
1992	0	**691**	**10194**	**10010**	**553**	**236**	**1575**	**157**	37
1993	0	**745**	**15008**	**15975**	**4594**	**290**	**219**	**910**	70
1994	0	**1017**	**6326**	**15037**	**5240**	**1484**	**76**	**175**	237
1995	0	540	3669	12774	6483	1472	387	34	111
1996	0	437	9457	4968	8626	3622	1007	324	23
1997	0	883	2831	16921	2125	2638	870	259	59
1998	0	1345	7129	5675	13387	1352	1036	377	124
1999	0	346	5501	7159	2960	4864	493	452	96
2000	0	759	2507	5864	3841	1054	1090	205	133
2001	0	245	8535	1822	3523	1393	533	314	65
2002	0	177	1227	13557	691	707	549	199	144
2003	0	21	1029	2150	8809	221	206	69	34
2004	0	14	245	804	1819	4071	286	100	26
2005	0	7	287	792	1252	1212	2018	57	42
2006	0	**67**	**567**	**1513**	**2300**	**2504**	**2259**	**2192**	33
2007	0	**34**	**842**	**1121**	**1429**	**2394**	**778**	**855**	478
2008	0	**21**	**297**	**2718**	**546**	**584**	**752**	**254**	161
2009	0	**4**	**57**	**188**	**3929**	**487**	**287**	**208**	79
2010	0	**44**	**260**	**377**	**453**	**4250**	**234**	**158**	52
2011	0	**0**	**525**	**319**	**265**	**315**	**1613**	**88**	57

Table 3.3.3. Continued. Haddock in Division VIa. Landings-at-age numbers (000s). Values used in the final assessment are boxed.

Year	Age						
	9	10	11	12	13	14	15+	8+
1965	6	6	0	0	0	0	0	24
1966	0	0	0	0	0	0	0	57
1967	4	0	0	0	0	0	0	19
1968	9	0	0	0	0	0	0	52
1969	9	0	0	0	0	0	0	200
1970	13	2	0	0	0	0	0	600
1971	175	16	0	0	0	0	0	212
1972	0	67	0	0	0	0	0	86
1973	6	125	0	0	0	0	0	163
1974	34	31	0	1	4	0	0	174
1975	72	8	0	0	0	0	0	3534
1976	1103	4	0	5	0	0	0	1119
1977	11	259	5	0	0	0	0	304
1978	7	17	211	3	0	0	0	**575**
1979	28	3	1	42	1	0	0	**221**
1980	5	21	3	0	4	0	0	**54**
1981	14	2	2	1	0	1	0	**60**
1982	31	12	1	0	0	0	0	**332**
1983	195	40	15	0	0	0	0	**444**
1984	44	73	3	0	0	0	0	**162**
1985	4	8	56	4	0	0	1	**157**
1986	38	7	15	1	3	0	0	**409**
1987	326	20	15	9	3	12	0	**2203**
1988	935	45	3	1	3	2	0	**1167**
1989	87	437	56	1	1	0	0	**666**
1990	22	12	2	0	0	0	0	**85**
1991	24	11	5	6	0	0	1	**457**
1992	108	25	0	0	0	0	0	**169**
1993	107	44	25	1	2	0	0	**250**
1994	17	16	9	1	0	0	0	**279**
1995	90	2	0	0	0	0	0	203
1996	40	12	4	0	0	0	0	80
1997	1	7	1	0	0	0	0	67
1998	45	2	4	1	0	0	0	175
1999	12	2	1	2	1	0	0	115
2000	21	1	0	0	0	0	0	156
2001	25	11	0	3	0	0	0	104
2002	18	9	0	0	0	0	0	172
2003	11	10	0	0	0	0	0	55
2004	6	2	2	0	0	0	0	37
2005	5	1	1	0	0	0	0	48
2006	26	5	0	0	1	0	0	**65**
2007	6	0	0	0	0	0	0	**485**
2008	122	0	0	0	0	0	0	**283**
2009	41	32	0	0	0	0	0	**152**
2010	39	26	24	0	0	0	0	**140**
2011	0	0	0	0	0	0	0	**57**

Table 3.3.4. Haddock in Division VIa. Discards-at-age numbers (000s). Values used in the final assessment are boxed.

Year	Age							
	0	1	2	3	4	5	6	7	8
1965	451	1026	877	11494	63	0	0	0	0
1966	5953	1537	354	31	529	0	0	0	0
1967	40122	18590	13196	169	3	0	0	0	0
1968	27	125753	25954	506	3	0	0	0	0
1969	2742	81	114887	1493	11	0	0	0	0
1970	17189	6148	348	16712	23	0	0	0	0
1971	6604	69556	2766	663	1057	0	0	0	0
1972	14215	20137	58442	494	24	0	0	0	0
1973	19589	46135	11607	3368	2	0	0	0	0
1974	63698	67131	8244	2132	56	0	0	0	0
1975	6849	174721	24423	604	35	0	0	0	0
1976	4227	23593	49767	2866	17	0	0	0	0
1977	4552	12658	2152	6492	59	0	0	0	0
1978	55	**14911**	**1090**	**157**	**738**	**27**	**7**	**0**	0
1979	5697	**68002**	**6833**	**104**	**2**	**53**	**0**	**0**	0
1980	13	**20224**	**9057**	**295**	**7**	**0**	**0**	**0**	0
1981	764	**51**	**63359**	**5002**	**0**	**0**	**0**	**0**	0
1982	136	**15241**	**3678**	**27393**	**163**	**0**	**0**	**0**	0
1983	2084	**13957**	**15316**	**1456**	**1464**	**12**	**0**	**0**	0
1984	269	**95634**	**4240**	**2156**	**284**	**2438**	**0**	**0**	0
1985	155	**21882**	**59488**	**231**	**71**	**6**	**159**	**0**	0
1986	2979	**7524**	**6423**	**18597**	**0**	**0**	**0**	**0**	0
1987	1498	**84767**	**9436**	**944**	**306**	**0**	**0**	**0**	0
1988	7582	**9160**	**37727**	**725**	**95**	**49**	**0**	**0**	0
1989	3773	**4083**	**2007**	**7308**	**11**	**0**	**1**	**0**	0
1990	437	**36460**	**2658**	**542**	**2708**	**23**	**0**	**0**	0
1991	8921	**34779**	**11413**	**42**	**0**	**1**	**0**	**0**	0
1992	4331	**51148**	**8776**	**1322**	**12**	**0**	**2**	**0**	0
1993	2196	**42914**	**45777**	**4787**	**74**	**16**	**0**	**5**	0
1994	2843	**18467**	**26312**	**6490**	**432**	**94**	**0**	**0**	0
1995	7692	17040	12090	10825	382	0	0	0	0
1996	10249	32907	30354	1674	1599	41	0	0	0
1997	2984	22961	7676	4629	53	30	0	0	0
1998	2058	10075	10872	2357	1728	0	0	0	0
1999	6898	5834	12554	4410	44	54	86	0	0
2000	5709	49383	4136	2731	372	1	14	0	0
2001	11818	10778	24961	611	143	128	0	0	0
2002	1362	16250	11168	18692	142	8	0	39	0
2003	3861	6951	4564	4697	4021	2	2	1	0
2004	2727	15146	6261	1580	2021	2635	0	1	0
2005	3965	7184	5915	2908	864	1457	686	0	1
2006	817	**15964**	**4263**	**2331**	**1501**	**605**	**471**	**557**	0
2007	257	**1743**	**15008**	**1775**	**296**	**34**	**33**	**48**	0
2008	1840	**2388**	**2033**	**1703**	**41**	**25**	**116**	**1**	24
2009	2021	**4994**	**378**	**240**	**2752**	**25**	**48**	**46**	0
2010	1373	**37326**	**1676**	**45**	**127**	**382**	**24**	**0**	13
2011	63	**1721**	**5662**	**83**	**25**	**3**	**12**	**0**	0

Table 3.3.4. Continued. Haddock in Division VIa. Discards-at-age numbers (000s). Values used in the final assessment are boxed.

Year	Age						
	9	10	11	12	13	14	15+	8+
1965	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	**0**
1979	0	0	0	0	0	0	0	**0**
1980	0	0	0	0	0	0	0	**0**
1981	0	0	0	0	0	0	0	**0**
1982	0	0	0	0	0	0	0	**0**
1983	0	0	0	0	0	0	0	**0**
1984	0	0	0	0	0	0	0	**0**
1985	0	0	0	0	0	0	0	**0**
1986	0	0	0	0	0	0	0	**0**
1987	0	0	0	0	0	0	0	**0**
1988	0	0	0	0	0	0	0	**0**
1989	0	0	0	0	0	0	0	**0**
1990	0	0	0	0	0	0	0	**0**
1991	0	0	0	0	0	0	0	**0**
1992	0	0	0	0	0	0	0	**0**
1993	0	0	0	0	0	0	0	**0**
1994	0	0	0	0	0	0	0	**0**
1995	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	1
2006	0	0	0	0	0	0	0	**0**
2007	0	0	0	0	0	0	0	**0**
2008	0	0	0	0	0	0	0	**24**
2009	0	0	0	0	0	0	0	**0**
2010	0	0	0	0	0	0	0	**13**
2011	0	0	0	0	0	0	0	**0**

Table 3.3.5. Haddock in Division VIa. Weights-at-age (kg) in total catch. Values used in the final assessment are boxed.

Year	Age								
	0	1	2	3	4	5	6	7	8
1965	0.040	0.160	0.242	0.412	0.692	0.916	1.041	1.249	1.517
1966	0.040	0.162	0.251	0.555	0.572	1.041	1.125	1.325	1.522
1967	0.040	0.160	0.266	0.569	0.573	0.667	1.177	1.844	1.611
1968	0.040	0.159	0.264	0.567	0.823	0.731	0.811	1.430	1.903
1969	0.040	0.158	0.243	0.526	0.916	1.042	1.024	0.999	1.569
1970	0.040	0.161	0.230	0.368	0.812	1.283	1.262	1.043	1.342
1971	0.040	0.160	0.248	0.341	0.546	1.040	1.313	1.651	1.426
1972	0.040	0.160	0.249	0.380	0.530	0.546	0.984	1.499	1.538
1973	0.040	0.159	0.251	0.384	0.597	0.512	0.571	1.185	1.706
1974	0.040	0.159	0.248	0.368	0.527	0.764	0.685	0.798	1.142
1975	0.040	0.159	0.260	0.428	0.581	0.832	1.027	1.001	1.009
1976	0.040	0.159	0.256	0.459	0.592	0.831	1.095	1.585	1.084
1977	0.040	0.161	0.274	0.406	0.684	0.800	1.128	1.337	1.117
1978	0.068	**0.134**	**0.278**	**0.388**	**0.516**	**0.827**	**1.045**	**1.152**	1.399
1979	0.032	**0.182**	**0.325**	**0.457**	**0.730**	**0.777**	**1.040**	**1.491**	1.944
1980	0.077	**0.134**	**0.319**	**0.572**	**0.719**	**0.998**	**0.985**	**1.143**	1.565
1981	0.082	**0.252**	**0.245**	**0.467**	**0.887**	**0.975**	**1.376**	**1.294**	1.347
1982	0.038	**0.157**	**0.273**	**0.376**	**0.746**	**1.126**	**1.539**	**1.549**	1.514
1983	0.050	**0.178**	**0.282**	**0.461**	**0.557**	**1.002**	**1.370**	**1.716**	1.558
1984	0.059	**0.149**	**0.319**	**0.456**	**0.688**	**0.667**	**1.087**	**1.392**	2.075
1985	0.019	**0.138**	**0.268**	**0.486**	**0.636**	**0.802**	**0.868**	**1.272**	1.277
1986	0.064	**0.182**	**0.270**	**0.362**	**0.637**	**0.903**	**1.115**	**1.043**	1.418
1987	0.028	**0.168**	**0.270**	**0.418**	**0.566**	**0.880**	**1.105**	**1.250**	1.147
1988	0.085	**0.170**	**0.254**	**0.444**	**0.562**	**0.704**	**1.027**	**1.280**	1.279
1989	0.052	**0.226**	**0.301**	**0.402**	**0.625**	**0.749**	**0.894**	**1.115**	1.465
1990	0.073	**0.112**	**0.355**	**0.445**	**0.534**	**0.891**	**1.108**	**1.280**	1.823
1991	0.058	**0.184**	**0.297**	**0.547**	**0.618**	**0.678**	**0.931**	**1.053**	1.091
1992	0.050	**0.133**	**0.321**	**0.437**	**0.766**	**0.892**	**0.932**	**1.407**	1.493
1993	0.037	**0.108**	**0.277**	**0.458**	**0.650**	**0.861**	**0.898**	**1.022**	1.514
1994	0.031	**0.169**	**0.253**	**0.405**	**0.611**	**0.698**	**0.929**	**0.959**	0.909
1995	0.030	0.149	0.274	0.354	0.553	0.833	0.978	1.322	1.059
1996	0.047	0.128	0.243	0.404	0.462	0.645	0.750	0.754	1.122
1997	0.048	0.153	0.263	0.394	0.614	0.730	0.925	1.057	0.921
1998	0.089	0.164	0.283	0.382	0.502	0.689	0.802	0.951	1.006
1999	0.035	0.172	0.255	0.365	0.494	0.611	0.729	0.840	1.067
2000	0.053	0.127	0.270	0.361	0.447	0.572	0.719	0.840	0.749
2001	0.050	0.112	0.242	0.403	0.432	0.514	0.657	0.808	1.029
2002	0.048	0.118	0.208	0.307	0.521	0.606	0.632	0.636	0.810
2003	0.036	0.124	0.239	0.282	0.382	0.652	0.648	0.908	0.945
2004	0.033	0.112	0.189	0.290	0.313	0.373	0.541	0.715	0.782
2005	0.053	0.103	0.198	0.295	0.451	0.429	0.525	1.163	0.916
2006	0.024	**0.155**	**0.254**	**0.326**	**0.388**	**0.471**	**0.496**	**0.563**	1.242
2007	0.060	**0.115**	**0.219**	**0.331**	**0.404**	**0.456**	**0.550**	**0.593**	0.682
2008	0.022	**0.113**	**0.245**	**0.367**	**0.492**	**0.570**	**0.619**	**0.708**	0.770
2009	0.048	**0.135**	**0.266**	**0.357**	**0.410**	**0.570**	**0.633**	**0.630**	0.897
2010	0.017	**0.067**	**0.180**	**0.388**	**0.409**	**0.459**	**0.725**	**0.755**	0.852
2011	0.012	**0.054**	**0.259**	**0.357**	**0.509**	**0.476**	**0.617**	**0.818**	1.107

Table 3.3.5. Continued. Haddock in Division VIa. Weights-at-age (kg) in total catch. Values used in the final assessment are boxed.

Year	Age						
	9	10	11	12	13	14	15+	8+
1965	1.920	1.833	0.000	0.000	0.000	0.000	0.000	1.713
1966	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.522
1967	2.355	0.000	0.000	0.000	0.000	0.000	0.000	1.786
1968	2.516	0.000	0.000	0.000	0.000	0.000	0.000	2.005
1969	2.065	0.000	0.000	0.000	0.000	0.000	0.000	1.590
1970	1.791	1.213	0.000	0.000	0.000	0.000	0.000	1.352
1971	1.466	2.042	0.000	0.000	0.000	0.000	0.000	1.506
1972	0.000	1.551	0.000	0.000	0.000	0.000	0.000	1.548
1973	2.202	1.520	0.000	0.000	0.000	0.000	0.000	1.581
1974	1.319	1.229	0.000	0.833	0.890	0.000	0.000	1.183
1975	1.190	2.523	0.000	0.000	0.000	0.000	0.000	1.016
1976	1.243	1.806	0.000	1.679	0.000	0.000	0.000	1.246
1977	1.394	1.339	1.593	0.000	0.000	0.000	0.000	1.325
1978	2.126	1.376	1.208	1.627	0.000	0.000	0.000	**1.338**
1979	1.735	1.569	1.781	1.119	1.590	0.000	0.000	**1.754**
1980	1.632	1.879	2.862	0.000	1.482	0.000	0.000	**1.747**
1981	1.366	1.314	1.785	1.587	0.000	1.677	0.000	**1.379**
1982	1.738	2.068	1.543	0.000	0.000	0.000	0.000	**1.555**
1983	1.556	1.555	1.999	0.000	0.000	0.000	0.000	**1.572**
1984	1.882	1.417	1.864	0.000	0.000	0.000	0.000	**1.724**
1985	1.695	2.014	2.152	2.741	0.000	0.000	4.141	**1.694**
1986	1.517	1.832	1.925	1.504	2.635	0.000	0.000	**1.463**
1987	1.149	1.851	2.774	3.040	2.828	2.664	0.000	**1.182**
1988	0.879	1.618	0.990	3.424	3.994	4.150	0.000	**0.984**
1989	1.357	0.949	1.388	2.807	3.008	0.000	0.429	**1.110**
1990	1.682	2.288	1.964	2.506	0.000	0.000	0.000	**1.860**
1991	1.755	3.290	2.170	1.343	0.000	0.000	2.869	**1.201**
1992	1.564	2.180	0.000	0.000	0.000	0.000	0.000	**1.639**
1993	1.210	1.578	2.304	1.800	2.405	0.000	0.000	**1.483**
1994	1.243	1.319	1.961	2.430	0.000	0.000	0.000	**0.992**
1995	0.940	1.953	1.996	2.492	0.000	0.000	0.000	1.020
1996	1.163	1.046	1.141	0.000	3.167	0.000	0.000	1.137
1997	2.024	1.630	2.252	0.000	3.033	0.000	0.000	1.020
1998	1.064	2.488	2.585	3.322	2.591	0.000	0.000	1.077
1999	1.465	1.465	3.246	1.993	2.954	2.829	0.000	1.172
2000	1.186	1.262	0.000	2.168	0.000	0.000	0.000	0.813
2001	0.975	1.089	3.361	0.597	0.000	0.000	0.000	1.015
2002	1.995	0.916	0.000	2.698	0.000	0.000	0.000	0.939
2003	1.232	1.393	2.682	0.000	0.000	0.000	0.000	1.086
2004	0.853	1.396	3.976	0.000	0.000	0.000	0.000	0.988
2005	1.467	2.084	3.491	2.275	0.000	0.000	0.000	1.018
2006	1.182	1.682	2.675	0.000	3.889	5.471	0.000	**1.294**
2007	0.825	2.160	2.270	0.000	0.000	0.000	0.000	**0.685**
2008	0.911	2.494	2.109	0.000	0.000	0.000	0.000	**0.827**
2009	1.042	1.233	1.874	0.000	0.000	0.000	0.000	**1.008**
2010	0.852	0.734	1.141	0.000	0.000	0.000	0.000	**0.877**
2011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**1.107**

Table 3.3.6. Haddock in Division VIa. Weights-at-age (kg) in landings. Values used in the final assessment are boxed.

Year	Age								
	0	1	2	3	4	5	6	7	8
1965	0.000	0.273	0.295	0.440	0.695	0.916	1.041	1.249	1.517
1966	0.000	0.315	0.324	0.563	0.575	1.041	1.125	1.325	1.522
1967	0.000	0.285	0.374	0.635	0.576	0.667	1.177	1.844	1.611
1968	0.000	0.259	0.367	0.627	0.827	0.731	0.811	1.430	1.903
1969	0.000	0.199	0.314	0.570	0.921	1.042	1.024	0.999	1.569
1970	0.000	0.348	0.261	0.389	0.817	1.283	1.262	1.043	1.342
1971	0.000	0.295	0.328	0.360	0.549	1.040	1.313	1.651	1.426
1972	0.000	0.285	0.325	0.406	0.532	0.546	0.984	1.499	1.538
1973	0.000	0.259	0.329	0.408	0.599	0.512	0.571	1.185	1.706
1974	0.000	0.264	0.328	0.393	0.530	0.764	0.685	0.798	1.142
1975	0.000	0.277	0.365	0.465	0.585	0.832	1.027	1.001	1.009
1976	0.000	0.251	0.345	0.504	0.596	0.831	1.095	1.585	1.084
1977	0.000	0.307	0.370	0.437	0.689	0.800	1.128	1.337	1.117
1978	0.000	**0.257**	**0.353**	**0.419**	**0.524**	**0.832**	**1.060**	**1.152**	1.399
1979	0.000	**0.269**	**0.386**	**0.467**	**0.732**	**0.779**	**1.040**	**1.491**	1.944
1980	0.000	**0.251**	**0.373**	**0.587**	**0.722**	**0.998**	**0.985**	**1.143**	1.565
1981	0.000	**0.289**	**0.357**	**0.502**	**0.887**	**0.975**	**1.376**	**1.294**	1.347
1982	0.000	**0.285**	**0.369**	**0.452**	**0.754**	**1.126**	**1.539**	**1.549**	1.514
1983	0.000	**0.479**	**0.424**	**0.518**	**0.568**	**1.004**	**1.370**	**1.716**	1.558
1984	0.000	**0.273**	**0.388**	**0.486**	**0.705**	**0.713**	**1.087**	**1.392**	2.075
1985	0.000	**0.283**	**0.346**	**0.494**	**0.641**	**0.803**	**0.875**	**1.272**	1.277
1986	0.000	**0.294**	**0.373**	**0.440**	**0.637**	**0.903**	**1.115**	**1.043**	1.418
1987	0.000	**0.276**	**0.337**	**0.435**	**0.570**	**0.880**	**1.105**	**1.250**	1.147
1988	0.000	**0.310**	**0.338**	**0.462**	**0.567**	**0.706**	**1.027**	**1.280**	1.279
1989	0.000	**0.372**	**0.406**	**0.468**	**0.625**	**0.749**	**0.894**	**1.115**	1.462
1990	0.000	**0.335**	**0.443**	**0.532**	**0.618**	**0.908**	**1.108**	**1.280**	1.823
1991	0.000	**0.287**	**0.382**	**0.556**	**0.618**	**0.678**	**0.931**	**1.053**	1.091
1992	0.000	**0.310**	**0.384**	**0.461**	**0.777**	**0.892**	**0.932**	**1.407**	1.493
1993	0.000	**0.313**	**0.395**	**0.509**	**0.655**	**0.889**	**0.898**	**1.026**	1.514
1994	0.000	**0.280**	**0.352**	**0.454**	**0.633**	**0.723**	**0.929**	**0.959**	0.909
1995	0.000	0.293	0.375	0.415	0.567	0.833	0.978	1.322	1.059
1996	0.000	0.285	0.363	0.445	0.492	0.649	0.750	0.754	1.122
1997	0.000	0.275	0.365	0.425	0.621	0.735	0.925	1.057	0.921
1998	0.000	0.265	0.331	0.416	0.524	0.689	0.802	0.951	1.006
1999	0.000	0.313	0.353	0.420	0.496	0.614	0.820	0.840	1.067
2000	0.000	0.265	0.347	0.410	0.465	0.572	0.724	0.840	0.749
2001	0.000	0.243	0.332	0.457	0.439	0.538	0.657	0.808	1.029
2002	0.000	0.254	0.321	0.383	0.566	0.608	0.632	0.691	0.810
2003	0.000	0.240	0.311	0.389	0.428	0.654	0.651	0.917	0.946
2004	0.000	0.253	0.329	0.394	0.391	0.448	0.541	0.718	0.782
2005	0.000	0.270	0.358	0.415	0.542	0.596	0.594	1.167	0.921
2006	0.000	**0.291**	**0.348**	**0.392**	**0.437**	**0.508**	**0.527**	**0.621**	1.242
2007	0.000	**0.248**	**0.357**	**0.398**	**0.423**	**0.458**	**0.558**	**0.605**	0.682
2008	0.000	**0.275**	**0.378**	**0.418**	**0.505**	**0.578**	**0.666**	**0.709**	0.823
2009	0.000	**0.344**	**0.469**	**0.467**	**0.488**	**0.581**	**0.687**	**0.691**	0.897
2010	0.000	**0.280**	**0.338**	**0.406**	**0.438**	**0.471**	**0.764**	**0.755**	0.990
2011	0.000	**0.000**	**0.358**	**0.379**	**0.523**	**0.478**	**0.619**	**0.818**	1.107

Table 3.3.6. Continued. Haddock in Division VIa. Weights-at-age (kg) in landings. Values used in the final assessment are boxed.

Year	Age							
	9	10	11	12	13	14	15+	8+
1965	1.920	1.833	0.000	0.000	0.000	0.000	0.000	1.713
1966	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.522
1967	2.355	0.000	0.000	0.000	0.000	0.000	0.000	1.786
1968	2.516	0.000	0.000	0.000	0.000	0.000	0.000	2.005
1969	2.065	0.000	0.000	0.000	0.000	0.000	0.000	1.590
1970	1.791	1.213	0.000	0.000	0.000	0.000	0.000	1.352
1971	1.466	2.042	0.000	0.000	0.000	0.000	0.000	1.506
1972	0.000	1.551	0.000	0.000	0.000	0.000	0.000	1.548
1973	2.202	1.520	0.000	0.000	0.000	0.000	0.000	1.581
1974	1.319	1.229	0.000	0.833	0.890	0.000	0.000	1.183
1975	1.190	2.523	0.000	0.000	0.000	0.000	0.000	1.016
1976	1.243	1.806	0.000	1.679	0.000	0.000	0.000	1.246
1977	1.394	1.339	1.593	0.000	0.000	0.000	0.000	1.325
1978	2.126	1.376	1.208	1.627	0.000	0.000	0.000	**1.338**
1979	1.735	1.569	1.781	1.119	1.590	0.000	0.000	**1.754**
1980	1.632	1.879	2.862	0.000	1.482	0.000	0.000	**1.747**
1981	1.366	1.314	1.785	1.587	0.000	1.677	0.000	**1.379**
1982	1.738	2.068	1.543	0.000	0.000	0.000	0.000	**1.555**
1983	1.556	1.555	1.999	0.000	0.000	0.000	0.000	**1.572**
1984	1.882	1.417	1.864	0.000	0.000	0.000	0.000	**1.724**
1985	1.695	2.014	2.152	2.741	0.000	0.000	4.141	**1.694**
1986	1.517	1.832	1.925	1.504	2.635	0.000	0.000	**1.463**
1987	1.149	1.851	2.774	3.040	2.828	2.664	0.000	**1.182**
1988	0.879	1.618	0.990	3.424	3.994	4.150	0.000	**0.984**
1989	1.357	0.948	1.388	2.807	3.008	0.000	0.429	**1.109**
1990	1.682	2.288	1.964	2.506	0.000	0.000	0.000	**1.860**
1991	1.755	3.290	2.170	1.343	0.000	0.000	2.869	**1.201**
1992	1.564	2.180	0.000	0.000	0.000	0.000	0.000	**1.639**
1993	1.210	1.578	2.304	1.800	2.405	0.000	0.000	**1.483**
1994	1.243	1.319	1.961	2.430	0.000	0.000	0.000	**0.992**
1995	0.940	1.953	1.996	2.492	0.000	0.000	0.000	1.020
1996	1.163	1.046	1.141	0.000	3.167	0.000	0.000	1.137
1997	2.024	1.630	2.252	0.000	3.033	0.000	0.000	1.020
1998	1.064	2.488	2.585	3.322	2.591	0.000	0.000	1.077
1999	1.465	1.465	3.246	1.993	2.954	2.829	0.000	1.172
2000	1.186	1.262	0.000	2.168	0.000	0.000	0.000	0.813
2001	0.975	1.089	3.361	0.597	0.000	0.000	0.000	1.015
2002	1.995	0.916	0.000	2.698	0.000	0.000	0.000	0.939
2003	1.253	1.395	2.682	0.000	0.000	0.000	0.000	1.091
2004	0.853	1.396	3.976	0.000	0.000	0.000	0.000	0.988
2005	1.467	2.084	3.491	2.275	0.000	0.000	0.000	1.023
2006	1.182	1.682	2.675	0.000	3.889	5.471	0.000	**1.294**
2007	0.825	2.160	2.270	0.000	0.000	0.000	0.000	**0.685**
2008	0.911	2.494	2.109	2.966	0.000	0.000	0.000	**0.862**
2009	1.042	1.233	1.874	0.000	3.002	0.000	0.000	**1.011**
2010	0.852	0.734	1.141	0.000	0.000	0.000	0.000	**0.930**
2011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**1.107**

Table 3.3.7. Haddock in Division VIa. Weights-at-age (kg) in discards. Values used in the final assessment are boxed.

Year	Age								
	0	1	2	3	4	5	6	7	8
1965	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000
1966	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000
1967	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000
1968	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000
1969	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000
1970	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000
1971	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000
1972	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000
1973	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000
1974	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000
1975	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000
1976	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000
1977	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000
1978	0.059	**0.125**	**0.208**	**0.231**	**0.259**	**0.265**	**0.308**	**0.000**	0.000
1979	0.032	**0.180**	**0.230**	**0.272**	**0.266**	**0.303**	**0.000**	**0.000**	0.000
1980	0.077	**0.120**	**0.243**	**0.287**	**0.334**	**0.000**	**0.000**	**0.000**	0.000
1981	0.082	**0.106**	**0.209**	**0.360**	**0.000**	**0.000**	**0.000**	**0.000**	0.000
1982	0.038	**0.155**	**0.238**	**0.247**	**0.363**	**0.000**	**0.000**	**0.000**	0.000
1983	0.050	**0.165**	**0.237**	**0.283**	**0.298**	**0.536**	**0.000**	**0.000**	0.000
1984	0.059	**0.145**	**0.248**	**0.303**	**0.331**	**0.278**	**0.000**	**0.000**	0.000
1985	0.019	**0.132**	**0.242**	**0.326**	**0.362**	**0.423**	**0.353**	**0.000**	0.000
1986	0.064	**0.173**	**0.193**	**0.248**	**0.000**	**0.000**	**0.000**	**0.000**	0.000
1987	0.028	**0.163**	**0.218**	**0.247**	**0.281**	**0.000**	**0.000**	**0.000**	0.000
1988	0.085	**0.157**	**0.208**	**0.279**	**0.331**	**0.341**	**0.000**	**0.000**	0.000
1989	0.052	**0.193**	**0.226**	**0.237**	**0.491**	**0.961**	**1.423**	**0.000**	2.572
1990	0.073	**0.108**	**0.250**	**0.228**	**0.242**	**0.268**	**0.000**	**0.000**	0.000
1991	0.058	**0.178**	**0.218**	**0.278**	**0.000**	**0.263**	**0.000**	**0.000**	0.000
1992	0.050	**0.130**	**0.247**	**0.258**	**0.242**	**0.000**	**0.947**	**0.000**	0.000
1993	0.037	**0.105**	**0.238**	**0.287**	**0.382**	**0.348**	**0.000**	**0.430**	0.000
1994	0.031	**0.163**	**0.229**	**0.291**	**0.337**	**0.304**	**0.000**	**0.000**	0.000
1995	0.030	0.144	0.243	0.281	0.310	0.000	0.000	0.000	0.000
1996	0.047	0.126	0.206	0.282	0.300	0.317	0.000	0.000	0.000
1997	0.048	0.148	0.226	0.283	0.340	0.317	0.000	0.000	0.000
1998	0.089	0.151	0.251	0.298	0.337	0.000	0.000	0.000	0.000
1999	0.035	0.163	0.213	0.276	0.318	0.311	0.206	0.000	0.000
2000	0.053	0.125	0.223	0.257	0.259	0.625	0.337	0.000	0.000
2001	0.050	0.109	0.211	0.243	0.254	0.245	0.000	0.000	0.000
2002	0.048	0.117	0.196	0.253	0.305	0.456	0.000	0.358	0.000
2003	0.036	0.123	0.223	0.233	0.282	0.462	0.439	0.496	0.591
2004	0.033	0.112	0.183	0.237	0.242	0.256	0.000	0.411	0.000
2005	0.053	**0.103**	**0.190**	**0.262**	**0.320**	**0.290**	**0.322**	**0.416**	0.493
2006	0.024	**0.154**	**0.241**	**0.284**	**0.313**	**0.318**	**0.348**	**0.336**	0.000
2007	0.060	**0.113**	**0.211**	**0.288**	**0.314**	**0.336**	**0.368**	**0.373**	0.000
2008	0.022	**0.112**	**0.226**	**0.287**	**0.322**	**0.389**	**0.312**	**0.458**	0.419
2009	0.048	**0.134**	**0.235**	**0.271**	**0.298**	**0.362**	**0.309**	**0.356**	0.000
2010	0.000	**0.067**	**0.156**	**0.240**	**0.307**	**0.320**	**0.345**	**0.000**	0.279
2011	0.012	**0.054**	**0.250**	**0.274**	**0.360**	**0.296**	**0.375**	**0.000**	0.000

Table 3.3.7. Continued. Haddock in Division VIa. Weights-at-age (kg) in discards. Values used in the final assessment are boxed.

Year	Age							
	9	10	11	12	13	14	15+	8+
1965	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1966	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1967	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1968	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1969	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1970	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1971	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1972	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1973	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1974	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1975	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1976	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1977	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1978	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1979	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1980	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1982	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1983	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1984	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1985	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1987	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1988	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1989	0.000	3.048	0.000	0.000	0.000	0.000	0.000	2.810
1990	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1993	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1995	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1996	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1997	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1998	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1999	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.432	0.689	0.000	0.000	0.000	0.000	0.000	0.493
2004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.493
2006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.419
2009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.279
2011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 3.3.8. Haddock in Division VIa. Available research-vessels survey data. Values used in the final assessment are boxed.

ScoGFS Q1

Year	Age 1	2	3	4	5	6	7	8	Total
1985	1104	4085	68	80	141	388	27	1	5893
1986	753	1669	1877	17	14	47	90	5	4467
1987	5518	446	460	690	25	34	25	67	7198
1988	571	3610	303	112	246	10	4	8	4856
1989	178	488	1701	98	49	69	5	1	2588
1990	2577	87	54	296	26	6	36	3	3082
1991	1591	1763	92	25	184	9	4	15	3668
1992	3618	1193	321	12	13	28	6	1	5191
1993	5371	5922	675	167	0	2	18	2	12 155
1994	1151	2300	787	126	39	3	1	8	4407
1995	7112	1074	1697	485	65	30	10	4	10 473
1996	4401	3742	315	456	125	20	11	3	9070
1997	4262	2018	1915	147	151	53	2	1	8548
1998	5034	2720	616	562	40	64	19	7	9055
1999	941	2989	687	168	128	15	11	2	4939
2000	7936	553	440	97	13	20	1	3	9060
2001	3421	5762	143	146	34	16	6	1	9528
2002	2339	3246	5293	56	70	24	9	3	11 037
2003	2650	1696	1449	1874	23	34	18	4	7744
2004	1397	2765	869	1199	609	11	3	5	6853
2005	573	633	1402	351	512	402	5	3	3878
2006	633	892	539	397	156	170	51	2	2838
2007	99	2019	296	121	192	82	89	65	2898
2008	86	113	1094	98	84	71	13	15	1558
2009	42	113	147	1445	29	43	63	7	1882
2010	706	111	26	71	452	23	4	9	1393

Table 3.3.8. Continued. Haddock in Division VIa. Available research-vessels survey data. Values used in the final assessment are boxed.

ScoGFS Q4

	Age								
Year	0	1	2	3	4	5	6	7	Total
1996	2907	761	656	70	137	57	24	6	1711
1997	3713	1359	282	151	25	26	14	4	1861
1998	399	1640	486	148	137	17	33	5	2466
1999	4670	366	574	267	92	68	11	18	1396
2000	2959	4231	147	191	59	25	5	3	4661
2001	3083	2219	3563	48	138	22	12	2	6004
2002	2943	1709	1770	2841	34	50	24	8	6436
2003	293	2023	965	1470	639	28	17	3	5145
2004	542	574	1068	410	649	524	5	9	3239
2005	286	419	409	410	223	309	87	1	1858
2006	19	543	233	162	281	79	100	40	1438
2007	125	69	1392	109	128	90	48	45	1881
2008	14	117	78	835	74	94	63	29	1290
2009	335	68	161	343	551	44	35	26	1228

IreGFS

	Effort	Age									
Year	(hours)	0	1	2	3	4	5	6	7	8	Total
1993	2130	143	2493	5691	1606	693	29	112	56	35	10 715
1994	1865	76	1237	3538	3303	367	187	13	18	66	8729
1995	2026	967	3104	1149	4152	1663	187	149	29	14	10 447
1996	2008	192	2536	3688	2155	627	254	126	45	24	9455
1997	1879	2900	8289	636	532	375	294	45	8	3	10 182
1998	1936	96	1098	1538	1353	192	84	75	15	49	4404
1999	1914	7985	1028	1967	1530	679	237	118	25	34	5618
2000	1878	1454	8865	569	691	484	183	32	30	0	10 854
2001	965	1951	2728	3548	136	187	151	36	4	0	6790
2002	796	6618	2541	2768	1788	67	90	32	5	2	7293

Table 3.3.8. Continued. Haddock in Division VIa. Available research-vessels survey data. Values used in the final assessment are boxed.

IRGFS													
	Effort	Age											
Year	(hours)	0	1	2	3	4	5	6	7	8	9	10	Total
2003	1127	207	7588	2382	839	355	22	30	7	0	3	2	11 228
2004	1200	86	2163	3322	1281	941	957	60	10	21	0	0	8755
2005	960	233	1160	767	778	315	87	3	0	0	1	0	3111
2006	1510	313	207	1027	381	1337	543	130	59	0	0	0	3684
2007	1173	320	979	1049	346	689	101	64	69	1	0	0	3298
2008	1135	76	2052	562	645	74	196	169	31	14	0	0	3742
2009	1378	744	535	919	309	328	76	187	61	6	0	0	2422
2010	1291	66	2997	213	348	123	237	48	70	57	0	3	4095
2011	1287	33	633	8951	121	726	70	193	20	30	13	1	10792

Table 3.3.9. Haddock in Division VIa. TSA parameter estimates from this year's assessment, along with those from previous assessments for comparison. * = fixed parameter.

Parameter	Notation	Description	2004	2005	2006	2007	2008	2009	2010	2011	2012
Initial fishing mortality	F (1, 1978)	Fishing mortality-at-age a in year y	0.28	0.26	0.23	0.25	0.40	0.40	0.43	0.4105	0.394
	F (2, 1978)		0.5	0.51	0.50	0.56	0.71	0.70	0.81	0.6707	0.7205
	F (4, 1978)		0.51	0.51	0.51	0.52	0.56	0.57	0.59	0.5971	0.5863
Survey selectivities	□(1)		2.25	2.35	2.49	2.58	2.60	2.58	3.11	2.50	-
ScoGFS Q1	□(2)	ScoGFS Q1 survey selectivity-at-age a	2.71	2.45	2.55	3.01	3.07	3.01	3.34	2.86	-
	□(4)		1.51	2.11	2.19	2.04	1.92	1.94	2.24	1.93	-
Survey selectivities	□(1)		-	-	1.99	1.62	1.77	1.75	2.24	2.09	-
ScoGFS Q4	□(2)	ScoGFS Q4 survey selectivity-at-age a	-	-	1.99	1.76	1.88	1.84	2.22	2.10	-
	□(4)		-	-	2.25	2.39	2.61	2.64	3.44	2.76	-
Fishing mortality standard deviations	□F	Transitory changes in overall F	0.11	0.10	0.10	0.12	0.20	0.20	0.19	0.076	0.1046
	□U	Persistent changes in selection (age effect in F)	0.04	0.01	0.00	0.09	0.03	0.03	0.05	0.08	0.0681
	□V	Transitory changes in the year effect in F	0.23	0.22	0.23	0.23	0.33	0.35	0.26	0.25	0.2475
	□Y	Persistent changes in the year effect in F	0.14	0.09	0.09	0.07	0.00	0.00	0.15	0.17	0.1414
Survey catchability standard deviations	□□□□	Transitory changes in ScoGFS Q1 catchability	0.08	0.18	0.30	0.19	0.12	0.12	0.27	0.23	-
	□□□□	Persistent changes in ScoGFS Q1 catchability	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00	0	-
	□□□□	Transitory changes in ScoGFS Q4 catchability	-	-		0.16	0.20	0.19	0.21	0.17	-
	□□□□	Persistent changes in ScoGFS Q4 catchability	-	-		0.00*	0.00*	0.00*	0.00	0.00	-
Measurement coefficients of variation	cv landings	Coefficent of variation of landings-at-age data	0.25	0.23	0.20	0.20	0.24	0.25	0.28	0.24	0.255
	cv discards	Coefficent of variation of discards-at-age data	0.43	0.45	0.42	0.41	0.54	0.54	0.59	0.51	0.5749
	cv survey	Coefficent of variation of ScoGFS Q1 survey data	0.34	0.53	0.57	0.33	0.35	0.36	0.41	0.37	-
	cv survey	Coefficent of variation of ScoGFS Q4 survey data	-	-	0.57	0.22	0.34	0.35	0.51	0.41	-

Table 3.3.9. Continued. Haddock in Division VIa. TSA parameter estimates from this year's assessment, along with those from previous assessments for comparison. * = fixed parameter.

Parameter	Notation	Description	2004	2005	2006	2007	2008	2009	2010	2011	2012
Discard curve parameters	□P	Transitory changes in overall discard proportion	0.19	0.20	0.19	0.18	0.20	0.20	0.00	0.30	0.0001
	□□1	Transitory changes in discard-ogive intercept	0.15	0.02	0.00	0.14	0.00	0.00	0.01	0.00	0.00
	□□1	Persistent changes in discard-ogive intercept	0.21	0.22	0.21	0.32	0.26	0.25	0.29	0.28	0.2594
	□□2	Transitory changes in discard-ogive slope	0.01	0.03	0.21	0.23	0.22	0.23	0.40	0.36	0.3868
	□□2	Persistent changes in discard-ogive slope	0.61	0.43	0.23	0.002	0.000	0.000	0.00	0.0	0.007
Trend parameters	□□1	Trend parameter for discard-ogive intercept	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
	□□2	Trend parameter for discard-ogive slope	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
Recruitment	□1	Ricker parameter (slope at the origin)	9.63	9.71	9.73	9.06	11.35	11.08	9.62	10.84	10.0321
	□2	Ricker parameter (curve dome occurs at $1/\eta^2$)	0.29	0.31	0.29	0.30	0.35	0.35	0.39	0.36	0.3604
	cv rec	Coefficent of variation of recruitment curve	0.89	0.89	0.90	0.62	0.60	0.61	0.69	0.55	0.6636

Table 3.3.10. Haddock in Division VIa. Estimates of population abundance (in thousands) from the final TSA run.

	Age							
Year	1	2	3	4	5	6	7	8+
1978	72985	7999	2488	59935	4413	619	476	1040
1979	154490	44298	3871	1085	23358	1530	229	572
1980	478997	88110	18229	1505	387	7782	445	246
1981	59881	313624	44756	7257	582	159	3054	250
1982	70906	40301	186651	22594	3509	288	80	1610
1983	45651	48045	23835	100668	11648	1831	149	885
1984	313813	28840	25758	10808	46189	5337	822	481
1985	73622	193715	12122	9801	4642	19681	2227	543
1986	60114	42781	93198	5075	4065	2044	8197	1188
1987	261243	39460	23335	47413	2570	2086	1067	4807
1988	21680	144591	14796	7995	16175	842	679	1985
1989	17085	11232	60640	5424	2807	5720	306	955
1990	98097	8690	4346	23020	1911	940	1923	428
1991	127085	59795	3446	1802	9468	780	387	958
1992	176428	70985	24100	1218	684	3477	291	497
1993	175661	111301	33078	10008	523	301	1480	338
1994	57053	101237	40969	9299	2963	145	81	517
1995	199819	31328	46377	15356	3276	1108	55	221
1996	102735	116773	13916	18419	5802	1236	429	106
1997	117965	55949	47925	4927	6616	2014	437	190
1998	132662	65209	22226	16467	1728	2346	693	218
1999	31438	73865	26178	7866	5658	629	871	322
2000	483398	17252	28721	8974	2808	1846	223	420
2001	180209	250029	6006	8413	2647	865	512	190
2002	89625	109053	117869	2463	3251	1028	347	270
2003	106972	58706	61973	62860	1178	1550	508	302
2004	41658	68136	31569	32587	27841	522	684	363
2005	28892	26129	35865	15967	15303	12510	230	469
2006	91247	17329	12412	15046	6134	5995	4576	261
2007	18173	57232	8274	5981	6506	2580	2550	2009
2008	7859	11317	34287	4342	3035	3213	1296	2281
2009	14759	5135	6736	21279	2426	1728	1797	2016
2010	68637	10158	3125	4349	13040	1458	1046	2310
2011	50295	45494	5921	1917	2590	7584	863	1980
2012	95486	36195	29810	3993	1253	1699	4931	1863
2013	101776	65945	22312	19028	2453	770	1044	4173

***Estimates for 2012 and 2013 are TSA forecasts.**

Table 3.3.11. Haddock in Division VIa. Standard errors of estimates of population abundance (in thousands) from the final TSA run.

	Age							
Year	1	2	3	4	5	6	7	8+
1978	8257	715	292	375	1114	200	119	307
1979	15421	4295	318	138	1920	542	105	172
1980	40280	8649	2301	173	68	1154	271	107
1981	6536	25977	5158	1147	96	40	664	162
1982	7937	4414	16361	2708	589	56	23	414
1983	6388	5283	2660	8677	1341	310	32	223
1984	34600	3570	2622	1135	3446	529	125	91
1985	8315	19371	1577	1232	454	1985	321	86
1986	6426	4533	9155	594	504	258	1200	204
1987	34734	3874	2518	4513	280	255	148	713
1988	4247	16121	1494	943	1743	117	125	346
1989	3989	1542	6549	604	355	746	55	180
1990	11735	1687	553	2750	237	156	364	98
1991	13255	6670	532	200	1005	94	66	168
1992	17376	6550	2594	174	69	423	43	82
1993	19271	10587	2794	1048	57	29	189	45
1994	11344	11989	4195	999	292	13	11	68
1995	28442	6790	7571	2787	621	197	10	45
1996	20348	19246	3178	3611	1218	269	93	25
1997	22045	11045	9031	979	1183	415	99	43
1998	22795	11419	4169	3048	282	349	131	43
1999	8564	12435	4650	1305	1017	98	141	60
2000	101543	4693	5829	1753	496	420	46	89
2001	23918	47878	1512	1700	491	151	138	47
2002	14653	13067	19433	408	517	148	53	56
2003	15481	9196	7559	9613	185	249	78	52
2004	5939	9625	4724	4136	4146	89	126	64
2005	3442	3360	5289	2186	1903	1938	43	85
2006	7150	1887	1286	1703	669	710	767	48
2007	2657	4272	1099	649	793	344	400	407
2008	1839	1506	3048	573	362	463	215	406
2009	4234	1192	945	2051	370	248	313	363
2010	20250	3012	836	721	1566	268	183	422
2011	35072	14568	2088	583	537	1270	199	413
2012	63669	26237	10876	1554	431	419	1031	446
2013	67612	44407	16721	7638	1046	301	317	1133

***Estimates for 2012 and 2013 are TSA forecasts.**

Table 3.3.12. Haddock in Division VIa. Estimates of fishing mortality from the final TSA run.

	Age							
Year	1	2	3	4	5	6	7	8+
1978	0.279664	0.421601	0.627901	0.74994	0.751513	0.736691	0.725944	0.731036
1979	0.361715	0.658832	0.743458	0.834234	0.862413	0.846441	0.854677	0.853246
1980	0.2361	0.476335	0.626062	0.706104	0.651677	0.676814	0.674415	0.667495
1981	0.201972	0.329865	0.473294	0.494942	0.493653	0.4808	0.497855	0.493031
1982	0.182337	0.315107	0.397893	0.465126	0.455645	0.46358	0.465811	0.456221
1983	0.279671	0.426825	0.420354	0.462615	0.479628	0.486456	0.485145	0.500152
1984	0.285675	0.605654	0.73341	0.641895	0.643231	0.670057	0.671609	0.660976
1985	0.342788	0.53078	0.657182	0.667125	0.619842	0.674572	0.646731	0.638862
1986	0.209206	0.408311	0.46657	0.467588	0.453949	0.440505	0.461937	0.462875
1987	0.391385	0.775811	0.870276	0.874647	0.915537	0.921749	0.897973	0.882136
1988	0.405232	0.670128	0.803047	0.843925	0.83948	0.814119	0.81831	0.828613
1989	0.407272	0.695342	0.763778	0.832561	0.86967	0.876015	0.867015	0.864396
1990	0.295832	0.69199	0.680073	0.676492	0.683642	0.666037	0.681108	0.679991
1991	0.365393	0.707839	0.814865	0.754454	0.80041	0.774553	0.798179	0.779807
1992	0.233078	0.500601	0.660278	0.634791	0.572918	0.612983	0.605435	0.595975
1993	0.346498	0.753474	1.020968	0.948203	0.929027	1.004876	0.962814	0.971219
1994	0.397263	0.569952	0.774836	0.842593	0.777312	0.76757	0.8029	0.789661
1995	0.337708	0.608003	0.723252	0.769664	0.772822	0.74884	0.758117	0.759629
1996	0.405343	0.691548	0.835897	0.82339	0.85712	0.837762	0.831047	0.838569
1997	0.399122	0.726953	0.87282	0.840846	0.803964	0.866955	0.847949	0.84512
1998	0.387442	0.713503	0.83323	0.871861	0.803033	0.786932	0.842871	0.826954
1999	0.399825	0.741587	0.869971	0.841459	0.901854	0.835684	0.83228	0.857342
2000	0.455565	0.869752	1.025837	1.022944	0.972095	1.078981	1.015143	1.024252
2001	0.288164	0.557073	0.724527	0.752177	0.717262	0.697092	0.755227	0.732283
2002	0.222951	0.361185	0.448035	0.538612	0.539189	0.504186	0.503253	0.520346
2003	0.251529	0.424407	0.435932	0.609282	0.616496	0.621265	0.612673	0.602011
2004	0.266093	0.441086	0.48562	0.550174	0.600083	0.620961	0.605054	0.598202
2005	0.350997	0.565102	0.658434	0.75897	0.738231	0.798872	0.787692	0.776026
2006	0.278748	0.521104	0.527306	0.631535	0.663373	0.651835	0.673555	0.644635
2007	0.266812	0.315896	0.441748	0.477418	0.499544	0.484363	0.488539	0.485314
2008	0.201102	0.321987	0.272629	0.376612	0.360928	0.377686	0.369934	0.370108
2009	0.168305	0.276545	0.232228	0.289553	0.307058	0.301012	0.302344	0.297691
2010	0.21104	0.336795	0.287476	0.317235	0.341944	0.32379	0.329222	0.326557
2011	0.129	0.222737	0.193932	0.225126	0.221744	0.230605	0.224067	0.222019
2012	0.17016	0.283793	0.24892	0.287444	0.287444	0.287444	0.287444	0.287444
2013	0.17016	0.283793	0.24892	0.287444	0.287444	0.287444	0.287444	0.287444

***Estimates for 2012 and 2013 are TSA forecasts.**

Table 3.3.13. Haddock in Division VIa. Standard errors of estimates of log fishing mortality from the final TSA run.

	Age							
Year	1	2	3	4	5	6	7	8+
1978	0.223034	0.154959	0.155861	0.120214	0.131332	0.143045	0.147607	0.145752
1979	0.20618	0.142906	0.131485	0.128086	0.119958	0.134827	0.144524	0.143082
1980	0.232044	0.154303	0.153039	0.131153	0.140702	0.134928	0.150048	0.151054
1981	0.232549	0.165074	0.150798	0.140991	0.145358	0.152637	0.152616	0.157837
1982	0.22282	0.160084	0.147584	0.135489	0.13921	0.146526	0.15611	0.149793
1983	0.200458	0.143656	0.157495	0.127546	0.132567	0.13915	0.149191	0.146044
1984	0.239727	0.143331	0.128901	0.134923	0.126496	0.14235	0.149992	0.15155
1985	0.204167	0.145143	0.143842	0.127254	0.131726	0.135452	0.147335	0.149162
1986	0.222188	0.151663	0.144901	0.137702	0.139292	0.144555	0.150573	0.153535
1987	0.21133	0.123491	0.126036	0.109026	0.115043	0.127812	0.137852	0.133367
1988	0.217889	0.140373	0.126787	0.117373	0.118767	0.132258	0.141336	0.139016
1989	0.224193	0.150904	0.136833	0.118542	0.122072	0.127856	0.142735	0.141034
1990	0.214182	0.145615	0.150279	0.129598	0.131252	0.138697	0.145713	0.148883
1991	0.205202	0.13807	0.143824	0.119905	0.120323	0.133213	0.142871	0.1406
1992	0.215334	0.14337	0.14002	0.130078	0.130449	0.137816	0.148309	0.147624
1993	0.209363	0.129233	0.114959	0.109634	0.111886	0.132905	0.136109	0.141487
1994	0.249229	0.204049	0.192161	0.172491	0.177066	0.186451	0.190115	0.189761
1995	0.340889	0.274664	0.259926	0.241609	0.24346	0.246212	0.249267	0.24927
1996	0.334842	0.260212	0.261098	0.236905	0.236988	0.239788	0.241912	0.243985
1997	0.32441	0.246332	0.230503	0.214359	0.214753	0.217172	0.221281	0.223495
1998	0.329703	0.247251	0.240485	0.214328	0.216141	0.218537	0.221697	0.224444
1999	0.337487	0.253677	0.244228	0.225941	0.224262	0.226564	0.228399	0.231449
2000	0.338213	0.250447	0.229004	0.217079	0.217065	0.21871	0.222449	0.224849
2001	0.340608	0.256925	0.243336	0.224764	0.226093	0.226588	0.229375	0.232116
2002	0.350241	0.265828	0.259634	0.237974	0.23636	0.237471	0.237879	0.241604
2003	0.347901	0.265681	0.251326	0.232462	0.231603	0.233301	0.235852	0.238006
2004	0.352533	0.264241	0.252531	0.236132	0.235909	0.238188	0.239855	0.241864
2005	0.330641	0.242181	0.214095	0.197432	0.197359	0.202379	0.207817	0.208239
2006	0.249089	0.162335	0.153715	0.131083	0.13207	0.137704	0.147013	0.151292
2007	0.255033	0.177876	0.169296	0.142705	0.142963	0.147655	0.156597	0.158939
2008	0.260955	0.193753	0.196157	0.157259	0.158292	0.159913	0.16935	0.170963
2009	0.267295	0.21209	0.215983	0.175847	0.175399	0.177168	0.185122	0.186748
2010	0.286211	0.249997	0.249669	0.202458	0.202651	0.204423	0.211448	0.211627
2011	0.360139	0.308444	0.304495	0.250688	0.244704	0.242914	0.252077	0.251678
2012	0.46931	0.418917	0.417745	0.390102	0.390102	0.390102	0.390102	0.390102
2013	0.494853	0.447346	0.446248	0.420484	0.420484	0.420484	0.420484	0.420484

***Estimates for 2012 and 2013 are TSA forecasts.**

Table 3.3.14. Haddock in Division VIa. Stock summary from final TSA run. "Obs." denotes the SOP of numbers and mean weights-at-age, rather than the reported caught, landed and discarded yield. "Pred." are TSA estimates, and "SE" denotes standard errors. *Estimates for 2012 and 2013 are TSA projections.

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
1978	17187	18872	1545	2318	2404	544	19505	21246	1720	0.658	0.061	39393	1085	72985	8257
1979	14837	16004	1542	13841	10049	2058	28678	26600	2875	0.789	0.067	31819	2055	154490	15421
1980	12759	13744	1614	4715	15479	3148	17474	31046	4289	0.627	0.061	36522	2674	478997	40280
1981	18233	19289	2531	15048	13677	2670	33281	33525	4391	0.455	0.048	76293	4762	59881	6536
1982	29635	28866	4008	10063	6402	1291	39698	33481	4107	0.419	0.042	100293	6731	70906	7937
1983	29411	28740	3333	6781	5303	1009	36192	34051	3574	0.455	0.043	90641	5486	45651	6388
1984	30689	27085	2457	15666	12731	3033	46355	40105	4460	0.659	0.059	62972	3183	313813	34600
1985	24451	24214	2412	17385	14751	2854	41837	38479	4455	0.630	0.058	66221	4080	73622	8315
1986	19561	19929	2453	7153	4698	910	26714	23423	2754	0.447	0.045	59727	4084	60114	6426
1987	27012	29081	2635	16193	14978	3561	43205	44195	4900	0.872	0.066	54258	3373	261243	34734
1988	21153	21632	2267	9519	9611	2031	30672	31090	3727	0.794	0.066	47080	3179	21680	4247
1989	16691	18697	2371	2979	2948	711	19669	21061	2598	0.807	0.070	38327	3024	17085	3989
1990	10141	10949	1428	5381	3083	707	15522	13121	1657	0.680	0.064	21993	1830	98097	11735
1991	10557	10032	1024	8691	9975	1912	19248	20685	2588	0.770	0.066	21819	1529	127085	13255
1992	11351	9737	1083	9161	9169	1511	20513	19786	2231	0.596	0.055	29519	1909	176428	17376
1993	19068	18244	1684	16803	15944	2269	35871	34208	3047	0.931	0.073	41949	2517	175661	19271
1994	14272	12562	1586	11070	12655	2320	25342	25629	3012	0.746	0.114	39646	3100	57053	11344
1995	12368	13511	3705	8552	12038	3497	20920	25274	6283	0.725	0.162	33882	4906	199819	28442

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Table 3.3.14. Continued. Haddock in Division VIa. Stock summary from final TSA run. "Obs." denotes the SOP of numbers and mean weights-at-age, rather than the reported caught, landed and discarded yield. "Pred." are TSA estimates, and "SE" denotes standard errors. *Estimates for 2012 and 2013 are TSA projections.

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
1996	13466	12764	3741	11351	13822	3837	24817	27009	6915	0.809	0.175	35438	5262	102735	20348
1997	12883	13869	3935	6461	12933	3601	19344	27884	6563	0.822	0.158	37685	5598	117965	22045
1998	14401	10878	2969	5535	13864	3766	19936	25856	6103	0.802	0.155	31226	4267	132662	22795
1999	10464	9723	2754	4856	9783	2682	15321	20533	4756	0.838	0.169	29225	3845	31438	8564
2000	6958	9215	2671	7893	23739	8619	14851	33562	10106	0.994	0.190	20505	3326	483398	101543
2001	6762	7301	2695	6626	23125	6940	13389	32324	9285	0.690	0.138	43053	7413	180209	23918
2002	7115	10185	3845	8862	12090	3467	15977	21818	5511	0.478	0.102	53595	6956	89625	14653
2003	5337	15408	4307	4101	9618	2736	9438	23856	5312	0.541	0.113	52071	5576	106972	15481
2004	3874	11727	3050	3705	6497	1824	7579	17090	3956	0.540	0.115	38164	4016	41658	5939
2005	3792	13631	3212	2902	5302	1479	6694	17867	3765	0.704	0.122	34601	3630	28892	3442
2006	6266	6869	867	4618	5884	1048	10884	12672	1433	0.599	0.057	21175	1345	91247	7150
2007	3777	4035	457	3968	3828	651	7745	7850	922	0.444	0.049	19566	1200	18173	2657
2008	2848	3708	435	1229	2077	461	4077	6033	806	0.342	0.044	22844	1677	7859	1839
2009	2851	3304	450	1643	1152	279	4494	4368	518	0.281	0.042	17550	1559	14759	4234
2010	3016	3206	371	2812	1298	332	5828	4554	558	0.321	0.059	13890	1704	68637	20250
2011	1737	2135	249	1540	2392	645	3277	4585	764	0.219	0.051	18624	3719	50295	35072
2012*	NA	3230	1104	NA	3764	1864	NA	7315	2806	0.279	0.103	24804	7464	24779	3803
2013*	NA	4439	1741	NA	5098	2783	NA	9799	4101	0.279	0.111	32130	11660	24779	3803
Min	1737	2135	249	1229	1152	279	3277	4368	518	0.219	0.042	13890	1085	7859	1839
GM	10213	11761	1794	6135	7423	1704	16828	20360	3035	0.598	0.077	36264	3124	79331	11266
AM	13086	14093	2226	7630	9509	2306	20716	23673	3822	0.632	0.087	40634	3547	122256	16661
Max	30689	29081	4307	17385	23739	8619	46355	44195	10106	0.994	0.190	100293	7413	483398	101543

Table 3.3.15. Haddock in Division VIa. Mean weights-at-age in total catches (or stock) and forecasted weights-at-age in 2011. Forecasts in this table are based on either of simple three year means or linear model projections: those that were used in the forecasts are shaded and boxed: simple three year means were used for the younger ages (1–4) and linear model projections for the older ages (5–8+). The weights for the 2000 year class are highlighted in red.

		Age							
	Year	1	2	3	4	5	6	7	8+
	1999	0.172	0.255	0.365	0.494	0.611	0.729	0.840	1.172
	2000	0.127	0.270	0.361	0.447	0.572	0.719	0.840	0.813
	2001	0.112	0.242	0.403	0.432	0.514	0.657	0.808	1.015
	2002	0.118	0.208	0.307	0.521	0.606	0.632	0.636	0.939
	2003	0.124	0.239	0.282	0.382	0.652	0.648	0.908	1.086
	2004	0.112	0.189	0.290	0.313	0.373	0.541	0.715	0.988
	2005	0.103	0.198	0.295	0.451	0.429	0.525	1.163	1.018
	2006	0.155	0.254	0.326	0.388	0.471	0.496	0.563	1.294
	2007	0.115	0.219	0.331	0.404	0.456	0.550	0.593	0.685
	2008	0.113	0.245	0.367	0.492	0.570	0.619	0.708	0.827
	2009	0.135	0.266	0.357	0.410	0.570	0.633	0.630	1.008
	2010	0.067	0.180	0.388	0.409	0.459	0.725	0.755	0.877
	2011	0.054	0.259	0.357	0.509	0.476	0.617	0.818	1.107
arithmetic mean	2012	0.085	0.235	0.367	0.443	0.502	0.658	0.734	0.997
linear model	2012			0.336	0.436	0.619	0.596	0.682	0.998
	year class in 2012	2011	2010	2009	2008	2007	2006	2005	2003
	CV	0.509	0.202	0.049	0.130	0.119	0.088	0.130	0.116

Table 3.3.16. Haddock in Division VIa. Inputs to short-term forecasts.

Label	Value	CV	Label	Value	CV
Number-at-age			Stock weight		
N1	95486.03	0.67	WS1	0.085	0.51
N2	36194.81	0.72	WS2	0.235	0.20
N3	29809.87	0.36	WS3	0.336	0.05
N4	3993.266	0.39	WS4	0.436	0.13
N5	1253.112	0.34	WS5	0.619	0.12
N6	1699.11	0.25	WS6	0.596	0.09
N7	4930.674	0.21	WS7	0.682	0.13
N8	1862.811	0.24	WS8	0.998	0.12
Removals selectivity			Removals weights		
sH1	0.169	0.24	WH1	0.085	0.51
sH2	0.279	0.20	WH2	0.235	0.20
sH3	0.238	0.20	WH3	0.336	0.05
sH4	0.277	0.17	WH4	0.436	0.13
sH5	0.290	0.21	WH5	0.619	0.12
sH6	0.285	0.17	WH6	0.596	0.09
sH7	0.285	0.19	WH7	0.682	0.13
sH8	0.282	0.19	WH8	0.998	0.12
Natural mortality			Prop.mature.		
M1	0.2	0.1	MT1	0	0.1
M2	0.2	0.1	MT2	0.57	0.1
M3	0.2	0.1	MT3	1	0.1
M4	0.2	0.1	MT4	1	0
M5	0.2	0.1	MT5	1	0
M6	0.2	0.1	MT6	1	0
M7	0.2	0.1	MT7	1	0
M8	0.2	0.1	MT8	1	0
Relative effort			Year effect for M		
'HF11'	1	0.08	'K11'	1	0.1
'HF12'	1	0.08	'K12'	1	0.1
'HF13'	1	0.08	'K13'	1	0.1
Recruitment					
'R13'	24779	1.233			
'R14'	24779	1.23			
Prop. F before spawning	0				
Prop. M before spawning	0				

Stock numbers in 2012 are TSA survivors.

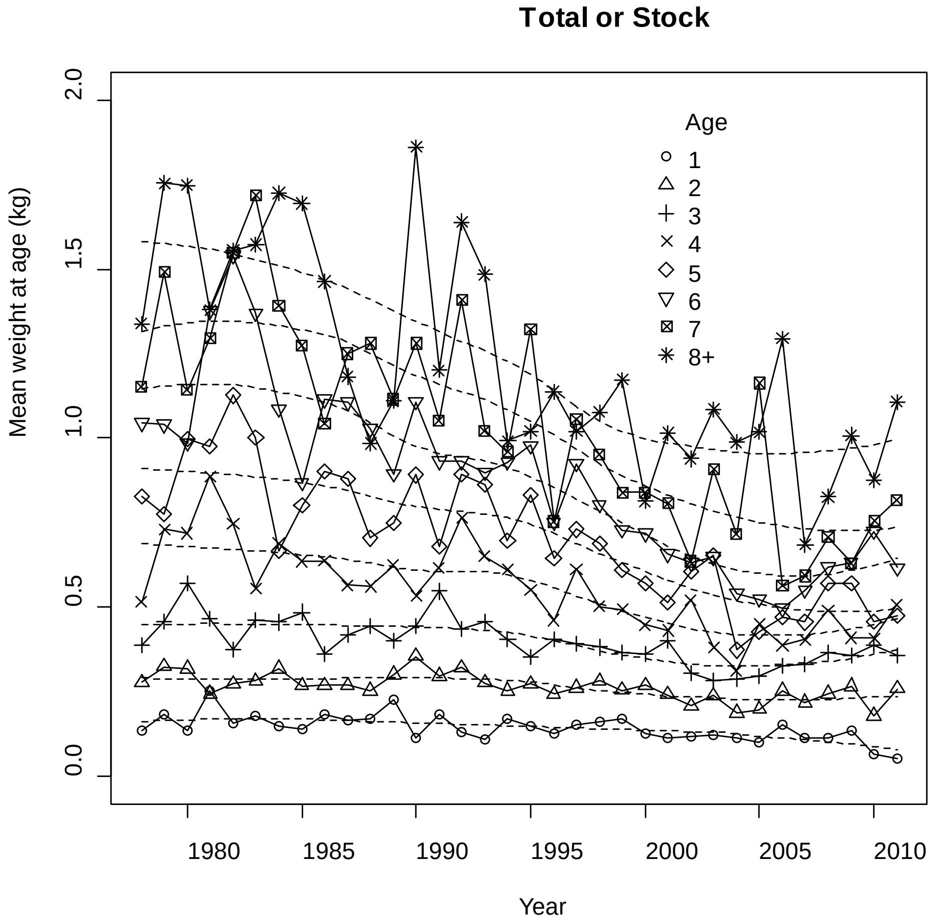

Figure 3.3.1. Haddock in Division VIa. Mean weights-at-age (kg) in total catch (also used for stock weights). Dotted lines show loess smoothers fitted through each time-series at age. For clarity, only ages 1–8+ are shown here.

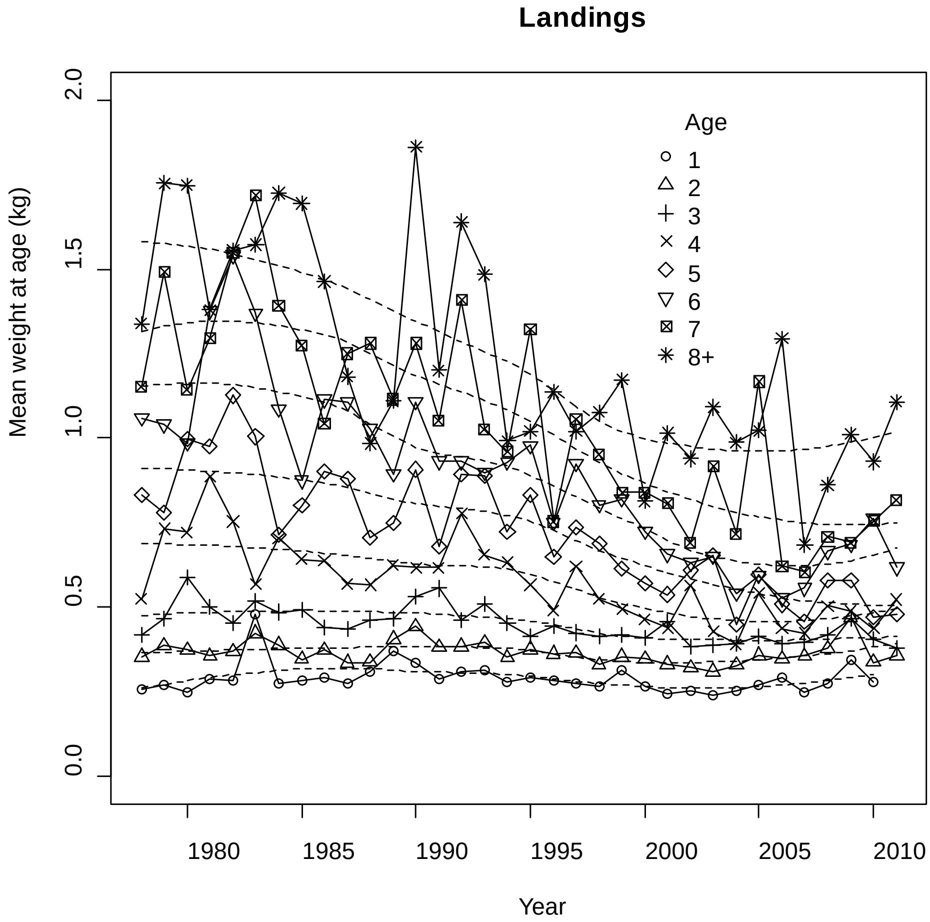

Figure 3.3.2. Haddock in Division VIa. Mean weights-at-age (kg) in landings. Dotted lines show Loess smoothers fitted through each time-series at age. For clarity, only ages 1–8+ are shown here.

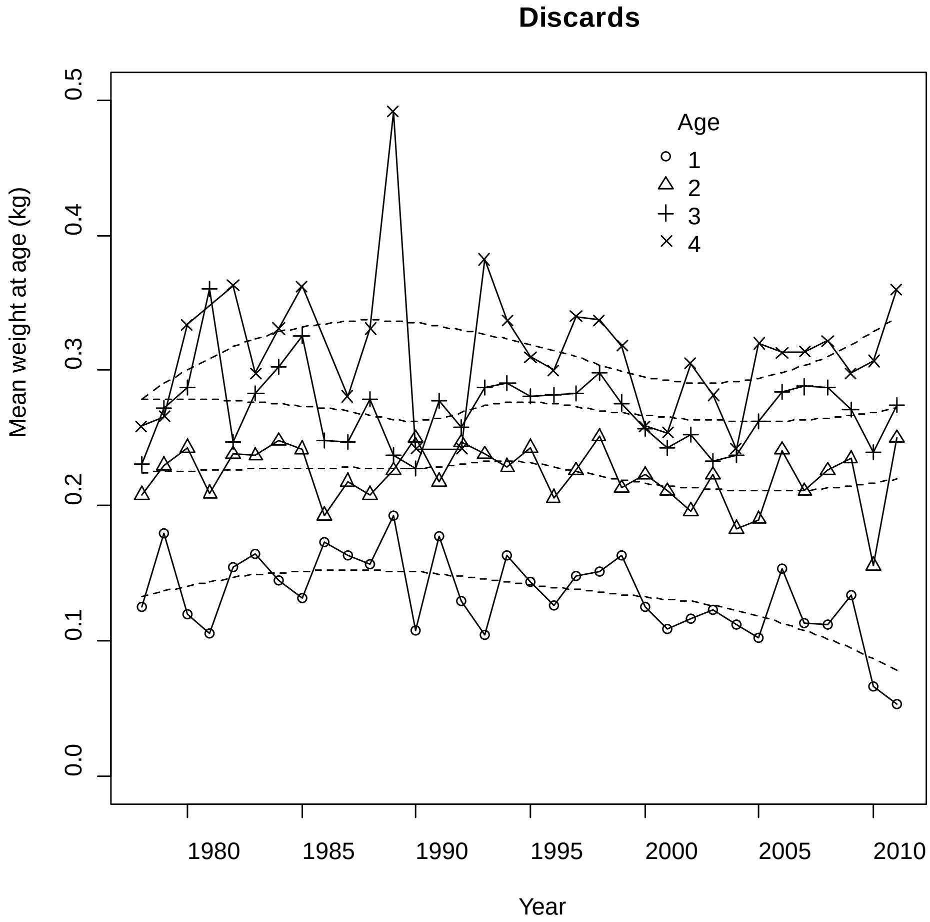

Figure 3.3.3. Haddock in Division VIa. Mean weights-at-age (kg) in discards. Dotted lines show Loess smoothers fitted through each time-series at age. For clarity, only ages 1–4 are shown here.

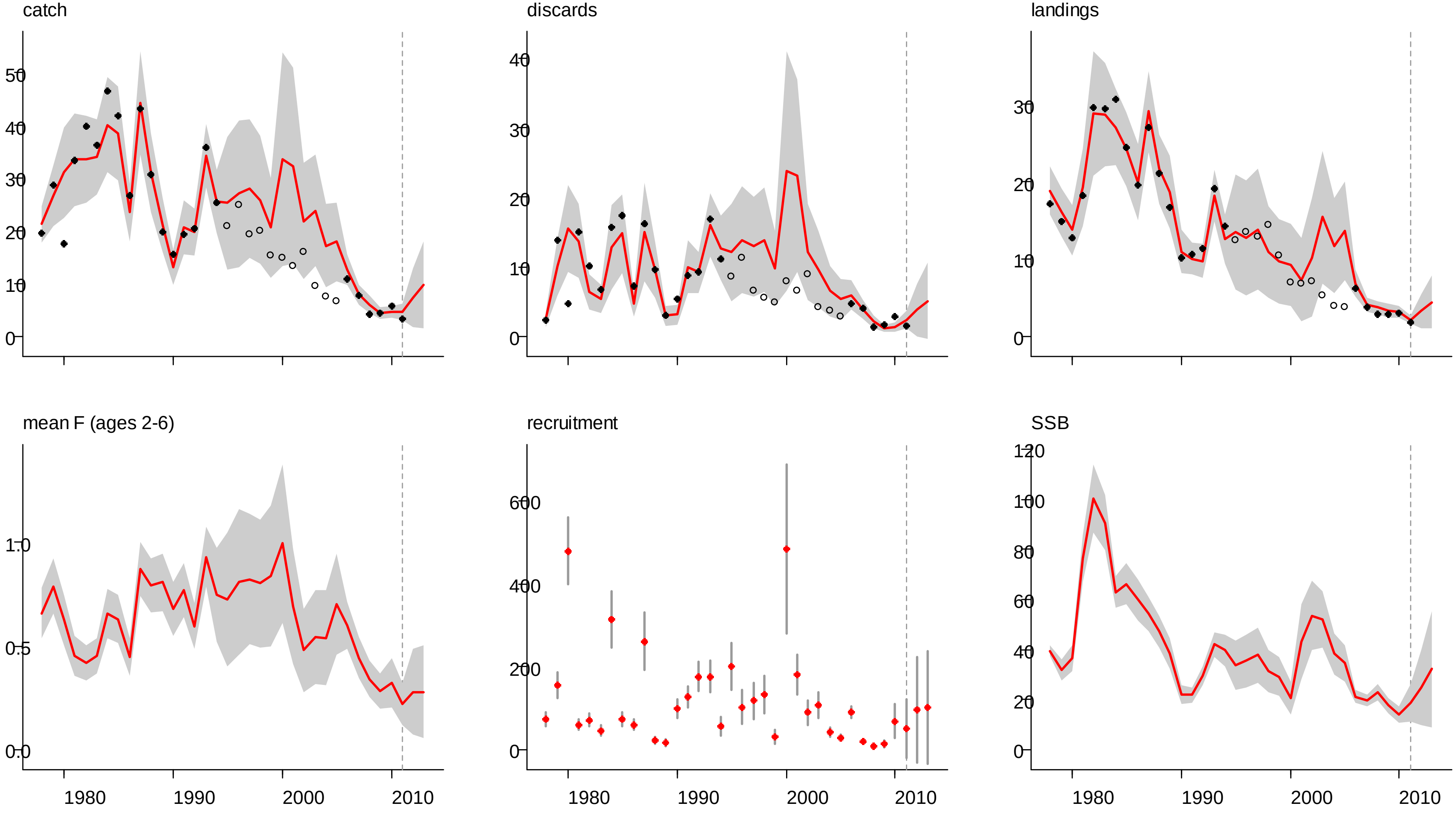

Figure 3.3.4. Haddock in Division VIa. TSA stock summaries from the final run with catch data included 1978–1994 and 2006–2011. Estimates are plotted with approximate pointwise 95% confidence bounds. Dots indicate observed values for catch, landings and discards. Values to the right of the vertical dashed line are forecasted by the model.

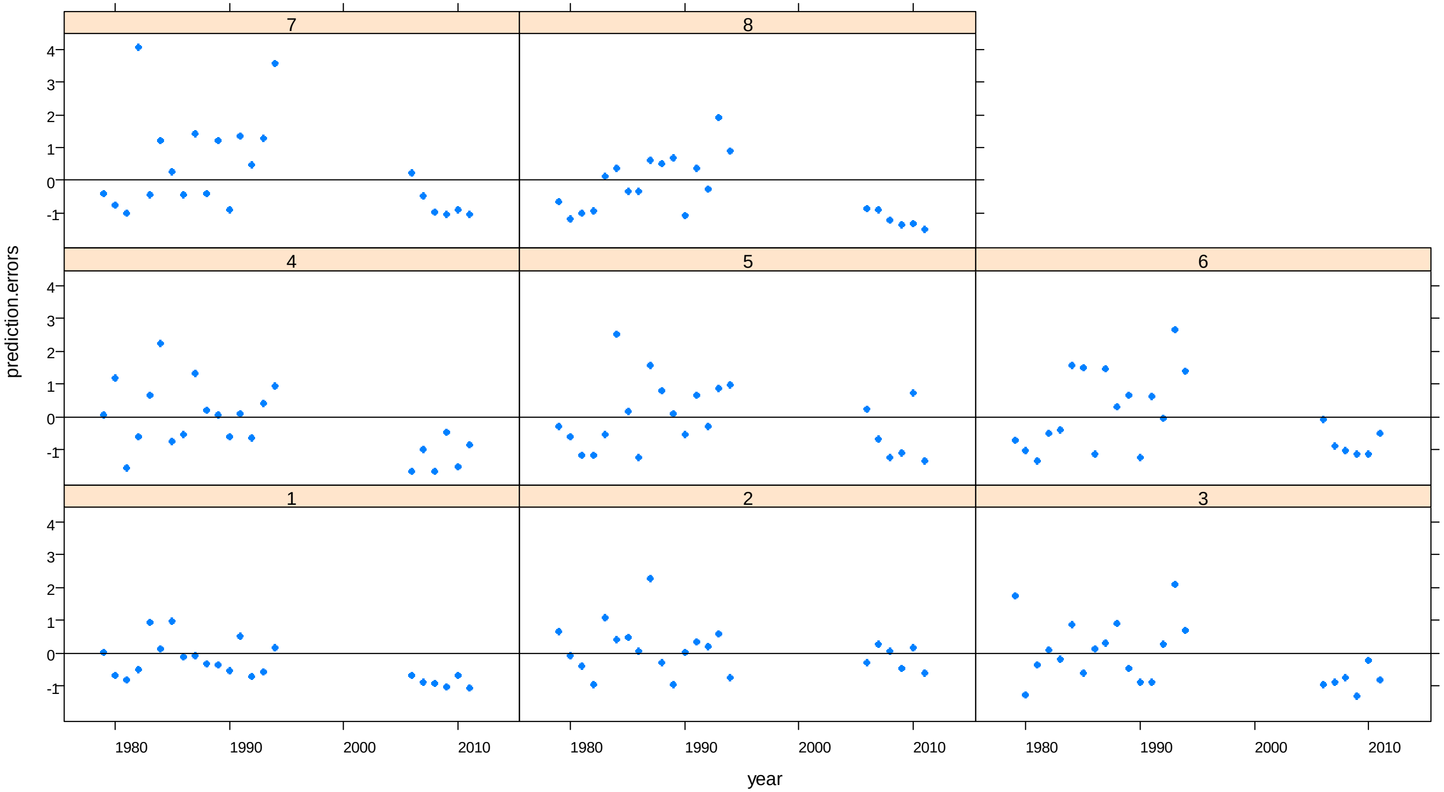

Figure 3.3.5. Haddock in Division VIa. Standardized landings prediction errors from the final TSA run.

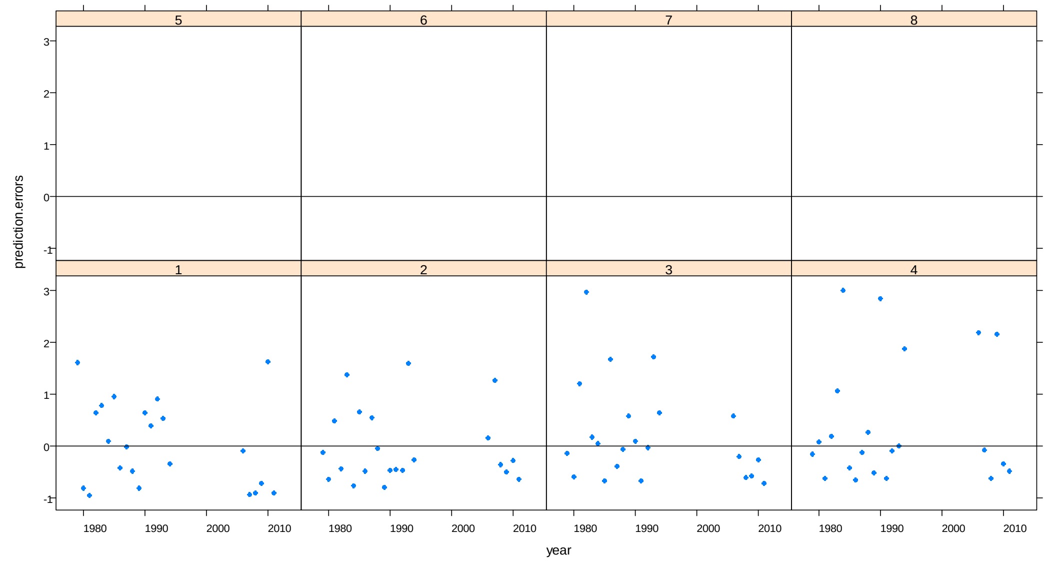

Figure 3.3.6. Haddock in Division VIa. Standardized discards prediction errors from the final TSA run.

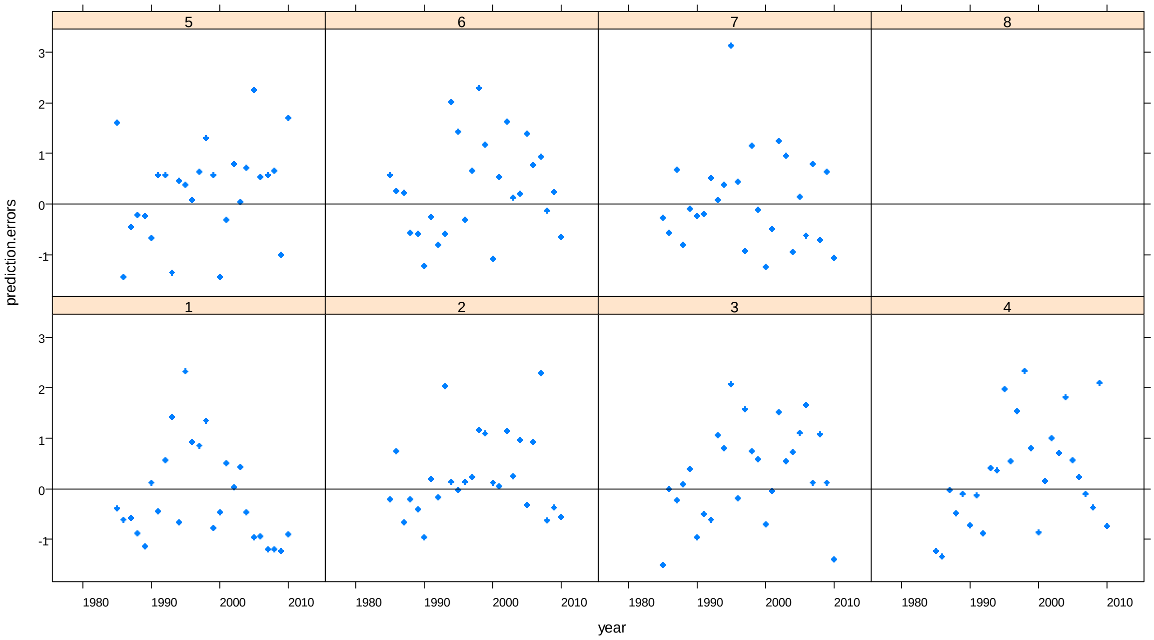

Figure 3.3.7. Haddock in Division VIa. Standardized ScoGFS Q1 prediction errors from the final TSA run.

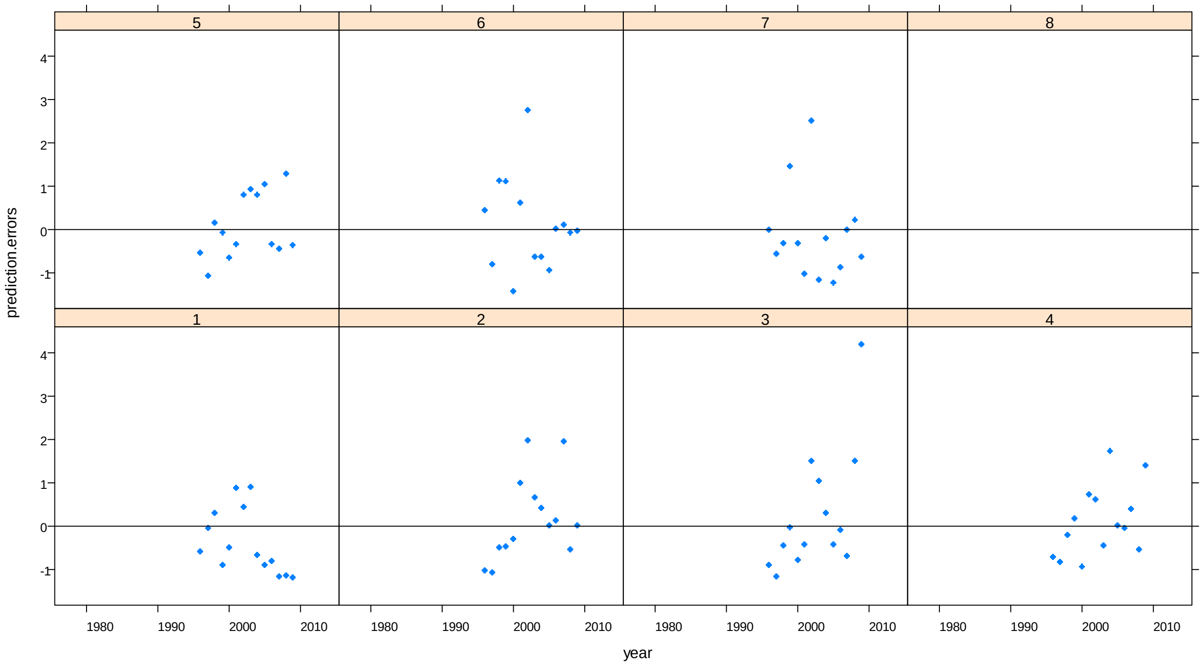

Figure 3.3.8. Haddock in Division VIa. Standardized ScoGFS Q4 prediction errors from the final TSA run.

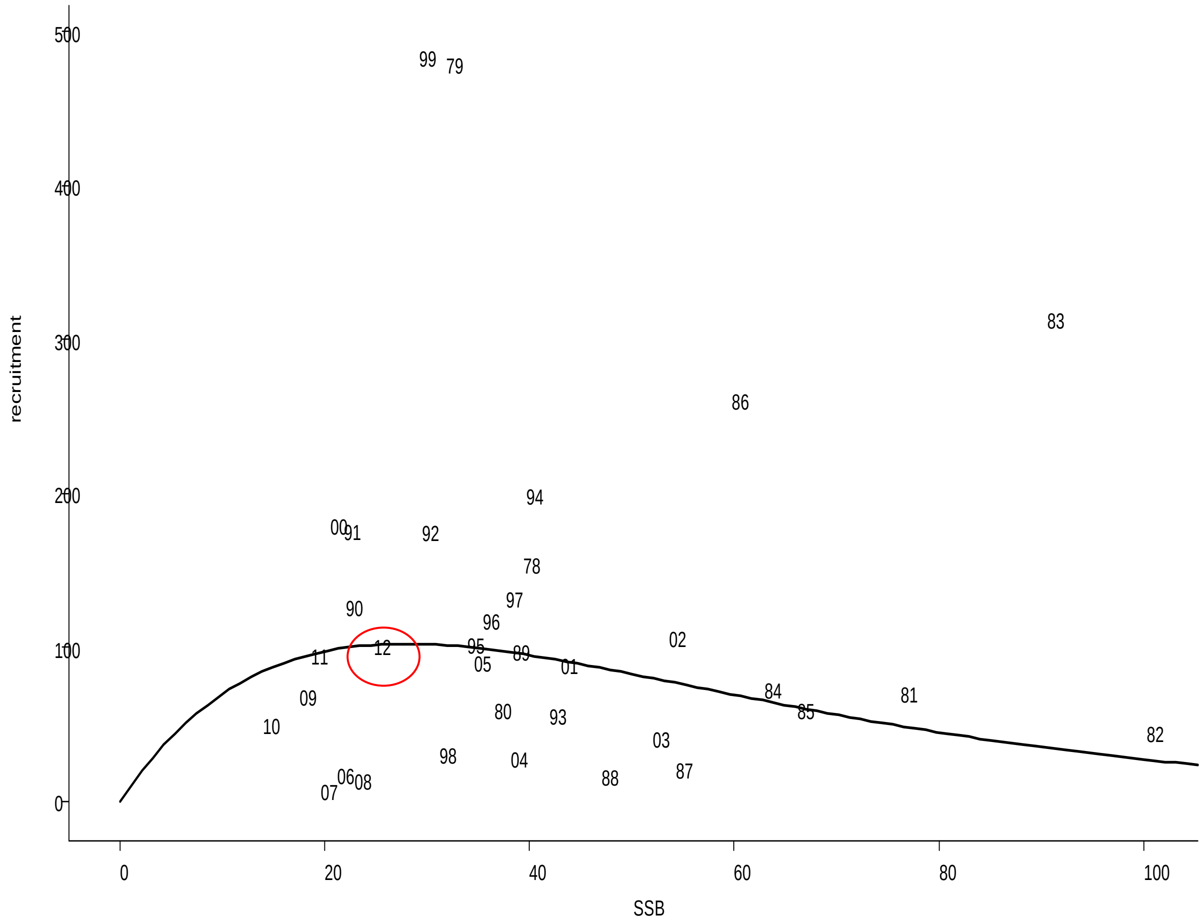

Figure 3.3.9. Haddock in Division VIa. Stock–recruit plot from the final TSA run, points labelled as year classes. Predicted recruitment is circled: for 2011 year class recruiting in 2012 (based on the underlying Ricker model).

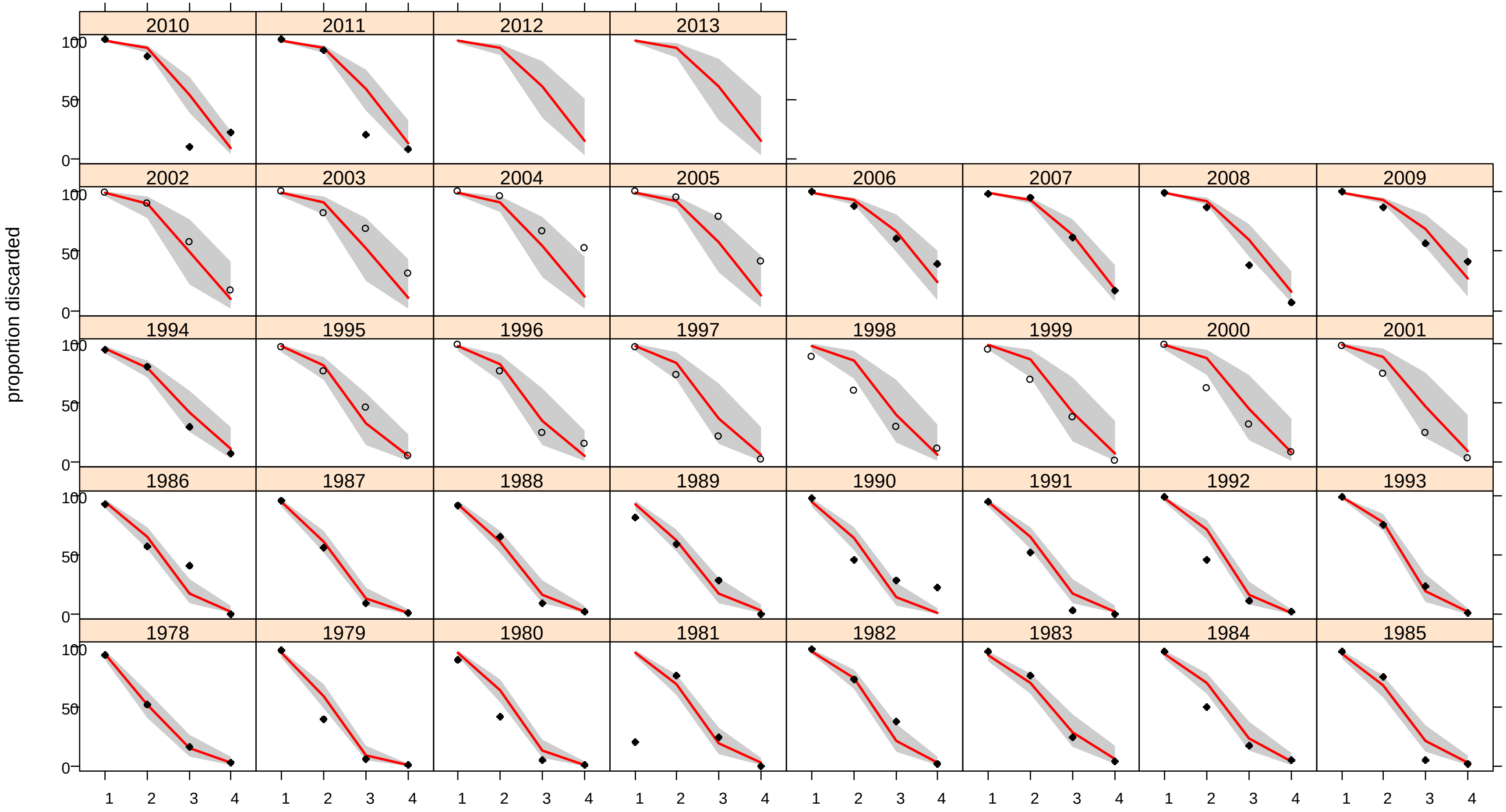

Figure 3.3.10. Haddock in Division VIa. Fitted (lines) and observed (dots) discard proportions-at-age from the final TSA run.

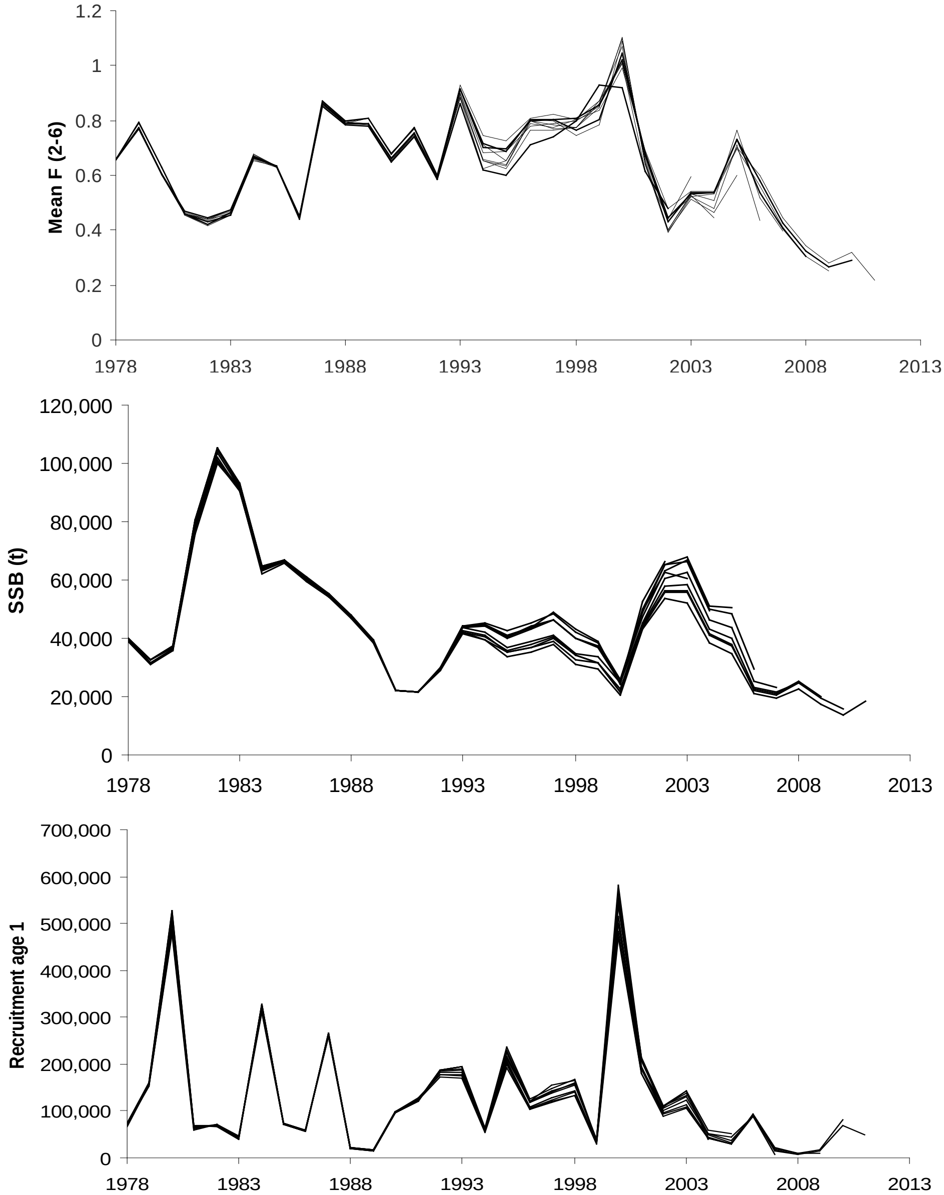

Figure 3.3.11. Haddock in Division VIa. Estimates of Mean F_{2-6}, SSB and recruitment from retrospective TSA runs.

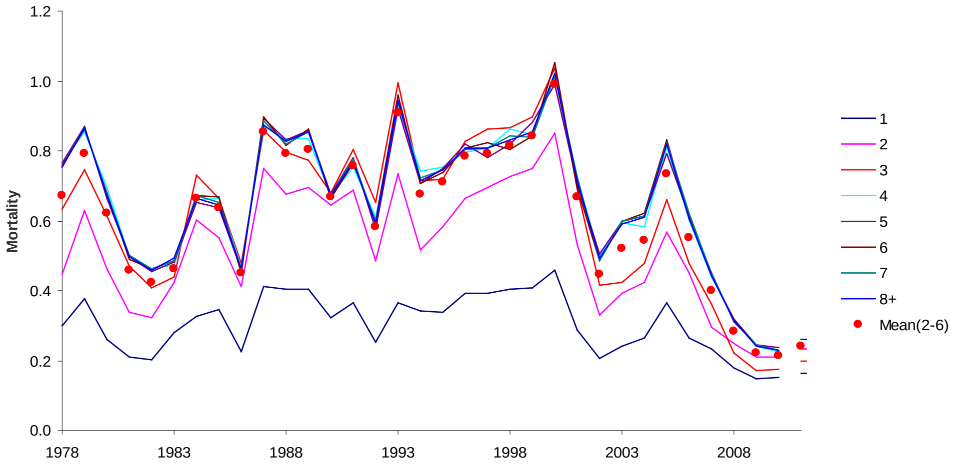

Figure 3.3.12. Haddock in Division VIa. Time-series of estimated fishing mortality-at-age, along with the mean over ages 2–6.

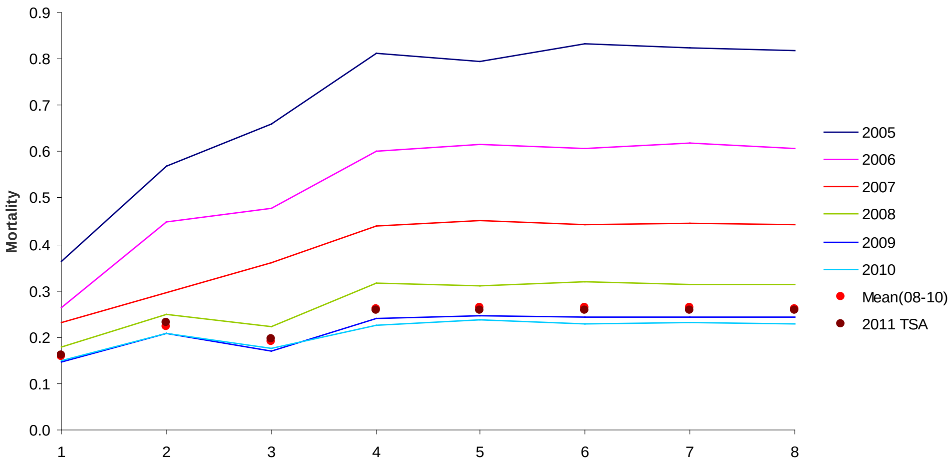

Figure 3.3.13. Haddock in Division VIa. Candidates for fishing mortality-at-age in short-term forecasts. Lines labelled 2005, 2006, 2007, 2008, 2009, 2010 indicate the TSA estimates for those years. Points marked 2010 TSA and 2011 TSA show the TSA-generated forecast values from the final assessment.

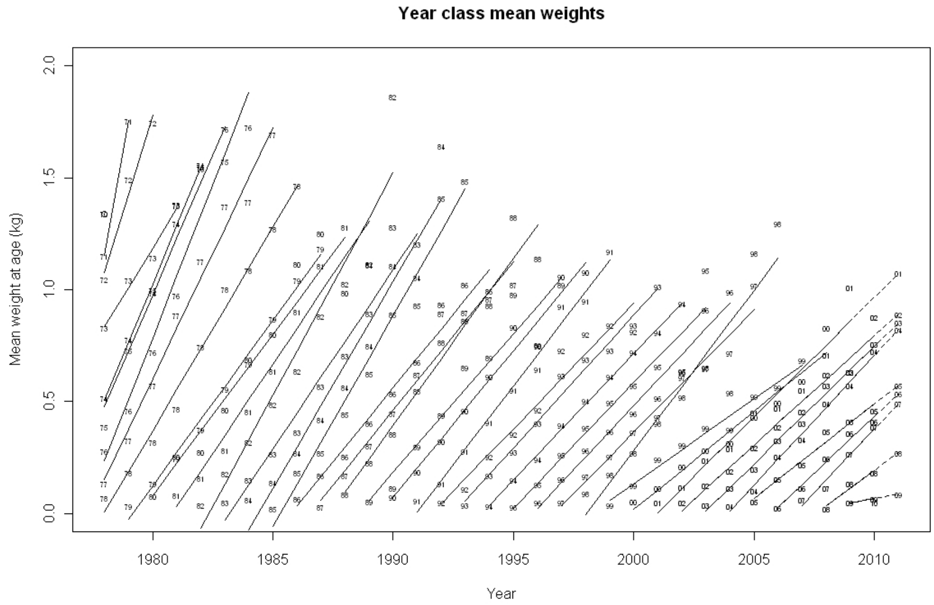

Figure 3.3.14. Haddock in Division VIa. Mean weights-at-age (kg) in total catch (or stock), tracked by year class with a linear model fit. Predicted weights in 2011 based on linear model fits indicated with the dotted lines.

3.3.10 References

Fryer R.J. 2001. TSA: is it the way? Annex of Report of the Working Group on Methods of Fish Stock Assessment, 2001.

Dickey-Collas, M., Armstrong, M.J., Officer, R.A., Wright, P.J., Brown, J., Dunn, M.R., Young, E.F. 2003. Growth and expansion of haddock (*Melanogrammus aeglefinus* L.) stocks to the west of the British Isles in the 1990s. ICES Journal of Marine Science, (In-Press).

3.4 Whiting in Division VIa

Type of assessment in 2012

As agreed at the 2011 meeting of ACOM, whiting in Division VIa was benchmarked in 2012. The benchmark assessment was conducted in February 2012 (ICES-WKROUND, 2012). The agreed assessment follows the procedure outlined in the stock annex developed at the benchmark. The main method adopted in this year's assessment is Time-series Analysis (TSA) used with catch and survey data.

ICES advice applicable to 2011 and 2012

In 2006, the ICES Advice for 2007 in terms of single stock exploitation boundaries was as follows:

1) Exploitation boundaries in relation to precautionary limits
2) "Given that SSB is estimated at the lowest observed level and total mortality at the highest level over the time period, catches in 2007 should be reduced to the lowest possible level."
3) The Advice given since then has been the same (see Table with the ICES Advice given in the years 2001–2012 below). Detailed advice given for 2012 taking into account MSY, PA and EU policy paper considerations was as follows

MSY considerations

Biomass has declined to record low level in recent years. Exploitation status is unknown with regards to MSY levels. To allow the stock to rebuild, catches (half of which are discarded) should be reduced to the lowest possible level in 2012.

There are strong indications that TAC management control is not effective in limiting the catch.

PA considerations

Given that SSB is estimated at the lowest observed level and that recent recruitment (with the exception of the 2009 year class) has been weak, catches in 2012 should be reduced to the lowest possible level.

Policy paper

In the light of the EU policy paper on fisheries management (EC, 2010), this stock is classified under category 10 (as catches should be reduced to the lowest possible level). This implies a 25% TAC decrease. The resulting TAC would be 242 t.

3.4.1 General

Stock description

General information is now located in the Stock Annex.

Management applicable to 2011 and 2012

The TAC for whiting is set for ICES Subareas VI, XII and XIV and EU and international waters of ICES Subdivision Vb, and for 2012 was as shown below:

Species: Whiting *Merlangius merlangus*		Zone: VI; EU and international waters of Vb; international waters of XII and XIV (WHG/56-14)
Germany	2	
France	37	
Ireland	92	
United Kingdom	176	
Union	307	
TAC	307	Analytical TAC

The following table summarises ICES advice and actual management applicable for whiting in Division VIa during 2001–2012:

Year	Single species exploitation (tonnes)	Basis for single species	TAC for Vb, VI, XII, XIV (tonnes)	% change in F associated with TAC[1]
2001	< 4200	Reduce F below F_{pa}	4000	-40%
2002	< 2000	SSB > B_{pa} in short term	3500	-40%
2003	-	SSB > B_{pa} in short term	2000	-60%
2004	-	SSB > B_{pa} in 2005	1600	(no assessment)
2005	-	-	1600	(assessment in relative trends only)
2006	-	-	1360	(assessment in relative trends only)
2007	0	Reduce catches to lowest possible level	1020	(assessment in relative trends only)
2008	0	Reduce catches to lowest possible level	765	(no assessment)
2009	0	Reduce catches to lowest possible level	574	(no assessment)
2010	0	Reduce catches to lowest possible level	431	(assessment in relative trends only)
2011	See scenarios	Reduce catches to lowest possible level	323	(assessment in relative trends only)
2012	0	Reduce catches to lowest possible level	307	

[1] **Based on F-multipliers from forecast tables.**

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

Fishery in 2011

4) A description of the fisheries on the west of Scotland is given in Section 3.1.

5) Tables and figures of total effort to 2006 by the fleets operating in Division VIa can be found in Section 16 of the Report of WGNSDS 2007 (ICES-WGNSDS, 2007).

6) 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. Quota uptake for UK vessels in 2010 and 2011 were 100% and 42% respec-

tively. Total landings in 2011 were 230 t, down considerably from 2010 (Table 3.4.1). These are the lowest recorded landings in the time-series.

7) The total estimated international catch of ages 1–7+ in 2011 was 569 t of which ap-proximately 339 t were discards (Table 3.4.2). Of the Scottish discards, 36 t were discarded by the TR1 fleet and 252 t were discarded by the TR2 (*Nephrops*) fleet. No 0-gp fish were recorded in the discards.

8) Mandatory introduction of larger square mesh panels for the TR2 (*Nephrops*) fleet in 2008 does not seem to have had much of an effect on the discards of whiting in Division VIa in 2011. In the TR1 fleet, discarding is expected to decline in subsequent years following the mandatory increase in mesh size to 120 mm in 2009. The discards in 2011 were lower than those in 2009 and 2010, and they are the second lowest in the time-series. However, in terms of discard rate (discards as a proportion of catch) they are among the highest in the time-series.

3.4.2 Data

Landings

Total landings, as officially reported to ICES in 1965–2011, are shown in Figure 3.4.1 and Table 3.4.2. There have been concerns that the quality of landings data is deteriorating, giving a possible reason for the different stock dynamics implied by the commercial fleet and the annual survey (ScoGFS-WIBTS-Q1) in recent years (see Section 5.1.6.1.3 in the 2005 WG Report; ICES-WGNSDS, 2005). Improved compliance measures and the introduction of UK and Irish legislation requiring registration of all fish buyers and sellers may mean that the reported landings from 2006 onwards are more representative of actual landings.

Details on nations which supply data and sampling levels are given in Table 2.1. 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 3.4.2. 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

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 3.4.2.

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. To reduce bias and increase precision of discard estimates, previous estimates (ICES-WGCSE, 2011) for the years 1981–2003 were replaced by those provided by Millar and Fryer (2005). Such revisions are particularly important for the estimation of total catch for this stock which has very high discards across a wide age range.

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 Stock Annex).

An alternative to the assumption of constant natural mortality (previously 0.2 for all ages and years) was proposed this year linking *M* to fish weight. Thus, 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 parameters for fish in natural ecosystems.

No changes to maturity data were considered this year. Maturity-at-age was assumed to be knife-edge, with the value 0 at age 1 and with 1 (full maturity) at age 2. That has been a source of criticism in previous assessments. However, recent research on gadoid maturity conducted by the UK gives no evidence for substantial change in whiting maturity since the 1950s, although there has been an increase in the incidence of precocious maturity-at-age 1, particularly in males, since 1998, in the Irish Sea. Also as in the 2007 assessment, the proportion mature before spawning and the proportion fished before spawning are both set to be zero.

Surveys

Six research vessel survey-series for whiting in VIa 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 0–8, 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. The largest obstacle preventing an earlier move to a more randomised survey design was the lack of confidence in the 'C' rig to tackle the potentially hard substrates that a new randomised survey was likely to encounter. The first step in the process of modifying the survey design was therefore to design a new groundgear that would be capable of tackling such challenging terrain. The introduction of the new design initiated two time-series:

- Scottish first-quarter west coast groundfish survey (UKSGFS-WIBTS-Q1): ages 1–7, years 2011–2012).
- Scottish fourth-quarter west coast groundfish survey (UKSGFS-WIBTS-Q4): ages 0–8, year 2011).

(see the distribution of whiting at age 1+ in the Q1 and Q4 surveys in 2011 and 2012, Figure 3.4.3).

The Irish groundfish survey:

- Irish fourth-quarter west coast groundfish survey (IreGFS): ages 0–5, years 1993–2002.

was a comparatively short series. It was discontinued in 2003 and has been replaced by a new survey:

- Irish fourth-quarter west coast groundfish survey (IRGFS-WIBTS-Q4): ages 0–6, years 2003–2011.

This 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 VIa, giving useful additional indications of year-class strength.

9) Further descriptions of these surveys can be found in ICES-IBTSWG (2011).

10) WKROUND 2012 decided to use three survey-series (ScoGFS-WIBTS-Q1, ScoGFS-WIBTS-Q4 and IGFS-WIBTS-Q4) in the tuning procedure in the final assessment. ICES will consider inclusion of the two new Scottish survey time-series to produce tuning indices through an inter-benchmark procedure when 4+ years of data have been gathered.

11) The survey indices are shown in Table 3.4.9 with data used in the final assessment highlighted in bold.

12) A comparison of scaled (standardised to z-scores) survey indices (from ScoGFS-WIBTS-Q1, ScoGFS-WIBTS-Q4 and IRGFS-WIBTS-Q4) at age show similar trends, mainly for the two Scottish surveys, for most ages (up to age 5, Figure 3.4.4).

13) Log mean-standardised survey indices by year class and by year and scatterplots of indices within year classes are shown in Figures 3.4.5, 3.4.6, 3.4.7 and 3.4.8. The year-class plots for all three surveys are quite noisy and the ability of these surveys to reliably track year-class strength is generally poor. In addition, some of the correlations for the older ages in the ScoGFS-WIBTS-Q1 scatterplot are negative, while the equivalent plots of the Q4 surveys show very scattered datapoints. Age 0 in the Q4 surveys appears to be a particularly poor measure of year-class strength (little evidence of positive correlation) and is therefore excluded in further analysis of this survey. There are no marked year effects. The log catch curves for these surveys along with those for the catch are shown in Figure 3.4.9. The curves for both ScoGFS-WIBTS-Q1 and ScoGFS-WIBTS-Q4 are relatively linear and not very noisy, and show a fairly steep and consistent drop in abundance.

Commercial cpue

Four commercial catch-effort dataseries were available to the WG including:

- Scottish light trawlers (ScoLTR): ages 1–7, years 1965–2005;
- Scottish seiners (ScoSEI): ages 1–6, years 1965–2005;
- Scottish *Nephrops* trawlers (ScoNTR): ages 1–6, years 1965–2005;

- Irish Otter Trawlers (IreOTB); ages 1–7, years 1995–2005.

Given the problems with non-mandatory effort reporting in the UK (described further in the report of WGNSSK for 2000, ICES-WGNSSK 2001), these cpue series have not been used for a number of years and are not presented in the Report. They are retained in the Stock Annex.

3.4.3 Historical stock development

The final assessment of whiting in VIa 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, but were not further explored in this assessment. A SURBA analysis may again be conducted to explore the tuning indices for the two new Scottish surveys when sufficient data have been gathered.

Data screening and exploratory runs

14) Model used: TSA

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

Input data types and characteristics:

- Landings, ages 1–7+, years 1981–2011 (1995–2005 age structure only used),
- Discards, ages 1–7+, years 1981–2011 (1995–2005 age structure only used)
- ScoGFS-WIBTS-Q1, ages 1–6, years 1985–2010
- ScoGFS-WIBTS-Q4, ages 1–6, years 1996–2009
- IRGFS-WIBTS-Q4, ages 1–4, years 2003–2006 and 2008–2011

The main assessment was carried out using a TSA model with ScoGFS-WIBTS-Q1, ScoGFS-WIBTS-Q4 and IRGFS-WIBTS-Q4. Natural mortality was assumed to vary with age being dependent on fish weight. No modification was made to account for misreporting (ICES-WKROUND, 2012). A "hockey-stick" model was employed to describe the stock–recruitment relationship. The proportion mature was knife-edge at age 2 (i.e. 0 at age 1, 1 at age 2 and above). 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. Methods of acquiring the input data are outlined in Section 3.4.2 and further details are given in the Stock Annex. 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.

Final assessment

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

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 three 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.

Discards continue to account for a large proportion of the total catch, with the proportion discarded tending to level off in the recent years (Figure 3.4.12). 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 the last decade.

TSA also estimated a large increase in catchability: this is plotted as the percentage change compared to the catchability at the start of each of the three surveys in Figure 3.4.14. The estimates are uncertain with relatively wide confidence intervals. The summary plots for the final assessment are shown in Figure 3.4.15.

The final estimates for the stock are:

i) $F_{(2\text{-}4)}$ in 2011 = 0.070

ii) SSB in 2012 = 10 000 t

Mean $F_{2\text{-}4}$ is estimated to have declined below F_{pa} (0.6) since 2002, but a sequence of low recruitments led to a fall in SSB in recent years. The 2009 year class is estimated as the strongest since 2000 (recruitment in 2001) and contributes towards a slight increase in SSB in 2012.

Estimated and observed catches diverged considerably in the period where catches are thought to be unreliable due to black landings (1995–2005). Recent estimates of catch are almost the same as observed values. This could indicate a beneficial effect of management regulations and changes in fleet behaviour since 2006, and is supported by anecdotal information from the fishing industry.

Retrospectives for the final assessment run are shown in Figure 3.4.16. This figure also shows lines at ±2 se (approximate 95% confidence limits) around the run in the respective years. Retrospective bias is small with respect to SSB. With respect to mean F and recruitment, all results are 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).

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 (000 fish) derived from TSA and used in the forecast for 2012 was 81 086. The value for 2013 and 2014 was taken as the geometric mean for 2001–2010 and was 37 152.

A three-year mean exploitation pattern rescaled to the final year F estimate 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 are shown in Table 3.4.18 and detailed tables of catch numbers-at-age are shown in Table 3.4.19.

A plot of the short-term forecast is shown in Figure 3.4.17. Results from sensitivity analysis from this forecast are shown in Figure 3.4.18 and probability profiles in Figure 3.4.19.

3.4.5 MSY explorations

The WG explored the use of the srmsymc package for defining MSY reference points. Estimates of F_{MSY} and potential proxies (e.g. F_{MAX}) were highly uncertain and parameter values were successfully estimated on only 50% of iterations for all three stock–recruit relationships. (Table 3.4.20). The WG concluded that the data did not support the provision of estimates of F_{MSY}.

3.4.6 Biological reference points

ICES considers that B_{lim} is 16 000 t and B_{pa} be set at 22 000 t. ICES proposes that F_{lim} is 1.0 and F_{pa} be set at 0.6.

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 occur and directly affects 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. The data since the mid-1990s are sufficiently consistent to conduct a catch-at-age analysis tuned with survey data. However, due to the discrepancy present in the earlier period, the Working Group considers that it is not possible to evaluate the current state of the stock with reference to precautionary reference points. A similar problem has been present in the North Sea whiting stock (as reported by ICES-WGNSSK, 2010). Three potential sources of this discrepancy were identified for the North Sea stock, and they may apply to whiting in VIa as well: bias in catch estimates, changes in survey catchability or changes in natural mortality due to predation or regime shift (ICES-WGNSSK, 2010).

Long-term information on the historical yield and catch composition indicates that the present stock size is low. The current assessment indicates that the stock is historically at a very 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. The persistence of this trend should be verified in subsequent assessments.

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 VIa. Given the new legislation on reporting landings, the quality of landings data is likely to continue to improve.

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).

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 inclusion of the two new Scottish surveys in this assessment should also be considered once a sufficient time-series becomes available.

3.4.10 Management considerations

Recruitment during the 1990s appears to have been high while more recently, it has been below average. The 2009 year class is still estimated to be relatively strong, following historically low recruitment of 2006 to 2008 year classes.

Recent estimates of SSB remain at a low level, but the latest estimate for 2011 indicates a potential upturn, driven by the relatively large 2009 year class. Fishing mortality also remains low. The perception of the state of this stock (as estimated from this assessment) appears not to have changed much from last year.

Whiting are caught in mixed fisheries with cod and haddock in VIa. 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 VIa gadoid fishery in recent years including the mandatory increases in mesh size to 120 mm.

Whiting are caught mainly as a bycatch species and there are no targeted fisheries for this stock, making direct management difficult. Whiting are caught and heavily discarded in small meshed fisheries for *Nephrops*: in 2011 this fleet discarded almost 50% of the total catch (across all fleets) of 569 t (> 60% in 2010). Any management measures which may result in a shift of vessels to these smaller mesh sizes will therefore result in a worse exploitation pattern and higher discards. Measures to improve the selectivity of these fisheries, such as sorting grids and appropriately placed square mesh panels should be introduced if these discards are to be avoided.

3.4.11 References

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Table 3.4.1. Whiting in Division VIa. 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	2011*
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	1	3	1	3	4
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	149
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)																				369	354	247	77
Total landings	7,669	6,026	6,908	6,010	6,751	5,786	6278	6642	6178	4657	4677	3203	2543	1735	1365	819	289	383	484	441	482	349	230

* Preliminary.

Table 3.4.2. Whiting in Division VIa. Landings, discards and catch estimates 1978–2011, 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	20452	14677	5775	93932	54369	39563
1979	20163	17081	3082	77794	61393	16401
1980	15108	12816	2292	57131	44562	12569
1981	16439	12203	4236	72113	46067	26046
1982	20064	13871	6193	87481	47883	39598
1983	21980	15970	6010	79114	49359	29755
1984	24118	16458	7660	125708	50218	75490
1985	23560	12893	10667	124683	43166	81517
1986	13413	8454	4959	64495	31273	33222
1987	18666	11544	7122	103485	41221	62264
1988	23136	11352	11784	141314	40681	100633
1989	11599	7531	4068	54633	26876	27757
1990	10036	5643	4393	42927	19201	23726
1991	12006	6660	5346	63112	25103	38009
1992	15396	6004	9392	86903	22266	64637
1993	15373	6872	8501	68351	23246	45105
1994	14771	5901	8870	87881	20060	67821
1995	13657	6076	7581	77932	18763	59169
1996	14058	7156	6902	71396	22329	49067
1997	11192	6285	4907	50459	19250	31209
1998	10476	4631	5845	56583	14387	42196
1999	7734	4613	3121	38260	15970	22290
2000	9715	3010	6705	78815	10118	68697
2001	4850	2438	2412	20802	8477	12325
2002	3829	1709	2120	25179	5765	19414
2003	2936	1356	1580	15403	4124	11279
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
Min	569	230	174	3085	583	1853
GM	7169	3630	3125	40327	11579	24812
AM	11319	6667	4652	57531	22808	34723
Max	24118	17081	11784	141314	61393	100633

Table 3.4.3. Whiting in Division VIa. 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
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

Table 3.4.4. Whiting in Division VIa. Discards-at-age (thousands). Previous discard estimates (ICES-WGCSE, 2011) for the years 1981–2003 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	27942	10505	889	206	1	20	0
1979	3450	10722	1619	533	76	0	0
1980	2376	6172	3206	651	156	9	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
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

Table 3.4.5. Whiting in Division VIa. 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	45612	28680	7571	9606	942	1452	68
1979	9784	44943	14901	3940	3565	276	384
1980	14026	17551	18065	4806	1400	1093	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	825	730	82	31
2005	2951	1854	988	178	118	53	11
2006	9865	991	1369	516	97	124	26
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

Table 3.4.6. Whiting in Division VIa. 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
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

Table 3.4.7. Whiting in Division VIa. 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
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

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

	Age						
Year	1	2	3	4	5	6	7+
1965	0.15	0.217	0.288	0.432	1.177	0.712	0.776
1966	0.155	0.213	0.304	0.361	0.597	0.713	0.824
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	0.731
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	0.42	0.547	0.71
1972	0.148	0.223	0.322	0.356	0.421	0.491	0.636
1973	0.146	0.21	0.336	0.458	0.477	0.528	0.663
1974	0.14	0.198	0.297	0.426	0.579	0.636	0.581
1975	0.145	0.214	0.288	0.449	0.636	0.61	0.717
1976	0.138	0.214	0.292	0.35	0.489	0.679	0.854
1977	0.139	0.218	0.281	0.379	0.425	0.624	0.816
1978	0.16	0.21	0.276	0.387	0.516	0.545	0.612
1979	0.202	0.222	0.295	0.378	0.531	0.678	0.693
1980	0.167	0.22	0.308	0.393	0.467	0.593	0.817
1981	0.173	0.196	0.271	0.379	0.401	0.408	0.547
1982	0.109	0.202	0.252	0.336	0.499	0.513	0.526
1983	0.155	0.215	0.27	0.324	0.405	0.479	0.51
1984	0.099	0.245	0.305	0.358	0.397	0.453	0.457
1985	0.107	0.216	0.288	0.383	0.427	0.448	0.537
1986	0.109	0.198	0.274	0.36	0.466	0.481	0.474
1987	0.097	0.21	0.297	0.369	0.51	0.52	0.576
1988	0.08	0.164	0.281	0.392	0.477	0.567	0.6
1989	0.108	0.204	0.255	0.337	0.446	0.422	0.555
1990	0.14	0.217	0.295	0.342	0.405	0.577	0.543
1991	0.096	0.207	0.265	0.338	0.376	0.424	0.761
1992	0.114	0.195	0.265	0.33	0.388	0.397	0.51
1993	0.123	0.211	0.271	0.331	0.361	0.452	0.474
1994	0.089	0.17	0.258	0.344	0.419	0.448	0.474
1995	0.076	0.166	0.235	0.361	0.44	0.473	0.528
1996	0.098	0.198	0.257	0.336	0.482	0.526	0.537
1997	0.116	0.2	0.275	0.369	0.505	0.629	0.661
1998	0.101	0.197	0.274	0.341	0.42	0.469	0.573
1999	0.084	0.194	0.269	0.34	0.433	0.504	0.593
2000	0.076	0.199	0.277	0.329	0.415	0.478	0.617
2001	0.1	0.183	0.28	0.35	0.395	0.376	0.589
2002	0.074	0.194	0.27	0.346	0.385	0.554	0.685
2003	0.08	0.211	0.287	0.34	0.36	0.427	0.526
2004	0.086	0.197	0.266	0.308	0.371	0.4	0.34
2005	0.089	0.166	0.264	0.344	0.42	0.455	0.362
2006	0.047	0.21	0.258	0.345	0.406	0.527	0.551
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

Table 3.4.9. Whiting in Division VIa. 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 10 hours. The Scottish surveys from 2011 have been conducted according to new design and ground gear.

	ScoGFS-WIBTS-Q1: Scottish Groundfish Survey - Effort in hours - Numbers at age							
	Effort	Age						
Year	(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

	UKSGFS-WIBTS-Q1: Scottish Groundfish Survey - Effort in hours - Numbers at age							
	Effort	Age						
Year	(hours)	1	2	3	4	5	6	7
2011	10	219	1770	401	69	32	47	13
2012	10	3251	313	862	86	16	6	7

Table 3.4.9. (continued).

	IR-WCGFS : Irish West Coast GFS (VIa) - Effort in minutes - Numbers at age						
	Effort	Age					
Year	(min)	0	1	2	3	4	5
1993	2130	14403	32643	11419	1464	231	13
1994	1865	264	11969	4817	2812	78	57
1995	2026	34584	5609	6406	734	186	80
1996	2008	376	7457	3551	374	232	5
1997	1879	1550	13865	8207	1022	524	50
1998	1936	1829	4077	3361	663	121	5
1999	1914	3337	3059	1965	322	11	12
2000	1878	682	10102	2126	109	109	4
2001	965	1118	5201	2903	149	70	3
2002	796	594	8247	9348	820	280	0

	IRGFS-WIBTS-Q4: Irish groundfish survey - Effort in minutes - Numbers at age							
	Effort				Age			
Year	(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

Table 3.4.9. (continued).

	ScoGFS-WIBTS-Q4: Scottish Groundfish Survey - Effort in hours - Numbers at age									
	Effort	Age								
Year	(hours)	0	1	2	3	4	5	6	7	8
1996	10	5154	**1908**	**1116**	**570**	**188**	**51**	**6**	1	0
1997	10	8001	**2869**	**951**	**323**	**160**	**46**	**12**	1	0
1998	10	1852	**2713**	**1125**	**150**	**100**	**20**	**1**	0	1
1999	10	8203	**2338**	**582**	**141**	**33**	**24**	**1**	1	0
2000	10	4434	**4056**	**789**	**160**	**9**	**7**	**1**	0	0
2001	10	9615	**1957**	**1420**	**155**	**40**	**12**	**2**	0	0
2002	10	14658	**1591**	**621**	**479**	**30**	**9**	**5**	0	0
2003	10	9932	**3446**	**567**	**338**	**83**	**27**	**4**	0	0
2004	10	5923	**1758**	**940**	**83**	**57**	**62**	**1**	0	0
2005	10	2297	**308**	**318**	**76**	**9**	**4**	**1**	1	0
2006	10	415	**296**	**140**	**101**	**35**	**8**	**3**	0	0
2007	10	1894	**434**	**326**	**99**	**83**	**48**	**1**	0	0
2008	10	2297	**208**	**78**	**110**	**28**	**24**	**4**	0	0
2009	10	4833	**236**	**178**	**50**	**58**	**12**	**6**	6	0
2010	10	NA	NA	NA	NA	NA	NA	NA	NA	NA

	UKSGFS-WIBTS-Q4: Scottish Groundfish Survey - Effort in hours - Numbers at age									
	Effort	Age								
Year	(hours)	0	1	2	3	4	5	6	7	8
2011	10	3243	146	2049	113	28	14	9	1	0

Table 3.4.10. Whiting in Division VIa. 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 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 VIa. TSA parameter estimates for final assessment presented this year.

Parameter	Notation	Description	2012 WG
Initial fishing mortality	F (1, 1981)	Fishing mortality-at-age a in year y	0.1054
	F (2, 1981)		0.1282
	F (4, 1981)		0.3968
Fishing mortality standard deviations	σF	Transitory changes in overall fishing mortality	0.0627
	σU	Persistent changes in selection (age effect in F)	0.0935
	σV	Transitory changes in the year effect in fishing mortality	0.0639
	σY	Persistent changes in the year effect in fishing mortality	0.2711
Measurement CVs	CVlandings	CV of landings-at-age data	0.1879
	CVdiscards	CV of discards-at-age data	0.5909
Recruitment		Hockey-stick parameter Recruitment value at change point	25.0080
		Hockey-stick parameter SSB at change point	2.9943
	CVrec	Coefficient of variation of recruitment data	0.2845
Discards	σlogit p	Transitory trends in discarding	0.2903
	σpersistent	Persistent trends in discarding	0.2071
Survey selectivities (ScoGFS-WIBTS-Q1)	Φ(1)	Survey selectivity at age a	1.9864
	Φ(2)		1.8925
	Φ(3)		1.5958
	Φ(4)		1.4244
	Φ(5)		1.2418
	Φ(6)		0.9273
	σsurvey	Standard error of survey data	0.4375
	???	???	0.0926
Survey catchability standard deviations	σΩ	Transitory changes in survey catchability	0.0137
	σβ	Persistent changes in survey catchability	0.2253
Survey selectivities (ScoGFS-WIBTS-Q4)	Φ(1)	Survey selectivity at age a	4.2790
	Φ(2)		3.9478
	Φ(3)		3.2596
	Φ(4)		2.8881
	Φ(5)		3.7300
	Φ(6)		0.8531
	σsurvey	Standard error of survey data	0.1678
	???	???	0.1601
Survey catchability standard deviations	σΩ	Transitory changes in survey catchability	0.0762
	σβ	Persistent changes in survey catchability	0.1486
Survey selectivities (IRGFS-WIBTS-Q4)	Φ(1)		11.6395
	Φ(2)		11.0456
	Φ(3)		5.9686

	Φ(4)		5.5077
	σsurvey	Standard error of survey data	0.0873
	???	???	0.3933
Survey catchability standard deviations	σΩ	Transitory changes in survey catchability	0.3195
	σβ	Persistent changes in survey catchability	0.0554
Misreporting		Transitory changes in misreporting	0.0
		Persistent changes in misreporting	0.0

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

	Age						
Year	1	2	3	4	5	6	7+
1981	201495	463709	83842	21293	6587	1891	999
1982	172550	81950	215262	37512	8782	2794	1251
1983	198523	69239	37063	92693	15325	3684	1721
1984	323972	75455	27374	13030	30926	5057	1840
1985	303170	116940	26529	8399	3600	8758	1988
1986	274758	110893	40400	7308	1884	787	2371
1987	380175	104679	42040	13917	2156	599	990
1988	105115	137737	36893	13032	3669	593	448
1989	302262	35802	44612	11385	2787	820	240
1990	171174	111470	11834	13507	2873	681	265
1991	230989	64154	42473	4412	4279	932	321
1992	290236	86708	24096	14788	1398	1412	428
1993	228829	111267	33495	9008	5091	496	669
1994	226911	88342	42884	12017	2693	1550	373
1995	221888	87993	35487	15522	3637	852	601
1996	138024	86340	34165	12925	4397	1056	421
1997	133926	48521	31330	10876	3055	1022	354
1998	164154	45876	16390	9799	2626	744	350
1999	122221	53824	13860	4720	2402	584	252
2000	184783	36529	14027	3200	890	446	154
2001	79829	56798	10200	3702	591	176	113
2002	32450	24108	15847	2742	680	96	50
2003	52579	9063	8184	5180	724	189	39
2004	36715	15610	2347	2844	1168	180	58
2005	25095	11653	5151	774	897	326	73
2006	33709	9299	4991	2247	317	371	169
2007	22090	12301	4027	2209	888	128	220
2008	25139	8003	5565	1890	956	398	159
2009	27293	9466	3555	2622	817	429	254
2010	78131	10353	4343	1719	1228	396	339
2011	21897	31187	4964	2203	876	643	395
2012	81086	9082	15379	2597	1183	485	587
2013	86965	33449	4470	8011	1387	651	604
GM(81-11)	110543	44937	17577	6700	2146	688	343

***2012 and 2013 values are TSA-derived projections of population numbers.**

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

	Age						
Year	1	2	3	4	5	6	7+
1981	46563	58514	11220	2505	804	272	306
1982	51527	16811	25789	5027	1099	395	206
1983	56085	18645	6951	11729	2211	546	270
1984	50623	15281	5575	2116	3832	847	309
1985	39990	16092	4952	1631	659	1565	452
1986	41802	13100	5761	1435	390	244	744
1987	51949	12275	4623	1717	373	126	309
1988	41014	17433	4048	1460	477	112	117
1989	46485	11380	6904	1495	524	180	70
1990	49020	14133	2971	2531	540	196	88
1991	44564	12952	4404	761	744	184	89
1992	47489	15173	4252	1606	219	256	90
1993	50376	17260	6075	1726	787	100	150
1994	51193	16668	7099	2441	685	370	107
1995	29767	11441	4025	1897	638	201	151
1996	23573	8917	3989	1487	672	251	134
1997	29050	7539	3125	1393	465	233	124
1998	34449	9336	2550	1123	457	175	120
1999	29443	10044	2797	706	328	145	87
2000	30066	7306	2413	573	135	85	54
2001	19227	9846	1853	534	98	30	31
2002	16543	5255	2975	478	128	31	18
2003	18112	4750	1726	1073	152	46	16
2004	13213	5604	1263	597	370	62	24
2005	6706	2814	1280	205	129	113	29
2006	5201	1780	921	411	54	49	52
2007	4974	1691	630	358	150	23	40
2008	4549	1519	702	276	163	73	29
2009	4895	1514	587	327	130	80	49
2010	10425	1754	689	290	178	70	67
2011	7902	4614	894	381	165	107	78
2012	26514	3365	2425	498	220	98	110
2013	30003	11274	1700	1367	286	132	123
GM(81-11)	23771	8073	2890	1038	359	142	92

***2012 and 2013 values are standard errors on TSA-derived projections of population numbers.**

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

	Age						
Year	1	2	3	4	5	6	7+
1981	0.0988	0.1227	0.2242	0.3446	0.3466	0.3489	0.3467
1982	0.1107	0.1504	0.2642	0.3578	0.3599	0.3695	0.3651
1983	0.1659	0.2679	0.4617	0.5720	0.6168	0.6106	0.5964
1984	0.2223	0.3927	0.5907	0.7672	0.7843	0.7803	0.7850
1985	0.2174	0.4303	0.6828	0.9162	0.9435	0.9553	0.9310
1986	0.1688	0.3294	0.4971	0.6975	0.6783	0.6916	0.6952
1987	0.2130	0.3993	0.5985	0.8247	0.8354	0.8602	0.8397
1988	0.2581	0.4935	0.6106	1.0390	1.0311	1.0276	1.0264
1989	0.2262	0.4649	0.6274	0.8747	0.9212	0.9274	0.9081
1990	0.1872	0.3057	0.4455	0.6495	0.6591	0.6511	0.6500
1991	0.1842	0.3575	0.4351	0.6516	0.6593	0.6595	0.6508
1992	0.1626	0.3196	0.4284	0.5426	0.5640	0.5660	0.5661
1993	0.1706	0.3246	0.4591	0.6949	0.7160	0.6876	0.6894
1994	0.1673	0.2931	0.4434	0.6714	0.6612	0.6958	0.6681
1995	0.1750	0.3074	0.4349	0.6957	0.6904	0.6971	0.6958
1996	0.2531	0.3916	0.5549	0.8727	0.8928	0.8770	0.8710
1997	0.2666	0.4284	0.5860	0.8371	0.8479	0.8208	0.8342
1998	0.3138	0.4934	0.6535	0.8738	0.9325	0.9105	0.9207
1999	0.3900	0.6521	0.8142	1.1292	1.1764	1.1731	1.1608
2000	0.3926	0.6142	0.7788	1.2141	1.1843	1.2526	1.2181
2001	0.3970	0.5768	0.7045	1.1250	1.1866	1.1871	1.1532
2002	0.2856	0.4046	0.4754	0.7808	0.7784	0.7870	0.7874
2003	0.2865	0.3774	0.4117	0.7747	0.7668	0.7849	0.7595
2004	0.2599	0.3108	0.3481	0.5764	0.6038	0.5974	0.5957
2005	0.1959	0.2095	0.2521	0.4003	0.3887	0.3977	0.3981
2006	0.2330	0.1958	0.2403	0.3983	0.4025	0.4212	0.4015
2007	0.2190	0.1505	0.1781	0.3034	0.2997	0.3061	0.3046
2008	0.1980	0.1698	0.1730	0.3028	0.2956	0.3034	0.2967
2009	0.1828	0.1357	0.1469	0.2202	0.2175	0.2143	0.2155
2010	0.1195	0.0908	0.0978	0.1350	0.1371	0.1341	0.1349
2011	0.0820	0.0621	0.0664	0.0808	0.0805	0.0799	0.0809
2012	0.0863	0.0660	0.0707	0.0868	0.0868	0.0868	0.0868
2013	0.0896	0.0685	0.0735	0.0903	0.0903	0.0903	0.0903
GM(81-11)	0.2055	0.2887	0.3815	0.5673	0.5744	0.5775	0.5722

***Estimates for 2012 and 2013 are TSA projections.**

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

	Age						
Year	1	2	3	4	5	6	7+
1981	0.0200	0.0200	0.0359	0.0528	0.0531	0.0538	0.0546
1982	0.0262	0.0292	0.0500	0.0633	0.0640	0.0662	0.0664
1983	0.0454	0.0572	0.1011	0.1097	0.1191	0.1195	0.1182
1984	0.0593	0.0763	0.1091	0.1249	0.1283	0.1317	0.1341
1985	0.0598	0.0803	0.1214	0.1530	0.1585	0.1647	0.1628
1986	0.0508	0.0681	0.0938	0.1226	0.1190	0.1248	0.1263
1987	0.0658	0.0803	0.1077	0.1390	0.1412	0.1517	0.1481
1988	0.0808	0.1127	0.1221	0.1966	0.1956	0.2016	0.2020
1989	0.0726	0.1141	0.1367	0.1814	0.1914	0.1973	0.1944
1990	0.0617	0.0774	0.1028	0.1504	0.1535	0.1540	0.1544
1991	0.0599	0.0866	0.0984	0.1425	0.1437	0.1469	0.1462
1992	0.0579	0.0890	0.1136	0.1452	0.1519	0.1543	0.1545
1993	0.0593	0.0893	0.1142	0.1788	0.1849	0.1805	0.1810
1994	0.0563	0.0766	0.1025	0.1541	0.1526	0.1627	0.1573
1995	0.0506	0.0605	0.0687	0.0986	0.1006	0.1044	0.1054
1996	0.0731	0.0787	0.0837	0.1064	0.1107	0.1137	0.1156
1997	0.0798	0.0940	0.0943	0.1147	0.1175	0.1177	0.1222
1998	0.0946	0.1106	0.1063	0.1231	0.1328	0.1343	0.1385
1999	0.1204	0.1371	0.1267	0.1480	0.1551	0.1626	0.1641
2000	0.1205	0.1221	0.1132	0.1501	0.1473	0.1641	0.1632
2001	0.1231	0.1238	0.1149	0.1666	0.1797	0.1870	0.1825
2002	0.0889	0.0910	0.0826	0.1180	0.1188	0.1237	0.1254
2003	0.0910	0.0899	0.0766	0.1241	0.1261	0.1320	0.1291
2004	0.0815	0.0740	0.0634	0.0923	0.0977	0.0988	0.1001
2005	0.0598	0.0495	0.0446	0.0589	0.0574	0.0597	0.0614
2006	0.0726	0.0495	0.0480	0.0725	0.0746	0.0795	0.0763
2007	0.0703	0.0414	0.0408	0.0645	0.0642	0.0664	0.0662
2008	0.0630	0.0461	0.0394	0.0597	0.0586	0.0609	0.0601
2009	0.0585	0.0374	0.0336	0.0433	0.0431	0.0427	0.0435
2010	0.0400	0.0264	0.0238	0.0288	0.0293	0.0288	0.0294
2011	0.0294	0.0197	0.0180	0.0182	0.0182	0.0179	0.0185
2012	0.0410	0.0291	0.0292	0.0338	0.0338	0.0338	0.0338
2013	0.0486	0.0351	0.0361	0.0431	0.0431	0.0431	0.0431
GM(81-11)	0.0627	0.0665	0.0744	0.1000	0.1021	0.1050	0.1053

***Estimates for 2012 and 2013 are standard errors of TSA projections of log F.**

Table 3.4.16. Whiting in Division VIa. TSA summary table. "Obs." denotes sum-of-products of numbers and mean weights-at-age, not reported caught, landed and discarded weight. *Estimates for 2012 and 2013 are TSA projections.

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	10856	2741	2132	4645	2078	14325	15501	1689	0.230	0.031	131708	13860	166351	17953	201495	46563
1982	13880	12958	1846	5485	4232	1354	19366	17190	1834	0.257	0.041	90800	9784	109384	12916	172550	51527
1983	15962	16950	1739	6294	5014	1338	22257	21965	2301	0.434	0.078	63578	8498	93597	13775	198523	56085
1984	16459	15348	1452	4017	5312	1323	20476	20660	2191	0.584	0.084	47559	5705	82998	8881	323972	50623
1985	12879	11900	1278	4840	6953	1545	17719	18853	1943	0.676	0.096	43321	4900	79032	7846	303170	39990
1986	8458	8088	897	2669	4832	1095	11127	12920	1411	0.508	0.080	39512	4217	71610	7787	274758	41802
1987	11542	10389	1008	11918	7099	1612	23460	17488	1959	0.608	0.093	41183	3816	75918	7123	380175	51949
1988	11349	10818	1055	8132	4959	1181	19481	15777	1526	0.714	0.126	41030	4011	49666	6306	105115	41014
1989	7523	7243	771	5876	5717	1330	13399	12960	1598	0.656	0.127	23836	4009	55398	7736	302262	46485
1990	5642	5614	624	4530	4679	1124	10172	10293	1314	0.467	0.098	33162	4398	56680	9979	171174	49020
1991	6658	5776	623	4883	3908	901	11541	9683	1183	0.481	0.097	27082	3684	49988	7260	230989	44564
1992	6005	5215	660	9249	5215	1221	15253	10430	1548	0.430	0.106	29263	4264	62130	8682	290236	47489
1993	6872	6438	715	4759	6152	1350	11631	12590	1577	0.493	0.116	39476	5794	67560	10669	228829	50376
1994	5901	5805	648	3455	4677	963	9356	10482	1173	0.469	0.099	33811	5450	54674	8894	226911	51193
1995	6078	5969	617	5771	4625	904	11849	10594	1126	0.479	0.057	31955	2792	48843	3996	221888	29767
1996	7158	6659	674	7940	5884	1185	15098	12544	1427	0.606	0.065	32694	2533	46202	3981	138024	23573
1997	6290	5817	559	5251	4988	1108	11542	10805	1340	0.617	0.078	24668	2421	40102	5064	133926	29050
1998	4627	4231	447	9216	5477	1266	13843	9707	1458	0.674	0.089	18099	2562	34482	5408	164154	34449
1999	4613	3941	475	3975	5052	1194	8588	8994	1428	0.865	0.104	16540	2512	27391	4573	122221	29443
2000	3011	2862	366	13285	5222	1223	16296	8084	1371	0.869	0.093	12436	1840	26368	3560	184783	30066
2001	2439	2531	296	4263	4340	960	6702	6871	1079	0.802	0.106	13843	2013	21822	3500	79829	19227
2002	1767	1766	249	2851	1556	431	4618	3322	578	0.554	0.076	9657	1624	12051	2621	32450	16543
2003	1355	1332	219	719	1266	410	2074	2598	558	0.521	0.078	6369	1657	10760	3005	52579	18112
2004	811	681	150	2159	1067	357	2970	1749	468	0.412	0.061	5101	1598	8272	2584	36715	13213
2005	341	443	75	629	561	157	970	1004	205	0.287	0.039	4109	814	6341	1303	25095	6706
2006	380	495	61	946	549	122	1326	1044	154	0.278	0.046	4434	683	6034	877	33709	5201
2007	427	440	46	317	416	94	745	856	118	0.211	0.041	4805	621	6653	968	22090	4974
2008	445	450	45	314	483	110	759	932	133	0.215	0.040	4907	680	6829	973	25139	4549
2009	488	446	45	419	405	94	908	851	118	0.168	0.032	6406	885	7861	1092	27293	4895
2010	307	327	35	893	344	83	1200	671	100	0.108	0.022	4961	720	7995	1060	78131	10425
2011	230	263	31	339	225	60	569	488	76	0.070	0.016	9324	1365	9981	1545	21897	7902
2012*	NA	384	122	NA	337	134	NA	721	235	0.075	0.028	10000	1859	13302	2506	81086	26514
2013*	NA	503	200	NA	482	223	NA	985	401	0.000	0.036	14110	3311	17652	3950	86965	30003
Min	230	263		314	225		569	488		0.070		4109	621	6034	877	21897	4549
GM	3160	3077		2847	2536		6408	5750		0.414		19035	2590	30011	4270	110543	23771
AM	5874	5550		4436	3737		10310	9287		0.476		28891	3539	45257	5868	155164	30864
Max	16459	16950		13285	7099		23460	21965		0.869		131708	13860	166351	17953	380175	56085

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

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Table_____Whiting,,,,VIa,,,
 input data for catch forecast and linear sensitivity analysis


 Label     Value     CV     Label     Value     CV

 Number at age              Weight in the stock
 N1        81086   0.33     WS1        0.04   0.28
 N2         9082   0.37     WS2        0.21   0.46
 N3        15379   0.16     WS3        0.36   0.07
 N4         2597   0.19     WS4        0.49   0.06
 N5         1183   0.19     WS5        0.52   0.14
 N6          485   0.20     WS6        0.55   0.07
 N7          587   0.19     WS7        0.41   0.87

 H.cons selectivity         Weight in the HC catch
 sH1        0.00   1.08     WH1        0.28   0.22
 sH2        0.02   1.05     WH2        0.36   0.11
 sH3        0.03   0.40     WH3        0.43   0.06
 sH4        0.07   0.29     WH4        0.52   0.08
 sH5        0.07   0.29     WH5        0.58   0.17
 sH6        0.08   0.29     WH6        0.57   0.09
 sH7        0.09   0.29     WH7        0.53   0.23

 Discard selectivity        Weight in the discards
 sD1        0.08   1.08     WD1        0.04   0.26
 sD2        0.04   1.05     WD2        0.18   0.49
 sD3        0.03   0.40     WD3        0.27   0.17
 sD4        0.01   0.29     WD4        0.30   0.21
 sD5        0.02   0.29     WD5        0.28   0.29
 sD6        0.01   0.29     WD6        0.22   0.93
 sD7        0.00   0.29     WD7        0.32   1.73

 Natural mortality          Proportion mature
 M1         0.80   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
 HF11       1.00   0.05     K11        1.00   0.10
 HF12       1.00   0.05     K12        1.00   0.10
 HF13       1.00   0.05     K13        1.00   0.10

 Recruitment in 2013 and 2014
 R13       37151   0.47
 R14       37151   0.47



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

 Stock numbers in 2011 are TSA survivors.,,,
```

Table 3.4.18. Whiting in Division VIa. Results of short-term forecasts from TSA run. Management options.

Table_____.Whiting,,,,VIa,,,
Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year 2012	2013						
Mean F Ages 2 to 4								
H.cons	0.07	0.00	0.01	0.03	0.04	0.06	0.07	0.08
Effort relative to 2011								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Biomass								
Total 1 January	13.2	15.6	15.6	15.6	15.6	15.6	15.6	15.6
SSB at spawning time	9.9	14.1	14.1	14.1	14.1	14.1	14.1	14.1
Catch weight (,000t)								
H.cons	0.357	0.000	0.107	0.213	0.317	0.420	0.522	0.622
Discards	0.318	0.000	0.065	0.128	0.192	0.254	0.316	0.377
Total Catch	0.675	0.000	0.172	0.342	0.509	0.674	0.837	0.998
Biomass in year.... 2014								
Total 1 January		15.93	15.73	15.54	15.34	15.15	14.96	14.77
SSB at spawning time		14.41	14.21	14.01	13.82	13.62	13.43	13.25

	Year 2012	2013						
Effort relative to 2011								
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	0.16	0.29	0.29	0.29	0.29	0.29	0.29	0.29
SSB at spawning time	0.16	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Catch weight								
H.cons	0.26	0.00	0.44	0.39	0.38	0.38	0.38	0.38
Discards	0.63	0.00	0.77	0.75	0.74	0.74	0.73	0.73
Biomass in year.... 2014								
Total 1 January		0.24	0.24	0.24	0.24	0.24	0.24	0.24
SSB at spawning time		0.26	0.26	0.26	0.26	0.26	0.26	0.26

Table 3.4.19. Whiting in Division VIa. Results of short-term forecasts from TSA run. Detailed tables.

Table_____.Whiting,,,,VIa,,,
Detailed forecast tables.

Forecast for year 2012
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Discards	Total
1	81086	0	4154	4154
2	9082	117	267	385
3	15379	385	329	714
4	2597	143	27	169
5	1183	63	15	78
6	485	29	3	32
7	587	38	0	39
Wt	13	0	0	1

Forecast for year 2013
F multiplier H.cons=1.00

Age	Populations: Stock No.	Catch number: H.Cons	Discards	Total
1	37152	0	1903	1903
2	33667	435	990	1425
3	4487	112	96	208
4	8061	442	84	526
5	1382	74	18	91
6	648	38	4	42
7	602	40	0	40
Wt	16	1	0	1

Table 3.4.20. Whiting in Division VIa. Output from srmsymc ADMB package.

Stock name
wgcse_whg-6a
Sen filename
.\wgcse_whg-6a.sen
pf, pm
0 0
Number of iterations
1000
Simulate variation in Biological parameters
TRUE
SR relationship constrained
TRUE

Ricker
503/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta	AIC
Deterministic	0.398	0.168	49185	4297	0.374	1.311	7.459	0.000	37.035
Mean	0.309	0.119	49114	4350	0.439	1.179	7.337	0.000	39.248
5%ile	0.062	0.030	19147	717	0.251	0.496	6.060	0.000	37.156
25%ile	0.142	0.068	30568	1927	0.339	0.942	6.773	0.000	37.696
50%ile	0.229	0.103	43597	3214	0.421	1.179	7.314	0.000	38.604
75%ile	0.344	0.147	55709	5614	0.508	1.432	7.853	0.000	40.156
95%ile	0.861	0.262	95485	10330	0.722	1.811	8.640	0.000	43.879
CV	1.092	0.652	0.898	1.190	0.326	0.326	0.109	0.326	0.055

Beverton-Holt
504/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta	AIC
Deterministic	0.389	0.142	59407	4527	1.147	1.879	616644	84062	40.092
Mean	0.331	0.105	50061	3947	1.233	1.975	703306	101932	42.342
5%ile	0.061	0.029	13156	538	0.556	1.397	344433	36738	40.229
25%ile	0.139	0.062	28302	1546	0.896	1.677	462120	60655	40.784
50%ile	0.217	0.088	41733	3028	1.198	1.945	590342	81633	41.735
75%ile	0.343	0.127	60625	4882	1.531	2.238	789131	117192	43.249
95%ile	0.930	0.238	111112	10137	2.054	2.693	1271893	207174	46.254
CV	1.372	0.627	0.831	0.990	0.388	0.210	0.756	0.923	0.050

Table 3.4.20. (Cont). Whiting in Division VIa. Output from srmsymc ADMB package.

Smooth hockeystick

505/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta	AIC
Deterministic	0.302	0.302	38886	5297	0.572	1.345	3.073	38868	32.146
Mean	0.233	0.195	43319	5512	0.581	1.468	3.118	42398	34.616
5%ile	0.038	0.038	30165	1412	0.502	1.008	2.697	29113	32.344
25%ile	0.100	0.100	36594	3075	0.546	1.243	2.930	35924	32.947
50%ile	0.167	0.164	42589	4630	0.577	1.418	3.102	40980	33.908
75%ile	0.265	0.249	49495	7104	0.611	1.634	3.280	47205	35.647
95%ile	0.633	0.471	63395	12475	0.671	2.010	3.606	58057	39.710
CV	1.114	0.722	0.295	0.635	0.090	0.225	0.090	0.225	0.067

Per recruit

	F35	F40	F01	Fmax	Bmsypr	MSYpr	Fpa	Flim
Deterministic	0.461	0.391	0.233	0.336	0.163	0.022		
Mean	0.455	0.377	0.242	0.400	0.168	0.021		
5%ile	0.177	0.153	0.126	0.168	0.143	0.006		
25%ile	0.251	0.216	0.166	0.232	0.155	0.012		
50%ile	0.324	0.275	0.213	0.307	0.165	0.019		
75%ile	0.465	0.390	0.287	0.432	0.177	0.027		
95%ile	1.141	0.882	0.465	0.932	0.206	0.043		
CV	0.975	0.963	0.475	0.794	0.118	0.600		

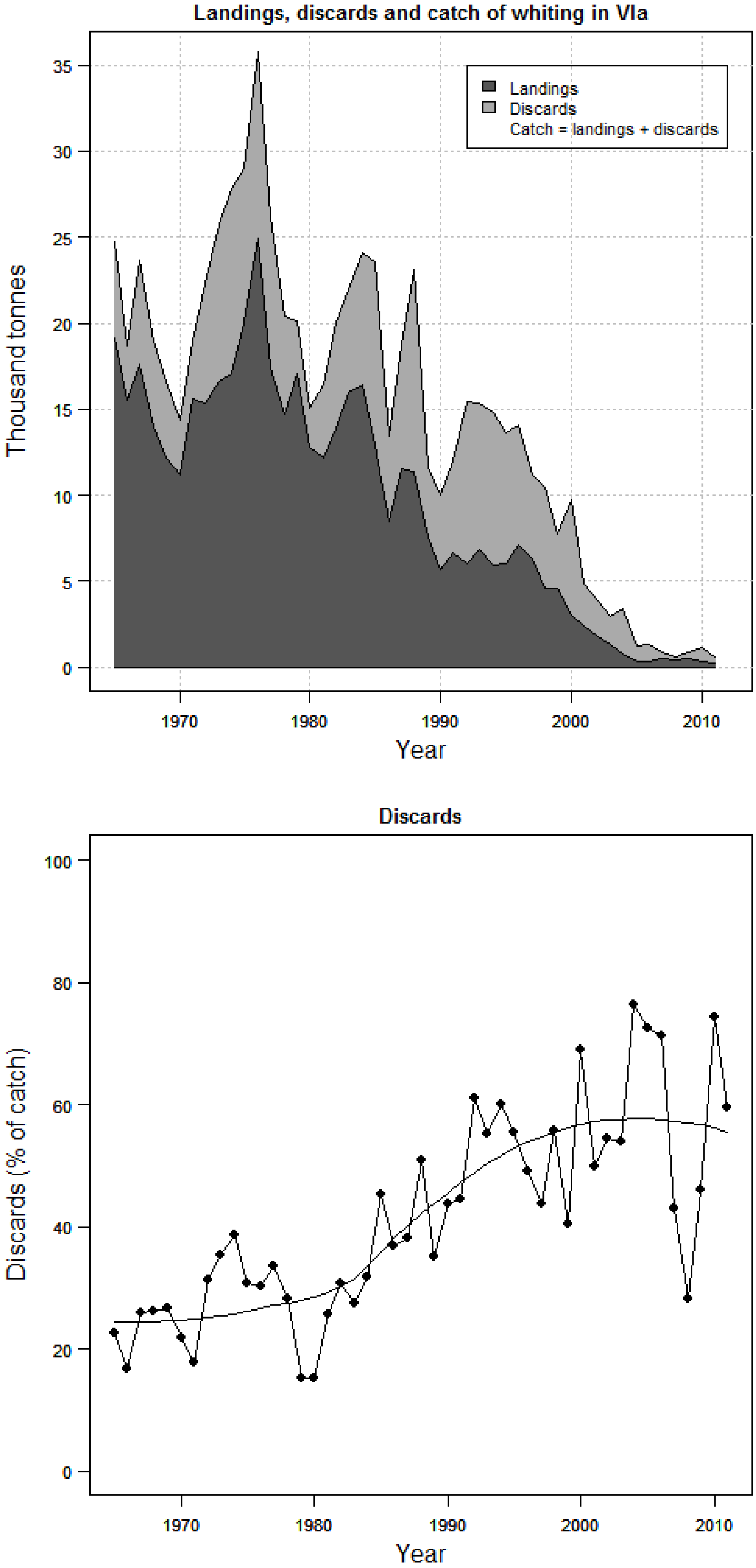
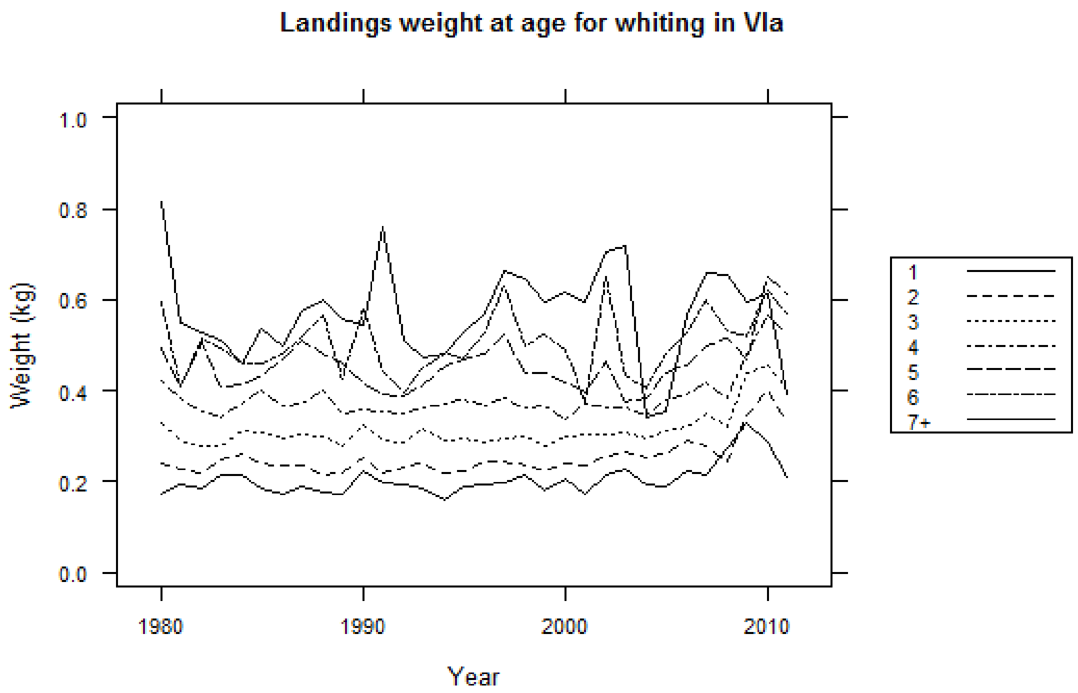


Figure 3.4.1. Whiting in Division VIa. Landings, discards and catch (in tonnes) as officially reported to ICES (upper panel) and discards (as % of catch, lower panel).



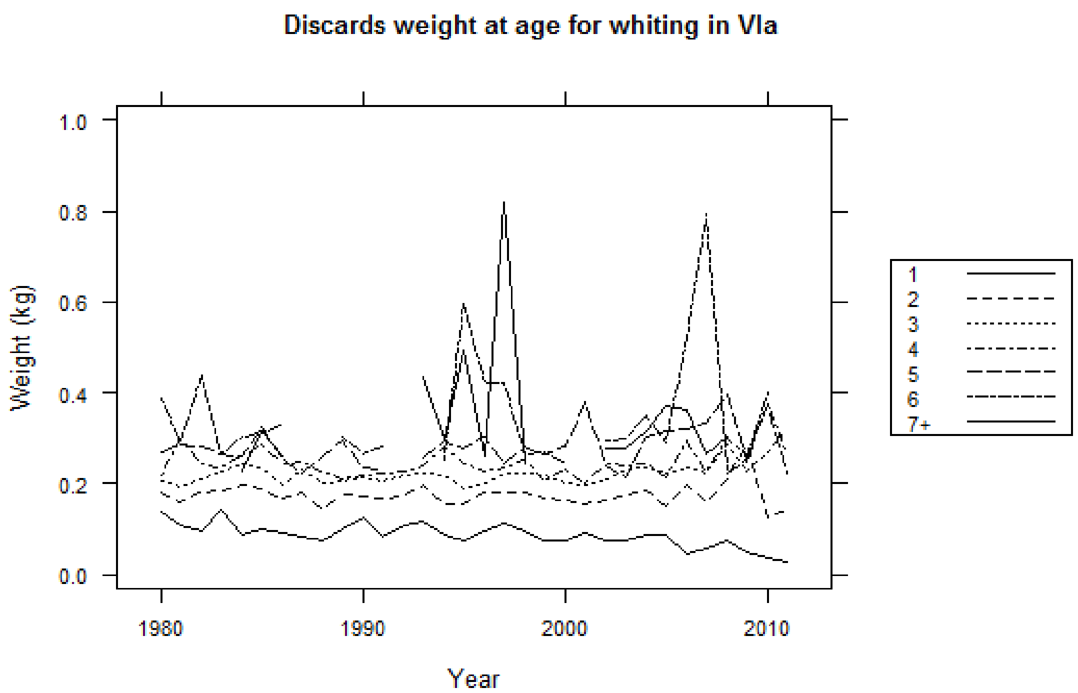


Figure 3.4.2. Whiting in Division VIa. Mean weight-at-age in the landings (upper panel) and discards (lower panel).

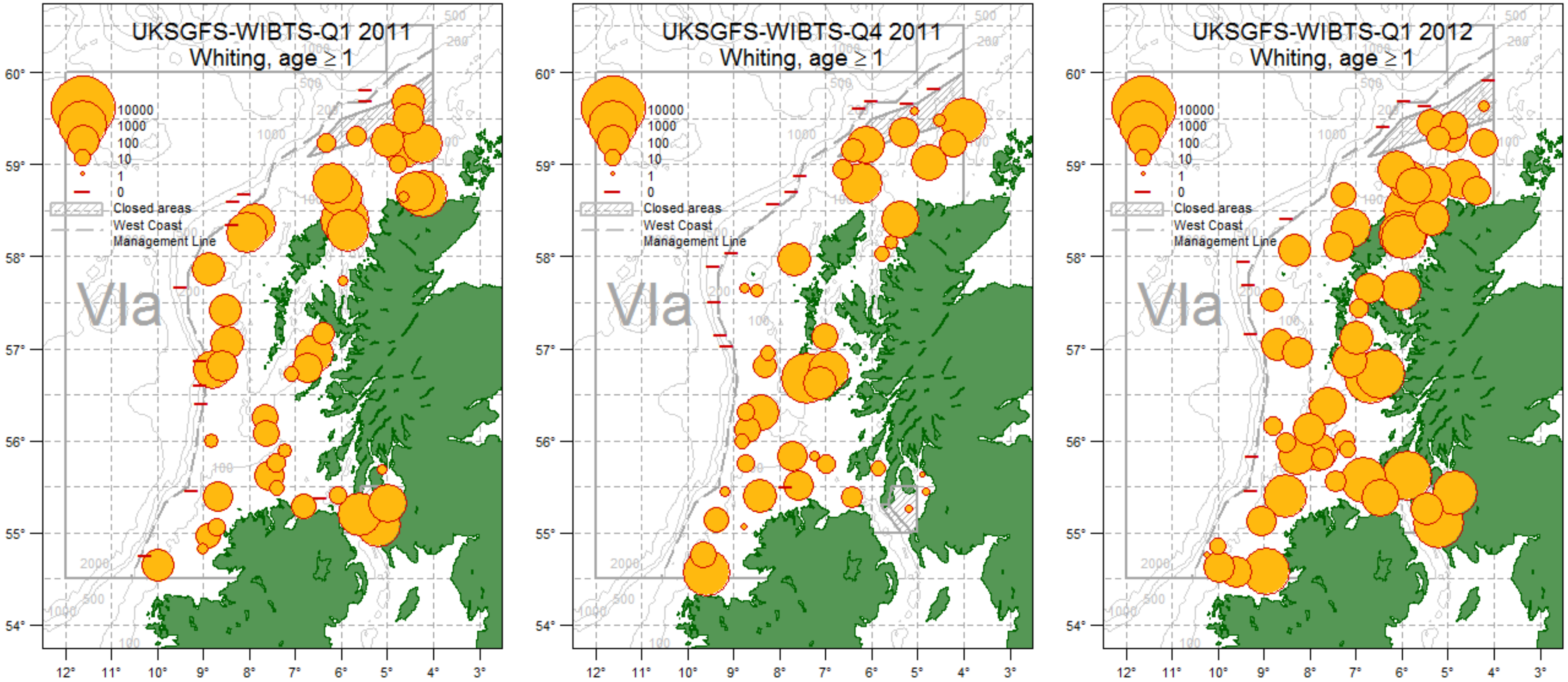


Figure 3.4.3. Whiting in Division VIa. Map of the west coast of Scotland showing the catch of whiting per unit of effort during the Scottish first quarter west coast groundfish survey (UKSGFS-WIBTS-Q1) in 2011 and 2012 (first and third panel, respectively) and the 2011 Scottish fourth quarter groundfish survey (UKSGFS-WIBTS-Q4) in 2011 (second panel). 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) of whiting at age 1+, according to the legend (top left).

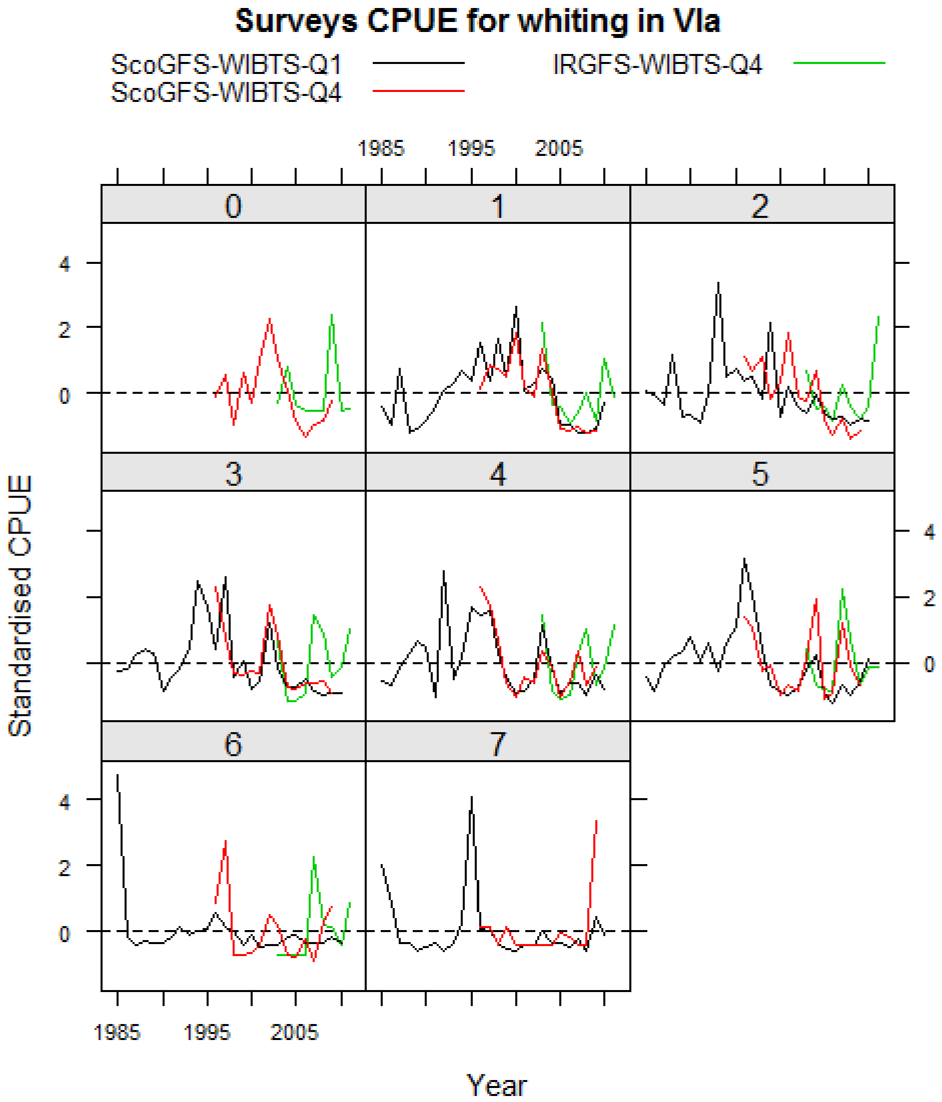


Figure 3.4.4. Whiting in Division VIa. Comparison of scaled survey indices from ScoGFS-WIBTS-Q1, ScoGFS-WIBTS-Q4 and IRGFS-WIBTS-Q4.

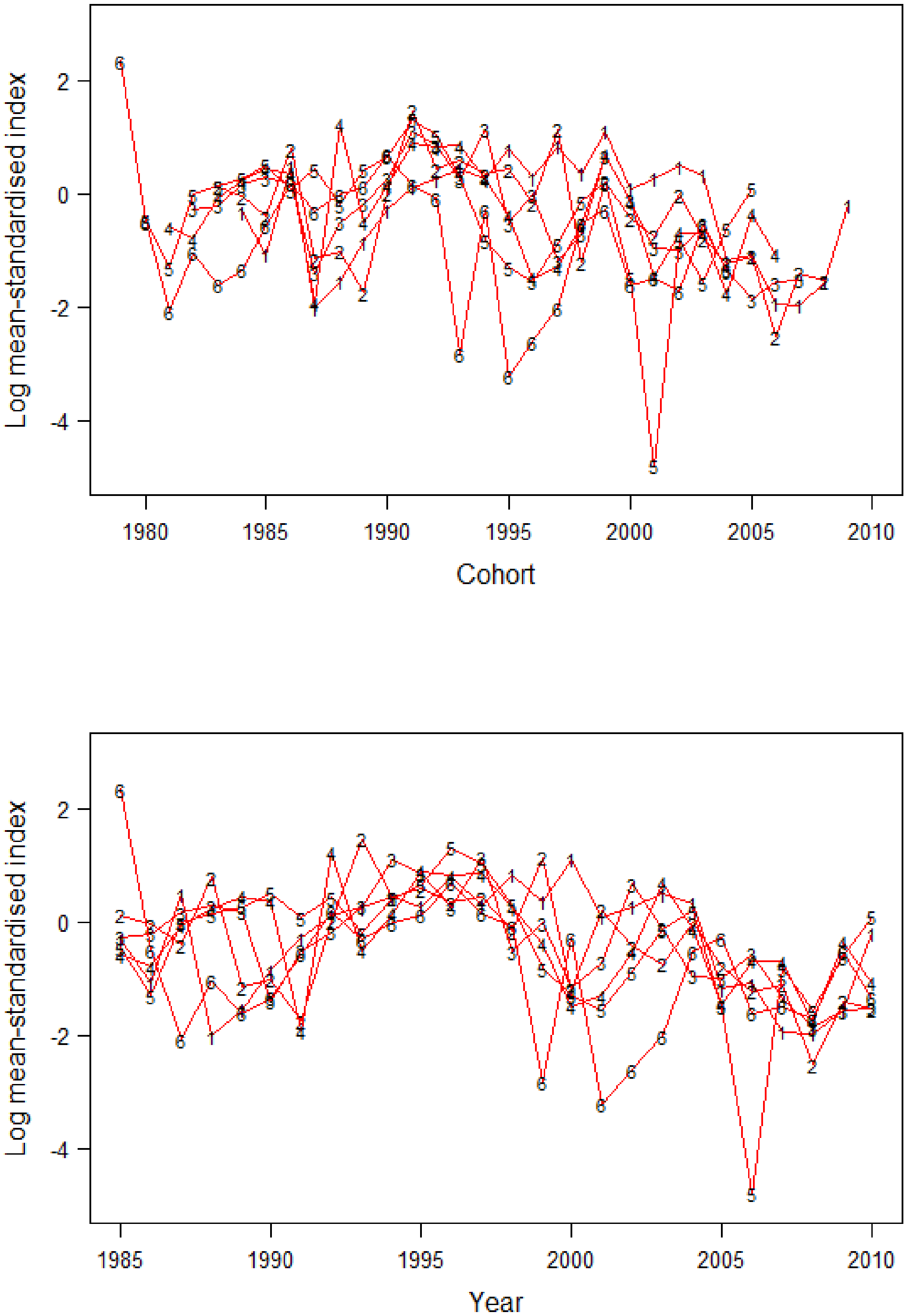


Figure 3.4.5. Whiting in Division VIa Whiting in Division VIa. Log mean standardised survey index for each age by cohort (upper panel) and year (lower panel) in ScoGFS-WIBTS-Q1.

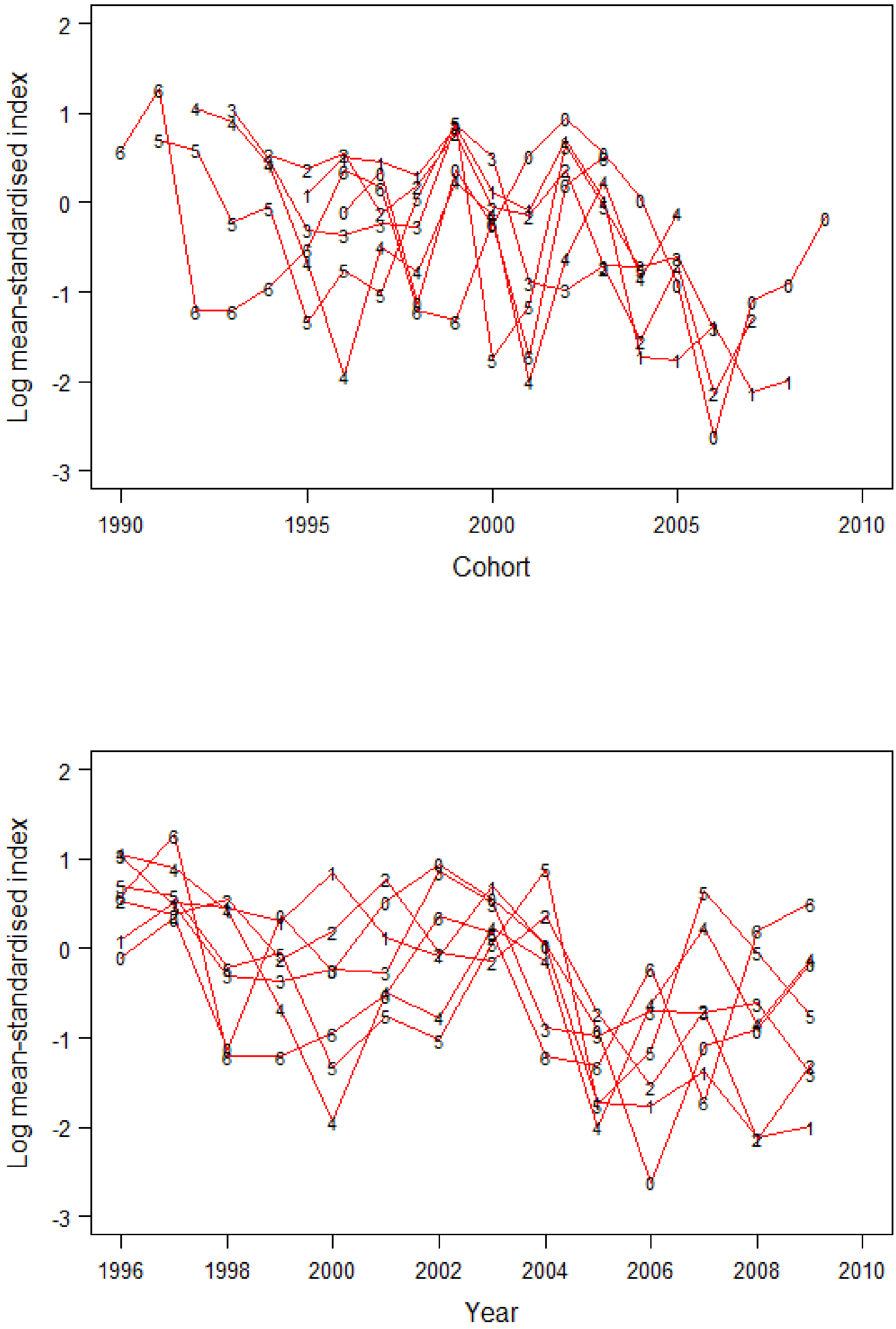
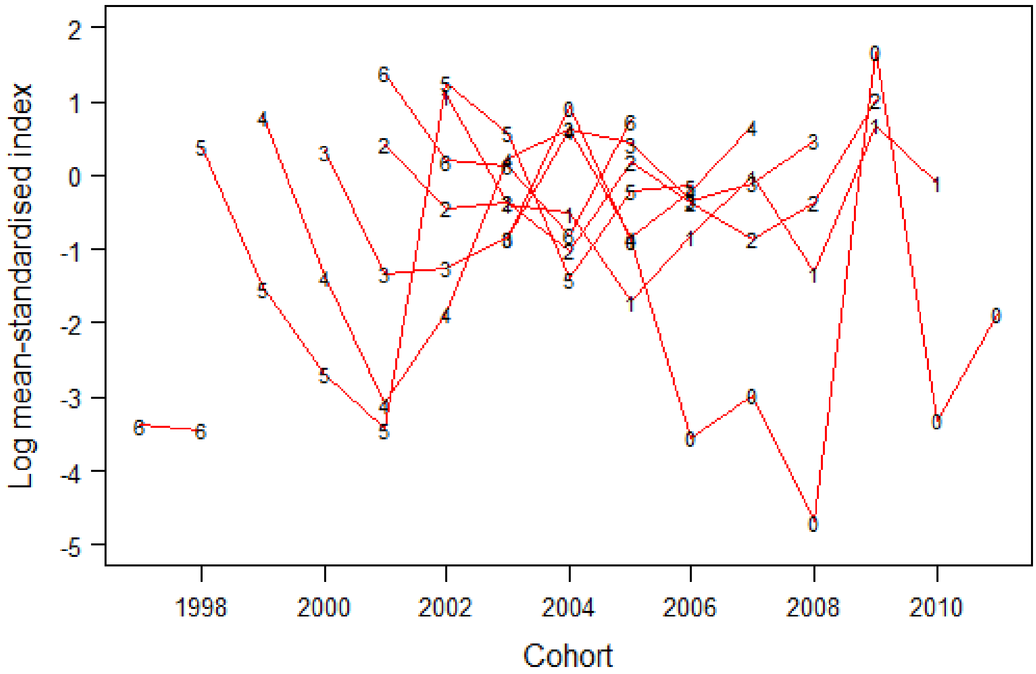


Figure 3.4.6. Whiting in Division VIa Whiting in Division VIa. Log mean standardised survey index for each age by cohort (upper panel) and year (lower panel) in ScoGFS-WIBTS-Q4.



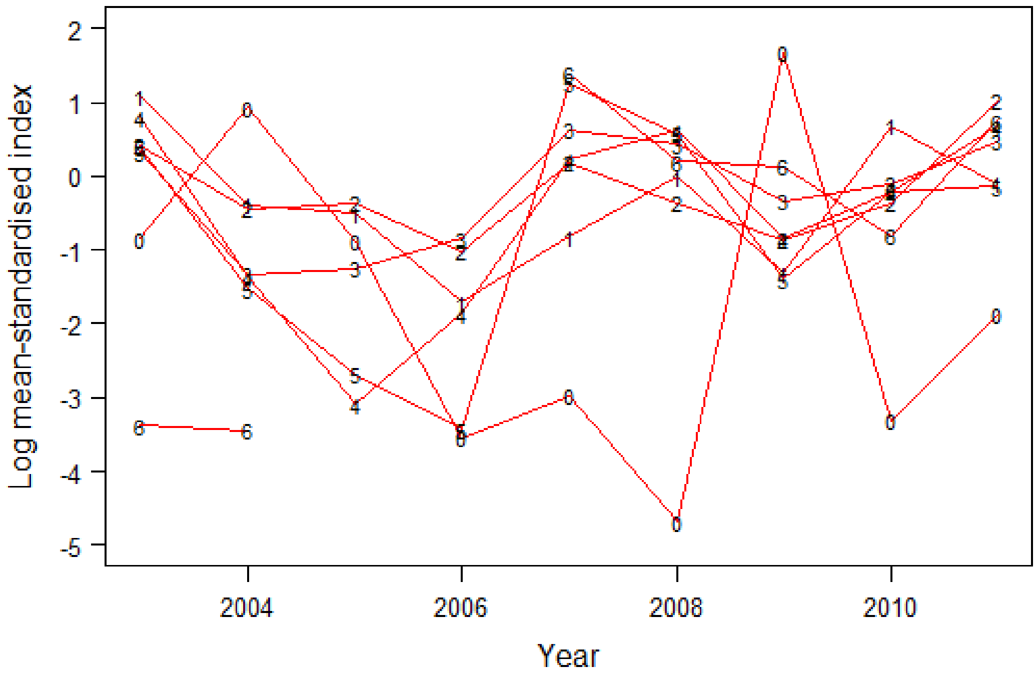


Figure 3.4.7. Whiting in Division VIa Whiting in Division VIa. Log mean standardised survey index for each age by cohort (upper panel) and year (lower panel) in IRGFS-WIBTS-Q4.

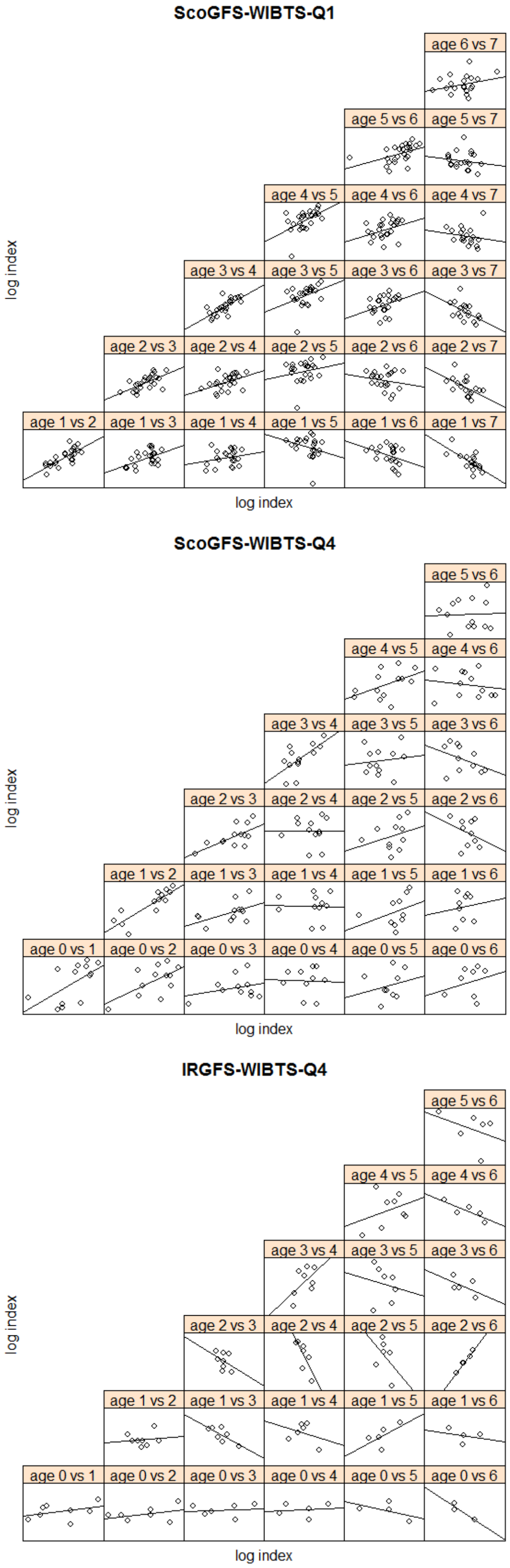


Figure 3.4.8. Whiting in Division VIa. Comparative scatterplots at age for the Scottish groundfish surveys, ScoGFS-WIBTS-Q1 (top panel) and ScoGFS-WIBTS-Q4 (middle panel), and for the Irish survey, IRGFS-WIBTS-Q4 (bottom panel).

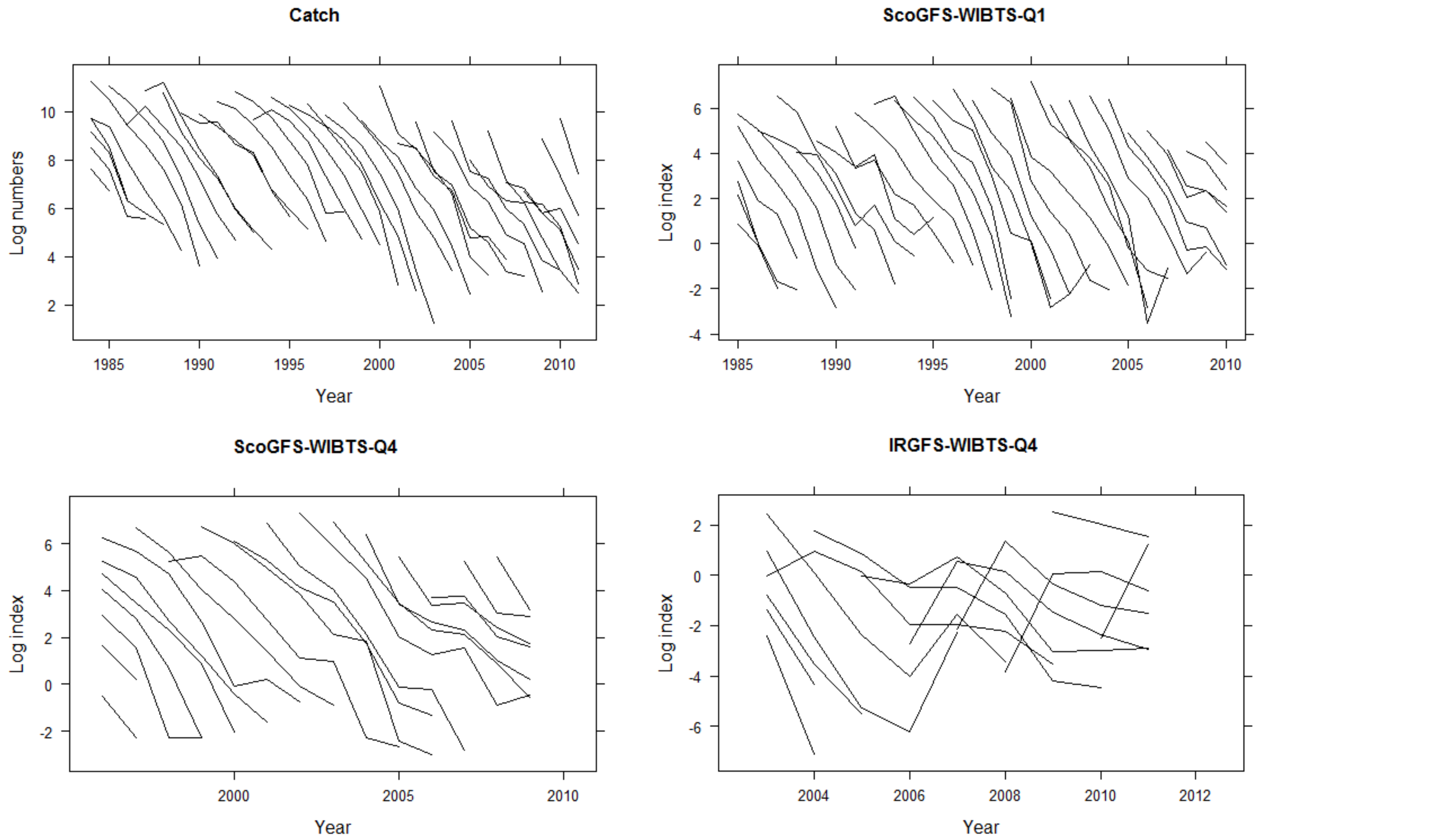


Figure 3.4.9. Whiting in Division VIa. Log catch curves from the catch (ages 1–7, upper left panel) and the two Scottish groundfish surveys, ScoGFS-WIBTS-Q1 (ages 1–7, upper right panel) and ScoGFS-WIBTS-Q4 (ages 0–7, lower left panel), and the Irish groundfish survey, IRGFS-WIBTS-Q4 (ages 0–6, lower right panel).

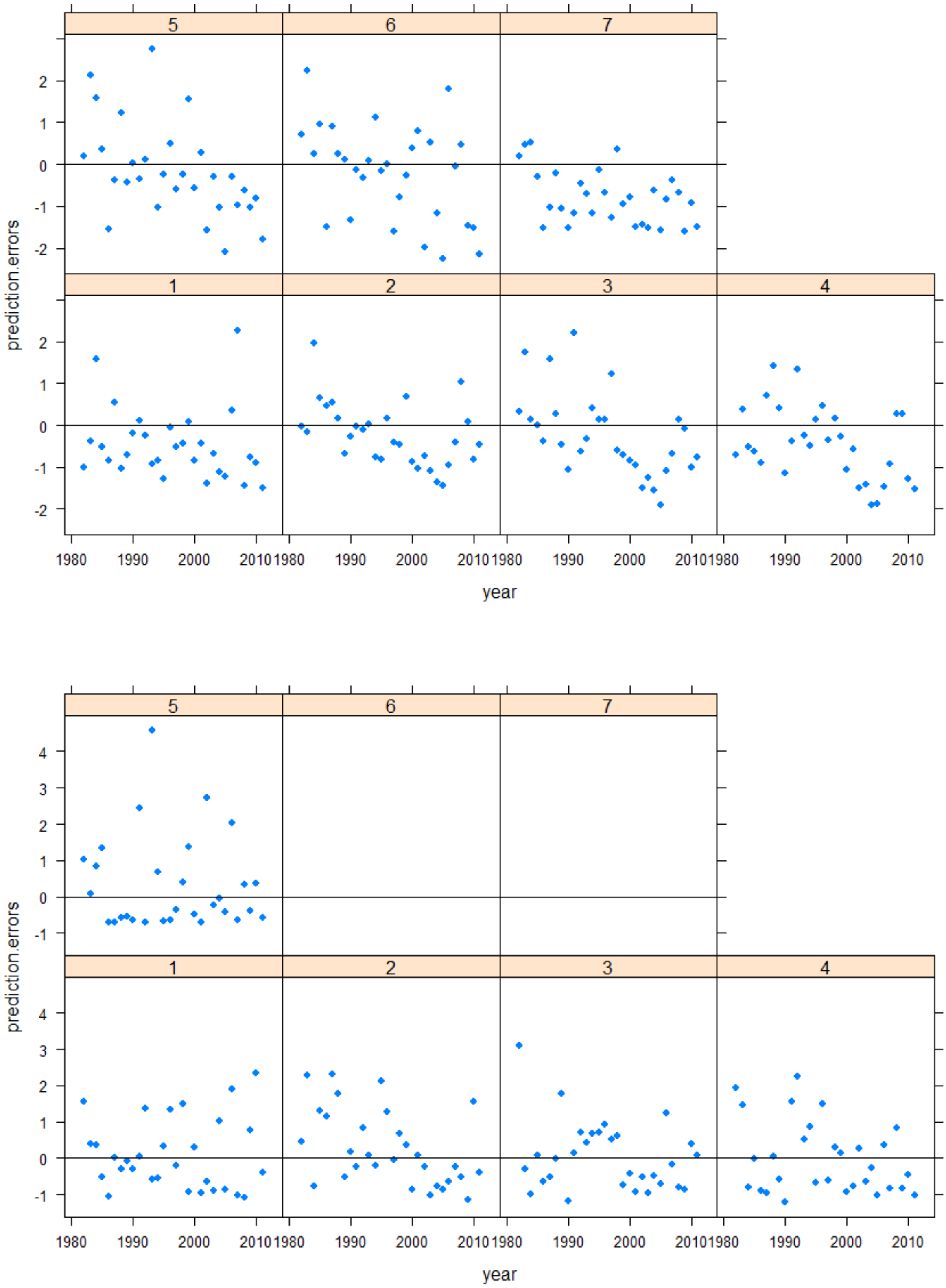


Figure 3.4.10. Whiting in Division VIa. Standardised landings (upper panel) and discards (lower panel) prediction errors from TSA.

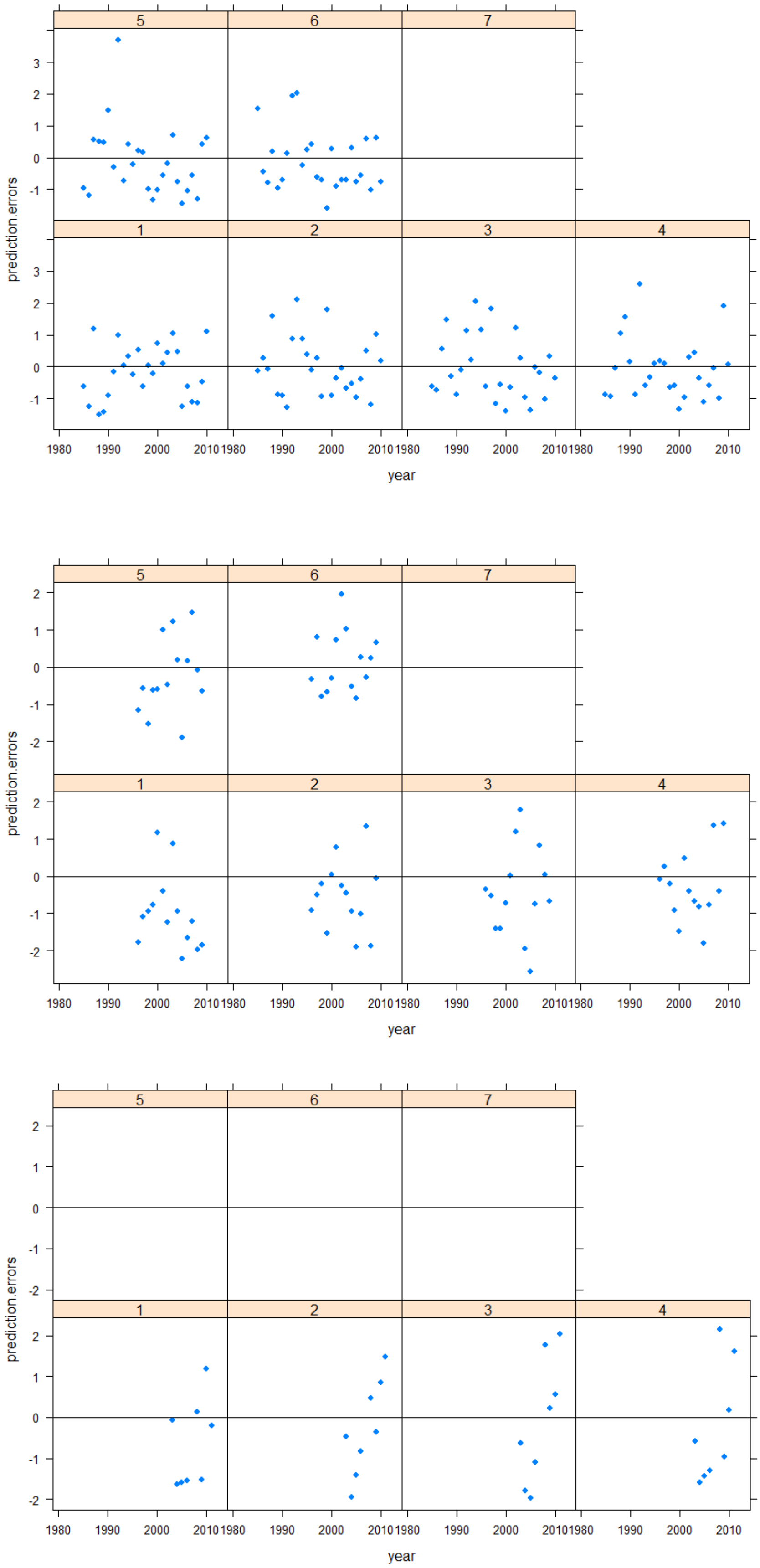


Figure 3.4.11. Whiting in Division VIa. Standardised survey errors from TSA in ScoGFS-WIBTS-Q1 (top panel), ScoGFS-WIBTS-Q4 (middle panel) and IGFS-WIBTS-Q4 (bottom panel).

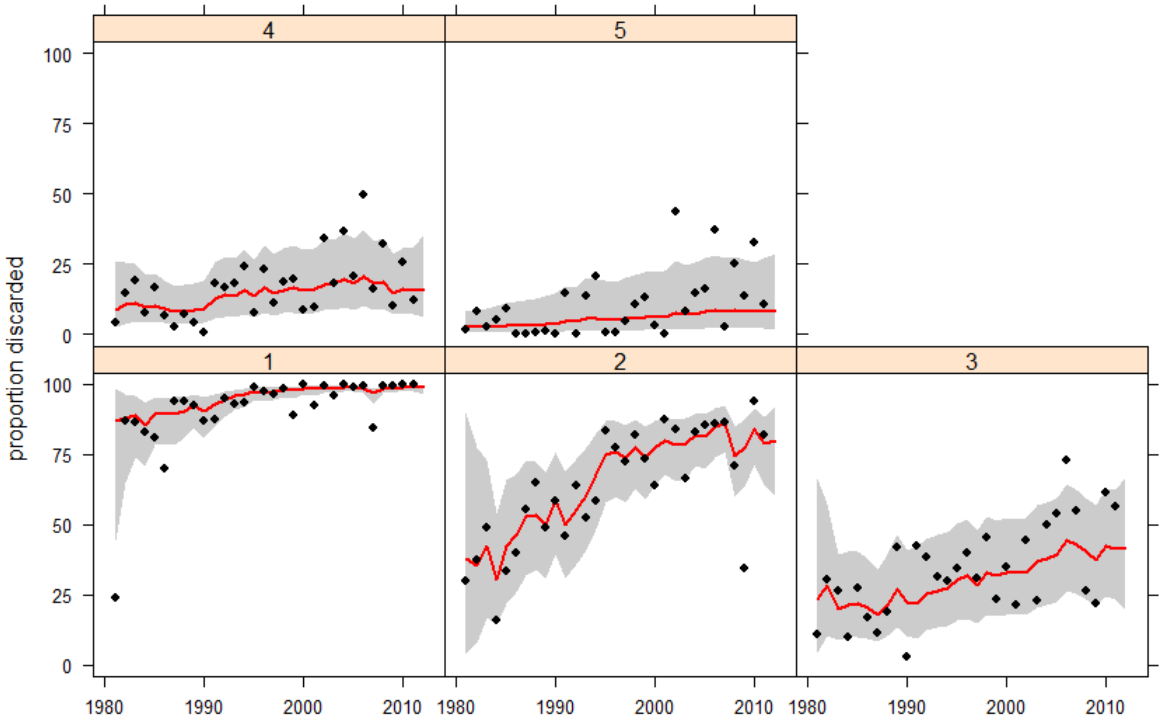


Figure 3.4.12. Whiting in Division VIa. Proportion discarded-at-age.

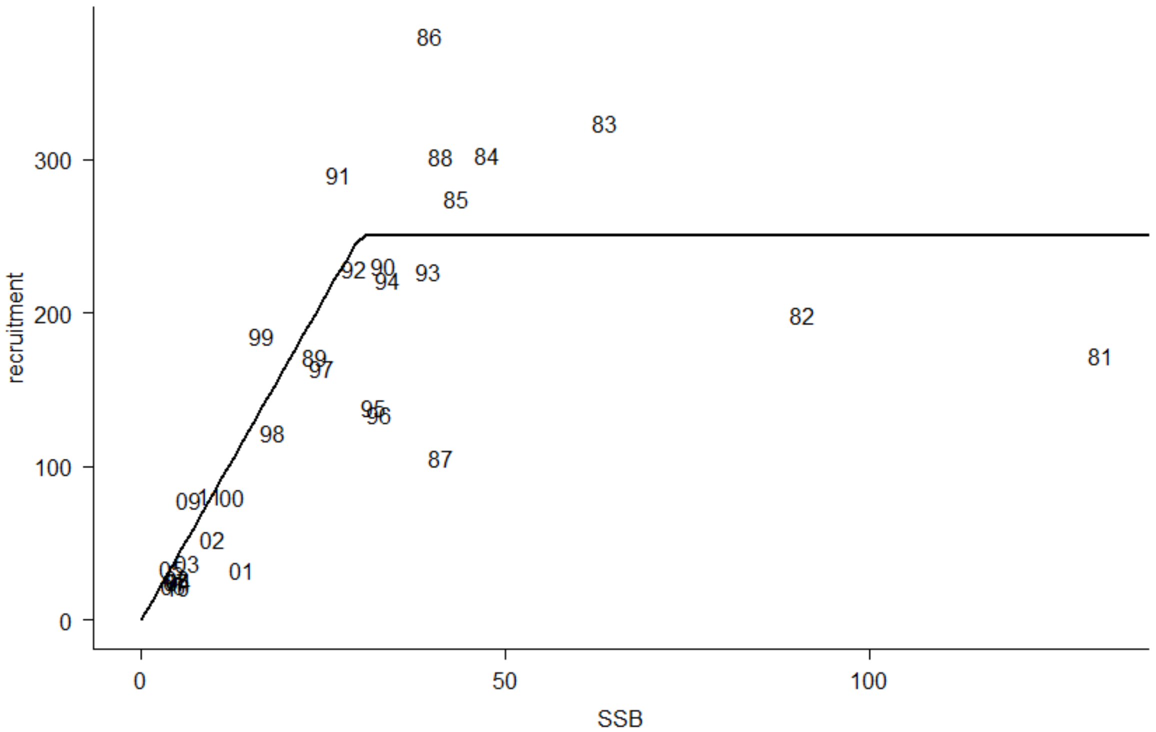


Figure 3.4.13. Whiting in Division VIa. Stock-recruitment relationship (recruitment in millions, SSB in thousand tonnes) from the final TSA run, with points labelled as year classes, and fitted with a "hockey-stick" model (solid line).

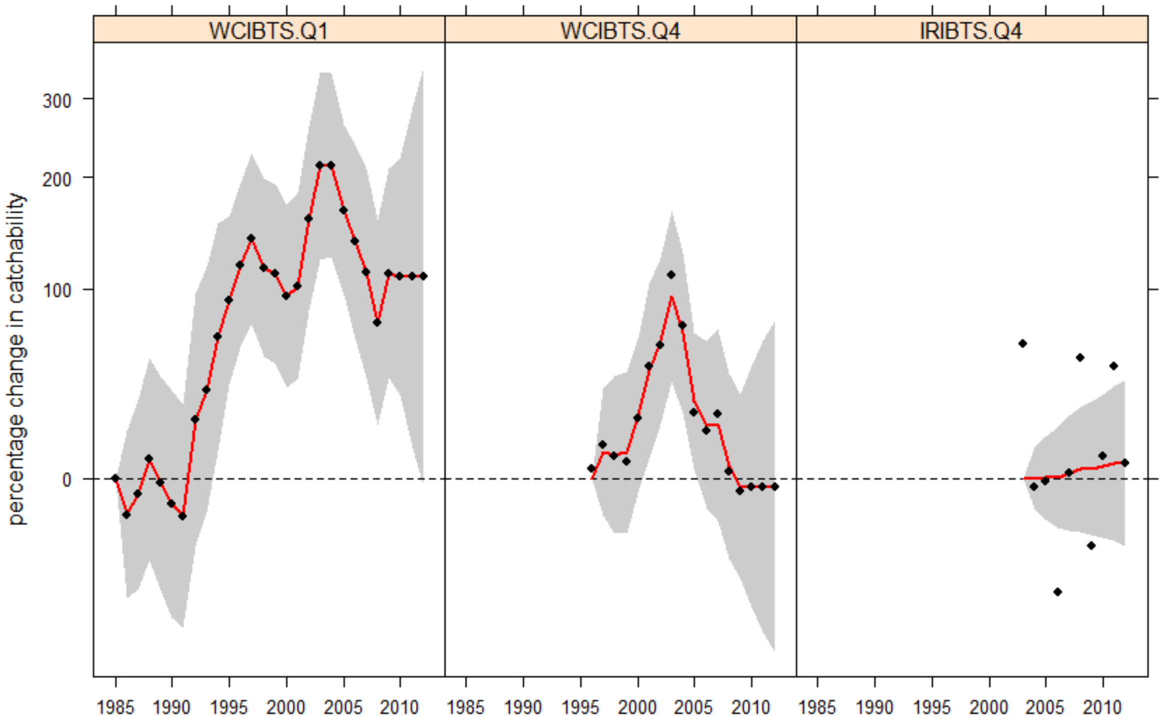


Figure 3.4.14. Whiting in Division VIa. Percentage change in catchability from the final TSA run. Transient changes (points) and the persistent change (solid line) with uncertainty bounds.

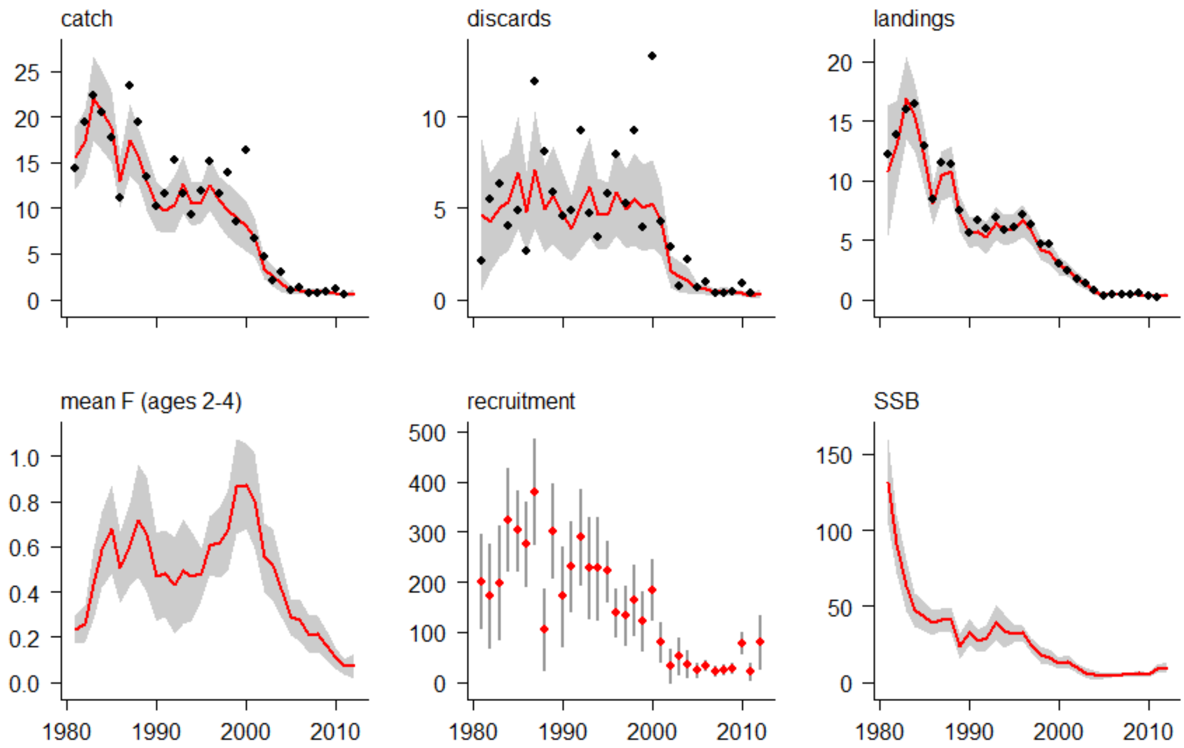


Figure 3.4.15. Whiting in Division VIa. TSA stock summaries from the final TSA run. Catch, landings, discards and SSB in tonnes, recruitment in thousands. Estimates are plotted with approximate pointwise 95% confidence bounds. Dots indicate observed values for catch, landings and discards.

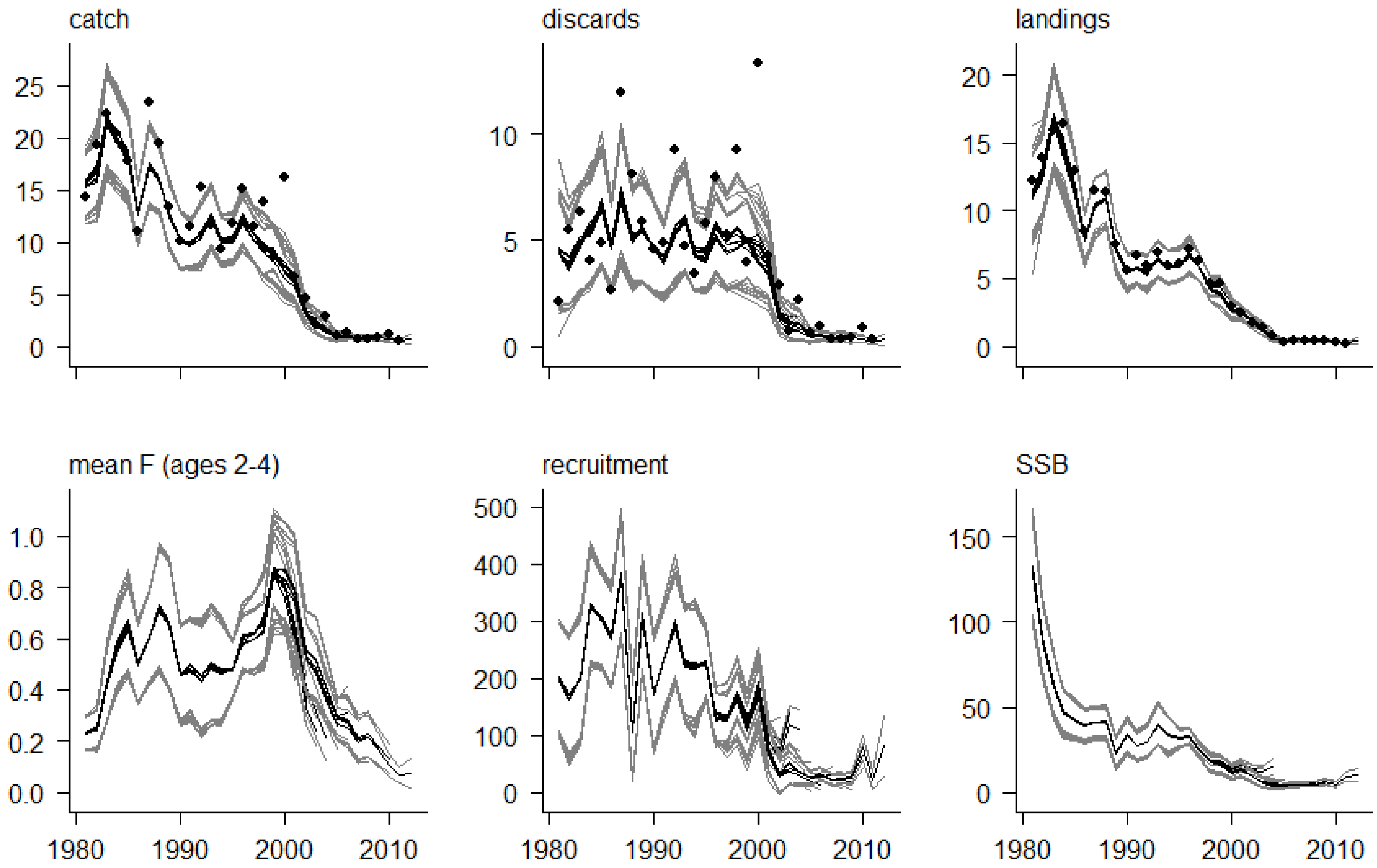


Figure 3.4.16. Whiting in Division VIa. Retrospective plots of TSA run. Black lines show estimates, grey lines show confidence intervals in the respective years.

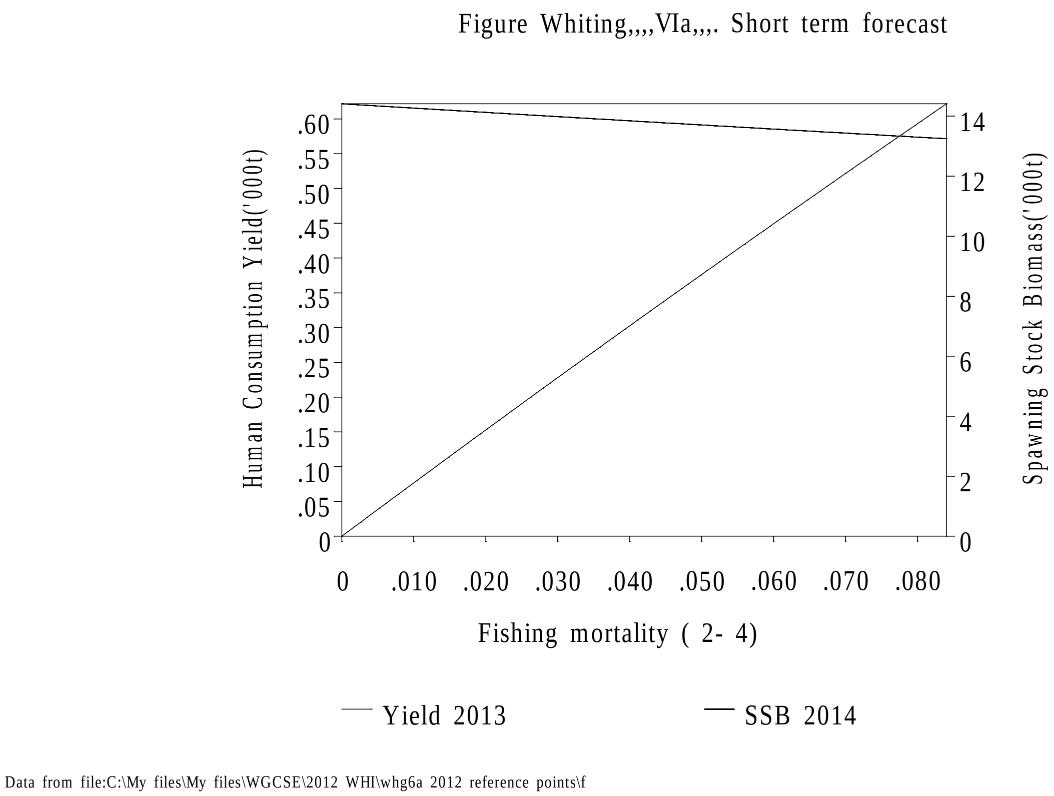


Figure 3.4.17. Whiting in Division VIa. Short-term forecast.

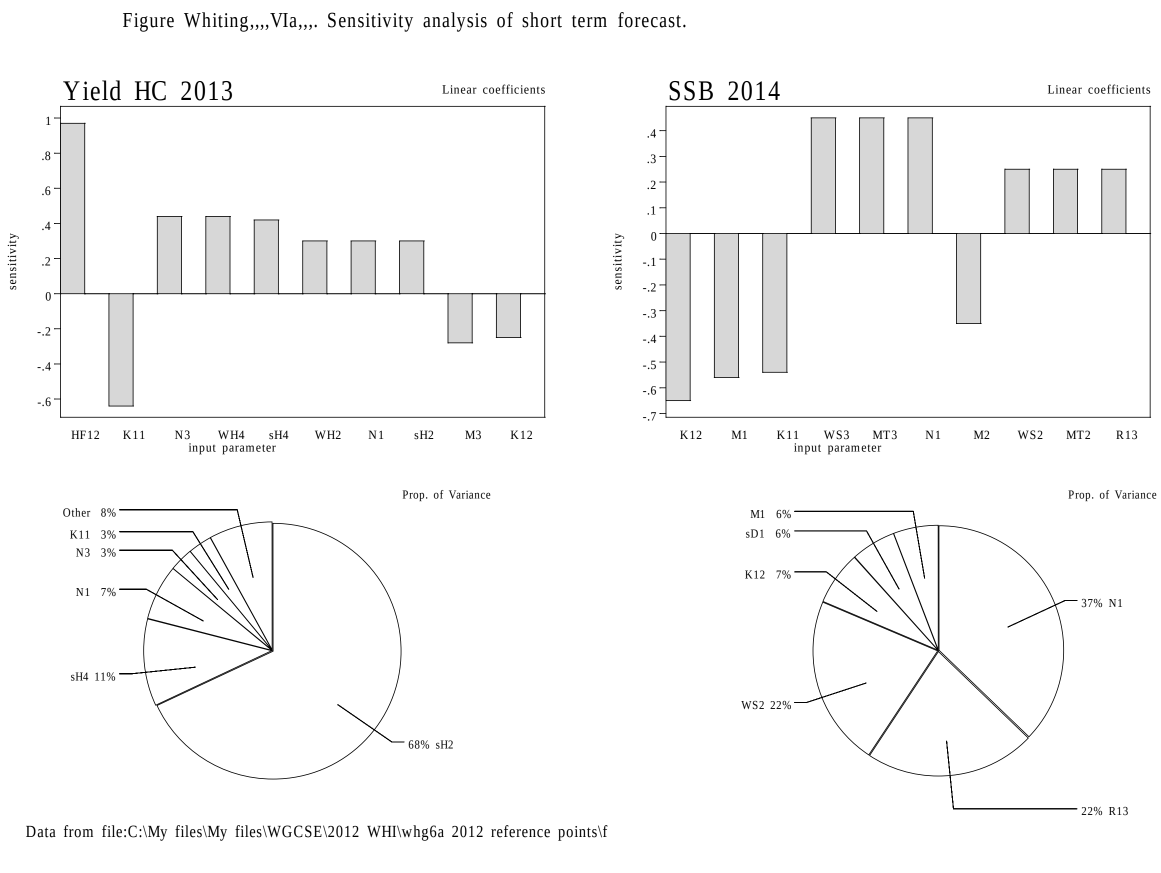


Figure 3.4.18. Whiting in Division VIa. Sensitivity analysis of short-term forecast.

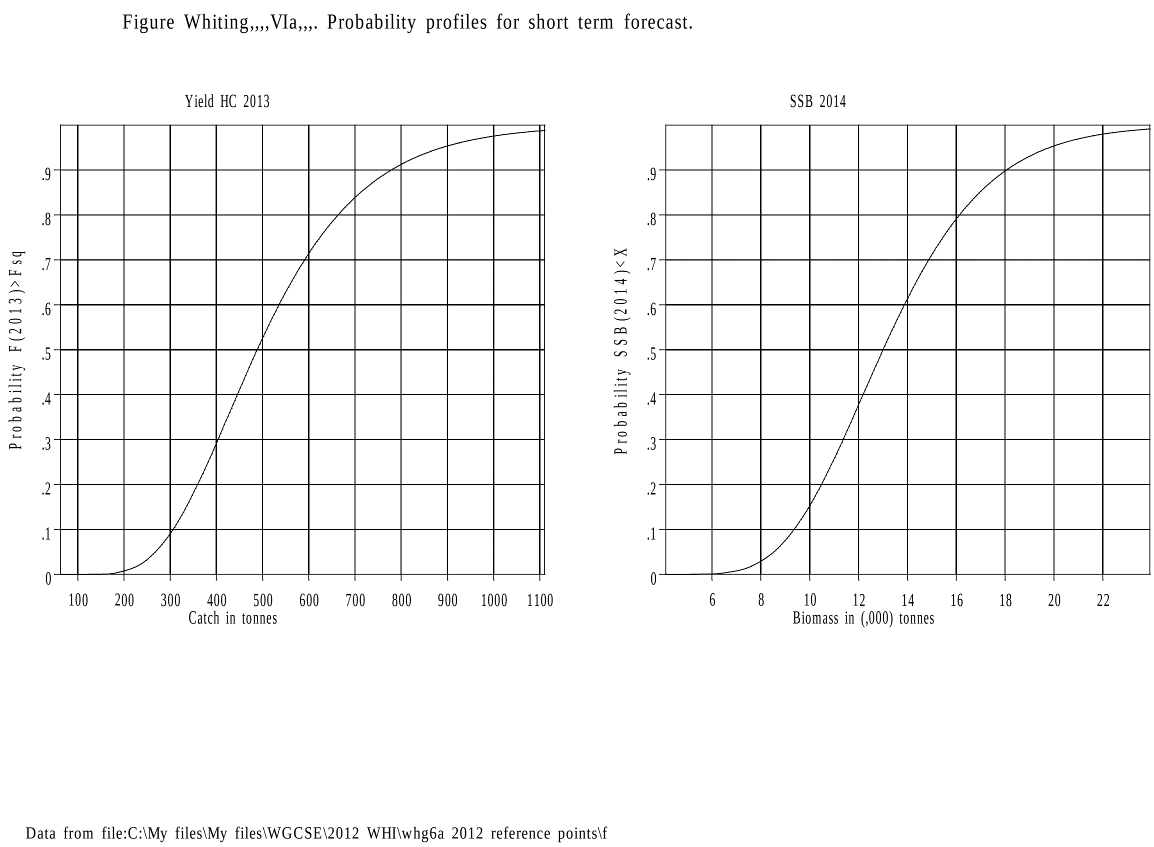


Figure 3.4.19. Whiting in Division VIa. Probability profiles for short-term forecast.

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) 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 collects fishery data (quantities landed and discarded, fishing effort, cpues and lpues, etc.) and length distributions, and at which it performs assessments.

There are three Functional Units in Division VIa, the level at which EU management of *Nephrops* currently takes place. Nominal landings as reported to ICES, along with WG estimates of landings are presented in Tables 3.5.2 and 3.5.3 respectively. Landings are also made from outside the Functional Units, from statistical rectangles where small pockets of suitable sediment exist, these are generally small amounts. There are no Functional Units in Division VIb and only very small quantities of *Nephrops* are landed.

Type of assessment in 2012

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) and described in Section 2.2.

3.5.1 Ecosystem aspects

The North Minch Functional Unit 11 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. The North Minch exhibits the most patchy ground amongst west coast FUs. Very soft sediments are found in the southeast while coarser sandy mud prevails to the north and west. Figure 3.5.9 shows the distribution of sediment in the area.

3.5.2 The fishery in 2011

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; some comments were also received from industry representatives.

The fishery in 2011 was described as being better than previous years with a good fishing season during summer and high demand and good prices for *Nephrops*. The fleet is mainly formed by smaller trawlers working 1–4 day trips from the main ports of Lochinver, Ullapool, Stornoway and Gairloch. The largest part of the North Minch fleets continued to be based at Stornoway, made up of mostly 15 m length vessels, both single-rigged and multi-rigged trawlers. The Barra fleet is more nomadic as the fishing grounds are more exposed which forces the fleet to find shelter on the east side of the North Minch. The Barra vessels are generally bigger than the Stornoway fleet, being all over 15 m in length. Vessels in North Minch have generally continued to fish with the same pattern, not changing the target species as mesh regulations impose that vessels with mesh <80 mm are not allowed to fish for squid in the area.

Most trawlers were landing daily or every second day. By the end of the third quarter in 2011, several boats shifted from Lochinver to the Moray Firth squid fishery. Trawlers are still fishing with 80 mm mesh. In 2009, under the west coast emergency measures a square meshed panel of 120 mm was also required (Council Reg. (EU) 43/2009). Little if any marketable fish bycatch was reported by the boats fishing in the North Minch, this was confirmed during *Nephrops* discard trips on board North Minch boats.

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

3.5.3 ICES advice for 2011 and 2012

ICES advice applicable to 2011:

"Following the ICES MSY framework implies the harvest ratio to be reduced to F_{MSY} 12.5%, resulting in landings of 1900 t in 2011. Following the transition scheme towards the ICES MSY framework implies the harvest ratio should be reduced to 20.1% (0.8 x harvest ratio(F_{2010} 22 %) + 0.2 x harvest ratio(F_{MSY} 12.5%) resulting in landings of 3100 t in 2011."

ICES advice applicable to 2012:

"Following the ICES MSY framework implies the harvest ratio for the North Minch Functional Unit to be less than 12.5%, resulting in landings less than 3200 t in 2012."

3.5.4 Management applicable to 2011 and 2012

Management is at the ICES Subarea level as described at the beginning of Section 3.5. In 2011, ICES again reiterated its advice that *Nephrops* stocks should be managed at the FU level.

3.5.5 Assessment

Conclusions of the Review of the 2011 assessment:

"*The RG considers the Underwater Television Survey (UWTV) and associated catch options to be an appropriate basis for management advice. The RG agrees with the WG that management of this stock should be applied at a local FU level rather than at the ICES division level. The RG agrees with the WG that F35%spr (combined between sexes) is consistent with the approach adopted by the WGCSE for choosing FMSY proxies for Nephrops.*"

The RG report contained some technical comments and attempts have been made to address these.

Approach in 2012

The assessment in 2012 is based on a combination of examining trends in fishery indicators and underwater TV using an extensive dataseries for the North Minch FU 11. The assessment of *Nephrops* 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) and is described in Section 2.2.

The provision of advice in 2012 follows the process defined by the benchmark WG and described in Section 3.5 and attempts to incorporate decisions taken at WKFRAME for the provision of MSY advice by ICES in 2010 (see Section 2.2). The approach was developed based on intersessional work carried out by participants of the benchmark and involving collaboration between WGNSSK and WGCSE. Previous TV based assessments have derived predicted landings by applying a harvest rate approach to populations described in terms of length compositions from the trawl component of the fishery. Creel fishing is an important component of the North Minch fishery and landings from creel vessels have risen since the mid 1990s having been at a stable level since then. Given that creels operate across similar areas to those of the trawl fishery, the assessments from 2010 onwards were performed using combined length compositions from trawl and creels.

The accuracy of the currently used boundaries of what is considered *Nephrops* suitable habitat has been considered a source of uncertainty particularly in highly heterogeneous grounds such those on the west coast of Scotland and particularly in the North Minch where differences between fished area and surveyed area are likely to exist. Marine Scotland Science recent access to Vessel Monitoring System data (VMS) makes it possible to link geographical information on the positioning of vessels to landings data resulting in more detailed information on the spatial distribution of fishing effort in the *Nephrops* trawl fishery. In the 2011 assessment a VMS area (rather than the British Geological Survey sediment area estimate) was used for the first time to raise the burrow counts and produce an overall abundance estimate. Following the acceptance from the WG, this approach is being used again for the 2011 assessment in North Minch. Further details are described in the Research Vessel Data section.

Data available

An overview of the data provided and used by the WG is shown in Table 2.1.

Commercial catch and effort data

Official catch statistics (landings) reported to ICES are shown in Table 3.5.2; these relate to the whole of VI of which the North Minch is a part. Landings by gear category for FU 11 provided through national laboratories are presented in Table 3.5.5. Landings from this fishery are only reported from Scotland. A variety of gear types make landings of *Nephrops*. Total reported landings in 2011 were 2696 tonnes, consisting of 2126 tonnes landed by trawlers and 570 tonnes landed by creel vessels.

Given the concerns about the previously (prior to 2010) presented Scottish effort data (due to non-mandatory recording of hours fished in recent years) and following recommendations made by the RG, effort data in terms of days absent were presented to the WG. Reported effort by all Scottish trawlers has shown a decreasing trend since 2000 (Figure 3.5.3). Recently there was some concern about the method used to store effort data at the Marine Scotland Science internal database. This is related with how the effort is split by statistical rectangle when vessels fish over a wide area. This is more likely to affect North Sea than West coast FUs. However, given that a new effort data extraction became available from another database held in Edinburgh which is thought to be more reliable, these new data is being presented in Figure 3.5.3. Therefore, the effort and lpue time-series range (2000–2011) do not match with the more extensive year range available for landings. This will be addressed before the next assessment and it is expected that the full effort dataseries will be available to the WG in 2013. The new effort data does not change the lpue perception for the North Minch when compared with the data presented last year in the same period.

The introduction of the "buyers and sellers" regulations in the UK in 2006 however, have led to increased reliability in the reported landings. Combined together, the increase in lpue in 2005 is probably reflecting the increase in reported landings rather than a change in stock abundance.

Males consistently make the largest contribution to the landings, although the sex ratio does seem to vary (61% males in 2011; Figure 3.5.4). 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 also prosecuted in all quarters. Females on the other hand are mainly taken in the summer when they emerge after egg hatching.

Discarding of undersized and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 2000. Discarding rates in this FU have varied considerably over the last five years. In 2009 the discard rate almost doubled from 10% to 20% and then decreased in 2010 to 12% followed by a further increase to 14% in 2011 (Table 3.5.10). This pattern is consistent with what was observed in the other FUs in Division VIa. An increase in mean size of smaller (<35 mm) animals (Figure 3.5.3) in 2010 may have contributed to the decrease in discard rate. Other factors related with market prices for *Nephrops* may also contribute for this trend. In 2011 the mean size of smaller animals decreased slightly. 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 rate adjusted for survivorship which is used in the provision of landings options for 2013 was 12.2% based on a three year average.

Length compositions

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Quarterly landings and discards at length data were available from Scotland and these sampling levels are shown in Table 3.5.4. Although assessments based on detailed catch analysis are not presently possible, examination of length compositions can provide a preliminary indication of exploitation effects.

Figure 3.5.5 shows a series of annual length frequency distributions for the period 1979 to 2011. 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 although in 2010 there is some evidence of a slight increase in the mean lengths followed by a decrease in 2011. 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) shows no evidence of reductions in relative numbers of larger animals.

The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35 mm) in the landings (trawl only) shown in Figure 3.5.3 and Table 3.5.6. This parameter might be expected to reduce in size if overexploitation were taking place but there is no evidence of this. The mean size of smaller animals (<35 mm) in the catch (and landings) is also relatively stable through time. The mean weight in the landings (Figure 3.5.6 and Table 3.5.9) shows a clear increase in the last three years. This has a strong effect in the catch forecast and therefore it was considered more appropriate to use a full time average, from 1999 (first year with creel and trawl length distributions combined) until 2011. This is further discussed under "quality of assessment and forecast".

InterCatch

Scottish data for 2011 were successfully uploaded into InterCatch prior the 2012 WG meeting according with the deadline proposed. Uploaded data was worked-up in InterCatch to generate 2011 raised international length–frequency distributions. Further data exploration in InterCatch showed 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 were used in the 2012 assessment.

Natural mortality, maturity-at-age and other biological parameters

Biological parameter values are included in the Stock Annex.

Research vessel data

Underwater TV surveys using a stratified random approach are available for this stock since 1994 (missing surveys in 1995 and 1997). Underwater television surveys of *Nephrops* burrow numbers and distributions, reduce 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. Traditionally, because of the uncertainty in the sediment distribution in the North Minch, the area surveyed has been divided in four arbitrary rectangles roughly corresponding to discrete patches of mud and the burrow densities in the four rectangles raised to the total sediment area in the FU. The sediment distribution around UK is given by the British Geological Survey (BGS) and the estimated area for the North Minch is 1775 km^2. VMS plots (Figure 3.5.9) have shown fishing effort for trawlers (length >15 m) clearly extends outside of the present survey area for FU 11, which would imply an underestimate of the stock area. In the 2008 and 2009 TV surveys, a number of exploratory stations were surveyed on the basis of the newly available VMS data and burrows were identified confirming the presence of *Nephrops* outside the BGS sediment grounds. To account for this, the VMS area was used to generate the sampling stations for the 2010 and 2011 surveys and the burrow densities were raised accordingly. The VMS area to which counts were raised was calculated as the average VMS area of the period 2008–2010 (2506 km^2). The decision not to change the period over which the VMS area was calculated is justified by the stability of the VMS distribution of effort, which is similar to previous years (Figure 3.5.9). In 2011, 41 valid stations were used in the survey final analysis (Table 3.5.8).

Data analyses

Exploratory analyses of survey data

A re-working of the UWTV survey abundances for Division VIa were presented to the *Nephrops* benchmark workshop (WKNEPH) in 2009 (ICES, 2009) and further details of the technical changes to the camera can be found in the report of that workshop. The revised abundance estimates for FU 11 from 1999 onwards were presented for the first time at WGCSE 2009 and are slightly higher than the previous values due to the field of view being smaller than previously calculated.

Table 3.5.7 shows the basic analysis for the three most recent TV surveys conducted in FU 11. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. From 2010 onwards, a single strata based on VMS was applied do calculate the overall abundance. The area calculation method is based in the alpha convex-hull method to define and characterize the overall shape of a set of points and is described in the 2010 SGNEPS report (ICES, 2010). From the work presented at the 2012 SGNEPS meeting (report still in draft form) it was decided by the group that a CV (relative standard error) of <20% was an acceptable precision level for UWTV survey estimates of abundance. CVs for the three most recent TV surveys (Table 3.5.7) are lower than the precision level agreed. Figure 3.5.7 shows the distribution of stations in recent TV surveys (2006–2011), with the size of the symbols reflecting the *Nephrops* burrow density. Table 3.5.7 and Figure 3.5.8 show the time-series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates. A correction ratio calculated as 1.41 (VMS area/Sediment area) was applied to the previous sediment abundance estimates to get a rough measure of the abundance raised to the VMS area (Table 3.5.8 and Figure 3.5.8).

The use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009). A number of potential biases were highlighted including those due to edge effects, species burrow misidentification and burrow occupancy. The cumulative bias correction factor estimated for FU11 was 1.33 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 33%.

FU	Area	Edge effect	detection rate	species identification	Occupancy	Cumulative bias
11	North Minch	1.38	0.85	1.1	1	1.33

Final assessment

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. The details of the 2011 survey are shown in Table 3.5.7 with the 2009 and 2010 outcomes. 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. The VMS calculated abundances for 2010 and 2011 presented at this meeting are not directly comparable with the previous 2009 estimate used for the advice. The abundance in 2011 (1979 million) shows a 33% increase and the confidence limits are close to those calculated for the 2010 survey.

The TV survey results reported here do not cover the sea loch areas adjacent to the main North Minch grounds and should therefore be considered underestimates of the overall biomass. The sea lochs support a significant but unknown percentage of the creel fishery. This issue is discussed further under quality of assessment.

3.5.6 Historic stock trends

The TV survey estimates of abundance for *Nephrops* in the North Minch suggest that historically the population increased until 2003 at which time it has fluctuated around the maximum value until 2006 when it declined for two years before. More recently, the increase in the estimated abundance for the last three years depicts the stocks at similar abundance to those observed in the mid 2000s. The bias adjusted abundance estimates from 1999–2011 (the period over which the survey estimates have been revised) are shown in Table 3.5.10. A new series with the VMS calculated abundance estimated for previous years was added to the table. In 2011, the stock is estimated to be at 1488 million individuals (bias adjusted value). Table 3.5.10 also shows the estimated harvest ratios over this period. It is likely that prior to 2006, the estimated harvest ratios may not be representative of actual harvest ratios due to underreporting of landings).

3.5.7 MSY considerations

A number of potential F_{MSY} proxies are obtained from the per-recruit analysis for *Nephrops* and these are discussed further in Section 2.2 of this report. The analysis assumes the same input biological parameters as used at the benchmark meeting in 2009 and an exploitation and discard ogive for trawl and creel caught *Nephrops* generated in 2010 for the years 2008–2009. The complete range of the per-recruit F_{MSY} proxies is given in the text table below and the process for choosing an appropriate F_{MSY} proxy is described in Section 2.2. All F_{MSY} proxy harvest rate values remain preliminary and may be modified following further data exploration and analysis.

For this FU, the absolute density observed on the UWTV survey is intermediate (based on the guideline categories suggested in Section 2.2) with an average of just over 0.59 m^{-2} suggesting the stock may have a medium productivity capability. Historical harvest ratios in this FU have been above that equivalent to fishing at F_{MAX} and landings have been relatively stable in the last thirty years. $F_{35\%SpR}$ (combined between sexes) is also estimated to be at F_{MAX}. For these reasons, the working group considered that **F35%SpR (combined between sexes) deliver high long-term yield with a low probability of recruitment overfishing and therefore is chosen as a proxy for F_{MSY}.**

			F_{bar}(20-40 mm)			SPR (%)		
		F_{mult}	M	F	HR (%)	M	F	T
$F_{0.1}$	M	0.20	0.14	0.05	7.4	39.7	69.2	50.6
	F	0.65	0.44	0.15	19.8	13.0	38.0	22.2
	T	0.24	0.16	0.06	8.7	34.6	65.0	45.8
F_{MAX}	M	0.36	0.24	0.08	12.2	24.3	54.4	35.4
	F	1.49	1.01	0.34	37.2	4.7	18.2	9.6
	T	0.52	0.35	0.12	16.6	16.7	44.2	26.8
$F_{35\%SpR}$	M	0.24	0.16	0.06	8.7	34.6	65.0	45.8
	F	0.73	0.49	0.17	21.7	11.4	34.9	20.0
	T	0.37	0.25	0.09	12.5	23.6	53.7	34.7

3.5.8 Landings forecasts

Landings prediction for 2013 based on principles established at the Benchmark Workshop WKNEPH (ICES 2009) and using the revised approach based on various proxies for F_{MSY} (Dobby, 2009) outlined in the introductory Section 2.2 was made for the North Minch. The text table below shows landings predictions at various harvest ratios, including a selection of those equivalent to the per-recruit reference points discussed in Section 2 of this report. The harvest ratio in 2011 is calculated using input parameters agreed at WKNEPH (ICES 2009). Inputs to the catch options table are the mean weight in landings (1999–2011), the average dead discard rate (2009–2011) and the survey bias for this FU. The landings prediction for 2013 at the F_{MSY} proxy harvest ratio is 4160 tonnes. There is no transition stage since the current harvest rate is below the F_{MSY} proxy. The inputs to the landings forecast were as follows:

Mean weight in landings (1999–2011) = 25.47 g

Dead discard rate (2009–2011) = 12.2%

Survey bias = 1.33

	Harvest rate	Survey Index (adjusted)	Implied fishery Retained number	Implied fishery Landings (tonnes)
F_{MSY}	12.5%	1488	163	4160
F_{2011}	7.3%	1488	95	2429
$F_{0.1(T)}$	8.7%	1488	114	2895
$F_{35\%SpR(T)}$	12.5%	1488	163	4160
$F_{MAX\,(T)}$	16.6%	1488	217	5525

Note: No F_{MSY} transition required as F_{2011} is below F_{MSY}.

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

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

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

A discussion of F_{MSY} reference points for *Nephrops* is provided in Section 2.2.

3.5.9 Biological reference points

Precautionary approach biological reference points have not been determined for *Nephrops* stocks. The $B_{trigger}$ point for this FU (bias adjusted lowest observed UWTV abundance corrected for the VMS area increase) is calculated as 465 million individuals.

3.5.10 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. From 2010 combined trawl and creel length compositions are used to account for the fact that the creel fishery accounts for over 21% 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 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. Effort data for years 2000–2011 extracted from another database was presented to the WG for the first time in 2012. This new effort data is considered to be more accurate and improved the estimates of lpue although it did not change its interpretation compared with what was presented in previous years. This new effort data is expected to be extended to the full dataseries in 2013.

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 quite small for this functional unit. There is a gap of 18 months between the survey and the start of the year for which the assessment is used to set management levels. It is assumed that the stock is in equilibrium during this period (i.e. recruitment and growth balance mortality) although this is rarely the case. The effect of this assumption on realised harvest rates has not been investigated.

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 (2009–2011) of discard rate (adjusted to account for some survival of discarded animals) have been used in the calculation of catch options. The recent observed discard rate shows a decline in 2010 and 2011 compared to previous years. This is discussed in Section 3.5.5 under "commercial catch and effort data". The cumulative bias estimates for FU 11 are largely based on expert opinion (See 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 has been increased in 2011 using integrated VMS-logbook data to more accurately estimate the spatial extent of *Nephrops* catches. Two other factors however, are likely 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, 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. The current stock area can be therefore considered a minimum estimate.

Recommendation for next benchmark

This stock is scheduled for a benchmark assessment in 2013. Issues common to *Nephrops* stocks assessed using UWTV surveys will be addressed such as the uncertainty associated with forecast inputs (mean weight in landings and discard rates).

It is known that most of the sea lochs to the east of the North Minch FU have grounds of mud substrate that are typically fished by creel boats. Recent work using VMS has refined the overall estimate of the North Minch area. However, the survey should still be considered as a minimum estimate since areas of suitable sediment in the sea lochs are not included. In recent years, limited TV surveys have taken place in some of the sea lochs and attempts are being made to utilize these data to improve estimates of mud area and *Nephrops* abundance. In the sea lochs there is a risk of entanglement of the TV survey gears with creels fishing in the grounds; therefore the survey methodology has to be modified. A drop frame consisting of a vertically mounted camera suspended and drifted across the survey area has been used in trials recently. This has an implication on the field of view and alternative methods have to be used to work-up the data to calculate *Nephrops* burrow densities.

The creel fishery in the North Minch takes place mainly in the sea-loch areas, but has recently extended also to further offshore. The discard practices in this component of the fleet have not been studied and included in the assessment. Some creel discard observer data is available and an analysis of these data is required.

3.5.11 Status of the stock

The evidence from the TV survey suggests that the population is at a similar level to that observed between 2003 and 2006. In 2011 a 33% increase in abundance was observed. The calculated harvest ratio in 2011 (dead removals/TV abundance) is below the values associated with high long-term yield and low risk depletion.

3.5.12 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 VIa 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 under the Scottish Conservation Credits scheme and west coast emergency measures include the implementation of larger meshed square meshed panels (120 mm).

The implementation of buyers and sellers legislation in the UK in 2006 has improved the reliability of fishery statistics but the transition period was accompanied in some cases by large changes in landings which produce significant changes in the lpue and cpue series that cannot be completely attributed to changes in stock. Until a sufficient time-series of reliable data has built up, use of fishery catch and effort data in the assessment process should be avoided.

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Table 3.5.1. *Nephrops* Functional Units and descriptions by statistical rectangle.

Functional Unit	Stock	Division	ICES Rectangles
11	North Minch	VIa	44–46 E3–E4
12	South Minch	VIa	41–43 E2–E4
13	Clyde	VIa	39–40 E4–E5
14	Irish Sea East	VIIa	35–38E6; 38E5
15	Irish Sea West	VIIa	36E3; 35–37 E4–E5; 38E4

Table 3.5.2. Nominal catch (tonnes) of *Nephrops* in Division VIa and VIb, 1980–2011, as officially reported to ICES. There are no Functional Units in ICES Division VIb but occasional small landings are made.

VIa Official Landings

	France	Ireland	Spain	UK-(Engl+Wales+N.Irl)	UK-Scotland	UK	TOTAL
1980	5	1	-	-	7,422	-	7,428
1981	5	26	-	-	9,519	-	9,550
1982	1	1	-	1	9,000	-	9,003
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	9,941	-	10,364
2005	-	153	17	153	7,616	-	7,939
2006	-	133	1	255	13,419	-	13,808
2007	-	155	-	2,088	14,120	-	16,363
2008	-	56	1	419	14,795	-	15,271
2009	-	53	-	1,226	11,462	-	12,741
2010	-	45	1	1,962	10,250	-	12,258
2011*	-	-	-	-	-	-	12,941

*** Figures are provisional.**

VIb Official Landings

	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

*** Figures are provisional.**

Table 3.5.3. *Nephrops*, Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1981–2011.

Year	FU11	FU12	FU13	Other	Total
1981	2861	3651	2968	39	9519
1982	2799	3552	2623	27	9001
1983	3196	3412	4077	34	10719
1984	4144	4300	3310	36	11790
1985	4061	4008	4285	104	12458
1986	3382	3484	4341	89	11296
1987	4083	3891	3007	257	11238
1988	4035	4473	3665	529	12702
1989	3205	4745	2812	212	10974
1990	2544	4430	2912	182	10068
1991	2792	4442	3038	255	10527
1992	3560	4237	2805	248	10849
1993	3192	4455	3342	344	11332
1994	3616	4415	2629	441	11101
1995	3656	4680	3989	460	12785
1996	2871	3995	4060	239	11165
1997	3046	4345	3618	243	11252
1998	2441	3730	4843	157	11171
1999	3257	4051	3752	438	11498
2000	3246	3952	3419	421	11038
2001	3259	3992	3182	420	10853
2002	3440	3305	3383	397	10525
2003	3268	3879	3171	433	10751
2004	3135	3868	3025	403	10431
2005	2984	3841	3423	254	10502
2006	4160	4554	4778	241	13733
2007	3968	5451	6495	420	16334
2008	3799	5347	5997	128	15271
2009	3497	4282	4777	185	12741
2010	2263	3725	5701	569	12258
2011*	2696	3703	6431	111	12941

*** Provisional.**

Table 3.5.4. *Nephrops*. Sampling levels all FUs in VIa.

IMS data only	2009	2010	2011
No. *Nephrops* Samples	133	106	143
No. *Nephrops* measured	74261	58197	71076
Discard data only	2009*	2010*	2011*
No. *Nephrops* Samples	25	22	19
No. Marketable *Nephrops* measured	46223	31315	30474
No. Discards Measured	13549	8941	9293

Table 3.5.5. *Nephrops*, North Minch (FU11), Nominal Landings of *Nephrops*, 1981–2011.

	UK Scotland		
Year	Trawl landings	Creel	Total**
1981	2490	371	2861
1982	2428	371	2799
1983	2879	317	3196
1984	3610	534	4144
1985	3353	708	4061
1986	2845	537	3382
1987	3601	482	4083
1988	3598	437	4035
1989	2715	490	3205
1990	2075	469	2544
1991	2353	439	2792
1992	3128	432	3560
1993	2784	408	3192
1994	3162	454	3616
1995	3124	532	3656
1996	2502	369	2871
1997	2655	391	3046
1998	2090	351	2441
1999	2847	410	3257
2000	2723	523	3246
2001	2692	567	3259
2002	2854	586	3440
2003	2651	617	3268
2004	2425	710	3135
2005	2285	699	2984
2006	3463	697	4160
2007	3378	590	3968
2008	3242	557	3799
2009	2884	613	3497
2010	1723	540	2263
2011*	2126	570	2696

*** Provisional. Na = not available.**

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

Table 3.5.6. *Nephrops*, North Minch (FU 11): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1981–2011.

	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
Year	Males	Females	Males	Females	Males	Females
1981	30.2	29.3	30.6	30.2	39.2	37.6
1982	29.8	28.6	30.1	29.0	39.8	37.4
1983	29.0	27.6	29.1	27.5	40.0	37.8
1984	28.5	28.0	28.5	28.1	39.2	37.4
1985	27.9	27.5	27.9	27.5	40.0	37.5
1986	29.5	28.4	29.7	28.6	39.1	37.6
1987	29.6	29.0	29.9	29.6	39.8	37.9
1988	29.9	29.5	30.3	30.1	38.9	38.0
1989	29.0	29.0	29.2	29.2	40.1	38.9
1990	29.3	28.6	29.8	28.9	39.1	38.1
1991	30.3	29.1	30.6	29.5	39.4	39.1
1992	29.3	28.0	29.7	28.3	39.6	38.3
1993	29.4	27.9	29.5	28.0	38.7	38.3
1994	28.1	27.0	29.4	28.3	39.5	38.8
1995	27.7	27.7	28.6	29.0	40.0	38.2
1996	29.5	29.4	30.2	30.2	40.0	38.7
1997	29.1	28.4	29.9	28.8	39.4	38.0
1998	29.8	28.8	30.6	29.3	39.6	38.4
1999	28.9	28.2	30.1	29.1	39.4	37.5
2000	29.9	28.6	30.4	29.0	39.4	37.8
2001	29.4	28.1	30.3	28.8	39.8	38.2
2002	29.2	28.4	30.4	29.5	39.7	38.3
2003	29.0	28.3	30.3	29.6	39.2	37.8
2004	29.6	28.9	30.4	29.5	40.3	38.8
2005	28.4	27.8	30.1	30.0	39.4	37.8
2006	29.0	27.4	30.5	28.9	39.1	38.2
2007	30.0	28.3	30.0	28.2	40.3	38.7
2008	29.6	28.3	30.1	28.8	40.0	38.5
2009	28.6	27.0	29.9	28.0	40.8	39.3
2010	30.2	28.8	31.2	29.5	40.7	39.8
2011*	28.6	28.3	29.7	29.4	41.2	39.3

*** Provisional. NA = not available.**

Table 3.5.7. ***Nephrops*, North Minch (FU 11): Results of the 2009–2011 TV surveys. Note that stratification in 2009 was based on a series of arbitrary rectangles (U, V, W, X).**

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)
2009 TV survey								
U	656	9	0.39	0.03	255	1476	0.174	
V	425	6	0.60	0.08	255	2251	0.266	
W	563	8	0.54	0.12	306	4644	0.549	
X	131	3	1.17	0.02	153	93	0.011	
Total	1775	26			969	8464	1	0.089
2010 TV survey*								
VMS	2506	37	0.592	0.103	1483	17494	1	
Total	2506	37			1483	17494	1	0.089
2011 TV survey*								
VMS	2506	41	0.79	0.11	1979	16855	1	
Total	2506	41			1979	16855	1	0.066

*** From 2010 survey estimates are based on the VMS area.**

Table 3.5.8. ***Nephrops*, North Minch (FU 11): Results of the 1994–2011 TV surveys (not adjusted for bias).**

Year	Number of valid stations	Mean density	Abundance (Sediment)	95% confidence interval (sediment)	Abundance (VMS)	95% confidence interval (VMS)
		burrows/m²	millions	millions	millions	millions
1994	41	0.38	665	99	938	-
1995	No survey					
1996	38	0.25	439	62	619	-
1997	No survey					
1998	38	0.41	728	103	1026	-
1999	36	0.36	644	119	908	-
2000	39	0.53	946	109	1334	-
2001	56	0.50	886	108	1249	-
2002	37	0.61	1084	121	1528	-
2003	41	0.80	1420	171	2002	-
2004	38	0.80	1420	142	2002	-
2005	41	0.70	1249	133	1761	-
2006	30	0.81	1429	134	2015	-
2007	36	0.55	978	122	1379	-
2008	41	0.48	848	127	1196	-
2009	26	0.55	969	184	1366	-
2010	37	0.59	-	-	1483	265
2011	41	0.79	-	-	1979	260

Table 3.5.9. *Nephrops* mean weight in the landings (FU 11–13).

Year	FU 11	FU 12	FU13 Firth of Clyde	FU13 Sound of Jura
1990	21.31	19.90	24.21	
1991	25.28	21.65	20.57	
1992	21.58	24.01	25.08	
1993	20.70	21.16	29.40	
1994	23.38	24.88	25.22	
1995	22.16	21.87	19.14	
1996	26.63	23.02	21.60	
1997	21.62	23.28	24.14	
1998	23.57	22.09	18.04	
1999*	22.7	25.14	16.88	
2000	24.19	27.3	19.82	
2001	25.33	23.79	19.45	
2002	25.93	26.83	16.3	
2003	26.03	27.86	19.16	
2004	25.16	27.37	18.81	16.90
2005	27.65	28.11	17.97	15.47
2006	24.52	26.24	19.28	15.05
2007	23.61	23.95	19.05	19.02
2008	23.81	23.84	16.42	21.60
2009	25.34	23.79	18.09	25.58
2010	29.33	25.79	21.16	17.13
2011	27.56	31.10	19.34	na
Mean (2009–2011)	27.41	26.89	19.53	21.44

*** From 1999 onwards mean weights are shown for trawl and creels combined except for Sound of Jura where there are no creel sampling available**

Table 3.5.10. *Nephrops*, North Minch (FU 11): 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 (millions)	Harvest ratio VMS	Harvest ratio sediment	Landings (tonnes)	Discard (tonnes)	Discard rate	Dead discard rate	Mean weight in landings (g)
1999	145	28	164	484	683	24.0	33.8	3257	275	16.4	12.8	22.7
2000	133	10	141	711	1003	14.1	19.9	3246	98	6.9	5.2	24.19
2001	130	17	141	666	939	15.0	21.2	3259	161	11.7	9.1	25.33
2002	132	28	153	815	1149	13.3	18.7	3440	276	17.6	13.8	25.93
2003	127	30	148	1068	1505	9.8	13.8	3268	303	19.2	15.2	26.03
2004	123	18	136	1068	1505	9.0	12.7	3135	203	13.0	10.1	25.16
2005	108	51	144	939	1324	10.9	15.3	2984	514	32.0	26.1	27.65
2006	171	74	223	1074	1515	14.7	20.7	4160	762	30.3	24.6	24.52
2007	170	12	177	735	1037	17.1	24.1	3968	216	6.5	5.0	23.61
2008	162	19	173	638	900	19.2	27.1	3799	198	10.5	8.1	23.81
2009	145	37	164	729	1027	16.0	22.5	3497	344	20.3	16.0	25.34
2010	77	11	85	-	1115	7.6	-	2263	121	12.4	9.6	29.33
2011	96	16	108	-	1488	7.3	-	2696	154	14.2	11.0	27.56

Average***

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

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

***** Dead discard average: 2009–2011; Mean weight in landings average: 1999–2011.**

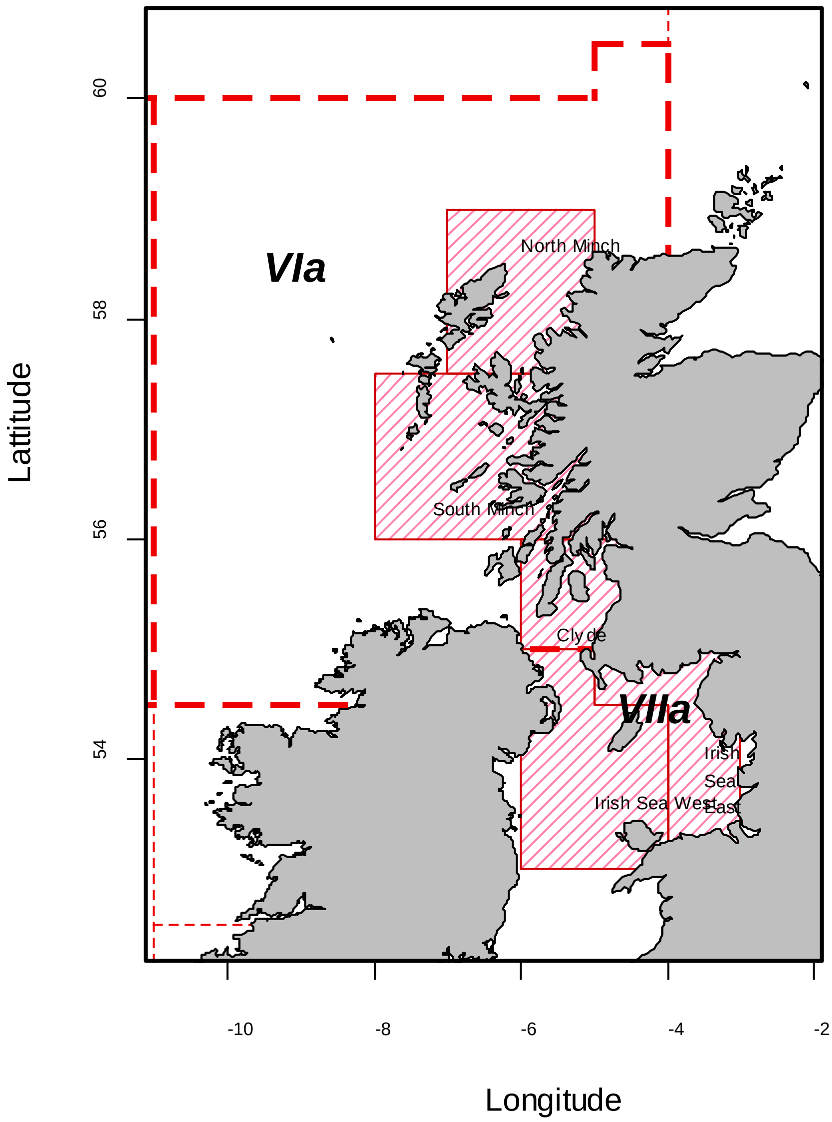

Figure 3.5.1. ***Nephrops*** **Functional Units in VIa and VIIa. North Minch (FU11), South Minch (FU12), Clyde (FU13), Irish Sea East (FU14) and Irish Sea West (FU15).**

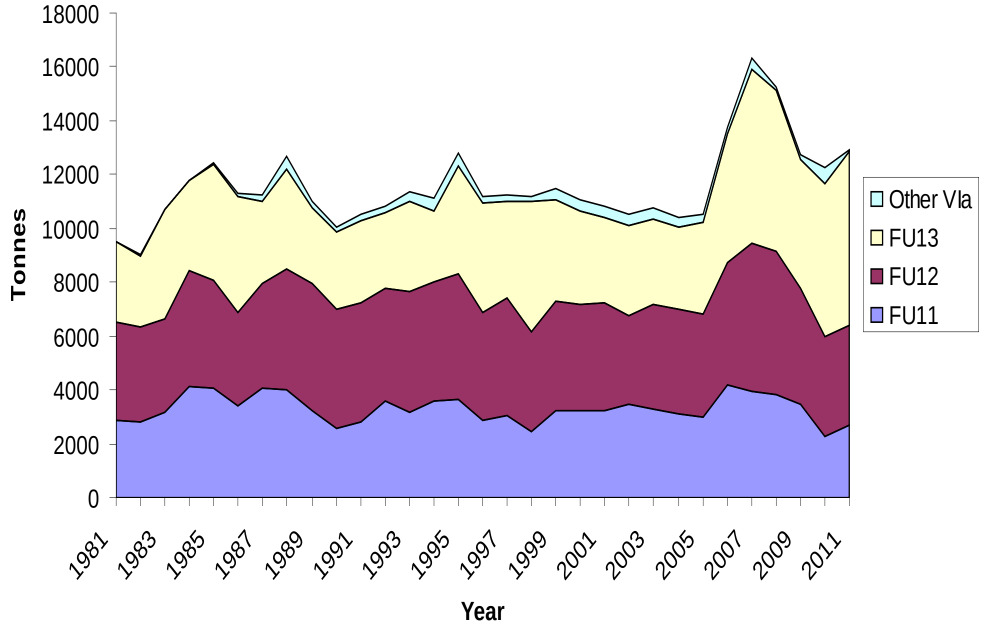

Figure 3.5.2. *Nephrops* in Division VIa. Landing (thousands tonnes) by FU and other rectangles.

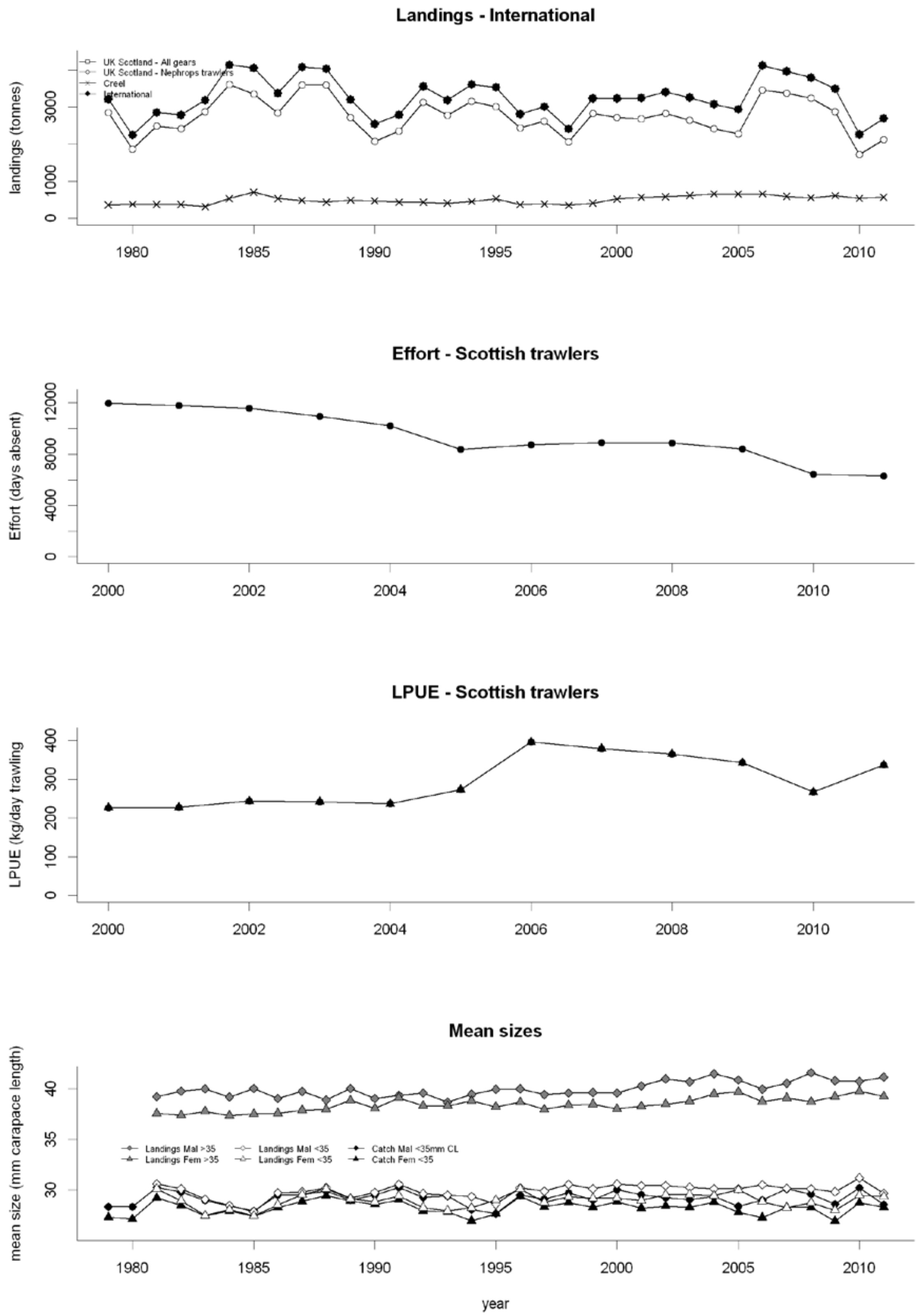

Figure 3.5.3. ***Nephrops*, North Minch (FU11). Long-term landings, effort, lpue and mean sizes. The interpretation of the lpue series is likely to be affected by the introduction of the "buyers and sellers" regulations in 2006.**

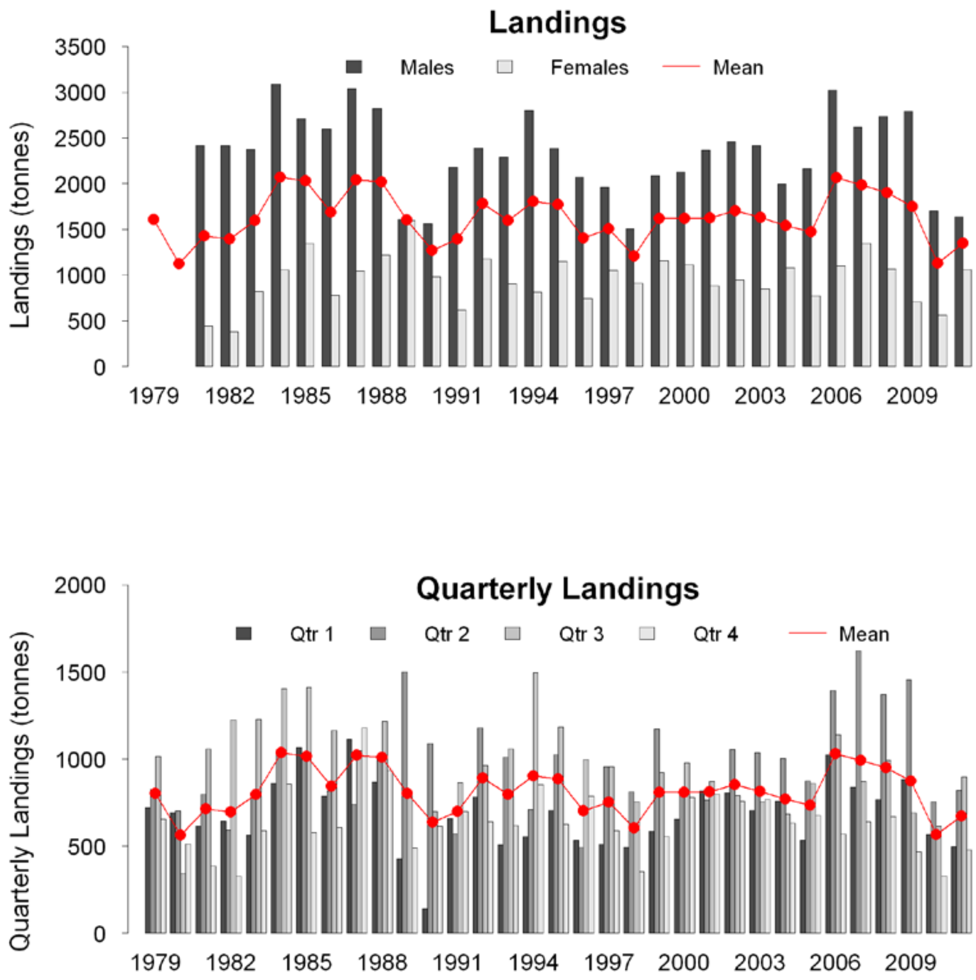

Figure 3.5.4. ***Nephrops,*** **North Minch (FU11), Landings by quarter and sex from Scottish trawlers.**

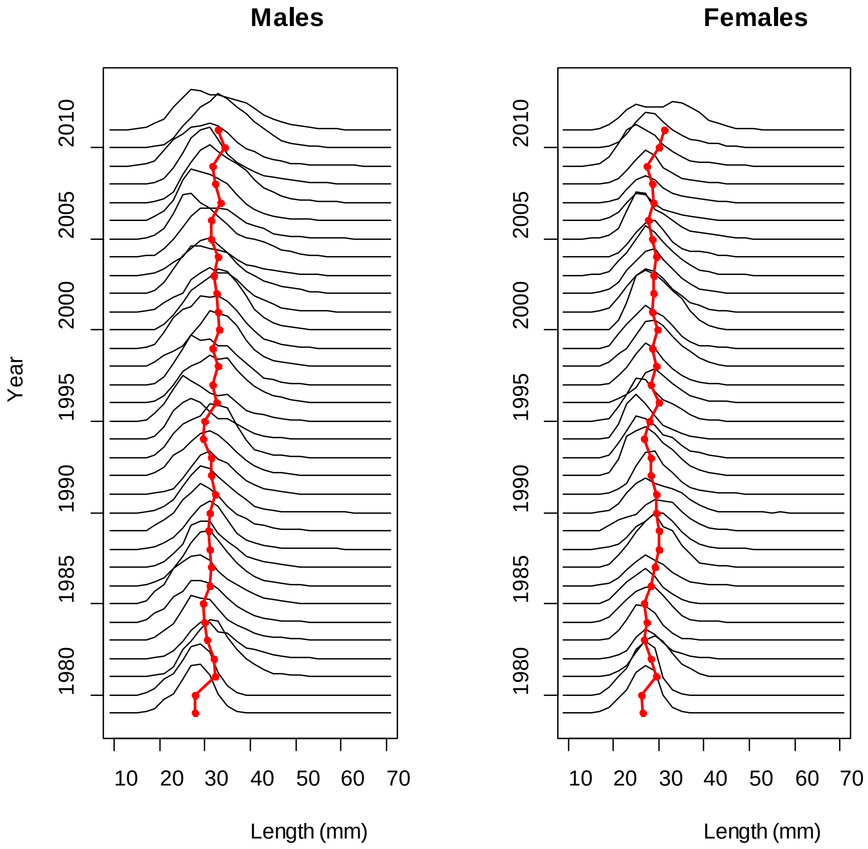

Figure 3.5.5. ***Nephrops*****, North Minch (FU11), Catch length frequency distribution and mean sizes (red line) for *Nephrops* in the North Minch, 1979–2011.**

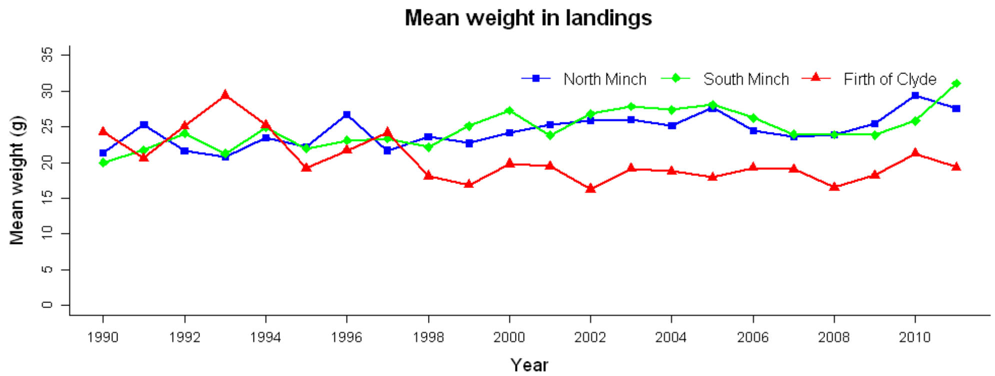

Figure 3.5.6. ***Nephrops*****, (FU 11-North Minch, FU 12-South Minch and FU 13-Clyde), individual mean weight in the landings from 1990–2011 (from Scottish market sampling data).**

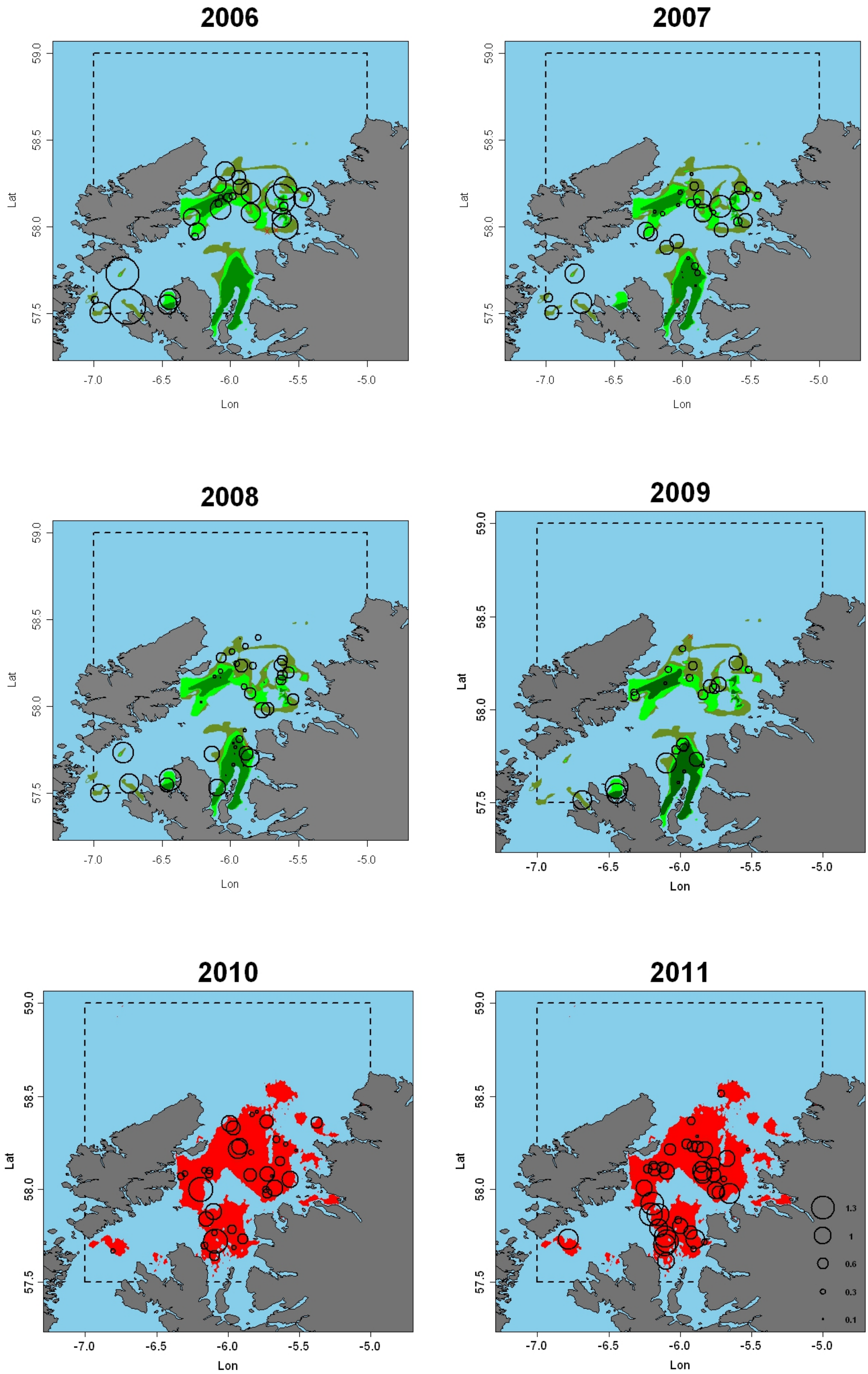
2006
2007
2008
2009
2010
2011
Lat
Lon
59.0
58.5
58.0
57.5
-7.0
-6.5
-6.0
-5.5
-5.0
1.3
1
0.6
0.3
0.1

Figure 3.5.7. ***Nephrops*****, North Minch (FU11), TV survey station distribution and relative density (burrows/m²), 2006–2011. Shaded green and brown areas represent areas of suitable sediment for *Nephrops*. Bubbles in these figures are all scaled the same. Crosses represent zero observations.**

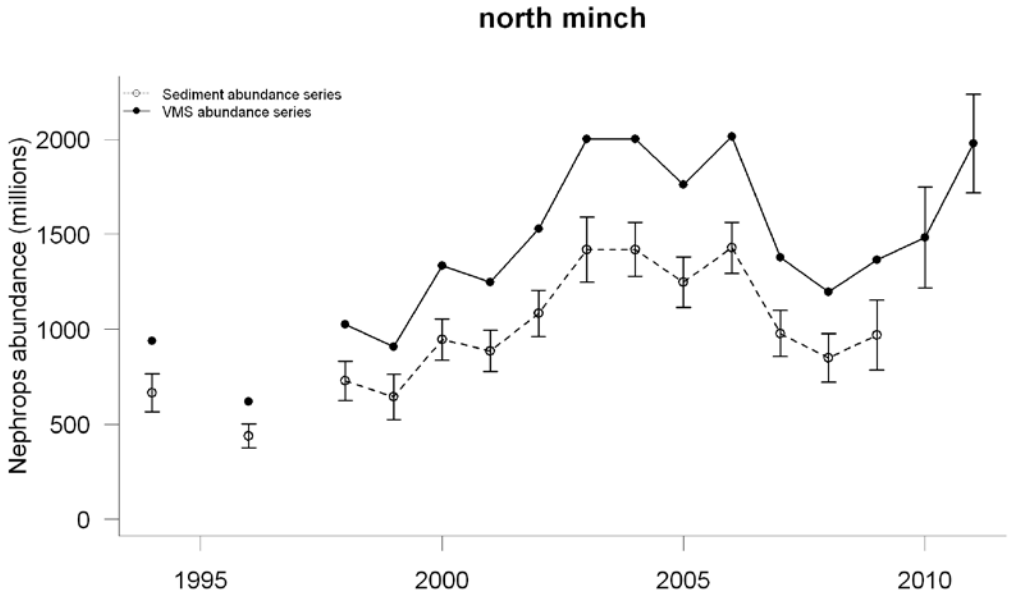

Figure 3.5.8. ***Nephrops*****, North Minch (FU11), time-series of revised TV survey abundance estimates (not adjusted for bias), with 95% confidence intervals, 1994–2011 (no survey in 1995 and 1997). The dashed and solid lines are the abundance estimated raised to the sediment area and VMS area, respectively.**

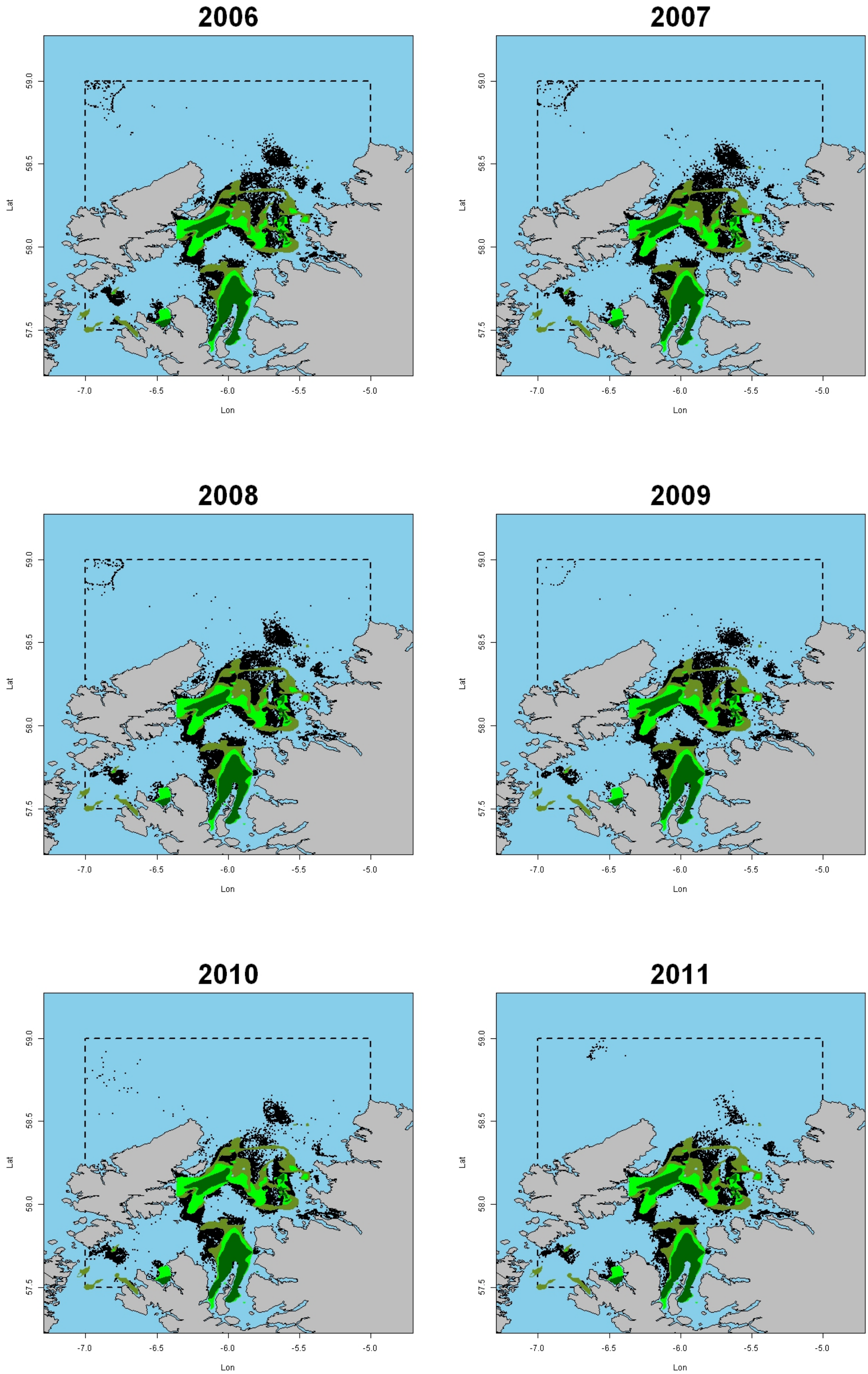
2006
2007
2008
2009
2010
2011
Lat
Lon
59.0
58.5
58.0
57.5
-7.0
-6.5
-6.0
-5.5
-5.0

Figure 3.5.9. *Nephrops*, North Minch (FU11), comparison of area of *Nephrops* ground defined by BGS sediment distribution (green shaded overlay) and by distribution of VMS pings (shown by black dots, underlay) recorded from *Nephrops* trawlers >15 m length for 2006–2011. VMS data filtered to exclude vessel speeds >4.5 knots.

3.6 South Minch, FU12

Type of assessment in 2012

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) and described in Section 2.2.

3.6.1 Ecosystem aspects

The South Minch Functional Unit 12 is located midway down 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 South 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. A more continuous extensive area of sediment suitable for *Nephrops* occurs further offshore to the southwest. Figure 3.6.6 shows the distribution of sediment in the area.

3.6.2 The fishery in 2011

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; some comments were also received from industry representatives. 2011 has been described as a good year for the South Minch fishery with steady catches throughout the year and good prices as demand was higher than supply. There has been some diversification in fishing in this area due to high prices for haddock that have been reported to be present in high numbers in the west coast of Scotland.

Two distinct fleets continued to operate in the South Minch during 2011, landing into the two main ports of Oban and Mallaig. Inshore, a fleet of smaller vessels including creel boats operated throughout the year, whilst some larger twin riggers fish further offshore. Most of these boats are thought to fish for *Nephrops* at some time. Traditionally east coast vessels (mainly twin riggers from Fraserburgh) visit Mallaig in March. This is reported to have happened in 2011 as the North Sea fishery has been poor throughout the year. There were fewer visitors from North Minch and Clyde in 2011 as the fishery in the west coast is generally better than in previous years. The number of local Boats in Mallaig is roughly the same as in 2010. The Mallaig local fleet tend to fish closer to shore in harder ground and land better quality *Nephrops* than visitor boats. Most boats landed 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. Boats on the west coast of Scotland are operating in accordance with the Scottish Conservation Credits Scheme and from 2009 have been required to fit 120 mm square meshed panels in accordance with the west coast emergency measures (Council Reg. (EU) 43/2009). Twin rig vessels tend to use a 200 mm square mesh panel (with a 100 mm codend), some of them slightly bigger than that. This means that they do not catch bulk quantities and this leads to prawns of better average size and quality.

There is very little fish bycatch landed; only 2–3 vessels do so owing to the restrictions on cod, haddock and whiting under the emergency measures. Estimates of discard rates of haddock and whiting remain high however.

3.6.3 ICES advice for 2011 and 2012

ICES advice applicable to 2011

"Following the ICES MSY framework implies the harvest ratio to be reduced to 12.3%, resulting in landings of 3800 t in 2011. Following the transition scheme towards the ICES MSY framework implies the harvest ratio should be reduced to 12.9% (0.8 x harvest ratio(F_{2010} 13.0%) + 0.2 x harvest ratio(F_{MSY} 12.3%) resulting in landings of 4000 t in 2011."

ICES advice applicable to 2012

"Following the ICES MSY framework implies the harvest ratio for the South Minch functional unit to be less than 12.3%, resulting in landings of less than 5500 t in 2012."

3.6.4 Management applicable to 2011 and 2012

Management is at the ICES subarea level as described at the beginning of Section 3.5. In 2011, ICES again reiterated its advice that *Nephrops* stocks should be managed at the FU level.

3.6.5 Assessment

Conclusions of the Review of the 2011 assessment

"*The RG considers the Underwater Television Survey (UWTV) and associated catch options to be an appropriate basis for management advice, and that $F_{35\%spr}$ (combined between sexes) is consistent with the approach adopted by WGCSE for choosing F_{MSY} proxies for Nephrops. The RG agrees with the WG that management of this stock should be applied at a local FU level rather than at the ICES division level.*"

The RG report contained some technical comments and attempts have been made to address these.

Approach in 2012

As last year the assessment in 2011 is based on a combination of examining trends in fishery indicators and underwater TV using an extensive dataseries for the South Minch FU 12. The assessment of *Nephrops* through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG and described in the stock annex.

The provision of advice in 2012 develops the process defined by the benchmark WG. Section 2.2 outlines the WG approach to integrate WKFRAME recommendations in the provision of F_{MSY} proxies for *Nephrops*. The approach was developed based on intersessional work carried out by participants of the benchmark and involving collaboration between WGNSSK and WGCSE. Previous TV based assessments have derived predicted landings by applying a harvest rate approach to populations described in terms of length compositions from the trawl component of the fishery. Creel fishing is important in the South Minch and increasingly operates across similar areas to the trawl fishery. For this reason the assessment is performed using combined length compositions from these fisheries.

Data available

An overview of the data provided and used by the WG is shown in Table 2.1.

Commercial catch and effort data

Official catch statistics (landings) reported to ICES are shown in Table 3.5.2. These relate to the whole of VIa of which the South Minch is a part. Landings for FU 12 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 in the mid 1990s, and low levels more recently reported for Ireland. Total international reported landings in 2011 were 3703 tonnes, consisting of 2883 tonnes landed by Scottish trawlers and 783 tonnes landed by Scottish creel vessels. These estimates for total landings show a reduction from the high values in 2006 to 2008 to landings more typical of the late 1980s. The high landings of 2006–2008 are thought to have arisen through a combination of good recruitment in the mid 2000s recruiting to the fished population, increased catching opportunities and to the introduction of the "buyers and sellers" regulations in the UK in 2006 which have increased the reliability of landings information. Landings from creel vessels decreased 12% to 783 tonnes in 2011. Reported effort by all Scottish trawlers has shown a decreasing trend since 2000 (Figure 3.6.1). Recently there was some concern about the method used to store effort data at the Marine Scotland Science internal database. This is related with how the effort is split by statistical rectangle when vessels fish over a wide area. This is more likely to affect North Sea than west coast FUs. However, given that a new effort data extraction became available from another database held in Edinburgh which is thought to be more reliable, these new data is being presented in Figure 3.6.1. Therefore, the effort and lpue time-series range (2000–2011) do not match with the more extensive year range available for landings. This will be addressed before the next assessment and it is expected that the full effort dataseries will be available to the WG in 2013. The new effort data does not change the lpue perception for the South Minch when compared with the data presented last year in the same period.

Sex ratio in the South Minch shows some variation but males consistently make the largest contribution to the annual landings (69% in 2011). This occurs because males are available throughout the year while females on the other hand are mainly taken in the summer when they emerge after egg hatching (Figure 3.6.2).

Discarding of undersized and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 2000. Discarding rates in this FU have varied considerably over the last five years. The discard rate decreased from 25% to 8% in the 2008–2010 period (Table 3.6.5). This pattern is consistent with what was observed in the other FUs in Division VIa. An increase in mean size of smaller (<35 mm) animals (Figure 3.6.1) from 2008 may have contributed to the decrease in discard rate. Other factors related with market prices for *Nephrops* may also contribute for this trend. 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 rate adjusted to account for some survival was estimated by taking a three year average 2009–2011 and amounts to 7.3% According to the agreed benchmark protocol this 'dead discard' value is used in the provision of landings options for 2013.

Length compositions

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Quarterly landings and discards-at-length data were available from Scotland and these sampling levels are shown in Table 3.5.4. Length compositions for the creel fishery are available for landings only since the small numbers of discards survive well and are not considered to be removed from the population. Although assessments based on detailed catch analysis are not currently possible, examination of length compositions can provide a preliminary indication of exploitation effects.

Figure 3.6.3 shows a series of annual length–frequency distributions for the period 1979 to 2011. 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 although there is some evidence of slight increases in the most recent years. 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) shows no evidence of reductions in relative numbers of larger animals.

The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35 mm) in the landings shown in Figure 3.6.1 and Table 3.6.2. This parameter might be expected to reduce in size if overexploitation were taking place but there is no evidence of this. The mean size of smaller animals (<35 mm) in the catch (and landings) is also quite stable through time. The mean weight in the landings (Figure 3.5.6 and Table 3.6.5) shows a marked increase in the last three years. This has a strong effect in the catch forecast and therefore it was considered more appropriate to use a full time average, from 1999 (first year with creel and trawl length distributions combined) until 2011. This is further discussed under "quality of assessment and forecast".

InterCatch

Scottish data for 2011 were successfully uploaded into InterCatch prior the 2012 WG meeting according with the deadline proposed. Uploaded data was worked-up in InterCatch to generate 2011 raised international length–frequency distributions. Further data exploration in InterCatch showed 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 were used in the 2012 assessment.

Natural mortality, maturity-at-age and other biological parameters

Biological parameter values are included in the Stock Annex.

Research vessel data

Underwater TV surveys using a stratified random approach are available for this stock since 1995. Underwater television surveys of *Nephrops* burrow number and distribution reduces 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. South Minch VMS data linked to landings suggest no major differences between areas fished and the mud sediment (Figure 3.6.6). Consequently, the approach followed is different from that used for North Minch and the sediment area is used to raise the abundance estimate in South Minch. This issue is discussed further under quality of assessment. The numbers of valid stations used in the final analysis in each year are shown in Table 3.6.4. On average, 34 stations have been considered valid each year, and then raised to a stock area of 5072 km^2.). In 2011, 36 valid stations were used in the survey final analysis (Table 3.6.4).

Data analyses

Exploratory analyses of survey data

Full details of the UWTV approach can be found in the stock Annex and the report of (WKNEPH) in 2009 (ICES, 2009). A reworking of the UWTV survey abundance-series for Division VIa was presented to the *Nephrops* benchmark workshop (WKNEPH) in 2009 (ICES, 2009) and further details of the technical changes to the camera can be found in the report of that workshop. The revised abundance estimates for FU 12 from 1999 onwards were presented for the first time at WGCSE 2009 and are slightly higher than the previous values due to the field of view being smaller than previously calculated.

Table 3.6.3 shows the basic analysis for the three most recent TV surveys conducted in FU 12. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. Results in 2011 were typical of previous years. From the work presented at the 2012 SGNEPS meeting (report still in draft form) it was decided by the group that a CV (relative standard error) of <20% was an acceptable precision level for UWTV survey estimates of abundance. CVs for the three most recent TV surveys (Table 3.5.7) are lower than the precision level agreed but higher than those estimates for FU 11 and FU 13. This is related to the high variance associated with the sandy mud strata. Figure 3.6.4 shows the distribution of stations in recent TV surveys (2006–2011), with the size of the symbol reflecting the *Nephrops* burrow density. The most recent survey suggests continued higher density in the northeast part of the functional unit around the island of Rhum. Densities were generally lower in the western parts of the area towards the Outer Hebrides. Table 3.6.4 and Figure 3.6.5 show the time-series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates. Confidence intervals, while relatively wide, have been fairly stable in recent years.

The review of the use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009). A number of potential biases were highlighted including those due to edge effects, species burrow misidentification and burrow occupancy. The cumulative bias correction factor estimated for FU 12 was 1.32 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 32%.

FU	Area	Edge effect	detection rate	species identification	Occupancy	Cumulative bias
12	South Minch	1.37	0.85	1.1	1	1.32

Final assessment

The underwater TV survey is presented as the best available information on the South Minch (FU 12) *Nephrops* stock. This survey provides a fishery-independent estimate of *Nephrops* abundance. The details of the 2011 survey are shown in Table 3.6.3

and compared with the 2009 and 2010 outcomes. (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). The 2011 TV survey abundance estimate (2568 million) has decreased by 6% compared to 2010. However, the estimates are within the range of estimates observed from 2000 to 2006.

The TV survey results reported here do not cover the sea loch areas adjacent to the main South Minch grounds and should therefore be considered underestimates of the overall abundance. The sea lochs support an unknown but significant part of both the trawl and creel fishery. This issue is discussed further under quality of assessment.

3.6.6 Historic stock trends

The TV survey estimates of abundance for *Nephrops* in the South Minch show that the population has fluctuated without obvious trend over the period of the survey (Figure 3.6.5). The recently observed abundance of 2568 represents a 6% decline in relation to 2010 but it is still above the long-term average. The bias adjusted abundance estimates from 1999–2011 are shown in Table 3.6.5. This table also shows the estimated harvest ratios over this period. . The current harvest ratio is currently at its low point in the time-series (6.5%). It is likely that prior to 2006, the harvest ratios are underestimates of the actual harvest ratios due to under-reported landings.

3.6.7 MSY considerations

A number of potential F_{msy} proxies are obtained from the per-recruit analysis for *Nephrops* and these are discussed further in Section 2.2 of this report. The analysis assumes the same input biological parameters as used at the benchmark meeting in 2009 and a recent exploitation pattern and discard ogive for trawl and creel caught *Nephrops* generated in 2010 for the years 2008–2009. The complete range of the per-recruit F_{MSY} proxies is given in the table below and the process for choosing an appropriate F_{MSY} proxy is described in Section 2.2. Note that all F_{MSY} proxy harvest rate values remain preliminary and may be modified following further data exploration and analysis.

For this FU, the absolute density observed in the UWTV survey-series is intermediate (average of just over 0.42 m^{-2}) suggesting the stock has moderate productivity. In addition, the fishery in this area has been in existence since the 1960s and the population has been studied numerous times (Afonso-Dias, 1998; Howard and Hall, 1983). Historical harvest ratios in this FU have been variable but generally around the $F_{35\%SpR}$.. **The WG concluded that combined sex $F_{35\%SpR}$ is an appropriate F_{proxy} for South Minch FU 12 *Nephrops*.** This is slightly below F_{MAX} in males and is predicted to result in about 27% SPR for males; in excess of the 20% considered precautionary lower bound outlined in Section 2.2.

		F_{BAR}(20–40 mm)				SPR (%)		
		FMULT	M	F	HR (%)	M	F	T
$F_{0.1}$	M	0.22	0.13	0.06	7.8	40.9	60.8	48.5
	F	0.44	0.27	0.12	13.8	23.8	43.7	31.4
	T	0.25	0.15	0.07	8.7	37.4	57.7	45.2
FMAX	M	0.42	0.25	0.12	13.3	24.8	44.8	32.5
	F	1.1	0.67	0.31	26.8	9.9	23.6	15.2
	T	0.54	0.33	0.15	16.1	19.8	38.7	27.1
$F_{35\%SpR}$	M	0.28	0.17	0.08	9.6	34.5	54.9	42.3
	F	0.64	0.39	0.18	18.3	16.9	34.8	23.8
	T	0.38	0.23	0.11	12.3	27.0	47.3	34.8

3.6.8 Landings forecasts

A landings prediction for 2013 was made for the South Minch (FU12) using the approach agreed at the Benchmark Workshop and outlined in Section 2.2. The text table below shows landings predictions at various harvest ratios, including a selection of those equivalent to the per-recruit reference points discussed in Section 2 of this report. The harvest ratio in 2011 is calculated by using input parameters agreed at WKNEPH (ICES 2009). Inputs to the catch options table are the mean weight in landings (1999–2011), the average dead discard rate (2009–2011) and the survey bias for this FU. The landings prediction for 2013 at the F_{MSY} proxy harvest ratio considered appropriate for the South Minch (i.e. 12.3%) is 5821 tonnes. There is no transition stage since the current harvest rate is below the F_{MSY} proxy. The inputs to the landings forecast were as follows:

Mean weight in landings (1999–2011) = 26.24 g

Dead discard rate (2009–2011)) = 7.3%

Survey bias = 1.32

			Implied fishery	
	Harvest rate	Survey Index (adjusted)	Retained number	Landings (tonnes)
F_{MSY}	12.3%	1945	222	5821
F_{2011}	6.5%	1945	117	3076
$F_{0.1(T)}$	8.7%	1945	157	4117
$F_{35\%SpR(T)}$	12.3%	1945	222	5821
$F_{MAX\ (T)}$	16.1%	1945	290	7620

Note: No F_{MSY} transition required as F_{2011} is below F_{MSY}.

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

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

$F_{MAX\ (T)}$: Harvest ratio equivalent to fishing at a rate which maximises the combined YPR.

A discussion of F_{MSY} reference points for *Nephrops* is provided in Section 2.2.

3.6.9 Biological reference points

Precautionary approach biological reference points have not been determined for *Nephrops* stocks. The $B_{trigger}$ point for this FU (bias adjusted lowest observed UWTV abundance) is calculated as 1016 million individuals.

3.6.10 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. Since 2010 this assessment combined trawl and creel length compositions. The creel fishery accounts for over 21% of the landings and increasingly operates over similar areas to trawling. The creel fishery 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. Effort data for years 2000–2011 extracted from another database was presented to the WG for the first time in 2012. This new effort data is considered to be more accurate and improved the estimates of lpue although it did not change its interpretation compared with what was presented in previous years. This new effort data is expected to be extended to the full dataseries in 2013.

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 on average greater during the most recent years, when abundance estimates have been slightly higher. The overlap of confidence intervals makes it difficult to determine which population changes are significant, although the recent increase from 2007 to 2010 is considered to be significant. Results suggest that overall the population has fluctuated without trend. There is a gap of 18 months between the survey and the start of the year for which the assessment is used to set management levels. It is assumed that the stock is in equilibrium during this period (i.e. recruitment and growth balance mortality) although this is impossible to test and is probably rarely the case. The effect of this assumption on realised harvest rates has not been investigated.

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 (2009–2011) of discard rate (adjusted to account for some survival of discarded animals) has been used in the calculation of catch options. The recent observed discard rate shows a decline in 2010 and 2011 compared to previous years. This is discussed in Section 3.5.5 under "commercial catch and effort data". The cumulative bias estimates for FU 12 are largely based on expert opinion (See 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. Work is underway to improve the area estimation although the problem is less severe than in the North Minch. 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. Figure 3.6.6 overlays the British Geological Survey based sediment distributions on the VMS based activity of >15 m trawlers. On the one hand there is some evidence of *Nephrops* fishing activity outside the contoured areas, but on the other hand, some of the sediment areas are apparently not fished. 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.

3.6.11 Status of the stock

The UWTV survey indicates that the population declined from a record high in 2004 to record low in 2007 but has increased to a level significantly above this again in 2010 and despite the small decrease in 2011 is still above the long-term average. The slightly increasing mean sizes in the length compositions of catches (of individuals >35 mm CL) and recent fall in estimated harvest ratios (removals/TV abundance) to below the F_{MSY} proxy suggests that the stock is slightly underexploited and that the population is sustainable.

3.6.12 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.

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 STECF continues to estimate that discards of whiting and haddock are high in VIa 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 under the Scottish Conservation Credits scheme and the West of Scotland emergency measures (Council Reg. (EU) 43/2009), include the implementation of larger meshed square meshed panels (120 mm).

The implementation of buyers and sellers legislation in the UK in 2006 has improved the reliability of fishery statistics but the transition period was accompanied in some cases by large changes in landings which produce significant changes in the lpue and cpue series that cannot be completely attributed to changes in stock. Until a sufficient time-series of reliable data has built up, use of fishery catch and effort data in the assessment process should be avoided.

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Table 3.6.1. *Nephrops*, South Minch (FU12), Nominal Landings of *Nephrops*, 1981–2011, as officially reported.

	UK Scotland					
Year	Trawl landings	Creel	Subtotal**	Other UK	Ireland	Total
1981	3219	432	3651	0	0	3651
1982	3132	420	3552	0	0	3552
1983	2956	456	3412	0	0	3412
1984	3706	594	4300	0	0	4300
1985	3520	488	4008	0	0	4008
1986	2982	502	3484	0	0	3484
1987	3345	546	3891	0	0	3891
1988	3908	555	4463	10	0	4473
1989	4184	561	4745	0	0	4745
1990	3994	436	4430	0	0	4430
1991	3938	503	4441	1	0	4442
1992	3687	549	4236	1	0	4237
1993	3801	649	4450	5	0	4455
1994	4008	404	4412	3	0	4415
1995	4158	508	4666	14	0	4680
1996	3526	468	3994	1	0	3995
1997	3850	492	4342	3	1	4346
1998	3191	538	3729	0	0	3730
1999	3524	513	4037	0	14	4051
2000	3251	699	3950	0	2	3952
2001	3216	767	3983	0	9	3992
2002	2549	742	3291	0	14	3305
2003	3015	858	3873	0	6	3879
2004	2969	880	3849	0	19	3868
2005	2856	953	3809	1	31	3841
2006	3588	922	4510	9	35	4554
2007	4444	958	5402	19	30	5451
2008	4437	895	5332	2	13	5347
2009	3367	900	4267	4	11	4282
2010	2814	889	3703	16	6	3725
2011*	2883	783	3671	23	9	3703

*** Provisional. NA = not available.**

**** Subtotal for Scotland includes landings from other gears**

Table 3.6.2. *Nephrops*, South Minch (FU 12): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1981–2011.

	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
Year	Males	Females	Males	Females	Males	Females
1981	28.2	26.4	29.6	27.5	41.5	38.0
1982	27.8	27.1	28.7	28.8	41.7	41.3
1983	28.6	26.5	29.3	27.6	39.5	37.6
1984	27.9	26.3	28.4	27.0	39.8	38.0
1985	27.9	27.5	28.6	28.5	40.0	37.6
1986	28.4	27.9	29.3	28.9	39.5	37.3
1987	28.3	26.6	29.2	28.1	39.8	37.6
1988	29.3	27.7	30.4	29.7	39.5	38.6
1989	28.6	28.1	29.8	29.4	39.5	38.4
1990	28.0	27.5	29.3	29.0	39.4	38.5
1991	29.4	27.5	29.9	27.9	39.0	38.5
1992	29.6	28.6	31.0	29.8	39.5	38.0
1993	29.0	27.8	30.0	28.5	39.5	38.0
1994	29.8	28.0	30.8	29.2	39.3	38.1
1995	29.5	28.2	30.0	28.4	39.4	38.0
1996	28.9	28.5	30.4	29.8	39.9	38.1
1997	29.3	28.7	30.6	29.6	39.8	37.8
1998	28.6	27.6	30.4	28.7	39.1	38.0
1999	28.6	27.7	30.0	29.5	39.4	38.3
2000	28.9	28.3	30.9	30.0	39.7	38.5
2001	27.7	27.3	29.7	28.8	39.6	38.1
2002	29.1	27.8	30.4	29.0	39.5	38.8
2003	29.0	28.1	30.4	29.5	39.8	38.4
2004	28.8	28.1	30.1	29.8	39.5	38.8
2005	28.1	27.8	30.4	29.5	39.8	38.6
2006	29.2	28.0	30.5	28.8	39.5	38.1
2007	29.7	28.2	29.9	28.2	40.0	38.3
2008	28.6	27.5	29.4	28.5	39.6	38.1
2009	28.9	27.9	29.9	28.7	40.8	38.8
2010	29.4	28.7	30.1	29.0	41.9	39.6
2011*	29.5	29.4	30.5	30.2	41.6	39.9

*** Provisional NA = not available.**

Table 3.6.3. *Nephrops* South Minch (FU12). Results by stratum of the 2009–2011 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)
2009 TV Survey								
M	303	2	0.135	0.004	41	186	0.001	
SM	2741	13	0.447	0.207	1088	109660	0.626	
MS	2028	10	0.397	0.146	906	65406	0.373	
Total	5072	25			2035	175252	1	0.203
2010 TV Survey								
M	303	5	0.512	0.255	155	4682	0.024	
SM	2741	13	0.615	0.251	1687	144966	0.753	
MS	2028	16	0.443	0.167	898	42875	0.223	
Total	5072	34			2740	192523	1	0.152
2011 TV Survey								
M	303	3	0.707	0.476	214	14572	0.055	
SM	2741	16	0.564	0.431	1545	202305	0.766	
MS	2028	17	0.399	0.195	809	47094	0.178	
Total	5072	36			2568	263971	1	0.190

Table 3.6.4. *Nephrops*, South Minch (FU 12): Results of the 1995–2011 TV surveys. (not adjusted for bias).

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1995	33	0.30	1520	331
1996	21	0.38	1945	700
1997	36	0.28	1434	244
1998	38	0.38	1916	306
1999	37	0.28	1433	343
2000	41	0.48	2447	460
2001	47	0.53	2689	606
2002	31	0.49	2507	749
2003	25	0.56	2847	998
2004	38	0.67	3377	625
2005	33	0.57	2914	977
2006	36	0.48	2436	789
2007	39	0.26	1341	205
2008	33	0.42	2123	548
2009	25	0.40	2035	837
2010	34	0.54	2740	878
2011	36	0.51	2568	1028

Table 3.6.5. *Nephrops*, South Minch (FU 12): 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 (millions)	Harvest ratio	Landings (tonnes)	Discard (tonnes)	Discard rate	Dead discard rate	Mean weight in landings (g)
1999	154	28	178	1086	16.4	4051	196	15.4	12.0	25.14
2000	140	32	168	1854	9.0	3952	275	18.7	14.7	27.3
2001	160	62	215	2037	10.6	3992	562	27.9	22.5	23.79
2002	119	25	142	1899	7.5	3305	239	17.6	13.8	26.83
2003	139	38	167	2157	7.7	3879	380	21.3	16.9	27.86
2004	138	43	173	2558	6.8	3868	443	23.8	19.0	27.37
2005	135	49	173	2208	7.8	3841	447	26.5	21.2	28.11
2006	174	29	196	1845	10.6	4554	320	14.3	11.1	26.24
2007	227	65	277	1016	27.2	5451	896	22.4	17.8	23.95
2008	224	74	279	1608	17.3	5347	605	24.7	19.8	23.84
2009	179	25	199	1542	12.9	4282	215	12.5	9.6	23.79
2010	142	12	153	2076	7.4	3725	127	7.7	5.9	25.79
2011	118	11	126	1945	6.5	3703	92	8.2	6.3	31.10
Average									7.3	26.24

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

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

***** Dead discard average: 2009–2011; Mean weight in landings average: 1999–2011.**

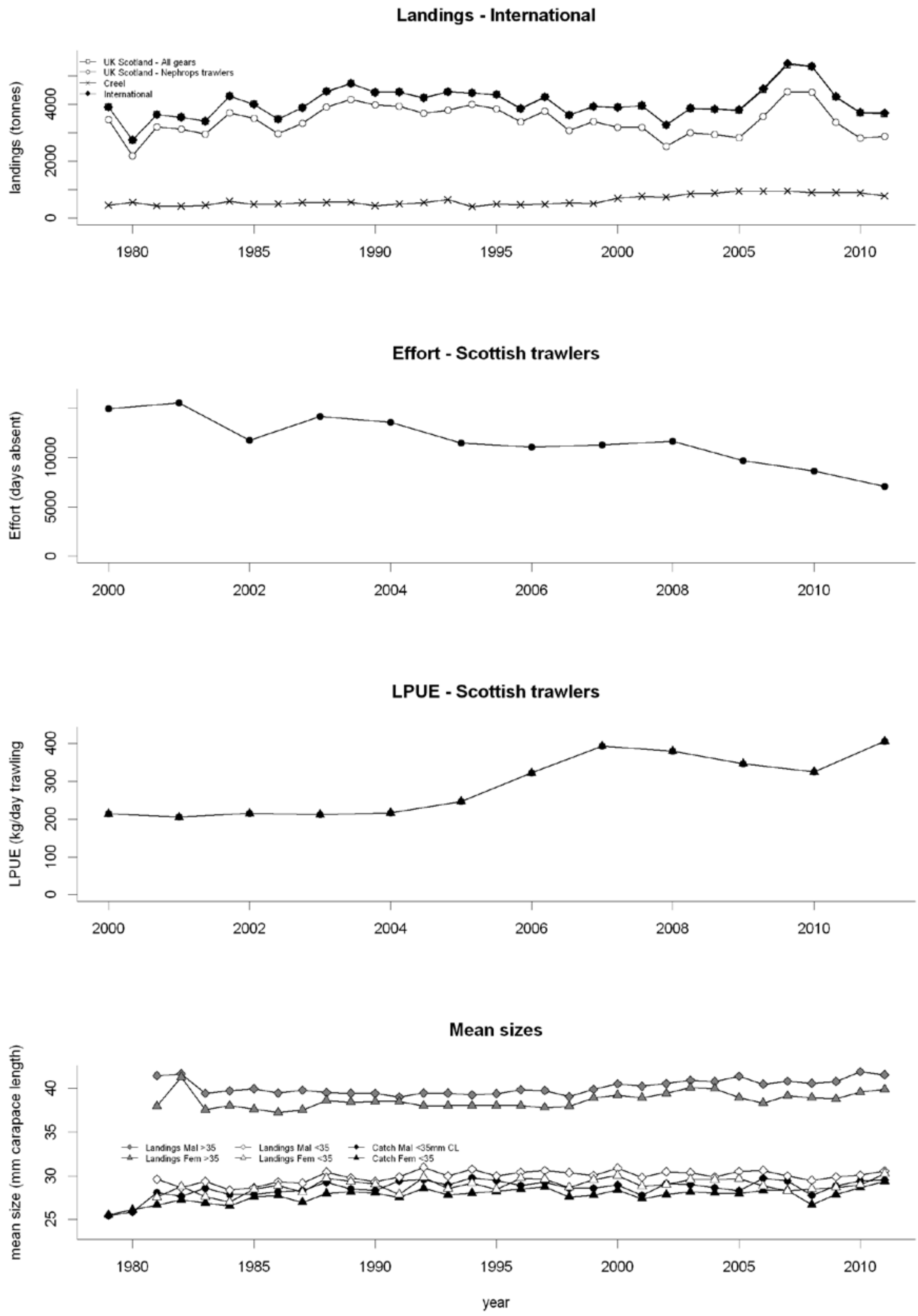
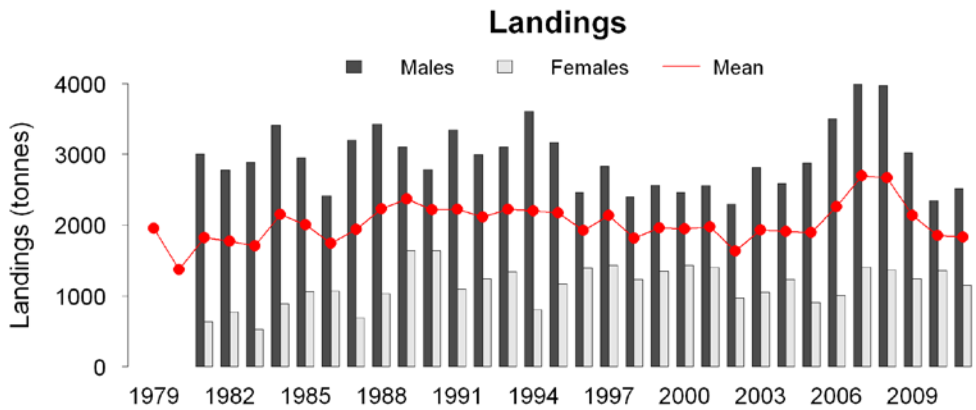


Figure 3.6.1. ***Nephrops,*** **South Minch (FU12). Long-term landings, effort, lpue and mean sizes. The interpretation of the lpue series is likely to be affected by the introduction of the "buyers and sellers" regulations in 2006.**



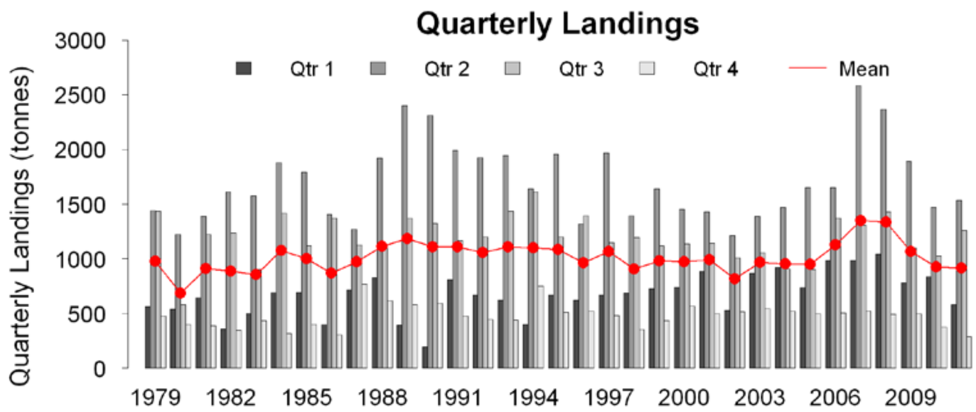


Figure 3.6.2. ***Nephrops,*** **South Minch (FU12). Landings by quarter and sex from Scottish trawlers.**

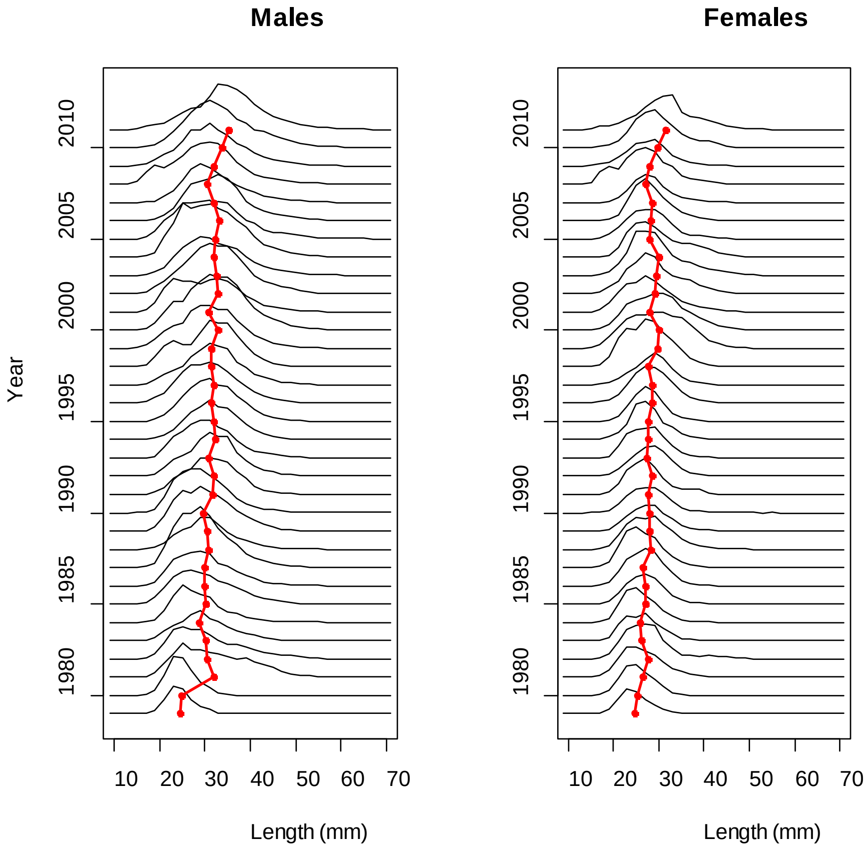


Figure 3.6.3. ***Nephrops*****. South Minch (FU12). Catch length–frequency distribution and mean sizes (red line) for *Nephrops* in the South Minch, 1979–2011.**

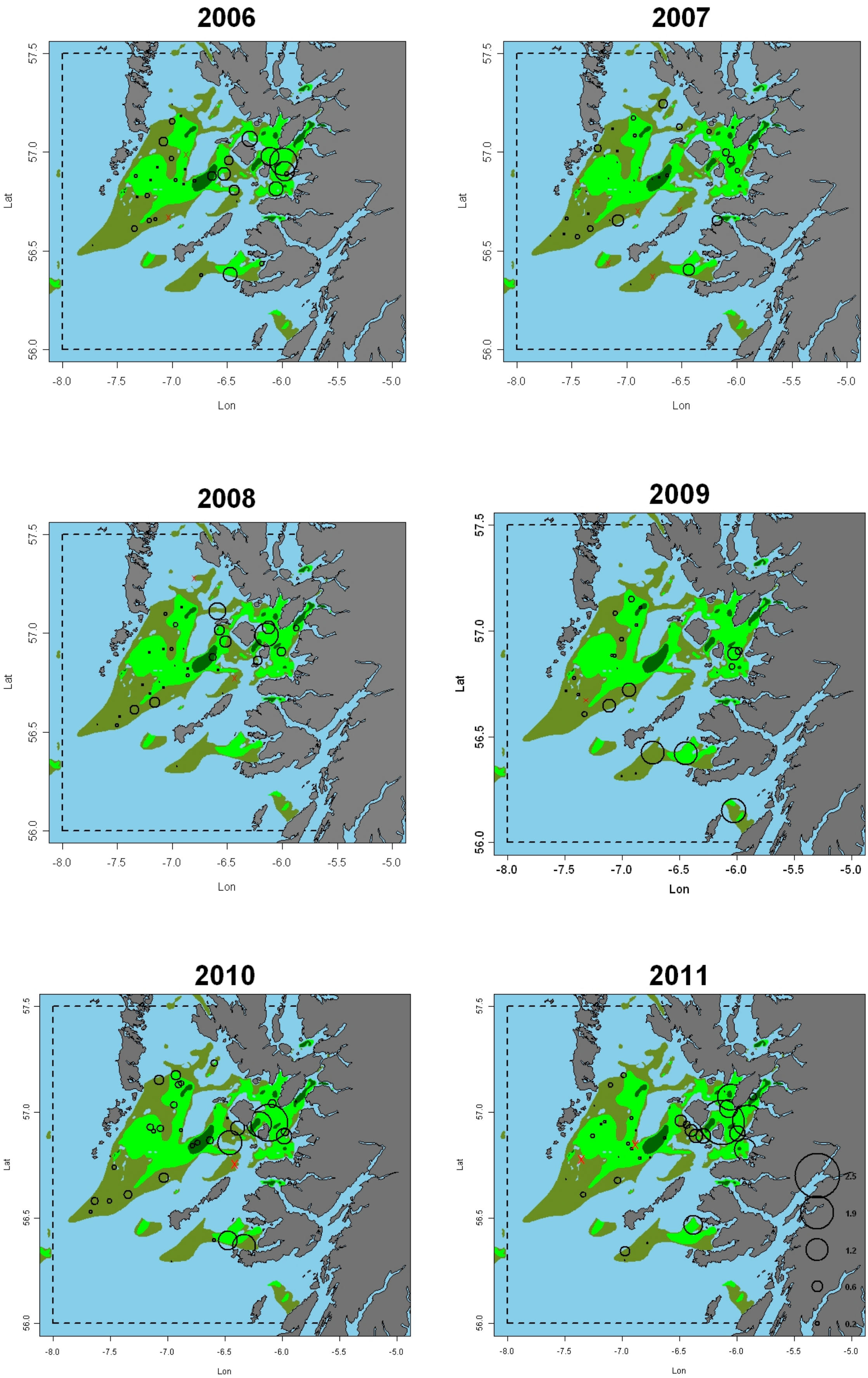

2006
2007
2008
2009
2010
2011
Lat
Lon
57.5
57.0
56.5
56.0
-8.0
-7.5
-7.0
-6.5
-6.0
-5.5
-5.0
2.5
1.9
1.2
0.6
0.2

Figure 3.6.4. ***Nephrops*****, South Minch (FU12), TV survey station distribution and relative density (burrows/m²), 2006–2011. 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.**

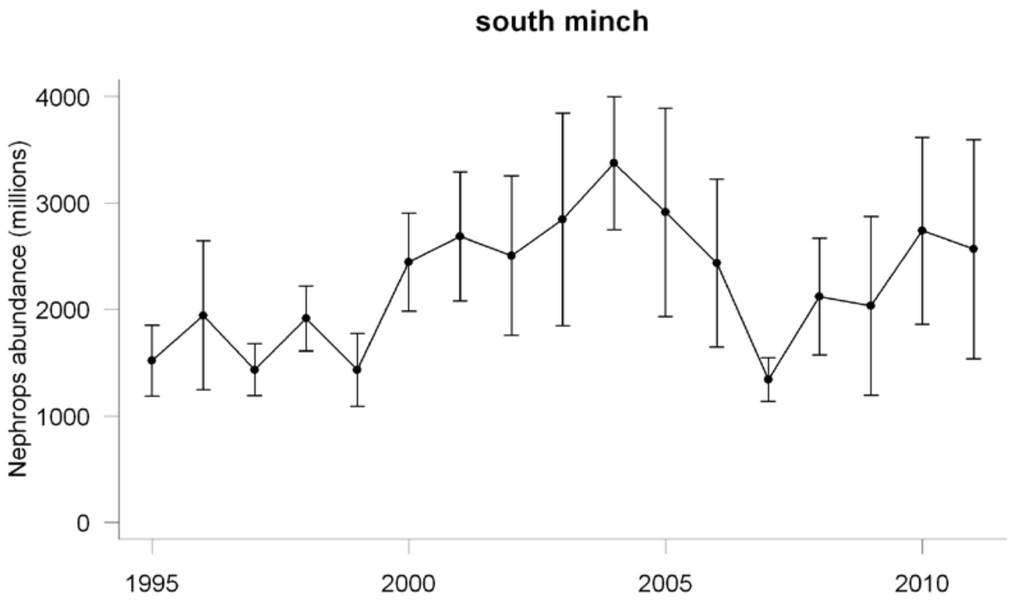


Figure 3.6.5. ***Nephrops*****, South Minch (FU12), Time-series of revised TV survey abundance estimate (not adjusted for bias), with 95% confidence intervals, 1995–2011.**

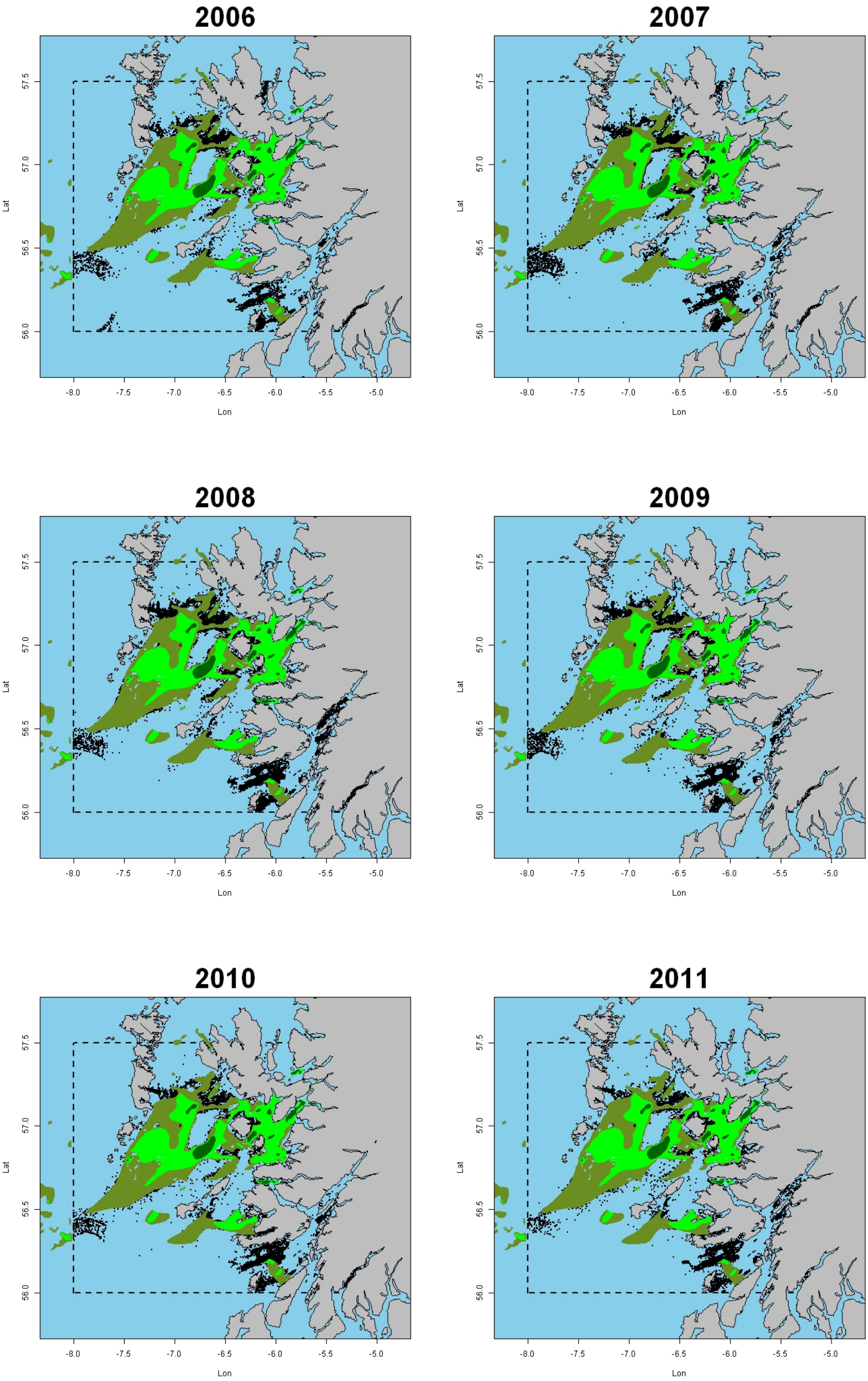

2006
2007
2008
2009
2010
2011
Lat
Lon
57.5
57.0
56.5
56.0
-8.0
-7.5
-7.0
-6.5
-6.0
-5.5
-5.0

Figure 3.6.6. *Nephrops*, South Minch (FU12), comparison of area of *Nephrops* ground defined by BGS sediment distribution (green shaded overlay) and by distribution of VMS pings (shown by black dots, underlay) recorded from *Nephrops* trawlers >15 m length for 2006–2011. VMS data filtered to exclude vessel speeds >4.5 knots.

3.7 Clyde, FU13

Type of assessment in 2012

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) and described in Section 2.2.

3.7.1 Ecosystem aspects

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 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. Figure 3.7.7 shows the distribution of sediment in the area.

3.7.2 The fishery in 2011

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; some comments were also received from industry representatives. The number of vessels fishing in Clyde has not changed much from that of 2010. Some vessels left the fleet through decommissioning or personal reasons but these have been replaced by others meaning that, overall, the number has remained similar. All vessels use 80 mm codends with 120 mm minimum square mesh panels, in accordance with west coast emergency measures conditions (Council Reg. (EU) 43/2009). The most significant landings came from the main Clyde landing ports of Troon, Girvan, 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. Vessels in the Clyde tend to stick the same gear type but traditionally some will swap between *Nephrops* and scallop gear during the year.

There has not been much movement of vessels from Clyde into other FUs in 2011. Some Northern Irish boats fish the Clyde at varying times of the year according to weather and catch rates. In 2011, the Northern Irish fleet (around 45 vessels) moved up into the Clyde area for six weeks. These boats fish mainly for tails in the Ailsa Craig area, landing into Campbeltown or Troon. The good prices for *Nephrops* and reduced fuel prices in Northern Ireland encouraged these vessels to stay in Clyde. Northern Ireland boats are reported to land more tails than local fleets.

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. Only about a third of creelers operated throughout the year, the rest prosecuted a summer fishery.

During the weekends, some of the larger boats fish in the Sound of Jura. There has been reports of good fishing in Sound of Jura however, the price of fuel means that it is not always worth the trip up for a weekend.

3.7.3 ICES advice for 2011 and 2012

ICES advice applicable to 2011

"Following the transition scheme towards the ICES MSY framework implies the harvest ratio for the Firth of Clyde should be reduced to 24.1% (0.8 x harvest ratio(F_{2010}) + 0.2 x harvest ratio(F_{MSY})), resulting in landings of 4100 t in 2011. For the Sound of Jura no transition is needed as the harvest rate is already below the F_{MSY} proxy."

ICES advice applicable to 2012

"*Following the ICES MSY framework implies the harvest ratio for the Firth of Clyde subarea to be reduced to less than 16.4%, resulting in landings of less than 4000 t in 2012. Following the transition scheme towards the ICES MSY framework implies the harvest ratio for the Firth of Clyde should be reduced to less than 17.1% (0.6 x harvest ratio(F_{2010}) + 0.4 x harvest ratio(F_{MSY})), resulting in landings of less than 4200 t in 2012.*

Following the ICES MSY framework implies the harvest ratio for the Sound of Jura subarea to be less than 14.5%, resulting in landings of less than 900 t in 2012. For the Sound of Jura no transition is needed as the harvest rate is already below the F_{MSY} proxy."

3.7.4 Management applicable to 2011 and 2012

Management is at the ICES Subarea level as described at the beginning of Section 3.5. In 2011, ICES again reiterated its advice that *Nephrops* stocks should be managed at the FU level.

3.7.5 Assessment

Conclusions of the Review of the 2011 assessment

"*The RG considers the Underwater Television Survey (UWTV) and associated catch options to be an appropriate basis for management advice, but notes that the catch forecast depends on the recent low discard rates continuing. The RG agrees with the WG that management of this stock should be applied at a local FU level rather than at the ICES division level. The RG agrees with the approach adopted by WGCSE for choosing F_{MSY} proxies for Nephrops. The F_{MSY} proxy is considered by WGCSE to be the combined-sex $F_{35\%SpR}$.*"

The RG report contained some technical comments and attempts have been made to address these.

Approach in 2012

The assessment in 2012 is based on a combination of examining trends in fishery indicators and underwater TV using an extensive dataseries for the Firth of Clyde component of FU 13. Following the 2010 assessment approach, the more limited UWTV data available for the Sound of Jura subarea was also used for providing advice. The assessment of *Nephrops* through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG and described in Section 2.2.

The provision of advice in 2012 develops the process defined by the benchmark WG and described in Section 2.2 and attempts to incorporate decisions taken at

WKFRAME for the provision of MSY advice by ICES in 2010. The approach was developed based on intersessional work carried out by participants of the benchmark and involving collaboration between WGNSSK and WGCSE.

Previous TV based assessments have derived predicted landings by applying a harvest rate approach to populations described in terms of length compositions from the trawl component of the fishery. In recent years, creel fishing has become more important in the Firth of Clyde and operates across similar areas to the trawl fishery. For this reason the assessment is performed using combined length compositions.

Data available

An overview of the data provided and used by the WG is shown in Table 2.1.

Commercial catch and effort data

Official catch statistics (landings) reported to ICES are shown in Table and Figure 3.7.1. These relate to the whole of VIa of which the Clyde FU is a part. Landings statistics for FU 13 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 the remainder of the UK also contributed about 8% in 2011; landings from Northern Ireland form the main part of this. Total international reported landings increased by 13% in 2011 and consisted of 5665 tonnes landed by Scottish trawlers and 219 tonnes landed by Scottish creel vessels. Creel landings have increased in the most recent years but remain at a low level compared to other methods and to the creel fisheries elsewhere on the west coast of Scotland.

Table 3.7.2 show the split in landings between the two subareas comprising FU13. Most of the landings are presently taken from the Firth of Clyde subarea with only about 1% from the Sound of Jura. Earlier in the time-series the Sound of Jura contributed as much a 20%. The decline has occurred through a progressive reduction in fishing activity in the area. The main reason for this is probably related to the size composition in the population which is characterised by small *Nephrops* (Bailey and Chapman, 1983) whereas the market has increasingly favoured larger whole animals.

The introduction of the "buyers and sellers" regulation in the UK in 2006 has led to increased reliability in the reported landings. Uncertainties over the accuracy of the effort data emerged recently. In an effort to improve reliability, effort from 2009 was extracted and expressed in terms of days fished (since the logbook field for hours is not mandatory). Preliminary examination of the effort series showed a marked discontinuity around 1995 with a large and inexplicable drop in effort in days. Further investigation revealed that at this time the process of recording days effort in the split rectangle region of the Clyde changed. For this reason, long-term trends in effort and lpue/cpue were not reported to the WG in 2011. Given that a new effort data extraction became available from another database held in Edinburgh which is thought to be more reliable, these new data is being presented in Figure 3.7.1. Therefore, the effort and lpue time-series range (2000–2011) do not match with the more extensive year range available for landings. This will be addressed before the next assessment and it is expected that the full effort dataseries will be available to the WG in 2013. Examination of these new effort series shows a fairly stable trend in effort since year 2000 whilst lpue has increased following the landings increase in the last decade.

Sex ratio in the Firth of Clyde shows some variation but males make the largest contribution to the annual landings (58% in 2011). This occurs because males are available throughout the year and the fishery is also prosecuted in all quarters. Females on the other hand are mainly taken in the summer when they emerge after egg hatching (Figure 3.7.2).

Discarding of undersized and unwanted *Nephrops* occurs in the Firth of Clyde fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 2000. Discarding rates have been high in this FU and average around 31% by number in this FU since 1999. In 2010, discard rates were estimated to be substantially lower than average and 2011 (18.6%) further confirms this decreasing trend (Table 3.7.8). This pattern is consistent with what was observed in the other FUs in Division VIa. An increase in mean size of smaller (<35 mm) animals (Figure 3.7.1) from 2009 may have contributed to the decrease in discard rate. Other factors related with market prices for *Nephrops* may also contribute for this trend. 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 rate adjusted to account for some survival was estimated to be 20% (taking a three year average 2009–2011) and according to the agreed benchmark protocol this value is used in the provision of landings options for 2013.

Length compositions

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Quarterly landings and discards-at-length data were available for the Firth of Clyde from Scotland and these sampling levels are shown in Table 3.5.4. Length compositions for the creel fishery are of landings only since the small numbers of discards survive well and are not considered to be removed from the population. Sampling of length compositions in the Sound of Jura is more infrequent and only limited data are available. In 2011 no samples were collected from Sound of Jura.

The long steaming to reach this ground combined with fuel costs make fishing trips to this component of FU 13 more infrequent despite anecdotal evidence of a good fishery in the area. Sampling at Clyde ports is opportunistic and two trips are usually carried out per quarter which means it is not always possible to sample Sound of Jura landings. It is envisaged that an agreement between Marine Scotland Science and Marine Scotland Compliance may improve *Nephrops* sampling at Sound of Jura through the collaboration of Compliance Officers in collecting scientific data at ports.

Although assessments based on detailed catch analysis are not presently considered advisable, examination of length compositions can provide a preliminary indication of exploitation effects. Figure 3.7.3 shows a series of annual Firth of Clyde length–frequency distributions for the period 1979 to 2011. 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 although in 2010–2011 there is some evidence of a slight increase in the mean lengths. 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) shows no evidence of reductions in relative numbers of larger animals. The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35 mm) in the landings shown in Figure 3.7.1 and Table 3.7.3. This parameter might be expected to reduce in size if overexploitation were taking place but there is no evidence of this. The mean size of smaller animals (<35 mm) in the catch (and landings) is also stable through time, although in 2010 the mean size of individuals in the landings and catch below 35 mm has increased slightly, which is in line with what was described in the previous year report about trawlers tubing larger *Nephrops* and not landing as many small tails as before. Mean weight in the Firth of Clyde landings is shown in Figure 3.5.6 and Table 3.7.8 and this also shows no systematic changes over the time-series.

InterCatch

Scottish data for 2011 were successfully uploaded into InterCatch prior the 2012 WG meeting according with the deadline proposed. Uploaded data was worked-up in InterCatch to generate 2011 raised international length–frequency distributions. Further data exploration in InterCatch showed 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 were used in the 2012 assessment.

Natural mortality, maturity-at-age and other biological parameters

Biological parameter values are included in the Stock Annex.

Research vessel data

Underwater TV surveys are available for both sub areas since 1995 although the Sound of Jura has been sampled more infrequently. Underwater television surveys of *Nephrops* burrow number and distribution reduces 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. Clyde VMS data linked to landings suggest no major differences between areas fished and the mud sediment. In fact, Figure 3.7.7 shows a closer VMS/sediment match in Clyde than South Minch. Therefore, the sediment area is used to raise the abundance estimate in Clyde. This issue is discussed further under quality of assessment.

The UWTV in the Firth of Clyde subarea is carried out using a stratified random approach. The numbers of valid stations used in the final analysis in each year are shown in Table 3.7.4. On average, 38 stations have been considered valid each year, and then raised to the estimated area of the ground available for *Nephrops*; 2080 km^2 based on contoured superficial sediment information (British Geological Surveys). In 2011, 40 valid stations were used in the survey final analysis for the Firth of Clyde (Table 3.7.5) and twelve stations for the Sound of Jura (Table 3.7.7).

Data analyses

Exploratory analyses of survey data

Full details of the UWTV approach can be found in the stock Annex and the report of (WKNEPH) in 2009 (ICES, 2009). A reworking of the UWTV survey abundance-series for Division VIa was presented to the *Nephrops* benchmark workshop (WKNEPH) in 2009 (ICES, 2009) and further details of the technical changes to the camera can be found in the report of that workshop. The revised abundance estimates for FU 13 from 1999 onwards were presented for the first time at WGCSE 2009 and are slightly higher than the previous values due to the field of view being smaller than previously calculated.

Table 3.7.4 shows the basic analysis for the most recent TV surveys conducted in the Firth of Clyde. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. The areas of all sediment types (mud, muddy sand and sandy mud) in this region are very similar and as such the number of stations surveyed in each sediment type is similar also. Basic analysis for the Sound of Jura is shown in Table 3.7.6. From the work presented at the 2012 SGNEPS meeting (report still in draft form) it was decided by the group that a CV (relative standard error) of < 20% was 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 3.7.4 and 3.7.6) are lower than the precision level agreed.

Figure 3.7.4 shows the distribution of stations in recent TV surveys (2006–2011) across FU13 (the two distinct subareas can be clearly seen) with the size of the symbols reflecting the *Nephrops* burrow density. Table 3.7.5 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 3.7.7 and Figure 3.7.6. The most recent survey suggests continued higher density in the south part of the functional unit.

The use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009). A number of potential biases were highlighted including those due to edge effects, species burrow misidentification and burrow occupancy. The cumulative bias correction factor estimated for the Firth of Clyde was 1.19 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 19%. A review of the Sound of Jura biases has not so far been carried out; biases are here assumed to be similar to the Firth of Clyde.

FU	Area	Edge effect	detection rate	species identification	Occupancy	Cumulative bias
13	Clyde	1.19	0.75	1.25	1	1.19

Final assessment

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 2011 Firth of Clyde survey are shown in Table 3.7.4 and compared with the 2008 and 2009 outcomes. The details of the 2011 Sound of Jura survey are shown in Table 3.7.6. At present it is not possible to extract any length or age structure information from the survey and it therefore only provides information on abundance over the area of the survey. The 2011 TV survey abundance estimate in the Firth of Clyde (2576 million) has reached a maximum in the time-series by increasing 24% compared to 2010. The abundance is still in line with values recorded before the abundance drop in 2007. The 2011 TV abundance estimate in the Sound of Jura (371 million) decreased 17% compared to the previous 2010 estimate remaining at the same range of values observed in the last decade.

The TV survey results reported here do not cover the sea loch areas adjacent to the main Firth of Clyde area and should therefore be considered underestimates of the overall biomass. This issue is discussed further under quality of assessment.

Historic stock trends

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 having increased again in the last two years. The bias adjusted abundance estimates from 1999–2011 (the period over which the survey estimates have been revised) is shown in Table 3.7.8. The 2011 bias adjusted stock estimate is 2165 million individuals.

Table 3.7.8 also shows the estimated harvest ratios over this period. These range from 12–50% over this period. It is unlikely that prior to 2006, the estimated harvest ratios are representative of actual harvest ratios due to under-reporting of landings.

Results for the Sound Jura are sparse and are associated with large confidence intervals particularly in 2002 and 2006. Table 3.7.9 summarise the bias adjusted estimates of abundance and harvest rates where available. The 2011 bias adjusted stock estimate is 312 million individuals.

3.7.6 MSY considerations

A number of potential F_{MSY} proxies are obtained from the per-recruit analysis for *Nephrops* and these are discussed further in Section 2.2 of this report. The analysis assumes the same input biological parameters as used at the benchmark meeting in 2009 and an exploitation and discard ogive for trawl and creel caught *Nephrops* generated in 2010 for the years 2008–2009. The complete range of the per-recruit F_{MSY} proxies for the Firth of Clyde subarea is given in the table below and the process for choosing an appropriate F_{MSY} proxy is described in Section 2.2. Note that all F_{MSY} proxy harvest rate values remain preliminary and may be modified following further data exploration and analysis.

For the Firth of Clyde subarea of this FU, the absolute density observed on the UWTV survey is generally high (average of over 0.8 m^{-2} for entire series and around 1.0 m^{-2} for the last five years suggesting the stock has relatively high productivity. In addition, the fishery in this area has been in existence since the 1960s and the population and biological parameters have been studied numerous times (Bailey and Chapman, 1983; Tuck *et al*., 1997; Tuck *et al*., 1999). Historical harvest ratios in this FU have been generally high at or above F_{MAX}.. **An appropriate F_{MSY} proxy is considered therefore to be the total population F_{MAX} which is predicted to deliver an $F_{35\%SpR}$ of about 22% for males;** considered precautionary for this species (See Section 2.2).

			F_{BAR}(20–40 mm)			SPR (%)		
		F_{MULT}	M	F	HR (%)	M	F	T
$F_{0.1}$	M	0.17	0.15	0.06	8.7	40.2	66.8	49.1
	F	0.43	0.37	0.14	21.1	16.2	40.7	24.4
	T	0.19	0.16	0.06	9.7	36.9	64.0	45.9
F_{MAX}	M	0.27	0.23	0.09	13.6	27.0	54.4	36.2
	F	0.71	0.61	0.24	34.0	8.3	26.5	14.3
	T	0.33	0.28	0.11	16.4	21.9	48.6	30.8
$F_{35\%SpR}$	M	0.21	0.18	0.07	10.7	34.0	61.4	43.1
	F	0.53	0.46	0.18	25.7	12.4	34.6	19.8
	T	0.29	0.25	0.10	14.5	25.1	52.4	34.2

Yield per recruit analysis is not yet available for the Sound of Jura subarea of this FU and so proxies from the Firth of Clyde (shown in the table above) are used. The absolute density observed on the UWTV survey is generally high (average of about 0.9 m^{-2} over the time-series and around 1 m^{-2} over the last five years) suggesting the stock has relatively high productivity. A number of studies have investigated biology and the area is acknowledged as having high abundance for many years. However, the time-series of TV data is more fragmented and sampling is at a relatively low level;

confidence intervals are larger. The fishery in this area has been in existence since the 1960s but in recent times has operated at a low level and harvest ratios in this FU have been low. **An appropriate F_{MSY} proxy is considered therefore to be the total population $F_{35\%SpR}$ which is predicted to deliver an $F_{35\%SpR}$ of about 25% for males;** above the level considered precautionary for this species (See Section 2.2).

3.7.7 Landings forecasts

A landings prediction for 2013 was made for the Firth of Clyde and Sound of Jura subareas of Clyde FU13 using the approach agreed at WKNEPH 2009 and outlined in the Section 2.2. The text table below shows landings predictions at various harvest ratios, including a selection of those equivalent to the per-recruit reference points discussed in Section 2 of this report. The harvest ratio in 2011 is calculated using input parameters agreed at WKNEPH (ICES 2009). Inputs to the catch options table are the mean weight in landings (2009–2011), the average dead discard rate (2009–2011) and the survey bias for this FU. The landings prediction for 2013 at the F_{MSY} proxy harvest ratio considered appropriate for the Firth of Clyde (i.e. 16.4%) is 5550 tonnes. As the current harvest ratio (17.6%) for 2011 is very close to the F_{MSY} proxy (16.4%), the landings projection for 2013 is based on the more conservative F_{MSY} and as such no transition stage was calculated.

For the Sound of Jura subarea, the landings prediction for 2013 at the F_{MSY} proxy harvest ratio of 14.5% is 776 tonnes. There is no transition stage since the current position is below the F_{MSY} proxy.

The inputs to the landings forecast for the Firth of Clyde and Sound of Jura were as follows:

Mean weight in landings in Firth of Clyde (2009–2011) = 19.53 g

Mean weight in landings in Sound of Jura (2008–2010) = 21.44 g (2008–2010 used as no sampling available in 2011)

Dead discard rate = 20.0%

Survey bias = 1.19 (as calculated at WKNEPH 2009).

Firth of Clyde

	Harvest rate	Survey Index (adjusted)	Implied fishery Retained number	Landings (tonnes)
F_{MSY}	16.4%	2165	284	5550
$F_{0.1(T)}$	9.7%	2165	168	3282
$F_{35\%SpR(T)}$	14.5%	2165	251	4907
$F_{MAX\,(T)}$	16.4%	2165	284	5550
F_{2011}	17.6%	2165	305	5956

Sound of Jura

	Harvest rate	Survey Index (adjusted)	Implied fishery Retained number	Landings (tonnes)
F_{MSY}	14.5%	312	36	776
F_{2011}	1.2%	312	3	64
$F_{0.1(T)}$	9.7%	312	24	519
$F_{35\%SpR(T)}$	14.5%	312	36	776
$F_{MAX\,(T)}$	16.4%	312	41	878

Note: No F_{MSY} transition required as F_{2011} is below F_{MSY}.

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

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

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

A discussion of F_{MSY} reference points for *Nephrops* is provided in Section 2.2.

3.7.8 Biological reference points

Precautionary approach biological reference points have not been determined for *Nephrops* stocks. The $B_{trigger}$ point for the Firth of Clyde (bias adjusted lowest observed UWTV abundance) is calculated as 579 million individuals. The $B_{trigger}$ point for the Sound of Jura has not been defined but is expected to be below 200 million individuals.

3.7.9 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 the Firth of Clyde subarea fishery since 1990, and is considered to represent the fishery adequately. Sampling in the Sound of Jura is sparser. 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. Effort data for years 2000–2011 extracted from another database was presented to the WG for the first time in 2012. This new effort data is considered to be more accurate and improved the estimates of lpue.

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 VIa. There is a gap of 18 months between the survey and the start of the year for which the assessment is used to set management levels. It is assumed that the stock is in equilibrium during this period (i.e. recruitment and growth balance mortality) although this is rarely the case. The effect of this assumption on realised harvest rates has not been investigated.

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 (2009–2011) of discard rate (adjusted to account for some survival of discarded animals) has been used in the calculation of catch options. The recent observed discard rate shows a decline in 2010 and 2011 compared to previous years. This is discussed in Section 3.5.5 under "commercial catch and effort data". Firth of Clyde discard rates and F_{MSY} proxy calculations were applied to the Sound of Jura in the absence of estimates for this subarea. The cumulative bias estimates for FU 13 Clyde and Jura component is largely based on expert opinion (See 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. 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. Figure 3.7.7 overlays the British Geological Survey based sediment distributions on the VMS based activity of >15 m trawlers. On the one hand there is some evidence of *Nephrops* fishing activity outside the contoured areas, but also some of the sediment areas are apparently not fished. 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 unestimated sea loch areas are relatively small.

3.7.10 Status of the stock

The 2011 TV survey abundance estimate is the maximum in the time-series which is an increase 24% compared to 2010. This is similar to those estimates observed in the period 2004–2006 and within the accepted confidence limits. The calculated harvest ratio in 2011 (dead removals/TV abundance) is slightly above the values associated with high long-term yield and low risk depletion.

3.7.11 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 STECF estimates that discards of whiting and haddock are generally high in VIa. 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 under the Scottish Conservation credits scheme and west coast emergency measures, include the implementation of larger meshed square meshed panels (120 mm). 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.

The implementation of buyers and sellers legislation in the UK in 2006 has improved the reliability of fishery statistics but the transition period was accompanied in some cases by large changes in landings which produce significant changes in the lpue and cpue series that cannot be completely attributed to changes in stock. Until a sufficient time-series of reliable data has built up, use of fishery catch and effort data in the assessment process should be avoided.

3.7.12 Other *Nephrops* populations within Division VIa

Nephrops fisheries also take place outside the Functional Units in Subdivision VIa, although they represent a low proportion of the reported landings (Table 3.5.3). Over the time-series, average landings have been just over 250 t and in recent ten years just over 300 t. An allowance for this activity is required in the final landings advice for 2013. The main areas of activity 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.

3.7.13 Stanton Bank

Underwater TV surveys were not conducted in Stanton Bank.

3.7.14 Shelf edge west of Scotland

Marine Scotland Science has taken the opportunity of using the Scotia deep-water surveys conducted in 2000, 2002 and 2004 to conduct preliminary underwater TV work on the *Nephrops* populations along the shelf edge. These TV runs are carried out during the night (when the vessel is not required for fishing). It is hoped that this can continue as an annual survey.

To date, successful survey runs have been conducted to a depth of 635 m, observing *Nephrops* burrows at a range of locations along the shelf edge and slope. Observed densities have been very low (average 0.04 m^{-2}) compared to shelf stocks on the west coast and in the North Sea (typically 0.2–0.9 m^{-2}), although the animals on the shelf edge are considerably larger than those found on the shelf. Forecasts of landings based on TV surveys were not attempted for this area.

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Table 3.7.1. *Nephrops*, Clyde (FU13), Nominal Landings of *Nephrops*, 1981–2011, as officially reported.

Year	UK Scotland			Other UK & Ireland	Total
	Trawl landings	Creel	Subtotal**		
1981	2902	66	2968	0	2968
1982	2544	79	2623	0	2623
1983	4010	53	4063	14	4077
1984	3223	77	3300	10	3310
1985	4214	64	4278	7	4285
1986	4249	79	4328	13	4341
1987	2939	65	3004	3	3007
1988	3615	43	3658	7	3665
1989	2761	35	2796	16	2812
1990	2854	24	2878	34	2912
1991	2990	25	3015	23	3038
1992	2778	10	2788	17	2805
1993	3309	5	3314	28	3342
1994	2552	28	2580	49	2629
1995	3899	26	3925	64	3989
1996	3991	27	4018	42	4060
1997	3530	25	3555	63	3618
1998	4620	40	4660	183	4843
1999	3504	38	3542	210	3752
2000	3206	76	3282	137	3419
2001	2956	94	3050	132	3182
2002	3127	105	3232	151	3383
2003	2974	117	3091	80	3171
2004	2677	90	2767	258	3025
2005	3180	95	3275	148	3423
2006	4446	0	4534	244	4778
2007	6129	0	6129	366	6495
2008	5384	197	5581	416	5997
2009	4305	189	4494	283	4777
2010	5050	186	5236	465	5701
2011*	5665	219	5891	540	6431

*** Provisional.**

**** Subtotal for Scotland includes landings from other gears.**

Table 3.7.2. *Nephrops*, Clyde (FU13), Nominal Landings of *Nephrops*, in each of the subareas (Firth of Clyde and Sound of Jura 1981–2011, as officially reported.

	UK		
Year	Firth of Clyde	Sound of Jura	All subareas
1981			2968
1982			2623
1983			4077
1984			3310
1985			4285
1986			4341
1987			3007
1988			3665
1989			2812
1990			2912
1991			3038
1992			2805
1993	2766	576	3342
1994	2094	535	2629
1995	3690	299	3989
1996	3673	387	4060
1997	3132	486	3618
1998	4372	471	4843
1999	3424	328	3752
2000	3230	189	3419
2001	2980	202	3182
2002	3349	34	3383
2003	3153	18	3171
2004	2975	50	3025
2005	3387	36	3423
2006	4717	61	4778
2007	6397	98	6495
2008	5919	78	5997
2009	4686	91	4777
2010	5643	58	5701
2011	5822	69	5891

*** Provisional. NA = not available.**

Table 3.7.3. *Nephrops*, Clyde (FU 13): Firth of Clyde subarea. Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish trawl catches and landings, 1981–2011.

	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
Year	Males	Females	Males	Females	Males	Females
1981	28.4	27.3	30.2	29.3	40.3	39.3
1982	28.2	26.4	29.9	29.0	39.9	40.1
1983	27.9	26.7	29.3	28.5	40.8	39.5
1984	27.0	25.9	28.0	26.8	40.9	39.6
1985	27.1	26.1	28.1	27.2	39.8	39.3
1986	27.1	26.0	27.9	27.1	40.5	39.0
1987	28.5	26.5	29.6	28.3	39.4	40.0
1988	28.1	27.0	30.6	29.5	41.2	40.1
1989	26.9	26.9	30.2	30.0	41.6	39.8
1990	27.4	26.2	30.4	29.5	40.1	39.8
1991	28.6	27.1	29.2	28.2	39.3	40.3
1992	29.6	28.8	30.1	29.2	39.9	41.1
1993	29.6	29.7	31.4	30.9	40.4	39.9
1994	26.4	27.0	29.4	29.4	40.8	39.2
1995	27.2	25.8	28.7	27.6	40.3	39.8
1996	28.8	28.0	30.0	29.1	38.6	40.4
1997	27.9	26.9	30.0	29.2	40.0	40.3
1998	25.9	25.2	28.4	27.9	38.9	39.1
1999	26.5	25.3	28.5	27.3	39.0	39.5
2000	28.3	27.7	29.3	28.6	38.7	39.1
2001	27.4	26.8	29.5	28.7	39.0	39.6
2002	27.5	25.6	28.4	26.4	39.0	39.4
2003	27.2	25.9	29.1	27.9	39.2	38.6
2004	27.1	26.5	28.4	27.6	39.2	39.5
2005	28.0	26.7	29.2	27.9	38.7	38.1
2006	28.7	27.1	29.0	27.3	40.0	38.7
2007	27.0	26.7	29.1	29.2	39.1	38.6
2008	27.2	25.2	28.6	26.6	39.1	38.2
2009	26.9	25.3	29.3	26.4	39.4	39.0
2010	29.0	27.9	29.8	28.7	39.9	38.2
2011	27.9	27.4	29.2	28.5	39.9	38.7

*** Provisional NA = not available.**

Table 3.7.4. ***Nephrops,*** **Clyde (FU 13): Firth of Clyde subarea. Results by stratum of the 2009–2011 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)
2009 TV survey								
M	717	16	0.741	0.049	531	1583	0.102	
SM	699	11	0.705	0.178	469	7150	0.459	
MS	665	12	1.122	0.168	784	6842	0.439	
Total	2081	39			1784	15575	1	0.066
2010 TV survey								
M	717	13	1.106	0.22	793	8712	0.23	
SM	699	15	1.23	0.516	859	16800	0.444	
MS	665	9	0.648	0.251	431	12324	0.326	
Total	2081	37			2083	37836	1	0.092
2011 TV survey								
M	717	13	1.286	0.141	922	5561	0.168	
SM	699	14	1.494	0.233	1044	8127	0.246	
MS	665	13	0.918	0.569	610	19325	0.585	
Total	2081	40			2576	33013	1	0.071

Table 3.7.5. *Nephrops*, Clyde (FU 13): Firth of Clyde subarea. Results of the 1995–2011 TV surveys. (not adjusted for bias).

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1995	29	0.33	689	210
1996	38	0.54	1113	288
1997	31	0.68	1426	312
1998	38	0.720	1502	254
1999	39	0.532	1107	344
2000	40	0.807	1679	293
2001	39	0.850	1768	319
2002	36	0.899	1870	343
2003	37	1.039	2162	347
2004	32	1.127	2344	437
2005	44	1.121	2331	342
2006	43	1.050	2203	306
2007	40	0.705	1467	260
2008	38	1.012	2105	346
2009	39	0.86	1784	250
2010	37	1.001	2083	389
2011	40	1.239	2576	363

Table 3.7.6. *Nephrops,* Clyde (FU 13): Sound of Jura subarea. Results by stratum of the 2009–2011 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)
2009 TV survey								
M	90	2	0.62	0.02	56	66	0.040	
SM	150	5	0.50	0.10	75	463	0.279	
MS	142	5	1.18	0.28	168	1127	0.681	
Total	382	12			299	1656	1	0.144
2010 TV survey								
M	90	2	1.305	<0.01	117	0.2	<0.01	
SM	150	5	1.066	0.039	160	173	0.332	
MS	142	5	1.202	0.086	171	349	0.668	
Total	382	12			448	522	1	0.057
2011 TV survey								
M	90	2	0.76	0.024	68	98	0.052	
SM	150	5	0.948	0.147	142	661	0.352	
MS	142	5	1.13	0.277	160	1118	0.596	
Total	382	12			371	1877	1	0.124

Table 3.7.7. *Nephrops*, Clyde (FU 13): Sound of Jura subarea. Results of the 1995–2011 TV surveys. (not adjusted for bias).

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1995	7	0.50	190	69
1996	10	0.53	204	31
1997	no surveys			
1998				
1999				
2000				
2001	13	0.850	324	90
2002	9	1.240	474	199
2003	12	0.810	309	81
2004	no survey			
2005	11	0.940	360	100
2006	10	1.340	512	160
2007	10	0.800	304	69
2008	no survey			
2009	12	0.780	299	81
2010	12	1.173	448	46
2011	12	0.971	371	87

Table 3.7.8. *Nephrops*, Clyde (FU 13): Firth of Clyde subarea. 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 (millions)	Harvest ratio	Landings (tonnes)	Discard (tonnes)	Discard rate	Dead discard rate	Mean weight in landings (g)
1999	189	79	267	930	28.7	3424	481	29.6	24.0	16.88
2000	154	43	197	1411	14.0	3230	418	21.8	17.3	19.82
2001	141	71	211	1486	14.2	2980	584	33.5	27.4	19.45
2002	193	47	243	1571	15.4	3349	379	19.4	15.3	16.3
2003	161	130	264	1817	14.5	3153	1209	44.7	37.8	19.16
2004	143	152	284	1970	14.4	2975	1298	51.5	44.4	18.81
2005	179	66	240	1959	12.3	3387	580	26.9	21.6	17.97
2006	234	52	286	1851	15.4	4717	487	18.3	14.3	19.28
2007	323	357	614	1233	49.8	6397	2372	52.5	45.3	19.05
2008	332	192	513	1769	29.0	5919	1329	36.6	30.2	16.42
2009	236	152	382	1499	25.5	4686	1248	39.1	32.5	18.09
2010	236	48	306	1750	17.5	5643	460	16.8	13.1	21.16
2011	326	73	380	2165	17.6	6431	556	18.2	14.3	19.34
Average 2009–2011									0.20	19.53

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

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

Table 3.7.9. *Nephrops*, Clyde (FU 13): Sound of Jura subarea. Adjusted TV survey abundance, landings, discard rate (proportion by number) and estimated harvest rate.

Year	Removals in number (millions)	Adjusted Survey (millions)	Harvest ratio	Landings (tonnes)	Discard Rate*	Dead discard Rate*	Mean weight in landings (g)
2005	3.2	303	1.1	36	26.9	21.6	15.47
2006	5.0	430	1.2	61	18.3	14.3	15.05
2007	10.8	255	4.3	98	52.5	45.3	19.02
2008	5.7	NA	NA	78	36.6	30.2	21.60
2009	5.8	251	2.3	91	39.1	32.5	25.58
2010	4.1	376	1.1	58	16.8	13.1	17.13
2011	3.6**	312	1.2	69	18.2	14.3	na
Average 2009–2011						0.20	21.44**

*** Discard rates assumed to be the same as in the Firth of Clyde.**

**** Average mean weight in landings and Removals number calculated from years 2008–2010 as there were no samples in 2011.**

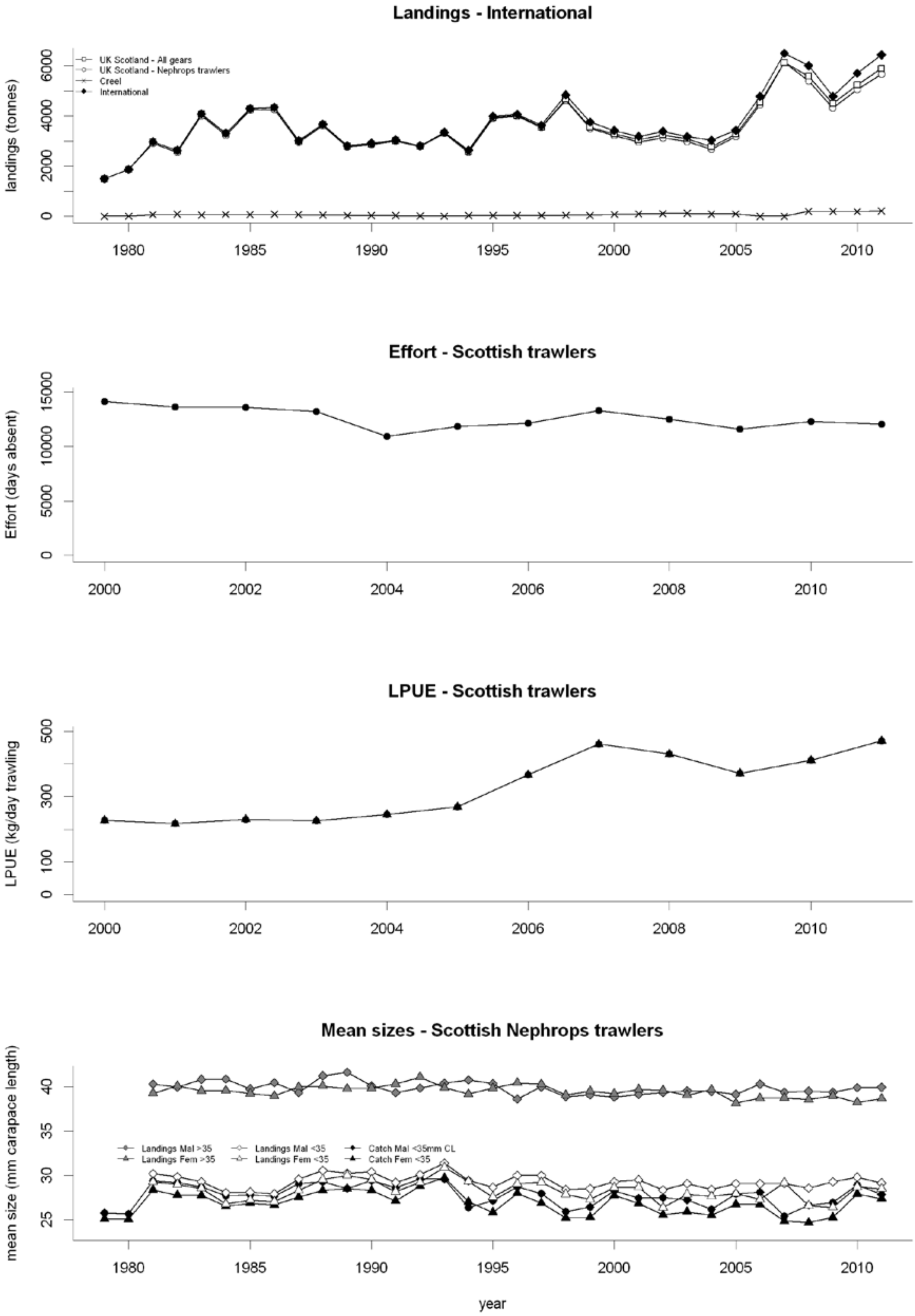
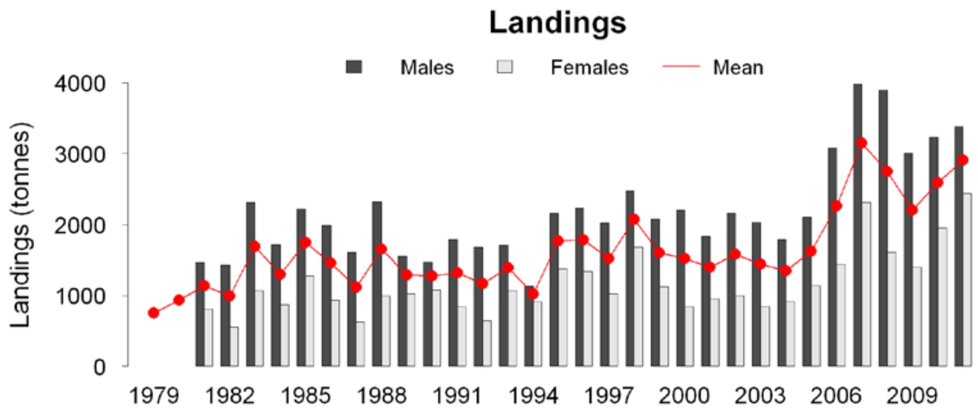


Figure 3.7.1. ***Nephrops*, Clyde (FU13), Firth of Clyde subarea. Long-erm landings, effort, lpue and mean sizes. The interpretation of the lpue series is likely to be affected by the introduction of the "buyers and sellers" regulations in 2006.**



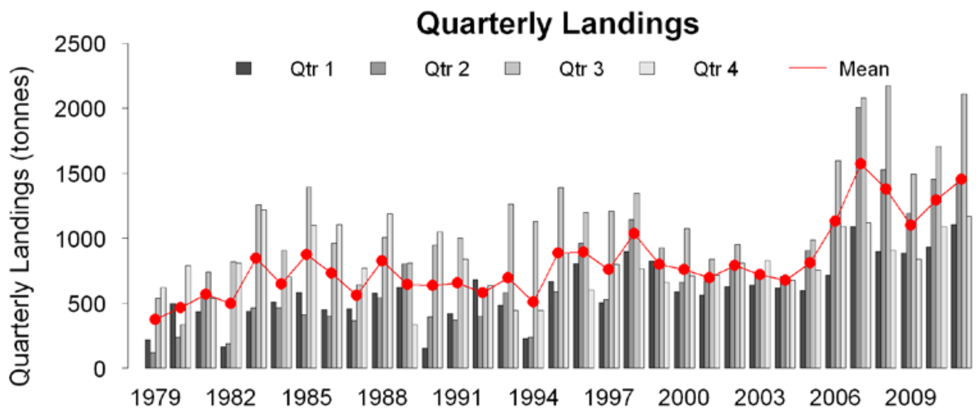


Figure 3.7.2. ***Nephrops*****, Clyde (FU13), Firth of Clyde subarea. Landings by quarter and sex from Scottish trawlers.**

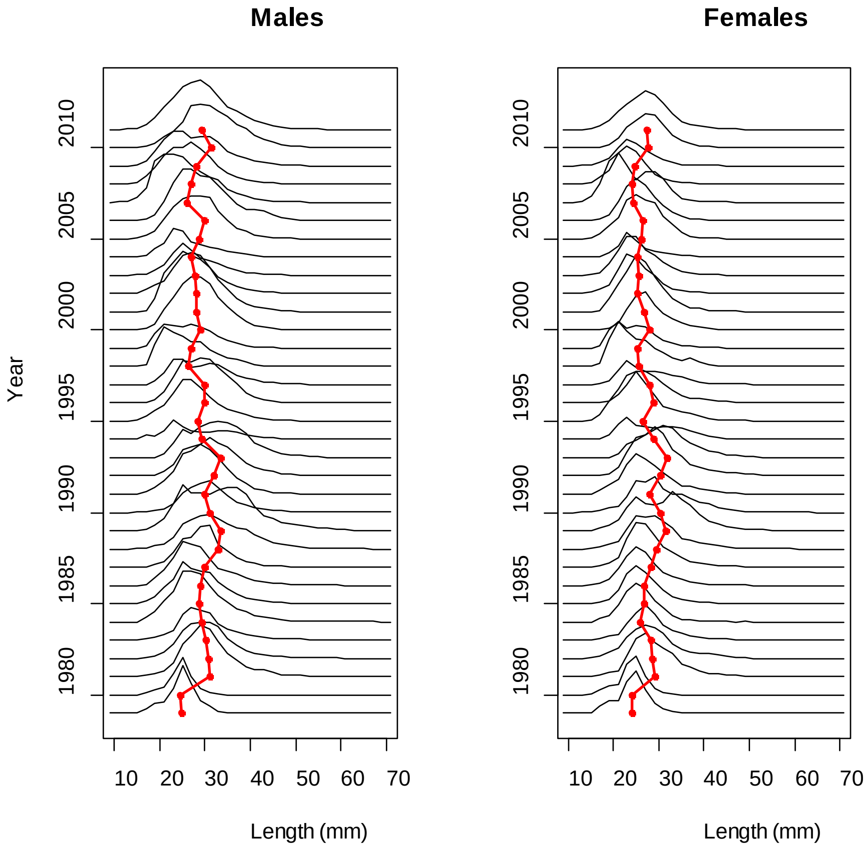
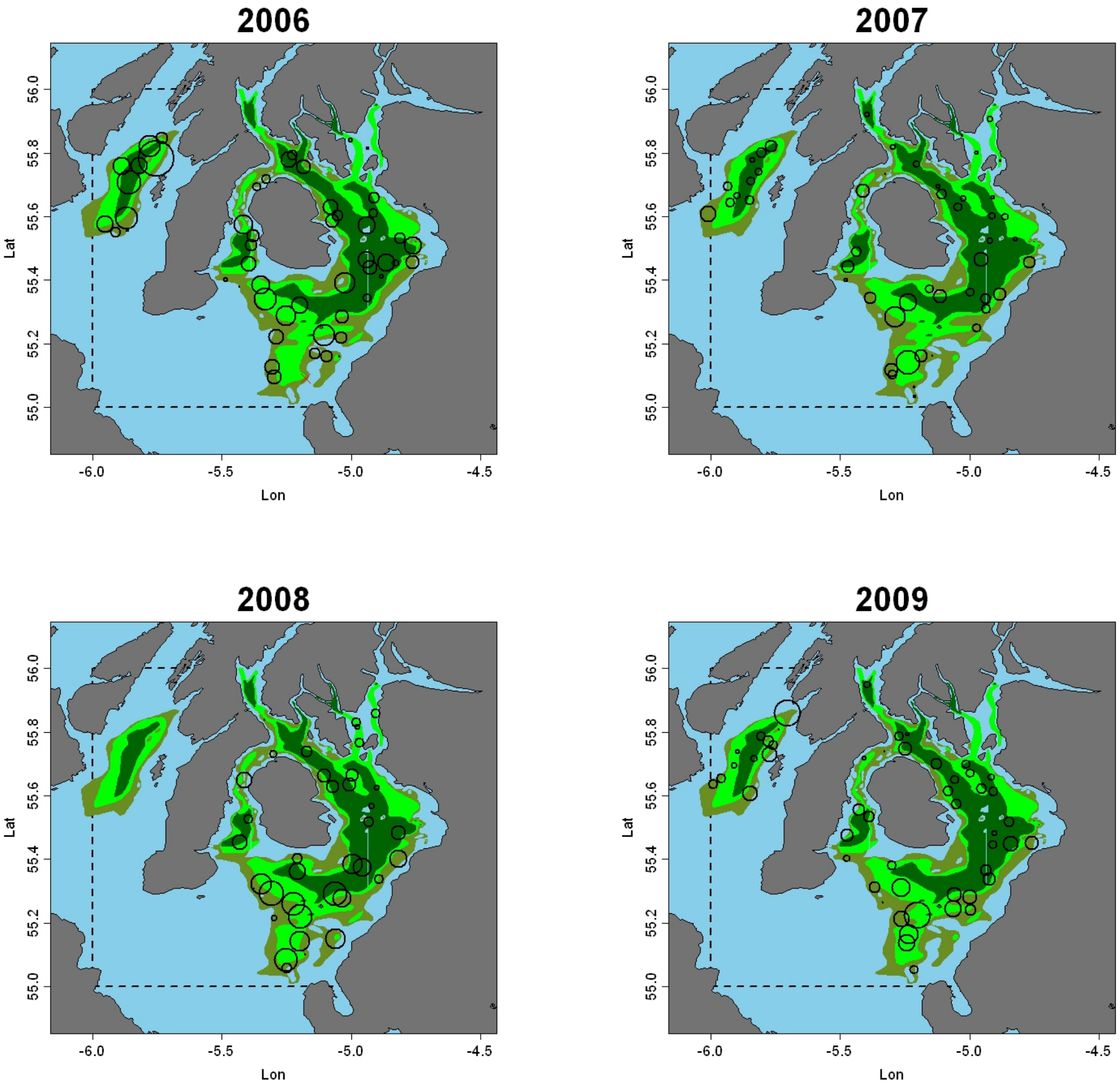


Figure 3.7.3. ***Nephrops*****, Clyde (FU13). Catch length frequency distribution and mean sizes (red line) for** ***Nephrops*** **in the Firth of Clyde, 1979–2011.**


2006
2007
2008
2009
Lat
Lon
56.0
55.8
55.6
55.4
55.2
55.0
-6.0
-5.5
-5.0
-4.5

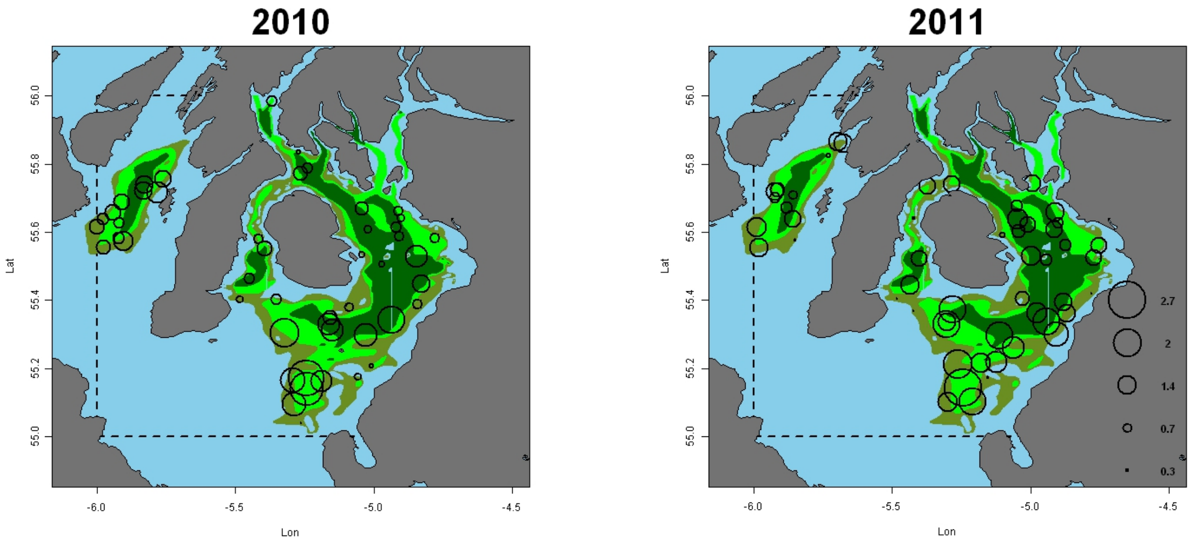


Figure 3.7.4. ***Nephrops*, Clyde (FU13), TV survey station distribution and relative density (burrows/m²) for Firth of Clyde and Sound of Jura subareas, 2006–2011. Sound of Jura located to the east. Shaded green and brown areas represent areas of suitable sediment for *Nephrops*. Bubbles scaled the same. Red crosses represent zero observations.**

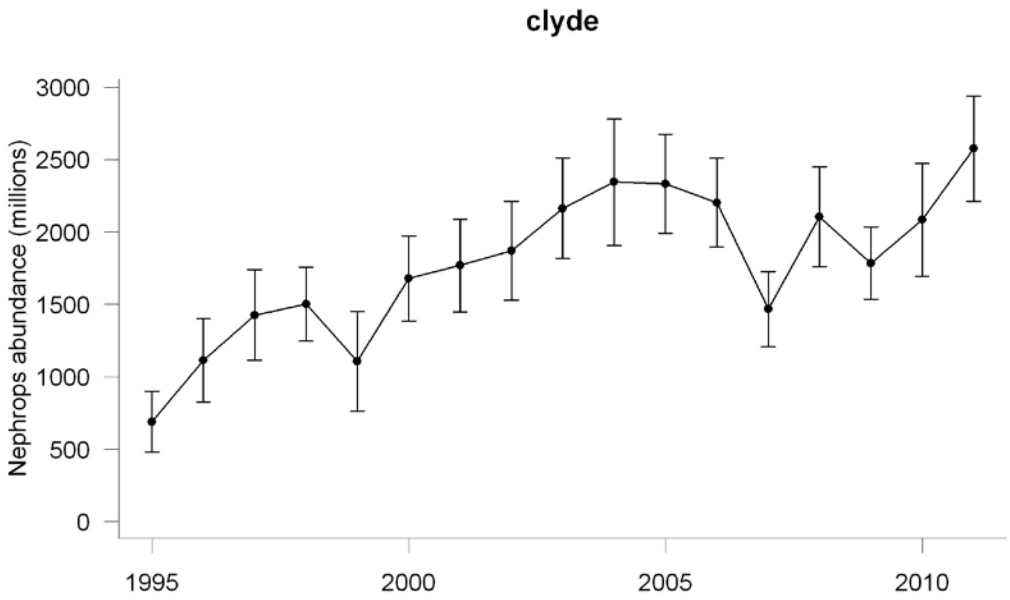


Figure 3.7.5. ***Nephrops*, Clyde (FU13): Firth of Clyde subarea. Time-series of revised TV survey abundance estimates (not adjusted for bias), with 95% confidence intervals, 1995–2011.**

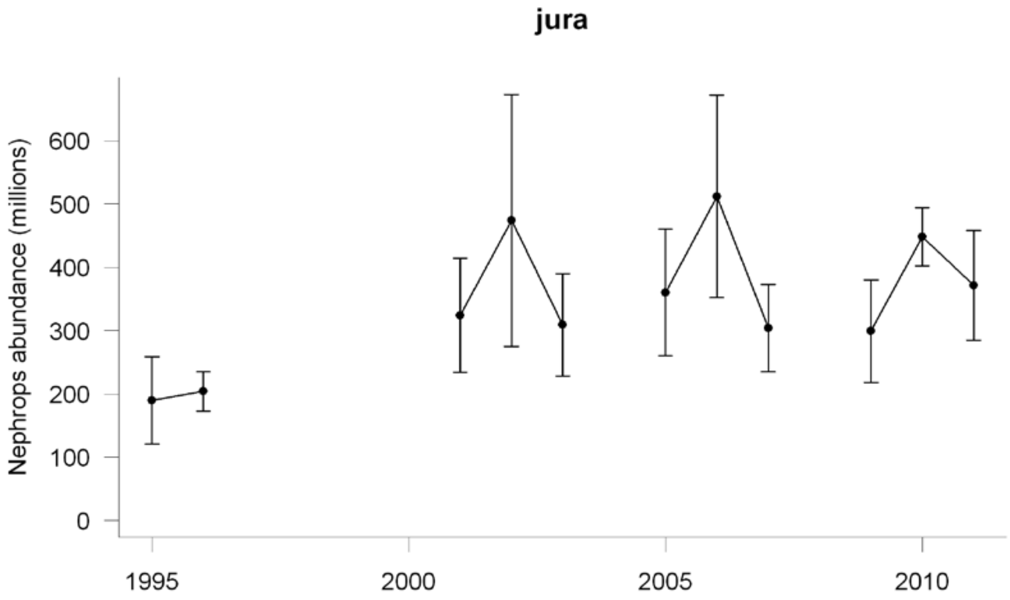
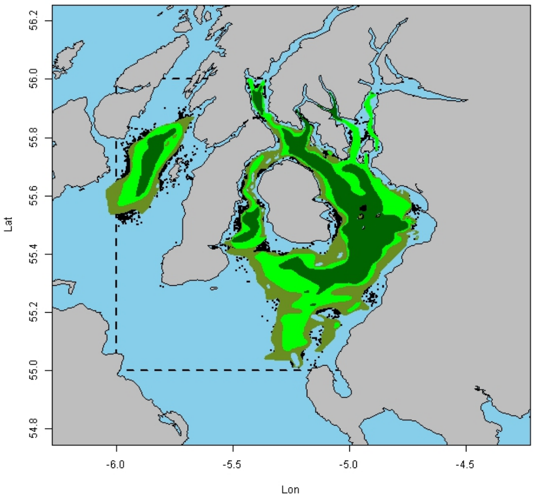
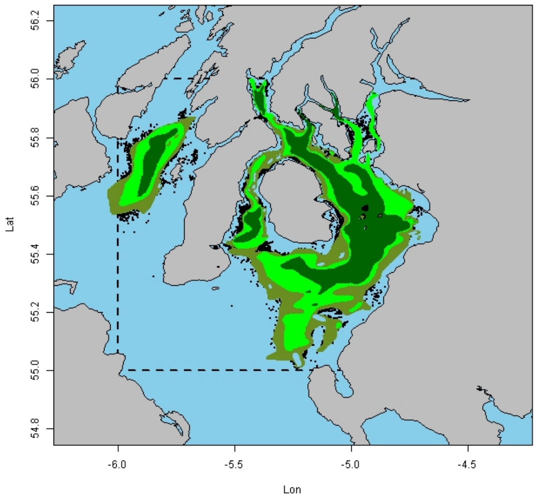


Figure 3.7.6. ***Nephrops*****, Clyde (FU13): Sound of Jura subarea, Time-series of TV survey abundance estimates with 95% confidence intervals, 1995–2011.**

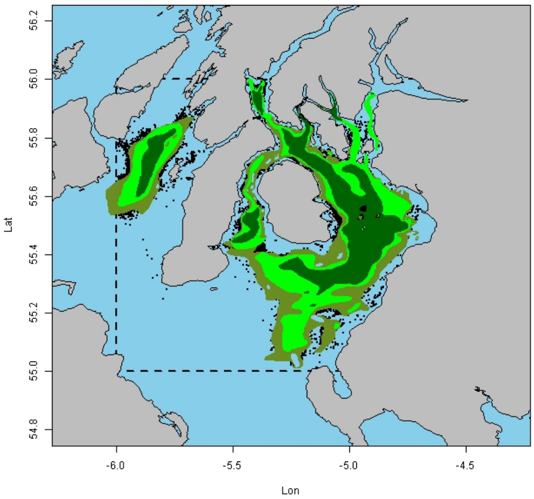
2006



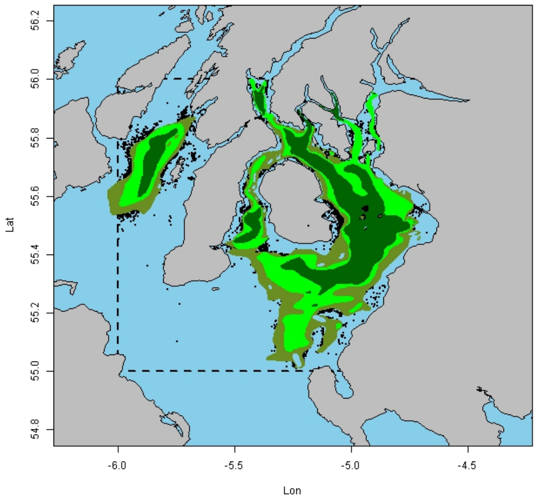
2007



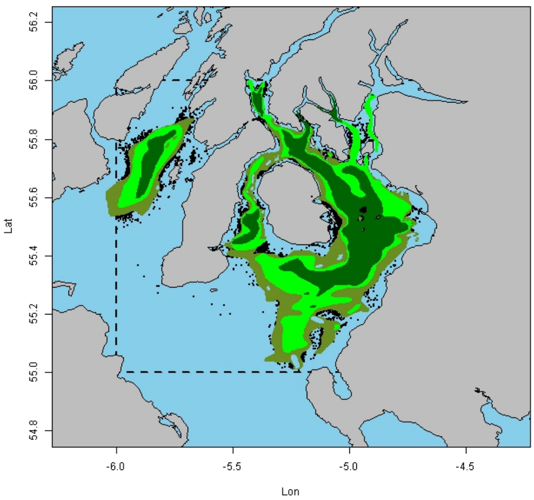
2008



2009



2010



2011

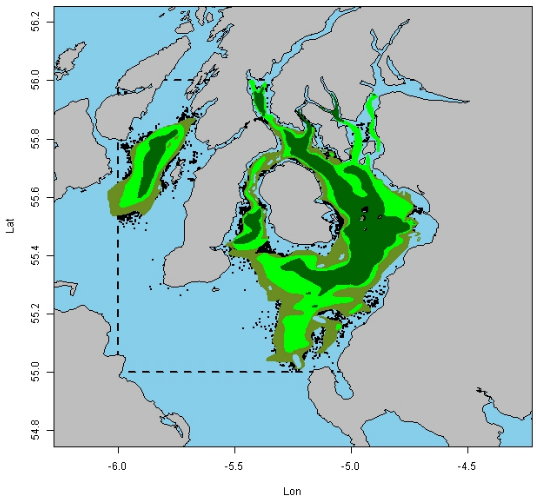


Figure 3.7.7. *Nephrops*, Clyde (FU13), comparison of area of *Nephrops* ground defined by BGS sediment distribution (green shaded overlay) and by distribution of VMS pings (shown by black dots, underlay) recorded from *Nephrops* trawlers >15 m length for 2006–2011. VMS data filtered to exclude vessel speeds >4.5 knots.

4 Rockall Area

4.1 Area overview

Description of fisheries

The demersal fisheries in Division VIb are predominantly conducted by large otter trawlers fishing for haddock, monkfish, saithe, cod, megrim, whiting, and squids, mainly in a mixed fishery. The majority of vessels are trawlers from Scotland, the Russian Federation and Ireland, which are targeted at haddock. The importance of Scottish seiners has been declining in recent years as many of these vessels have switched to pair seining or have been decommissioned.

Apart from otter-trawl fishery, there is a longline fishery, targeting mainly ling andtusk. There is also a significant directed fishery with pelagic trawls for blue whiting in the area.

In 2009–2011 catches of grey gurnard at Rockall increased and the specie often prevailed in catches. But practically all fish was discarded and in fishery statistic not reflected.

Environmental influence on the stocks

At Rockall Bank inhabit many fish species but blue whiting, haddock, grey gurnard and Norway haddock are the most abundance. Recruitment of many species for the last years has been low. Especially poor year classes for the last four were for haddock despite a large SSB. This may be related to environmental factors including observed in the present on the Rockall bank rising seawater temperature.

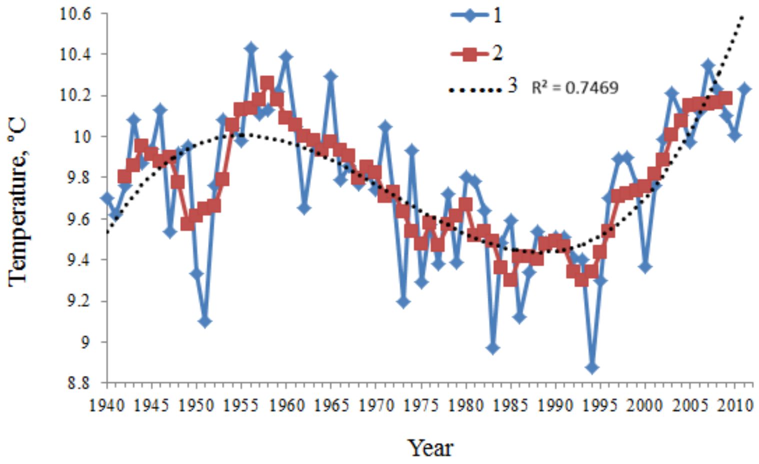
Ocean conditions in the Rockall Bank area are determined by the North Atlantic current. The circulation of water in the Rockall Bank has a general northeast direction. There is the vertical homothermy at the Rockall bank. In recent years in that area has been a significant increase in water temperature (Figure 4.1.1.). An increase in temperature leads to an acceleration of metabolic processes and increasing of the energy and food consumption. Calculations by Jones metology (Jones, 1978) showed that since 2002 the energy consumption of juvenile haddock increased by 1.5–2 times (Figure 4.1.2.). At the same time there was a significant reduction of *Calanus finmarhicus* which is the main food item for larval and juvenile haddock at Rockall (Figure 4.1.3.). In the conditions of lack of food a negative impact on juveniles has increased predation and food competition from the grey gurnard. All these factors led to a reduction in the recruitment and SSB of haddock and other fish.

References

HADSST2 data. Met Office Hadley Centre observations datasets http://www.metoffice.gov.uk/hadobs/.

Jones R. 1978. Estimates of the food consumption of haddock (*Melanogrammus aeglefinus*) and cod (*Gadus morhua*). J. Cons. Int. Explor. Mer, Vol. 38(1), 1978: P. 18–27.

Johns D. 2012. Monthly averaged data for *Calanus finmarhicus* 1958–2010 as recorded by continuous Plankton recorder, Sir Hardy Foundation for Ocean Science. Plymouth. [2012].



1) Temperature °C

2) 5-yr Smoothed data

3) A polynomial trend of 3 degrees

Figure 4.1.1. The temperature in April for the upper ocean (0 m) of the northwestern Rockall bank (HADSST2 Data).

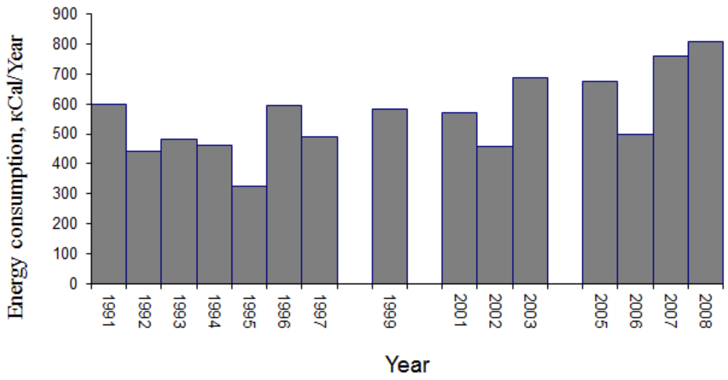


Figure 4.1.2. Energy consumption (kilocalories per year) for one individual of the Rockall haddock at age 1.

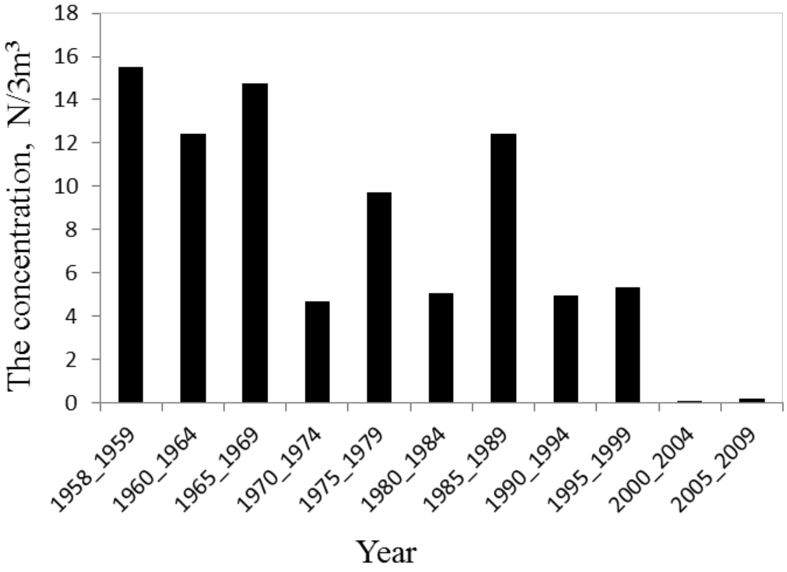


Figure 4.1.2. The concentration of *Calanus finmarhicus* at Rockall in May–June averaged by 5-years periods (by data of Johns, 2012).

4.2 Cod in Division VIb

Officially reported catches are shown in Table 4.2.1 and Figure 4.2.1. Lpue results from the Irish and Scottish otter-trawl fleet are presented in Figures 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 series is too short to draw firm conclusions about trends. No analytical assessment of this stock has been carried out.

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
Faroe Islands	18	-	1	-	31	5	-	-	-	1	-	-
France	9	17	5	7	2	-	-	-	-	-	-	-
Germany	-	3	-	-	3	-	-	126	2	-	-	-
Ireland	-	-	-	-	-	-	400	236	235	472	280	477
Norway	373	202	95	130	195	148	119	312	199	199	120	92
Portugal	-	-	-	-	-	-	-	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-	-	-	-	-
Spain	241	1200	1219	808	1345	-	64	70	-	-	-	2
UK (E. & W. & N.I.)	161	114	93	69	56	131	8	23	26	103	25	90
UK (Scotland)	221	437	187	284	254	265	758	829	714	322	236	370
Total	1,023	1,973	1,600	1,298	1,886	549	1,349	1,596	1,176	1,097	661	1,031

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Faroe Islands	-	-	-	-	n/a	n/a	n/a				
France	-	-	-	-	+	+*	1			0.08	
Germany	10	22	3	11	1	-	-				
Ireland	436	153	227	148	119	40	18	11	7	12	22.7
Norway	91	55*	51*	85*	152*	89	28	25	23	7	7
Portugal	-	5	-	-	-	-	-				
Russia	-	-	-	-	7	26	-				
Spain	5	1	6	4	3	1		6			
UK (E. & W. & N.I.)	23	20	32	22	4	2	2	3			
UK (Scotland)	210	706	341	389	286	176	67	57	45	43	
UK											28.7
Total	775	962	660	659	572	334	115	102	75	62	58.4

Country	2007	2008	2009	2010	2011*
Faroe Islands	-		3	4.9	0.07
France	-			0	
Germany	-				
Ireland	24	40.7	20.4	6.4	11.7
Norway	12	14	25	27.2	48.9
Portugal	-				
Russia	-		1		
Spain	-				
UK (E. & W. & N.I.)					
UK (Scotland)	26	41.3	47.8		
UK				22.7	36.1
Total	62	96.0	97.2	61.2	96.8

*** Preliminary**

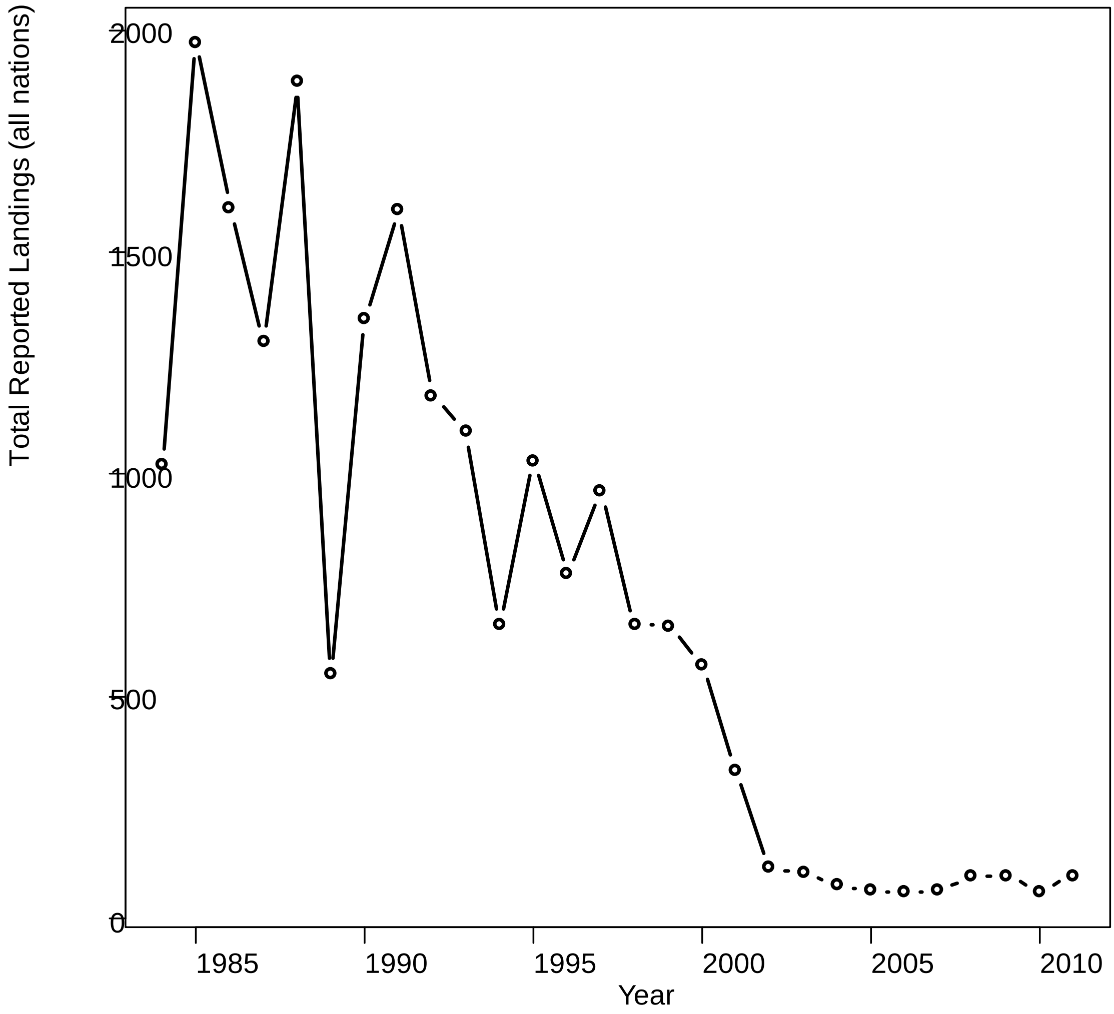


Figure 4.2.1. Cod in Division VIb. Total of official catch (all nations combined), 1984–2011. Values for 2011 are provisional.

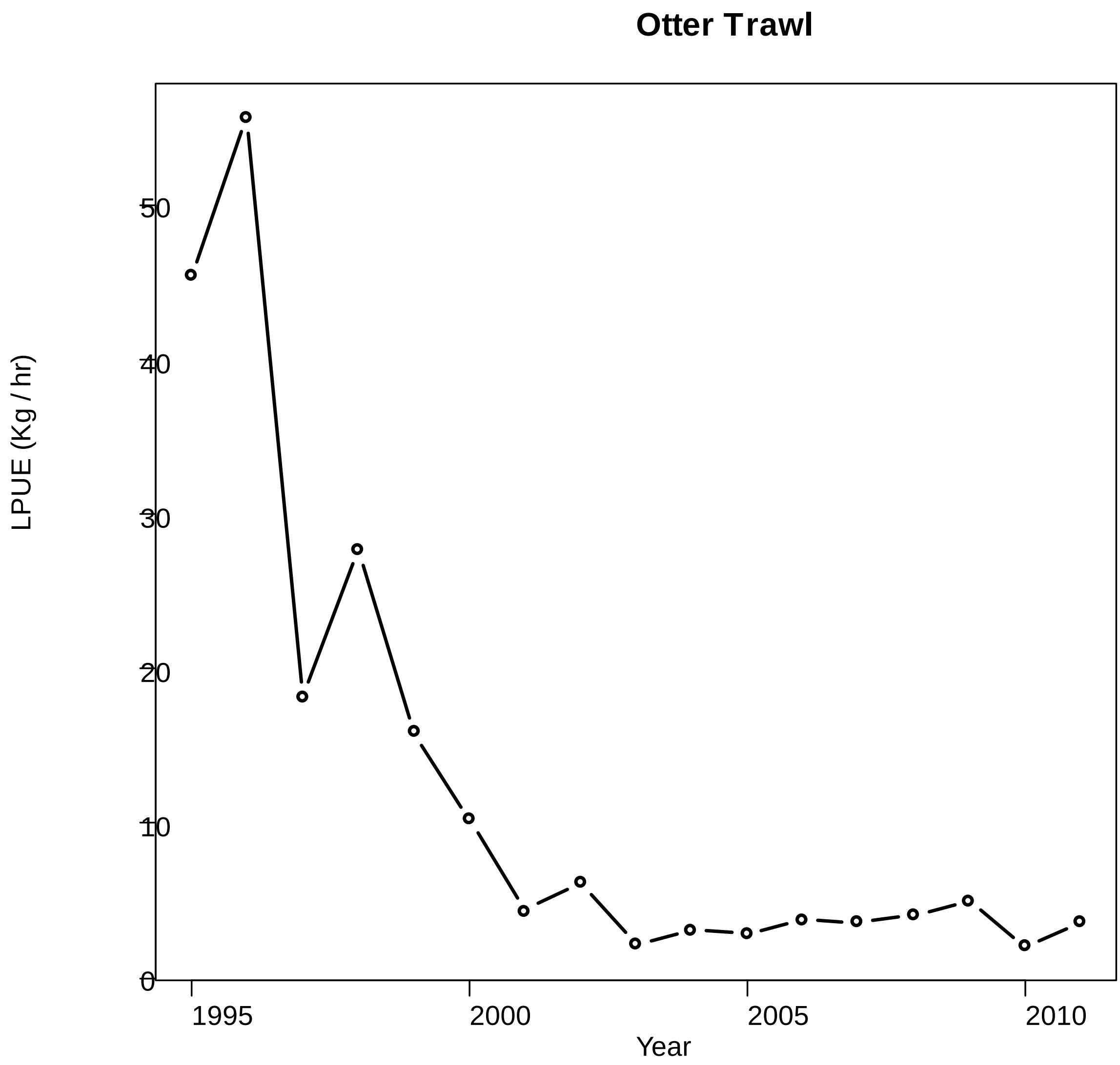


Figure 4.2.2. Cod in Division VIb. Lpue (kg/hr) from Irish Otter-trawl fleet, 1995–2011.

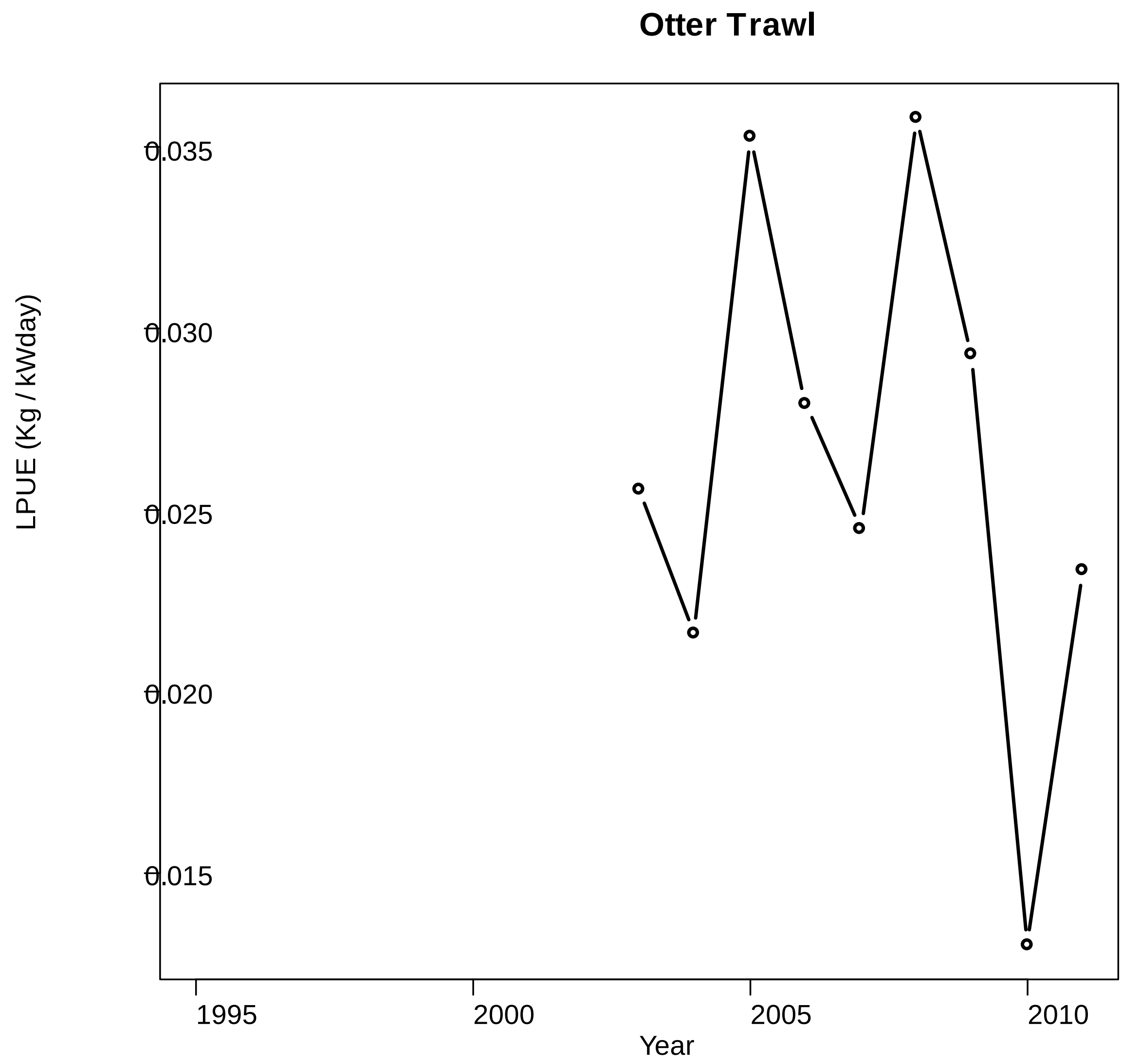


Figure 4.2.3. Cod in Division VIb. Lpue (Kg/kWday) from Scottish Otter trawl fleet, 2003–2011.

4.3 Haddock in Division VIb (Rockall)

Type of assessment in 2012: Update assessment

The assessment of the haddock stock in Division VIb is based on catch-at-age and one survey index (Scottish Rock-IBTS-Q3) and conducted using the XSA method. Discarding occurs in part of the fishery. Discards have been estimated and used in the assessment. In 2005, WGNSDS, on the recommendation of RGNSDS, adopted a new assessment approach, which allows modelling of the total catch (including discards) of the Irish, Scottish and Russian fleets (for details see Stock Annex). The same approach has been used in the annual assessment since 2005. The current assessment is an update of the last year assessment.

ICES advice applicable to 2011

The ICES advice for 2011 in terms of exploitation boundaries was as follows:

MSY approach

Following the ICES MSY framework implies fishing mortality to be reduced to 0.3 (=F_{MSY}), resulting in landings of less than 2700 t in 2011. This is expected to lead to an SSB of 8540 t in 2012.

Because F in 2010 is very close to F_{MSY}, no transition scheme is necessary.

Further management measures should be introduced to reduce discarding of small haddock in order to maximize their contribution to future yield and SSB.

PA approach

A 26% reduction in F is needed to keep SSB to above B_{PA} in 2012. This corresponds to landings of 2350 t in 2011.

ICES advice applicable to 2012

In the advice for 2012, the stock status was presented as follows:

F (Fishing Mortality)				
	2008	2009	2010	
MSY (F_{MSY})	✗	✓	✓	Below target
Precautionary approach (F_{pa},F_{lim})	✓	✓	✓	Harvest sustainably
SSB (Spawning-Stock Biomass)				
	2009	2010	2011	
MSY ($B_{trigger}$)	✓	✓	✓	Above trigger
Precautionary approach (B_{pa},B_{lim})	✓	✓	✓	Full reproductive capacity

MSY approach

"A fishing mortality of 0.3 (=F_{MSY}) corresponds to landings of less than 3300 t in 2012 and is expected to lead to an SSB of 9600 t.

Because F in 2010 is below F_{MSY}, no transition scheme is necessary.

Further management measures should be introduced to reduce discarding of small haddock in order to maximize their contribution to future yield and SSB."

PA approach

"A fishing mortality of 0.4 (=F_{PA}) corresponds to landings of 4200 t in 2012 and is expected to lead to an SSB of 8600 t which will be below B_{PA} in 2013. To keep SSB above B_{PA}, landings in 2012 should be less than 3800 t."

4.3.1 General

Stock description and management units

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

Management applicable to 2011 and 2012

The EU TAC for VIb, XII and XIV was set at 3748 t in 2011 (a 25% reduction compared to TAC for 2010) and is shown below.

Species: Haddock *Melanogrammus aeglefinus*		**Zone:** EU and international waters VIb, XII and XIV (HAD/6B1214)
Belgium	8	
Germany	10	
France	413	
Ireland	295	
United Kingdom	3 022	
EU	3 748	
TAC	3 748	Analytical TAC

The EU TAC for VIb, XII and XIV was set at 3300 t in 2012 (a 12% reduction compared to TAC for 2011).

Species: Haddock *Melanogrammus aeglefinus*		**Zone:** EU and international waters VIb, XII and XIV (HAD/6B1214)
Belgium	7	
Germany	9	
France	364	
Ireland	260	
United Kingdom	2 660	
Union	3 300	
TAC	3 300	Analytical TAC

The ICES advice, agreed TAC for EU waters, and WG estimates of landings during 2002–2011 are summarised below. All values are in tonnes.

YEAR	CATCHES CORRESPONDING TO ICES ADVICE (VIB)	BASIS	AGREED TAC	WG LANDINGS
2002	< 1,300	Reduce F below 0.2	1300[a]	3336
2003	-	Lowest possible F	702[a]	6242
2004	-	Lowest possible F	702[b]	6445
2005	-	Lowest possible F	702[b]	5179
2006	-	Lowest possible F	597[b]	2765
2007	< 7100	Reduce F below F_{PA}	4615[b]	3349
2008	< 10640[c]	Keep F below F_{PA}	6916[b]	4221
2009	< 4300[d]	No long-term gains in increasing F	5879[b]	3814
2010	< 3300[d]	Little gain on the long-term yield by increasing F	4997[b]	3405
2011	<2700[d]	Reduction in F is needed to keep SSB to above B_{PA} in 2012	3748[b]	1903
2012	< 3300[d]	MSY approach	3300[b]	3300

[a] 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.

[b] 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.

[c] Total catch, including landings and discards.

[d] Only landings.

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 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 Stock Annex). A new area to protect cold-water corals (Empress of British Banks) was established by the NEAFC in 2007.

Fishery in 2011

Nominal landings for 2011 and previous years as reported to ICES are given in Table 4.3.1.

Russian fishery in 2011

In 2011 the Russian fishery was not conducted. This was mainly the result of recommendations to reduce the Russian effort at Rockall in response to the decreasing of the haddock stock.

Scottish fishery in 2011

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 in 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 (Table 4.3.1). In

2011 landings declined to 1738 t of haddock. Other important target species included anglerfish (*Lophius* spp.), saithe, ling and megrim.

Irish fishery in 2011

Irish effort in Rockall continued to decline in 2011, and 2011 saw the second lowest effort at Rockall in the time-series (1995–2011). This was prompted by two primary factors, the declining TAC and fuel costs.

Landings totalling 123 t were reported from Irish otter trawlers in 2011 (over a two-fold decrease from 721 t in 2008; Table 4.3.1). The majority of the Irish activity occurred in quarter 2 and early quarter 3. Most of the primary target species (haddock and monkfish) are taken during this time. 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 2011

In 2009, Norwegian landings of haddock amounted to 71 t and 65 in 2010 which was a two-fold increase compared to 2008, and was within the catch range for the periods 2001–2005 and 2007–2009 (32–84 t).

In 2011 the Norwegian demersal fleet fishing on the Rockall Bank consisted mainly of longliners and targeted mainly ling and tusk. Total Norwegian landings of haddock at Rockall in 2011 were 40 t.

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. Reported international landings of Rockall haddock in 1991–2005 varied between 4000 and 6000 t, except for 2001–2002, when they decreased down to about 2300–3000 t. In 2006, they were also low at 2760 t, but increased to 3348 t in 2007 and 4221 t in 2008. In 2010, international landings decreased to 3405 t. In 2011 the decline continued and total landings were 1903 t.

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.

Age composition and mean weight-at-age of Scottish and Irish landings were obtained from port sampling.

Age composition and mean weight-at-age of Russian landings were obtained by observers onboard commercial fishing vessels. In 2002 and 2009, there was no sampling of the Russian catch and therefore the length composition for that year had to be estimated (for estimation details, see Stock Annex). The age composition in the Russian catch in 2009 was assumed to be the same as in the Scottish catches including discards.

Observer data from commercial vessels are also available for Norwegian landings for 2006–2010. The age composition in 2011 was assumed to be the same as in the Scottish landings.

Discards

Historically the discard rate was as high as 12–87% by numbers by results of discards trips (see Stock Annex).

Discarding by EC fleets is significant and therefore the assessment of the stock is done based on the total catch (landings+ discards). On Russian vessels, the whole catch of haddock is kept onboard and therefore, total catch is equivalent to landings and there is no need to calculate discards. Haddock discards onboard Scottish and Irish vessels were in some years determined directly, while in other years, indirect estimates of discards were done (for details of the estimation of discards see Stock Annex).

The proportion of fish discarded from Scottish and Irish catches at different sizes was determined and modelled using a logistic curve. Calculations where the discard curve was applied agree well with the results of size composition measurements from Scottish vessels in 1999 and 2001 and from the combined 1995–2002 Irish discard trips (see Stock Annex).

For estimation of the discards in 2010, no onboard observations for Scottish and Irish fleets were available, and it was not possible to use the logistic selectivity curve to the haddock stock length composition obtained from the survey (see stock annex), since no survey was carried out in 2010. The discards were therefore estimated using the mean proportion of discards/landings-at-age over the period 1999–2009. As the recent recruitments are weak and the landings mainly composed of age 5, the resulting overall discards rate is estimated to be one of the lowest in the time-series.

The discards for 2010 in assessment 2011 were estimated as for the period 2007–2009 from sampling aboard Scottish and Irish vessels (Table 4.3.2). Last year the discards ratio declined as a result of the poor year classes and decreasing number of small haddock. In 2011 the discards ratio was 7% by weight and 11% by numbers.

Biological

There was no change in biological parameters compared to the 2011 assessment (see Stock Annex).

Surveys

There is only one abundance index available for VPA assessment of this stock from the Scottish Rock-IBTS-Q3 survey (Figure 4.3.1). The survey is conducted in about 40 standard trawl stations. However, the survey area varied along with the number of stations in different years and survey covers only part of the currently known distribution area of haddock (see Stock Annex).

The distribution of sampling stations has slightly varied over time (Figure 4.3.1). The stations located in the southwest were not sampled every year and area that was covered by survey considerably differed in same years. Survey data were standardized for exploratory runs in 2009–2010. The stations which were located in the southwest were excluded from calculation. VPA in 2011 was run with the non-standardised indices, i.e. same indices as last years for final run (Table 4.3.3). The indices for 2010 are missing, since the Scottish Rock-IBTS-Q3 survey did not occur in 2010 due to a technical problem on the vessel. In 2011 the survey used in the assessment was carried out.

Before 2011 the survey covered only part of the currently known distribution area of haddock, and that raised uncertainty in the assessment. The survey area coverage was reviewed and extended into deeper waters in 2011. Using trawl survey data, the abundance and the length composition of haddock located in shallow waters of the central part of the bank and areas with >200 m depths showed different patterns (WD 8).

Area covered by survey, in the majority of the cases, included areas with depths less than 200 m is regarded as the standard survey area. The indices obtained from the standard survey area were used for assessment (Figure 4.3.2). New survey indexes will be used for the assessment once the time-series for the whole area of haddock distribution is of sufficient length (WD 8).

Abundance and biomass assessments were conducted on the basis of Scottish Rock-IBTS-Q3 trawl surveys using three methods of stratification of the survey area (WD 8):

1) by geographic strata of 15' latitude wide and 15' longitude long (Figure 4.33);
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).

For all three methods, the haddock stock at Rockall in 2011 went to 20 years minimum level due to emergence of quite sparse generations throughout 2007–2011 (Figure 4.3.3, Figure 4.3.4, Figure 4.3.5) (WD 8).

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 stock 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 Stock Annex). No such survey has been conducted in subsequent years. In 2010 the Russian survey covered only small part of Rockall bank.

Commercial cpue

Commercial cpue 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 4.3.4. Commercial cpue series for the different fleets are shown in Figure 4.3.7.

In 2005–2009, the Russian effort in bottom fishery (in hours and number of vessels/days) decreased due to economic reasons (Figure 4.3.7). Haddock catches varied accordingly with the changes in fishing effort. In 2006–2007, cpue in the Russian haddock fishery (mainly with trawlers of tonnage class 10) increased compared to previous years. In 2008–2009, it slightly decreased (with trawlers of class 8 and 9 only). The dynamics of catch per unit of effort for vessels agrees of tonnage class 10 agreed well with year-to-year variations in total biomass of haddock (Figure 4.3.8).

The effort data from the Scottish fleets are known to be unreliable due to changes in the practices of effort recording and non-mandatory effort reporting (see Stock Annex). Despite the uncertainty about the fishing effort, the lpue for the Scottish fleet increased considerably in 2007 and 2008 compared to previous years (Figure 4.3.7).

The effort information for 2010 and 2011 was considered inconsistent with previous years, and thus not presented here.

The Irish otter-trawl effort series indicated low values between 2002 and 2005 with the lowest value in 2004. In 2006–2008, the effort increased considerably, but declined in 2009–2011 (Figure 4.3.6). The lpue showed an increase in 2007–2009, but decreased in 2010–2011 (Figure 4.3.7).

In 2009–2011, 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.

Other relevant data

The Irish Fisheries Board (BIM) and the Marine Institute recently conducted a collaborative series of surveys to assess the length structure of haddock at various locations on the Rockall Bank and tested the selectivity of a number of codend configurations, which are typically used by the Irish fleets.

The selectivity of gears with different mesh sizes was also investigated at Rockall by Russian scientists in 2010.

4.3.3 Historical stock development

Model used:

The assessment is based on catch-at-age data and one survey index (Scottish Groundfish Survey) 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 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

Q plateau: 5

Shrinkage stand. error: 1.0

Shrinkage age, year: 4 years, 3 ages

Minimum stand. error: 0.3

Plus group: 7+

F_{BAR}: 2–5

Input data types and characteristics:

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

Year range: 1991–2011

Age range: 1–7+

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

Year range: 1991–2009

Age range: 1–6

Data screening

Figures 4.3.9 and 4.3.10 and Table 4.3.5 show landings, discards and total catch by number and weight. Landings, discards and total catch-at-age by number are shown in Tables 4.3.6–4.3.8.

Mean weights-at-age in total catch, landings, discards and stock are shown in Tables 4.3.9–4.3.12. The mean weights-at-age in the stock are assumed to be the same as the catch weights. The temporal dynamics of haddock mean weights-at-age in the total catch (including discards) are shown in Figure 4.3.11. In 2011 discard rate was the relatively low and a small number of samples of discarded haddock were collected (especially for older ages). As results mean weights-at-age 5 and 6 in discards were higher in 2011 compared to previous years (Figure 4.3.11). This increase was observed in the Scottish samples. Mean weights and accordingly numbers of Scottish discards at age 5 and 6 for 2011 has been recalculated using linear regression by analogy with haddock VIa. Due to low numbers of discards of these changes did not significantly affect the mean weights-at-age of the total catch.

The mean weights-at-age in the total catch (including discards) and in the stock are shown in Figure 4.3.12.

There were small landings of haddock aged 1 in 2010–2011 and very few aged 2 to 4 compared to historical values. Discarded fish are, primarily, haddock aged 1–2 (see Tables 4.3.1 and 4.3.2 in Stock Annex). Figures of log catch by age show that these values are much less variable when discards are included (Figures 4.3.13–4.3.18). Data on catches, landings and discards-at-age are given in Tables 4.3.6–4.3.8.

The Scottish trawl survey was the only survey index available to the working group. Plots of log cpue by age, year and year class are shown in Figures 4.3.19–4.3.21.

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 4.3.22. SSB shows a declining trend from 1995, an increase in 2003–2004 and a general decrease in the subsequent years. The estimates of the temporal component of Z are very noisy, but indicates a steep between 2000 and 2003 followed by an upward trend Retrospective analysis showed consistent estimation of SSB and Z (2–5) (Figure 4.3.22a).

Comparative scatter plots of log index at age are shown in Figure 4.3.22b. 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 Stock Annex. There were no changes in settings compared to the assessments 2010.

The diagnostics file of the final XSA run is given in Table 4.3.13 and Figure 4.3.23. Adjusted survey cpue against XSA population estimates are shown in Figures 4.3.24–4.3.25. The analysis of residuals and retrospective analysis (Figures 4.3.23, 4.3.25, 4.3.26) shows that applying the chosen parameters for XSA (as in the Stock Annex) improves the residual patterns compared to other exploratory settings. However, there are still same trends 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 21 years 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 4.3.27. The final XSA results are given in Tables 4.3.14–4.3.16. The final XSA and SURBA results are compared in Figure 4.3.28. 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 4.3.29.

Comparison with previous assessments

XSA was conducted with the same basic assumptions and setup as last year's assessment. Perceptions of the stock have not changed. Figure 4.3.30 shows, for comparison, SSB, recruitment at age 1 and mean F (2–5) estimates in the present assessment and assessments going back to 2001. The estimates from this year's assessment are reasonably consistent with the assessments carried out in previous years (Figure 4.3.30).

State of the stock

Spawning biomass has increased in recent years as a result of the 2001 and 2005 year classes. SSB has been above B_{PA} since 2003, but reduced from 2009. Fishing mortality was above F_{PA} throughout most of the time-series but declined in 2005 and has remained below or close to F_{PA} since then. Recruitments since 2007 are estimated to be extremely weak and there is a high probability that SSB will decrease to levels below B_{PA} in 2013 and below B_{lim} in 2013.

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 0.4 for total survey index (Figures 4.3.31–4.3.32).

StatCam summary plots are shown in Figure 4.3.33.

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 4.3.34.

4.3.4 Short-term projections

Estimating year-class abundance

In 2011 the abundance index for age 0 in the survey are estimated to be extremely weak, in line with previous estimates over the period 2007–2009 (Figure 4.3.35). VPA abundance for age 1 has been highly correlated with age 0 indices over most of the time-series (from 1993 onwards, Figure 4.3.36). The recruitment (age 1) in 2012 was therefore estimated using RCT3 regression (Shepherd, 1997) relating survey indices to stock abundance. The recruitment in 2012 was estimated at 398 thousand, one of the lowest values of the time-series. Poor year classes may be related to environmental factors including observed presently on the Rockall bank rising seawater temperature, reduction of *calanus finmarhicus* and negative impact on eggs and larval predation and food competition from the grey gurnard (See Section Rockall area overview).

For forecasting recruitment (age 1) in 2013 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 correspond 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 5. The 5th lowest value of the time-series corresponds to a value in 2007 (13 432 thousands).

The input data for the short-term forecast can be found in Table 4.3.23. *Status quo* fishing mortality is taken as a 3-year mean of the values over the period 2009–2011 rescaled to the last value because of the persistence of the recent downward trend in F. Three year mean values were used for stock weights and catch weights.

For forecasting discards and landings, the proportion of discards/landings-at-age in 1999–2011 as defined in the Stock Annex was used, (Tables 4.3.5–4.3.8, Figure 4.3.37). The input to RCT3 is given in Table 4.3.17. Results obtained from the forecast (including discards) are given in Tables 4.3.18–4.3.21. The short-term forecast is also shown in Figure 4.3.38.

The sensitivity analysis of forecast is shown in Figures 4.3.39. The probability of SSB in 2014 being below B_{pa} is about 98% and below B_{lim} is about 92% (Figure 4.3.40).

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 are shown in Tables 4.3.22.

4.3.5 Medium-term projection

Medium-term projections were conducted using the Marlab software. There appears to be little or no relationship between spawning biomass and recruitment levels at age 1 and no attempt to fit a stock–recruitment relationship to these data has been made. Particularly high discard rates result in very poor estimation of both the overall level and the inter-annual variability of recruitment. Significant year-to-year fluctuations of recruit abundance can be seen, and that the link between adult haddock biomass and abundance of survived fingerlings and yearlings is absent. In the years when biomass is at high levels, poor year classes are often observed. So in 2001, when the stock was low, one of the most abundant year classes appeared. Strong year classes previously appeared on average once every 4–5 years, although the available time-series is relatively short. In the last years recruitment is very poor, since 2005 no strong year classes. SSB has been higher than B_{PA} in recent years but recruitment for the last four years has been low which may be a consequence of rising temperature. With F_{sq} = 0.21 there is a more 80% probability of SSB falling below B_{pa} in the long term (See Figures 4.3.41–4.3.42).

4.3.6 Biological reference points

Precautionary approach reference points

Biological reference points for this stock are given below:

B_{lim}: 6000 t (lowest observed SSB)

B_{pa}: 9000 t (B_{loss} × 1.4)

F_{pa}: 0.4 (by analogy with other haddock stocks).

Figure 4.3.43 shows the stock in 2011 to be above B_{pa} and below F_{pa}.

Yield per recruit analysis

The stock–recruitment scatter plot is shown in Figure 4.3.44. Yield per recruit results, long-term yield and SSB (conditional on the current exploitation pattern) are shown in Figure 4.3.45. *Status quo* F (0.21) is approximately twice as lower than F_{max} (0.40) and twice as high as $F_{0.1}$ (0.11).

MSY evaluation

MSY estimates were evaluated in 2010 (WGCSE 2010) and 2011 using the srmsymc ADMB package. The number of stock and recruit pairs for this stock is fairly limited and these also show a relatively wide dynamic range. Given the high CVs on all F parameters the WG concluded that the underlying data did not support the provision of absolute estimates of F_{MSY} but that current F was close to that expected to deliver long-term equilibrium yield in causes if recruitment will be higher than in recent years (See Figures 4.3.46–4.3.50). Estimates of F reference points and equilibrium yield and SSB against mortality are present in Table 4.3.24.

4.3.7 Management plans

There is a need for an internationally agreed management plan. This would require a management strategy evaluation to identify an appropriate F_{MSY} target. Such a plan should involve extensive collaboration between stakeholders, scientists and management authorities in both the design and the monitoring of conservation measures. Management measures in the haddock fishery could be a combined application of TAC and limits of fishing efforts and should include effective control and enforcement measures. It would be beneficial to develop and introduce into fisheries practice measures aimed at minimising exploitation of juveniles.

In 2008–2009 the Russian Federation and the European Community have had consultations to develop a fisheries management plan. The report of the scientific working group was presented to the Delegations in 2009. It was recognised that the report contained all the relevant available data on the state of the stock and identified the issues, which would require continued cooperation between the Parties both at scientific and management levels.

In 2004, an ICES Expert Group met to deal with a request for advice from the EU and Russia concerning Rockall haddock management plans. They concluded that the lack of alternative assessment approaches precluded the identification of potential alternative limits to exploitation that may be useful to long-term management. In addressing this term of reference the Expert Group considered alternative approaches to management.

A management plan is under development and is currently being evaluated. European Community and Russian Federation have proposed draft plan for harvest control component of a long-term management plan for haddock at Rockall. NEAFC requests ICES to evaluate the proposal for the harvest control component of a long-term management plan for Rockall haddock and in particular to consider whether the plan is consistent with the precautionary approach and will provide for the sustainable harvesting of the stock.

The 2004 Expert Group acknowledged that the Precautionary Approach requires that management be implemented in data poor situations. The Expert Group considered that the principles of the Precautionary Approach may have application to Rockall haddock provided the implementation considers the particular biology of the target species and the way it is exploited. For Rockall haddock the Expert Group considered that the fishing mortality should not be allowed to expand. Adoption of a TAC may actually allow increased fishing mortality if the stock is declining or there is significant unreported catch. Moreover, application of TACs implies that there is a simple relationship between a recorded landing of a species and the effort exerted on that species. Such an assumption is unlikely to be true for Rockall haddock. Furthermore, there are ways of evading TACs including misreporting, high grading and discarding. In the case of Rockall haddock these may occur to a large extent due to the remote nature of the fishery and the processing of catches at sea by some fleets. The Expert Group concluded that effort regulation rather than TACs may be a better means of controlling fishing mortality on Rockall haddock in the long term but that TAC regulation could be used in the future if more objective and accurate biological and fishery information are routinely provided (ICES CM 2004/ACFM:33). In circumstances where population is dominated by small individuals and differences in length of older and younger age groups are not great, the effectiveness of using selective properties of trawl gear is very low. Comparison of the discard practices of the national fleets operating at Rockall indicate that an increase of minimum mesh size (as was the case in 1991) does not result in considerable reduction of the proportion of small individuals in catches, however catch rates are decreased. ACFM 2007 was unable to forecast discards and include them in TAC, and as a result, there were no recommendations on allowable landings. ACOM 2008 recommended applying TAC to landings only.

Further measures should be introduced to reduce discarding of haddock in VIb.

A management plan is under development and is currently being evaluated. In September 2011 in accordance with the conclusions of the 2010 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 2011 Annual Meeting. The ICES is requested to evaluate the EU-Russia proposal for the harvest control component of the management plan for Rockall haddock. EU-Russian proposal for harvest control component of the management plan for Rockall haddock will be consider at next Annual Meeting of the NEAFC.

4.3.8 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 probably indicative of the general stock trends. However, F is considered to be poorly estimated due to the following sources of uncertainty in the current assessment:

1) The method of estimating discards from survey data, although considered appropriate, is likely to be the main source of error, especially in 2010 where an average rate had to be used since the survey could not take place.
2) There are concerns over the accuracy of landings statistics from Rockall in earlier years.
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 done 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.

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.

The survey covers only part of the currently known distribution area of haddock that raises uncertainty of an assessment.

There are concerns about the ability to forecast future catches and landings given substantial changes in national composition of the fleets operating at Rockall. A substantial change in TAC may lead to big changes in discarding practices. The Working Group previously presented forecast for total catch. However, with increased EU catches with discards, this approach is no longer considered appropriate. The present forecast predicts future catches disaggregated into landings and discard components.

The WG makes the following reservations about the forecast:

1) The future fleet composition at Rockall is very uncertain.

2) Discard proportion-at-age has varied considerably over time (Figure 4.3.37) but without clear trend since 1999. Therefore, average proportions at age for 1999–2011 were used and it is assumed that these values will also apply for 2012–2013.
3) The recent recruitment estimates are among the lowest in the time-series. The chosen 25th percentile for forecasting, although more precautionous than the geometric mean is still ten times the average value over the period 2009–2011.

4.3.9 Recommendation for next benchmark

The main conclusion of WGCSE is that time-series of improved landings and discard data is needed before progress can be made towards the next benchmark assessment of this stock.

The indices obtained from the standard survey area must be used for the next assessment on account of heterogeneity of the abundance and length–age composition of 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.

It is recommended to analyse the opportunity of using new estimation models including Statistical catch-at-age analysis which could improve quality of assessment.

It would be beneficial to develop and introduce standardization methods for reading of age for haddock.

No timeframe for the next benchmark could be proposed at this stage.

4.3.10 Management considerations

Fishing mortality has declined over time and is now below F_{MSY} and F_{PA}. Spawning biomass has increased up to 2008 as a result of the 2001 and 2005 year classes and decreased constantly since. SSB has been above B_{PA} since 2003. Recruitments since 2007 are estimated to be extremely weak and there is a high probability that SSB will decrease to levels below B_{PA} and MSY$B_{trigger}$ in 2013 and below B_{lim} in 2013. Because of the absence of recent recruitment, any values of F, including F_{MSY} lead to a decreasing of SSB below $B_{trigger}$, this option should not be chosen for management.

Fishing mortality levels have historically been high but has decreased since 2005. The fishing mortality has decreased for small individuals (age 1 and 2) since 2001. Survey-based indices of SSB indicate that the stock was at a historical low in 2002, but have increased since.

The forecast predicts future catches disaggregated into landing and discard components. The mean discard ratio at age is around 47% in 1991–2009 and 34% by number in the recent period (1999–2009). In 2011, the discards are significantly reduced as a result of the small number of young haddock in population. Some countries land the whole catch while others discard part of the catch. For countries which discard part of the catch the discard rate in the past was as high as 52–87% by numbers by results of discards trips. 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).

In 2004–2011, the analytical methods of stock estimation were improved, the new data on biology and distribution were obtained, a trawl acoustic survey was carried out and the biomass of haddock from the Rockall Bank was estimated. The results from these investigations allow us to draw the following conclusions:

1) Due to the appearance of above average year classes in 2000–2001 and 2005, the haddock stock has increased over the subsequent few years.
2) The recruitments since 2007 are estimated to be extremely weak and there is a high probability that SSB will decrease to levels below B_{PA} in 2013.
3) It would be beneficial to conduct the ground fish/trawl-acoustic survey annually. An annual trawl survey covering the whole of the distributional area may improve the assessment of the stock status.
4) Discarding and the use of small mesh gear have historically resulted in significant mortality of small haddock.
5) Regulation measures applied for haddock fishery encourage discards. Changes in the level of fishing mortality will not improve the situation as it will still be difficult to present forecasts both for discards and landings, and consequently for fishing mortality rates. Furthermore, there are ways of evading recommended fishing mortality including misreporting, high grading and discarding.
6) It would be beneficial to develop and introduce into fisheries practice measures aimed at preventing discards of undersized haddock.
7) General management issues aimed at maintaining a healthy stock of Rockall haddock, such as changes in landing size, changes in mesh size, use of square mesh and headline panels, licenses to fishing and closed areas, are currently being discussed through ongoing negotiations between EU and the Russian Federation.

4.3.11 References

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Table 4.3.1. Nominal catch (tonnes) of haddock in Division VIb, 1993–2011, as officially reported to ICES.

Country	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010[1]	2011[1]
Faroe Islands	-	-	-	-	-	-	-	n/a	n/a	-	-	-	-	2	2	16	-	42	2
France	...[2]	...[2]	...[2]	-	-	-		5	2	-	1	-	-	-	-	-	-	-	<1
Iceland	-	-	-	-	-	-	167	-	-	-	-	-	-	-	-	-	-	-	-
Ireland	692	956	677	747	895	704	1,021	824	357	206	169	19	105	41	338	721	352	169	123
Norway	68	75	29	24	24	40	61	152	70	49	60	32	33	123	84	36	71	65	40
Portugal	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Russian Federation	-	-	-	-	-	-	458	2,154	630	1,630	4,237	5,844	4,708	2,154	1,282	1669	55	198	-
Spain	-	-	28	1	22	21	25	47	51	7	19	-	-	5	-	-	-	-	-
UK (E, W & NI)	308	169	318	293	165	561	288	36	-	-	56	-	-	-	-	-	-	-	-
UK (Scotland)	3,045	2,535	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]
Total	4,113	3,735	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
Unallocated catch	671	1,998	-379	-543	-591	-599	-851	-357	-279	299	94	139	1	0	0	0	-192	0	0
WG estimate	4,784	5,733	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

[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. Discards and retained catch haddock (number per trip) by Irish discard trips in the Rockall area in 2007–2009 and 2011.

Year	2007		2008		2009		2011	
Length (cm)	Discards	Retained Catch	Discards	Retained Catch	Discards	Retained Catch	Discards	Retained Catch
19	1.3							
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
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
31	462.6	47.2	7573.7	40.6	1338.1	9.9	28.6	17.1
32	298.8	88.3	4639.0	77.8	1762.8	57.8	46.9	125.3
33	227.3	99.4	3664.7	126.8	2256.5	235.9	20.7	92.4
34	120.8	139.2	2391.8	277.4	1496.5	397.3	16.0	196.8
35	78.3	118.8	1590.1	503.6	656.6	614.8	4.8	118.6
36	27.4	187.0	871.7	580.5	423.5	567.1	0.3	340.4
37	26.1	139.8	280.3	640.9	66.9	526.8	0.0	235.8
38	24.3	142.7	78.3	581.9	57.4	421.4	0.0	632.2
39	3.4	162.5	206.6	443.0	23.1	346.9	4.8	312.7
40	8.7	119.4	37.5	535.6		281.4		158.9
41	1.3	133.8	5.2	310.7		197.9		203.4
42	4.6	133.1	5.2	334.7		155.7		348.1
43	3.2	109.3		333.5		195.1		225.4
44		118.6		291.1		201.7		305.4
45		97.9		253.6		149.9		226.0
>45 cm		574.5	0.0	1791.2	0.0	1001.7		2490.8
Total	2659.9	2436.9	47916.8	7136.8	9134.4	5371.3	688.6	6263.7
Discard rate, %	52.2		87.0		63.0		10.0	

Table 4.3.3. Haddock in VIb. Tuning data available from the Scottish groundfish survey conducted in September. In bold, the data used in the assessment.

HADDOCK WGCSE 2011 ROCKALL
101
SCOGFS (Numbers per 10 hours fishing at Rockall)
1991 2011
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	0
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

Table 4.3.4. Details of Scottish and Irish effort (in hours) in 1985–2011 (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

SCOTRL* – Scottish Heavy Trawl , SCOLTR* – Scottish Light Trawl , SCOSEI* – Scottish Seine, IROTB* – Irish bottom otter trawl

Table 4.3.5. 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	9965	26980	36945	5167	5894	11061
1998	9034	47831	56865	4986	10862	15848
1999	12930	52881	65811	5356	11062	16418
2000	15999	26033	42031	5444	6609	12053
2001	5361	9222	14583	2123	1535	3658
2002	11167	21899	33066	3117	4152	7270
2003	24409	25087	49496	5969	5521	11490
2004	22705	3989	26694	6437	883	7321
2005	19505	1877	21382	5191	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	1904	152	2056

[1] **Landings and discards.**

Table 4.3.6. Haddock in VIb. International catch (landings and discards) numbers (*10³) at age.

Terminal Fs derived using XSA (With F shrinkage)

Catch number-at-age (start of year) Numbers*10**-3

AGE	YEAR									
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	21186	16084	11178	8170	2749	12096	9957	14224	17282	8222
2	33847	24711	19375	20623	9831	18811	10535	19807	21949	12581
3	15189	18584	15494	17868	21585	10911	5388	10173	12203	10697
4	5341	5361	4938	8210	9756	9612	4098	4763	5499	4917
5	1704	1761	1617	2449	2464	3299	5002	3740	3419	2050
6	346	676	461	476	787	751	1758	2767	2684	1498
+gp	522	206	359	233	79	92	207	1391	2776	2066
TOTAL	78134	67383	53423	58028	47251	55572	36945	56865	65811	42031

Catch number-at-age (start of year) Numbers*10**-3

AGE	YEAR										
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	7667	13364	6576	932	1061	2880	1491	476	223	0.05	4
2	1961	11119	23606	4112	3723	1475	9829	2207	707	118	59
3	1815	4536	14559	10282	7420	1626	3605	11437	1237	264	107
4	1018	2445	2063	9212	8124	2414	1503	1291	8046	426	186
5	1038	898	1285	1386	753	2291	2213	507	495	4718	188
6	484	260	925	296	109	436	1816	964	263	308	2725
+gp	601	444	483	474	193	151	741	930	504	310	276
TOTAL	14583	33066	49496	26694	21382	11273	21198	17812	11474	6144	3545

Table 4.3.7. Haddock in VIb. International landings numbers (*10³) at age.

Terminal Fs derived using XSA (With F shrinkage)

Landings number-at-age (start of year) Numbers*10**-3

AGE	YEAR									
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	87	86	28	30	1	2	1	4	245	33
2	6807	3642	1919	1160	146	5149	319	392	2600	3445
3	3011	5624	4740	5299	5205	1861	2102	1815	2994	5081
4	1344	964	1157	3665	4791	4149	2155	1340	1972	3006
5	558	580	489	1040	1319	2347	3658	1898	1228	1295
6	32	364	144	66	279	473	1540	2284	1600	1176
+gp	464	160	290	141	43	85	192	1301	2291	1963
TOTAL	12302	11418	8767	11400	11784	14066	9966	9034	12930	15999

Landings number-at-age (start of year) Numbers*10**-3

AGE	YEAR										
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	399	657	920	197	887	2344	31	17	5	0.03	2
2	941	2983	8103	1765	2835	768	1220	749	11	71	23
3	1232	3998	11001	9502	6866	1290	2709	6191	244	196	102
4	752	2111	1846	9119	7913	2356	1074	1164	5243	352	180
5	988	809	1188	1364	725	2269	1539	479	460	4078	188
6	470	217	878	286	98	428	1623	761	261	274	2412
+gp	579	392	475	472	182	150	740	848	486	294	249
TOTAL	5361	11167	24409	22705	19505	9605	8936	10209	6709	5265	3156

Table 4.3.8. Haddock in VIb. International discards numbers (*10³) at age.

Terminal Fs derived using XSA (With F shrinkage)

Discards number-at-age (start of year) Numbers*10**-3

AGE	YEAR									
	1991	1992	1993	1994	1995*	1996	1997*	1998	1999*	2000
1	21099	15998	11151	8140	2748	12094	9957	14220	17037	8189
2	27040	21069	17456	19464	9685	13662	10216	19415	19349	9136
3	12178	12961	10755	12570	16379	9051	3287	8357	9210	5616
4	3998	4397	3781	4545	4965	5463	1944	3423	3526	1912
5	1146	1182	1128	1409	1145	952	1344	1842	2191	755
6	313	312	317	410	509	278	218	483	1084	322
+gp	58	46	69	91	36	7	15	91	485	103
TOTAL	65832	55964	44656	46628	35467	41506	26980	47831	52881	26033

Discards number-at-age (start of year) Numbers*10**-3

AGE	YEAR										
	2001*	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	7268	12706	5655	736	174	536	1459	458	218	0.02	2
2	1020	8136	15503	2346	888	707	8610	1458	696	47	36
3	583	539	3558	781	554	336	896	5246	993	68	4
4	266	334	217	93	210	58	429	128	2803	74	6
5	50	89	97	22	28	22	674	28	36	640	1
6	15	43	48	10	11	8	193	203	2	33	313
+gp	21	51	8	2	11	1	1	82	18	16	27
TOTAL	9222	21899	25087	3989	1877	1667	12261	7603	4765	878	389

*** data calculated using estimates from discard observer trips.**

Table 4.3.9. 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

Table 4.3.10. 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

Table 4.3.11. 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

Table 4.3.12. 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

Table 4.3.13. XSA diagnostics in assessment of Haddock in VIb. Final run with old survey indices.

Lowestoft VPA Version 3.1

12/05/2012 20:21

Extended Survivors Analysis

HADDOCK LANDISC 2004 ROCKALL

CPUE data from file had6b.tun

Catch data for 21 years. 1991 to 2011. Ages 1 to 7.

Fleet	Fi year	Last year	First age	Last age	Alpha	Beta
SCOGFS	1991	2011	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 had not converged after 50 iterations

Total absolute residual between iterations
49 and 50 = .00799

Final year F values

Age	1	2	3	4	5	6
Iteration	0.0157	0.0498	0.119	0.2517	0.0828	0.2718
Iteration	0.0154	0.0492	0.1173	0.2483	0.0816	0.271

1

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	0.143	0.152	0.075	0.073	0.033	0.131	0.157	0.132	0	0.015
2	0.231	0.403	0.134	0.475	0.138	0.151	0.291	0.369	0.095	0.049
3	0.592	0.539	0.307	0.38	0.392	0.585	0.264	0.263	0.228	0.117
4	0.698	0.596	0.802	0.426	0.203	0.781	0.428	0.301	0.136	0.248
5	0.322	1.045	1.104	0.131	0.202	0.29	0.669	0.288	0.29	0.082
6	0.663	0.65	0.733	0.215	0.104	0.244	0.198	0.924	0.292	0.271

Table 4.3.13 cont.

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6
2002	1.11E+05	5.95E+04	1.12E+04	5.38E+03	3.60E+03	5.94E+02
2003	5.15E+04	7.86E+04	3.86E+04	5.08E+03	2.19E+03	2.14E+03
2004	1.43E+04	3.62E+04	4.30E+04	1.85E+04	2.29E+03	6.30E+02
2005	1.66E+04	1.09E+04	2.59E+04	2.59E+04	6.77E+03	6.22E+02
2006	9.76E+04	1.26E+04	5.54E+03	1.45E+04	1.38E+04	4.86E+03
2007	1.34E+04	7.73E+04	8.99E+03	3.06E+03	9.70E+03	9.26E+03
2008	3.62E+03	9.65E+03	5.44E+04	4.10E+03	1.15E+03	5.94E+03
2009	1.99E+03	2.53E+03	5.90E+03	3.42E+04	2.19E+03	4.82E+02
2010	1.67E+03	1.43E+03	1.43E+03	3.71E+03	2.07E+04	1.35E+03
2011	2.60E+02	1.36E+03	1.06E+03	9.34E+02	2.66E+03	1.27E+04

Estimated population abundance at 1st Jan 2012

0.00E+00	2.13E+02	1.07E+03	7.84E+02	6.04E+02	2.03E+03

Taper weighted geometric mean of the VPA populations:

2.72E+04	2.54E+04	1.70E+04	9.44E+03	4.81E+03	2.09E+03

Standard error of the weighted Log(VPA populations) :

1.6945	1.3252	1.1138	0.8667	0.761	0.9805

Log catchability residuals.

Fleet : SCOGFS

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-0.32	0.48	0.18	-0.08	0.18	0.39	-0.29	99.99	0.23	99.99	-0.74
2	-0.45	0.76	0.67	0.15	0.25	0.37	-0.45	99.99	-0.34	99.99	-1.07
3	-0.44	0.34	0.45	0.32	0.31	0.03	-0.66	99.99	-0.19	99.99	-0.2
4	-0.14	0.64	0.42	0.51	0.85	0.01	-1.09	99.99	-0.26	99.99	-0.75
5	-0.13	0.3	0.73	-0.36	1.03	0.19	-0.55	99.99	-0.12	99.99	-0.28
6	0.07	0.22	0	-0.11	0.14	-0.16	-0.35	99.99	-0.05	99.99	-0.33

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	-0.17	-0.01	99.99	0.33	-0.21	0.22	0.25	-0.33	99.99	-0.11
2	-0.88	0.34	99.99	0.06	0.64	-0.36	0.1	0.47	99.99	-0.26
3	-0.67	-0.27	99.99	-0.02	0.22	0.43	-0.14	0.57	99.99	-0.08
4	-0.78	-0.52	99.99	0.46	0.47	0.73	-0.15	-0.15	99.99	-0.26
5	-0.87	0.54	99.99	-0.37	0.96	0.19	0.06	-0.88	99.99	-0.43
6	0	0.32	99.99	0.13	0.36	-0.14	0.01	-0.41	99.99	0.07

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 Loç	-2.5268	-2.7785	-2.7785
S.E(Log q	0.5782	0.579	0.2206

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	0.83	3.52	2.97	0.97	17	0.33	-1.47
2	0.93	0.596	2.53	0.85	17	0.56	-1.99
3	0.74	2.792	4.44	0.88	17	0.39	-2.54

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	0.87	0.967	3.4	0.78	17	0.5	-2.53
5	0.9	0.553	3.36	0.66	17	0.53	-2.78
6	0.94	1.165	3.08	0.96	17	0.2	-2.79

Table 4.3.13 cont.

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2010

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	188	0.412	0	0	1	0.787	0.017
P shrink	25366	1.33				0.077	0
F shrinkage	29	1				0.136	0.105

Weighted prediction :

Survivors at end of	Int s.e	Ext s.e	N	Var Ratio	F
213	0.37	1.08	3	2.946	0.015

Age 2 Catchability dependent on age and year class strength

Year class = 2009

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	819	0.663	0	0	1	0.546	0.063
P shrink	17010	1.11				0.203	0.003
F shrinkage	210	1				0.252	0.228

Weighted prediction :

Survivors at end of	Int s.e	Ext s.e	N	Var Ratio	F
1075	0.49	1.08	3	2.183	0.049

Age 3 Catchability dependent on age and year class strength

Year class = 2008

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	619	0.295	0.122	0.41	2	0.794	0.145
P shrink	9441	0.87				0.117	0.01
F shrinkage	240	1				0.088	0.337

Weighted prediction :

Survivors at end of	Int s.e	Ext s.e	N	Var Ratio	F
784	0.27	0.57	4	2.094	0.117

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2007

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	666	0.288	0.199	0.69	3	0.863	0.225
F shrinkage	327	1				0.137	0.414

Table 4.3.13 cont.

Weighted prediction :

Survivors at end of	Int s.e	Ext s.e	N	Var Ratio	F
604	0.28	0.21	4	0.755	0.248

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2006

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	2372	0.233	0.214	0.92	4	0.918	0.069
F shrink	361	1				0.082	0.387

Weighted prediction :

Survivors at end of	Int s.e	Ext s.e	N	Var Ratio	F
2031	0.23	0.32	5	1.412	0.082

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2005

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	7601	0.198	0.07	0.35	5	0.936	0.281
F shrink	15277	1				0.064	0.15

Weighted prediction :

Survivors at end of	Int s.e	Ext s.e	N	Var Ratio	F
7947	0.2	0.1	6	0.506	0.271

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2005

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	7746	0.2	0.057	0.28	4	0.884	0.439
F shrinkage mean	10401	1				0.116	0.344

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8014	0.21	0.07	5	0.322	0.427

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	1367	0.202	0.333	1.65	5	0.9	0.185
F shrinkage mean	1323	1				0.1	0.191

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1363	0.21	0.28	6	1.362	0.19

Table 4.3.14. Haddock in VIb. Final runs with old survey indices. Fishing mortality-at-age.

At 12/05/2012 20:22

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE											
1	0.2377	0.1756	0.1044	0.14	0.0506	0.2401	0.166	0.2423	0.4956	0.3845	0.1103
2	0.588	0.4817	0.3318	0.285	0.2496	0.5692	0.3406	0.5777	0.7272	0.8449	0.1468
3	0.886	0.7695	0.6423	0.5856	0.5474	0.485	0.3123	0.6513	0.8879	1.0121	0.2666
4	0.9044	0.9532	0.4716	0.8746	0.7569	0.5048	0.3373	0.504	0.9315	1.2167	0.2275
5	0.3626	0.8969	0.885	0.4541	0.7184	0.63	0.5402	0.5928	0.8544	1.2056	0.9486
6	0.529	0.2377	0.6247	0.7168	0.2558	0.4962	0.847	0.6616	1.2344	1.2813	1.1234
+gp	0.529	0.2377	0.6247	0.7168	0.2558	0.4962	0.847	0.6616	1.2344	1.2813	1.1234
0 FBAR 2-!	0.6852	0.7753	0.5827	0.5498	0.5681	0.5472	0.3826	0.5814	0.8502	1.0698	0.3974

Table 8 Fishing mortality (F) at age

YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	FBAR **-**
AGE											
1	0.1431	0.1521	0.0747	0.0733	0.0331	0.1308	0.157	0.1319	0	0.0154	0.0491
2	0.2315	0.4034	0.134	0.4751	0.1384	0.1514	0.2914	0.3694	0.0954	0.0492	0.1714
3	0.5923	0.5388	0.307	0.38	0.3923	0.5851	0.2644	0.2633	0.2278	0.1173	0.2028
4	0.6984	0.5958	0.8023	0.4258	0.203	0.7813	0.4275	0.3012	0.1356	0.2483	0.2284
5	0.322	1.0455	1.1038	0.131	0.2019	0.2903	0.6689	0.2875	0.29	0.0816	0.2197
6	0.6626	0.6505	0.7332	0.2152	0.1043	0.2442	0.1976	0.9242	0.2916	0.271	0.4956
+gp	0.6626	0.6505	0.7332	0.2152	0.1043	0.2442	0.1976	0.9242	0.2916	0.271	
FBAR 2- 5	0.461	0.6459	0.5868	0.353	0.2339	0.452	0.4131	0.3054	0.1872	0.1241	

Table 4.3.15. Haddock in VIb. Final runs with old survey indices. Stock number (*10³) at age.

Run title : HADDOCK LANDISC 2004 ROCKALL

At 12/05/2012 20:22

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	1996	1997	1998	1999	2000	2001
AGE											
1	110673	110396	124613	69113	61545	62632	71929	73055	48873	28468	81110
2	84143	71442	75831	91910	49193	47901	40334	49882	46942	24376	15868
3	28563	38265	36133	44554	56589	31381	22197	23490	22918	18573	8574
4	9917	9642	14513	15563	20310	26801	15819	13298	10027	7722	5527
5	6192	3287	3043	7414	5314	7801	13245	9243	6577	3234	1873
6	930	3528	1097	1028	3854	2121	3402	6318	4183	2292	793
+gp	1389	1070	845	495	384	257	393	3137	4234	3091	964
TOTAL	241808	237630	256075	230079	197190	178894	167320	178423	143755	87756	114709

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	GMST 91-**	AMST 91-**
AGE													
1	110762	51510	14318	16583	97604	13432	3617	1991	1667	260	0	40237	60643
2	59470	78592	36223	10879	12617	77306	9649	2531	1429	1365	213	34419	46584
3	11218	38629	42986	25936	5538	8995	54399	5903	1432	1063	1075	22421	27623
4	5377	5080	18453	25891	14521	3063	4102	34190	3714	934	784	11200	13674
5	3604	2190	2292	6773	13847	9705	1148	2190	20712	2655	604	4596	5735
6	594	2138	630	622	4864	9264	5943	482	1345	12688	2031	1948	2847
+gp	1000	1102	994	1096	1682	3757	5707	907	1345	1278	8745		
TOTAL	192024	179241	115897	87780	150673	125522	84564	48193	31643	20242	13452		

Table 4.3.16. Haddock in VIb. Final run with old survey indices. Summary table.

Run title : HADDOCK LANDISC 2004 ROCKALL

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Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 5
1991	110673	52203	16293	5655	0.3471	0.6852
1992	110396	51710	19953	5320	0.2666	0.7753
1993	124613	55784	20664	4784	0.2315	0.5827
1994	69113	57064	25074	5733	0.2287	0.5498
1995	61545	48573	30389	5587	0.1839	0.5681
1996	62632	48004	26169	7075	0.2704	0.5472
1997	71929	41963	22500	5166	0.2296	0.3826
1998	73055	44270	21499	4984	0.2318	0.5814
1999	48873	33221	16713	5221	0.3124	0.8502
2000	28468	23366	11892	4558	0.3833	1.0698
2001	81110	21818	6952	1918	0.2759	0.3974
2002	110762	36504	7338	2571	0.3504	0.4610
2003	51510	38080	14244	5961	0.4185	0.6459
2004	14318	27341	18064	6400	0.3543	0.5868
2005	16583	22513	18479	5191	0.2809	0.3530
2006	97604	28034	16459	2759	0.1676	0.2339
2007	13432	29707	13797	3348	0.2427	0.4520
2008	3617	30618	27573	4205	0.1525	0.4131
2009	1991	19214	17991	3237	0.1799	0.3054
2010	1667	16760	16090	3404	0.2116	0.1872
2011	260	11441	11007	1905	0.1731	0.1241
Arith. Mean	54960	35152	18054	4523	0.2615	0.5120
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 4.3.17. Haddock in VIb. Input RCT3 file.

```
Had in VIb age 1
1 19 2
'Y-class' 'VPA' 'Scotsr0'
     1993     69113     15220
     1994     61545     23474
     1995     62632     16923
     1996     71929     33578
     1997     73055     28897
     1998     48873       -11
     1999     28468     10178
     2000     81110       -11
     2001    110762     31813
     2002     51510     11704
     2003     14318      2526
     2004     16583       -11
     2005     97604     24452
     2006     13432      3570
     2007      3617       558
     2008      1991        85
     2009      1667       132
     2010       260       -11
     2011       -11        13
```

Table 4.3.18. Haddock in VIb. Results of RCT3 runs.

Year Class Prediction	Weighted Average Error	Log WAP Error	Int Std	Ext Std	Var Ratio	VPA VPA	Log
1995	No	valid	surveys				
1996	63648	11.06	0.06	0.05	0.6	71930	11.18
1997	66543	11.11	0.07	0.03	0.18	73055	11.2
1998	No	valid	surveys				
1999	60519	11.01	0.14	0.12	0.76	28468	10.26
2000	No	valid	surveys				
2001	69835	11.15	0.27	0.22	0.65	110762	11.62
2002	48097	10.78	0.29	0.33	1.26	51510	10.85
2003	40004	10.6	0.33	0.86	6.75	14319	9.57
2004	No	valid	surveys				
2005	69634	11.15	0.28	0.18	0.39	97604	11.49
2006	20516	9.93	0.32	0.48	2.21	13432	9.51
2007	6027	8.7	0.4	1.2	9.16	3618	8.19
2008	1183	7.08	0.39	1.35	12.22	1991	7.6
2009	2196	7.69	0.4	0.81	4.03	1668	7.42
2010	No	valid	surveys				
2011	398	5.99	0.45	0.84	3.55		

Table 4.3.19. Haddock in VIb. Input data to short-term forecast.

MFDP version 1a						
Run: 3Run_New						
Time and date: 10:40 21.05.2012						
Fbar age range (Total) : 2-5						
Fbar age range Fleet 1 : 2-5						
2012						
Age	N	M	Mat	PF	PM	SWt
1	398	0.2	0	0	0	0.189
2	213	0.2	0	0	0	0.307
3	1075	0.2	1	0	0	0.407
4	784	0.2	1	0	0	0.427
5	604	0.2	1	0	0	0.643
6	2031	0.2	1	0	0	0.609
7	8745	0.2	1	0	0	0.897
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.0126	0.189	0.0365	0.195		
2	0.0615	0.368	0.1099	0.258		
3	0.1382	0.456	0.0646	0.303		
4	0.1839	0.445	0.0445	0.327		
5	0.1882	0.662	0.0315	0.375		
6	0.436	0.616	0.0596	0.49		
7	0.4677	0.913	0.0279	0.511		
2013						
Age	N	M	Mat	PF	PM	SWt
1	13432	0.2	0	0	0	0.189
2	.	0.2	0	0	0	0.307
3	.	0.2	1	0	0	0.407
4	.	0.2	1	0	0	0.427
5	.	0.2	1	0	0	0.643
6	.	0.2	1	0	0	0.609
7	.	0.2	1	0	0	0.897
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.0126	0.189	0.0365	0.195		
2	0.0615	0.368	0.1099	0.258		
3	0.1382	0.456	0.0646	0.303		
4	0.1839	0.445	0.0445	0.327		
5	0.1882	0.662	0.0315	0.375		
6	0.436	0.616	0.0596	0.49		
7	0.4677	0.913	0.0279	0.511		
2014						
Age	N	M	Mat	PF	PM	SWt
1	13432	0.2	0	0	0	0.189
2	.	0.2	0	0	0	0.307
3	.	0.2	1	0	0	0.407
4	.	0.2	1	0	0	0.427
5	.	0.2	1	0	0	0.643
6	.	0.2	1	0	0	0.609
7	.	0.2	1	0	0	0.897
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.0126	0.189	0.0365	0.195		
2	0.0615	0.368	0.1099	0.258		
3	0.1382	0.456	0.0646	0.303		
4	0.1839	0.445	0.0445	0.327		
5	0.1882	0.662	0.0315	0.375		
6	0.436	0.616	0.0596	0.49		
7	0.4677	0.913	0.0279	0.511		
Input units are thousands and kg - output in tonnes						

Table 4.3.20. Haddock in VIb. Short-term forecast.

MFDP version 1a								
Run: 3Run_New								
Time and date: 10:40 21.05.2012								
Fbar age range (Total) : 2-5								
Fbar age range Fleet 1 : 2-5								
2012								
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield		
10382	10242	1	0.143	3258	0.0626	173		
2013							2014	
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	Biomass	SSB
8392	5758	0	0	0	0	0	10941	5027
.	5758	0.1	0.0143	228	0.0063	19	10703	4805
.	5758	0.2	0.0286	446	0.0125	38	10475	4593
.	5758	0.3	0.0429	653	0.0188	56	10257	4391
.	5758	0.4	0.0572	852	0.0251	73	10048	4199
.	5758	0.5	0.0715	1042	0.0313	91	9848	4015
.	5758	0.6	0.0858	1223	0.0376	107	9657	3840
.	5758	0.7	0.1001	1397	0.0438	124	9474	3673
.	5758	0.8	0.1144	1562	0.0501	140	9299	3514
.	5758	0.9	0.1287	1721	0.0564	156	9131	3362
.	5758	1	0.143	1872	0.0626	171	8970	3217
.	5758	1.1	0.1572	2017	0.0689	187	8816	3078
.	5758	1.2	0.1715	2155	0.0752	201	8668	2946
.	5758	1.3	0.1858	2288	0.0814	216	8526	2820
.	5758	1.4	0.2001	2414	0.0877	230	8390	2700
.	5758	1.5	0.2144	2536	0.0939	244	8260	2585
.	5758	1.6	0.2287	2652	0.1002	258	8135	2475
.	5758	1.7	0.243	2762	0.1065	271	8015	2371
.	5758	1.8	0.2573	2869	0.1127	285	7900	2271
.	5758	1.9	0.2716	2970	0.119	298	7790	2176
.	5758	2	0.2859	3067	0.1253	311	7683	2084
Input units are thousands and kg - output in tonnes								

Table 4.3.21. Haddock in VIb. Detailed short-term forecast output.

MFDP version 1a												
Run: 3Run_New												
Time and date: 10:40 21.05.2012												
Fbar age range (Total) : 2-5												
Fbar age range Fleet 1 : 2-5												
Year:	2012	F multiplie	1	Fleet1 HCF	0.143	Fleet1 DFb	0.0626					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST	SSB(ST)
1	0.0126	4	1	0.0365	13	3	398	75	0	0	0	0
2	0.0615	11	4	0.1099	20	5	213	65	0	0	0	0
3	0.1382	122	56	0.0646	57	17	1075	438	1075	438	1075	438
4	0.1839	117	52	0.0445	28	9	784	335	784	335	784	335
5	0.1882	93	61	0.0315	16	6	604	388	604	388	604	388
6	0.436	638	393	0.0596	87	43	2031	1237	2031	1237	2031	1237
7	0.4677	2947	2691	0.0279	176	90	8745	7844	8745	7844	8745	7844
Total		3933	3258		397	173	13850	10382	13239	10242	13239	10242
Year:	2013	F multiplie	1	Fleet1 HCF	0.143	Fleet1 DFb	0.0626					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST	SSB(ST)
1	0.0126	150	28	0.0365	434	85	13432	2539	0	0	0	0
2	0.0615	16	6	0.1099	28	7	310	95	0	0	0	0
3	0.1382	17	8	0.0646	8	2	147	60	147	60	147	60
4	0.1839	107	48	0.0445	26	9	719	307	719	307	719	307
5	0.1882	79	52	0.0315	13	5	511	328	511	328	511	328
6	0.436	125	77	0.0596	17	8	397	242	397	242	397	242
7	0.4677	1811	1654	0.0279	108	55	5375	4821	5375	4821	5375	4821
Total		2305	1872		635	171	20890	8392	7148	5758	7148	5758
Year:	2014	F multiplie	1	Fleet1 HCF	0.143	Fleet1 DFb	0.0626					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNos	DYield	StockNos	Biomass	SSNos(Jan	SSB(Jan)	SSNos(ST	SSB(ST)
1	0.0126	150	28	0.0365	434	85	13432	2539	0	0	0	0
2	0.0615	538	198	0.1099	961	248	10470	3214	0	0	0	0
3	0.1382	24	11	0.0646	11	3	214	87	214	87	214	87
4	0.1839	15	7	0.0445	4	1	98	42	98	42	98	42
5	0.1882	72	48	0.0315	12	5	468	301	468	301	468	301
6	0.436	105	65	0.0596	14	7	336	204	336	204	336	204
7	0.4677	970	886	0.0279	58	30	2879	2582	2879	2582	2879	2582
Total		1874	1242		1494	378	27897	8970	3995	3217	3995	3217
Input units are thousands and kg - output in tonnes												

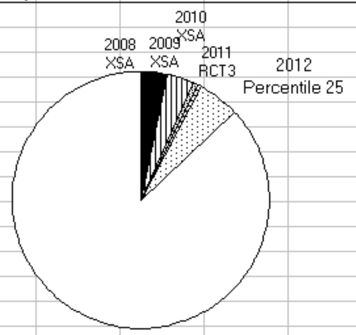
Table 4.3.22. Haddock VIb. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

Year-class			2008	2009	2010	2011	2012
Stock No. (thousands)			1991	1667	260	398	13432
of	1	year-olds					
Source			XSA	XSA	XSA	RCT3	Percentile 25
Status Quo F:							
% in	2012	landings	2.3	2.6	0.3	0.1	-
% in	2013	landings	3.4	3.2	0.6	0.6	5.3
% in	2012	SSB	4.1	5.1	0.0	0.0	-
% in	2013	SSB	7.0	6.2	1.2	0.0	0.0
% in	2014	SSB	7.7	10.7	1.6	2.5	0.0

GM : geometric mean recruitment

Haddock VIb : Year-class % contribution to

a) 2013 Catches



b) 2014 SSB

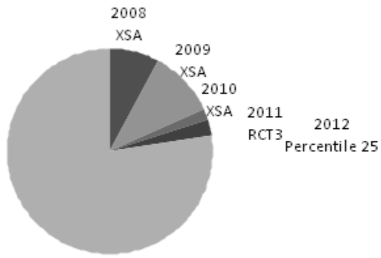


Table 4.3.23. Haddock VIb. Fmsy approach. Estimates of F reference points and equilibrium yield and SSB against mortality.

Stock name									
had10									
Sen filename									
had10.sen									
pf, pm									
0	0								
Number of iterations									
1000									
Simulate variation in Biological parameters									
TRUE									
SR relationship constrained									
TRUE									
Ricker									
638/1000 Iterations resulted in feasible parameter estimates									
	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta	AIC
Deterministic	0.778326	0.2456	19114.8	4523.43	0.545591	0.957285	4.32587	5.88E-05	85.239
Mean	0.747456	0.327236	28887.2	8429.772	0.783686944	1.48540158	20.598803	9.12E-05	87.41305
5%ile	0.184939	0.075898	6729.492	2270.809	0.36813215	0.27714215	2.0893535	1.70E-05	85.35753
25%ile	0.332026	0.144269	11255.38	3723.73	0.5257645	0.84582775	4.4274775	5.19E-05	85.7902
50%ile	0.530083	0.225035	15344.15	5279.355	0.6830565	1.39083	8.36659	8.54E-05	86.48965
75%ile	0.875625	0.368911	21150.75	8104.735	0.9263305	1.97086	16.19825	0.000120964	88.33465
95%ile	2.260286	0.987367	50912.6	19790.54	1.4807985	3.045376	63.212985	0.000186913	92.51833
CV	0.875027	1.02315	3.604955	2.015691	0.551654665	0.584294742	2.511824042	0.584294776	0.0283694
Beverton-Holt									
643/1000 Iterations resulted in feasible parameter estimates									
	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta	AIC
Deterministic	2.31406	0.181829	26137.9	5050.66	1.60243	1.70424	30951.7	1035.17	84.8393
Mean	0.42508	0.08022	162262.8	9623.293	1.616273909	3.053948816	102754.3802	72302.42923	87.049197
5%ile	0.066755	0.013384	6326.619	724.5045	0.1512306	1.383874	13417.41	498.5034	84.91632
25%ile	0.148023	0.042771	16120.1	1956.515	0.735289	2.07745	22659.85	4982.125	85.5322
50%ile	0.274514	0.068973	27728.7	3311.24	1.36742	2.69228	36271.3	12787.4	86.1919
75%ile	0.48236	0.097474	55147.1	5632.065	2.188845	3.59455	67454.15	38948.85	87.7601
95%ile	1.380585	0.172367	411336.7	24019.08	3.696534	5.545006	328048.2	221667.1	91.67075
CV	1.159369	0.920179	8.068648	5.711126	0.764000764	0.635393036	3.141431208	4.161327372	0.0294214
Smooth hockeystick									
649/1000 Iterations resulted in feasible parameter estimates									
	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta	AIC
Deterministic	0.276401	0.195031	27819.4	5639.34	0.252985	1.19435	0.770119	21563.1	85.8898
Mean	0.321931	0.153559	43350.2	6079.584	0.478164354	0.861971824	1.455593985	15562.28473	86.840954
5%ile	0.090728	0.04617	10465.32	2186.138	0.1836712	0.4052456	0.55912	7316.414	84.90964
25%ile	0.161471	0.095349	18103.1	3606.43	0.286593	0.507003	0.872425	9153.58	85.7996
50%ile	0.246182	0.128522	25431.6	5142.84	0.40725	0.743373	1.23972	13421.1	86.3175
75%ile	0.377142	0.174805	38207.6	7517.15	0.594494	1.21271	1.80972	21894.7	87.3793
95%ile	0.81286	0.316664	90963.08	12800	0.9779338	1.583038	2.976956	28580.62	90.45896
CV	0.960259	0.740534	2.071988	0.614934	0.592501699	0.462558189	0.592501649	0.462558221	0.02104
Per recruit									
	F35	F40	F01	Fmax	Bmsypr	MSYpr	Fpa	Flim	
Deterministic	0.173038	0.139471	0.097513	0.195031	0.837623	0.169796	0	0	
Mean	0.114048	0.093827	0.080324	0.224004	1.129795746	0.154642142			
5%ile	0.018735	0.015052	0.017647	0.058998	0.3444662	0.08924332			
25%ile	0.07689	0.063506	0.055719	0.104472	0.558828	0.117116			
50%ile	0.10391	0.086091	0.076681	0.138699	0.753628	0.146487			
75%ile	0.141571	0.117262	0.098404	0.196338	0.9769	0.181969			
95%ile	0.221096	0.177304	0.151506	0.691897	1.82516	0.2457784			
CV	0.581253	0.560786	0.491329	1.488343	1.785104503	0.33480839			

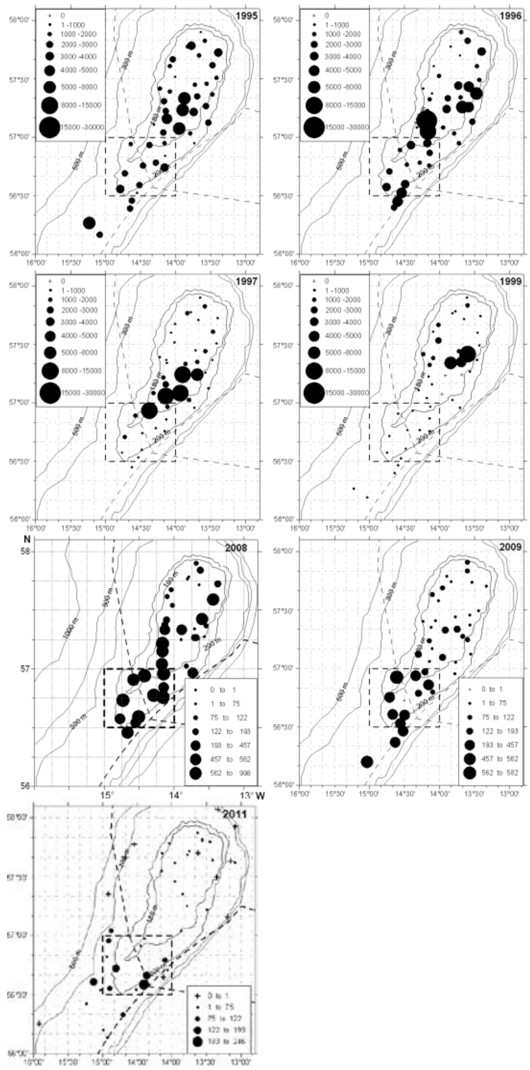
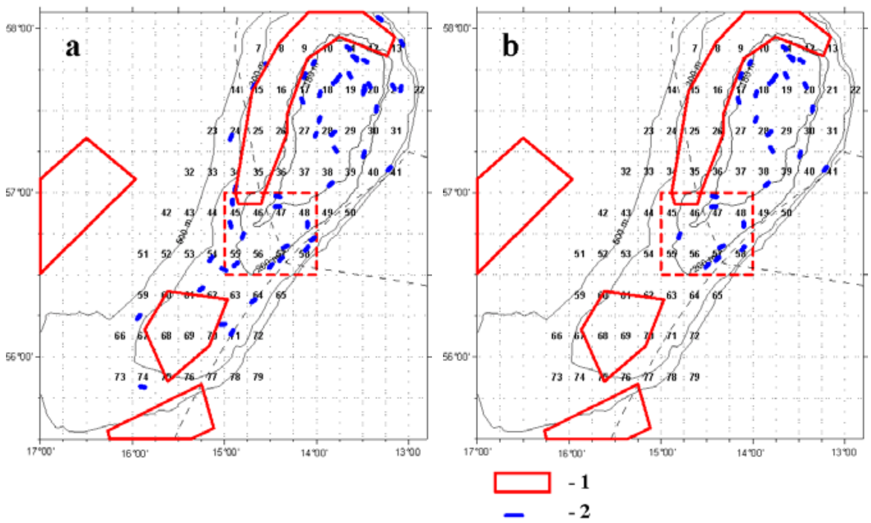


Figure 4.3.1. Distribution of haddock (catch per 30 minutes) on the Rockall Bank in 1995–1999, 2008–2009 and 2011 from the Scottish trawl survey.



-1) areas where bottom trawling is banned

-2) trawling transects

Figure 4.3.2. Haulings pattern during bottom fish survey by R/V 'Scotia' in August–September 2011. a–the whole area; b–the standard area.

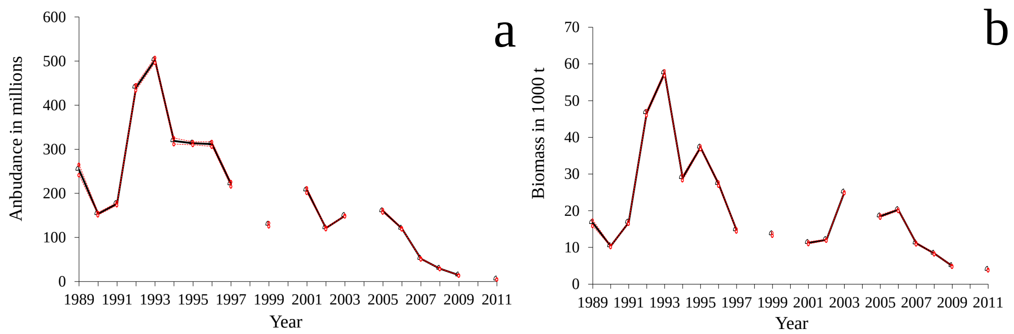


Figure 4.3.3. Abundance (a) and biomass (б) of haddock, assessed with the trawl survey method with geographical stratification based on rectangles of 15′ latitude and 15′ longitude, by R/V 'Scotia' survey. Red dashed line indicates the confidence interval with 0.95 reliability level.

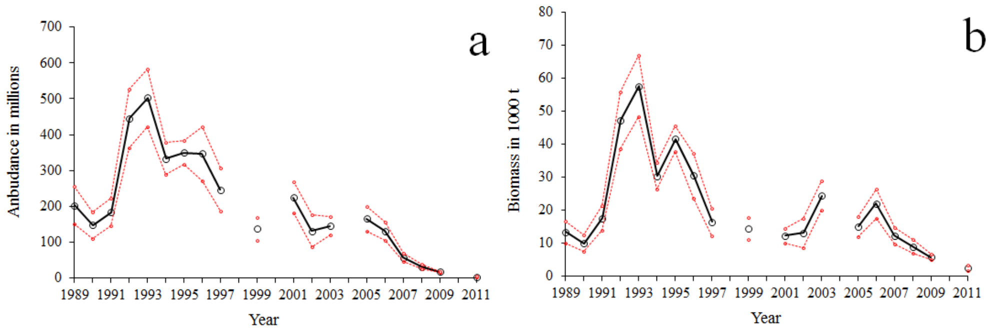


Figure 4.3.4. Abundance (a) and biomass (б) of haddock, assessed with the trawl survey method with geographical stratification based on bathymetry, by R/V 'Scotia' survey. Red dashed line indicates the confidence interval with 0.95 reliability level.

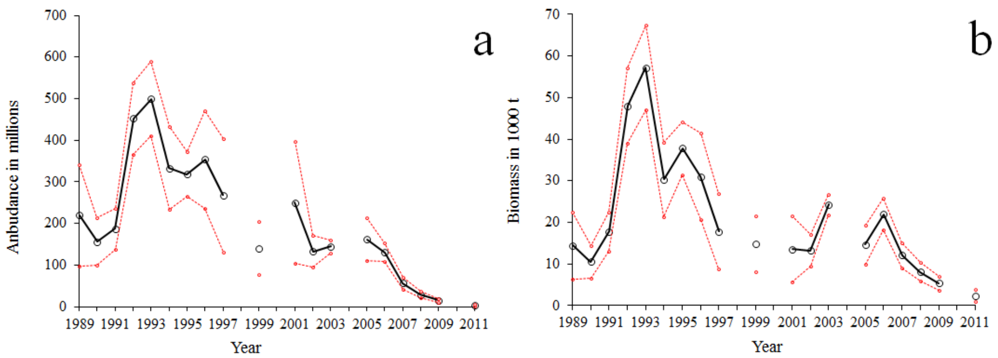


Figure 4.3.5. Abundance (a) and biomass (б) of haddock, assessed with the trawl survey method without geographical stratification by R/V 'Scotia' survey. Red dashed line indicates the confidence interval with 0.95 reliability level.

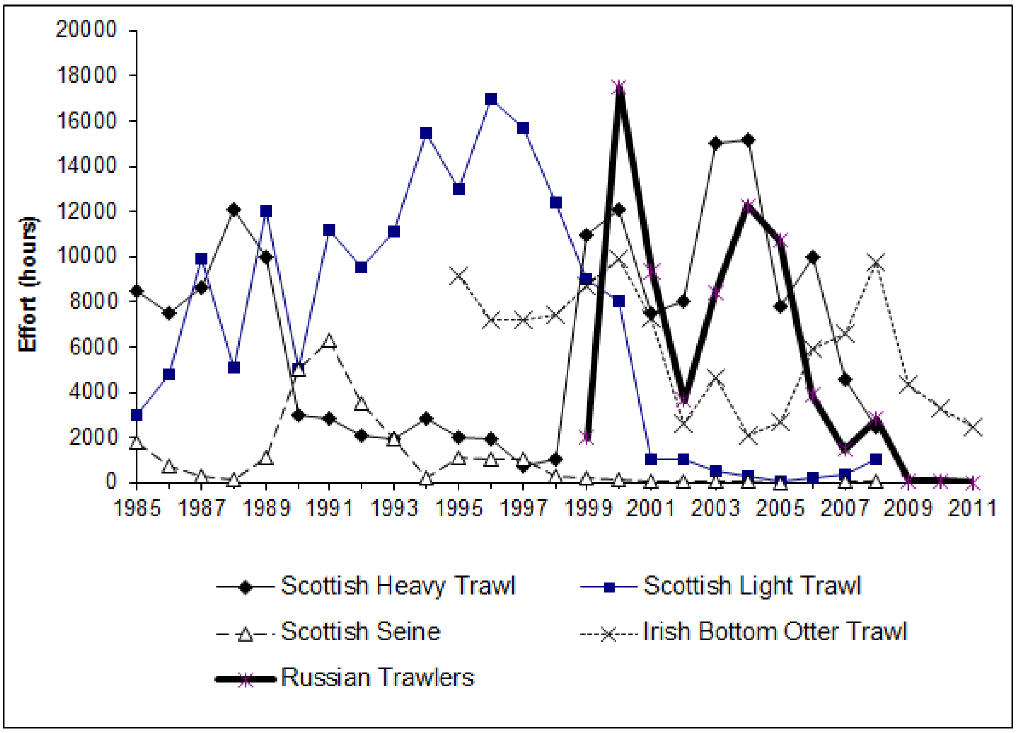


Figure 4.3.6. Rockall haddock in VIb. Scottish, Irish effort in 1985–2011 and Russian effort in 1999–2011.

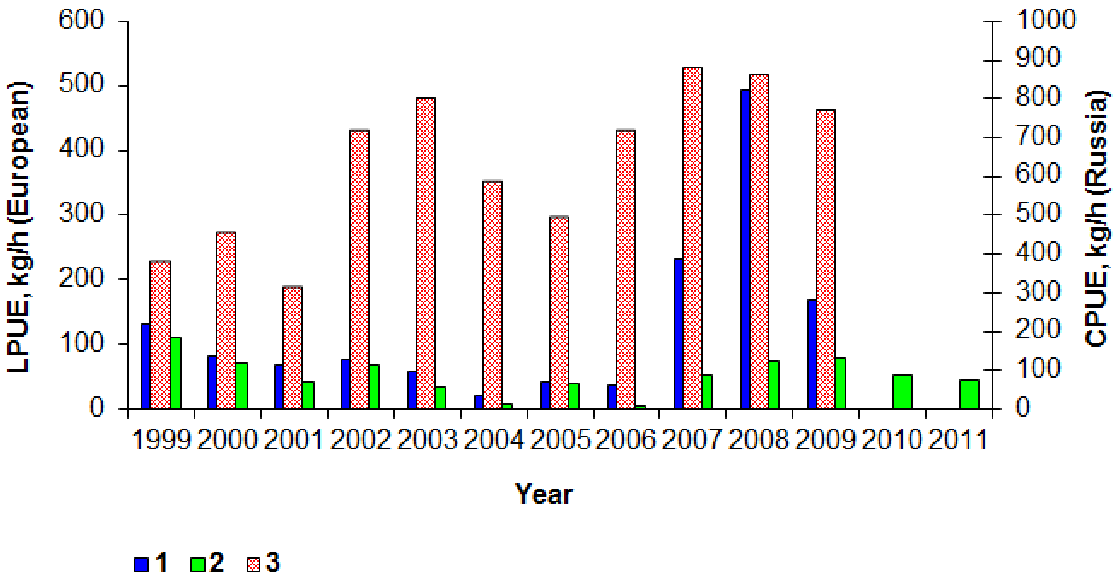


Figure 4.3.7. Lpue and cpue of the fleets fishing for Rockall haddock. Note that Scottish and Irish effort data are not reliable because reporting is not mandatory.

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).

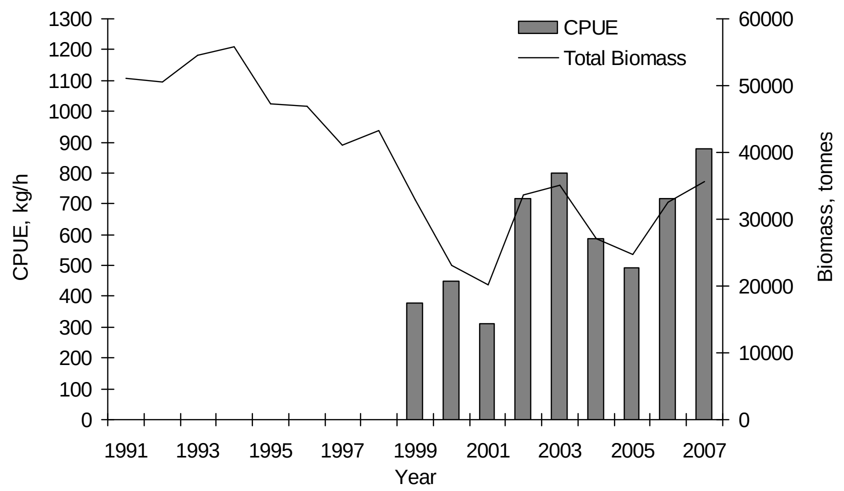


Figure 4.3.8. Dynamics of haddock total biomass (ICES, 2008a; ICES, 2008b) and directed fishing efficiency (t per a trawling hour) for tonnage class 10 vessels in 1999–2007.

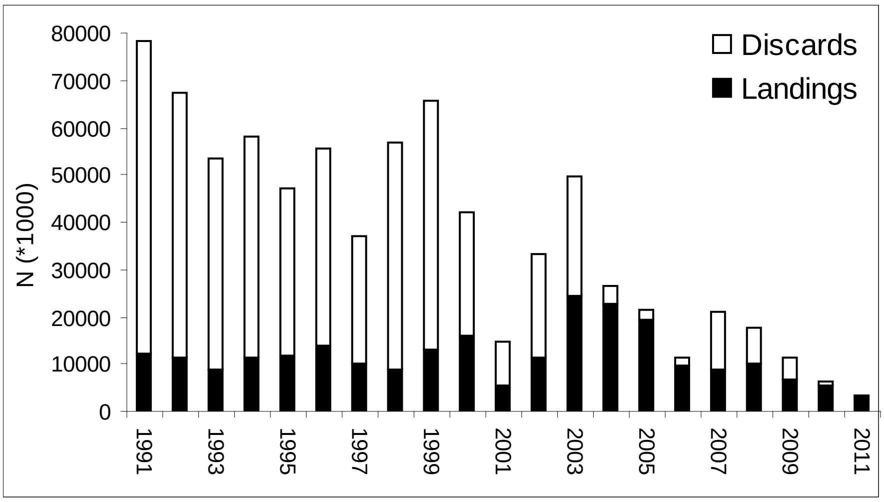


Figure 4.3.9. Total landings and discards of Rockall haddock (‘000 individuals).

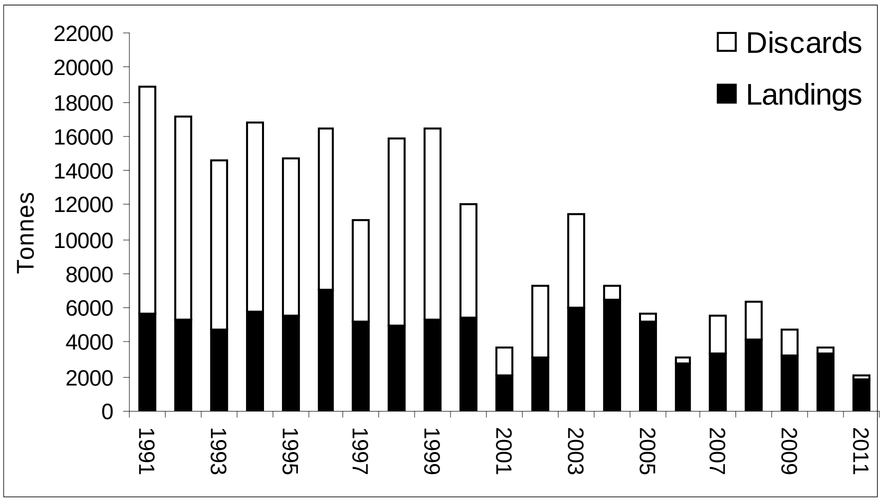


Figure 4.3.10. Total landings and discards of Rockall haddock (tonnes).

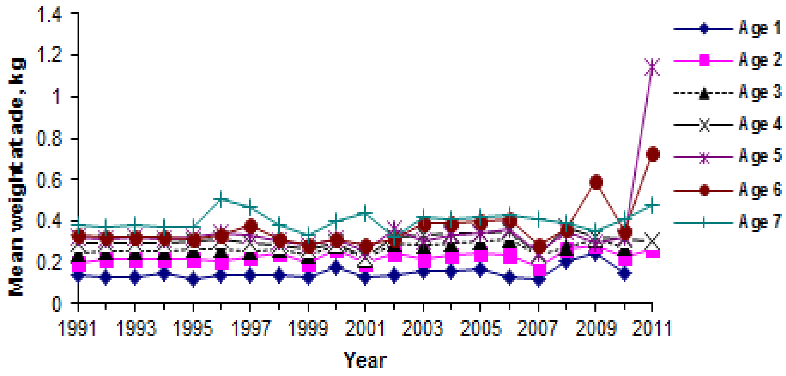


Figure 4.3.11. Haddock in VIb. Mean weights-at-age in discards by Scottish samples data.

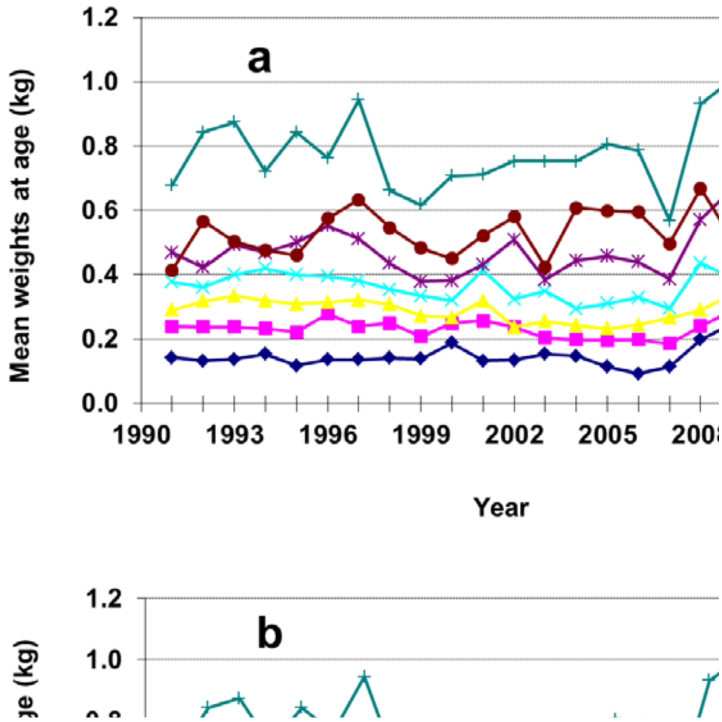


Figure 4.3.12. Haddock in VIb. Mean weights-at-age a) in catch and b) in stock.

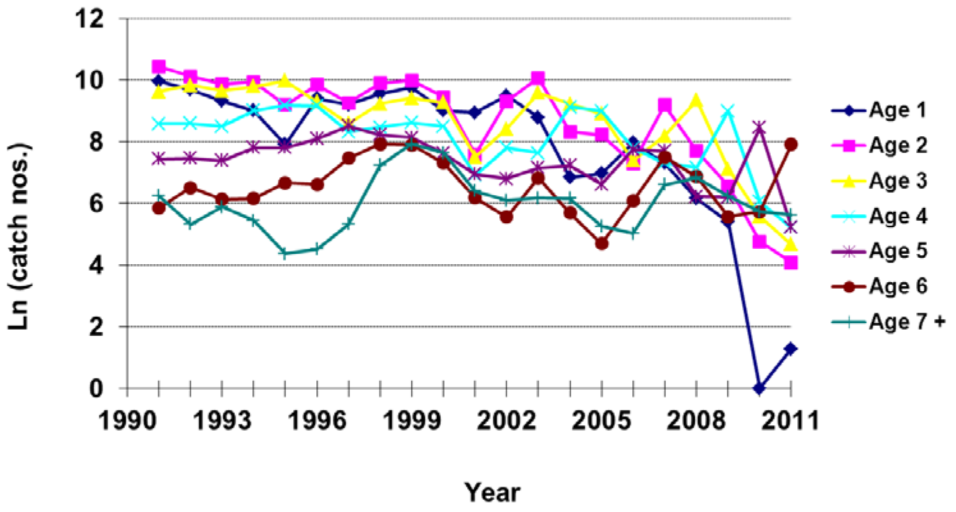


Figure 4.3.13. Haddock in VIb. Log catch (with discards in numbers) at age by year.

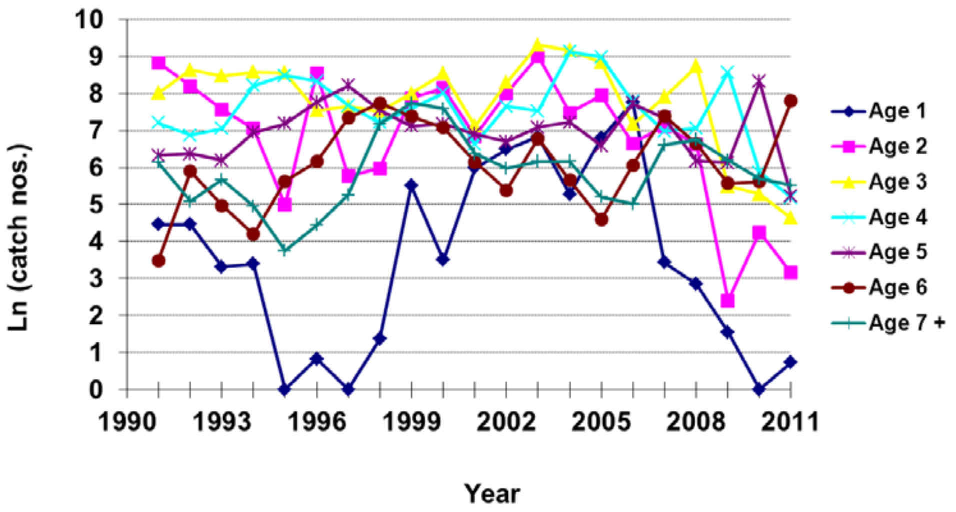


Figure 4.3.14. Haddock in VIb. Log landings (in numbers) at age by year.

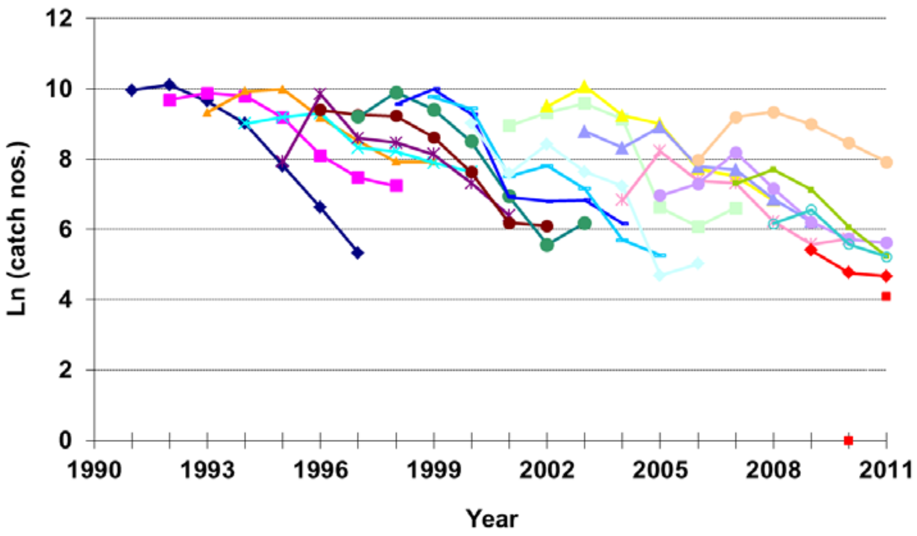


Figure 4.3.15. Haddock in VIb. Log catch (with discards, in numbers) at age by year class.

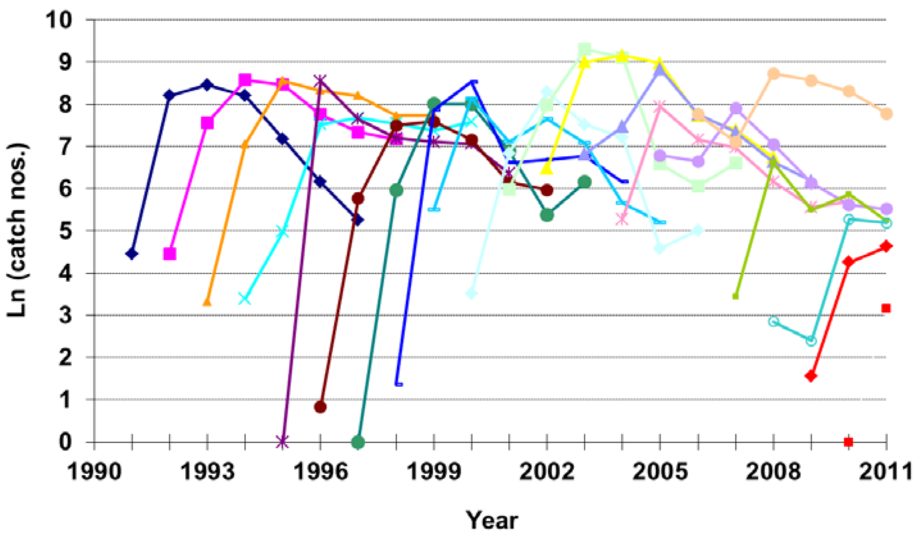


Figure 4.3.16. Haddock in VIb. Log landings (without registered discards, in numbers) at age by year class.

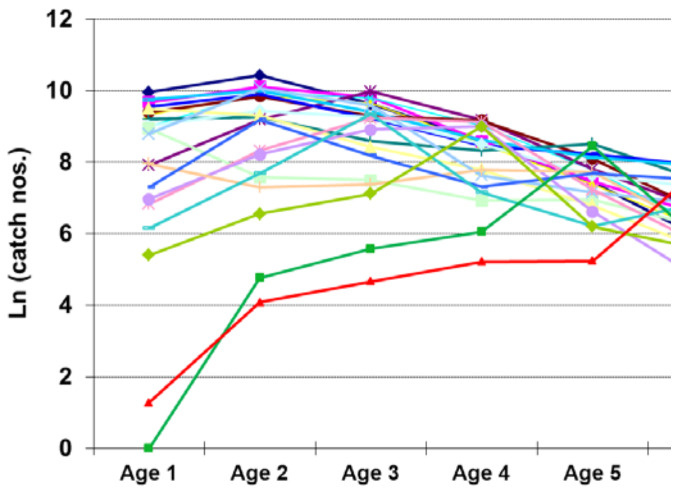


Figure 4.3.17. Haddock in VIb. Catch curves (with registered discards).

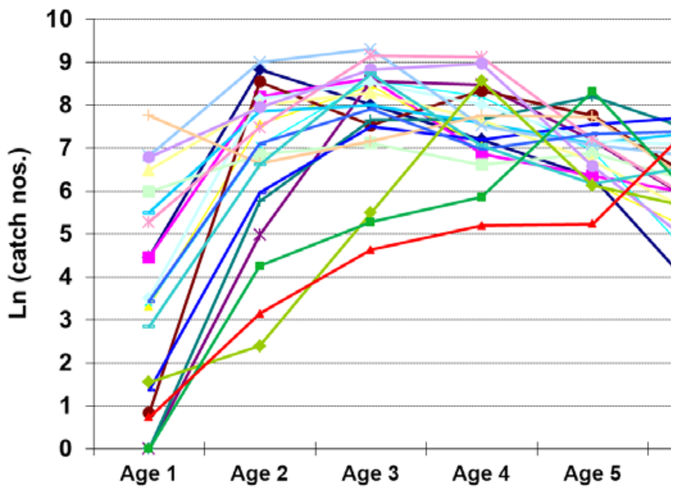


Figure 4.3.18. Haddock in VIb. Catch curves (landings without registered discards).

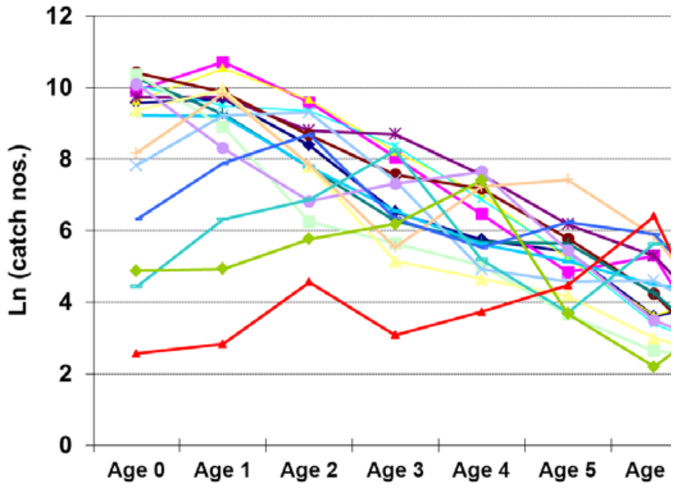


Figure 4.3.19. Haddock in VIb. Log survey cpue at age by year.

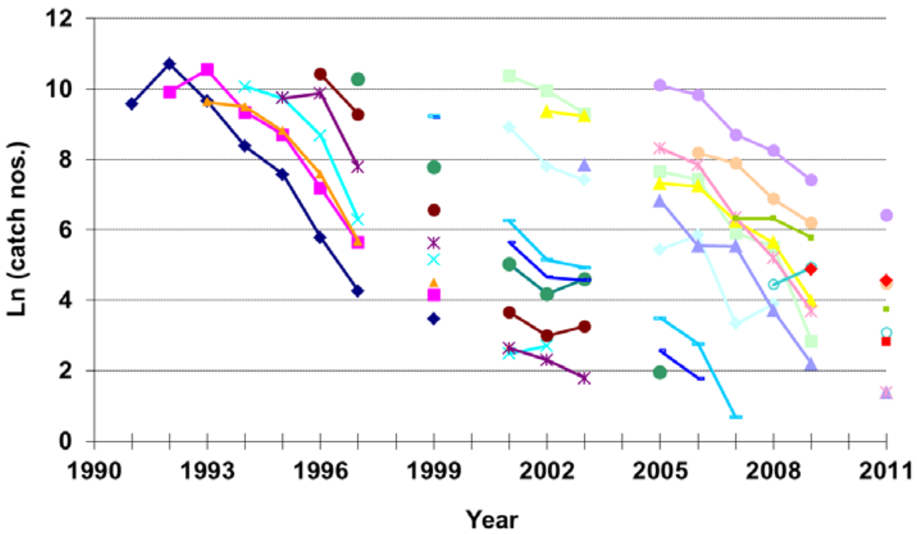


Figure 4.3.20. Haddock in VIb. Log survey cpue by year class.

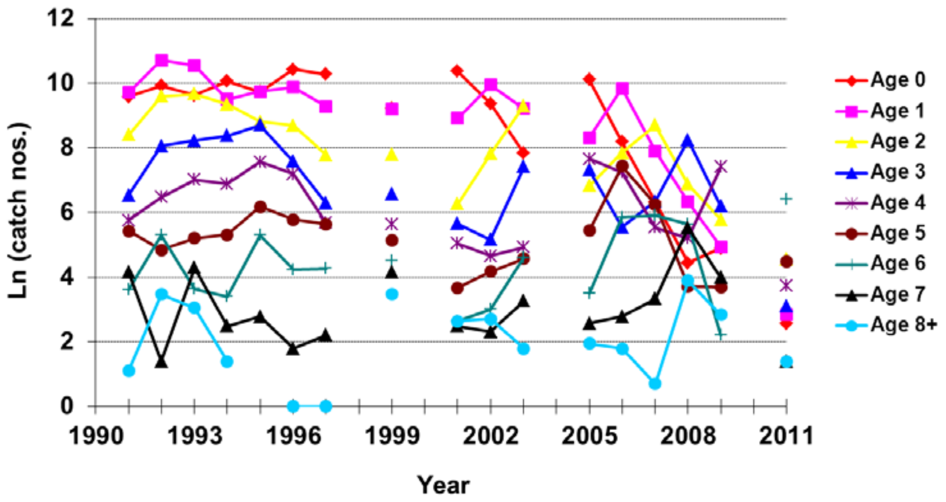


Figure 4.3.21. Haddock in VIb. Log survey cpue at age.

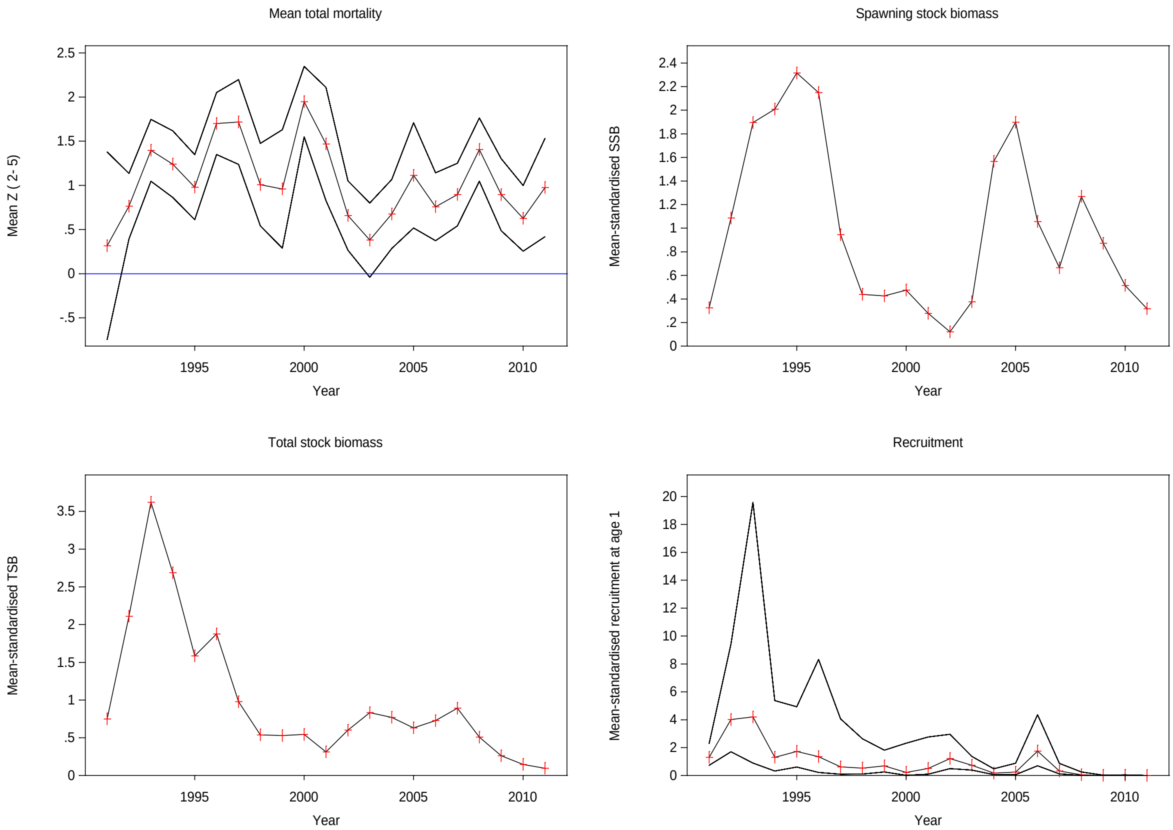


Figure 4.3.22. SURBA analysis for Rockall haddock.

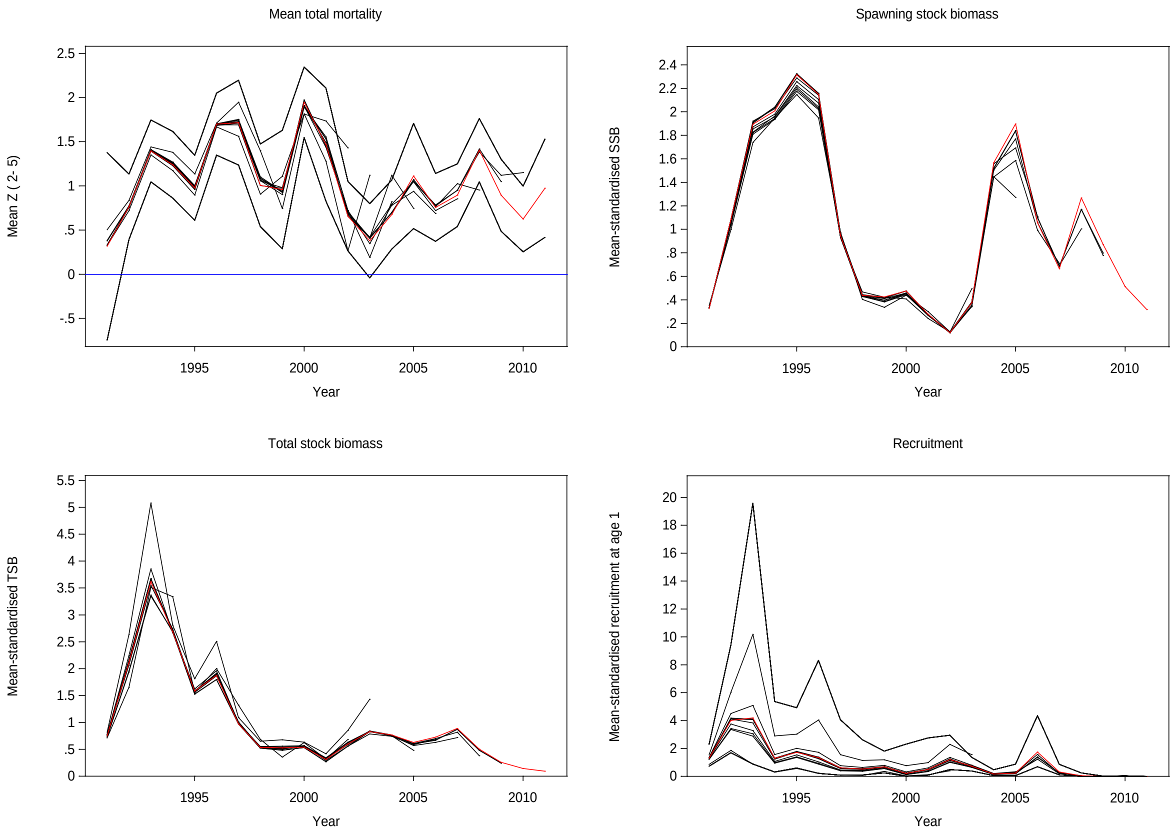


Figure 4.3.22a. SURBA analysis for Rockall haddock. Retrospective plots.

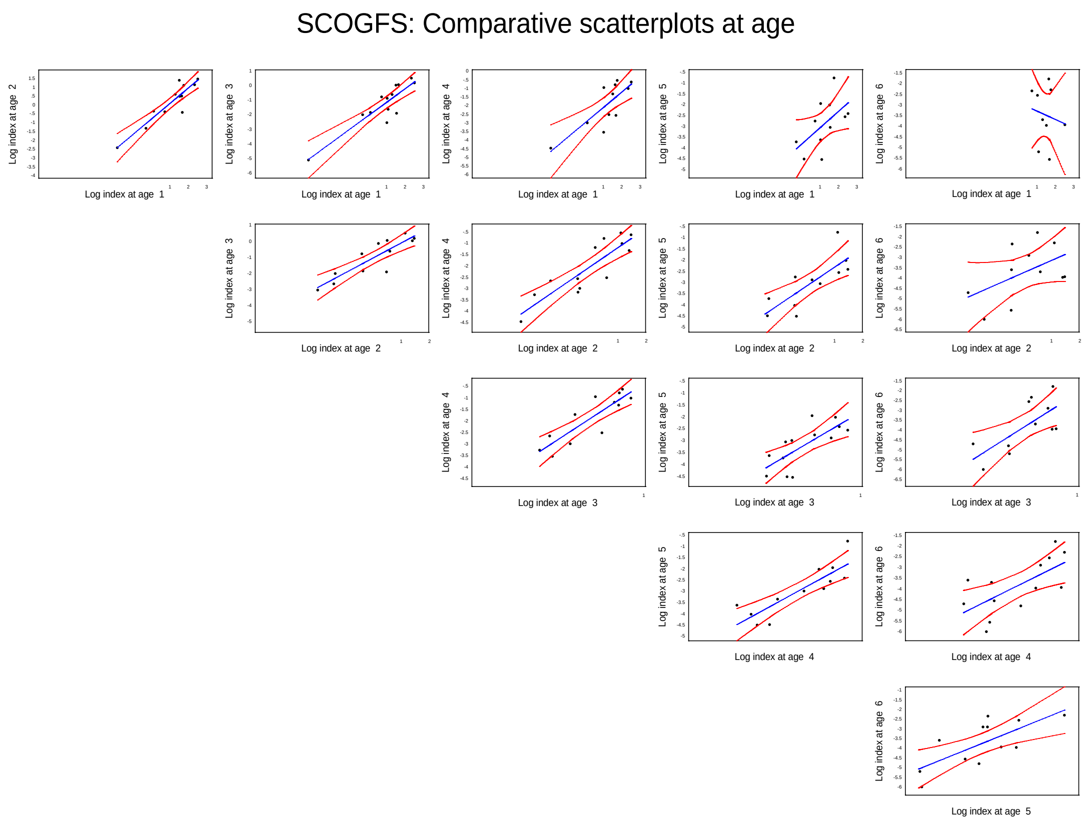


Figure 4.3.22b. SURBA analysis for Rockall haddock. Pairwise plots of age.

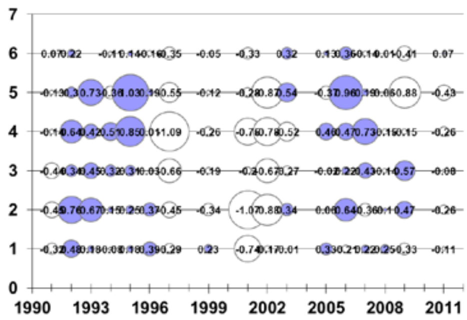


Figure 4.3.23. Haddock in VIb. Log catchability residual plots (shrinkage 1.0). Final XSA 2011: catchability dependent on stock size at ages <4.

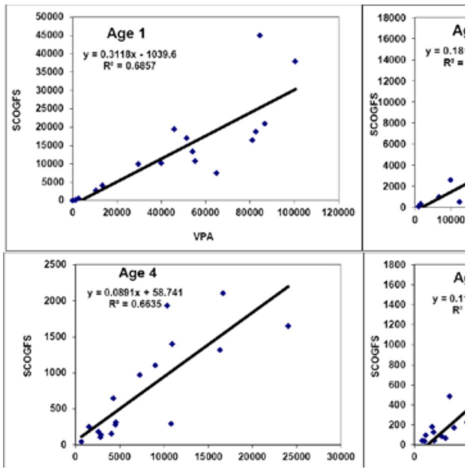


Figure 4.3.24. Haddock in VIb. Adjusted Scottish groundfish survey cpue from the final XSA run plotted against VPA numbers (shrinkage 1.0) at age. Catchability dependent on stock size at ages <4.

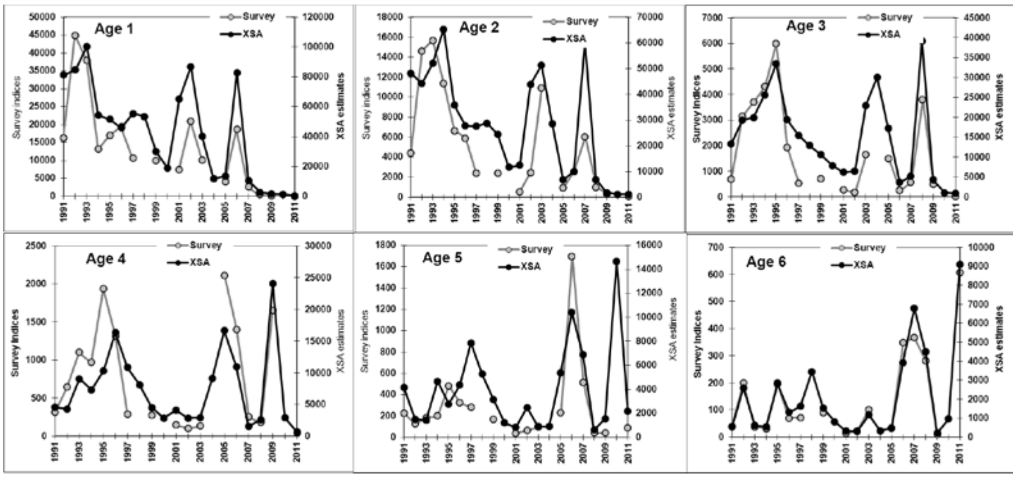


Figure 4.3.25. Haddock in VIb. Survey indices and XSA estimates (shrinkage 1.0) at age. Final XSA: catchability dependent on stock size at ages <4.

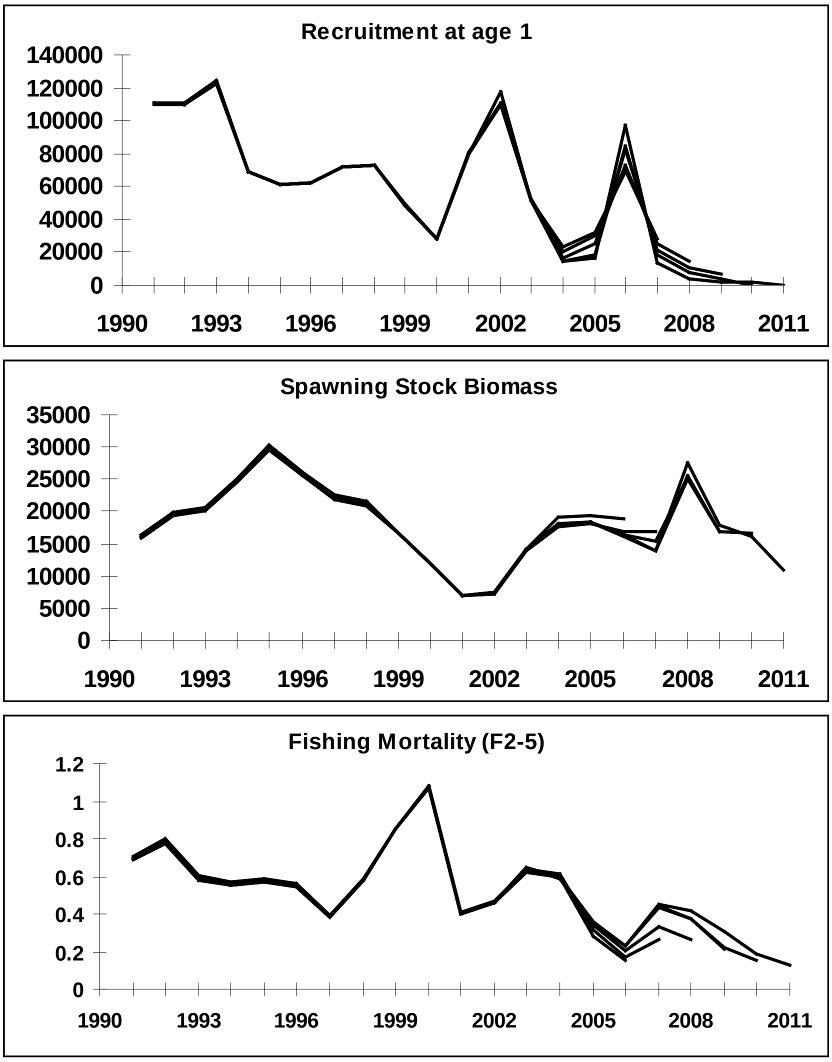


Figure 4.3.26. Haddock in VIb. Retrospective analyses (F shrinkage 1.0).

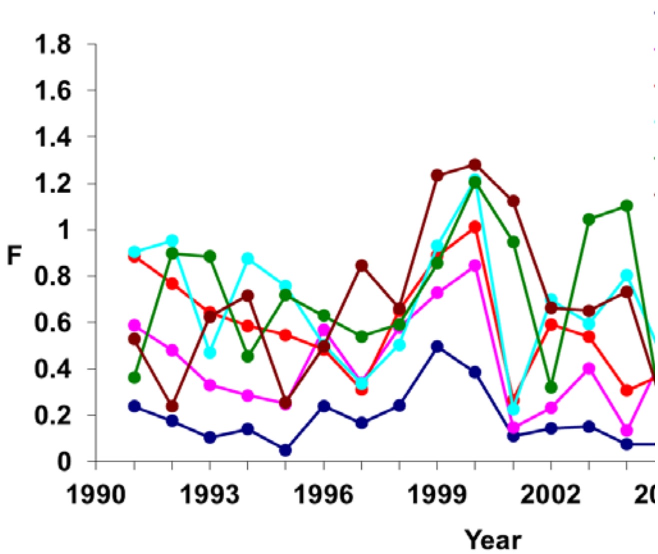


Figure 4.3.27. Haddock in VIb. F-at-age (F shrinkage 1.0).

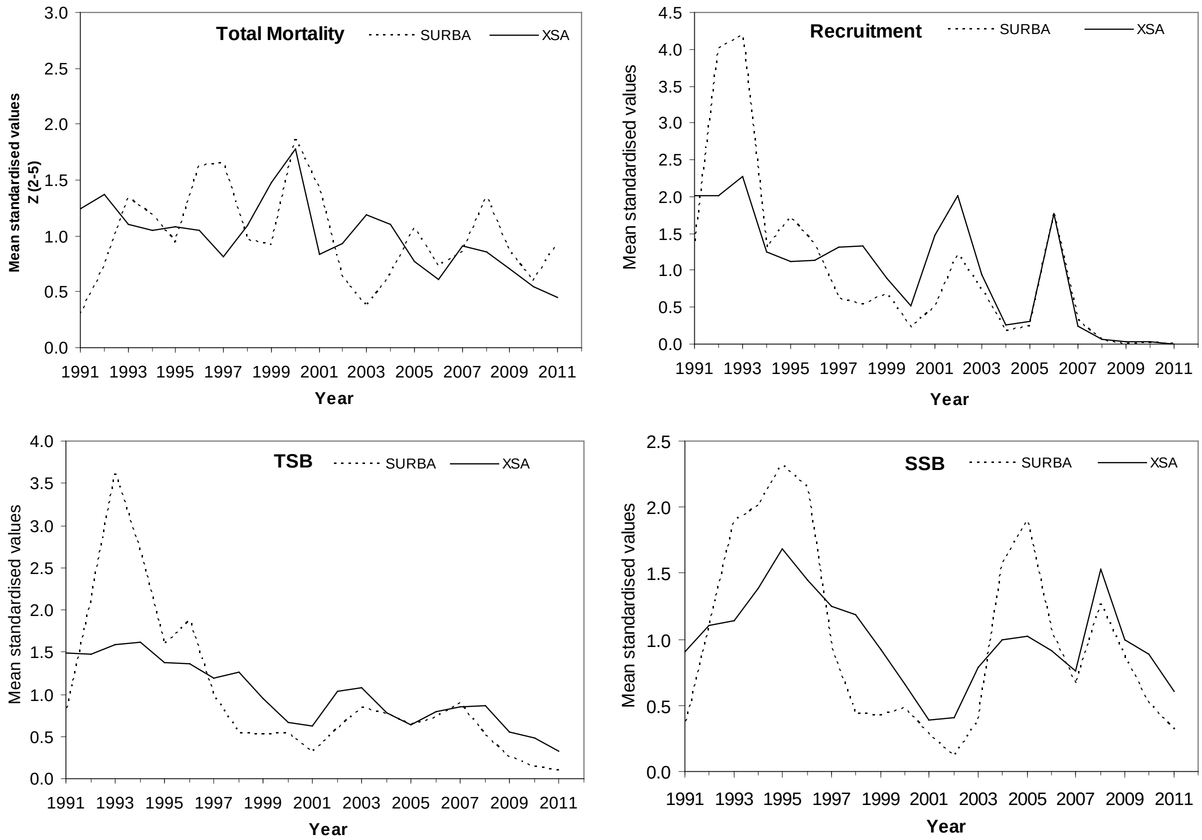


Figure 4.3.28. Haddock in VIb. XSA and SURBA analyses.

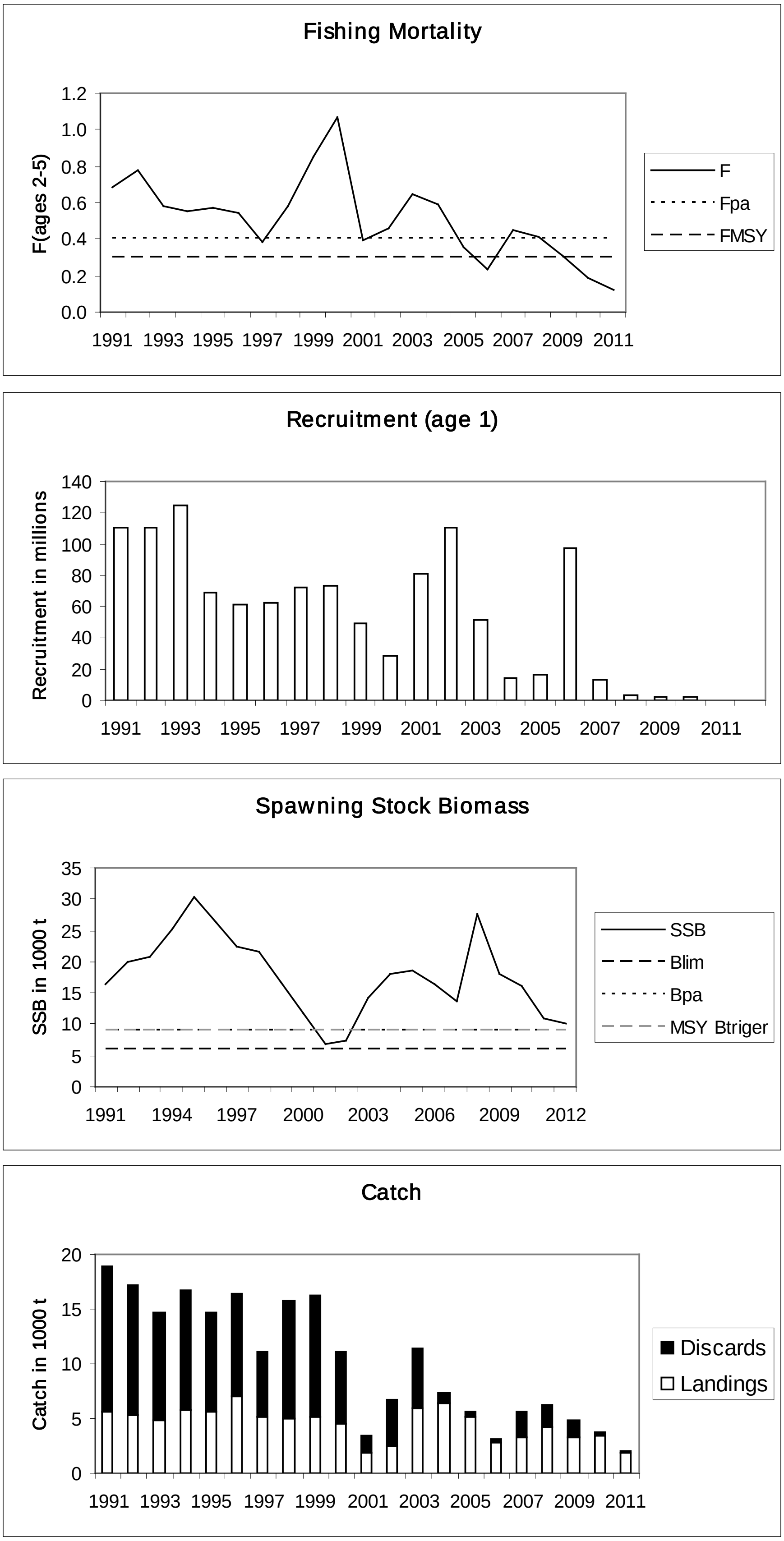


Figure 4.3.29. Haddock in VIb. Summary plots.

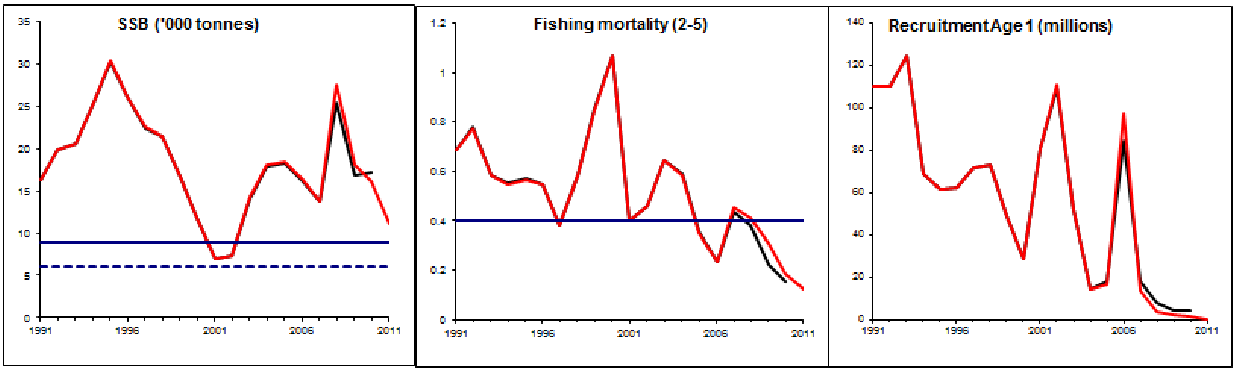


Figure 4.3.30. Haddock in VIb. Comparison of the current assessment (in red) with the previous one (in black).

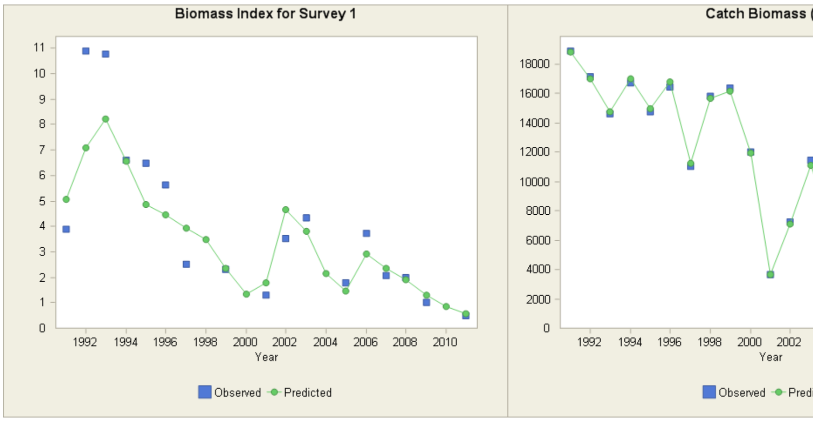


Figure 4.3.31. Haddock in VIb. Comparison observed and predicted by StatCam survey index and catch biomass . Scenario 2.

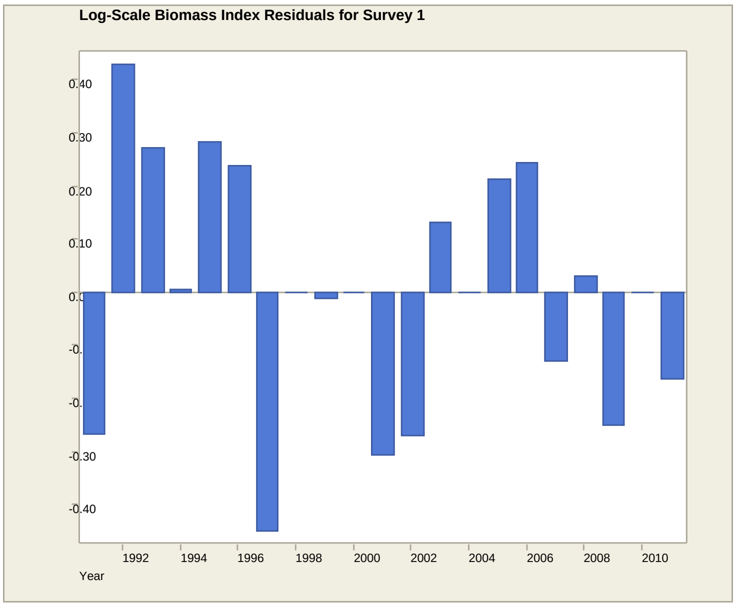


Figure 4.3.32. Haddock in VIb. Log catchability residuals plot for survey biomass index. Scenario 2 of Statcam run.

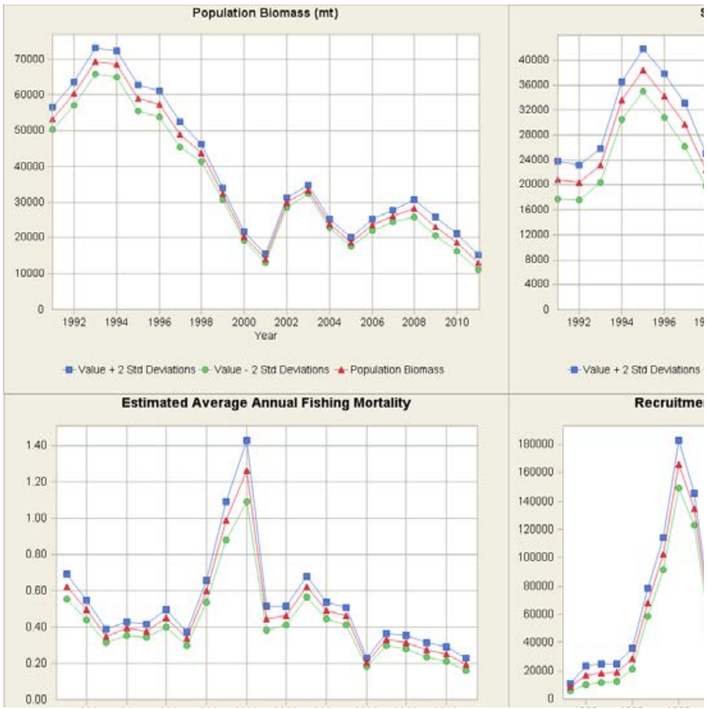


Figure 4.3.33. Haddock in VIb. Population biomass, SSB, fishin mortality and recruitment by Statcam estimation. Scenario 2.

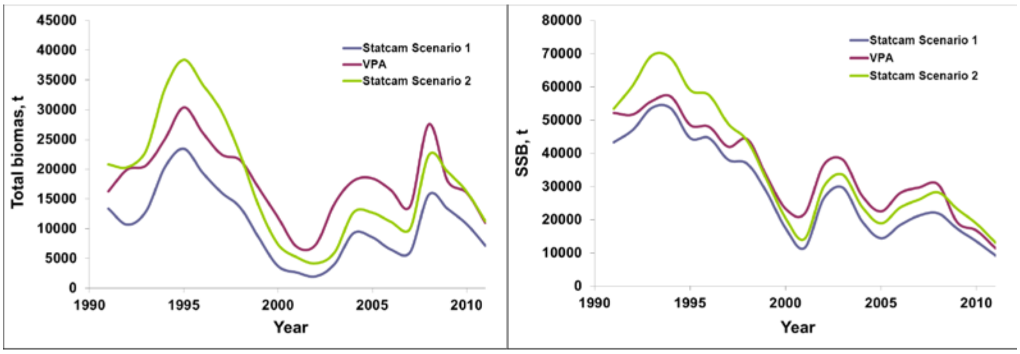


Figure 4.3.34. Haddock in VIb. Comparison of VPA assessment with the statistical catch-at-age model StatCam assessment.

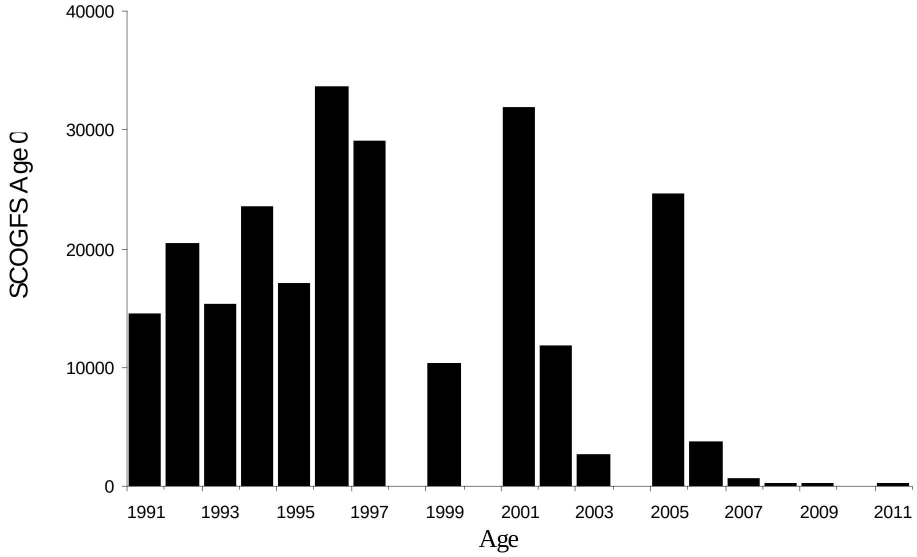


Figure 4.3.35. Haddock in VIb. Scottish Groundfish survey indices of haddock at age 0.

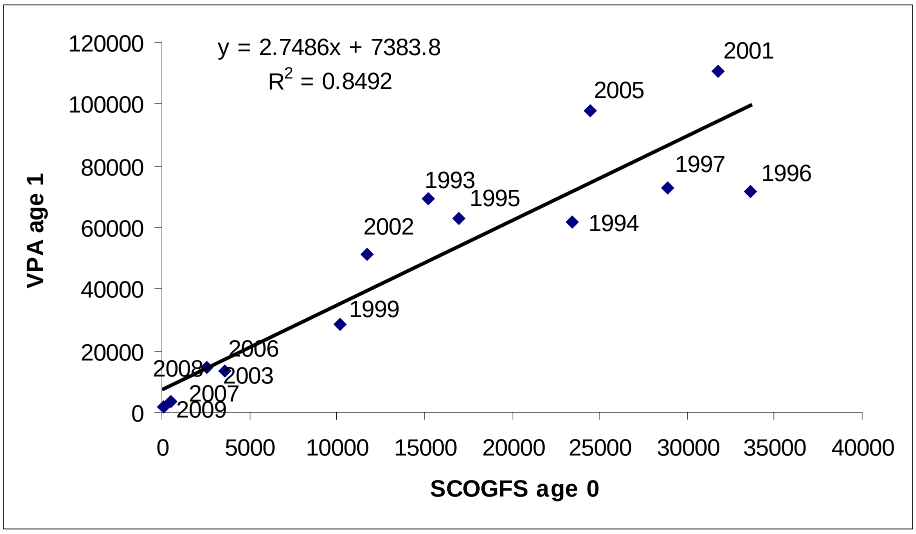


Figure 4.3.36. Haddock in VIb. VPA numbers-at-age 1 from XSA plotted against Scottish Groundfish survey indices of haddock at age 0.

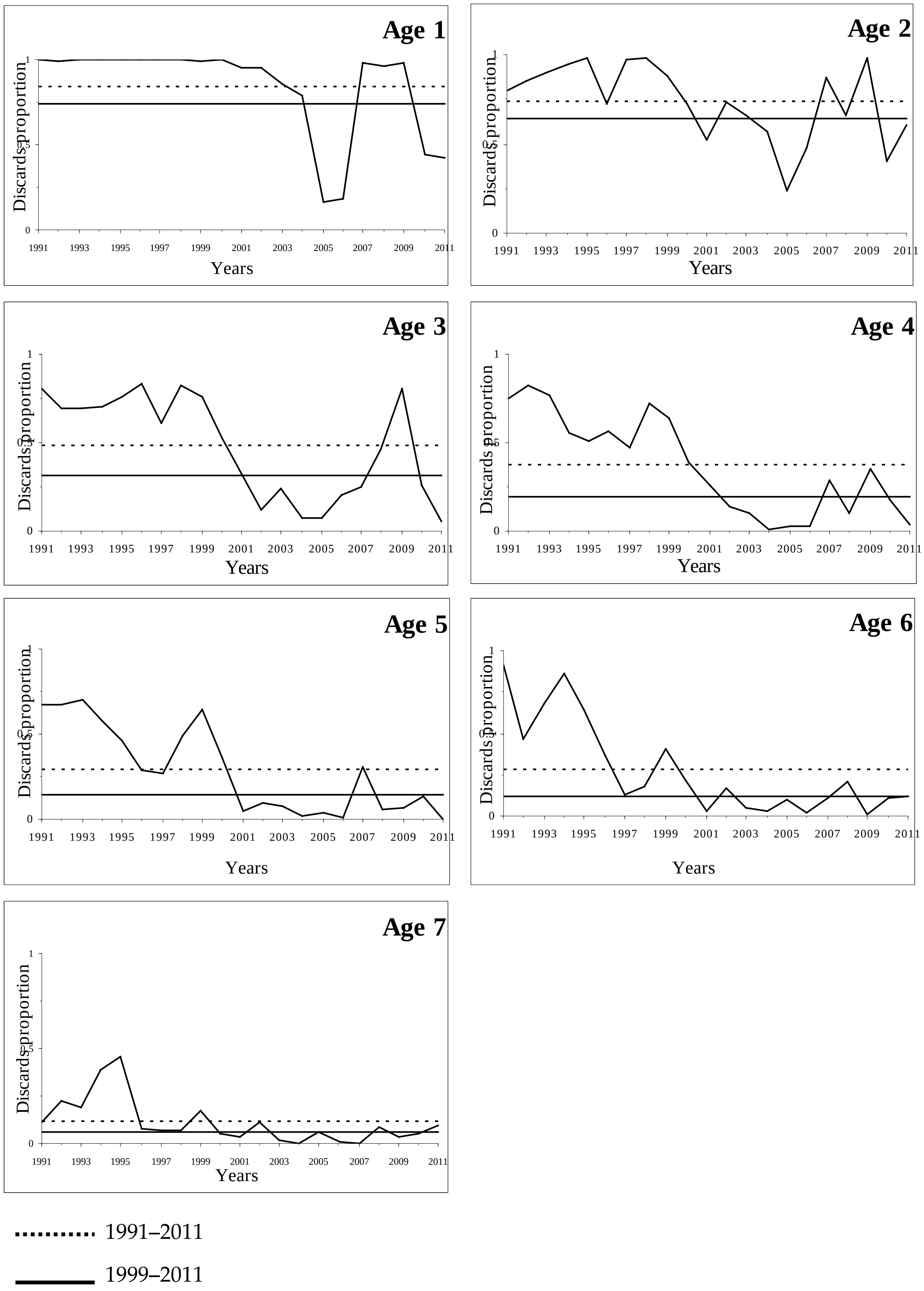


Figure 4.3.37. Haddock in Division VI b. Discard proportion at age by year and mean discard proportion-at-age for two periods, 1991–2011 and 1999–2011.

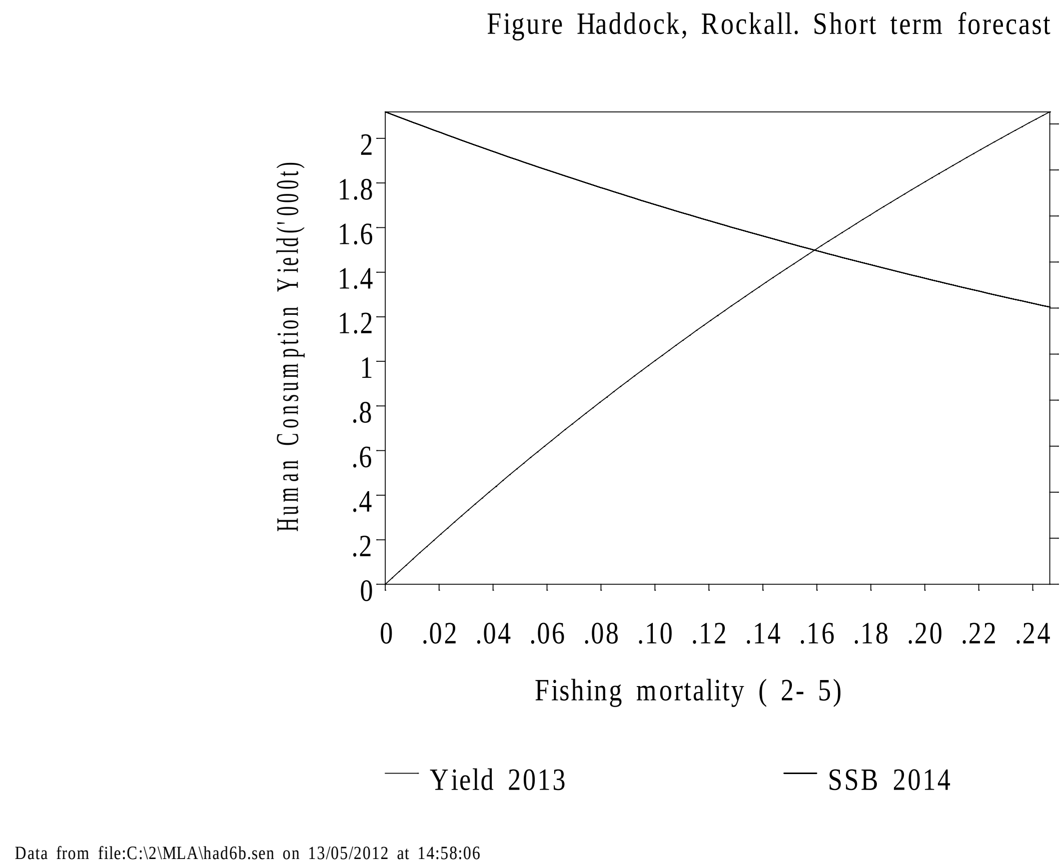


Figure 4.3.38. Haddock in VIb. Short-term forecast.

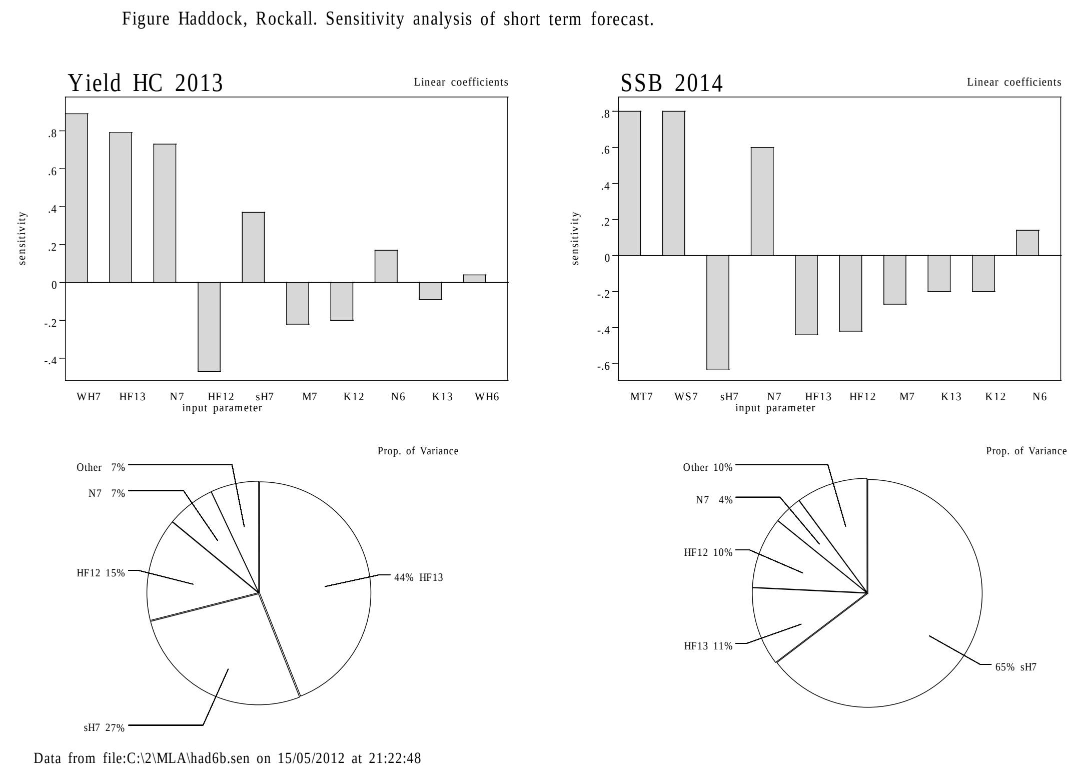


Figure 4.3.39. Haddock in VIb. Delta plots from sensitivity analysis.

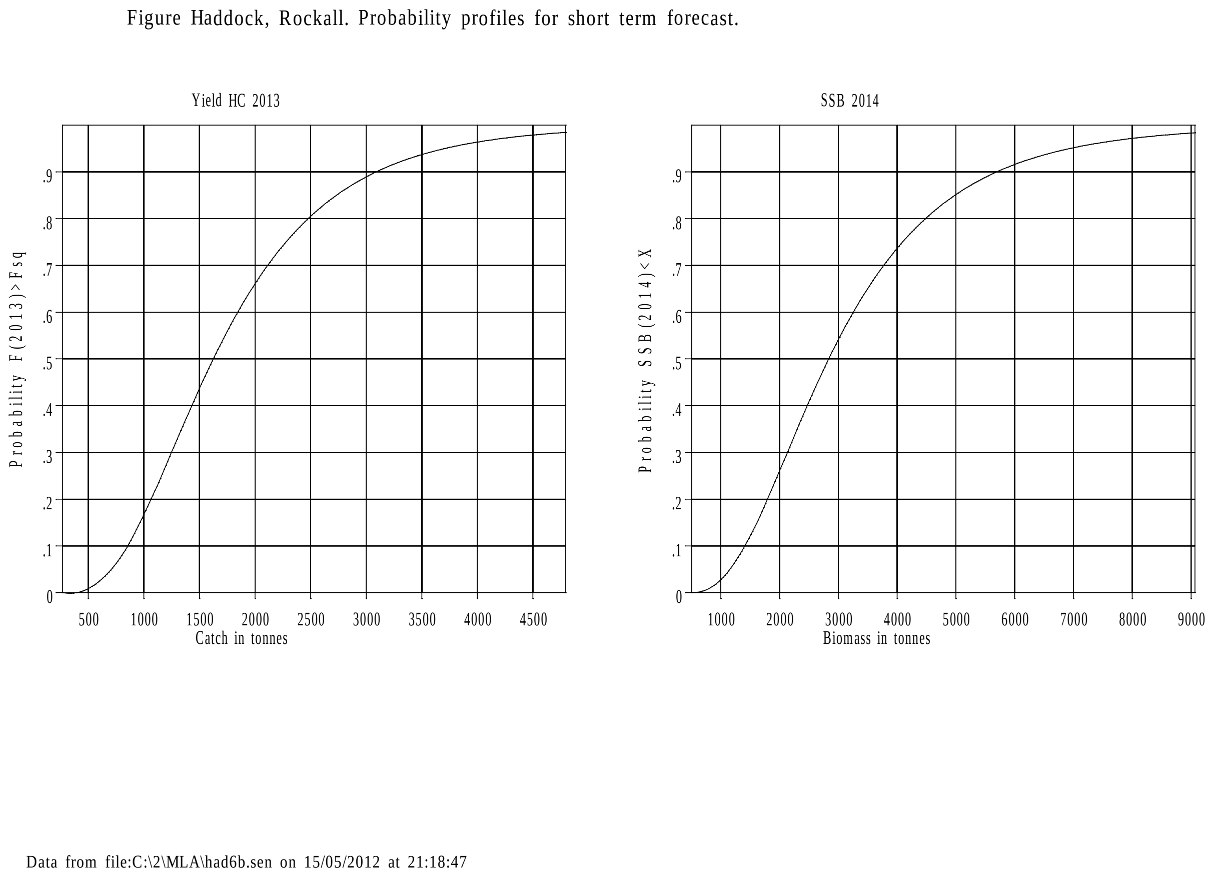


Figure 4.3.40. Haddock in VIb. Probability plots for yield in 2012 and SSB in 2013.

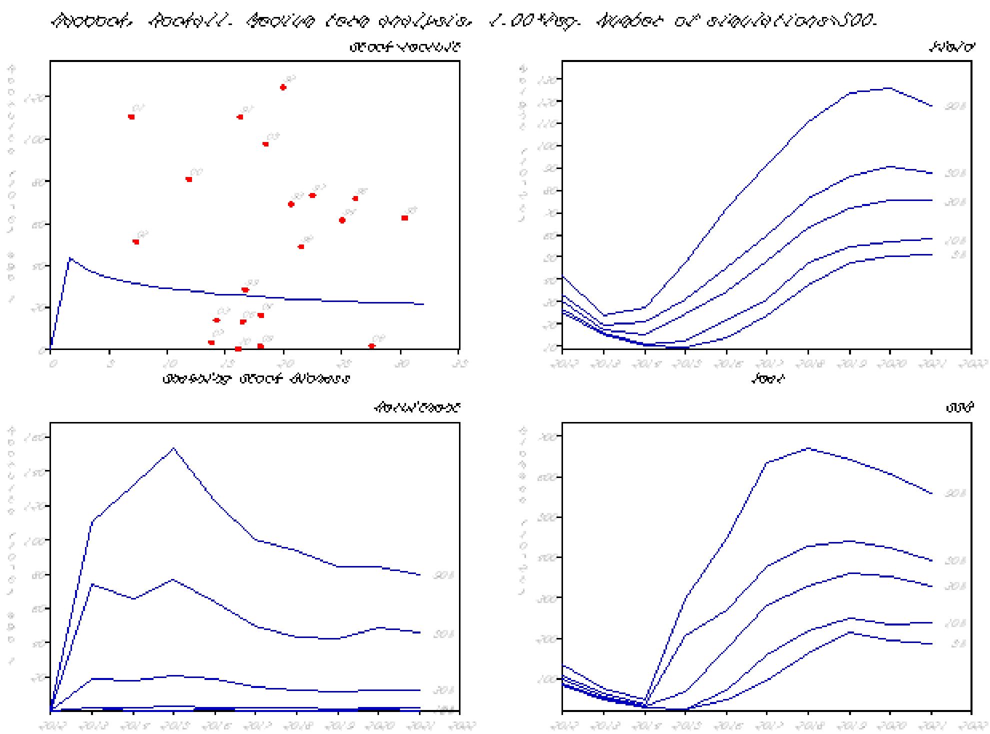


Figure 4.3.41. Haddock VIb. Medium-term analysis.

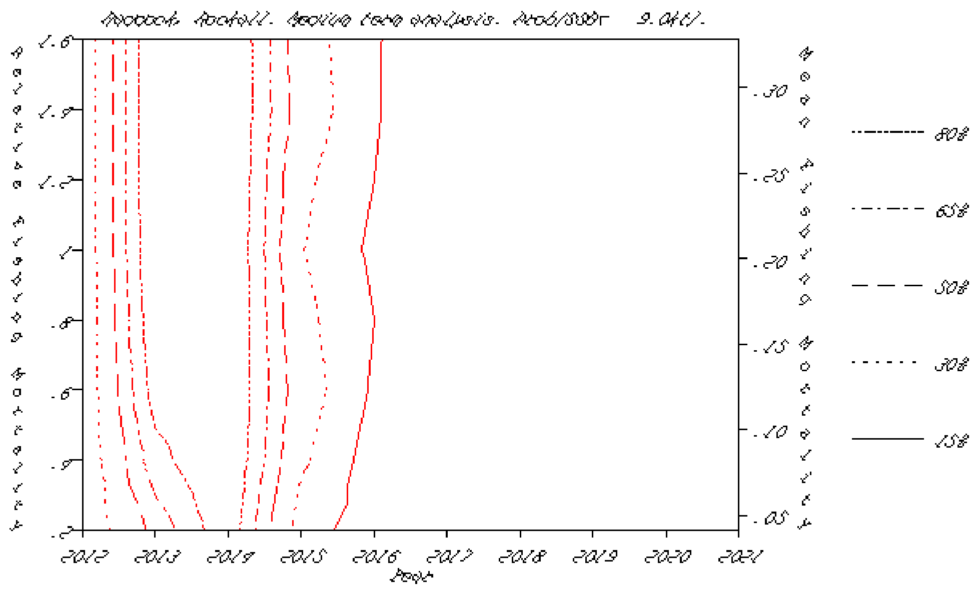


Figure 4.3.42. Haddock VIb. Medium-term analysis.

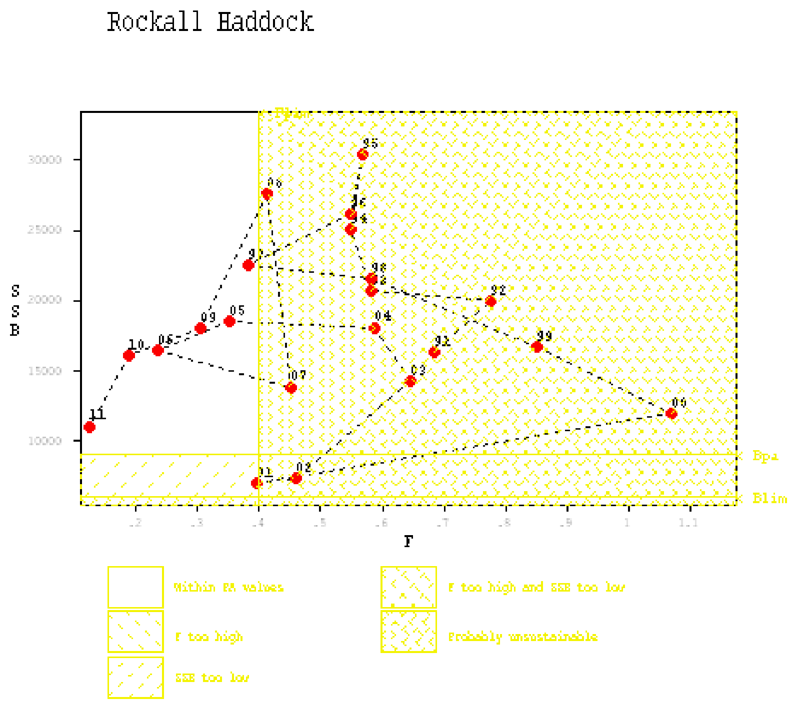


Figure 4.3.43. Haddock in VIb. Biological reference points.

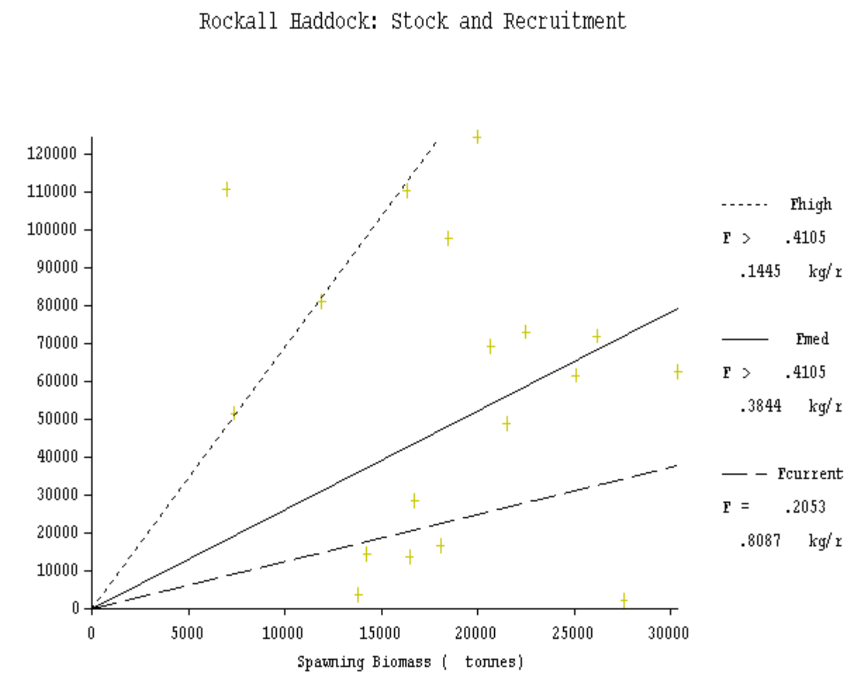


Figure 4.3.44. Haddock in VIb. SSB and recruitment.

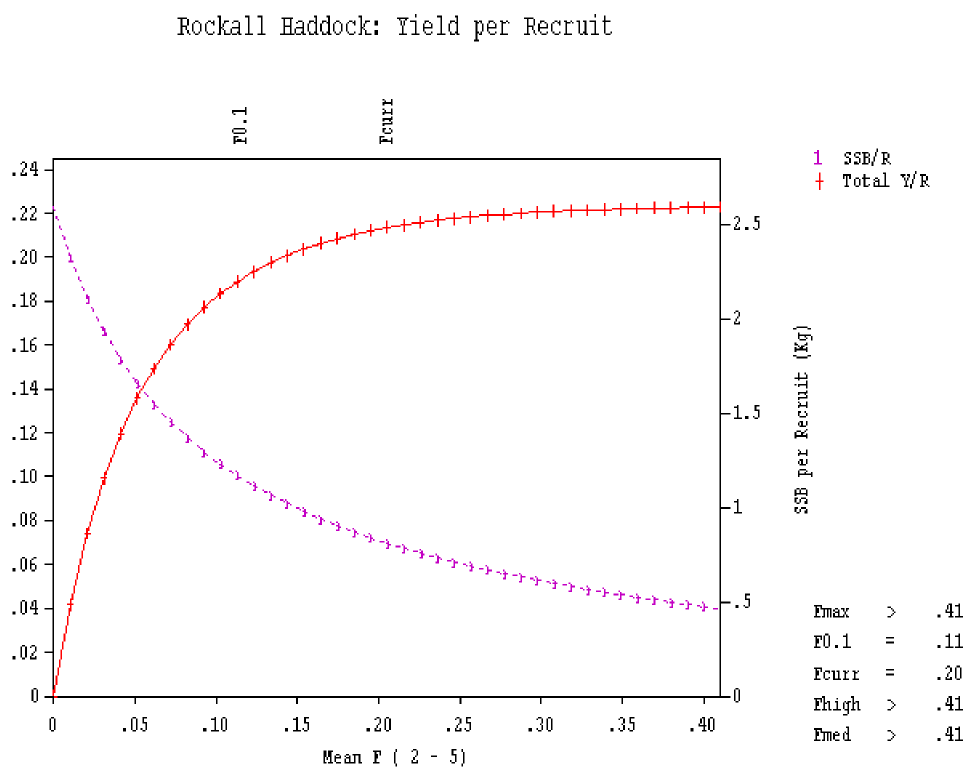


Figure 4.3.45. Haddock in VIb. Yield per recruit.

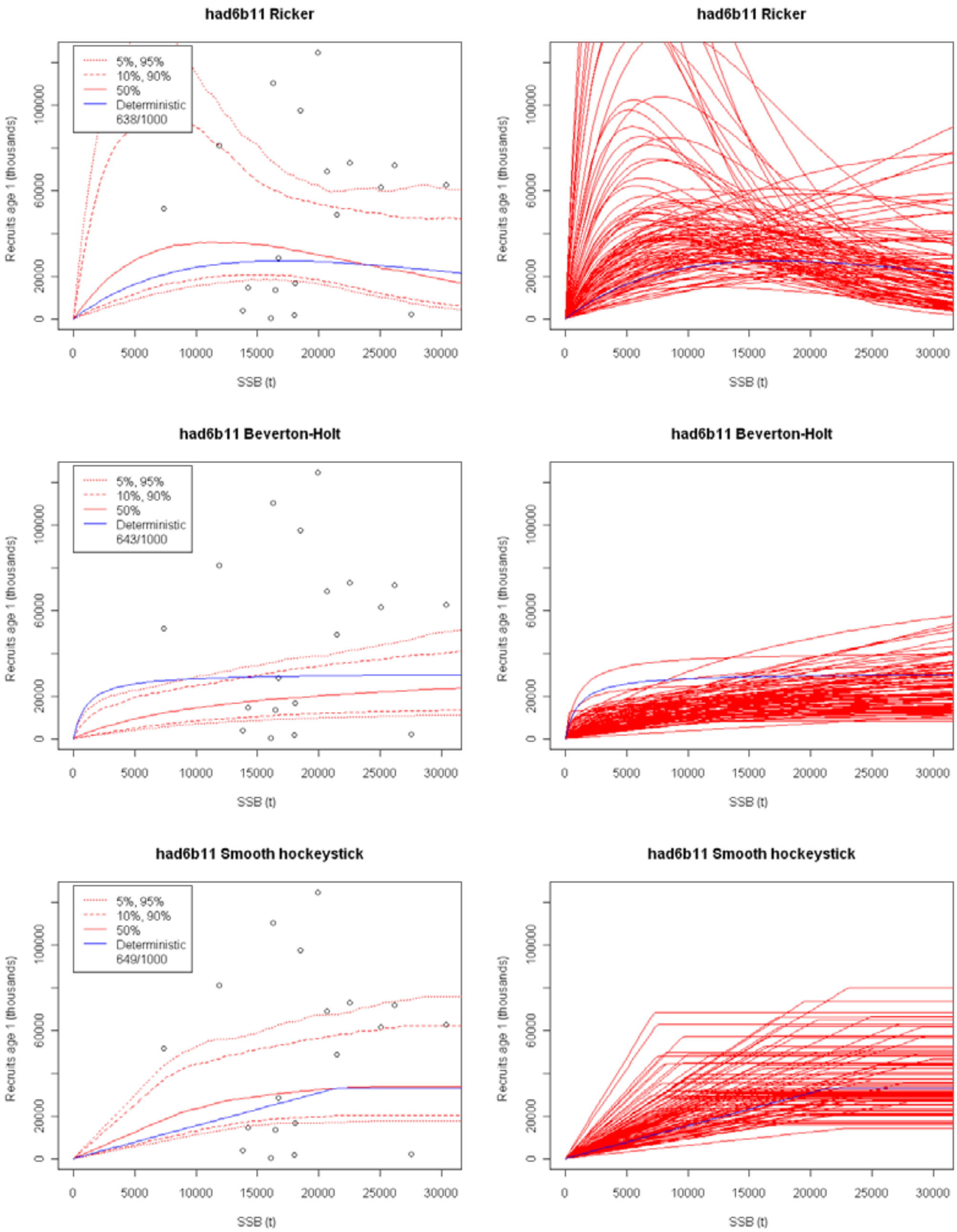


Figure 4.3.46. Haddock in VIb. Fitted stock–recruit relationships with 1000 MCMC re-samples. The left-hand plots show the deterministic fit (blue) as well as the confidence intervals from converged estimates of Fmsy (red). Right-hand panels show the fits from the first 100 converged MCMC re-samples for illustration. The legends show the number of converged values for FMSY from 1000 re-samples

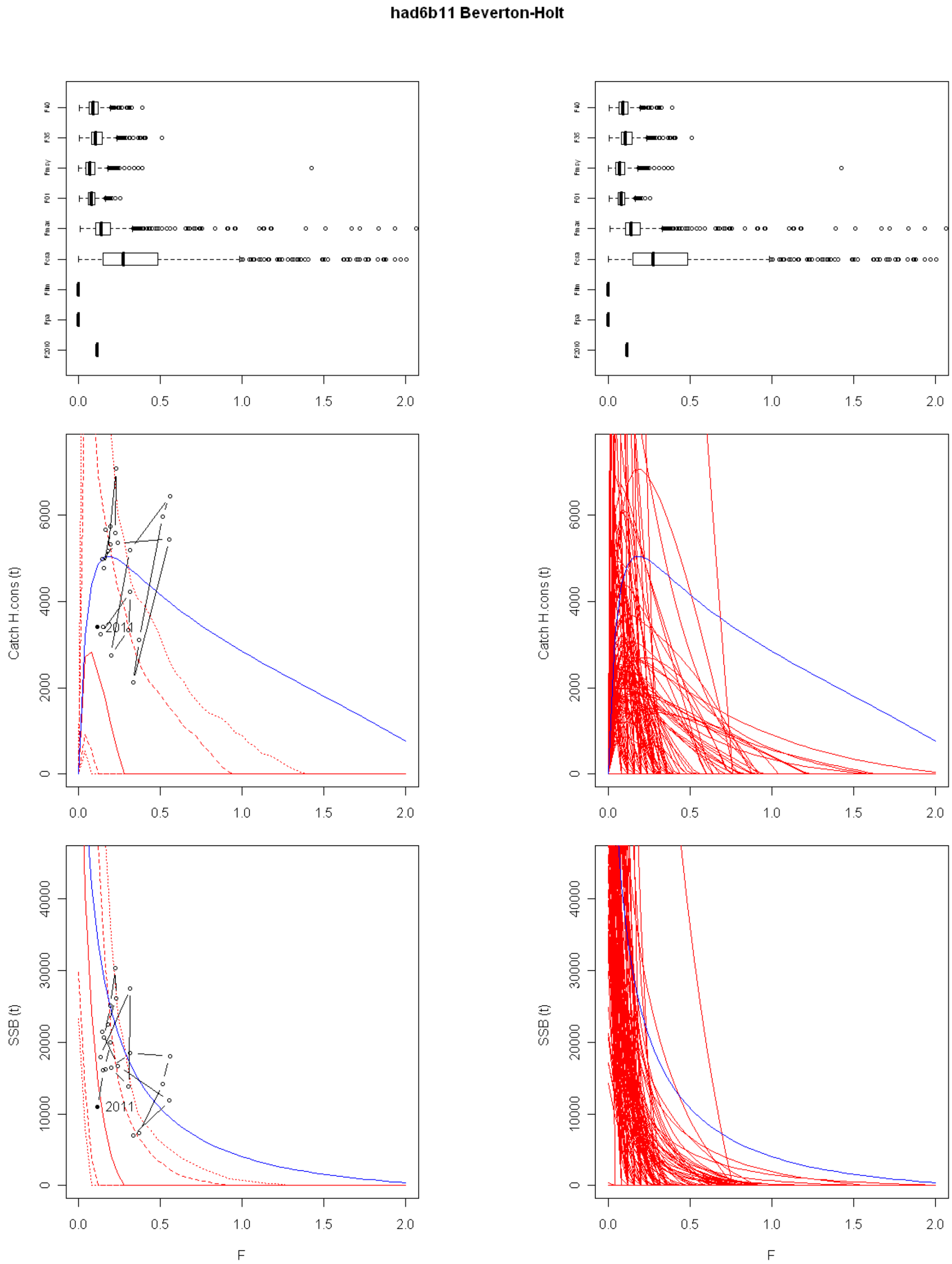


Figure 4.3.47. Haddock in VIb. Estimates of F reference points and equilibrium yield and SSB against mortality using a Beverton and Holt recruitment model. The left-hand plot illustrate the deterministic fit (blue) and confidence intervals of the converged estimates (red) and the right hand plots show the fit for the first 100 re-samples for illustration. The top two plots are identical.

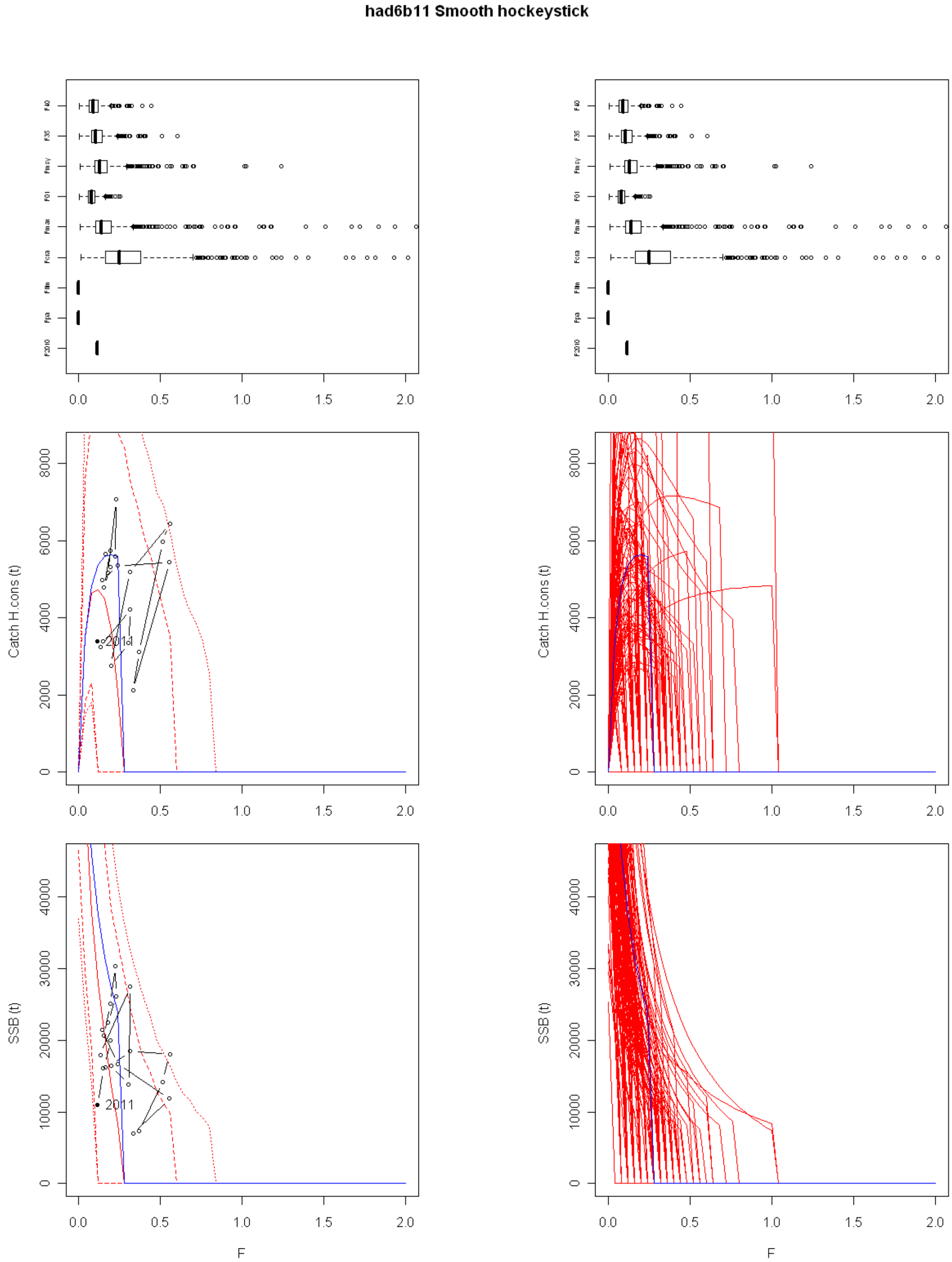


Figure 4.3.48. Haddock in VIb. Estimates of F reference points and equilibrium yield and SSB against mortality using a hockey-stick recruitment model. The left-hand plot illustrate the deterministic fit (blue) and confidence intervals of the converged estimates (red) and the right hand plots show the fit for the first 100 re-samples for illustration. The top two plots are identical.

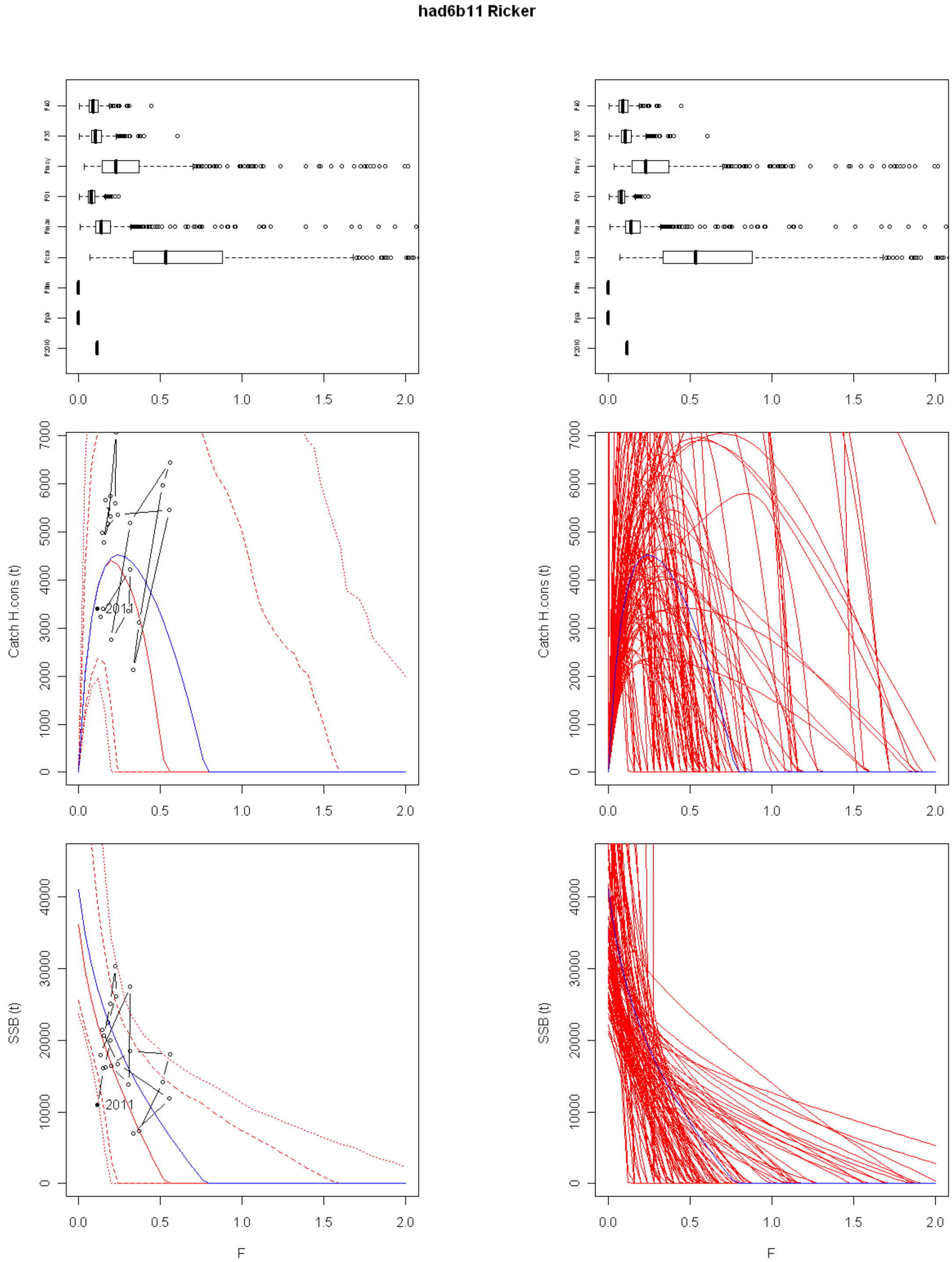


Figure 4.3.49. Estimates of F reference points and equilibrium yield and SSB against mortality using a Ricker recruitment model. The left-hand plot illustrate the deterministic fit (blue) and confidence intervals of the converged estimates (red) and the right hand plots show the fit for the first 100 re-samples for illustration. The top two plots are identical.

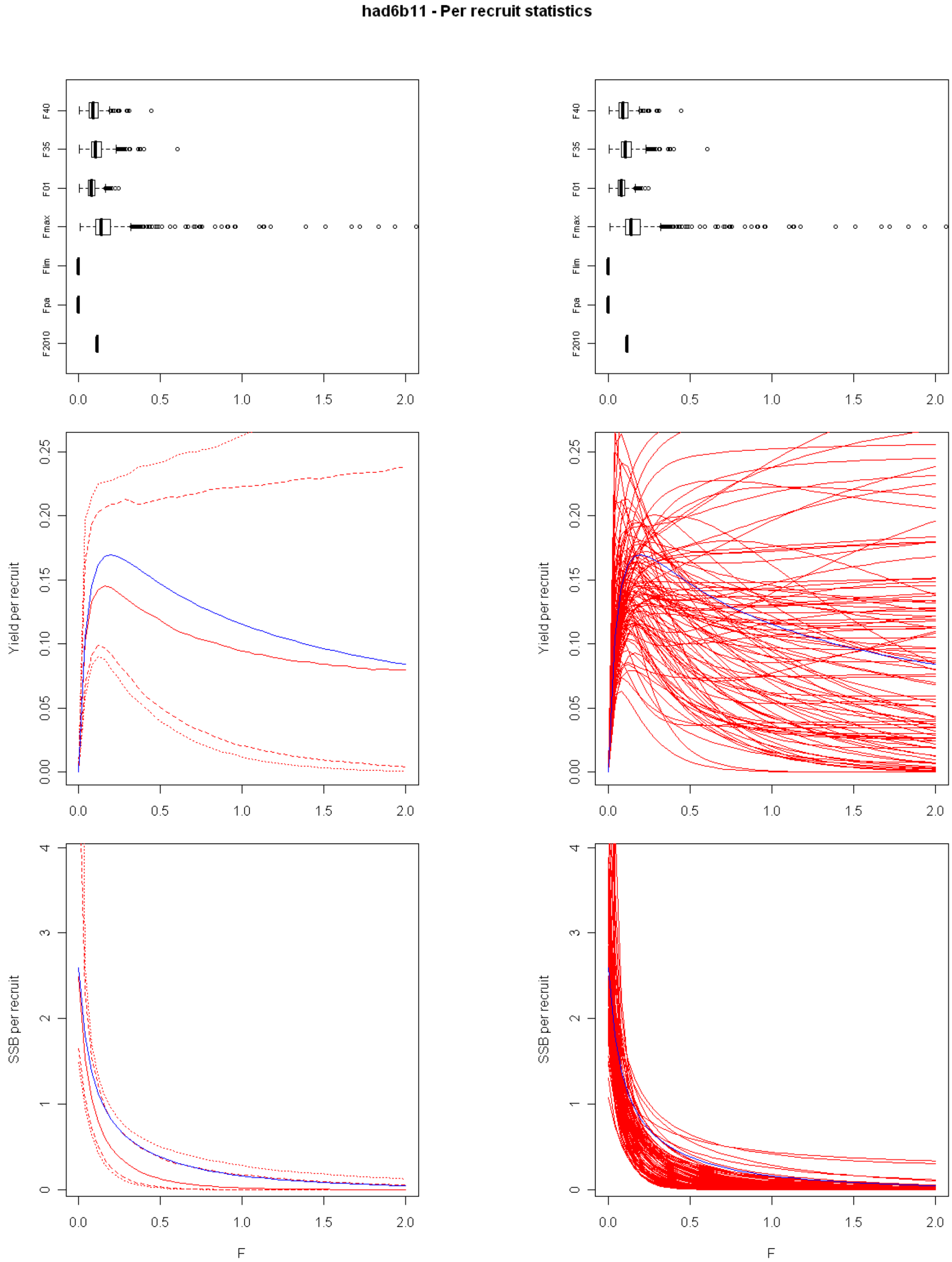


Figure 4.3.50. Fitted of F reference points and equilibrium yield and SSB. The left-hand plot illustrate the deterministic fit (blue) and confidence intervals (red) and the right hand plots show the fit for the first 100 iterations. The top two plots are identical.

4.4 Whiting in Subarea VIb

Type of assessment in 2012

No assessment was performed in 2012

ICES advice applicable in 2011

Management Objective (s)	Landings in 2011
Transition to an **MSY approach** with caution at low stock size	n/a
Cautiously avoid impaired recruitment (**Precautionary Approach**)	n/a
Cautiously avoid impaired recruitment and achieve other objective(s) of a **management plan** (e.g., catch stability)	n/a

The state of the stock is unknown and there is no basis for an advice. Landings of whiting from Division VIb are negligible (16 t in 2009).

ICES advice applicableto 2012

There is insufficient information to evaluate the status of the stock. Therefore, based on precautionary considerations, ICES advises that no increase of the catch should take place unless there is evidence that this will be sustainable.

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 in 2012

The TAC for whiting is set for ICES Subareas VI, XII and XIV and EU and international waters of ICES Subdivision Vb, and for 2012 was as shown below:

Species: Whiting *Merlangius merlangus*		Zone: VI; EU and international waters of Vb; international waters of XII and XIV (WHG/56-14)
Germany	2	
France	37	
Ireland	92	
United Kingdom	176	
Union	307	
TAC	307	Analytical TAC

The fishery in 2011

No specific information is available for 2011. Whiting at Rockall are taken as a by-catch in fisheries for other species such as haddock and anglerfish.

4.4.2 Data

Only official landings data are available for whiting in VIb. These are shown by nation in Table 4.4.1 and Figure 4.4.1. Reported landings are currently negligible (9 tonnes in 2011). 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.

Survey catch rates of whiting at Rockall are extremely low 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 WKLIFE considerations

WKLIFE considered VIb whiting to be a category 6 stock; data limited (including stocks for which only landings data are available). WGCSE reviewed the categorisation and concluded that VIb whiting should actually be categorised as a stock caught in minor amounts as a bycatch species in other fisheries (category 7).

For stocks with a time-series of catch data, the WG agreed to explore the use of DCAC (Depletion Corrected Average Catch) to provide potential levels of sustainable catch for these types of stocks.

DCAC input data/parameters:

Total landings of 2977 tonnes over 35 years (1976–2011);

M = 0.2 (by analogy with other whiting stocks);

B_{MSY}/B_0 = 0.4 (as recommended in the DCAC manual).

A number of exploratory runs were conducted with alternative assumptions for the depletion delta (0.5, 0.8 and 0.99) and F_{MSY}/M ratio (0.6, 0.8, 1.0) and these resulted in levels of sustainable catch ranging from 53.4 tonnes to 71.2 tonnes. The results are, however, highly sensitive to the total landings (sustainable catch of ~180 t using 1961–2011 data). Given the uncertainties associated with i) the accuracy of the total landings data and ii) stock definition, the results were not considered further.

4.4.4 Management considerations

The TAC is 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, 1989–2011, 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	2011*
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ireland	-	-	-	-	32	10	4	23	3	1	-	-	10		2	3	3	104	16	23	4	2	3
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	1	8	12	16	
UK (all)																							6
Total	34	488	460	288	128	80	62	85	117	44	44	58	14	7	13	4	4	105	17	31	16	18	9

*** Preliminary.**

1989–2009 N. Ireland included with England and Wales.

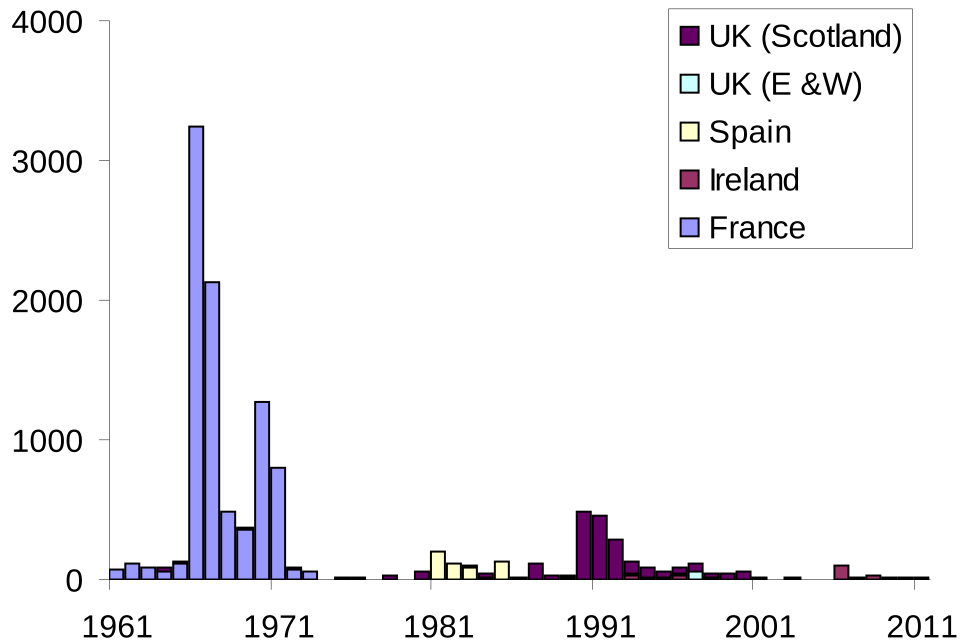


Figure 4.4.1. Whiting in Subarea VIb. Official landings of whiting in VIb by nation.

5.1 Northern Shelf overview

Description of fisheries

UK (Scottish) vessels account for most of the reported anglerfish landings from the Northern Shelf area. The Danish and Norwegian fleets are the next most important exploiters of this stock in the North Sea while Irish and French vessels take a substantial proportion of the landings from the West of Scotland. A description of the fisheries can be found in the Stock Annex.

5.2 Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Division IIa, IIIa, Subarea IV and VI

The WGNSDS considered the stock structure of anglerfish on a wider European scale in 2004, and found no conclusive evidence to indicate an extension of the stock area northwards to include Division IIa. For the purposes of reporting, anglerfish in IIa is treated in a separate section (5.2.2) from anglerfish on the Northern Shelf (Division IIIa, Subarea IV and VI, Section 5.2.1), but the advice refers to both.

5.2.1 Anglerfish in Division IIIa, Subarea IV and VI

There has been no assessment of the anglerfish stock on the Northern Shelf since 2003. ACFM review groups highlighted the generally poor data for this stock and the need to continue with the recently instigated data collection schemes (both survey and commercial data) in order to obtain time-series of sufficient length. Since 2005, an annual science–industry partnership survey has been conducted by the Scottish, and in some years, Irish institutes: updates to these survey data are presented this year, along with updates to catch and effort data where available.

ICES advice applicable to 2011 and 2012

The ICES advice for 2011 (Single-Stock Exploitation Boundaries) was as follows:

MSY approach

Due to a decrease in survey estimates of stock abundance and biomass and unknown exploitation pattern catches should be reduced at rate greater than the rate of stock decrease. Because the catch levels are not known (only landings) this cannot be quantified. Therefore, effort in fisheries that catch anglerfish should be reduced. The time-series is only five years so the provision of the 2010 survey data will be important for confirming recent trends.

Precautionary approach

The catch should be reduced and effort in fisheries that catch anglerfish should decrease.

Policy paper approach

In the light of the EU policy paper on fisheries management (17 May 2010, COM(2010) 241) this stock is classified under category 7 (State of the stock is not known precisely and reduction of fishing effort is advised). Under Annex IV.5, applying the indices of biomass from the survey as indicators of stock development, then the average total biomass in the last two years is 2–3% higher than the biomass in the three years previous to that, resulting in an unchanged TAC. Applying the indices of abundance from the survey as indicators of stock development gives a decline of around 27%. This would result in a TAC reduction of 15% for 2011.

The ICES advice for 2012 (Single-Stock Exploitation Boundaries) was as follows:

ICES advises on the basis of precautionary considerations that catches in 2012 should be reduced.

5.2.1.1 General

Stock description and management units

In this section, the anglerfish stock on the Northern Shelf is considered to occur in Divisions IIa, IIIa (Skagerrak and Kattegat), Subarea IV (the North Sea) and Subarea VI (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. In 2004, the WG was asked to consider the stock structure of anglerfish on a wider Northern European scale and despite a lack of conclusive evidence to indicate a single stock, anglerfish in IIa was included in the ToR at subsequent WG meetings.

Management of Northern Shelf anglerfish is based on separate TACs for the North Sea area and West of Scotland area. The following Table summarises ICES advice and actual management applicable for Northern Shelf anglerfish during 2003–2011.

Year	Single stock exploitation boundary	Basis	West of Scotland TAC[4)]	West of Scotland % change in F associated with TAC	West of Scotland WG landings	North Sea TAC[5)]	North Sea % change in F associated with TAC	North Sea WG landings
2003	<67001)	Reduce F below F_{pa}	3180	49% reduction	4126	7000	49% reduction	8268
2004	<88002)	Reduce F below F_{pa} [2)]	3180	48% reduction	3296	7000	48% reduction	9027
2005	-	No effort increase[2)]	4686	-	n/a	10314	-	n/a
2006	-	No effort increase[2)]	4686	-	n/a	10314	-	n/a
2007	-	No effort increase[2)]	5155	-	n/a	11345	-	n/a
2008	-	No effort increase[3)]	5155	-		11345	-	
2009	-	No effort increase[3)]	5567	-		11345	-	
2010	-	No effort increase[3)]	5567	-		11345	-	
2011	-	Decrease effort	5456	-		9643	-	
2012	-	Reduce catches	5183	-		9161	-	

All values in tonnes.

1) Advice for Division IIIa, Subarea IV and Subarea VIa combined.

2) Advice for Division IIIa, Subarea IV and Subarea VI combined.

3) Advice for Division IIa, Division IIIa, Subarea IV and Subarea VI combined.

4) TAC applies to Vb(EC), VI, XII and XIV.

5) TAC applies to IIa & IV (EC)

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 IV in 2011.

The fishery in 2011

A description of the fisheries on the northern shelf is given in the stock annex.

The official landings by area are given in Table 5.2.1 and the breakdown by country in Tables 5.2.2–4. In 2011, total [officially reported] landings (12 232 t) were similar to 2010 (12 696 t). Total officially reported landings of anglerfish from the Northern Shelf are shown in Figure 5.2.1. During the 1970s landings were fairly stable at around 9000 t, but from about 1983 they increased steadily to a peak of over 35 000 t in 1996, and then declined rapidly during the following six years. However, any subsequent declines in reported landings may have been due to restrictive TACs and are not necessarily representative of actual landings. The overall trend in landings is driven by the landings from the Northern North Sea and West of Scotland. Together these two areas account on average for approximately 85% of the total landings over 1973–2011.

Uptake of EC quota in 2011, based on the officially reported landings was as follows:

	TAC[1]	Landings	Uptake (%)	TAC	TAC	TAC	Landings	Uptake (%)
	VI	VI		IV (Nor[2])	IIa & IV	IIa & IV (total)	IIa & IV (total)	
Belgium	196	0	0	45	341	386	0	0
Denmark		0		1152	752	1904	1128	59
France	2412	926	0		70	70	11	16
Germany	224	0	0	18	367	385	0	0
Ireland	546	596	109				0	
Netherlands	189	0	0	16	258	274	59	22
Portugal		1					0	
Russia		0					0	
Spain	210	0	0				0	
Sweden		0			9	9	16	178
UK (total)	1679	2046	122	269	7846	8115	6400	79
Total	5456	3569	65	1500	9643	11143	7732	69

[1] TAC applies to VI, Vb(EC), and international waters of XII and XIV.

[2] Norwegian waters

Catches in Division IIIa are not regulated: Table 5.2.4 shows the official landings which came to a total of 432 t in 2011, a figure similar to last year. The landings by fleet for Denmark and Norway are given in Figures 5.2.2 and 5.2.3 respectively. The Scottish and Irish fleets are dominated by demersal trawlers and so they are not shown here.

5.2.1.2 Data

Landings (Tables 5.2.1–5.2.4)

The TACs for both the West of Scotland and North Sea areas were reduced substantially in 2003 and 2004, and at previous WGs it has been highlighted that these reductions would likely imply an increased incentive to misreport landings and increase discarding unless fishing effort was reduced accordingly (Section 6.4.6, ICES WGNSDS 2003). Anecdotal information from the fishery in 2003 to 2005 appeared to suggest that the TACs were particularly restrictive in these years. The official statistics for these years are, therefore, likely to be particularly unrepresentative of actual landings. The introduction of UK & Irish legislation requiring registration of all fish buyers and sellers (See Section 1.7) may mean that the total reported landings from 2006 onwards are more representative of actual total landings in the UK & Ireland.

In the meantime, collation of an international landings-at-age dataset is being hampered by the different approaches to age determination by the institutes which could provide these data. Several countries use the illicia to age, whilst others use otoliths. An anglerfish ageing exchange was held in 2011 and found little agreement between methods or readers.

The absence of a TAC for Subarea IV prior to 1999 means that before 1999, landings in excess of the TAC in other areas were likely to be misreported into the North Sea. In 1999, a precautionary TAC was introduced for North Sea anglerfish, but unfortunately for current and future reporting purposes, the TAC was set in accord with recent catch levels from the North Sea which includes a substantial amount misreported from Subarea VI. The area misreporting practices have thus become institutionalised and the statistical rectangles immediately east of the 4°W boundary (E6 squares) have accounted for a disproportionate part of the combined VIa/North Sea catches of anglerfish. The Working Group historically (prior to 2005) provided estimates of the actual Division VIa landings by adjusting the reported data for Division VIa to include a proportion of the landings declared from Division IVa in the E6 ICES statistical rectangles. This adjustment has been adapted to include landings declared from the whole of Area VI. Details of how the correction has been applied are given in the Stock Annex. Scottish officially reported landings adjusted for area misreporting are shown along with landings from England & Wales, Ireland, Denmark, France and Norway in Figure 5.2.4. Due to a lack of landings data provided to the Working Group by some of the major nations exploiting the fishery, WG estimates of the actual Division VIa and IVa landings have not been calculated for recent years (2005–2011).

The corrected spatial distribution of anglerfish landings shows a typical pattern, with most landings being taken from the area around Shetland and also the area to the west of Scotland close to the shelf edge. Some landings, associated with the *Nephrops* fishery, are taken from the Fladen ground in the middle of the northern North Sea. A substantial amount of landings were taken from Rockall. The spatial distribution of Danish landings shows the typical pattern of higher landings around the Norwegian deeps. The Irish fishery in 2011 landed principally from the west coast of Ireland and in the south of Division VIa, with some landings from Rockall.

Consideration should be given in future to examining the distribution of landings combined with vessel monitoring system (VMS) data, perhaps using a kilowatt fishing hours metric to produce spatial distributions of lpue.

Commercial catch-effort data

Scotland

Effort data in terms of kw.days are available from official logbooks and these data are presented by gear in the report of WGNSDS 2007. However, given the uncertainties associated with the official landings from the recent past, no attempt has been made to use these data to calculate an lpue series and they have not been updated this year.

Attempts have recently been made to obtain more reliable data on catch and effort from the Scottish anglerfish fishery. In 2005, an analysis of data collated from the personal diaries of Scottish skippers operating across the Northern Shelf was presented to this WG (ICES, 2006 and Bailey *et al.*, 2004). Following recommendations made by ACFM that this data collection scheme should be continued and extended, in 2006, Marine Scotland Science (in consultation with the fishing industry) established a monkfish tallybook project. A fuller description and analysis of these data can be found in the WGNSDS 2008 Report and Dobby *et al*. (2008). However, there were problems in the scheme in terms of falling participation levels (four vessels in 2008; two vessels in 2009), the scheme was discontinued and the data are not included.

Ireland

Trends in official landings, effort in hours fished) from the Irish otter-trawl fleets (OTB) operating in Division VIa and VIb are shown in Table 5.2.5 and Figure 5.2.5. This fleet is responsible for the majority of the landings from the south of Division VIa. Landings and effort data from the other fleets (1995–2006) are available in the Stock Annex. The Irish lpues from logbooks are shown in Figure 5.2.5. The time-series show increasing trends in (particularly) Division VIa in recent years. However, it is not clear whether such trends are indicative of stock trends as such increases in lpue could also be due to changes in targeting behaviour due to reductions in fishing opportunities for other species and changes in reporting practices.

Denmark

Danish logbook data for anglerfish landings and corresponding effort by main fishery in the North Sea and IIIA for the period 2001–2011 are shown in Tables 5.2.6 and Table 5.2.7. Figure 5.2.6 shows the fluctuations in lpue for anglerfish in mixed demersal fisheries (targeting roundfish, anglerfish, *Nephrops*) in the northeastern North Sea) and the shrimp (*Pandalus*) fishery (small meshed). The lpue series for the mixed demersal trawl fisheries in the North Sea represents the fisheries where most anglerfish is taken (Table 5.2.6). On the other hand, the lpue series for shrimp trawl represents a 'bycatch lpue' and may be a better indicator of stock fluctuations. Note the upwards trend, especially from 2003 to 2004 for both series. Since 2006 the trends of the two series have differed, although there has been a decline in both series from 2010 to 2011. There was a decline in overall (nominal) effort in 2010 compared to the previous two years but this has increase again in 2011 (Table 5.2.7).

The decline in effort (measured in days) reflects the development in the Danish mixed fishery taking anglerfish in recent years, where there have been TAC constraints on the Danish fishery in the Norwegian EEZ which was not in evidence in earlier years. In 2008–2009 around 30 vessels were engaged in this fishery, but in 2010 only ten vessels participated. Several factors are causing this reduction in number of vessels (and therefore also fishing trips): TACs in the Norwegian EEZ (1152 t in 2011), increasing fuel prices and also the system of vessel ITQs used in the national management of the Danish fishery. Restrictive bycatch rules in the Norwegian zone have probably also influenced the decline in number of vessels.

Due to increasing fishing power of the vessels effective effort is probably greater than indicated by the nominal effort.

Norway

Norwegian landings by fishery are given in Table 5.2.8. Available logbook data from Norwegian trawlers have been examined for the possibility of establishing a cpue time-series for anglerfish. However, several problems were encountered in the dataset, and it is still considered insufficient for providing any reliable information on trends in stock abundance.

Six gillnetters have been included in a self-sampling scheme established along the Norwegian coast within IVa and IIIa. Detailed information about effort and catch will be provided through this scheme, and will potentially be valuable in future assessments of anglerfish in this area.

Other countries

No effort data were available for the Spanish and French fleets operating in Subarea VI.

Research vessel surveys

At previous meetings of this WG it has been concluded that the traditional groundfish surveys are ineffective at catching anglerfish and do not provide a reliable indication of stock size. As a result of this conclusion, and the urgent requirement for fishery-independent data, Marine Scotland Science, began a new joint science/industry survey in 2005. This is a targeted anglerfish survey using commercial gear. In 2006, 2007 and 2009, Ireland also participated extending the anglerfish survey to cover the remaining part of VIa (from 54°30′ to 56°39′) and, in 2006 and 2007, into ICES Areas VIIb,c,j. In 2011, the Scottish survey covered the whole of VIa. These surveys are referred to in this section as Sco-IV-VI-AMISS-Q2, Further details of the survey including information on design, sampling, gear and vessel were recently considered by ICES WKAGME and are available in ICES (2009).

The estimation of abundance and biomass from these surveys was described in previous working documents to this WG (WD 5, Fernandes, 2010 and WD 6, Yuan *et al.*, 2010). Estimates for the 2005–2011 surveys are summarised in Table 5.2.9, with the appropriate error and its propagation. The estimates represent the best available knowledge to date from the seven surveys carried out (2005–2011) and as such they take into account the following factors:

1) herding of anglerfish by the trawl doors and sweeps;

2) escapes of fish under the trawl footrope;

3) anglerfish abundance and biomass in the southern part of Area VI not covered in 2005, 2008 and 2010;

4) visual counts of anglerfish in areas closed to trawling at Rockall carried out in 2007–2011 (McIntyre *et al.*, in prep);

5) variability due to:

  5.1) sampling;

  5.2) missing ages;

  5.3) herding (based on experimental data);

  5.4) footrope escapes (based on experimental data).

The estimates currently do not take account of the following:

1) areas in the central and southern North Sea (eastern part of ICES Division IVa and all of IVb and IVc);
2) areas inaccessible to the trawl in Division VIa.

Methods to account for these factors are under development.

The 2011 survey took place in April: the sample locations (n = 152) are illustrated in Figure 5.2.7 as the number density (number per square kilometre) and Figure 5.2.8 as the weight density (kilograms per square kilometre) of anglerfish. The highest densities of anglerfish occurred close to the 200 m contour in the northern and western areas, including the north western North Sea. The highest densities were found on the eastern Rockall plateau. The abundance and biomass estimates from the survey are presented in Table 5.2.9. The total estimate for the Northern Shelf in 2011 was 33 254 t. The 95% confidence limit estimates for this estimate were between 26 970 and 39 274 t, and the relative standard error 9.5%.

Estimates of biomass from the survey in ICES Area IV (14 949 t) were smaller than those in Area VI (18 305 t). The estimates-at-age (Figure 5.2.9) indicate that despite corrections for catchability, which largely affect the smaller, younger fish, there is still an issue with catchability which is unaccounted for.

In the North Sea (ICES Division IV), the time-series estimates for anglerfish age 1 and older, indicate a decline in numbers since 2007 (Figure 5.2.7). However, estimates at Rockall (ICES Division VIb) are more stable over the seven year time-series. Numbers in the west of Scotland (ICES Division VIa), declined from 2005 to 2009, but have since increased (Figure 5.2.7). The biomass estimates are more variable, but show a decrease in the North Sea since 2008, a more stable trend at Rockall and a slight decline in the west of Scotland (Figure 5.2.8).

The estimates of abundance of anglerfish from the surveys are in line with previous attempts to quantify their abundance (ICES 2004): the last assessment estimated the total stock biomass to be just under 37 000 t in 2002. 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 younger anglerfish (ages 0–4) still look to be underestimated (Figure 5.2.9). 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. Methods to compensate for these additional catchability and availability factors are being considered by developing a survey based assessment model. Secondly, the area considered was not complete. Although only a small part of ICES Area VI was missed, quite a large part of ICES Area IV was not surveyed (Figure 5.2.8). Although repeated requests have been made to countries with an interest in the anglerfish fishery to consider participating, no other countries have done so, with the exception of the Irish who participated in 2006, 2007 and 2009. The problem is, therefore, being tackled by an examination of data from the International Bottom Trawl survey. If a relationship can be found between the IBTS survey data and the data from the anglerfish survey where they overlap, then abundance estimates in the southern North Sea could be derived by interpolation where there is only IBTS data. These methods are currently under development (see ICES WKAGME 2009).

The catch curves for the fully selected data (age 5 and older) are given in Figure 5.2.10. These provide evidence that the survey is performing reasonably well because year classes (cohorts) can be tracked through time. The slopes of these catch curves (multiplied by -1) give an estimate of total mortality (Z) over the course of the survey time-series. The average total mortality of ages 6 to 8 was 0.44.

5.2.1.3 Historical stock development

There has been no assessment of this stock since the length-based assessment presented in ICES (2004). This indicated a total stock size of approximately 36 590 t in 2002.

The estimates of abundance of anglerfish from the surveys from 2005–2011 are in line with these previous attempts to quantify their abundance. There are still several factors which make the survey estimates likely to be underestimates or minimum estimates (see above).

5.2.1.4 Short-term projections

In the absence of an age-based assessment, there are no short-term projections for this stock.

In terms of setting the TAC for 2013, this should consider the results of the 2012 survey which is currently in progress (May 2012), along with other ICES' survey updates later on in the year.

5.2.1.5 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

Previous attempts to determine suitable harvesting rates, based on a yield per recruit analysis, estimated F_{MAX} to be 0.19 (ICES 2004). The aforementioned southern stock has recently been benchmarked and an F_{MAX} of 0.28 was used there (ICES 2012a).

5.2.1.6 Management plans

There is no management plan for this stock.

5.2.1.7 Uncertainties and bias in assessment and forecast

This WG 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.

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).

However, the introduction of legislation on buyers and sellers registration in the UK and Ireland since 2006 may mean that the reported landings for 2006 onwards are more reliable for these two countries.

A Scottish tallybook scheme was implemented from 2007–2009 as part of a long-term approach to provide better information on the fishery. The scheme had the potential to deliver relatively extensive information on spatial and depth distribution of catch rates provided that participation remained high. In addition to total catch rate information, the fishermen were also asked to provide information on landings by size category, discards, catches of mature females and bycatches of other species. However, participation in this scheme fell significantly in the final years and in 2010 ceased completely because of data sensitivities associated with the compliance of fishery regulations. The tally book programme was terminated as a result.

Survey data

In addition to obtaining estimates of abundance from swept area methods and a time-series of data for use in survey based assessments, a visual count method has been developed at Marine Scotland Science to provide alternative estimates of anglerfish density in areas where trawling is prohibited (at Rockall for example). It is also anticipated that the new Scottish-Irish science–industry survey will provide further useful information on the biology and stock structure of anglerfish. So far, a total of 48 live anglerfish have been tagged with data storage tags (DSTs) on the Marine Scotland Science surveys which if and when recovered will provide information on the vertical migration, depth distribution and temperature regime of individuals. So far two tags have been returned from fish tagged in 2005: these data are currently being analysed. Tagging carried out on the Irish survey (800 ribbon tags) should also provide information on movement of anglerfish.

In 2006, 2007 and 2009 Ireland extended the survey area to include the more southerly regions of the Northern Shelf stock of anglerfish area not covered by the Scottish survey. This larger survey area was also covered in 2011 by the Scottish survey. However the participation of other nations in a collaborative survey to include coverage of waters in the east and south of the North Sea would be invaluable.

Biological information

Knowledge of the biology of anglerfish is improving. Some of the basic biological parameters used in the assessments, such as mean weight-at-age in the stock, are now becoming available from the industry science surveys. Difficulties still remain in finding mature females. However, recent studies by Laurenson *et al*. (2005; 2008) carried out whilst observing the fishery, have obtained similar growth parameters and maturity ogives to those previously used. 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 VI (including Vb(EC), XII and XIV) and the North Sea (& IIa (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 VII) could also be part of the same stock.

Following the recent expansion of the anglerfish fishery in ICES Divisions IIa and V, in 2004 the WG group was asked to consider the stock structure on the wider Northern European scale (Section 16 of the WGNSDS 2004 Report). It was concluded that there was currently insufficient information to conclusively define new stock areas for assessment and further co-ordinated work is still required. Given the request to also assess anglerfish in Division IIa and that there may be an extension to include ICES Division V in the near future, the likely spatial disaggregation of the stock (drift of larvae and possible migration of mature fish back into deeper water) means that any assessment model would need to be spatially structured, possibly supported by assessments for each of the stock units separately. Given the problems with data quality associated with Northern Shelf anglerfish, the WG wishes to highlight fundamentals required for a wider area assessment:

- Accurate information on the spatial distribution of catch and effort;
- Data on movement and migration of mature and immature individuals; and,
- An internationally co-ordinated, dedicated anglerfish survey over the wider Northern European area to include waters further east. Currently the Scottish survey provides a biomass estimate for the whole of VI, but there is only partial coverage of the North Sea. The survey should be expanded to cover the entire distribution of the stock and this would require the participation of other nations.

5.2.1.8 Recommendations for next Benchmark

This stock was benchmarked in February 2012 at WKFLAT. The main conclusions of the meeting were:

Part of the problem with producing acceptable assessment models for anglerfish was data quality and a lack of knowledge of some of the basic biological processes for these species. There is a lot of uncertainty about maturity, sex ratio, growth, and length frequencies of the catch and there needs to be an improvement in these data.

Use of ageing in anglerfish assessments: The use of *illicia* based ageing was not warranted for either species. For *Lophius piscatorius* the studies of growth of Landa *et al*. (2012) should be used as the basis for length based assessments. For anglerfish in Divisions IIa and IIIa, Subarea IV and Subarea VI, ageing based on otoliths exists and age based assessments could be considered for this stock if the internal consistency of the age composition of the data were examined in more detail and sensitivity to growth assumptions considered. Further growth and (ageing) age validation studies taking sex into account are required.

Anglerfish stock structure: There is no clear biological evidence to support the management and assessment units as they are now. Tagging experiments and other stock structure studies are encouraged to determine if the migratory rate between areas is low enough not to impair the assessment models that consider the current stocks as isolated populations with little movement.

Anglerfish (Divisions IIa and IIIa, Subarea IV and Subarea VI): For this stock ageing based on otoliths exists. These age readings have been carried out by a single reader and have been very consistent over time. The benchmark concluded that an age-based assessment could be considered for this stock if the internal consistency of the age composition data was examined in more detail and sensitivity to growth assumptions considered. Work should continue on the proposed survey based model and preliminary results should be presented to the WGCSE. A bench-mark should be considered once the work as identified is ready for review.

As well as the recommendations of WKFLAT above, given the lack of agreement between readers and reliance on one age reader it may be prudent to also consider length based approaches in future benchmarks.

5.2.1.9 Management considerations

In a previous "Policy Statement" Communication, the European Commission set out its approach to setting TACs where "the state of the stock is not known precisely and STECF advises on an appropriate catch level". These were designated "Category 6" stocks. In such cases the Commission proposed simple rules to adjust the TAC based on comparisons between average catch rates (catch per unit of effort, cpue) in the time-series. In relation to this, the European Commission's STECF had considered use of stock biomass to be a more appropriate indicator of reproductive potential as it is less sensitive to fluctuations in numbers of small, immature fish.

However, in 2011 the commission changed their approach (Council Regulation (EU) No 298/2011), initially suggesting that "When scientific advice on overfishing is unavailable..." as would be the case for anglerfish, "...a reduction of 25% in the TAC and/or in the fishing effort levels should be proposed...". This approach was dropped in advance of the council decisions to set the TAC, resulting in an *ad hoc* approach in 2012.

ICES WKFLAT (ICES 2012a) reviewed the SCO-IV-VI-AMISS-Q2 survey data and also the findings of an anglerfish age reading exchange. Despite the reservations of the latter process, which concluded that age readings were too inconsistent to provide an international catch-at-age dataset, WKFLAT concluded that there was sufficient evidence to be able to use the estimates of abundance-at-age from the surveys in an assessment model if the internal consistency of the data were examined in more detail and sensitivity to growth assumptions considered.

These data are, therefore, amenable to further analyses to provide some advice in line with the categorisation of WKLIFE (ICES 2012b) which considered the stock to be in

Category 4 – stocks for which survey-based assessments indicate trends. WKLIFE has suggested re-invoking the previous commission rule (EC Communication COM (2010) 241: Annex IV – Request to ICES for categories 6 to 9) which states:

"Where ICES considers that representative stock abundance information exists, the following rule applies:

a) If the average estimated abundance in the last two years exceeds the average estimated abundance in the three preceding years by 20% or more, a 15% increase in TAC applies.

b) If the average estimated abundance in the last two years is 20% or more lower than the average estimated abundance in the three preceding years, a 15% decrease in TAC applies.

A comparison of mean biomass estimates from the SCO-IV-VI-AMISS-Q2 surveys (Table 5.2.9) shows that the mean biomass in Areas IV & VI combined has decreased by 20.2% from 2007–2009 to 2010–2011.

Area flexibility is also an issue which can be considered in the light of the survey data. The TACs in Subareas IV (including Norwegian waters) and VI in 2011 were 10 611 t and 5183 t respectively, which is a 67:33% split. However, the stock is fairly continuously and evenly distributed across the two areas (Figs. 5.2.1.4 and 5.2.1.5). Over the course of the surveys the IV:VI split has fluctuated around 50:50 (49:51% in 2005; 54:46% in 2006; 57:43% in 2007; 55:45% in 2008; 47:53% in 2009; 52:48% in 2010; 45:55% in 2011). Care should be taken in the interpretation of these splits, because the North Sea is only partially surveyed: however, the area covered does encompass most of the distribution of anglerfish.

The exploitation status of the stock is very much dependent on assumptions of natural mortality given that the survey can only estimate the total mortality. Estimates of natural mortality (M) for this stock were previously set at 0.15 (ICES 2004): the fishing mortality would then be 0.29. Other estimates of M could also be considered. The assessment of southern anglerfish stock (VIIIc and IXa) uses an M of 0.2: if this were applied then F would be 0.24. Finally, an estimate based on the relationship to mean weight-at-age (Lorenzen 1996) would give an average M of 0.28 from ages 6–8 for the Northern Shelf stock, in which case the stock would be exploited at an F of 0.16. According to which level of M is assumed the stock of Northern Shelf anglerfish is either being overexploited or exploited sustainably: the options are summarised in Table 5.2.10.

Whatever action is taken, it should be noted that it cannot be taken without some risk to the long-term sustainability of the stock given the uncertainties about its long-term exploitation. 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 Regional Advisory Council. The survey data need to be subjected to some form of stock assessment to take into account the low numbers of younger fish and in particular the likely number of recruits. Some form of management evaluation can then be implemented to develop a more specific and sustainable harvesting regime. The outcome of this exercise will almost certainly result in a change to the way the stock is managed in forthcoming years.

5.2.2 Anglerfish in Division IIa

The WGNSDS considered the stock structure on a wider European scale in 2004, and found no conclusive evidence to indicate an extension of the stock area northwards to include Division IIa. Anglerfish in IIa is therefore treated in this separate chapter.

Type of assessment in 2012

No assessment was performed.

ICES advice applicable to 2011 and 2012

The ICES advice for 2010 and 2011 (Single-Stock Exploitation Boundaries) was as follows, and applies to Subarea VI, Subarea IV, Division IIIa and Division IIa:

"ICES advises on the basis of precautionary considerations that the effort in fisheries that catch anglerfish should not be allowed to increase. ICES advises on the basis of precautionary considerations that catches in 2012 should be reduced."

5.2.2.1 General

Stock description and management units

The WGNSDS considered the stock structure on a wider European scale in 2004, and found no conclusive evidence to indicate an extension of the stock area northwards to include Division IIa. Anglerfish in IIa is therefore treated in this separate chapter.

Fishery in 2011

There has been an expansion of the fishery in recent years. This is largely due to a northward expansion of the Norwegian gillnet fishery. The official landings from the areas north of 64° account for approximately 81% of the total figure for Division IIa in 2011, which is 4% higher than in 2010 and 17% higher than 2009. Norway is by far the largest exploiter of the IIa fishery accounting for over 95% of official landings. UK is now the next most important exploiter in this area, with landings of approximately 2.5% of the total reported to ICES (Table 5.2.11). The coastal gillnetting accounts for 85–90% of the landings, while 4–6% is taken as bycatch in different offshore gillnet fisheries (Table 5.2.12).

No TAC is given for Division IIa, Norwegian waters. Catches of anglerfish in Division IIa, EC waters are taken as a part of the TAC for Subarea IV. The Norwegian fishery is regulated through:

- A prohibition against targeting anglerfish with other fishing gear than 360 mm gillnets. A discard ban on anglerfish regardless of size.
- A maximum of 10% bycatch of anglerfish in the shrimp trawl fishery, maximum 15% bycatch of anglerfish in the trawl and Danish seine fishery.
- 72 hours maximum soak time in the gillnet fishery.
- A maximum of 500 gillnets (each net being 27.5 m) per vessel.
- A closure of the gillnet fishery from 1 March to 20 May. This closure period was expanded to 20 December to 20 May in the areas north of N 65° in 2008 and this area was expanded southwards to N 64° in 2009.

5.2.2.2 Data

Landings

The official landings for each country are shown in Table 5.2.10. Landings in 2011 as reported to ICES for the total Division IIa were 5077 t, which is 8% lower than the year before. No information suggests that the official landing figures from Norway give a biased estimate of the actual landings.

Discards

The absence of a TAC in Norwegian waters probably reduces the incentive to underreport landings. Anecdotal evidence from the industry, observer trips and data from the self-sampling-fleet suggest that a small percentage of the catch (not marketable) is discarded. This happens when the soaking time is too long, mostly due to bad weather. Data from the self-sampling-fleet are not adequate for estimating discards yet.

Biological

Length distributions are available from the directed gillnetting during the period 1992–2011, but data is lacking 1997–2001 (Figure 5.2.12). The length data indicates a decrease in mean length of 15–20 cm occurring during the period without length samples. The mean length has increased somewhat during the last five years, but is still below the level seen during the 1990s (Figure 5.2.13). One third of the anglerfish measured during the 1990s were above 100 cm, this proportion was between 1–6% for the early 2000s and 12–17% in 2006–2010. For 2006–2011, some length data from anglerfish caught as bycatch in other fisheries are presented in Figure 5.2.14.

Surveys

Anglerfish appears in demersal trawl surveys along the Norwegian shelf, but in very low numbers. There has been a change in the surveys, going from single species- to multispecies surveys, during recent years. The procedures for data collection on anglerfish have varied and, at present, no time-series from surveys in Division IIa yields reliable information on the abundance of anglerfish.

Commercial cpue

Reliable effort data are not available from the Norwegian gillnetters due to non-mandatory effort recording. In late 2005, ten gillnetters were included in a self-sampling scheme established along the Norwegian coast within Division IIa. Detailed information about effort and catch is provided through this scheme, and will potentially be valuable in future assessments of anglerfish in this area. The time-series was examined prior to WGCSE 2010, and this revealed some data quality problems for the first two years which have to be solved before any further analysis.

5.2.2.3 Historical stock development

Anglerfish in Div IIa have never been assessed quantitatively and it is not possible to describe the historical stock development.

5.2.2.4 Management considerations

The WG notes the apparent changes in size composition in anglerfish caught in the gillnet fishery. If the selectivity in the gillnets has been stable, this could be interpreted as an altering of the size spectrum in the stock. As the information on trends in effort is lacking for the main fishery, it remains unclear whether the increased landings in recent years might reflect an increased abundance in the area. Time-series on effort and catch by length should be established to facilitate future analytical assessments of this stock. The possibility of establishing a survey, similar to the one being carried out for the Northern Shelf area, should also be considered for Division IIa.

5.2.2.5 References

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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.

Table 5.2.1. Anglerfish on the Northern Shelf (IIIa, IV and VI). Total official landings by area (tonnes).

Year	IIIa	IVa	IVb	IVc	VIa	VIb	IV	VI	Total
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
1992	938	10209	3053	39	5479	1089	13301	6568	20807
1993	843	12309	3144	66	5553	681	15519	6234	22596
1994	811	14505	3445	210	5273	777	18160	6050	25021
1995	823	17891	2627	402	6354	830	20920	7184	28927
1996	702	25176	1847	304	6408	602	27327	7010	35039
1997	776	23425	2172	160	5330	899	25757	6229	32762
1998	626	16857	2088	78	4506	900	19023	5406	25055
1999	660	13326	1517	24	4284	1401	14867	5685	21212
2000	602	12338	1617	31	3311	1074	13986	4385	18973
2001	621	12861	1832	21	2660	1309	14714	3969	19304
2002	667	11048	1244	21	2280	718	12313	2998	15978
2003	478	8523	847	20	2493	643	9390	3136	13004
2004	519	8987	851	15	2453	671	9853	3124	13496
2005	458	8424	688	5	3019	958	9117	3977	13552
2006	423	10338	685	3	2785	916	11026	3701	15150
2007	433	10632	749	4	3352	1260	11385	4612	16430
2008	486	11038	769	5	3373	1630	11812	5003	17300
2009	479	10096	658	8	3029	2119	10757	5148	16389
2010	477	6979	619	11	3187	1423	7609	4610	12696
2011	432	7477	745	8	2378	1192	8230	3570	12232
Min	140	2085	575	3	1387	29	2701	1718	5623
Max	938	25176	3445	402	9221	3308	27327	9348	35039
Average	557	8684	1551	79	3943	809	10314	4753	15623

Table 5.2.2. Anglerfish in Subarea VI. Nominal landings (t) as officially reported to ICES.

Division VIa (West of Scotland)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*
Belgium	3	2	9	6	5	-	5	2	-	-	+	+	-	+	-	-	-	-	-	-	
Denmark	1	3	4	5	10	4	1	2	1	+	+	-	+	+	-	-	-	-	-	-	
Estonia																					
Faroe Is.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	3	2	1	2	4	1
France	1,910	2,308	2,467	2,382	2,648	2,899	2,058	1,634	1,814	1,132	943	739	1,212	1,191	1,392	1,314	1763	1746	1555	1,160	912
Germany	1	2	60	67	77	35	72	137	50	39	11	3	27	39	39	1	-	54	79	79	
Ireland	250	403	428	303	720	717	625	749	617	515	475	304	322	219	356	392	470	295	328	510	488
Netherlands	-	-	-	-	-	-	27	1	-	-	-	-	-	-	-	-	-	-	-	-	0
Norway	6	14	8	6	4	4	1	3	1	3	2	1	+	+	1	1	1	2	-	1	1
Russia																					
Spain	7	11	8	1	37	33	63	86	53	82	70	101	196	110	82	76	3	174	189	-	
UK(E,W&NI)	270	351	223	370	320	201	156	119	60	44	40	32	31	30	20	24	42	5	12	393	
UK(Scot.)	2,613	2,385	2,346	2,133	2533	2,515	2,322	1,773	1,688	1,496	1,119	1,100	705	862	1,127	974	1,071	1096	864	1,040	
UK (total)																			876	1,021	976
Total	5,061	5,479	5,553	5,273	6,354	6,408	5,330	4,506	4,284	3,311	2,660	2,280	2,493	2,453	3,019	2,785	3,352	3,373	3,029	3,187	2,378
Unallocated	296	2,638	3,816	2,766	5,112	11,148	7,506	5,234	3,799	3,114	2,068	1,882	985	1,938							
As used by WG	5,357	8,117	9,369	8,039	11,466	17,556	12,836	9,740	8,083	6,425	4,728	4,162	3,478	4,391							

*Preliminary.

Table 5.2.2 contd. Anglerfish in Subarea VI. Nominal landings (t) as officially reported to ICES.

Division VIb (Rockall)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*
Belgium																					
Denmark																					
Estonia	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-		-		
Faroe Is.	-	2	-	-	-	15	4	2	2	-	1	-	-	-	-	-	-	1	4	8	+
France	-	-	29	-	-	-	1	1	-	48	192	43	191	175	293	224	327	327	637	23	14
Germany	-	-	103	73	83	78	177	132	144	119	67	35	64	66	77	72	222	0	132	87	
Ireland	272	417	96	135	133	90	139	130	75	81	134	51	26	13	35	53	70	76	91	107	108
Norway	18	10	17	24	14	11	4	6	5	11	5	3	6	5	4	6	7	5	9	12	0
Portugal	-	-	-	-	-	-	-	+	429	20	18	8	4	19	63	-	-	-	-		
Russia	-	-	-	-	-	-	-	-	-	-	1	-	-	2	4	1	1	35	-		
Spain	333	263	178	214	296	196	171	252	291	149	327	128	59	43	34	36	12	85	57		
UK(E,W&NI)	99	173	76	50	105	144	247	188	111	272	197	133	133	54	93	46	146	5	48	15	
UK(Scot)	201	224	182	281	199	68	156	189	344	374	367	317	160	294	355	478	475	1096	1141	1171	
UK (total)																			1189	1192	1070
Total	923	1089	681	777	830	602	899	900	1401	1074	1309	718	643	671	958	916	1260	1630	3308	2615	1192
Unallocated									-9	17	-178	-47	145	121							
As used by WG	923	1,089	681	777	830	602	899	900	1392	1091	1131	671	788	792							

***Preliminary.**

Table 5.2.2 contd. Anglerfish in Subarea VI. Nominal landings (t) as officially reported to ICES.

Subarea VI (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*
Belgium	3	2	9	6	5	0	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Denmark	1	3	4	5	10	4	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0
Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Faroe Is.	0	2	0	0	0	15	4	2	2	0	1	0	0	2	2	3	2	2	6	12	1
France	1910	2308	2496	2382	2648	2899	2059	1635	1814	1180	1135	782	1403	1366	1685	1538	2090	2073	2192	1183	926
Germany	1	2	163	140	160	113	249	269	194	158	78	38	91	105	116	73	222	54	211	166	
Ireland	522	820	524	438	853	807	764	879	692	596	609	355	348	232	391	445	540	370.6	419	617	596
Netherlands																					
Norway	18	10	17	24	14	11	31	7	5	11	5	3	6	5	4	6	7	5	9	12	0
Portugal	6	14	8	6	4	4	1	3	430	23	20	9	4	19	64	1	1	2	0	1	1
Russia	0	0	0	0	0	0	0	0	0	0	1	0	0	2	4	1	1	35	0	0	0
Spain	340	274	186	215	333	229	234	338	344	231	397	229	255	153	116	112	15	259	246	0	0
Sweden																					
UK(E,W&NI)	369	524	299	420	425	345	403	307	171	316	237	165	164	84	113	70	188	10	60	408	0
UK(Scot)	2814	2609	2528	2414	2732	2583	2478	1962	2032	1870	1486	1417	865	1156	1482	1452	1546	2192	2005	2211	0
UK (total)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2065	2213	2046
Total	5984	6568	6234	6050	7184	7010	6229	5406	5685	4385	3969	2998	3136	3124	3977	3701	4612	5003	7213	6823	3570
Unallocated																					
As used by WG	923	1,089	681	777	830	602	899	5406	5685	4385	3969	2998	3136	3124							

***Preliminary.**

Table 5.2.3. Nominal landings (t) of Anglerfish in the North Sea, as officially reported to ICES.

Northern North Sea (IVa)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*
Belgium	2	9	3	3	2	8	4	1	5	12	-	8	1	-	-	-	-	-	-		
Denmark	1,245	1265	946	1,157	732	1,239	1,155	1,024	1,128	1,087	1,289	1,308	1,523	1,538	1,379	1,311	961	1,071	1,134	1	841
Faroes	1	-	10	18	20	-	15	10	6	-	2	+	3	11	22	2	+	-	4		0
France	124	151	69	28	18	7	7	3	18	8	9	8	8	8	4	7	13	13	48	6	7
Germany	71	68	100	84	613	292	601	873	454	182	95	95	65	20	84	173	186	344	216	124	
Ireland																					0
Netherlands	23	44	78	38	13	25	12	-	15	12	3	8	9	38	13	14	14	12	5	8	5
Norway	587	635	1,224	1,318	657	821	672	954	1,219	1,182	1,212	928	769	999	880	1,005	831	860	859	735	490
Sweden	14	7	7	7	2	1	2	8	8	78	44	56	8	6	5	5	20	67	-	4	9
UK(E, W&NI)	129	143	160	169	176	439	2,174	668	781	218	183	98	104	83	34	99	303	13	320	371	
UK (Scotland)	7,039	7,887	9,712	11,683	15,658	22,344	18,783	13,319	9,710	9,559	10,024	8,539	6,033	6,284	6,003	7,722	8,304	8,658	7,510	5730	
UK (total)																			7,830	6101	6125
Total	9,235	10,209	12,309	14,505	17,891	25,176	23,425	16,860	13,344	12,338	12,861	11,048	8,523	8,987	8,424	10,338	10,632	11,038	17,926	13,080	7,470

*** Preliminary.**

Table 5.2.3 continued. Nominal landings (t) of Anglerfish in the North Sea as officially reported to ICES.

Central North Sea (IVb)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*
Belgium	357	538	558	713	579	287	336	371	270	449	579	435	180	260	207	138	179	181	134	124	
Denmark	345	421	347	350	295	225	334	432	368	260	251	255	191	274	237	276	173	237	248	194	287
Faroes	-	-	2	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	0
France	-	1	-	2	-	-	-	-	-	-	-	-	-	+	-	-	-	-	9	6	4
Germany	4	2	13	15	10	9	18	19	9	14	9	17	11	11	9	14	12	22	17	21	
Ireland													1	-	-	-	-	-	-	-	
Netherlands	285	356	467	510	335	159	237	223	141	141	123	62	42	25	31	33	61	58	36	46	53
Norway	17	4	3	11	15	29	6	13	17	9	15	10	12	22	16	14	24	15	21	10	11
Sweden				3	2	1	3	3	4	3	2	9	2	1	4	4	6	9	-	5	7
UK(E, W&NI)	669	998	1,285	1,277	919	662	664	603	364	423	475	236	167	120	96	108	122	105	85	88	
UK (Scotland)	845	733	469	564	472	475	574	424	344	318	378	210	241	138	88	98	172	142	103	125	
UK (total)																			193	213	271
Total	2,522	3,053	3,144	3,445	2,627	1,847	2,172	2,088	1,517	1,617	1,832	1,244	847	851	688	685	749	769	846	832	629

*** Preliminary**

Table 5.2.3 continued. Nominal landings (t) of Anglerfish in the North Sea as officially reported to ICES.

Southern North Sea (IVc)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*
Belgium	13	12	34	37	26	28	17	17	11	15	15	16	9	5	4	3	3	4	6	7	6
Denmark	2	+	-	+	+	+	+	+	+	+	+	+	+	+	+	-	-		-	-	0
Faroes																					
France	-	-	-	-	-	-	-	10	-	+	-	+	-	-	-	-	-	+	-	1	+
Germany	-	-	-	-	-	-	-	-	-	+	-	+	+	-	-	-	-	-	-	-	-
Ireland																					
Netherlands	5	10	14	20	15	17	11	15	10	15	6	5	1	-	1	-	1	1	-	2	1
Norway	-	-	-	-	+	-	-	-	+	-	+	-	-	-	-	-	-	-	1	-	-
Sweden																					
UK(E&W&NI)	6	17	18	136	361	256	131	36	3	1	-	-	10	3	-	-	-	-	1	1	
UK (Scotland)	-	-	-	17	-	3	1	+	+	+	-	-	-	7	-	-	-	-	-	-	
UK (Total)																		+	1	1	1
Total	26	39	66	210	402	304	160	78	24	31	21	21	20	15	5	3	4	5	9	12	2

*** Preliminary.**

Table 5.2.3 continued. Nominal landings (t) of Anglerfish in the North Sea as officially reported to ICES.

Total North Sea

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011*
Belgium	372	559	595	753	607	323	357	389	286	476	594	459	190	265	211	141	182	184.6	140	131	118
Denmark	1592	1686	1293	1507	1027	1464	1489	1456	1496	1347	1540	1563	1714	1812	1616	1587	1134	1308	1382	195	1128
Faroes	1	0	12	18	20	0	15	10	6	0	2	10	3	11	22	2	0	0	4	0	0
France	124	152	69	30	18	7	7	13	18	8	9	8	8	8	4	7	13	13	57	13	11
Germany	75	70	113	99	623	301	619	892	463	196	104	112	76	31	93	187	198	366	233	145	
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Netherlands	313	410	559	568	363	201	260	238	166	168	132	75	52	63	45	47	76	71	41	56	59
Norway	604	639	1227	1329	672	850	678	967	1236	1191	1227	938	781	1021	896	1019	855	875	881	745	501
Sweden	14	7	7	10	4	2	5	11	12	81	46	65	10	7	9	9	26	76	0	9	16
UK(E&W&NI)	804	1158	1463	1582	1456	1357	2969	1307	1148	642	658	334	281	206	130	207	425	118	406	460	0
UK (Scotland)	7884	8620	10181	12264	16130	22822	19358	13743	10054	9877	10402	8749	6274	6429	6091	7820	8476	8800	7613	5855	0
UK (Total)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8024	6315	6397
Total	11783	13301	15519	18160	20920	27327	25757	19026	14885	13986	14714	12313	9390	9853	9117	11026	11385	5	10757	7609	8230

*** Preliminary.**

Table 5.2.4. Nominal landings (t) of Anglerfish in Division IIIa, 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*
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
Germany	-	-	1	-	-	1	1	1	2	1	-	1	-	1	1	2	1	1	1	1	2
Netherlands							-	-	-	-	-	.	3	4	4	3	1	3	-	5	0
Norway	64	170	154	263	440	309	186	177	260	197	200	242	189	130	100	137	132	144	134	158	153
Sweden	23	62	89	68	36	25	39	33	36	27	46	55	71	73	79	54	44	51	…	43	26
Total	595	938	843	811	823	702	776	626	660	602	621	667	478	519	458	423	433	486	479	477	432

***Preliminary.**

Table 5.2.5. Anglerfish in Subarea VI. Landings, effort and lpue from the Irish OTB fleet.

Year	Hours (VIa)	Kw.Days (VIa)	Hours VIb)	kw.Days (VIb)	Landings (VIa)	Landings (VIb)	LPUE (VIa_Hours)	LPUE (VIa kw.days)	LPUE (VIb_Hours)	LPUE (VIb kw.days)
1995	56863	1408312	9029	599053	655	114	11.52	0.47	12.63	0.019
1996	60960	1388902	7219	469212	624	74	10.24	0.45	10.25	0.022
1997	63159	1462368	7169	377836	587	93	9.29	0.40	12.97	0.025
1998	57398	1343782	7337	403310	558	99	9.72	0.42	13.49	0.024
1999	54075	1348480	8680	437920	449	64	8.30	0.33	7.37	0.019
2000	52847	1325585	9883	613229	410	62	7.76	0.31	6.27	0.013
2001	47224	1320179	7232	593467	315	93	6.67	0.24	12.86	0.011
2002	35016	1007965	2626	217918	276	41	7.88	0.27	15.61	0.036
2003	39211	1536279	4543	478464	314	26	8.01	0.20	5.72	0.017
2004	35217	1279049	2234	205349	210	13	5.96	0.16	5.82	0.029
2005	30748	1075974	3844	216991	351	35	11.42	0.33	9.11	0.053
2006	28014	1031169	5903	464965	386	53	13.78	0.37	8.98	0.030
2007	25373	911973	6589	548392	467	69	18.41	0.51	10.47	0.034
2008	17327	630615	9740	n/a	295	78	17.03	0.47	8.01	n/a
2009	17108	567289	4354	n/a	332	91	19	n/a	20.90	n/a
2010	24870	825760	3280	n/a	525	107	21	n/a	32.53	n/a
2011	15199	n/a	2495	n/a	487	105	32	n/a	42.22	n/a

Landings in tonnes

Lpue estimates on '000 hours fished or '000 kw.days

Table 5.2.6. Total Danish Anglerfish landings (tonnes) and effort (days fishing) by fishery. Landings by fishery (from logbook data).

Year			North Sea	tons			North Sea			IIIA	tons			IIIA	Grand Total
	Beam trawl	Demersal trawl	Industrial trawl	Lobster trawl	Other gear	Shrimp trawl	total	Beam trawl	Demersal trawl	Industrial trawl	Lobster trawl	Other gear	Shrimp trawl	total	(Tons)
1993	45	621	346	94	96	90	1293	12	262	9	163	83	34	564	1857
1994	59	827	196	285	93	60	1520	51	201	5	108	61	23	449	1969
1995	57	344	127	254	78	168	1027	82	97	1	62	48	21	312	1339
1996	17	762	130	282	42	234	1467	70	125	2	90	40	40	368	1834
1997	58	1148	105	57	33	89	1489	137	183	8	139	59	24	550	2040
1998	118	1036	96	41	62	102	1456	86	167	2	89	58	13	415	1871
1999	98	1127	86	39	69	77	1496	41	121	1	105	82	12	362	1858
2000	88	1066	68	16	52	56	1347	47	117	0	140	61	13	377	1724
2001	18	1343	67	7	53	52	1540	18	86	4	211	45	11	375	1915
2002	59	1268	53	86	42	54	1562	41	116	1	161	35	15	369	1931
2003	40	1515	30	59	28	42	1714	4	27	1	144	31	8	215	1929
2004	45	1524	42	67	83	48	1809	13	39	0	20	231	7	310	2119
2005	48	1423	26	97	15	16	1625	5	84	0	136	39	8	274	1898
2006	8	1454	10	96	9	9	1587	1	107	0	105	10	3	227	1814
2007	24	1020	10	67	10	2	1134	10	124	0	97	14	9	255	1389
2008	33	1162	1	86	18	8	1308	8	91	0	145	27	17	287	1595
2009	19	1186	0	133	35	8	1382	3	77	1	225	17	20	344	1725
2010	12	1242	0	45	34	4	1337	3	66	0	175	18	9	270	1607
2011	19	959	0	47	98	4	1127	1	30	0	194	17	10	251	1378

Tables 5.2.7. Total Danish Anglerfish landings (tonnes) and effort (days fishing) by fishery. Effort by fishery (from logbook data).

Year			North Sea	days			North Sea			IIIA	days			IIIA	Grand Total
	Beam trawl	Demersal trawl	Industrial trawl	Lobster trawl	Other gear	Shrimp trawl	total	Beam trawl	Demersal trawl	Industrial trawl	Lobster trawl	Other gear	Shrimp trawl	total	(days)
1993	292	3370	4414	968	1286	1534	11864	228	2914	81	3452	651	928	8253	20117
1994	356	3694	1963	2423	971	831	10239	595	2267	42	1991	618	616	6129	16369
1995	360	1882	1896	2254	948	2526	9866	617	1586	23	1288	391	594	4499	14365
1996	110	2869	1597	2027	394	2364	9360	739	1267	29	1767	424	820	5046	14407
1997	221	4707	1562	729	461	1415	9096	980	1820	106	2207	526	468	6108	15204
1998	413	4482	1321	379	549	1702	8845	665	1447	14	1455	390	262	4234	13079
1999	523	5056	1069	409	648	1214	8919	475	1463	23	2305	621	237	5123	14042
2000	787	6297	808	285	699	1095	9970	568	1332	6	3007	438	314	5664	15634
2001	250	8165	1039	182	789	1122	11548	361	1047	42	3940	431	291	6111	17659
2002	536	7412	1155	740	689	1011	11544	432	1277	22	3115	370	253	5468	17012
2003	447	7952	530	714	306	814	10763	78	409	9	2436	301	192	3424	14187
2004	419	6210	517	356	623	592	8717	191	235	5	226	3195	154	4006	12723
2005	404	6123	242	440	180	259	7649	123	695	4	2359	513	205	3899	11548
2006	96	5912	125	543	174	154	7003	54	675	2	1758	124	65	2679	9682
2007	194	3808	106	362	107	36	4613	164	882		1475	135	214	2870	7482
2008	191	3985	38	469	189	104	4977	63	855	1	2517	230	492	4158	9136
2009	175	3936	11	362	338	136	4959	45	817	15	3015	177	579	4648	9607
2010	116	3468	0	255	428	126	4393	24	649	1	2772	198	374	4018	8411
2011	139	3380	2	273	970	143	4908	18	357		2957	222	458	4013	8921

Table 5.2.8. Abundance (millions of individuals; age 1 and older) and biomass (thousands of tonnes; age 1 and older) estimates from the 2005–2011 anglerfish surveys (SCO-IV-VI-AMISS-Q2) by ICES subareas and divisions.

	Abundance (millions)						
ICES subarea/division	2005	2006	2007	2008	2009	2010	2011
Subarea IV (partial)	11.168	12.844	15.304	12.613	8.279	7.366	5.150
Division VIa	10.866	10.459	7.956	7.718	5.144	5.161	6.057
Division VIb	1.800	3.174	4.000	3.952	3.688	3.131	3.669
Subarea VI	12.666	13.633	11.956	11.670	8.832	8.292	9.725
Northern Shelf (partial)	23.833	26.477	27.261	24.283	17.111	15.658	14.875

	Biomass (thousand tonnes)						
	2005	2006	2007	2008	2009	2010	2011
Subarea IV (partial)	18.642	21.921	28.534	29.721	17.058	21.944	14.949
Division VIa	14.096	12.175	11.072	14.383	8.150	11.590	9.330
Division VIb	5.879	6.889	10.786	9.442	12.852	8.745	8.974
Subarea VI	19.975	19.064	21.858	23.825	21.002	20.334	18.305
Northern Shelf (partial)	38.617	40.985	50.392	53.546	38.060	42.279	33.254

Table 5.2.9. Percentage change in mean stock biomass from 2007–2009 to 2010–2011 in ICES Areas IV, VI and the two combined.

Region	2007–2009	2010–2011	%change biomass
IV	25 104	18 447	-26.5
VI	22 228	19 320	-13.1
IV & VI	47 333	37 767	-20.2

Table 5.2.10 Status of the northern shelf anglerfish stock (F) according to various assumptions about natural mortality (M) and sustainable fishing mortality (FMSY). a) M used in previous assessment (ICES 2004); b) M used for Southern anglerfish stock assessment (ICES 2012a); c) M based on relationship to mean weight-at-age in the Northern shelf stock (Lorenzen, 1996); d) FMSY based on FMAX from previous assessment (ICES 2004); e) FMSY based on FMAX from Southern anglerfish stock assessment (ICES 2012a). Status is indicated by the red circle & white cross where F>FMSY; or a green circle and white tick where F<FMSY. In one case, both are included because F is close to FMSY.

M	F	Fmsy	Status
0.15a	0.29	0.19d	✗
0.20b	0.24	0.19d	✗
0.28c	0.16	0.19d	✓
0.15a	0.29	0.28e	✗ ✓
0.20b	0.24	0.28e	✓
0.28c	0.16	0.28e	✓

Table 5.2.11. Nominal catch (t) of Anglerfish in Division IIa, 1996–2010, as officially reported to ICES and preliminary data for 2011.

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010*	2011
Denmark	+	+	+	+	+	2	+	-	1	-	-	-	-	+		
Faroes	+	+	+	+	-	1	1	2	5	11	4	7	4	2	1	+
France	-	-	-	+	-	-	-	-	-	-	1			2		
Germany	4	20	53	4	17	65	59	55	70	55	-		-		83	70
Norway	893	576	1,488	1,731	2,952	3,552	2,000	2,404	2,906	2,649	4,253	4,455	3,999	4,289	5,368	5,004
Russia	-	-	-	-	-	-	-	-	-	1	-	-	-			
Sweden	+	+	+	+	+	+	-	-	-	-	-	-	-			
UK (total)	15	5	7	6	30	2	10	15	18	19	86	115	138	152	40	3
Other	-	-	-	-	-	-	-	-	-	-	-	-	2	6	1	+
Total	912	601	1,548	1,741	2,999	3,622	2,070	2,476	2,999	2,672	4,341	4,577	4,143	4,451	5,493	5,077

***Preliminary**

Table 5.2.12. Anglerfish in IIa. Norwegian landings (tonnes) by fishery in 2005–2010 and preliminary data for 2011.

Fleet	2005	2006	2007	2008	2009	2010	2011
Coastal gillnetting	2,301	3,723	4,039	3,574	3,934	4,806	4,557
Offshore gillnetting	115	261	204	240	171	391	319
Offshore dem trawling	77	71	52	26	27	25	19
Coastal Danish seine	54	54	63	75	68	40	26
Other gears	102	144	98	84	89	106	83
Total	2,649	4,253	4,456	3,999	4,289	5,368	5,004

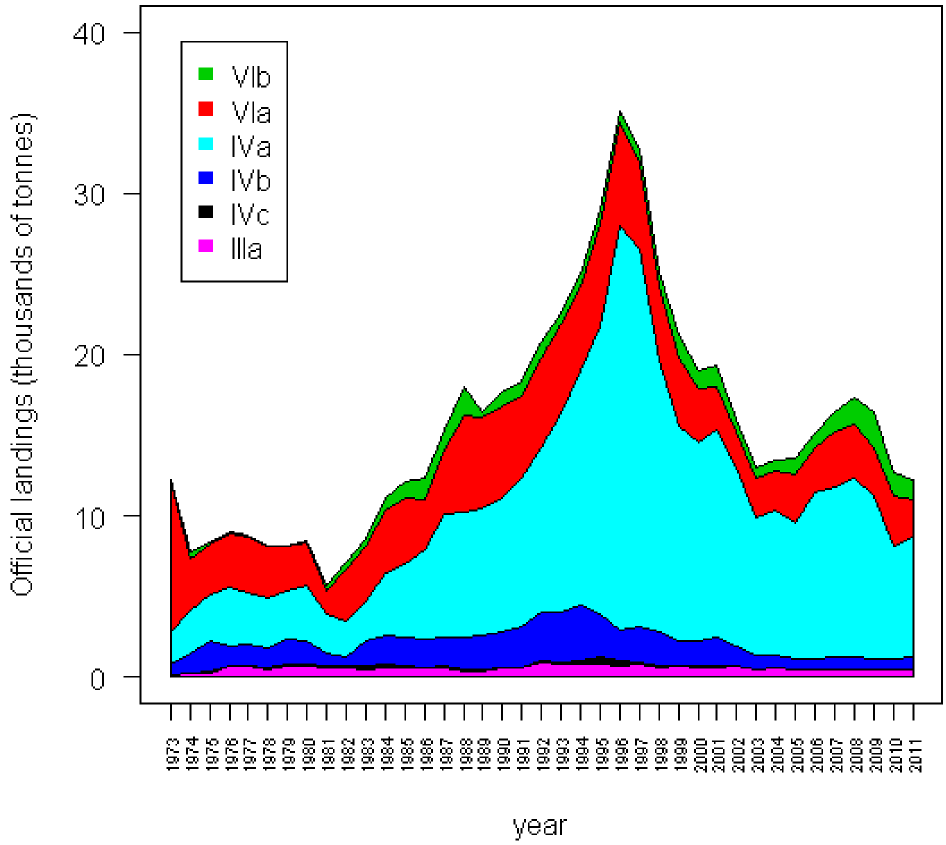
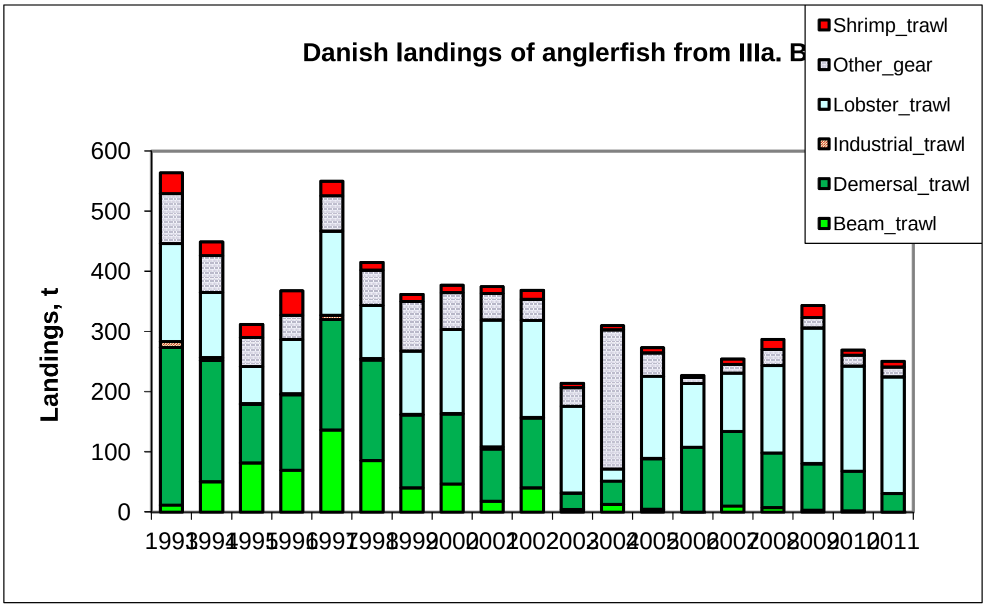


Figure 5.2.1. Northern Shelf anglerfish. Officially reported landings by ICES area.



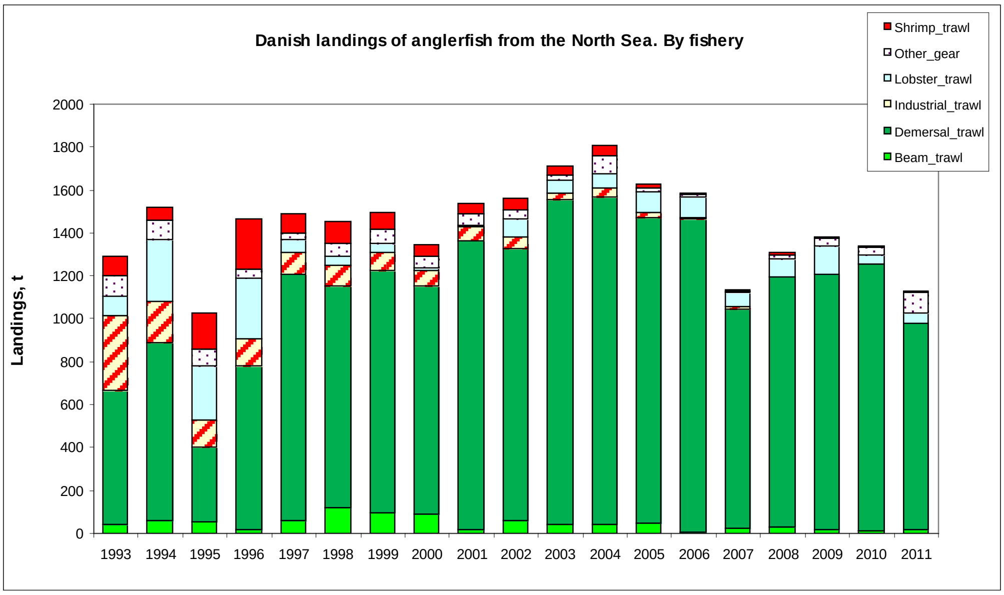


Figure 5.2.2. Danish landings of Anglerfish by fishery in the North Sea (top) and Division IIIa (bottom) 1992–2010.

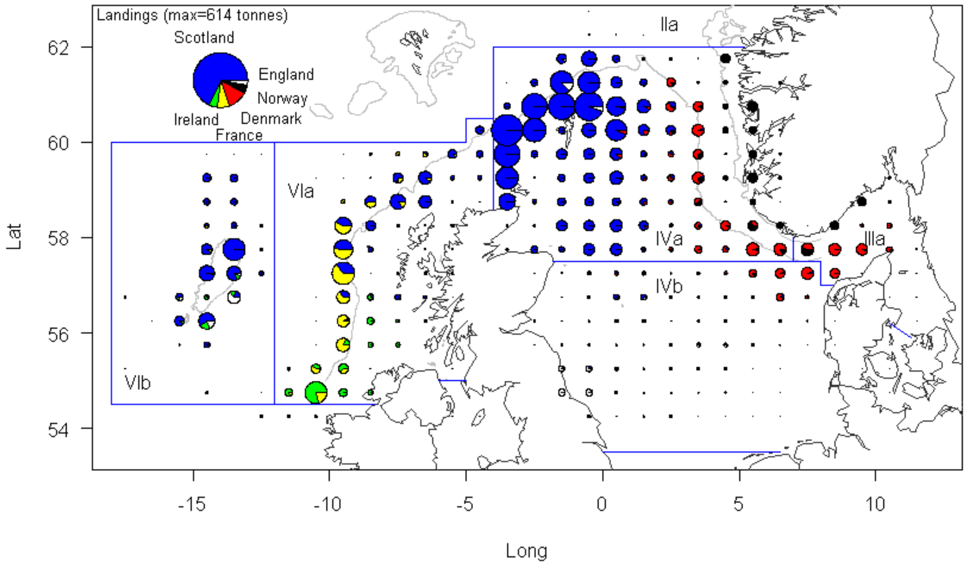
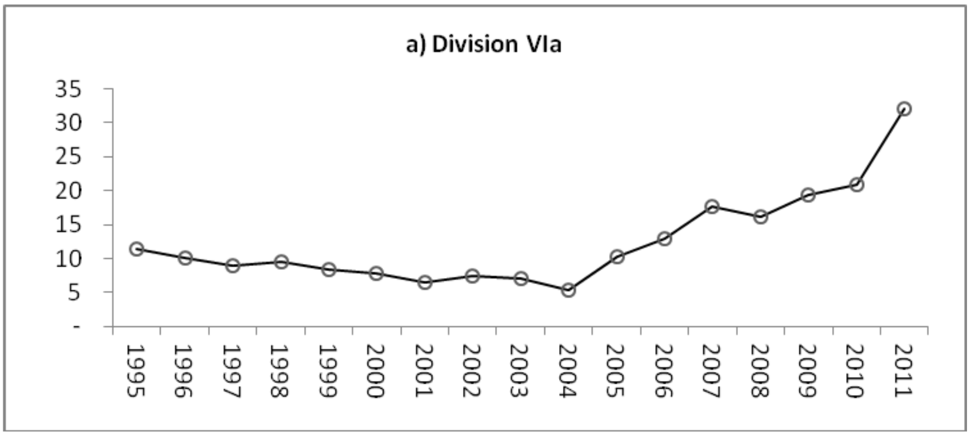


Figure 5.2.4. Map of the European Northern Shelf showing the distribution of reported landings of anglerfish for 2010 from Scotland, Ireland, France, Denmark, and Norway. The circles are centred on each ICES rectangle and segmented according to the landings of each country according to the legend. The legend is divided according to the total reported landings of each country. The area of each circle is proportional to the landings in tonnes relative to the maximum as indicated. The Scottish data have been corrected according to certain assumptions about area misreporting (see Stock Annex).



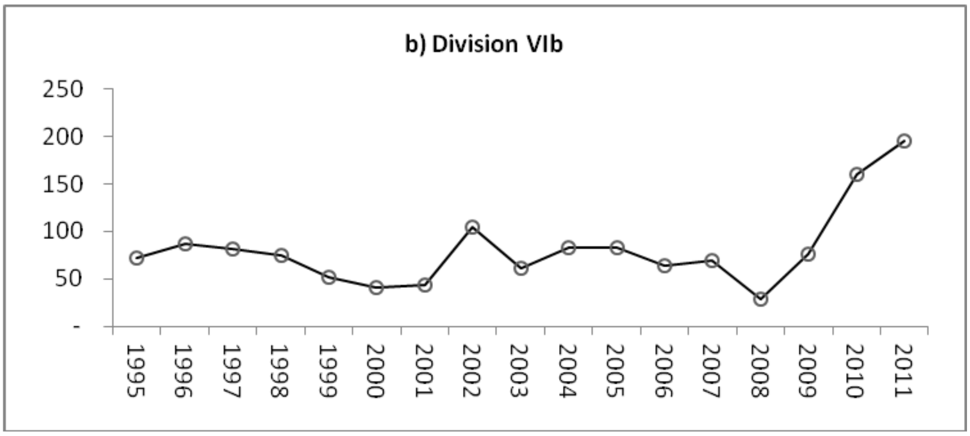


Figure 5.2.5. Lpue for the Irish otter-trawl fleet with effort in hours fished for a) Division VIa, and b) Division VIb.

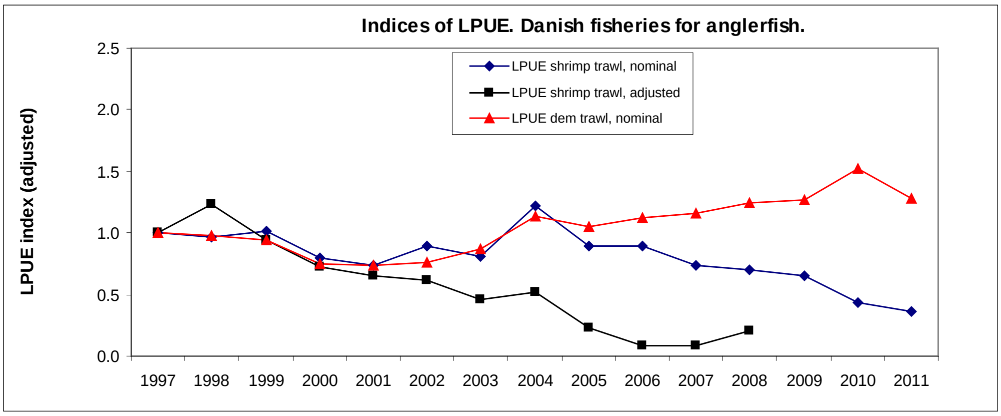


Figure 5.2.6. Anglerfish in the North Sea & Division IIIa. Danish lpue by demersal trawl and shrimp trawl, relative to 1997. Based on nominal logbook records.

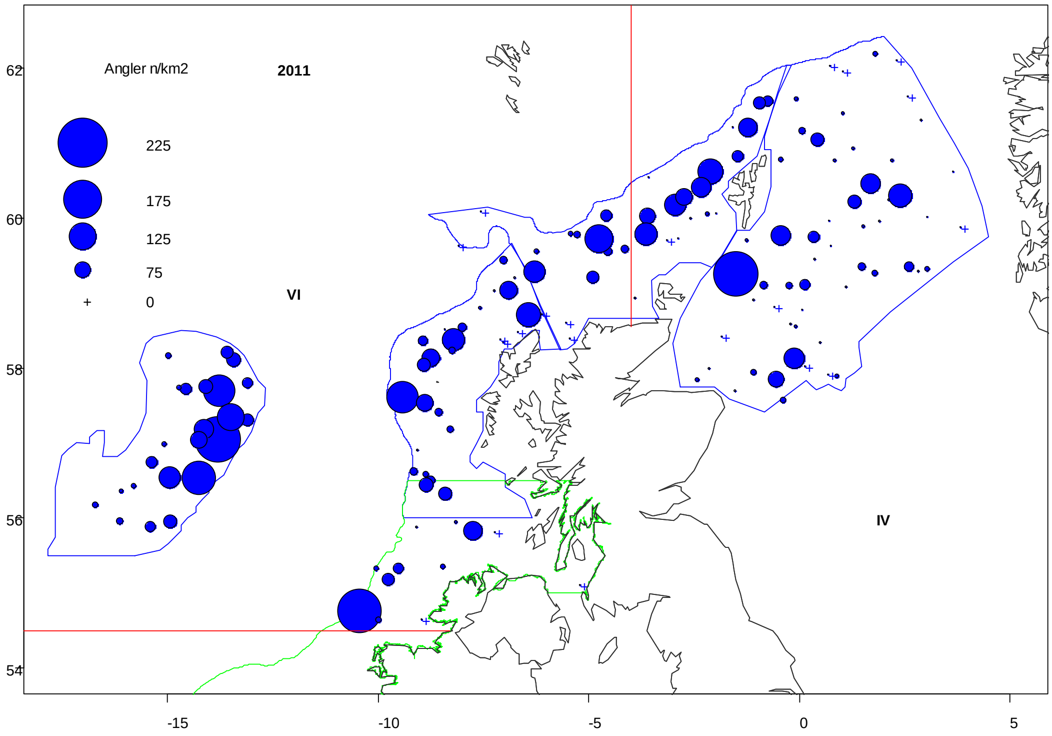


Figure 5.2.7. Map of the northern continental shelf around Scotland showing the number density of anglerfish during the 2010 surveys. Each circle is centred on the sample location and circle size is proportional to the number density in n/km² according to the legend (top left). Trawl densities in this figure account for herding but not footrope escapes. The red lines separate the ICES subareas indicated by roman numerals: IV (east) and VI (west).

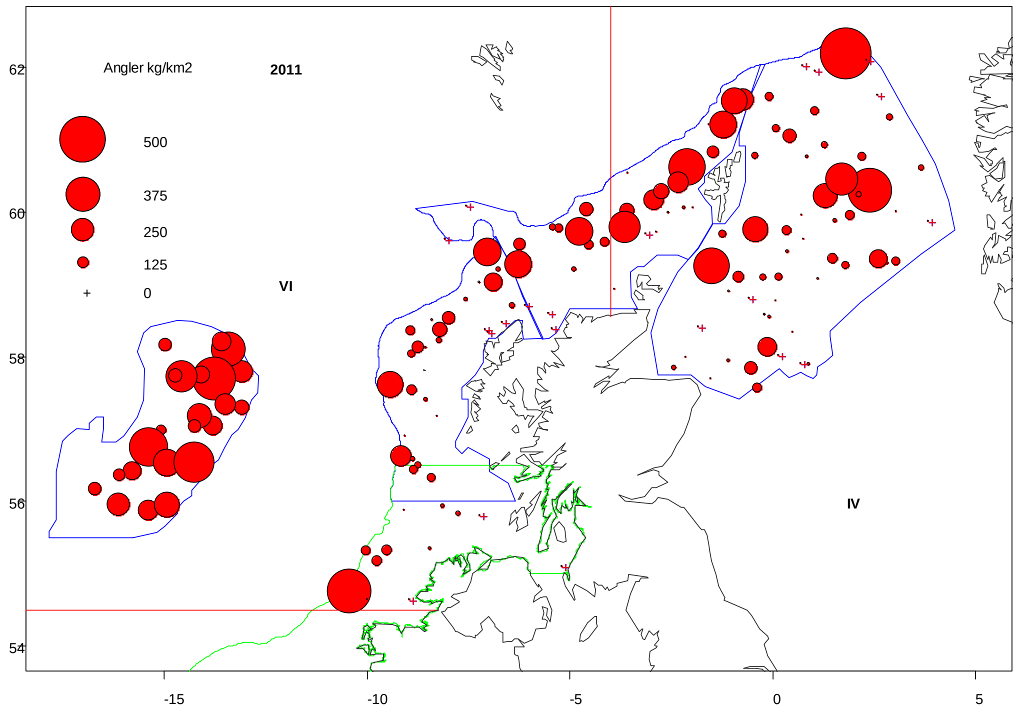


Figure 5.2.8. Map of the northern continental shelf around Scotland showing the weight density of anglerfish during the 2010 anglerfish survey. Each circle is centred on the sample location and circle size is proportional to weight density in kg/km² according to the legend. Trawl densities in this figure account for herding but not footrope escapes. The red lines separate the ICES subareas indicated by roman numerals: IV (east) and VI (west).

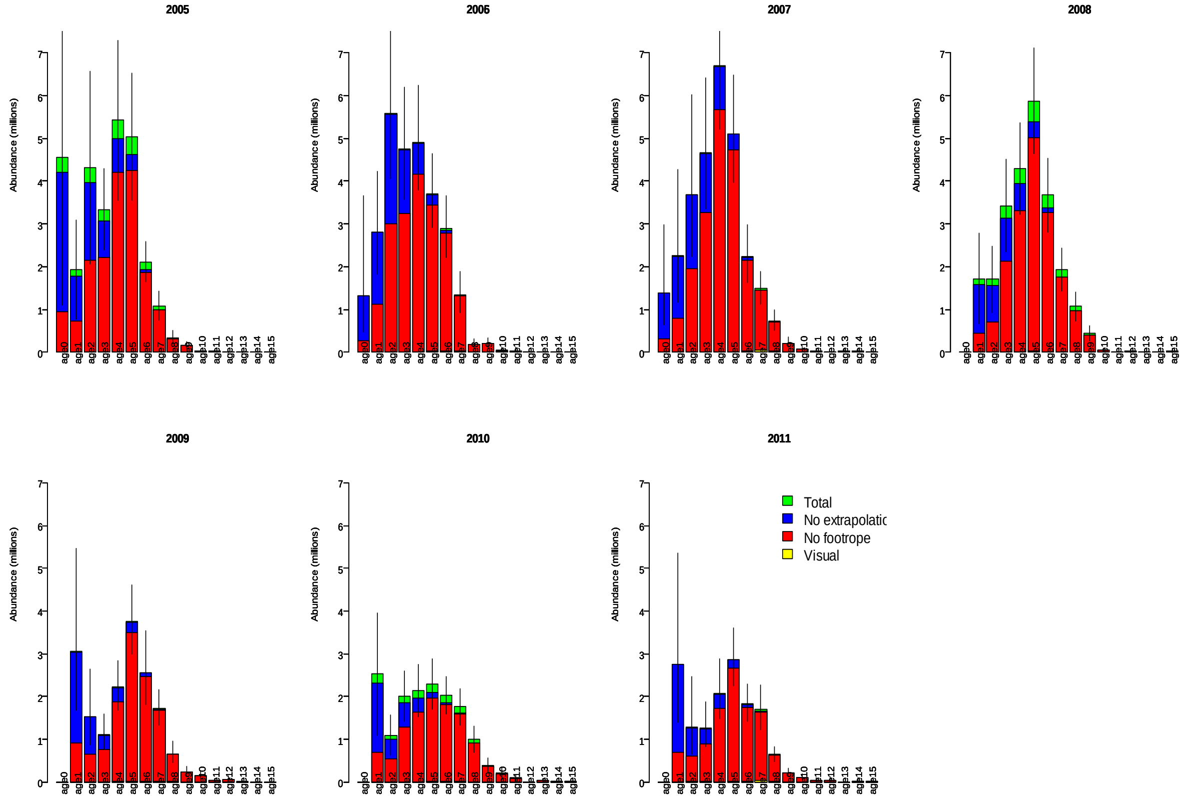


Figure 5.2.9. Estimates of total abundance-at-age for each of the anglerfish surveys 2005–2010. Red bars indicate estimates prior to correction for footrope escapes; blues bars include the latter correction; green bars indicate an additional correction for the unsurveyed part of ICES Division VIa based on data when the area was surveyed by the Irish. Error bars are 95% confidence intervals.

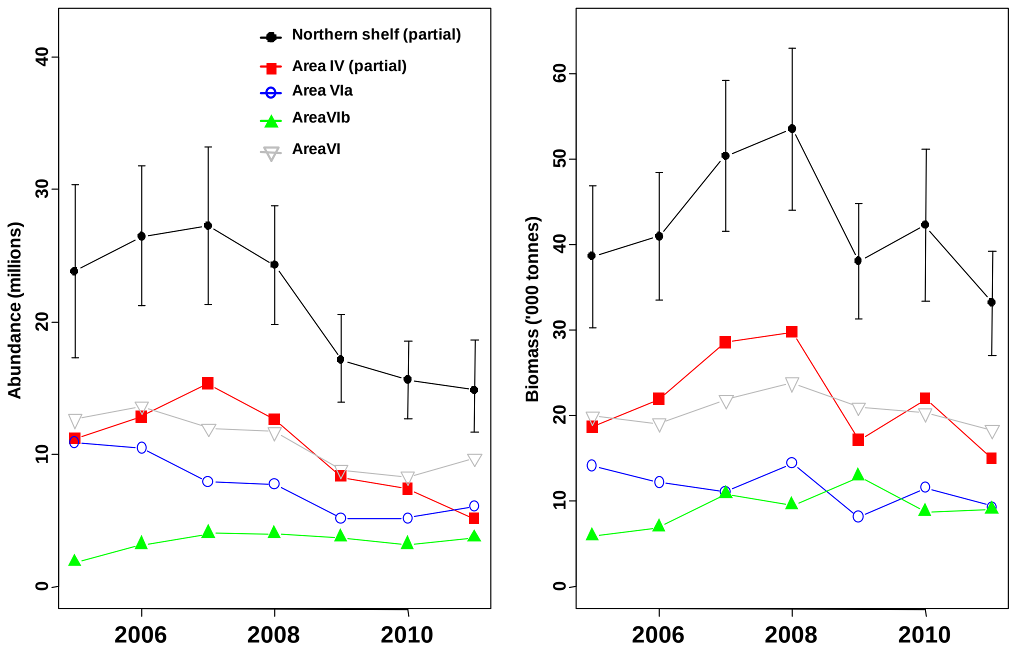


Figure 5.2.10. Estimates of total abundance (left) and biomass (right) of anglerfish for the Northern shelf (black filled circles), with confidence intervals derived from variance estimates of the Scottish surveys. Estimates are also provided for ICES Subarea IV (red filled squares), Division VIa (blue open circles) and Division VIb (green filled triangles). Confidence limits for 2005 biomass are provisional.

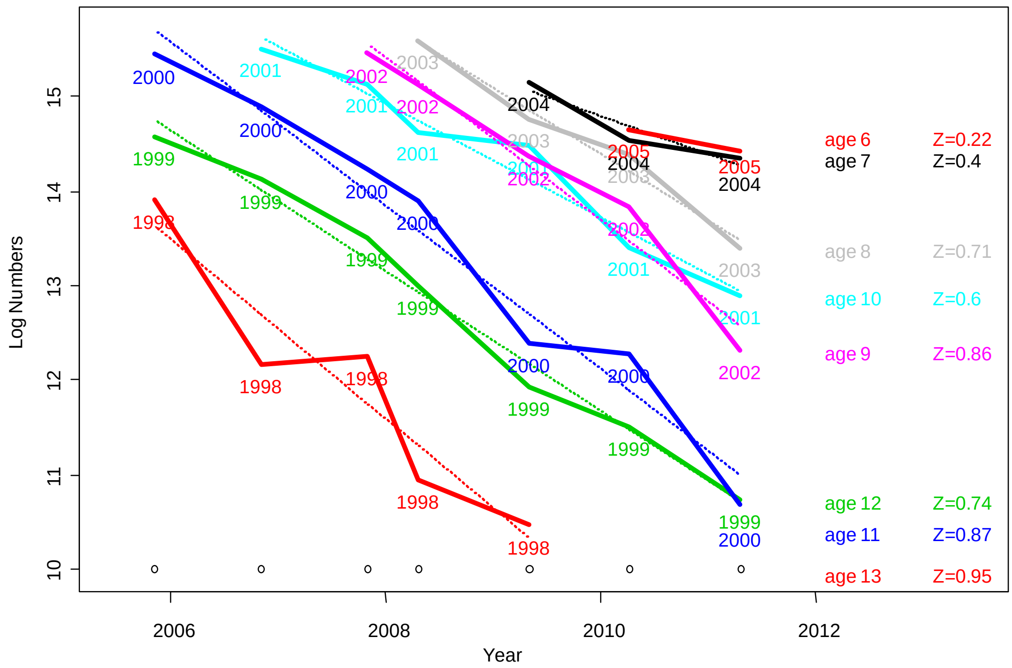


Figure 5.2.11. Catch curves (natural logarithm of abundance in each year of the survey by cohort) for the 1998–2005 year classes. Each cohort is labelled and coloured differently: cohort age in 2011 is printed on the right hand side along with the estimate of total mortality (Z) for the cohort as derived from the slope of the fitted (dotted) line.

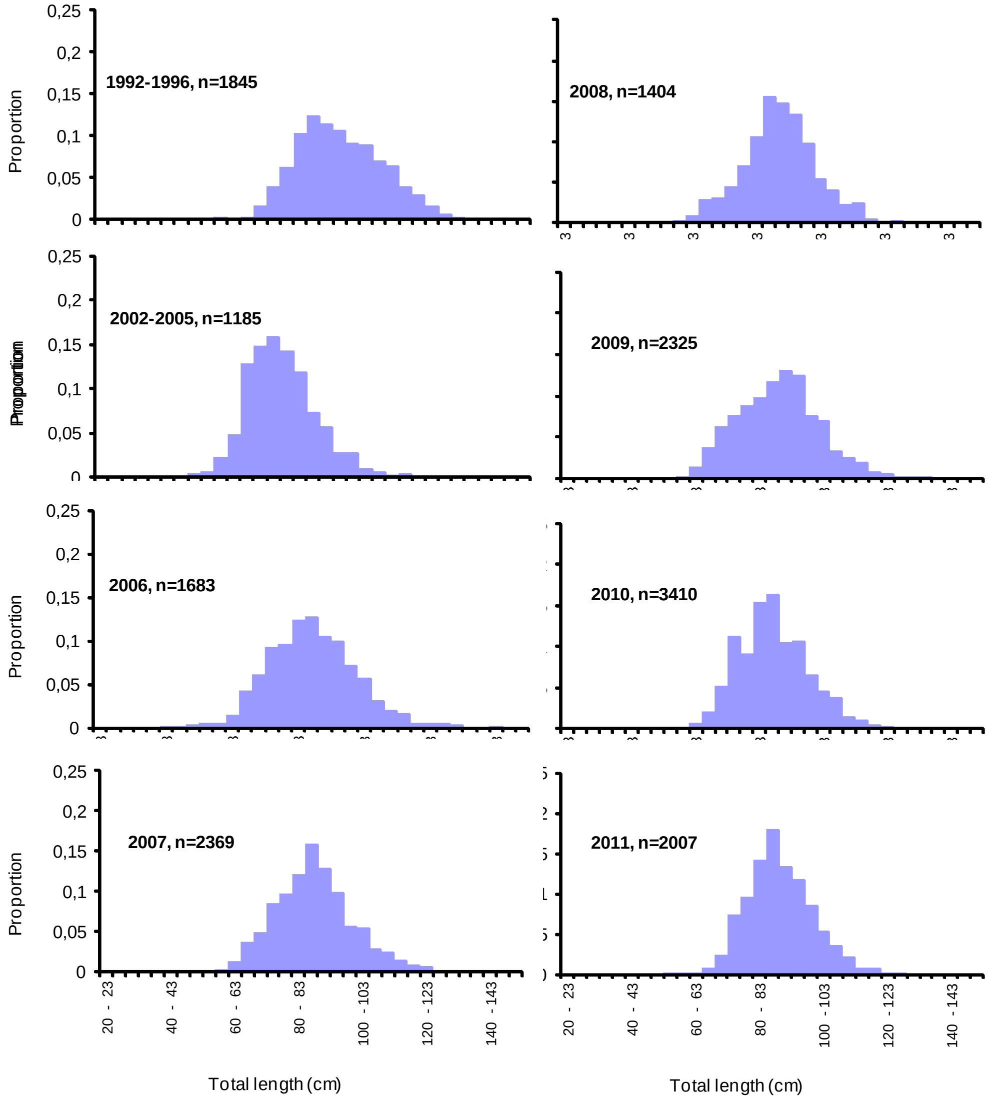


Figure 5.2.12. Anglerfish in IIa. Length distributions for anglerfish caught in the directed coastal gillnetting in Division IIa during 1992–2011. Note that data are lacking for 1997–2001.

Figure 5.2.12. Anglerfish in IIa. Mean lengths for anglerfish caught in the directed coastal gillnetting in Division IIa during 1992–2011, dotted lines represents ±2SE of the mean. Note that data are lacking for 1997–2001.

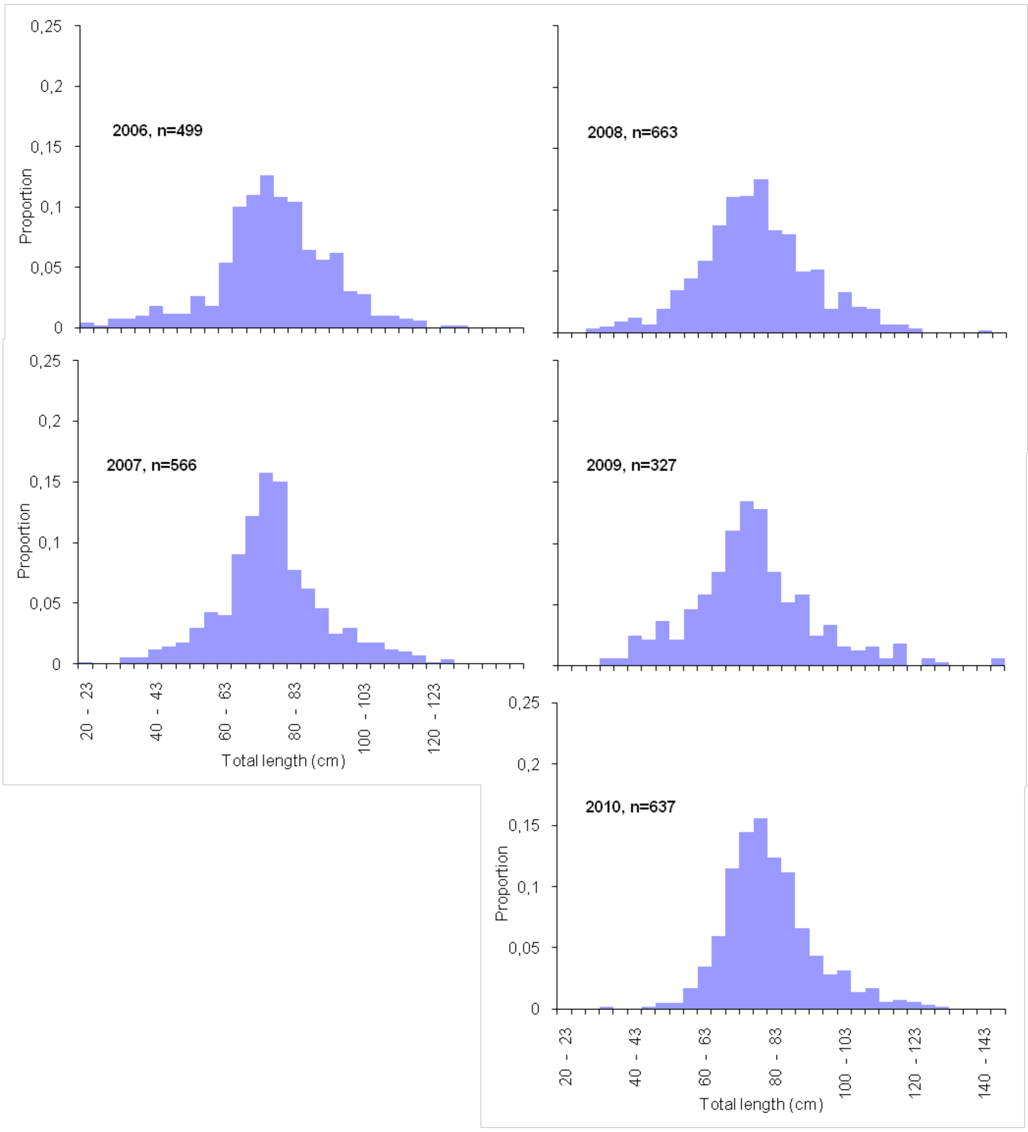


Figure 5.2.13. Anglerfish in IIa. Length distribution for anglerfish caught as bycatch by other gears (offshore gillnetting and longlining) in Division IIa in 2005–2010.

5.3 Megrim in IVa and VIa (Northern North Sea and West of Scotland) and Megrim in VIb (Rockall)

Based on the recommendation of WGNSDS (2008), in addition to megrim in VI, WGCSE now also considers megrim in IVa and IIa. 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 VIa and IVa are indeed separate stocks. Based on the recommendations from WKFLAT (2011), megrim in VIa and IVa are considered a single unit stock and assessed accordingly. Megrim in VIb is considered a separate stock unit for assessment purposes.

5.3.1 Megrim in Divisions IVa and VIa (Northern North Sea and West of Scotland)

Type of assessment in 2012

Due to ageing issues with megrim in VIa and IVa associated with low sample size and depth dependent growth issues, a surplus production process model is used (Schaefer, 1954) following on from the exploratory Bayesian state–space biomass dynamic model presented at WKFLAT(2011) and WGCSE (2011), the assessment method was subject to inter-benchmark in 2012 (IBP-MEG 2012).

The model describes the current exploitation of megrim relative to F_{MSY} and stock biomass relative to B_{MSY}. The biomass dynamics are given by a difference form of a Schaefer biomass dynamic model:

$$B_t = B_{t-1} + rB_{t-1}\left(1 - \frac{B_{t-1}}{K}\right) - C_{t-1}$$

where B_t is the biomass at time t , r is the intrinsic rate of population growth, K is the carrying capacity, and C_t is the catch, assumed known exactly. To assist the estimation the biomass is scaled by the carrying capacity, denoting the scaled biomass $P_t = \frac{B_t}{K}$. Lognormal error structure is assumed giving the scaled biomass dynamics (process) model:

$$P_t = \left(P_{t-1} + rP_{t-1}(1 - P_{t-1}) - \frac{C_{t-1}}{K}\right)e^{u_t}$$

where the logarithm of process deviations are assumed normal $u_t \sim N(0, \sigma_u^2)$; σ_u^2 is the process error variance.

The starting year biomass is given by $B_{1985} = aK$, where a is the proportion of the carrying capacity in 1980.The biomass dynamics process is related to the observations on the indices through the measurement error equation:

$$I_{j,t} = q_j P_t K e^{\varepsilon_{j,t}}$$

where $I_{j,t}$ is the value of abundance index j in year t , q_j is index-specific catchability, $B_t = P_t K$, and the measurement errors are assumed lognormally distributed with $\varepsilon_t \sim N(0, \sigma_{\varepsilon,j}^2)$; $\sigma_{\varepsilon,j}^2$ is the index-specific measurement error variance.

ICES advice applicable to 2011

ICES advises that effort should be consistent with no increase in catches.

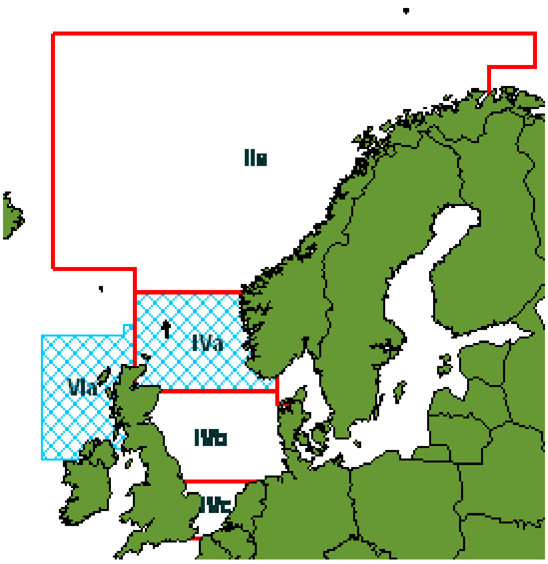
ICES advice applicable to 2012

ICES advises on the basis of precautionary considerations that there should be no increase in catch.

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 VIa and VIb 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 VIa and VIb (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 IVa has historically not been considered by ICES and WGNSDS (2008). Since 2009 data from IV and IIa are included in this report, but international catch and weight-at-age data for IV prior 2006 was not available to the working group or WKFLAT (2011). Given that there is little evidence to suggest that megrim in VIa and IVa 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 VIa and IVa should be considered as a single stock. As a consequence, the assessment area is now incompatible with the management area.



Management area (red boxes) and assessment area (blue hatched boxes).

Species: Megrims *Lepidorhombus* spp.		**Zone:** EU waters of IIa and IV (LEZ/2AC4-C)
Belgium	6	
Denmark	5	
Germany	5	
France	30	
The Netherlands	24	
United Kingdom	1 775	
Union	1 845	
TAC	1 845	Analytical TAC

Species: Megrims *Lepidorhombus* spp.		**Zone:** VI; EU and international waters of Vb; international waters of XII and XIV (LEZ/56-14)
Spain	385	
France	1 501	
Ireland	439	
United Kingdom	1 062	
Union	3 387	
TAC	3 387	Analytical TAC

2011 TAC for VI, EC waters of Vb and international waters of XII and XIV

Country	TAC	WG Landings[2]	% TAC Uptake[1]
Spain	385	288*	75%
France	1501	139	9%
Ireland	439	298	68%
UK	1062	771	73%
EU	3387	1496	44%
TAC	3387		

***nr – not reported to the Working Group, Spanish landings in 2011 assumed to be equal to those in 2010.**

[1] **Post regulation quota swaps have not been taken into account.**

[2] **Provisional figures.**

The uptake of the TAC for ICES Division VI and EU waters of Vb was 44% in 2011. Uptake varied considerably between countries. France, which holds much of the quota allocation, utilised only 9% of its allocation. This pattern is typical. It should be noted that no landings data were made available to the Working Group by Spain and the uptake during 2011 is likely to be higher than shown above: while historically Spanish uptake has been low, this has increased in recent years.

In ICES Area IV and IIa, 77% of the TAC was used in 2011. The majority of available TAC is allocated to the UK.

2011 TAC for EC IV and IIa

	TAC	WG landings[1]	% TAC uptake
Belgium	6	2	33%
Denmark	5	25	500%
Germany	5	5	100%
France	30	6	20%
Netherlands	24	16	67%
UK	1775	1367	77%
EC	1845	1421	77%

[1] **Post regulation quota swaps have not been taken into account.**

Fishery in 2012

The introduction of the Cod Long-Term Management Plan (EC Regulation 1342/2008) and additional emergency measures applicable to VIa in 2009 (EC Regulation 43/2009, annex III 6) has impacted on the amount of effort deployed and increased the gear selectivity pattern of the main otter trawl fleets. Figure 5.3.1 shows the effort pattern for the main fleets catching megrim in VIa. Additionally, EC regulation 43/2009 has effectively prohibited the use of mesh sizes <120 mm for vessels targeting fish, which had been used particularly by the Irish fleet up to that point, the resultant rapid decline in effort for this category (IRE TR2) can be seen in Figure 5.3.1 Much of the effort has been transferred into the TR1 fleet. Effort associated with the French fleet has continued to decline while the substantial decline seen in the Scottish TR1 fleet (120 mm mesh) appears to have stabilized at levels well below the earlier part of the time-series. The increase in mesh size (from 100 to 120 mm) has also impacted on the retention length of megrim, increasing L50 from 28 cm to 42 cm, an increase of almost 50%.

Fishing effort in IVa (Figure 5.3.2) for the main Scottish otter fleets (TR1 and TR2) have stabilized since the large total effort reductions observed between 2000 and 2003.

An overview of the data provided to and used by the WG is provided in Table 2.1.

Landings

Official landings data for each country together with Working Group best estimates of landings from VIa are shown in Table 5.3.1 and for IVa in Table 5.3.2. Note that there were no Spanish landings data provided to the working group this year. Spanish landings have increased considerably in recent years. The 2011 landings are assumed to be equal to the 2010 landings for the purpose of running the 2012 assessment. The distributions of landings by statistical rectangle for 2010 in VIa, IVa and VIb are shown in Figure 5.3.3. 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. These were supplied for VIa by Ireland, France and UK in 2011 and by UK for division IVa. Landings have increased in recent years and are more in line with historic catches.

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. Previously, the reported Division VIa landings have been adjusted to the Working Groups estimate of catch by including landings declared from Subarea IVa in the ICES statistical rectangles immediately east of the 4 degree W line (see anglerfish Annex 5.2 for a detailed methodology). Area-misreporting peaked in 1996 and 1997 when around 50% of the estimated Working Group landings for Division VIa were area-misreported. The correction process has not been conducted for the past two years. There are indications that more recently the process has reversed. Laurenson and MacDonald (2008) note that in more recent years that megrim TAC in the North Sea has become more restrictive and anecdotal evidence suggest that megrim catches from IVa are misreported as coming from Division VIa. Therefore, because of conflicting information on the potential direction of area-misreporting, megrim landings at a statistical rectangle level have not been adjusted. However, the decision to consider megrim in VIa and IVa as single unit stock removes this problem. However, it is unknown whether misreporting from Division VIb is an issue.

Discards

Raised discard data were made available by Scotland (VIa and IVa) and Ireland (VIa). Scottish data give a discard rate (by weight) of 5% and 31% for IVa and VIa respectively. Unraised discard data was provided by France. Irish discards were 3% by weight. Discards were estimated to be 15% by weight for the stock area in 2011.

Laurenson and MacDonlad (2008) note that while discarding of megrim below minimum landing size is low (<1%), discarding of legal sized fish was much higher at 22% over the six observed trips. This is attributed to low market price for small grades and bruised fish, resulting in high grading of catches on length/quality reasons to maximise the value of a restrictive quota. Other studies (BIM, unpublished data) show that high grading of damaged fish is in the range of 10 to 15% of the marketable megrim catch. A historic time-series of discards for all areas and fleets in not available and in general, discard data for this stock is very sparse and intermittent. As catch weights are required for the model, sensitivity runs contrasting runs using landings data only and runs with different historic levels of discards (fixed 15% discard rate over time series and linear decline from 30 to 15%) have been undertaken (see Section 5.3.1.3).

Surveys

Indices from six fishery-independent surveys are used in the assessment. These comprise of the Scottish North Sea IBTS survey (IBTSWG, 2011), Scottish quarter 1 (ScoGFS-WIBTS-Q1) and quarter 4 (ScoGFS-WIBTS-Q4) West of Scotland survey and the Scottish (SAMISS-Q2) and Irish (IAMISS-Q2) dedicated anglerfish survey which provides estimates of absolute biomass and abundance (see Fernandes *et al*., 2007 and Reid *et al*., 2007 for further details), however the survey also catches significant quantities of megrim, but as there are no estimates of catchability, for the purposes of this work, the indices are treated in a relative sense.

NUMBER	SURVEY	NATIONALITY	AREA	TIME-SERIES	DEPTH RANGE (M)
1	Sco-IBTS-Q3	Scotland	IVa	1987–2011	<400 m
2	Sco-IBTS-Q1	Scotland	IVa	1987–2011	<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	2005–2011	50–1050
6	IAMISS-Q2	Ireland	VIa*	2005–2011	50–850

The surveys adequately cover the distribution of the stock. The start positions from all six surveys with the distribution of reported megrim landings by statistical rectangle (VIa and IVa) and VMS data associated with megrim landings (VIa only) for 2009 (last year of complete landings data attributed to ICES rectangles) is shown in Figure 5.3.4.

The anglerfish surveys cover a depth range of up to 1050 m (IVa-VIa-SAMISS-Q2/IAMISS-Q2) while the Sco-WIBTS surveys are distributed to depths of 400 m. In 2011 both the groundgear and the survey design associated with the ScoGFS-WIBTS Q1 and Q4 surveys were changed. Rather than relying on fixed trawling locations moved to a new random-stratified survey design with trawl locations randomly distributed within 10 *a priori* sampling strata. While there were rationale reasons for these changes, it has resulted in a breach in the time-series and it will not be possible to use these indices until a reasonable time-series, ca. five years has been built up. The indices from the six surveys, together with commercial landings are given in Table 5.3.3.

5.3.1.2 Estimation of survey cpue indices

International Bottom-trawl Surveys (IBTS)

IBTS survey data from Scottish groundfish survey data (surveys 1–4 shown above) are available for quarters 1 and 4 in ICES area VIa and quarters 1 and 3 in ICES area IVa north. The survey design is based on ICES statistical rectangles. One tow is selected per rectangle based on a library of clean tows. The tow location is largely the same every year and as such the design may be considered fixed station although minor changes to tow locations can occur.

Catch weights are not routinely collected on all IBTS surveys so the length data was converted to weight using the length–weight relationship

$$\mathbf{W} = 0.0047\mathbf{L}^{3}.13 \qquad [1]$$

where $\mathbf{W}$ is the weight in grammes and $\mathbf{L}$ is the length in centimeters. This relationship was estimated using all available megrim length–weight measurements from the dedicated monkfish survey. The weights were then raised by the numbers at length per tow and summed to provide a catch in kilogrammes per tow. This was divided by the duration of the tow in decimal hours to provide a cpue measured in units of kg.hr-1.

The data from all four 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.

The data are modelled at the level of the station (largely synonymous with tow for a quarterly fixed-station survey design). The binomial data were modelled as follows:

$$\ln\left(\frac{p_{st}}{1-p_{st}}\right) = \alpha_1 + \delta_{1,s} + \gamma_{1,t} \qquad (2)$$

where p_{st} is the probability of non-empty tow at station s in year t - note the logit link function; $\delta_{1,s}$ is the station (ICES rectangle) effect (number subscript used to differentiate from parameters of the second GLM below); stratum effects (strata defined as sampling areas 40—48 for VIa surveys and roundfish areas in IVa) were included as alternatives to the more spatially resolved station effects or potentially modelled in a nested hierarchy (not considered further here); and $\gamma_{1,t}$ is the year effect. Additional covariates such as depth could also be included here. The predominantly best fitting model by survey (lowest AIC) of those considered (from a single overall mean; yearly effects only; stratum effects only; station effects only and various combinations) was that given in Equation 2, i.e., including year and station effects. Quarter 4 in VIa differed in that year was not significant (proportion of non-zero tows constant across time).

Positive cpue observations were modelled using a gamma-distributed GLM with a loglink. The linear predictor given by:

$$\ln(\mu_{st}) = \alpha_2 + \delta_{2,s} + \gamma_{2,t} \qquad (3)$$

where μ_{st} is the mean positive cpue at station s in year t - note the log link function; $\delta_{2,s}$ is the station effect; again, stratum effects were included as alternatives to the more spatially resolved station effects; and $\gamma_{2,t}$ is the year effect. The best fitting model was that given in Equation 3. Model diagnostics including Q-Q plots of the residuals indicated the suitability of the gamma distribution; although the percentage of the deviance explained was only 42% (VIa Q1), indicating substantial unexplained variability in the data.

The estimated probability of a non-zero tow and the mean of the positive tows were combined to produce the mean estimated cpue per station by year:

$$\widehat{CPUE}_{st} = \hat{p}_{st}\hat{\mu}_{st} \qquad (4)$$

These values are combined across stations within strata by the taking the average of the station-level estimates by stratum. Similarly, the overall mean is then taken as the average of the stratum-level means (Stefánsson, 1996).

Anglerfish survey indices

Scottish (SAMISS-Q2) and Irish (IAMISS) dedicated anglerfish surveys (surveys 5–6 shown above) have been undertaken in VIa and IVa (SAMISS-Q2 only) since 2005. The survey design is stratified based on expected densities of anglerfish (not megrim), within each strata, the location of individual tows are randomly selected. The modelling approach of Stefánsson, (1996) is mainly applicable to a fixed station design and therefore for the anglerfish indices we used the weighted cpue estimates and allow the observation error to be estimated within the model. The anglerfish survey provides absolute estimates of abundance and biomass. The average fish density-at-age a in stratum s, ρ_{as}, is estimated from the weighted mean of fish densities corrected for the catchability of each trawl, as follows:

$$\hat{\rho}_{as} = \sum_{i \in s} w_i \left\{ \sum_{l \in a} \frac{n_{lai}}{v_{1i}\hat{Q}_{li}} \right\} = \sum_{i \in s} w_i \left\{ \sum_{l \in a} \frac{n_{lai}}{\hat{e}_l (v_{1i} + v_{2i}\hat{h})} \right\}$$

where:

n_{lai} is the number of fish of age *a* and length *l* caught in trawl *i*,

$$w_i = \frac{v_{1i} + v_{2i}}{\sum_i (v_{1i} + v_{2i})},$$

v_{1i} is the area swept by gear in trawl *i* (the area swept by the wing),

v_{2i} is the sweep area of gear in trawl *i* i.e. the area swept by the door minus that swept by the wing,

$\hat{Q}_{li} = \hat{e}_l + \hat{e}_l \hat{h} \frac{v_{2i}}{v_{1i}}$ is the catchability estimate for a fish of length *l* in trawl *i* , following the definition by Somerton *et al*. (2007),

$\hat{e}_l$ is the estimated footrope selectivity at length *l*, is the proportion of fish of length *l* originally in the area swept by the wing which are caught by the net and do not escape under the footrope,

$\hat{h}$ is the estimated herding coefficient. ($\hat{h}$=0.017).

It should be noted that the methods outlined above were specifically designed for anglerfish. The most significant issue for megrim is that as there is no estimates of footrope selectivity, $\hat{e}_l$ is assumed to be 1. While this is not an issue when the survey indices are treated in a relative sense as presented here for megrim, Fernandes (2007) does use this approach to provide a raised absolute biomass based but notes that due to the full retention assumption for ground gear selectivity, the estimates are considered as a minimum estimate.

Cpue trends and length analysis of survey data

The modelled cpue trends from indicate that the Sco-WIBTS-Q3 and Sco-WIBTS-Q1 surveys appear to show an increase in cpue earlier when compared to the other surveys (Figure 5.3.5).

The results from mixture distribution model (Figure 5.3.6) shows clear bimodal and multimodal distributions in some of the survey data. In particular the IBTS surveys (Sco-WIBTS Q1/Q4 and Sco-IBTS Q1 /Q3) in some years show discrete modes around 20 cm. This may offer up the possibility to use survey data as a means to estimate the strength of incoming year classes before they enter the fishery and could therefore be used as the basis for estimating future catch options. Further work is proposed. In contrast, the SAMISS and IAMISS surveys do not appear to catch these smaller length classes, although the component model does indicate some catch, this is probably due to the larger trawl and codend mesh size used in these surveys (100 mm).

Commercial cpue

Logarithmic lpues for Scottish, French and Irish vessels split by mesh bands corresponding to gear groups TR1 (>100 mm) and TR2 (>70<100 mm) as defined by EC regulation 1342/2008 are available for VIa (Ireland, France, Scotland) and IVa (Scotland) based on data presented to SGMOS 09-05 (Part 2). These are presented in Figure 5.3.7 (IVa/VIa). Between 2005 and 2010, both the commercial lpues and the survey cpues trends are reasonably consistent across fleets with all showing generally positive increases. It should be noted that the IRE TR2 fleet has been discontinued due to the prohibition of mesh sizes <120 mm for vessels targeting fish (EC regulation 43/2008).

Since 2007, the lpues for both the SCO TR1 and FR TR1 fleets show a dramatic increase as has the IRE TR1 since 2008 in VIa. These signals give a much stronger positive signal than the survey-series during this period. It is not possible to determine how much this could be attributed to changes in megrim abundances or changes in targeting behaviour, but there is anecdotal information from the fishery that indicate changes in targeting behaviour. Over the period, there have been reduced fishing opportunities for other species (e.g. cod) and reduced effort allocations inside the West of Scotland management line, particularly affecting Scottish and Irish vessels; this may have resulted in increased targeting of anglerfish and megrim to the west of the management line, where effort opportunities are far less constrained.

5.3.1.3 Stock assessment

The input data for the stock assessment is given in Table 5.3.3. This comprises of a time-series from all six surveys and landings data presented to the working group.

International landings data collated by the ICES Working Group on the Celtic Seas Ecoregion (WGCSE) is used as an estimate of catch. However, discarding is a feature of the key fisheries but note that discard data is not available for the entire time-series. The availability or raised discard data is highly variable across fleets and areas and prior to 2000, discard data from VIa and VIb was combined into a single VI estimate.

To assess the sensitivity of the model outputs to this assumption, two alternative model runs with (i) a fixed 20% discard proportion over the full landings time-series and (ii) a linear decline in proportion from 30% at the start of the time-series to 15% at the end (see section discards section). It is probable that the proportion of megrim discarded in IVa has declined since 2000 and in VIa since 2009. The mesh size in the North Sea increased from 100 to 110 mm in 2000 and was further increased to 120 mm in 2001, while in Division VIa, the mesh size was increased from 100 to 120 mm in 2009. It is therefore likely that the discarding profiles have changed significantly in line with these mesh size increases.

Previous runs have shown that the inclusion of discard data has some impact on the output.

Parameter	Landings only	Fixed 15%	Slope 30–15%	%diff. 15%	% diff. Slope
r.hat	0.59	0.61	0.62	3%	5%
K.hat	32996	35760	38536	8%	14%
MSY	4539	5147	5645	12%	20%
F_{MSY}	0.29	0.30	0.31	3%	5%
B_{MSY}	16498	17 880	19 268	8%	14%
B_{2011}	26762	28 697	30 617	7%	13%
F_{2010}	0.15	0.14	0.13	-8%	-18%
B_{lim}	4949	5364	5780	8%	14%
B_{trig}	8249	8940	9634	8%	14%

Effectively, the inclusion of discard information into the catch introduces more fish into the system back in time. As a result the carrying capacity (K) is scaled upwards by 8% and 14% for the fixed 15% discard and linear decline from 30–15% respectively. This impacts on all the biomass estimates and biomass reference points. The impact on *r* is less pronounced (3 and 5%) and as a consequence there is less impact on the F_{MSY} (F_{MSY} = r/2). Despite increases in catch, the final year estimate of fishing mortality (F2010) is revised downwards. IBP-MEG (2012) concluded that in the absence of a historic time series of discard data, the assumption of a linear decline is appropriate given the technical changes in the fishery. In future, observed discard estimates from national observer programmes will be used.

2012 final run

The survey cpue indices and landings data used are provided in Table 5.3.3 and model priors are presented in Table 5.3.4. The final run assumed a linear decline in discards from 30 to 15% over time. There is no deviation from the agreed stock annex with the exception of Spanish landings in 2011 set equal to the 2010 level.

Figure 5.3.8 shows the trends in landings of VIa and IVa (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. A plot contrasting the prior and posterior assumed and estimated is given in Figure 5.3.9.

It is noted that the modelled cpue trend tends to deviate in recent years from the raw cpues for the SCO Q1 IVa and SCO Q3 IVa surveys. This can be seen more clearly in the survey residuals plot in Figure 5.3.10 with a sequence of positive residuals from 2005 onwards. This is a consequence of the low inter-annual variation in cpue from the monk VIa (SAMISSQ2/IAMISSQ2) and monk IVa (SAMISSQ2) surveys and the in comparison to the much higher inter-annual variation seen in the other 'IBTS' surveys. As a result the model places more weighting on the two 'monk' surveys. As a sensitivity analysis, a run excluding the Sco-IBTS-Q3 survey was undertaken. This had the result of greatly expanding the credible intervals on both biomass and harvest ratio estimates. This resulted in unrealistic estimates of fishing mortality and biomass being obtained when the SCO-NSIBTS Q3 and Q1 surveys were reduced indicating that in spite of the apparent trends in residuals they continue to provide important information to the assessment model. Similarly, a run was undertaken excluding the two monk surveys to assess whether they are having a strong influence over the model given their low residuals. This again resulted in increasing the credible intervals but with limited impact on the underlying trend in the model. A slight increase in both K and r was noted when the last five years of data were omitted from the SAMISS Q2 series.

The model output in terms of current stock status and exploitation relative to biomass and mortality reference levels are presented in Table 5.3.5. The MSY is estimated at 5565 tonnes and fishing mortality in 2011 was estimated at 0.13, considerably lower than F_{MSY} (0.3). The trends in F and biomass over the full time-series are shown in Figure 5.3.11 and tabulated together with the ratio of B/B_{MSY} and F/F_{MSY} in Table 5.3.6.

To investigate the stability of the fits, retrospective runs were conducted up to five years preceeding. The results are presented in terms of the estimated B/B_{MSY} and F/F_{MSY} inferences (Figure 5.3.12). Retrospective patterns do exist but overall the inference remains relatively constant over the five years.

In age-disaggregated models, biomass and fishing mortality trajectories would be expected to converge back in time as cohorts become exhausted and estimates of catch-at-age become more precise. Such patterns should not be expected with surplus production methods as the *K* and *r* estimates can vary according to the potential contrast that additional years of data offer as such, with between year variation in *K* and *r*, the entire times-series is recalculated.

5.3.1.4 Historical stock development

State of the stock

The biomass dynamic model estimates that over the available time-series that the stock has been only moderately exploited with fishing mortality being below F_{MSY} for almost the entire time-series. Stock biomass is estimated to be well above B_{MSY}.

5.3.1.5 Short-term projections

The assessment method outputs a range of management objectives, including the yield at F_{MSY}, F_{MSY}, F_{2011}, B_{MSY}, $B_{MSY\ trigger}$ (50% B_{MSY}) and B_{lim} (30% B_{MSY}). However, as there is no recruitment estimate for megrim it is not possible to construct a traditional style catch forecast for management purposes. Instead, short term projections over a range of catch options are provided on a risk based approach. A forward projection on the risk of the stock falling below $B_{MSY\ trigger}$, B_{lim} and fishing mortality exceeding F_{lim} are estimated. Catch options ranging from 3000 to 6000 tonnes in increments of 1000 tonnes are presented in Table 5.3.7. It should be noted that although the risk in almost all scenarios is low, there is some discrepancies in the estimates due to re-sampling. Further runs with a greater number of iterations are required to resolve this. Biomass dynamic models tend to offer better precision on estimates of biomass in comparison to the estimates of fishing mortality. Therefore even at very low levels of fishing mortality, the risk of exceeding fishing mortality reference points are elevated in comparison to the risk of falling below biomass thresholds. This can be seen in Figure 5.3.13 which shows the projected effects on fishing mortality and biomass levels associated with the catch options presented in Table 5.3.7. IBP-MEG (2012) concluded that managing the stock based on biomass reference points rather than fishing mortality reference points is more appropriate for this stock.

5.3.1.6 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 1.7F_{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*

$xFmsy=Flim$

$x(r/2)=0.85r$

$x=2*0.85$

$x=1.7$

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 in the fishery.

5.3.1.7 Uncertainties and bias in assessment and forecast

The age-aggregated biomass dynamic model provides estimates of total fishing mortality. No Spanish landings data were provided for 2011. Spanish landings contribute between 5 and 10% of the total landings.

5.3.1.8 Recommendation for next Benchmark

This stock was recently subject to an inter-benchmark (IBP-MEG, 2012). Due to incomplete age data, particularly for IVa, a Bayesian state–space surplus production model has been used. Further work is proposed to investigate the utility of the survey data as an estimate of recruitment.

5.3.1.9 Management considerations

The TAC in VI 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. There are two separate TAC areas covering ICES Areas VI and IV whereas the assessment covers ICES Divisions VIa, and IVa combined. Due consideration of the inconsistency between management and assessment area is required when setting fishing opportunities for this stock and the separate VIb Rockall stock.

5.3.1.10 References

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5.3.2 Megrim in VIb

Type of assessment in 2011

Based on the recommendation of WGNSDS (2008), in addition to megrim in VI, WGCSE now also considers megrim in IVa and IIa. 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 VIa and IVa are indeed separate stocks. Based on the recommendations from WKFLAT (2011) Megrim in VIb 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 VIa only was undertaken. However, lack of specific ageing data from VIb 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 VIa, IVa and VIb.

ICES advice applicable to 2011

ICES advises that effort should be consistent with no increase in catches.

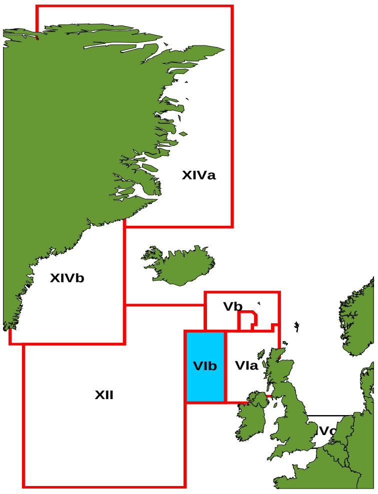
ICES advice applicable to 2012

ICES advises on the basis of precautionary considerations that there should be no increase in catch.

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 VIa and VIb 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 VIa and VIb (Anon, 2001). Spawning fish occur in both areas but whether these populations are reproductively isolated is not clear. WKFLAT (2011) concluded that megrim in VIb should be considered as a single stock. As a consequence, the assessment area is now incompatible with the management area.



Management area (red box) and assessment area (blue hatched area).

Species: Megrims *Lepidorhombus* spp.		Zone: VI; EU and international waters of Vb; international waters of XII and XIV (LEZ/561214)
Spain	385	
France	1 501	
Ireland	439	
United Kingdom	1 062	
EU	3 387	
TAC	3 387	Analytical TAC

Fishery in 2011

Following the increases in Irish effort in Subdivision VIb from 2004–2008, effort in 2009 (the last available year) has declined significantly (Figure 5.3.14) while Scottish effort has increased. Based on landings data presented to the Working Group, only 50% of the overall TAC for VI, EC waters of Vb and international waters of XII and XIV was taken. It should be noted that no landings data were made available to the Working Group by Spain and the uptake during 2011 is likely to be higher: while historically, France only utilizes ~10% of its available quota, Spanish uptake has been ~80%.

2011 TAC for VI, EC waters of Vb and international waters of XII and XIV.

Country	TAC	WG Landings[2]	% TAC Uptake[1]
Spain	385	288*	75%
France	1501	139	9%
Ireland	439	298	68%
UK	1062	771	73%
EU	3387	1496	44%
TAC	3387		

***nr not reported to the Working Group, Spanish landings in 2011 are assumed equal to those in 2010 for assessment purposes.**

[1] Post regulation quota swaps have not been taken into account.

[2] Provisional figures.

5.3.2.2 Data

An overview of the data provided and used by the WG is provided in Table 2.1.

As part of the 2011 benchmark, landings-at-age data were compiled from 1990 to 2010. However, there is very sparse age data available from VIb and prior to 2002 age a common Subarea VI ALK was applied to megrim from VIa and VIb. 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 VIb are shown in Table 5.3.11. The distributions of landings by statistical rectangle in 2011 in VIa, IVa and VIb is shown in Figure 5.3.3. 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. These were supplied for VIb by Ireland and Scotland in 2011.

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 VIb is an issue.

Discards

Discard data was available from Ireland and Scotland.

Surveys

In 2005, Scotland initiated a new industry–science partnership survey to provide an absolute abundance estimate for anglerfish (see Section 5.2). Seven years of survey data is 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 the Northern Shelf. Currently, seven years of data are available (2005–2011).

The sample locations and the density of megrim are illustrated in Figure 5.3.15 as numbers (number per square kilometre) and in Figure 5.3.16, as weight (kilograms per square kilometre). The highest densities of megrim occurred close to the 200 m contour in the northern and western areas, and on the eastern slopes of the Rockall plateau; high densities were also present in the northern North Sea. Prior to 2011, survey indices for VI and IV (partial) were presented. However, based on the recommendations of WKFLAT (2011), the megrim in VIb is considered as a separate stock. The survey index for VIb is presented in Figure 5.3.17 and Table 5.3.8.

Abundance and biomass in VIb and from 2005 to 2010 has increased considerably (Table 5.3.4) but has shown a marked decline in 2011 (Figure 5.3.17). It is unclear whether this is a year effect in the survey or an actual decline in biomass. The recent harvest ratios have been very low and the yield in 2011 is estimated to be <200 tonnes. Additionally, the trend in commercial lpue (IRE OTB) has been increasing over recent years (Figure 5.3.18). Under the WKLIFE categorisation procedure, VIb megrim falls under category 4. The average biomass and abundance from the last two years of survey data are contrasted with the average of the preceding three years (EU Survey

HCR from 2010). This shows that the biomass has declined by 7% and abundance has increased by 4% (Table 5.3.9).

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 (Table 5.3.7). 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 VIa/IVa megrim assessment provides megrim catchability estimates for SAIMISS-Q2/IAMISS-Q2 VIa and IVa surveys (q5 and q6 in Figure 5.3.9). 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 (with assumed discard profiles) have been used to provide a broad estimate of the relative harvest ratio of megrim in VIa (Table 5.3.10). This shows that the harvest ratio for megrim to be in the range 3 to 21% over the time-series and this has been very low in recent years typically less than 6%.

Commercial cpue

Logarithmic lpues for Irish OTB vessels are available for VIb. These are presented in Figure 5.3.18. The trends in the commercial lpue and the cpue trends observed in the survey time-series and are somewhat contradictory. Care should be taken in interpreting the commercial lpues given possible shifts in targeting behaviour and the conflicting signal between the two fleets in recent years.

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 reference points

Precautionary approach reference points

No precautionary reference points have been defined for this stock.

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 VIb, it was not possible to undertake any exploratory age based assessments.

Age data will be gathered during the surveys from 2012 onwards. Intersessional work on a Bayesian state–space surplus production model is continuing.

5.3.2.8 Management considerations

The TAC in VI 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.

5.3.2.9 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.

Table 5.3.1. Megrim in Subarea VIa. Nominal catch (t) of Megrim West of Scotland, as officially reported to ICES and WG best estimates of landings. *Unallocated landings in 2011 relates to lack of Spanish landings data for 2011. 2011 landings assumed to be equal to 2010 levels for purpose of assessment.

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Belgium	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Denmark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
France	398	455	504	517	408	618	462	192	172	0	135	252	79	92	50	48	53	104	92	134	270	139
Ireland	317	260	317	329	304	535	460	438	433	438	417	509	280	344	278	156	221	191	172	188	318	226
Netherlands	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	91	48	25	7	1	24	22	87	111	83	98	92	89	98	45	69	52	5	149	112	288	NA
UK - Eng+Wales+N.Irl.	25	167	392	298	327	322	156	123	65	42	20	7	14	13	17	10	0	8	6			
UK – Scotland	1093	1223	887	896	866	952	944	954	841	831	754	770	643	558	469	269	336	658	868	953		
UK																					822	705
Offical Total	1924	2154	2125	2047	1907	2451	2044	1795	1622	1394	1424	1630	1105	1105	859	552	662	966	1287	1387	1698	1070
Unallocated	286	278	424	674	786	1047	2010	1477	1083	1254	823	843	723	537	469	9	213	n/a	8	0	0	288*
As used by WG	2210	2432	2549	2721	2693	3498	4054	3272	2705	2648	2247	2473	1828	1642	1328	561	875	1301	1545	1387	1698	1358
Area Mispreported landings	339	338	466	735	871	1126	2062	1556	1156	1066	868	829	731	544	421	n/a	212	478	250	0	0	0

Table 5.3.2. Megrim in Subarea IV and IIa. Nominal catch (t) of Megrim North Sea, as officially reported to ICES and WG best estimates of landings.

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Belgium	4	3	2	7	2	7	5	3	5	4	10	2	5	3	-	-	2	6	3	1.6		1.6
Denmark	2	1	4	6	1	2	7	5	18	21	29	52	8	11	7	1	6	11	31		22	25
France	-	-	36	25	27	24	14	16	14	.	7	5	6	11	9	3	4	18	21		5	6
Germany	.	6	3	4	1	2	1	2	4	1	3	1	-	2	2	4	7	16	5	4		5
Germany, Fed. Rep. of	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.				
Ireland	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	.				-
Netherlands	24	28	27	30	28	26	9	20	30	26	20	11	9	7	11	19	22	20	3	2	1	16
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	<0.5	<0.5	1	1	4		2	1
Spain	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.				
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
UK - Eng+Wales+N.Irl.	17	9	47	8	19	44	4	3	5	4	2	2	3	1	1	1	9	17				
UK - England & Wales	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6			1367
UK - N. Ireland	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.				
UK - Scotland	1126	1169	1372	1736	2000	2193	3221	3091	2628	2121	2044	1854	1675	1235	1130	958	1340	1436	1526			
UK																				1476	1469	
Official total	1176	1216	1491	1816	2078	2298	3261	3140	2704	2177	2115	1927	1706	1271	1160	986	1391	1525	1599	1484	1499	1421
As used by WG	837	878	1025	1081	1207	1172	1199	1584	1548	1111	1247	1098	975	727	739	n/a	1179	1047	1349	1484	1499	1421
Area Mispreported landings	339	338	466	735	871	1126	2062	1556	1156	1066	868	829	731	544	421	n/a	212	478	250	0	0	0

Table 5.3.3. Time-series of survey indices and landings of megrim in ICES Area VIa and Division IV as used in the 2012 surplus production model. Units: Sco-IBTS surveys in kg/hr, SAM-ISS/IAMISS swept area estimate in tonnes and landings in tonnes.

Year	ScoGFS-WIBTS-Q1	ScoGFS-WIBTS-Q4	Sco-IBTS-Q1	Sco-IBTS-Q3	SAMISS-Q2/ IAMISS-Q2 (VIa)	SAMISS-Q2 (IVa)	VIa & IVa landings
1985	NA	NA	NA	NA	NA	NA	4499
1986	2.022041	NA	NA	NA	NA	NA	2858
1987	1.438229	NA	0.15231	0.538613	NA	NA	4614
1988	2.433792	NA	0.85134	0.352888	NA	NA	5212
1989	1.372235	NA	1.349909	0.478759	NA	NA	3451
1990	1.172838	1.421119	0.321947	0.241552	NA	NA	3047
1991	0.993033	0.816731	0.489991	0.390778	NA	NA	3310
1992	0.86039	1.872102	0.513651	0.27403	NA	NA	3574
1993	1.091872	1.529652	0.879519	0.317033	NA	NA	3802
1994	1.633247	5.962035	0.00751	0.267762	NA	NA	3900
1995	1.626724	2.06466	0	0.386454	NA	NA	4670
1996	1.994012	1.589756	0.174242	0.559735	NA	NA	5253
1997	1.236186	1.08362	0.366326	0.438556	NA	NA	4856
1998	1.257126	2.50406	0.585829	0.480087	NA	NA	4253
1999	1.572227	2.486679	0.685998	0.35149	NA	NA	3759
2000	1.774741	2.746517	0.782337	0.387239	NA	NA	3494
2001	1.571553	2.001607	0.167189	0.135261	NA	NA	3571
2002	1.32686	1.882926	0.943994	0.695834	NA	NA	2803
2003	1.365124	1.534736	0.417331	0.428694	NA	NA	2369
2004	1.396114	1.436756	0.144181	0.432644	NA	NA	2067
2005	0.768293	1.24548	0.345727	0.861051	2847.751	4612.849	1527
2006	0.946288	1.429524	0.415692	1.144823	3049.429	3464.123	2054
2007	0.952731	1.496073	0.751438	1.393703	3304.689	6940.738	2348
2008	1.281508	1.235648	1.264974	1.396733	3653.99	8023.604	2894
2009	1.956423	1.689299	1.813651	0.985541	4560.281	6297.433	2759
2010	1.233817	NA	1.212913	1.568344	4115.859	7502.313	2909
2011	NA	NA	1.400436	1.594589	3732.823	5128.571	2779*

***Provisional landings data. Spanish 2011 landings set equal to Spanish 2010 landings.**

Table 5.3.4. *Lepidorhombus whiffiagonis* in ICES Areas VIa and IVa. Prior distributions on parameters.

Parameter	Symbol	Prior distribution	Notes
Intrinsic rate of population growth	r	$\text{Uniform}(0.001, 2.0)$	
Carrying capacity	K	$\text{Uniform}\left(\ln(\max(C)), \ln\left(10 \times \sum_{t=1985}^{2010} C_t\right)\right)$	From the maximum catch to ten times the cumulative catch across all years assuming uniform distribution on the logarithmic scale
Catchabilities	$\log(q_j)$	$\text{Uniform}(-11.0, 0.0)$	Uniformly distributed on log-scale. See catchability sensitivity in Section 2.2.3.1
Process error variance	$\frac{1}{\sigma_u^2}$	$\text{Gamma}(\text{shape} = 0.001, \text{rate} = 0.001)$	Gamma distributed on inverse variance (precision) scale
Measurement error variances	$\frac{1}{\sigma_{\varepsilon,j}^2}$	$\text{Gamma}(\text{shape} = 0.001, \text{rate} = 0.001)$	Gamma distributed on inverse variance (precision) scale
Proportion of K in 1985	a	$\text{Uniform}(0.01, 2.0)$	

Table 5.3.5. Estimates of Estimates of MSY, F_{MSY}, B_{MSY}, B_{2012}, F_{2011}, with reference points of $B_{trigger}$ (50% B_{MSY}) and B_{lim} (30% B_{MSY}).

Parameter	Estimate
r.hat	0.61
K.hat	38360
MSY	5565
Fmsy	0.30
Bmsy	19180
B2012	26214
F2011	0.13
Blim	5754
Btrig	9590

Table 5.3.6. Time-series of biomass and fishing mortlaity estimates and ratios of B/B_{MSY} and F/F_{MSY}.

Year	B/B^{MSY}	F/F^{MSY}	Biomass	mean F
1985	2.32	0.68	45874	0.18
1986	1.7	0.5	33916	0.13
1987	1.53	0.92	30423	0.24
1988	1.62	1.01	31987	0.26
1989	1.25	0.8	24811	0.2
1990	1.08	0.8	21298	0.2
1991	0.98	0.95	19409	0.24
1992	1	1.01	19848	0.26
1993	1.13	0.95	22380	0.24
1994	1.4	0.8	27534	0.2
1995	1.44	0.93	28371	0.24
1996	1.44	1.06	28452	0.27
1997	1.21	1.12	24030	0.29
1998	1.27	0.92	25039	0.24
1999	1.37	0.74	27127	0.19
2000	1.45	0.65	28578	0.17
2001	1.33	0.71	26232	0.18
2002	1.26	0.58	24815	0.15
2003	1.21	0.5	23721	0.13
2004	1.16	0.45	22715	0.11
2005	0.99	0.37	19504	0.09
2006	1.05	0.48	20633	0.12
2007	1.16	0.5	22860	0.13
2008	1.31	0.55	25721	0.14
2009	1.57	0.44	30757	0.11
2010	1.43	0.5	28208	0.13
2011	1.33	0.51	26071	0.13

Table 5.3.7. Risk of stock falling below biomass reference points ($B_{MSY\ Trigger}$ and B_{lim}) and fishing mortality exceeding F_{lim} based on a range of potential catch options for 2013.

Total catch option 2013 (tonnes)				
Management Risks	3000	4000	5000	6000
Probability of falling below BMSY trigger)	1.7%	0.4%	1.5%	2.1%
Probability of falling below Blim	0.3%	0.1%	0.7%	0.5%
Probability of exceeding Flim	0.1%	0.7%	4.2%	8.8%
Stock Size (B/Bmsy)	1.441	1.404	1.325	1.29
Fishing Mortality (F/Fmsy)	0.429	0.589	0.825	1.04

Table 5.3.8. Survey index for VIb megrim from the SAMISSQ2 survey.

Year	Abundance (millions)	Biomass (tonnes)
2005	1.14	679
2006	3.488	910
2007	4.813	1289
2008	6.545	1728
2009	6.622	1507
2010	9.221	1911
2011	3.231	885

Table 5.3.9. Changes in relative megrim abundance and biomass from surveys based on percentage changes in mean abundance and biomass from the first three years of the survey relative to the mean of the last two years.

	Biomass		Abundance		Percentage Change	
Trend mean (2007/2009)/(2010–2011)	Mean 07–09	Mean 10/11	Mean 08–09	Mean 10/11	Biomass	Abundance
VIb	1508	1398	6.0	6.2	-7%	4%

Table 5.3.10. Estimates of VIb (Rockall) megrim biomass from Scottish-Irish anglerfish surveys.

Survey Biomass	Survey q	Raised Biomass	Landings	Catch	Harvest Ratio
679	0.3	2263	382	469	21%
910	0.3	3033	344	419	14%
1289	0.3	4297	106	128	3%
1728	0.3	5760	294	353	6%
1507	0.3	5023	226	270	5%
1911	0.3	6370	139	165	3%
885	0.3	2950	138	162	6%

Table 5.3.11. Megrim in Subarea VIb. Nominal catch (t) of Megrim Rockall, as officially reported to ICES and WG best estimates of landings.

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Belgium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
France	-	-	-	-	-	-	-	-	-	.	4	<0.5	<0.5	-	-	-	-	-				
Ireland	196	240	139	128	176	117	124	141	218	127	167	176	87	83	43	68	95	87	68	48	47	72
Spain	363	587	683	594	574	520	515	628	549	404	427	370	120	93	71	88	59	19	84	0	0	0
UK - Eng+Wales+N.Irl.	19	14	53	56	38	27	92	76	116	57	57	42	41	74	42	19	9	.				
UK - England & Wales	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	1			
UK - Scotland	226	204	198	147	258	152	112	164	208	278	309	236	207	382	372	207	181	.	141	178		
UK																					92	66
Offical Total	804	1045	1073	925	1046	816	843	1009	1091	866	964	824	455	632	528	382	344	106	294	226	139	138
Unallocated																						
As used by WG	804	1045	1073	925	1046	816	843	1009	1091	866	964	824	455	632	528	382	344	106	294	226	139	138

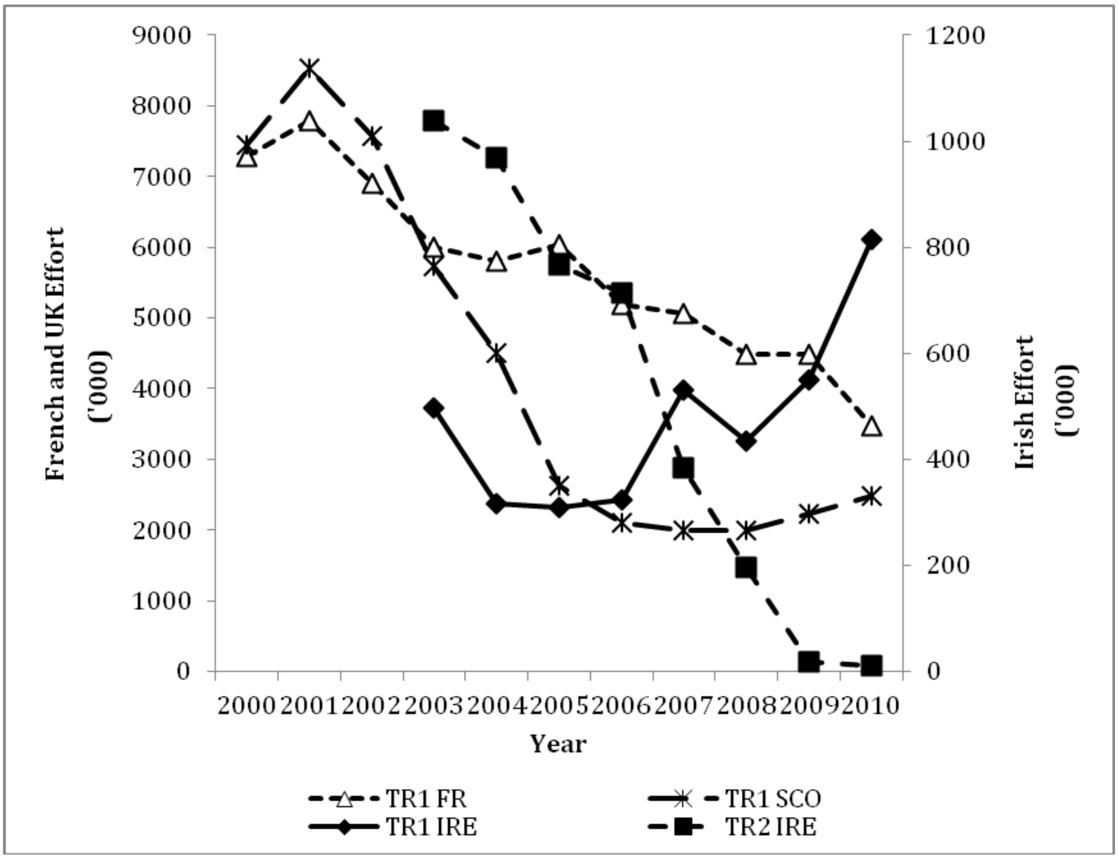


Figure 5.3.1. Scottish TR1, French TR1, Irish TR1 and TR2 effort in ICES Division VIa expressed in kw.days.

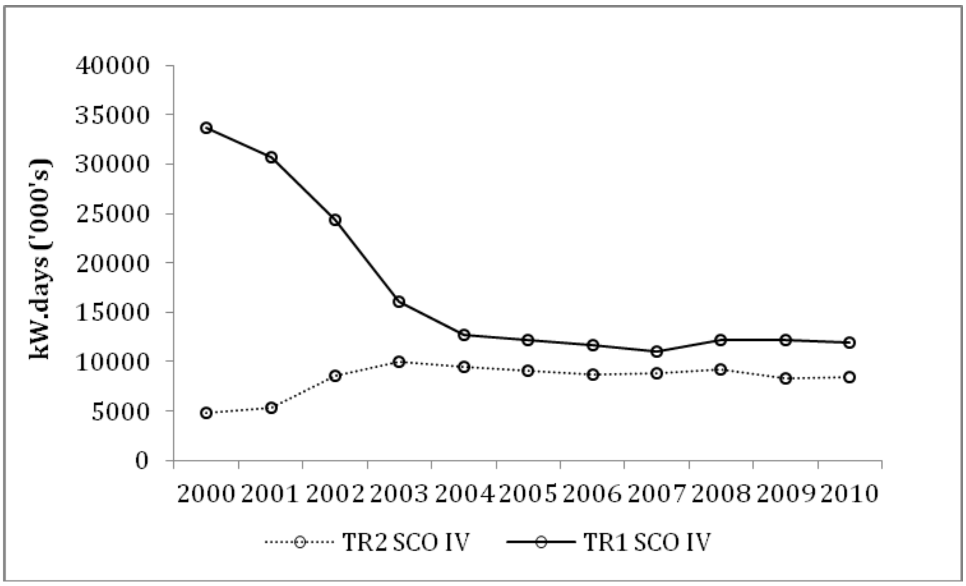


Figure 5.3.2. Scottish TR1 and TR2 effort in ICES Division IVa expressed in kw.days.

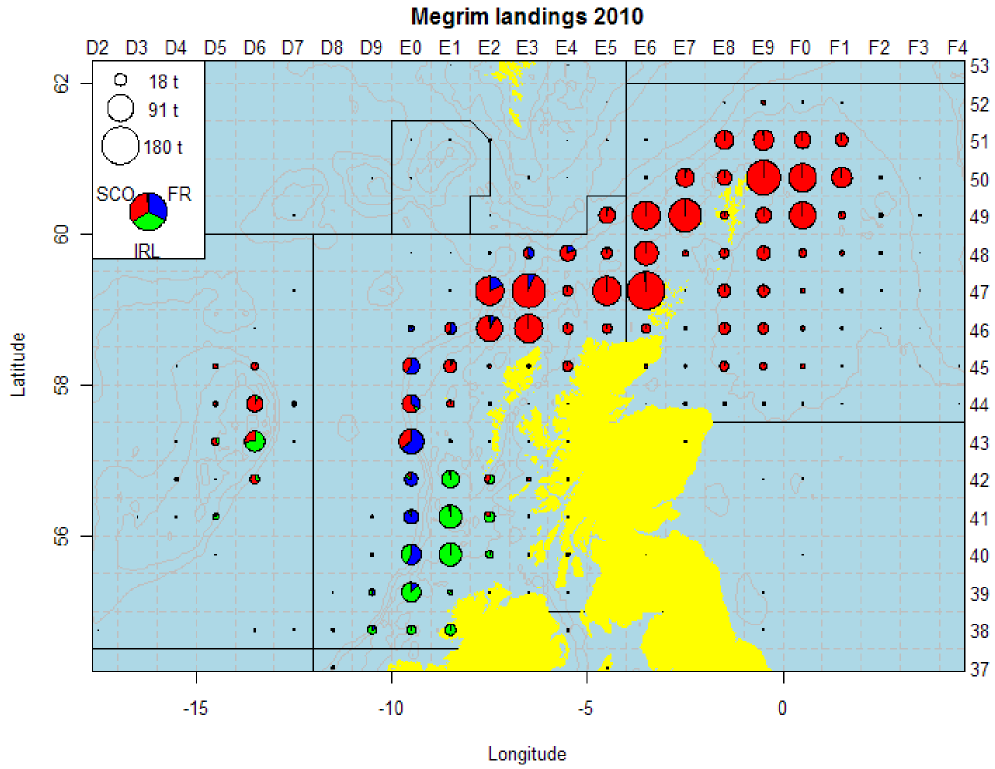


Figure 5.3.3. International megrim landing by ICES statistical rectangle for ICES Divisions VIa, VIb and IVa for 2010.

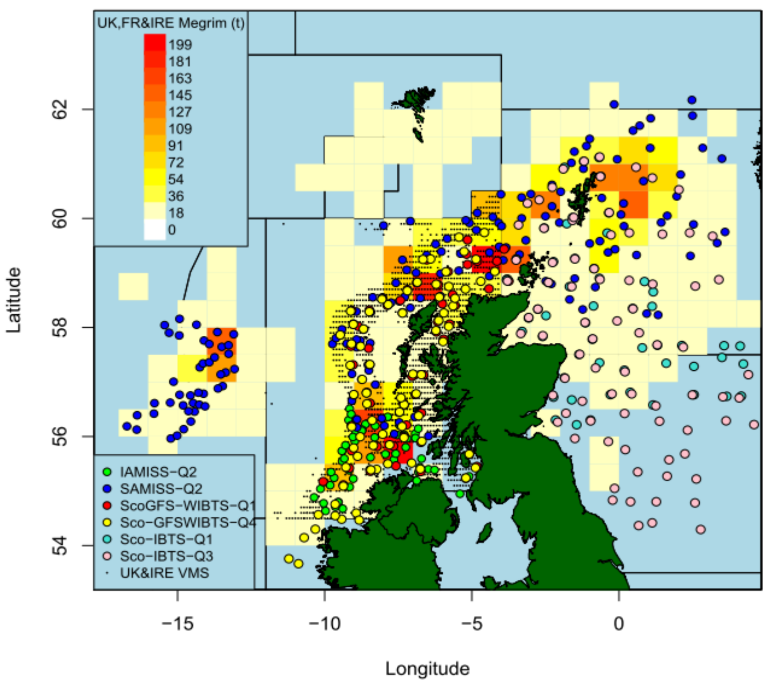


Figure 5.3.4. Distribution of individual haul start positions for all six surveys overlaid on landings by statistical rectangle for VIa, IV and VIb. VMS distribution of UK and Ireland activity in VIa is also shown.

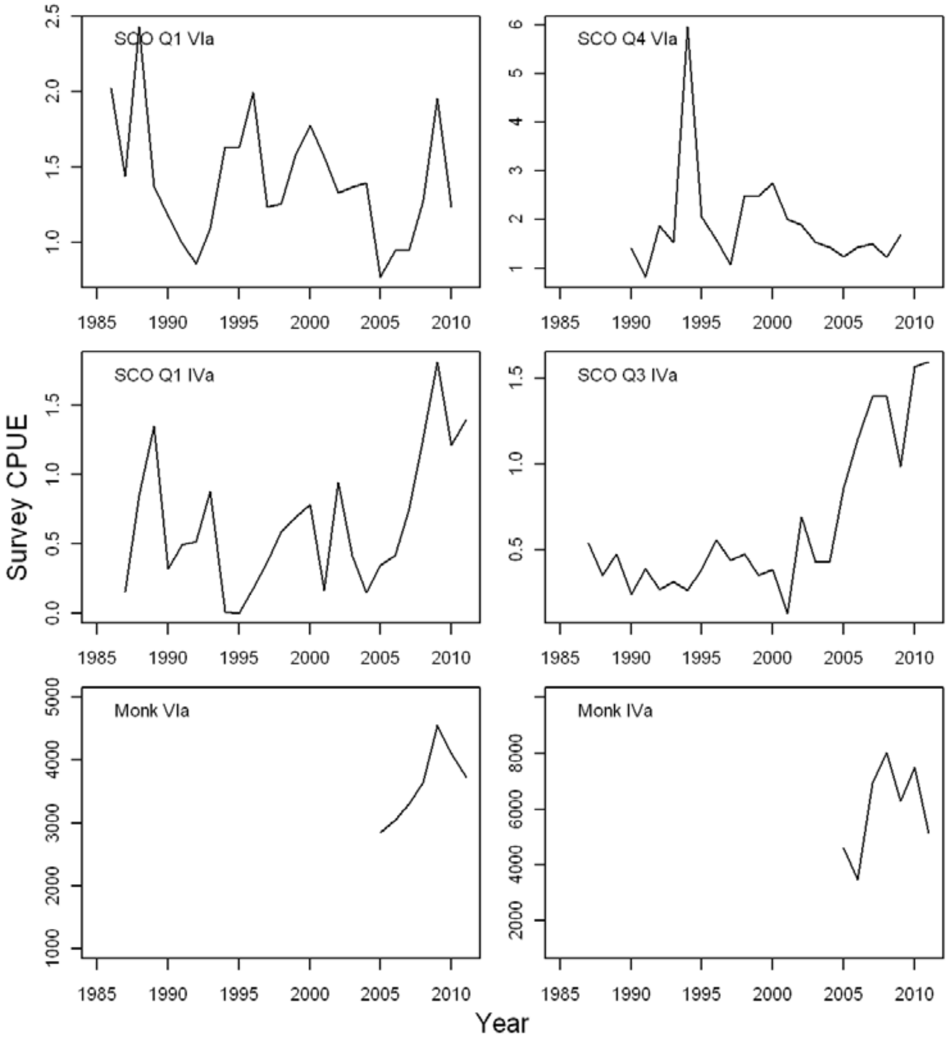


Figure 5.3.5. Trends in Megrim VIaIVaN survey cpue indices as used in the assessment.

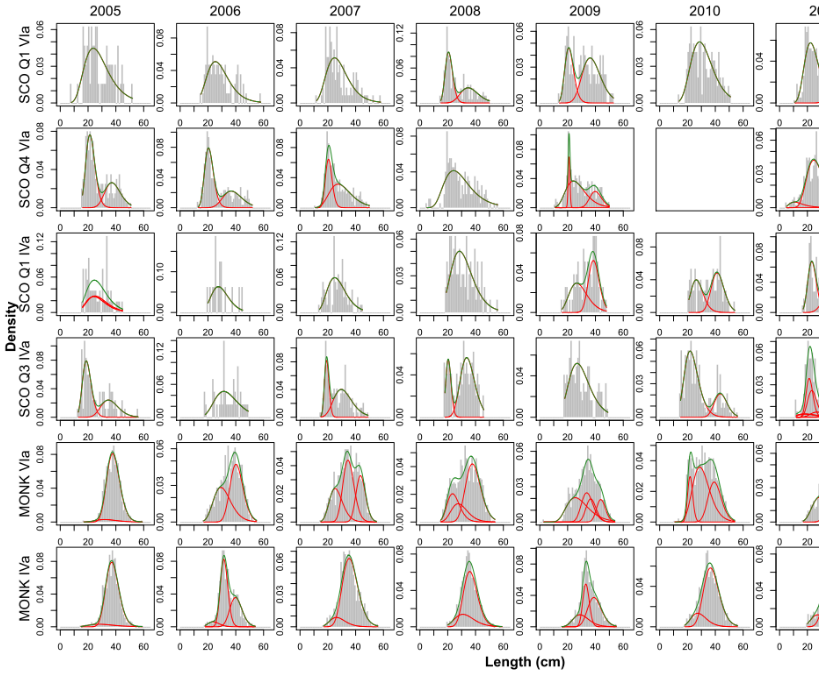


Figure 5.3.6. Results from a mixture distribution models showing possible cohorts in the length distributions associated with the survey indices (2005–2011). Green lines show the overall distribution while the red lines show possible subcomponents (cohorts) from a mixture distribution model.

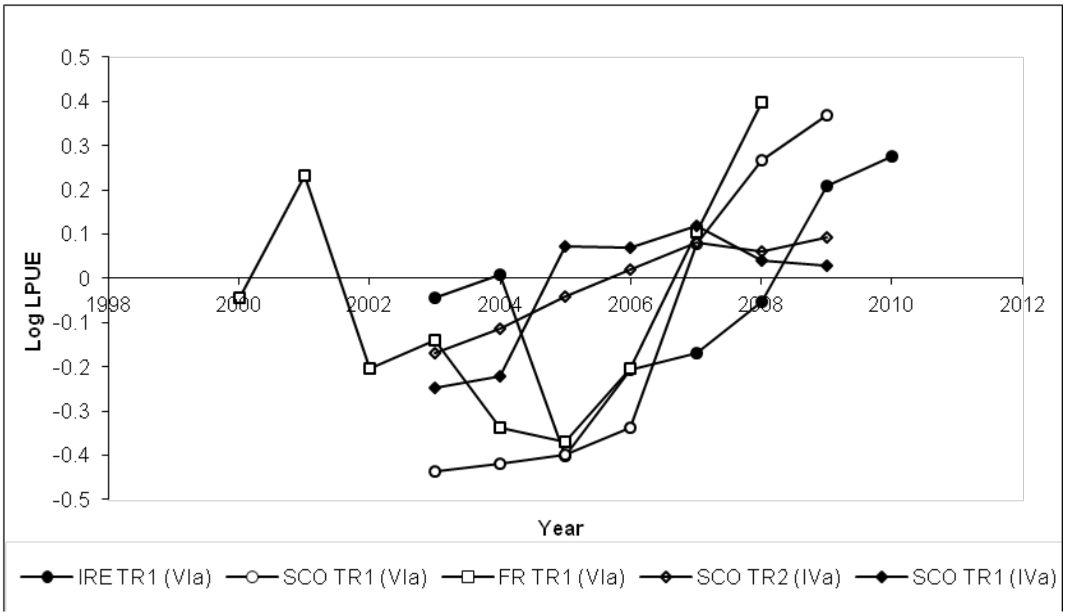


Figure 5.3.7. Change in commercial standardised log lpue and relative to long-term average for Megrim in VIa and IVa.

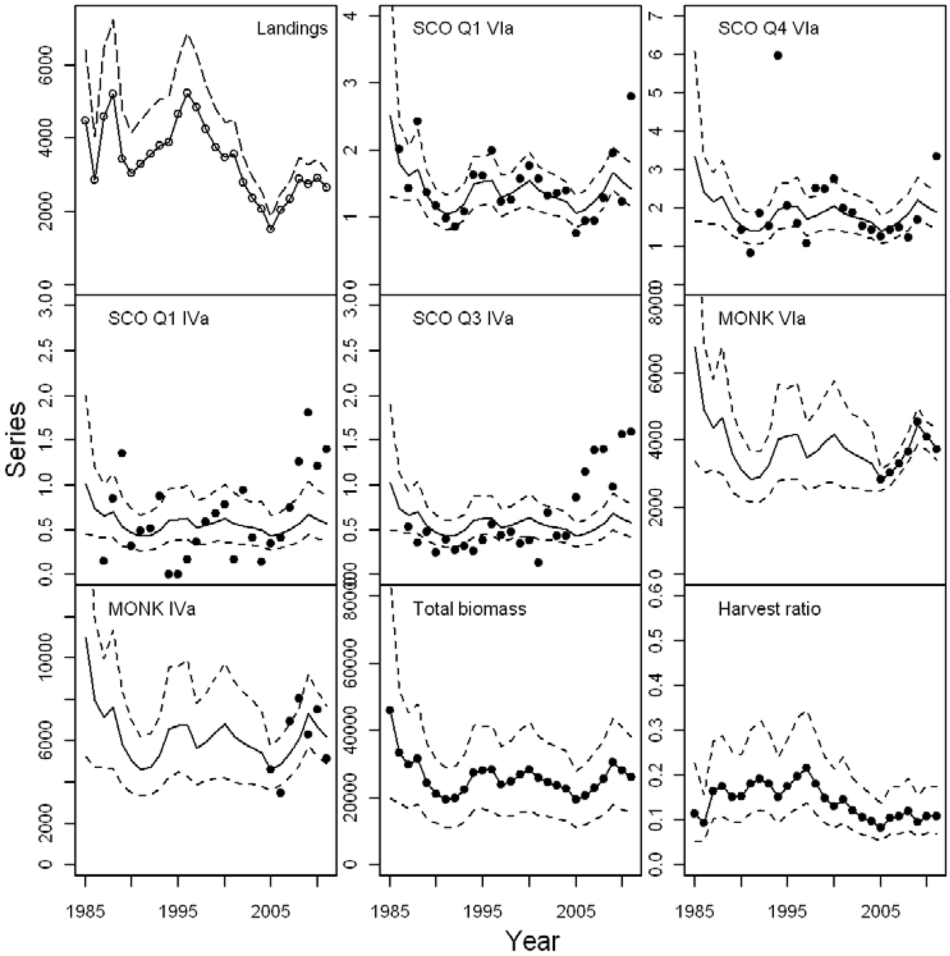


Figure 5.3.8. Trends in landings of VIa and IVa (solid line) with catch estimate (dashed line) assuming a linear decline in discards from 30 to 15% over the times-series, estimated trends in total biomass and exploitation rate. Trends in annual cpue from the NS-IBTS, W-IBTS and IRE-IV.VI.-AMISS-Q2 and SCO-IV.VI.AMISS-Q2 surveys used in the surplus production model. The solid line is the modelled cpue trend across all surveys.

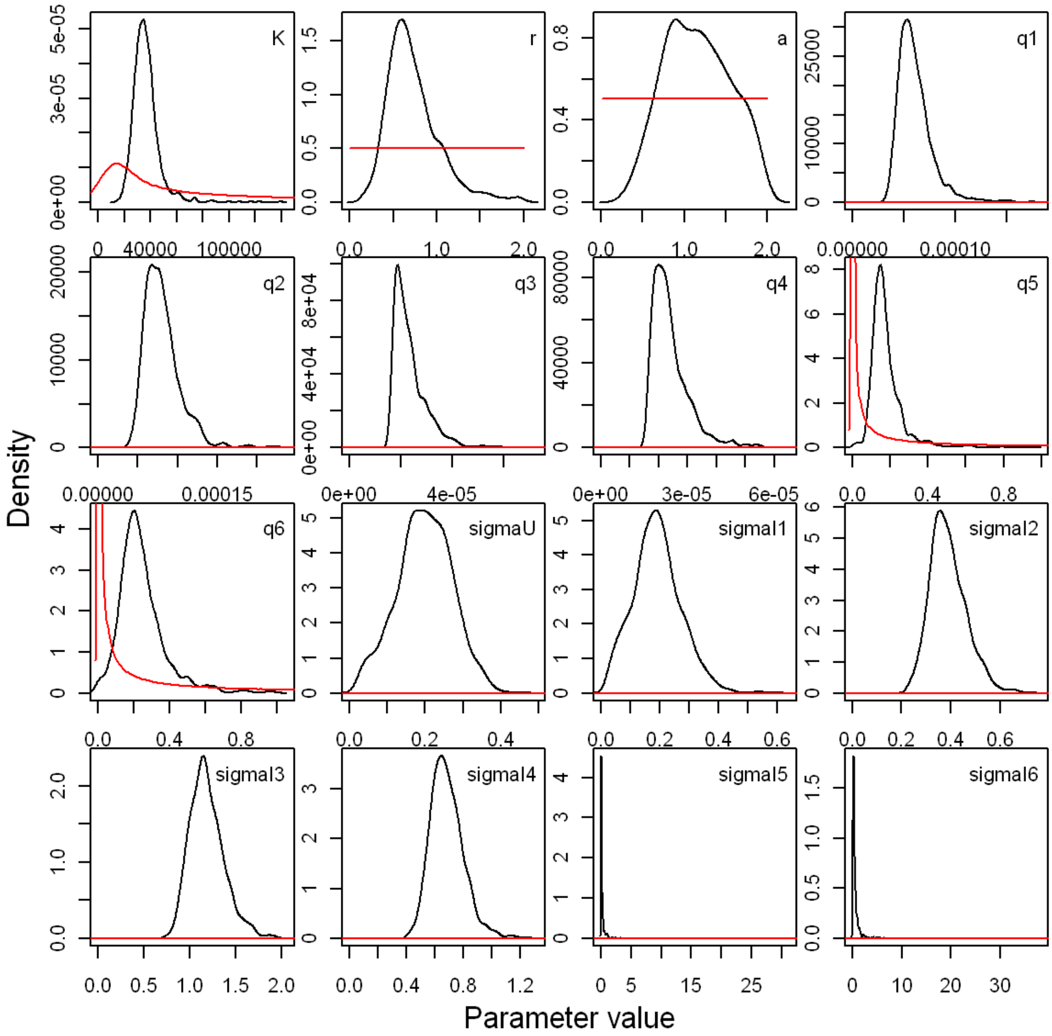


Figure 5.3.9. Prior (red) and posterior (black) distributions assumed and estimated.

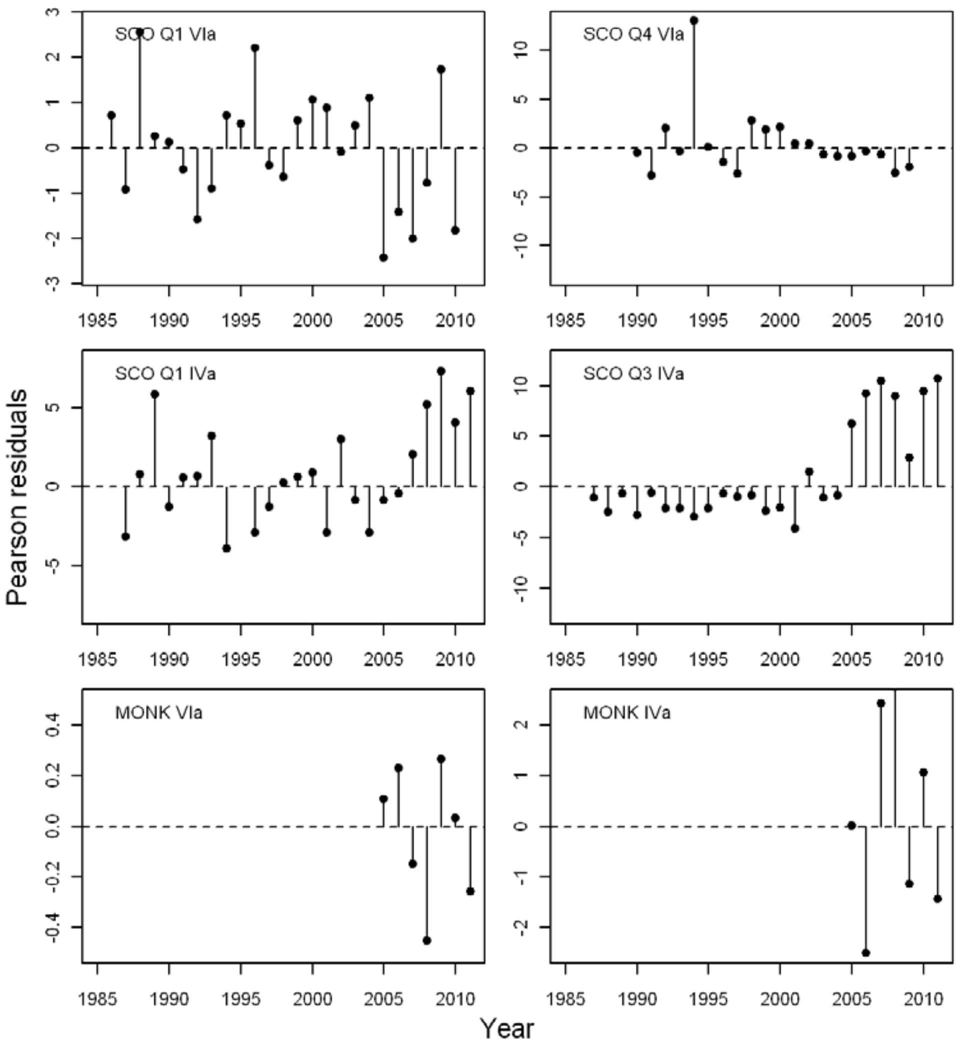


Figure 5.3.10. Pearson residuals for the six survey indices.

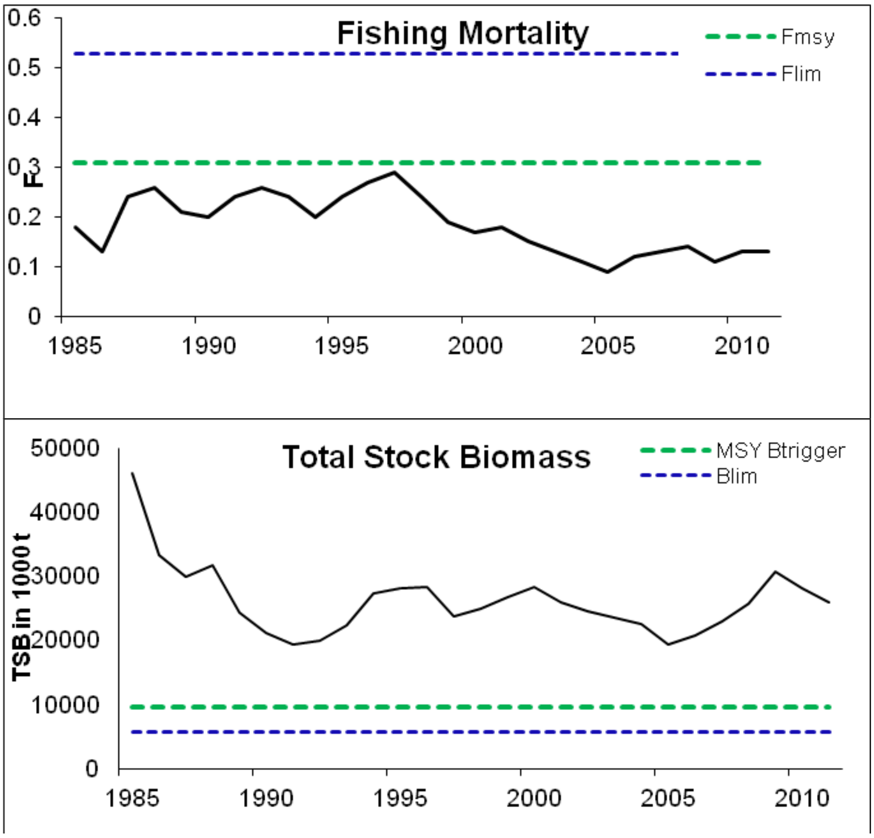


Figure 5.3.11. Trends in fishing mortality and biomass relative to fishing mortality and biomass reference points.

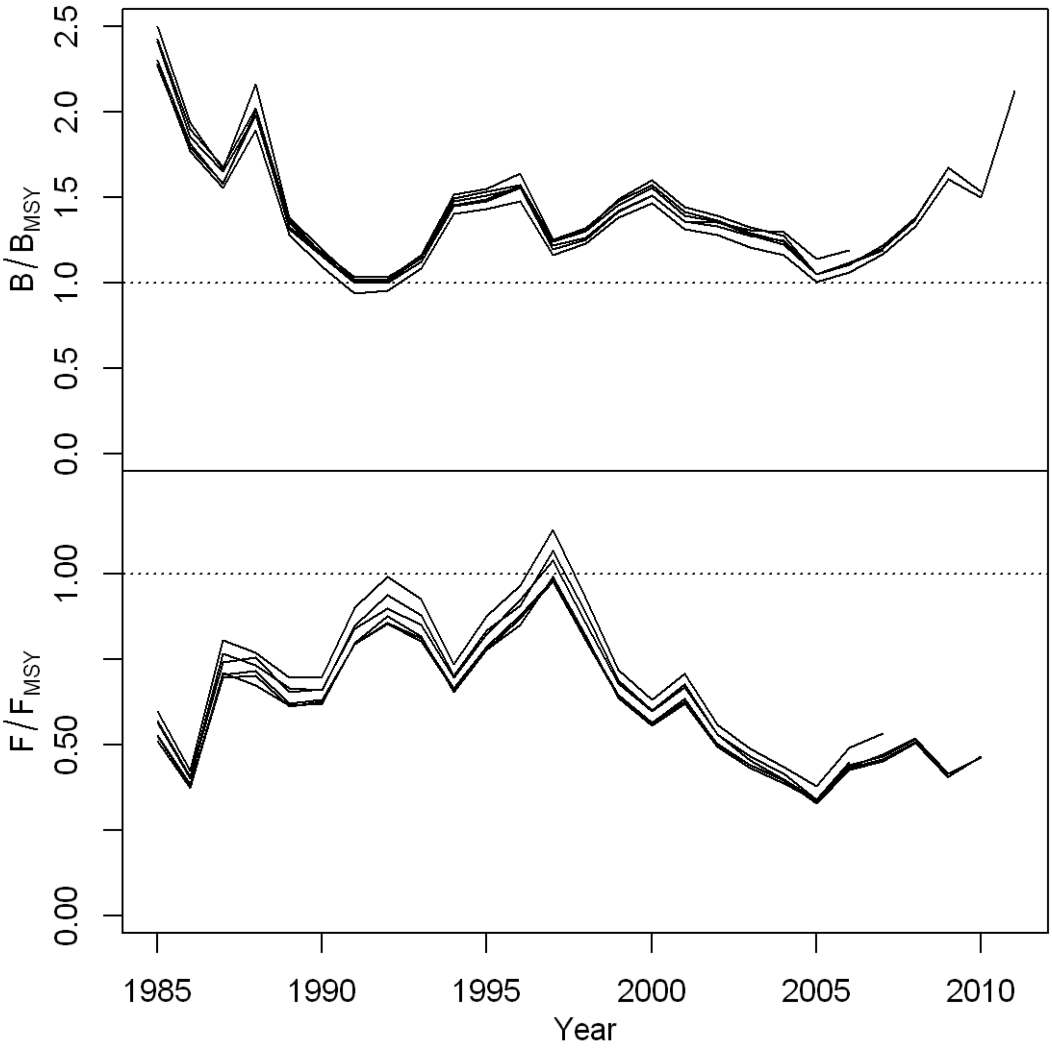


Figure 5.3.12. Up to five year retrospective analysis. Relative biomass and fishing mortality indices obtained using the yearly deletions of the datasets up to 2006. Note no F_{MSY} value is available for 2011 as this requires a landings estimate for that year.

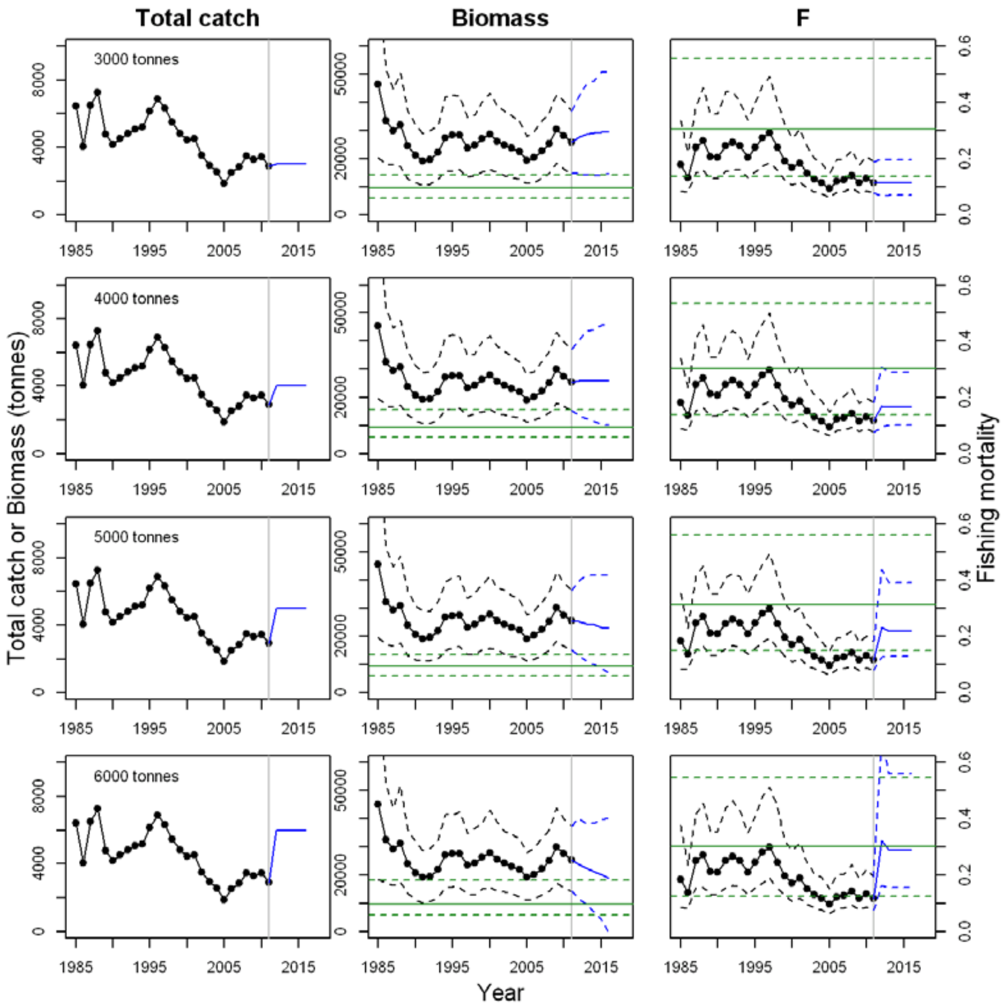


Figure 5.3.13. Projected effect on biomass and fishing mortality together with uncertainty based on catch options of 3000, 4000, 5000 and 6000 tonne catch. The solid line is $B_{MSY\ trigger}$ in the biomass plots and F_{MSY} in the F plots.

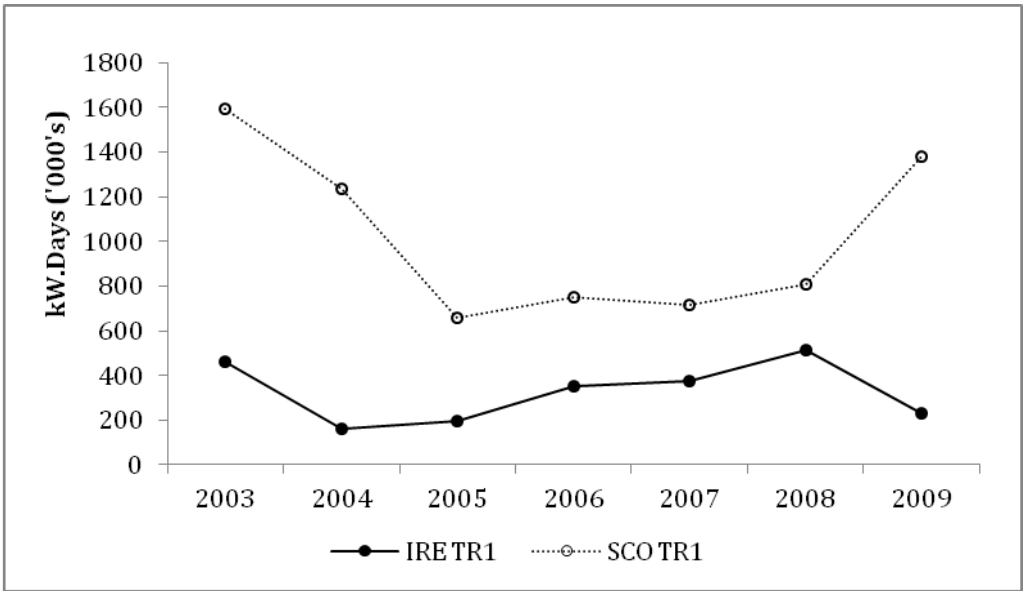


Figure 5.3.14. Irish and Scottish TR1 effort in ICES Subdivision VIb (Rockall) expressed in kw.days.

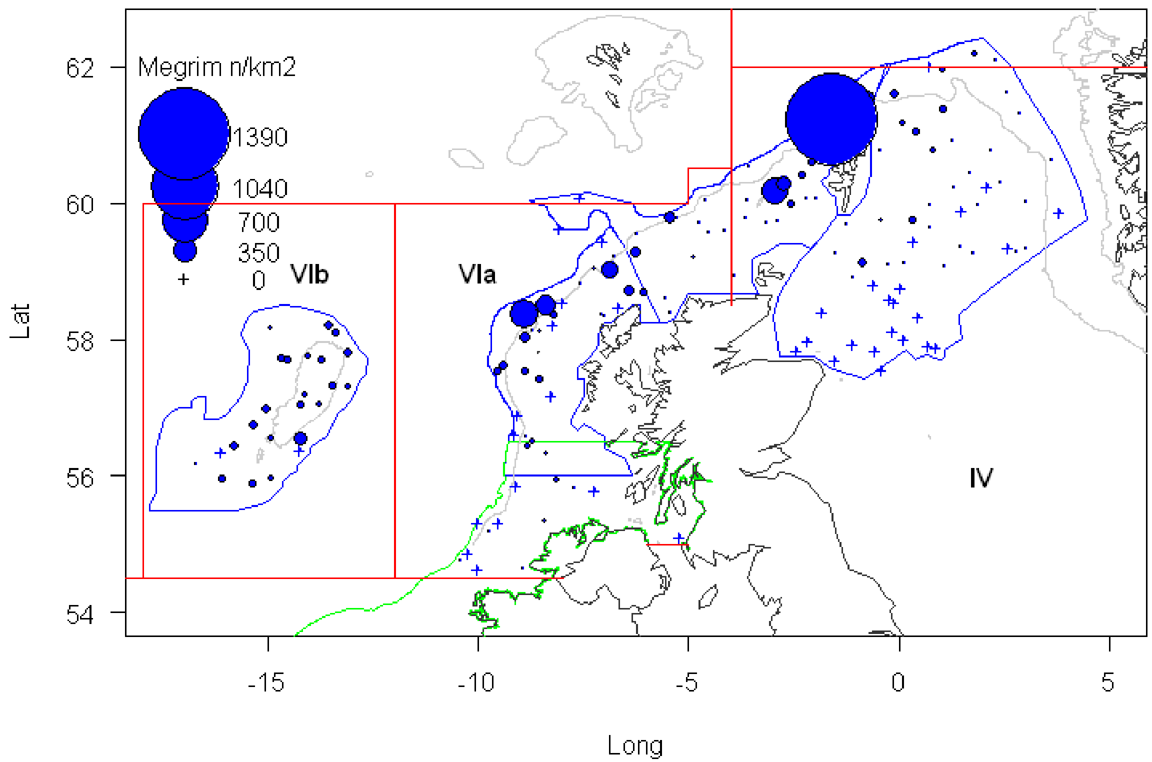


Figure 5.3.15. Maps of the northern continental shelf around the British Isles showing the number density of megrim caught during the anglerfish surveys 2010. Each circle is centred on the sample location and the size of the circle is proportional to the number density in n/km² according to the legend (top left). The red lines indicate the position of the borders between the main ICES subareas (labelled with Roman numerals).

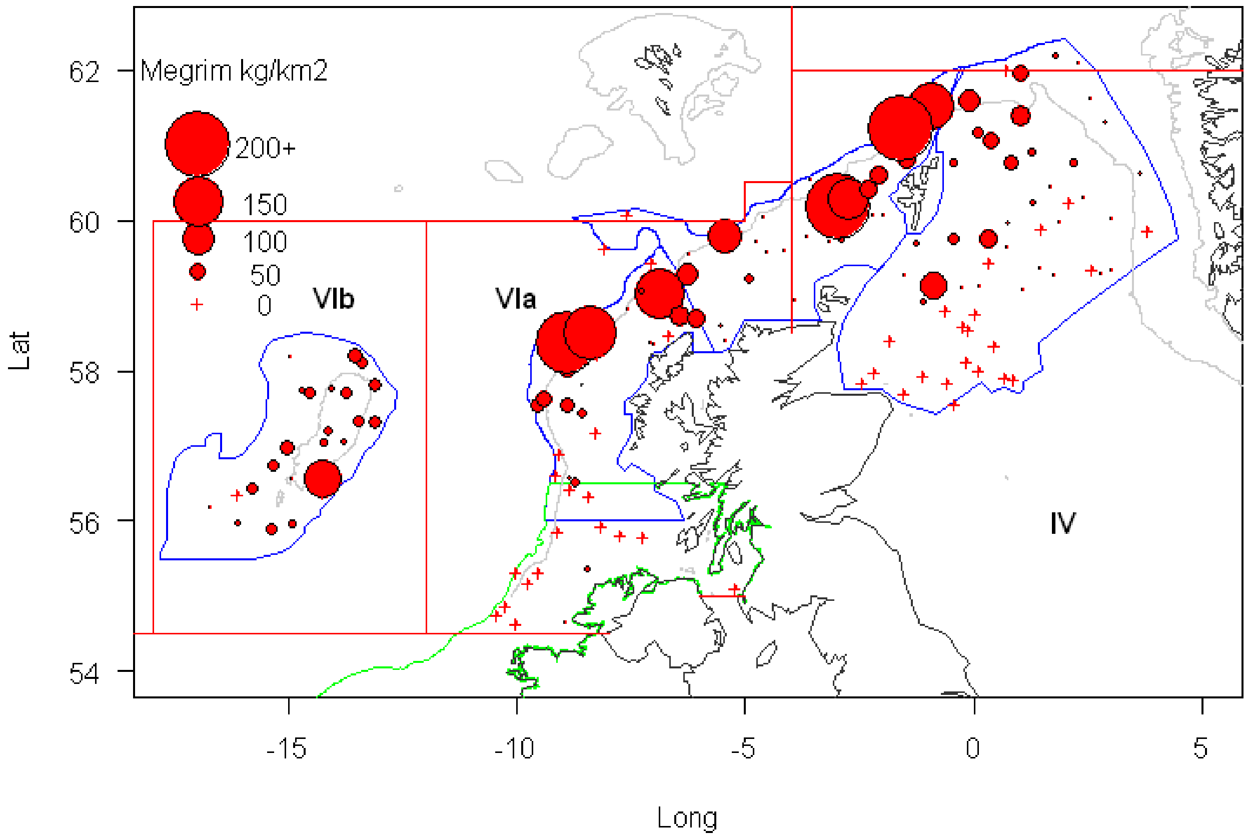


Figure 5.3.16. Maps of the northern continental shelf around the British Isles showing the weight density of megrim during the anglerfish surveys 2005–2010. Each circle (blue for Scottish surveys; green for Irish surveys) is centred on the sample location and the size of the circle is proportional to the weight density in kg/km² according to the legend (top left). The red lines indicate the position of the borders between the main ICES subareas (labelled with Roman numerals).

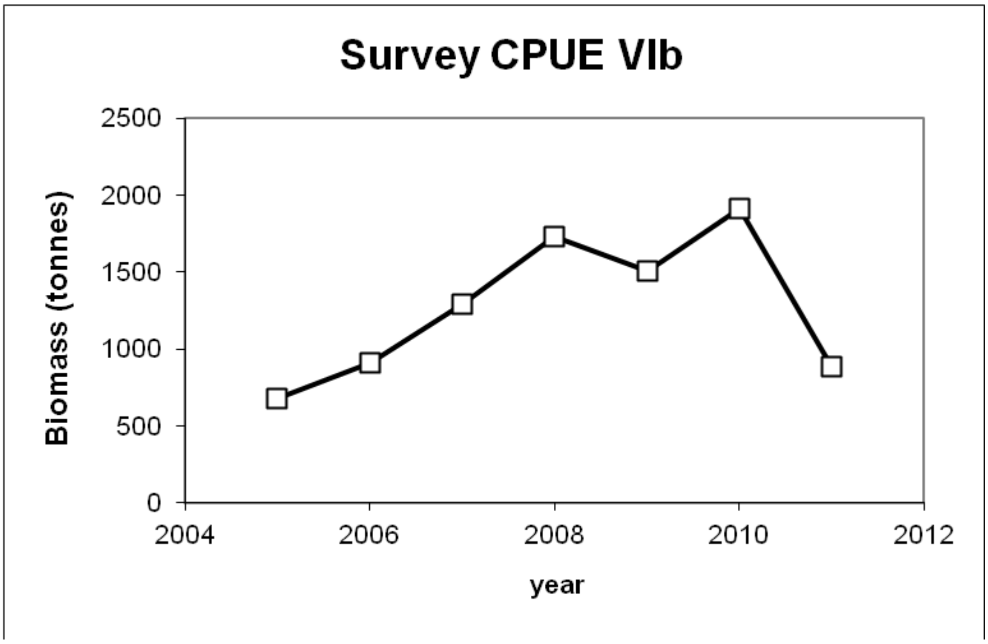


Figure 5.3.17. Change in megrim biomass in ICES Division VIb from the 2005–2011 anglerfish (Sco-IV-VI-AMISS-Q2) survey.

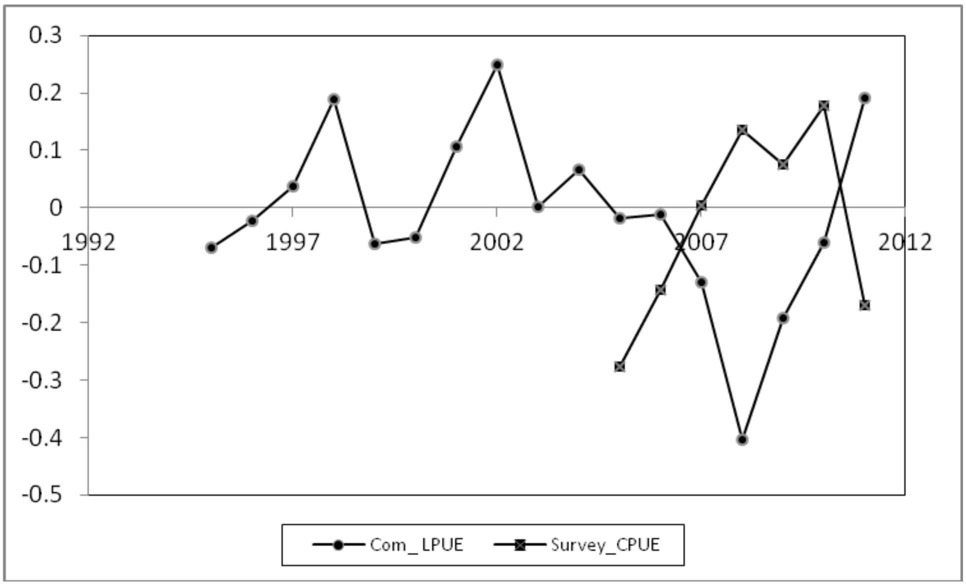


Figure 5.3.18. Change in commercial Log lpue and survey cpue for VIb megrim.

6.1 Irish Sea overview

There is no overview.

6.2 Cod in VIIa

Type of assessment

This is an update assessment of the benchmark model fitted at ICES WKROUND2 (2012). At that meeting it was agreed that:

1) The assessment model should be the state–space model SAM as estimates of unallocated mortality are more robust when fitted to noisy survey data and the model allows the fitting of an SSB index time-series which is currently available for VIIa cod. In order to fit the model age 0 (no catches) was removed from the assessment and a 1–6+ age range applied.

2) New survey-series should be included within the assessment; the SSB index, and two UK(E&W) Fisheries partnership surveys conducted by commercial fishers with observation and analysis of the data conducted by Cefas (www. cefas.co.uk/fsp).

3) Although there is evidence for increased maturity within the stock at age 2 in recent years and historic problems with weights-at-age resulting in SOP bias, these represent only minor refinements to the model estimates which are heavily dependent on the estimation of unallocated mortality. Research effort should be concentrated on determining the reasons for the current high mortality rates on the stock.

4) The model agreed by WKROUND2 is considered work in progress rather than a final model structure. As such it should be used to give advice on the status of the stock and total mortality rate but the actual causes of that high mortality rate are still undetermined.

ICES advice applicable to 2011

"*ICES has evaluated the long-term management plan and found it not precautionary. … Given the low SSB and low recruitment it is not possible to identify any non zero catch which would be compatible with the MSY transition scheme. This implies no targeted fishing should take place on cod in Division VIIa. Bycatches including discards of cod in all fisheries in VIIa should be reduced to the lowest possible level.*"

ICES advice applicable to 2012

"*ICES has evaluated the long-term management plan and found it not precautionary..... Given the low SSB and low recruitment it is not possible to identify any non zero catch which would be compatible with the MSY transition scheme. This implies no targeted fishing should take place on cod in Division VIIa. Bycatches including discards of cod in all fisheries in Division VIIa should be reduced to the lowest possible level and uptake of further technical measures to reduce discards.*"

6.2.1 General

Stock description and management units

The stock and the management unit are both ICES Division VIIa (Irish Sea).

Management applicable to 2010 and 2011

TACs and quotas set for 2011

Zone VIIa (COD/07A)	Analytical TAC	Weight tonnes
	Belgium	7
	France	19
	Ireland	332
	The Netherlands	2
	United Kingdom	146
	EU	506
	TAC	506

TACs and quotas set for 2012

Zone VIIa (COD/07A)	Analytical TAC	Weight tonnes
	Belgium	5
	France	14
	Ireland	231
	The Netherlands	1
	United Kingdom	109
	EU	380
	TAC	380

Management of cod is by TAC, days-at-sea limits and technical measures. Technical regulations in force in the Irish Sea, including those associated with the cod recovery plan since 2000, are described in Section 6.1.

Fishery in 2011

Landings of cod in 2011 (Table 6.2.1) were the lowest recorded, continuing the downward trend in recorded landings in recent years following restrictions on the fishery. The total uptake of quota was only 73%, however this is not reflected across all of the national uptake figures with the UK (170/146 Landings/TAC) and Belgium (36/7) trading in quota to enable them to exceed their national allocation and Ireland (160/333) and France (3/19) have low uptake. Northern Ireland landed approximately 40% of the cod (Table 6.2.2), with the majority taken by whitefish otter trawlers and *Nephrops* trawlers. The percentages landed into southern Ireland have increased from 13% in 2008 to 43% in 2011, with Belgium and UK (England and Wales) at roughly 10% and 5% respectively. Irish landings over that last few years have been adjusted downwards to take account of catches taken in the Celtic Sea off SE Ireland. In 2011 147 tonnes of cod landings reported as taken in VIIa were reallocated to the Celtic Sea (see Section 7.2.1).

6.2.2 Data

An overview of the data provided and used by the WG is provided in Table 2.1 in the WGCSE Report.

Fishery landings

The input data on fishery landings and age compositions are split into four periods (Figure 6.2.1):

1) 1968–1990. Landings in this period, provided to ICES by stock coordinators from all countries, are assumed to be un-biased and are used directly as the input data to stock assessments.

2) 1991–1999. TAC reductions in this period caused substantial misreporting of cod landings into several major ports in one country, mainly species misreporting. Landings into these ports were estimated based on observations of cod landings by different fleet sectors during regular port visits. For other national landings, the WG figures provided to ICES stock coordinators were used.

3) 2000–2005. Cod recovery measures were considered to have caused significant problems with estimation of landings. The ICES WG landings data provided by stock coordinators for all countries are considered uncertain and estimated within an assessment model. Observations of misreported landings were available for 2000, 2001, 2002 and 2005. However, they have generally not been used to correct the reported landings but have been used to evaluate model estimates in those years.

4) 2006–2011. The introduction of the UK buyers and sellers legislation is considered to have reduced the bias in the landings data but the level to which this has occurred is unknown. Consequently comparisons were made between the fit of the model to recorded landings under an assumption of bias and unbiased information.

In addition to the above Irish landings of cod reported from ICES rectangles immediately north of the Irish Sea/Celtic Sea boundary (ICES rectangles 33E2 and 33E3) have been reallocated into the Celtic Sea as they represent a combination of inaccurate area reporting and catches of cod considered by ICES to be part of the Celtic Sea stock (ICES, 2009). The amount of Irish landings transferred from VIIa to VIIe–k by year is shown below:

Year	2004	2005	2006	2007	2008	2009	2010	2011
Tonnes	108	54	103	527	558	193	143	147

The higher level in 2007 and 2008 was a consequence of limited quota in VIIe–k and available quota in VIIa. Since 2009 more restrictive monthly quotas have been set for VIIa during periods of high cod abundance close to the VIIa–VIIg boundary.

The total landed weight, annual numbers-at-age landed and the mean weights-at-age in the landings by age class are given in Tables 6.2.3 and 6.2.4 and Figures 6.2.1–6.2.3. There are no long-term trends in catch weights-at-age from 1982 onwards. Weights-at-age prior to 1982 are fixed at constant values lower than estimated for subsequent years, leading to sum-of-products errors, and weights-at-ages 6+ are becoming noisy for the last few years (Figure 6.2.3). Given these problems, and the likelihood of further deterioration in the quality of the data on older aged fish, WGCSE and

WKROUND2 considered that future revision of historical catch-at-age data and associated weights is considered appropriate.

However, WKROUND2 established that revising the weight-at-age would only represent only minor refinements to the model estimates of mortality and SSB trends and the reference point which are dependent on them compared to the sensitivities associated with the estimation of unallocated mortality. Consequently the revision of the weights-at-age should be conducted following the determination of the reasons for the current high mortality rates on the stock.

The catch-at-age data were screened using separable VPA (reference age 3; terminal F = 1.5; S = 1.0; default year and age weighting). The data show a historic change in residuals for log catch ratios at ages 1–2 after 1991 reflecting the decreased landings of small fish (due to discarding) (Figure 6.2.4). Outliers at age 5–6 in 2003/2004 and age 1–2 in 2006/2007 are not associated with any obvious anomalies in any national dataset and reflect small catches and sample sizes.

Figure 6.2.5 presents the log catch (landings) curve plot for the landings-at-age data; this can be considered to represent the catch-at-age data for ages 2+ and the plot therefore represents a catch curve time-series. Total mortality rates for the stock have been high throughout the time period for which information is available. Even when the stock was considered abundant and recruitment levels supported high levels of catch the gradient of the catch curve was in the range 0.8–1.0. Year classes rapidly disappeared from the commercial landings data. The increase in the negative slope indicates that total "mortality" rates have increased over time and now are double that recorded in the historic data during the period when the stock was abundant. There is currently no evidence from the age compositions from surveys or commercial fishery operations of any improvement in age structure that would result from a reduction in total mortality.

Discards data

No discards data are currently included in the assessment. Suitable discards estimates are not available prior to the mid-1990s and are not complete for many subsequent years. Available data indicates that discarding was historically mainly a function of MLS (35 cm) and therefore mainly restricted to catches of <= 1-gp cod.

EU countries are now required under the EU Data Collection Framework to collect data on discards of cod and other species. Consequently at WKROUND 2012 collation of recent discard information provided by Member States for the stock was carried out as a scoping exercise ready for future modelling and the provision of advice.

Up to 2003, estimates of discards are available only from limited observer schemes and a self-sampling scheme. Observer data are collected using standard at-sea sampling schemes. Results have been reported to ICES. Discards data (numbers-at-age and/or length frequencies) are have been supplied for VIIa cod by Ireland, UK(Northern Ireland) and UK (E&W) and Belgium. The data were supplied raised to the appropriate fleet/metier level by the member states.

Raising to total national discards

Ireland: Length frequencies from Irish (Marine Institute) observer trips in specified fleet métiers are raised to the trip level, averaged across trips during each year (not by quarter) then multiplied by the annual number of trips per year in the Irish fleet in VIIa to give raised annual LFDs for discards. An age–length key from discards trips is then applied to give annual discards by age class and métier.

Northern Ireland self sampling scheme: The quantity of cod discarded from the UK (NI) *Nephrops* fishery from 1996 to 2002 was estimated on a quarterly basis from samples of discards and total catch provided by skippers. The discards samples contain the heads of *Nephrops* tailed at sea. Using a length–weight relationship, the live weight of *Nephrops* that would have been landed as tails only is calculated from the carapace lengths of the discarded heads. The number of cod in the discard samples is summed over all samples in a quarter and expressed as a ratio of the summed live weight of *Nephrops* in the discard samples (i.e. those represented as heads only in the samples). The reported live weight of *Nephrops* landed as tails only is then used to estimate the quantity of cod discarded using the cod:*Nephrops* ratio in the discard samples. The length frequency of cod in the discard samples is then raised to the fleet estimate. Age data have not been collected; however the discards are mainly of small cod that can be allocated to ages 0 and 1 based directly on their length. Roughly 40 discard samples were collected annually.

Northern Ireland observer trips: Length frequencies from NI (AFBI) observer trips in specified fleet métiers are raised to the trip level, summed across trips during each year or by quarter then raised to the annual number of trips per year in the NI fleet in VIIa to give raised annual LFDs for discards. An age–length key from discards trips is then applied to give annual discards by age class and métier.

UK(E&W) observer trips: Trips are arranged on vessels selected using a vessel randomisation scheme. Discard numbers are raised to sampled hauls then to the trip. The trip-raised length frequencies from Cefas observer trips in specified fleet métiers are then raised to the trip level, summed across trips during each quarter. Sampled quarters are then raised to total discards by quarter from the landings to discards ratios at age. As recorded in the data sent annually to ICES catches and discards of cod within the Irish Sea by UK(E&W) vessels have been extremely low for a number of years. For instance in 2010, 63 hours fishing were observed distributed across quarters 1–4 with three cod caught and one discarded in quarter 1 (six hours trawling), 21 caught and 20 discarded in quarter 2 (32 hours) and 0 (zero) cod caught and discarded in quarters 3 (twelve hours) and 4 (13 hours).

Belgium observer trips: Several Belgian métiers are operating in the Irish Sea. The beam-trawl fleet targeting sole and plaice (TBB_DEF_70-99_0_0) is the most important fleet, but, it should be noted that the OTB_DEF_70-99_0_0 métier (otter trawls) is becoming more important each year. Part of the landings and effort that could not be allocated to the main métiers, are referred to as: 'no allocated métier'. Since the observers only collect information from the commercial beam trawlers, the data can only be raised to the TBB_DEF_70-99_0_0 fleet and not to all Belgian métiers operating in the Irish Sea. In order to find the most suitable raising procedure for the Belgian discard (and landing) data, the tools developed by the COST project were used. Having considered the different raising procedures, raising by hauls was found to be the most appropriate method for the Belgian cod VIIa data. The results of the raising procedure were scaled relative to the official landings. The time stratification for the Belgian data is by year, as sampling was insufficient to provide quarterly figures. It should be noted that due to the lack of Belgian individual length–weight information, the length–weight keys used in the analyses, are based on Irish sampling data. Note also that the Belgian minimum landing size has changed a couple of times over the last years, which is reflected in the differences in length frequency distributions between years of the retained and discarded part of the catch.

- From the beginning of 2004 until the 30th of June 2008: 40 cm;
- From the 1st of July 2008 until 30th of September 2011: 50 cm;

- From the 1st of October 2011 up to today: 35 cm.

Raising to total international discards

National, raised to fleet discard numbers-at-age from Ireland, Belgium, UK(E&W) and NI were added to give the international numbers (with no additional weighting). The data represents the main fleets discarding cod, i.e. *Nephrops* and beam trawlers. Table 6.2.5 presents the raised discard numbers-at-age for the years 2007–2011, the years for which common raised discard datasets are available, the associated reported landings numbers-at-age and the proportion discarded at age.

Total raised discarding has been 100% at age 0 in all years. At age 1 the discarding rate is high and has been relatively constant at around 77%. At older ages discarding has been very low until 2010 during which it has increased at all ages but particularly at age 1 indicating highgrading.

The current discard information is considered representative of the information for the main fleets highlighting strong differences between national, quarterly and potentially regional discard rates as the national fleets tend to fish differing areas with differing gears.

The time-series are still too short to include the data within an assessment and at the youngest ages discard raising still needs some development, however that also applies to landings numbers-at-age, which have deteriorated significantly in quality in recent years in terms of sampling levels due to low levels of landings.

Impact of discards on the assessment

Historical F and recruitment for 1-gp cod will be underestimated by the assessment which does not include discards but there will not any impact on the estimated average fishing mortality used to monitor the stock and estimated dynamics of the SSB. The increase in discarding at age 2 is likely to result in an underestimate if the mortality rate at that age.

Biological data

Natural mortality

The current assessment uses constant values of M=0.2 (all ages) and combined-sex proportion mature values of 0 at age 1, 0.38 at age 2 and 1.0 for older ages.

WKROUND2 evaluated revised natural mortality estimates derived from weights-at-age using the approach proposed by Lorenzen (1996). The corresponding mortality rates derived from catch weights only showed differences at ages 0 (not included in the revised assessment) and age 1 as tabulated below:

Age	0	1	2	3	4	5	6	7
M	1.27	0.83	0.43	0.31	0.26	0.24	0.24	0.23

The affect on the assessment was only to rescale the time-series without altering the trends. WKROUND2 therefore recommended that:

1) In the future benchmark assessments the Lorenzen natural mortality should be applied, held constant in time.

2) The change should be introduced when the assessment model has been stabilised and issues such as the potential revision of the historic weights-

at-age have been addressed as all of the changes will act together to alter the estimated PA and MSY management reference levels. The introduction of a new time-series of constant weights-at-age will only rescale biomass and recruitment levels rather than altering trends.

Consequently natural mortality was not changed in the assessment from the value of 0.2 at all ages.

Maturity

Maturity-at-age has been considered constant in all years within the assessment at the values listed in the text table below.

Age	0	1	2	3+
Proportion Mature	0	0	0.38	1

However, Armstrong *et al*. (2004) and Nash *et al*. (2010) have shown that maturity at age 2 has increased during the late 1990s. WKROUND2 evaluated the time-series of maturity information as estimated from the Northern Ireland first quarter groundfish survey by Armstrong *et al*. (2004) using a weighted average plotted with the raw average from the full time-series of data. The survey data indicates that the proportion mature at age 2 increased between 1995 to around 2003 from levels close to that of the WG historic estimate of 38% to 65% and has subsequently remained stable at that proportion. Changing the maturity at age 2 in the most recent years increases the estimated spawning biomass but does not change the conclusions that would be drawn from the assessment fit in that spawning biomass is well below historic values and the PA reference thresholds. WKROUND2 therefore recommended that:

1) The time-series of the proportion mature at age 2 be changed to reflect the increased proportion mature at that age.
2) That the average value from 2000 is used for the recent time period and that the transition from the historic value of 0.38, developed at WKROUND2, be adopted for the period between 1996 and 2000.
3) The biomass thresholds for the stock will be unaffected by the change to recent maturity proportions however care will need to be taken in the choice of maturity values to use when estimating F_{MSY}.

Survey data used in assessment

Five research vessel survey series for cod in VIIa have been used by WGCSE previously for the assessment of the stock until 2011. In 2012 three additional surveys became available, two fisheries science partnership surveys from the UK(E&W) and a UK(E&W) egg production biomass estimate. The year ranges for each survey are presented below. The time-series of catch per unit of effort for each series are presented in Table 6.2.6.

Survey	Ages	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
NIGFS-MAR	1 - 6		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
ScoGFS-Q1	1 - 5					■	■	■	■	■	■	■	■	■	■	■					
ScoGFS-Q4	0 - 4						■	■	■	■	■	■	■	■	■	■	■				
NIGFS-OCT	0 - 3	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
E/W FSPW	1 - 6														■	■	■	■	■	■	■
E/W FSPE	1 - 5														■	■	■	■	■	■	■
E/W BTS Sept	0		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
NIMIK	0			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
AEPM SSB	Biomass				■					■						■		■		■	

WKROUND2 evaluated the consistency of the survey data between and within series and the fit of the SAM model to each survey. The group concluded that the older ages in the autumn surveys did not represent the dynamics of those ages in the population due, most likely to changes in the spatial distribution of the stock during the summer and autumn. Consequently the group recommended using all of the available surveys, which cover the time period when catch data is suspected to have been biased, and the following age ranges from each survey and this has been carried out in the update assessment.

Survey	Ages	Years				
NIGFS-MAR	1–6	1993	2011			
ScoGFS-Q1	1–5	1996	2006			
ScoGFS-Q4	1–4	1997	2007			
NIGFS-OCT	1–3	1992	2011			
E/W FSPw	1–6	2005	2011			
E/W FSPe	1–5	2005	2011			
E/W BTS Sept age 0 brought forward to age 1	1 (0)	1994 (1993)	2011 (2010)			
NIMIK age 0 brought forward to age 1	1 (0)	1995 (1994)	2011 (2010)			
AEPM SSB	Biomass	1995	2000	2006	2008	2010

Internal consistency of survey data

The survey data during spring each year are of critical importance for the fit of the assessment models as noted by WGCSE previously and evaluated by WKROUND2. The data for all surveys were screened by WKROUND2 and due to the number of plots produced the exercise is not repeated in this report this year.

Following WKROUND2 three new updates of survey data were available in 2012, the spring Northern Ireland groundfish survey, and the two March FSP surveys from UKE&W. The survey data were compared internally and between surveys for consistency with no outliers and therefore the most recent data were used in the fit of the assessment model.

Commercial cpue

Commercial cpue data are available for this stock but are not currently used in the assessment.

Other relevant data

Indices of abundance from the UK Fisheries Science Partnership (www. cefas.co.uk/fsp) are now used in the update assessment following their inclusion in the model fit by WKROUND2 the most recent results are described with Armstrong *et al*. (WD 7 to WKROUND2). The SSB trends from the UK Fisheries Science Partnership trawl surveys support the trends given by the previous assessment by WGCSE from 2004 onwards (Figure 6.2.6) with the western survey giving a more optimistic increase than the eastern.

The series of cod SSB estimates from applications of the annual egg production method, using gene probes to identify early-stage cod eggs, were presented for 2010 in Armstrong *e al.* (WKROUND2 WD 8). The final estimates for 2010 were 1097 t (RSE 17%) in the western Irish Sea, 522 t (RSE 13%) in the eastern Irish Sea and 1619 t (RSE 16%) for the whole Irish Sea. The time-series was reviewed at WKROUND2 and included in the assessment as a relative index of SSB abundance.

6.2.3 Historical stock development

Deviations from Stock Annex

The assessment does not deviate from the procedure developed at WKROUND2 and described the report of that meeting which will be developed into the stock Annex.

Software used and model options chosen

The SAM method, software version FLSAM was used to allow estimation of removals bias from 2000 onwards and to allow inclusion of the SSB egg survey.

Model settings for the update assessment are given in Table 6.2.7. SAM can use survey data for the year after the last year of catch data, and in this assessment the survey indices for NIGFS-Mar, E/W FSPw and E/W FSPe in 2012 are used.

Input data types and characteristics

New data added to the update SAM assessment are the fishery landings data for 2011, the NIGFS-Mar survey data and E/W FSPw and E/W FSPe for 2012 and the NIGFS-Oct, UK (BTS-3Q) and NIMIK 0-gp indices for 2011 (both series brought forward to provide indices of age 1).

The update SAM assessment follows the same procedure as in the WKROUND2 assessment by including the sample-based estimates of landings at three major ports from 1991–2002 and 2005 while estimating removals in excess of the assumed natural mortality rate in 2003, 2004 and 2006–2011. The sample based estimates of landings for 2000–2002 and 2005 had previously been used to provide a comparison with the model estimates of removals.

Data screening

Screening of input catch and survey data is described in Section 6.2.2.

Final update assessment: diagnostics

The diagnostics of the update SAM run are given in Figure 6.2.7–6.2.20.

Figure 6.2.7 presents the estimated catchability parameters at age for each time-series. The noise in the estimates increases with age such that the oldest ages of the NI March groundfish survey, the E/W FSP west and east catchability can be estimated as a single parameter for each survey as there is no significant difference between each age. Both the NI GFS March survey and the E/W FSP east are dome shaped, catching fewer older fish whereas the historic Scottish surveys and the E/W western FSP survey have increasing catchability with age.

Figure 6.2.8 presents the estimated catch and catchability variances at age. As is usual with the SAM model, the fit to the catch-at-age data is closest as selectivity is allowed to vary in time; there is increasing variance at the youngest and oldest ages.

Figure 6.2.9 presents the SAM estimated fishing mortality-at-age, with age 5=age 6. "Fishing mortality" is estimated to have increased until ~2000 and decreased subsequently, but is still at high levels. As noted previously the model allocates mortality that is not the input base level of natural mortality to fishing mortality therefore the unallocated mortality could be discarding (although unlikely given the observed estimates) or additional natural mortality. Tagging studies reported in WKROUND2 would indicate that emigration is an unlikely source of the rapid decline in the cohorts.

Figure 6.2.10 presents the selectivity-at-age of the fishery in five year blocks.

Figure 6.2.11a–f presents the residuals of the fit of the time-series model to the catch data for each age. The fitted values track the trends in the observations well in the early years in which there is no calibration information, with no strong pattern in the residuals. After the introduction of the tuning data the residuals are increasingly noisy especially during the period when the scale parameters are estimated.

The diagnostics for the Northern Ireland groundfish March survey are presented in Figure 6.2.12. The fit to the survey still has some pattern in the early years but is much improved over a fit without estimation of catch bias in recent years. Similarly a transition from negative to positive residuals which is apparent when no bias is fitted in the model is also reduced by the estimation of bias in the Scottish quarter 1 groundfish survey, which also spans this period (Figure 6.2.13). Fits of the model to the Scottish groundfish q3, the Northern Ireland groundfish October survey, UK FSP west and east, UK BTS, Miknet and the SSB egg survey data are presented in Figures 6.2.14–6.2.20. As with the fit of the model to the survey data at WKROUND2, there are no apparent anomalies in the fits to the survey data that would indicate a systematic problem with the model estimates.

Final update assessment: long-term trends

Figure 6.2.21 presents the SAM estimated spawning–stock biomass, average F (ages 2–6) and recruitment. The population numbers and F-at-age from the update SAM assessment are given in Tables 6.2.8 and 6.2.9, and the summary data are given in Table 6.2.10.

SSB is estimated to be very low but has shown a small increase after two improved but still low recruitments and a slight reduction in mortality rates. SSB is well below historic and reference levels following the recent protracted period of low recruitments and fishing/total mortality is estimated to be very high.

The SAM estimates of total removals for 2003, 2004 and 2006 are consistent with the WG port estimates up to 2002 and that for 2005 (Figure 6.2.22); the additional "catch" may represent unaccounted discards, landings and additional natural mortality. Since 2006 the estimated catch is well above that reported.

In order to investigate the sensitivity of this assessment to the SAM estimates of total removals, another assessment was conducted using the same software and settings, but without estimating the bias. Figure 6.2.23 presents the results. Although the values of SSB and recruitment are lower without the estimated additional removals, both assessment runs indicate that recent SSB and recruitment both have been at historic lows in recent years. Trends in fishing mortality differ with the model which does not estimate unallocated mortality having a steeper decline from a higher peak. However both models indicate that recent mortality is high compared to historic estimates, consistent with the lack of older ages classes in the catch and survey-series.

Comparison with previous assessments

The current assessment is a direct update of the model fitted at the benchmark meeting WKROUND2. The current assessment is consistent with that assessment.

The state of the stock

The spawning–stock biomass has declined ten-fold since the late 1980s and is suffering reduced reproductive capacity (SSB < B_{lim} of 6000 t).

The fishing mortality estimates since 1988 have remained above the F_{lim} value of F=1.0 and the stock has therefore been harvested unsustainably over this period.

Fishing mortality throughout the assessment period has been well above the candidate reference points associated with high long-term yields and a low risk of depleting the productive potential of the stock. There are indications that the total mortality rate on the stock is declining; however it is still well above the rate at which the stock will recover to historic levels of biomass at the current low recruitment abundance.

Recruitment has been below average for the past eighteen years. The 2002 to 2008 year classes were amongst the smallest on record but there has been a slight improvement subsequently. The 2009 year class increased recruitment compared the recent period of low recruitment, but is still well below the long-term average. The 2010 year class is, unfortunately, estimated to be at the low levels recorded from 2002–2008.

6.2.4 Short-term predictions

Due to the inability to identify the source of the bias in removals estimates from the assessment, and the relationship between future TAC and total removals, detailed short-term catch forecasts are not provided for this stock.

6.2.5 Medium-term projections and MSY evaluation

F_{MSY} Evaluations

A full F_{MSY} evaluation was carried out at WGCSE in 2010 and the suggested level of F_{MSY} for this stock was Fs within the range of 0.25 to 0.54. No further work was carried out this year.

6.2.6 Biological reference points

The current precautionary reference points for Irish Sea cod are given below they are unchanged since 1998:

B_{lim}	6000 t
B_{pa}	10 000 t
F_{lim}	1.00
F_{pa}	0.72

6.2.7 Management plans

The Irish Sea cod management plan, as described in Council Regulation (EC) 1342/2008 was evaluated independently by ICES in 2009 using the approach adopted in AGCREMP 2008 and found to be not consistent with the ICES Precautionary Approach (WGCSE 2009).

The long-term target for the management plan is a fishing mortality of 0.4, based on the EU-Norway negotiated target for North Sea cod. This target is within F_{msy} range for Irish Sea cod, and well below the current estimates of total removals mortality in excess of M=0.2.

6.2.8 Uncertainties and bias in assessment and forecast

Landings data

The quality of the commercial landings and catch-at-age data for this stock deteriorated in the 1990s following reductions in the TAC without associated control of fishing effort. The Working Group has, since the 1990s, attempted to overcome this problem by incorporating sample-based estimates of landings from three major ports in the WG landings figures. The data for this method have become more limited since 2003, and the WG uses modelling approaches to estimate subsequent removals for 2003, 2004 and 2006 onwards. The unaccounted removals figures given by models could potentially include components due to increased natural mortality and discarding as well as misreported landings or catches from the stock taken outside VIIa.

Discarding

Discarding has historically been mainly at age 1, and the omission of estimates of discards at that age will result in under-estimation of historical F and recruitment at age 1. However, this will not bias the management metrics as this age is not included in the fishing mortality average and is immature and therefore does not alter the perception of spawning biomass trends.

Strict controls on catch reporting following the introduction of the Registration of Fish Buyers and Sellers regulations has resulted in documented increases in discarding of cod above the MLS off the west of Scotland and in the Celtic Sea (see Sections 3.2 and 7.2). Observer data provided no evidence for this in the Irish Sea in 2008–2009, but the 2010 Irish and Northern Irish data do show shifts towards the discarding of older fish and there is anecdotal evidence that this is occurring in 2012.

Compliance with catch composition rules for some fleets could also result in increased discarding of cod. Implementation of unbiased sampling schemes to estimate discarding with adequate precision is likely to be of increasing importance for this stock to prevent further deterioration in fishery catch data.

Surveys

The Irish Sea has relatively good survey coverage. The surveys in general give consistent signals of fish abundance-at-age. All surveys catching adult cod indicate a severe depletion of the SSB during a run of very poor recruitment from 2002, with one reasonable recruitment estimated in 2010.

The UK Fisheries Science Partnership surveys of the Irish Sea cod spawning grounds in spring 2005–2012 (now included in the assessment), carried out using commercial trawlers, indicated a widespread distribution of cod mostly at low density but with some localized aggregations. The time-series of SSB indices shows an upward trend similar to that shown by NIGFS-WIBTS-Q1 pointing to some recovery following the maturation of the 2009 year class. As with all survey and catch data information there is a highly truncated age composition of cod in the FSP surveys supporting the ICES assessment in indicating continuing high mortality rates.

Estimates of cod SSB from applications of the annual egg production method are below B_{lim} and show a similar trend in SSB to the assessment.

Model formulation

The SAM estimates of removals bias vary around relatively high values of 2.0–3.0 despite more accurate catch reporting. WKROUND2 examined the potential for unaccounted losses from other sources including fishery catches taken outside VIIa during seasonal migrations, a gradual shift in distribution to areas beyond VIIa, but could find no supporting evidence for this.

The estimates of bias could also be influenced by any remaining non-randomness of survey catchability, but this would have had to have occurred across several independent surveys consistently in time.

There is currently limited evidence from surveys and fishery age compositions of a reduction in mortality rates resulting from the current management measures. However the models estimates continue to indicate relatively large unaccounted-for removal of fish from the stock, but unfortunately there is currently very little direct evidence to evaluate the potential source(s) of this and how much is due to fishing in VIIa or elsewhere.

Stock structure and migrations

The VIIa commercial fishery for cod extends into the North Channel, particularly for vessels using mid-water trawls. It is not clear if the cod in this region belong to the Irish Sea stock, the nearby Clyde stock which exhibits dense aggregations of adult fish during spring in the area covered by the Clyde closure, or to other VIa cod populations. Incorrect allocation of catches to stocks could lead to biases in the assessments.

Bendall *et al*. (WD9 WKROUND2 2012) presented the results of a series of tagging studies of the cod stocks in ICES Divisions VIa, VIIa and VIIe–k. The study analysed conventional returns and data storage tag point location estimates to determine the movement within and between cod stocks during the year and consequently the potential exchange of fish between them.

Although there is evidence for limited seasonal migrations into neighbouring regions, most fish will stay within their management area. There is no significant long-term emigration from VIIa into the adjacent northern (VIa) and southern (VIIe–k) management units that would indicate that the areas should be considered together.

The seasonal migrations can be used to explain the underlying stock dynamics that have led to the selection of only the youngest survey ages from the autumn groundfish surveys in the VIIa cod assessment model calibration by the ICES WGCSE working group. Bendall *et al*. (WD9 WKROUND2 2012) showed that during the first two quarters of the year the adult cod are distributed throughout the western Irish Sea (in quarter 2 two cod moved south into the VIIg but returned later). Later in the year in quarters 3 and 4 the cod have a very restricted distribution, confined to deeper waters in the northern and southern channels. If the survey station distributions do not cover the deeper water this could explain the lack of consistency in the catch rates of the surveys in autumn.

Tagging of cod off Greencastle on the north coast of Ireland (O Cuaig and Officer, 2007), and more limited tagging on UK Fisheries Science Partnership surveys (Armstrong *et al*., WD2 to WGNSDS 2007), have demonstrated movements of cod between Division VIa and VIIa. Most recaptures in VIIa from cod tagged in VIa have come from the North Channel and in or near the deep basin in the western Irish Sea that is a southward extension of the North Channel. The research surveys used for tuning the VIIa cod assessment cover only the western and eastern Irish Sea, and do not extend into the deeper water of the North Channel, where large catches of cod were made by mid-water trawlers in the 1980s and 1990s.

Historical tagging studies have also shown more limited movements of cod between spawning components in the western and eastern Irish Sea, for which the migrations tend to be in a north-south direction. STECF Subgroup SGRST (2005, Appendix 4) concluded that management of the Irish Sea stock on the basis of substock assessment regions would be difficult in practice, particularly the separation of catches when the stock units are mixed. Further tagging and genetics studies are required to investigate stock structure, seasonal movements and mixing in VIIa and neighbouring areas.

The WKROUND2 concluded from these studies that:

1) The present evidence does not call for radical changes in the current assessment units. Most fish can be expected to remain within their respective area.
2) Seasonal migrations, sometimes leading outside the area, may affect catchability in surveys. In particular, surveys in quarters 3 and 4 in Division VIIa may not pick up all ages properly as established by WGCSE.
3) Within VIIa, the population of cod is likely to consist of several partly isolated substocks. The opportunity for exchange may be variable, but in general, one cannot expect a depleted substock to be repopulated from neighbouring areas.
4) For management, this implies that in addition to maintaining the current stocks at a productive level, care needs to be taken to avoid depletion of local stock components.

6.2.9 Recommendations for next benchmark assessment

WKROUND2 concluded that:

- The status of the assessment of Irish Sea cod is considered to be “work in progress”.
  - The current assessment structure which includes the estimation of unallocated mortality in the most recent period is considered suited to the provision of advice on the status of the biomass and the total mortality rate for the Irish sea cod.
  - The fishing mortality rate in recent years is uncertain, but total mortality remains very high; a conclusion that is independent of the model assumptions.
  - Spawning–stock biomass has declined tenfold since the late 1980s and has been considered to be well below B_{lim} at reduced reproductive ca-

pacity since the mid-1990s. With the exception of the 2009 year class, recruitment has been low for the last nine years.

- The model estimates of total removals continue to vary around two to three times the reported landings, despite more accurate catch reporting and lack of evidence for significant high grading of cod until 2010.

- Discard estimates are not currently integrated into the assessment but sampling by observers indicates that until 2010 discarding only occurred at ages 0 and 1 consequently this could not result in the high mortality rates estimated across older ages.
    - It is recommended that the work to collate and provide discard estimates for each year should be continued and the data be used to partition the estimated mortality rates into landings discards and unallocated within a forecast in order to provide management advice on the order of their magnitude and the impact on the stock.
- Tagging studies have indicated that migration from the stock is not occurring at a rate that would lead to it being misinterpreted as unallocated mortality. The tagging studies have revealed that the aggregating behaviour of cod it is resulting in high cod density even at low abundance which can result in high catches in localised areas and low levels of fishing effort causing high mortality on the stock.
    - Short-term migrations of cod out of and back into the Irish Sea in the north Channel is indicated by the studies and consequently the impact of catches taken in these areas, assuming all are from the Irish sea stock, should be investigated in a sensitivity analysis.
- There are model assumption and data issues that require investigation and which should be included within the final assessment when the unallocated mortality issue has been resolved and reference point values re-estimated.
    - Natural mortality-at-age; In the future assessments the Lorenzen natural mortality should be used, constant in time.
    - The proportion mature at age 2 should be re-estimated from survey data and used within the assessment and estimation of reference levels.

6.2.10 Management considerations

A number of emergency and cod recovery plan measures have been introduced since 2000 to conserve Irish Sea cod. These include a spawning closure since 2000 and effort control since 2003. There have also been several vessel decommissioning schemes. As it has not been possible to provide analytical catch forecasts in recent years, the TAC has been reduced by 15–20% annually since 2006 and by 25% since 2009. These measures may have prevented a further increase in fishing mortality of cod and may have resulted in some reduction in fishing mortality. However, the current assessment does not provide sufficiently robust estimates of fishing mortality to allow the possible changes to be determined.

Although recent recruitment patterns appear well estimated in the assessment, the problem of inaccurate landings and discards estimates makes it difficult to estimate the absolute value and recent trends in fishing mortality. However, all sources of information on age composition in the stock, from the fishery as well as surveys using research vessels and chartered commercial vessels, indicates a continued paucity of cod older than four years of age in the Irish Sea indicating a continued very high mortality rate. Possible causes of this include:

- TACs have not restricted catches as intended. Substantial underreporting of landings is known to have occurred since the 1990s, although there is some indication that this is reduced since 2006. However the assessment continues to indicate a large unaccounted removal of fish. The relative contribution of fishing to this has not been identified;
- The effort reductions have not been sufficient, although considerable effort reductions have been observed in some fleets (particularly vessels using >100 mm mesh);
- Cod continues to be taken in mixed demersal fisheries (particularly for haddock, sole and *Nephrops*);
- Time and area closures have not been sufficient to lead to rebuilding of this stock;
- Other non-fishery causes, such as increased natural mortality, have increased over time.

It is difficult to reconcile the large apparent mortality rate and unaccounted removals in recent years with the reduction in fishing effort by whitefish trawlers (shown by STECF Subgroup STECF (2011) the very low abundance of cod, and the evidence for more accurate catch reporting since the introduction of the Registration of Buyers and Sellers.

The scientific evaluation of the revised cod Management Plan (Council Regulation (EC) 1342/2008) indicates that it may not be sufficiently precautionary to allow rebuilding of the Irish Sea cod stock to a level where it can regain historical productivity by 2015 (see WGCSE 2009 Report, Section 9.2). The probability of recovery of the cod stock will be increased by measures to eliminate discards of cod which historically have mainly comprised undersized fish.

A closure of the western Irish Sea spawning grounds for cod from mid February to end of April has been in place since 2000, with an extension to the eastern Irish Sea in 2000. The closure was reviewed in 2007 by STECF SGMOS-07-03. On the basis of the information available, SGMOS-07-03 was unable to determine the extent to which the closure has reduced fishing mortality to a lower value than would otherwise have occurred, through protection of adult cod during spawning or influencing changes in fishing effort in the different fleets. SGMOS advised that a comprehensive evaluation of how fleet activities have been affected by the closure and other regulations and factors is required to evaluate the cod closure.

Estimates of spawning–stock biomass of cod in 2010 based on the annual egg production and estimates of fecundity and sex ratio give SSB below B_{lim} and indicate declines in SSB in recent years.

6.2.11 References

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6.2.1. Nominal landings (t) of COD in Division VIIa as officially reported to ICES, and figures used by ICES.

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011[1]
Belgium	142	183	316	150	60	283	318	183	104	115	60	67	26	19	21	36
France	148	268	269	n/a	53	74	116	151	29	35	18[2]	17[2]	3	12	1	3
Ireland	2,476	1,492	1,739	966	455	751	1,111	594	380	220	275	608	618[2]	323[2]	289	275
Netherlands	25	29	20	5	1	-	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-
UK (England, Wales & NI)	2,359	2,370	2,517	1,665	799	885	1,134	505	646	594	5892	423	5432	3872	282	169
UK (Isle of Man)	27	19	34	9	11	1	7	7	5	n/a	n/a	n/a	22	12	1	1
UK (Scotland)	126	80	67	80	38	32	29	23	15	3	6	2	12	12	-	-
Total	5,303	4,441	4,962	2,875	1,417	2,026	2,715	1,477	1,179	967	948	1,117	1224	754	594	485
Unallocated	-339	1,418	356	1,909	-143	226	-20	-192	-107	-57	-108	-415	-563	-286	-130	-117
Total as used by WG	4964[3]	5859[3]	5318[3]	4784[3]	1274[4]	2252[4]	2695[4]	1285[4]	1072[4]	910[4]	840[4]	702[4]	661[4]	468[4]	464[4]	368

[1]Preliminary. [2]Revised. n/a = not available [3] includes sample-based estimates of landings into three ports [4] based on official data only.

Table 6.2.2. Cod in VIIa. Working Group figures for annual landings by country since 2000.

(a) WG landings (tonnes)

Year	NI	E&W	Scotland	Ireland	France	Belgium	Isle of Man	Netherlands	Total	TAC	%uptake
2000	638	156	39	321	52	56	11	0	1273	2100	61
2001	697	209	32	645	361	300	8	0	2251	2100	107
2002	983	171	39	953	251	294	1	2	2695	3200	84
2003	381	118	32	415	145	187	7	0	1285	1950	66
2004	539	103	15	271	37	103	5	0	1072	2150	50
2005	523	72	4	168	31	108	3	0	910	2150	42
2006	552	32	6	172	17	59	3	0	840	1828	46
2007	396	27	2	191	18	66	2	0	702	1462	48
2008	523	22	1	85	3	27	1	0	662	1199	55
2009	375	15	0	55	3	19	1	0	468	899	52
2010	274	17	0	151	1	21	1	0	465	674	69
2011	152	17	0	160	3	36	1	0	368	506	73

2009	UK	Ireland	France	Belgium	Netherlands	Total
Landings	391	55	3	19	0	468
TAC	259	592	33	12	3	899
%uptake	151%	9%	9%	160%	0%	

2010	UK	Ireland	France	Belgium	Netherlands	Total
Landings	292	151	1	21	0	465
TAC	194	444	25	9	2	674
%uptake	150%	34%	4%	233%	0%	

2011	UK	Ireland	France	Belgium	Netherlands	Total
Landings	170	160	3	36	0	369
TAC	146	333	19	7	2	506
%uptake	117%	48%	16%	533%	0%	

(b) Percentage of annual total

Year	NI	E&W	Scotland	Ireland	France	Belgium	Isle of Man	Netherlands	Total
2000	50.1	12.3	3.0	25.2	4.1	4.4	0.9	0.0	100
2001	31.0	9.3	1.4	28.6	16.1	13.3	0.4	0.0	100
2002	36.5	6.4	1.5	35.4	9.3	10.9	0.0	0.1	100
2003	29.7	9.2	2.5	32.3	11.3	14.6	0.6	0.0	100
2004	50.3	9.6	1.4	25.2	3.5	9.6	0.4	0.0	100
2005	57.5	7.9	0.5	18.5	3.5	11.8	0.3	0.0	100
2006	65.7	3.8	0.7	20.4	2.0	7.1	0.3	0.0	100
2007	56.5	3.8	0.3	27.2	2.5	9.5	0.3	0.0	100
2008	78.9	3.4	0.2	12.8	0.5	4.0	0.2	0.0	100
2009	80.1	3.1	0.0	11.7	0.6	4.1	0.3	0.0	100
2010	41.3	4.6	0.0	43.5	0.8	9.8	0.3	0.0	100

Table 6.2.3. Cod in VIIa. Landings numbers-at-age used in the update SAM assessment.

Catch numbers at age Numbers*10**-3

Age\Year	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	364	882	1317	2739	789	2263	530	1699	1135	816	687	1762	2533	1299	345
2	1563	1481	1385	2022	3267	1091	3559	642	3007	511	1092	1288	2797	3635	2284
3	1003	1050	352	904	824	1783	557	1407	363	1233	310	608	729	1448	1455
4	456	269	204	144	250	430	494	294	500	163	311	127	243	244	557
5	177	186	163	67	58	173	131	249	61	218	39	164	49	99	102
+gp	30	113	71	51	59	81	74	117	104	71	65	71	55	47	79
TOTALNUM	3593	3981	3492	5927	5247	5821	5345	4408	5170	3012	2504	4020	6406	6772	4822
TONSLAND	8541	7991	6426	9246	9234	11819	10251	9863	10247	8054	6271	8371	10776	14907	13381
SOPCOF %	87	81	94	97	86	91	86	93	97	99	113	113	102	108	99

Age\Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	814	1577	1218	974	4323	2792	582	710	1973	1375	223	749	498	318	523
2	932	1195	2105	2248	1793	4734	2163	1075	1408	1243	2907	569	1283	1113	1149
3	751	439	703	699	841	702	1886	545	442	664	403	848	180	700	501
4	499	240	158	203	252	263	231	372	127	132	119	68	163	38	213
5	154	161	84	64	75	71	86	70	98	42	16	20	7	39	17
+gp	46	75	77	65	43	38	37	30	22	49	13	10	6	6	16
TOTALNUM	3196	3687	4345	4253	7327	8600	4985	2802	4070	3505	3681	2264	2137	2214	2418
TONSLAND	10015	8383	10483	9852	12894	14168	12751	7379	7095	7735	7555	5402	4587	4964	5859
SOPCOF %	98	101	101	100	100	100	100	100	100	100	100	100	100	100	100

Age\Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	204	70	289	338	196	45	68	42	14	49	14	20	40	11
2	1926	843	176	841	564	439	101	224	142	205	166	53	128	105
3	335	871	107	53	405	93	158	62	112	56	87	66	15	36
4	80	66	50	13	7	35	21	33	16	11	9	17	7	2
5	28	21	4	9	2	1	6	5	8	1	3	3	2	1
+gp	8	7	1	2	3	0	3	1	3	0	0	0	1	1
TOTALNUM	2581	1877	627	1256	1177	613	357	367	296	322	279	159	192	155
TONSLAND	5318	4784	1274	2252	2695	1285	1072	910	840	702	662	466	464	365
SOPCOF %	100	100	100	100	100	100	100	100	100	101	100	100	100	100

Table 6.2.4. Cod in VIIa. Mean weights-at-age in the landings (used for stock and catch).

Catch and stock weights at age (kg)

AGE\YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	1.01
2	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.52
3	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.49
4	5.09	5.09	5.09	5.09	5.09	5.09	5.09	5.09	5.09	5.09	5.09	5.09	5.09	5.09	5.57
5	6.19	6.19	6.19	6.19	6.19	6.19	6.19	6.19	6.19	6.19	6.19	6.19	6.19	6.19	7.59
+gp	6.86	7.26	7.17	7.12	7.28	7.16	7.34	7.05	7.13	7.63	7.19	7.48	6.87	7.55	9.11
SOPCOFAC	0.8734	0.8126	0.9407	0.9683	0.8622	0.9114	0.8575	0.9261	0.9706	0.9855	1.1287	1.1266	1.023	1.0757	0.9916

AGE\YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	1	0.68	0.78	0.81	0.71	0.61	0.94	0.84	0.86	0.81	0.85	0.8	0.9	0.98	0.85
2	1.84	1.81	2.02	1.83	2.16	1.56	1.85	1.94	1.64	1.96	1.71	1.92	1.84	1.63	1.94
3	3.99	3.81	4.24	3.86	3.91	3.76	3.22	3.57	3.54	3.99	3.67	3.61	4	3.26	3.62
4	5.96	5.87	5.83	5.86	6.41	5.67	5.41	5.28	5.42	5.98	5.68	6.08	5.79	5.3	5.29
5	7.97	7.48	7.5	7.39	7.82	8.02	6.57	7.53	6.39	6.92	7.37	7.68	8.45	7.72	6.12
+gp	9.97	10.05	9.04	8.78	10.32	9.88	9.47	9.4	9.11	8.67	10.17	8.57	9.14	9.79	9.4
SOPCOFAC	0.9833	1.0131	1.0051	1.0018	1.0014	1.0003	0.9972	0.9971	1.0013	1.004	0.9986	0.9993	1.0001	0.9987	0.9996

AGE\YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	0.93	0.85	0.85	0.99	0.94	1.21	1.11	0.91	0.83	0.83	0.89	1.1	1.26	0.949
2	1.65	1.62	1.99	1.82	1.84	1.66	2.2	1.94	1.84	1.85	1.59	2.01	2.29	1.88
3	3.73	3.18	3.57	4.15	3.44	3.29	3.63	3.51	3.67	3.78	3.54	3.46	3.93	3.745
4	5.37	5.51	5.14	5.61	5.73	5.43	6.51	5.32	4.71	5.35	6	5.31	6.34	5.536
5	7.03	7.52	7.15	7.33	7.71	10.2	7.64	7.74	6.39	7.99	7.57	7.1	7.33	6.754
+gp	9.35	10.25	8.39	9.51	10.01	11.09	8.61	8.89	7.84	10.04	9.46	6.82	9.64	9.036
SOPCOFAC	1.0004	1.0003	1.0004	1.0027	0.9979	0.9955	0.9969	0.9971	1.002	1.0051	1.0001	0.9951	0.9988	0.9989

Table 6.2.5. Cod in VIIa. Estimates of numbers discarded and the discarded proportion during 2007–2011. Data are total numbers ('000 fish) discarded at age, estimated from numbers per sampled trip raised to total fishing effort by each country supplying data (UK, Ireland and Belgium). Discards are not currently used in the assessment due to the short time-series available.

Discards	0	1	2	3	4	5
2007	16	167	4.6	0	0	0
2008	5.5	63.4	3.4	0	0	0
2009	329.3	39.8	4.4	0.1	0	0
2010	48.7	180	60.3	1.4	0.5	0.1
2011	9.7	42.7	0.9	0	0	0

Landings	0	1	2	3	4	5
2007	0	49	205	56	11	0.5
2008	0	13.7	165.7	87.1	9.4	2.7
2009	0	19.7	53.2	65.5	16.9	2.9
2010	0	40.2	127.6	15	7.4	1.5
2011	0	109	105.1	35.8	1.7	1.0

Proportion	0	1	2	3	4	5
2007	1	0.773	0.022	0.000	0.000	0.000
2008	1	0.822	0.020	0.000	0.000	0.000
2009	1	0.669	0.076	0.002	0.000	0.000
2010	1	0.817	0.321	0.085	0.063	0.063
2011	1	0.282	0.008	0.000	0.000	0.000

Table 6.2.6. Cod in Division VIIa: Survey catch numbers-at-age and annual effort multiplier. Numbers in bold are used in the assessment model fit.

Northern Ireland groundfish survey March							
Year	Effort/Age	1	2	3	4	5	6
1993	1	**138.121**	**648.763**	**44.599**	**10.421**	**1.417**	2.769
1994	1	**1380.438**	**109.71**	**120.271**	**8.45**	**1.367**	0
1995	1	**700.728**	**386.153**	**20.039**	**10.779**	**0**	0.994
1996	1	**1106.129**	**329.282**	**111.668**	**1.394**	**8.808**	0
1997	1	**537.298**	**415.843**	**66.723**	**21.392**	**1.394**	0
1998	1	**169.385**	**769.234**	**56.874**	**11.984**	**0**	0
1999	1	**49.499**	**253.08**	**241.874**	**15.286**	**2.787**	0
2000	1	**629.595**	**101.053**	**34.576**	**33.014**	**0**	2.258
2001	1	**406.682**	**561.441**	**18.438**	**5.775**	**4.042**	0
2002	1	**662.163**	**253.311**	**333.543**	**0**	**0**	1.129
2003	1	**73.865**	**1079.204**	**104.05**	**32.702**	**3.652**	3.049
2004	1	**216.956**	**171.956**	**88.622**	**5.375**	**4.381**	0
2005	1	**63.533**	**225.07**	**29.407**	**27.963**	**18.27**	0
2006	1	**169.989**	**130.752**	**58.304**	**2.523**	**0**	0
2007	1	**164.351**	**124.393**	**30.601**	**5.148**	**0**	0
2008	1	**40.658**	**217.151**	**13.018**	**5.172**	**4.178**	0.994
2009	1	**144**	**59**	**33**	**9**	**0**	0
2010	1	**1022.117**	**208.961**	**14.656**	**2.258**	**0**	0
2011	1	**353.981**	**414.689**	**46.006**	**2.258**	**2.01**	0

Scottish groundfish survey quarter 1						
Year	Effort/Age	1	2	3	4	5
1996	1	**3**	**31**	**44**	**7**	**9**
1997	1	**22**	**29**	**15**	**13**	**2**
1998	1	**5**	**81**	**27**	**5**	**1**
1999	1	**7**	**33**	**93**	**15**	**5**
2000	1	**51**	**6**	**11**	**16**	**0**
2001	1	**28**	**56**	**1**	**1**	**4**
2002	1	**13**	**18**	**37**	**1**	**1**
2003	1	**8**	**69**	**18**	**9**	**0**
2004	1	**8**	**11**	**49**	**0**	**3**
2005	1	**1**	**25**	**8**	**9**	**1**
2006	1	**2**	**5**	**11**	**0**	**2**

Table 6.2.6. (cont.) Cod in Division VIIa: Survey catch numbers-at-age and annual effort multiplier. Numbers in bold are used in the assessment model fit.

Scottish groundfish survey quarter 4						
Year	Effort/Age	0	**1**	**2**	3	4
1997	1	3	**28**	**19**	1	2
1998	1	0	**8**	**42**	5	0
1999	1	164	**2**	**24**	6	2
2000	1	24	**136**	**4**	0	0
2001	1	0	**0**	**7**	0	0
2002	1	0	**18**	**15**	9	0
2003	1	2	**0**	**27**	0	0
2004	1	2	**12**	**5**	5	0
2005	1	3	**8**	**25**	2	0

Northern Ireland groundfish survey October						
Year	Effort/Age	0	1	2	3	4
1992	1	57.9	**1109.37**	**50.06**	**47.6**	8.64
1993	1	780.82	**553.23**	**146.44**	**0.76**	0
1994	1	1996.19	**1672.49**	**25.44**	**10.44**	0
1995	1	788.56	**1206.8**	**33.32**	**0**	0
1996	1	1481.33	**486.65**	**50.15**	**6.54**	0
1997	1	420.45	**1322.2**	**97.19**	**0**	0
1998	1	36.98	**376.51**	**163.9**	**5.72**	0
1999	1	2022.49	**58.47**	**32.48**	**9.49**	0
2000	1	724.17	**301.64**	**2.03**	**0**	0
2001	1	841.1	**506.79**	**109.91**	**0**	0
2002	1	89.68	**487.89**	**37.68**	**12.53**	0
2003	1	275.94	**161.45**	**29.4**	**0**	0
2004	1	443.71	**578.97**	**23.71**	**0**	0
2005	1	824.45	**706.13**	**107.72**	**17.28**	2.89
2006	1	117.02	**130.2**	**1.47**	**6.58**	0
2007	1	6.78	**86.99**	**0**	**2.98**	0
2008	1	19	**17**	**17**	**0**	0
2009	1	535.61	**213.62**	**6.1**	**0**	0
2010	1	277.95	**171.8**	**2.98**	**0**	0

Table 6.2.6. (cont.) Cod in Division VIIa: Survey catch numbers-at-age and annual effort multiplier. Numbers in bold are used in the assessment model fit.

UK(E&W) Fisheries science partnership survey (west).

Year	Effort/Age	1	2	3	4	5	6
2005	1	**0**	**0.427**	**1.409**	**0.99**	**0.084**	0.025
2006	1	**0.003**	**0.536**	**2.815**	**0.427**	**0.104**	0.01
2007	1	**0.008**	**0.611**	**1.322**	**0.585**	**0.055**	0.058
2008	1	**0.003**	**0.221**	**0.824**	**0.147**	**0.084**	0.02
2009	1	**0.009**	**0.171**	**1.152**	**0.377**	**0.099**	0.018
2010	1	**0**	**0.735**	**0.452**	**0.467**	**0.13**	0.023
2011	1	**0**	**0.407**	**1.681**	**0.144**	**0.095**	0.039

UK(E&W) Fisheries science partnership survey (east).

Year	Effort/Age	1	2	3	4	5	6	7
2005	1	**0.06**	**4.02**	**0.25**	**0.38**	**0.004**	0.01	0
2006	1	**0.83**	**0.77**	**0.67**	**0.007**	**0.042**	0	0.001
2007	1	**0.59**	**1.43**	**0.09**	**0.08**	**0**	0	0
2008	1	**0.01**	**1.8**	**0.32**	**0.02**	**0.03**	0.003	0.01
2009	1	**0.5**	**0.36**	**0.21**	**0.09**	**0.01**	0.004	0
2010	1	**0.97**	**0.65**	**0.03**	**0.04**	**0.01**	0	0
2011	1	**0.46**	**1.57**	**0.06**	**0**	**0**	0	0

Table 6.2.6. (cont.) Cod in Division VIIa: Survey catch numbers-at-age and annual effort multiplier. Numbers in bold are used in the assessment model fit.

UK(E&W) September beam-trawl survey **Northern Ireland Methot Isaacs–Kidd Survey**

Year	Effort/Age	0	Year	Effort/Age	0
1993	1	**22**			
1994	1	**30**	1994	1	**57.4**
1995	1	**40**	1995	1	**6.9**
1996	1	**29**	1996	1	**66.3**
1997	1	**32**	1997	1	**5.7**
1998	1	**2**	1998	1	**0.1**
1999	1	**49**	1999	1	**26.2**
2000	1	**37**	2000	1	**6.1**
2001	1	**24**	2001	1	**9.6**
2002	1	**7**	2002	1	**3.4**
2003	1	**9**	2003	1	**3.2**
2004	1	**22**	2004	1	**25.8**
2005	1	**42**	2005	1	**11.4**
2006	1	**6**	2006	1	**9**
2007	1	**4**	2007	1	**0**
2008	1	**7**	2008	1	**0.8**
2009	1	**6**	2009	1	**23.6**
2010	1	**4**	2010	1	**5.7**

Table 6.2.7. SAM model configuration file settings for update run in 2012. Same settings as WKROUND 2012 settings.

```
# Auto generated file
# Datetime : 2012-05-09 16:59:50

# Min, max age represented internally in model
 1 6
# Max age considered a plus group? (0 = No, 1= Yes)
 1

# Coupling of fishing mortality STATES (ctrl@states)
 # 1 2 3 4 5 6 #
   1 2 3 4 5 5 # catch
   0 0 0 0 0 0 # NIGfsMar
   0 0 0 0 0 0 # ScoGfsQ1
   0 0 0 0 0 0 # ScoGfsQ4
   0 0 0 0 0 0 # NIGfsOct
   0 0 0 0 0 0 # UKFspW
   0 0 0 0 0 0 # UKFspE
   0 0 0 0 0 0 # EngBtsSep
   0 0 0 0 0 0 # NIMikNet
   0 0 0 0 0 0 # EggSurvey

# Coupling of catchability PARAMETERS (ctrl@catchabilities)
 # 1  2  3  4  5  6 #
   0  0  0  0  0  0 # catch
   1  2  3  4  4  0 # NIGfsMar
   5  6  7  8  9  0 # ScoGfsQ1
  10 11  0  0  0  0 # ScoGfsQ4
  12 13 13  0  0  0 # NIGfsOct
  14 15 16 17 17  0 # UKFspW
  18 19 20 20 20  0 # UKFspE
  21  0  0  0  0  0 # EngBtsSep
  22  0  0  0  0  0 # NIMikNet
   0  0  0  0  0  0 # EggSurvey
```

Table 6.2.7 (cont.) SAM model configuration file settings for update run in 2012. Same settings as WKROUND 2012 settings.

```
# Coupling of power law model EXPONENTS (ctrl@power.law.exps)
 # 1 2 3 4 5 6 #
   0 0 0 0 0 0 # catch
   0 0 0 0 0 0 # NIGfsMar
   0 0 0 0 0 0 # ScoGfsQ1
   0 0 0 0 0 0 # ScoGfsQ4
   0 0 0 0 0 0 # NIGfsOct
   0 0 0 0 0 0 # UKFspW
   0 0 0 0 0 0 # UKFspE
   0 0 0 0 0 0 # EngBtsSep
   0 0 0 0 0 0 # NIMikNet
   0 0 0 0 0 0 # EggSurvey

# Coupling of fishing mortality RW VARIANCES (ctrl@f.vars)
 # 1 2 3 4 5 6 #
   1 1 1 1 1 1 # catch
   0 0 0 0 0 0 # NIGfsMar
   0 0 0 0 0 0 # ScoGfsQ1
   0 0 0 0 0 0 # ScoGfsQ4
   0 0 0 0 0 0 # NIGfsOct
   0 0 0 0 0 0 # UKFspW
   0 0 0 0 0 0 # UKFspE
   0 0 0 0 0 0 # EngBtsSep
   0 0 0 0 0 0 # NIMikNet
   0 0 0 0 0 0 # EggSurvey

# Coupling of log N RW VARIANCES (ctrl@logN.vars)
   1 1 1 1 1 1
```

Table 6.2.7 (cont.) SAM model configuration file settings for update run in 2012. Same settings as WKROUND 2012 settings.

```
# Coupling of OBSERVATION VARIANCES (ctrl@obs.vars)
 # 1  2  3  4  5 6 #
   1  1  1  1  1 1 # catch
   2  3  3  4  4 0 # NIGfsMar
   5  6  6  7  7 0 # ScoGfsQ1
   8  9  0  0  0 0 # ScoGfsQ4
  10 11 11  0  0 0 # NIGfsOct
  12 13 13 14 14 0 # UKFspW
  15 16 16 17 17 0 # UKFspE
  18  0  0  0  0 0 # EngBtsSep
  19  0  0  0  0 0 # NIMikNet
   0  0  0  0  0 0 # EggSurvey

# Stock recruitment model code (0=RW, 1=Ricker, 2=BH, ... more
in time
 0
# Years in which catch data are to be scaled by an estimated
parameter (mainly cod related)
 8

# Years
 2003 2004 2006 2007 2008 2009 2010 2011

#Ages
  1  1  1  1  1  1
  2  2  2  2  2  2
  3  3  3  3  3  3
  4  4  4  4  4  4
  5  5  5  5  5  5
  6  6  6  6  6  6
  7  7  7  7  7  7
  8  8  8  8  8  8

# Fbar range
 2 4

# Checksums to ensure correct reading of input data
 123456 123456
```

Table 6.2.8. Estimated fishing mortalities.

Year\Age	1	2	3	4	5&6+
1968	0.223	0.701	0.874	0.755	0.816
1969	0.229	0.706	0.872	0.753	0.826
1970	0.236	0.696	0.855	0.758	0.819
1971	0.242	0.692	0.847	0.762	0.804
1972	0.243	0.689	0.838	0.769	0.805
1973	0.248	0.686	0.84	0.788	0.82
1974	0.248	0.689	0.837	0.802	0.821
1975	0.253	0.686	0.841	0.823	0.834
1976	0.255	0.69	0.846	0.83	0.835
1977	0.252	0.688	0.856	0.84	0.846
1978	0.25	0.697	0.86	0.841	0.845
1979	0.252	0.712	0.87	0.851	0.868
1980	0.253	0.732	0.887	0.864	0.874
1981	0.25	0.755	0.904	0.883	0.89
1982	0.245	0.775	0.924	0.907	0.916
1983	0.25	0.789	0.946	0.925	0.928
1984	0.256	0.808	0.97	0.944	0.946
1985	0.258	0.837	1.002	0.967	0.967
1986	0.261	0.863	1.036	0.998	0.996
1987	0.268	0.89	1.079	1.038	1.025
1988	0.267	0.921	1.13	1.078	1.055
1989	0.258	0.952	1.195	1.125	1.09
1990	0.254	0.973	1.255	1.177	1.118
1991	0.253	1.002	1.322	1.238	1.138
1992	0.242	1.041	1.4	1.315	1.175
1993	0.226	1.062	1.48	1.365	1.183
1994	0.216	1.069	1.505	1.395	1.205
1995	0.204	1.058	1.521	1.398	1.214
1996	0.192	1.055	1.549	1.417	1.258
1997	0.184	1.045	1.586	1.474	1.32
1998	0.175	1.029	1.605	1.48	1.369
1999	0.166	1.027	1.629	1.489	1.376
2000	0.158	1.002	1.611	1.455	1.304
2001	0.151	0.96	1.561	1.436	1.288
2002	0.142	0.93	1.512	1.406	1.278
2003	0.135	0.907	1.497	1.453	1.236
2004	0.126	0.87	1.463	1.453	1.289
2005	0.116	0.848	1.433	1.443	1.269
2006	0.11	0.874	1.455	1.459	1.325
2007	0.111	0.896	1.478	1.407	1.282
2008	0.108	0.899	1.481	1.363	1.237
2009	0.106	0.897	1.463	1.335	1.198
2010	0.106	0.891	1.436	1.298	1.16
2011	0.105	0.878	1.419	1.264	1.166

Table 6.2.9. Estimated stock numbers (Thousands).

Year\Age	1	2	3	4	5	6+
1968	3038	3598	1839	913	379	59
1969	4693	2437	1606	612	337	187
1970	6722	3249	798	444	267	151
1971	9194	4380	1583	296	151	121
1972	5661	6899	1786	582	122	117
1973	7580	2821	3130	759	286	125
1974	4090	6500	1158	1069	281	150
1975	6242	1792	2714	462	436	193
1976	4511	5371	730	985	135	211
1977	4262	1599	2189	275	373	129
1978	4585	2600	634	686	86	152
1979	7711	2936	1170	240	271	109
1980	9212	5754	1304	461	91	117
1981	5962	6816	2574	462	186	83
1982	3152	4116	2652	930	170	118
1983	4210	1980	1411	886	293	88
1984	6091	2637	796	445	289	130
1985	6165	3873	1130	282	150	138
1986	6342	4117	1291	361	103	105
1987	11681	3575	1440	407	122	69
1988	8368	8136	1210	433	121	61
1989	4055	3911	2734	360	130	57
1990	4127	2138	953	629	103	49
1991	5457	2623	673	214	166	38
1992	4771	2175	895	157	57	64
1993	1940	3594	425	156	27	24
1994	3290	818	1002	81	28	14
1995	2972	2051	216	214	14	10
1996	2434	1683	807	54	58	8
1997	2917	1682	505	186	17	21
1998	1363	3116	455	95	28	10
1999	613	1115	1100	83	22	8
2000	2030	307	190	114	9	3
2001	2125	1672	71	20	18	3
2002	1850	1093	750	14	4	4
2003	981	2161	394	125	6	1
2004	986	471	523	55	16	4
2005	608	782	153	78	9	2
2006	505	420	301	26	13	5
2007	681	608	156	45	3	2
2008	334	552	177	24	8	1
2009	632	211	182	42	8	2
2010	1012	580	62	33	9	2
2011	691	884	211	13	7	4
2012	647	568	362	52	4	3

Table 6.2.10. Estimated recruitment (age 1), total stock biomass (TBS), spawning–stock biomass (SSB), and average fishing mortality for ages 2 to 4 (F24).

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F24	Low	High	Reported Landings	WG estimates	Model estimates
1968	3038	1812	5096	21352	16448	27718	15796	11814	21120	0.777	0.626	0.964	8541		
1969	4693	2971	7412	18815	14925	23719	13444	10310	17531	0.777	0.635	0.95	7991		
1970	6722	4295	10519	17151	13522	21753	9707	7590	12414	0.77	0.636	0.932	6426		
1971	9194	5850	14449	21459	16661	27638	11342	8621	14924	0.767	0.639	0.922	9246		
1972	5661	3631	8826	25438	19477	33224	14874	11401	19407	0.765	0.641	0.914	9234		
1973	7580	4865	11811	26265	20516	33626	18734	13912	25227	0.771	0.648	0.917	11819		
1974	4090	2618	6389	25413	19717	32753	16236	12665	20814	0.776	0.655	0.92	10251		
1975	6242	4020	9692	22226	17427	28345	16577	12387	22185	0.783	0.662	0.926	9863		
1976	4511	2919	6971	21455	16655	27637	13175	10228	16971	0.789	0.668	0.932	10247		
1977	4262	2757	6588	17232	13459	22061	12986	9665	17448	0.795	0.674	0.938	8054		
1978	4585	2951	7123	14343	11333	18152	8870	6852	11482	0.8	0.678	0.942	6271		
1979	7711	4997	11899	17190	13637	21670	9464	7347	12192	0.811	0.69	0.954	8371		
1980	9212	5932	14308	23225	17987	29989	11687	9043	15104	0.828	0.706	0.971	10776		
1981	5962	3869	9187	27667	21298	35940	17002	12838	22517	0.847	0.724	0.992	14907		
1982	3152	1990	4993	26239	20695	33268	19180	14557	25271	0.869	0.744	1.015	13381		
1983	4210	2726	6501	21976	17640	27378	15506	11977	20076	0.887	0.76	1.034	10015		
1984	6091	3948	9398	18027	14543	22344	10925	8661	13780	0.907	0.779	1.057	8383		
1985	6165	4002	9498	21438	16875	27235	11778	9178	15115	0.936	0.806	1.087	10483		
1986	6342	4105	9797	21448	16869	27271	11640	9012	15035	0.966	0.834	1.119	9852		
1987	11681	7393	18456	25926	20371	32995	12846	9921	16633	1.002	0.867	1.158	12894		
1988	8368	5343	13107	26370	20119	34564	13397	10401	17257	1.043	0.905	1.202	14168		
1989	4055	2613	6293	23202	18029	29860	14897	11026	20126	1.09	0.948	1.254	12751		
1990	4127	2675	6368	15578	12425	19530	9540	7390	12314	1.135	0.989	1.303	7379		
1991	5457	3458	8613	13941	10958	17736	6581	5179	8363	1.187	1.035	1.361	6714	7095	
1992	4771	3118	7300	13585	10690	17264	7077	5411	9256	1.252	1.09	1.438	7173	7735	
1993	1940	1286	2925	10682	8223	13876	5223	4100	6654	1.302	1.132	1.499	5727	7555	
1994	3290	2215	4886	8652	6836	10952	5047	3720	6848	1.323	1.153	1.517	4187	5402	
1995	2972	2015	4383	8761	6948	11049	3747	2960	4743	1.326	1.162	1.512	3721	4587	
1996	2434	1650	3591	8569	6920	10611	4483	3488	5761	1.34	1.177	1.526	3622	4964	
1997	2917	1994	4266	8849	7173	10918	4510	3598	5652	1.369	1.198	1.564	4360	5859	
1998	1363	929	2000	8900	7014	11293	5011	3973	6319	1.371	1.199	1.568	4418	5310	
1999	613	405	927	6532	5110	8349	5180	3909	6863	1.382	1.202	1.589	2975	4784	
2000	2030	1361	3027	3687	2923	4651	1712	1352	2169	1.356	1.18	1.558	1274	2179	
2001	2125	1433	3151	5714	4367	7475	2545	1872	3458	1.319	1.151	1.511	2252	3598	
2002	1850	1257	2724	6475	5094	8231	4032	3014	5394	1.282	1.12	1.468	2695	4431	
2003	981	661	1456	6817	5353	8681	4374	3403	5623	1.286	1.119	1.478	1285		4027
2004	986	668	1455	4540	3617	5699	3083	2356	4035	1.262	1.096	1.455	1072		1884
2005	608	403	917	3115	2478	3917	2031	1612	2559	1.241	1.075	1.434	910	1646	
2006	505	325	786	2541	2030	3181	1852	1451	2363	1.263	1.091	1.462	840		1274
2007	681	457	1017	2564	2041	3221	1605	1268	2030	1.26	1.088	1.46	702		1606
2008	334	220	506	2016	1597	2546	1412	1105	1803	1.247	1.073	1.449	662		1335
2009	632	416	960	2039	1622	2565	1196	941	1519	1.232	1.053	1.442	466		994
2010	1012	654	1566	3144	2391	4133	1403	1071	1840	1.209	1.022	1.43	464		1335
2011	691	438	1089	3271	2505	4271	2033	1545	2675	1.187	0.987	1.427	365		1677
2012							2394	1662	3450						

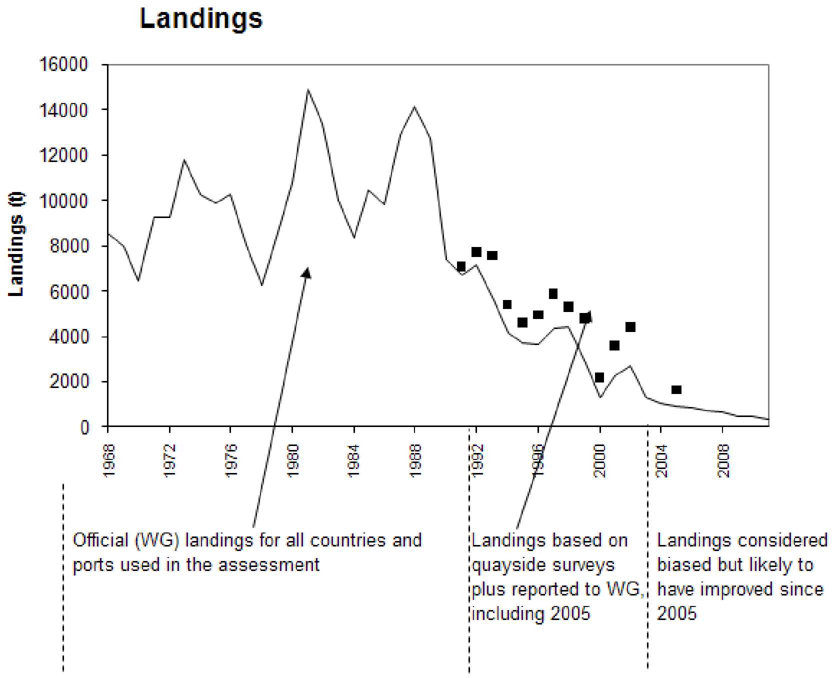


Figure 6.2.1. Cod in VIIa. Landings data used in the SAM assessment.

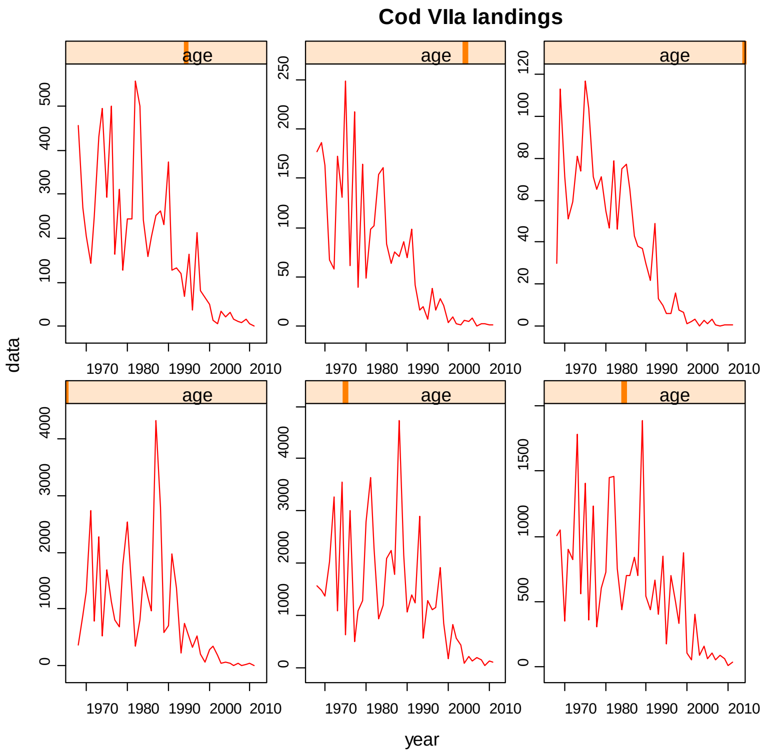


Figure 6.2.2. Cod in VIIa. Landings number-at-age.

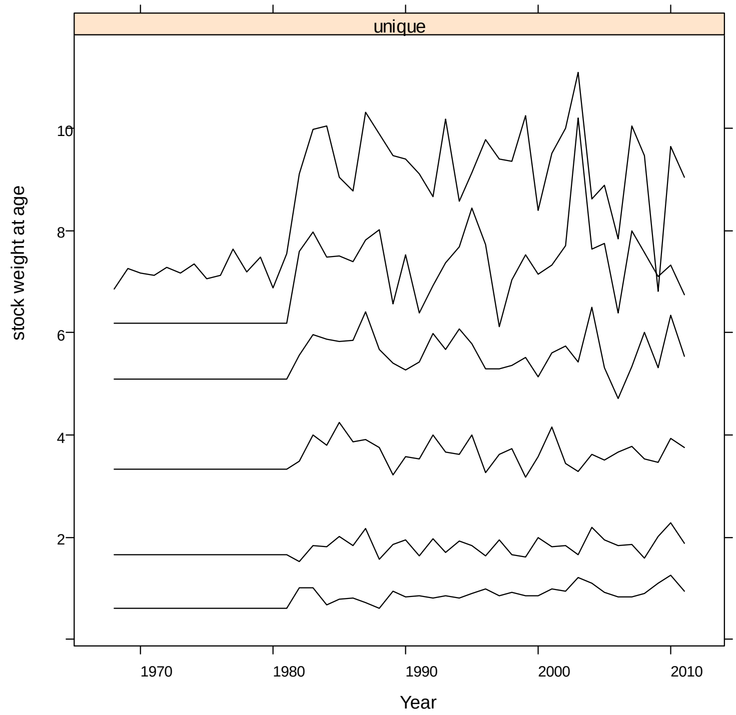


Figure 6.2.3. Cod in VIIa. Catch weights-at-age (same as stock weights).

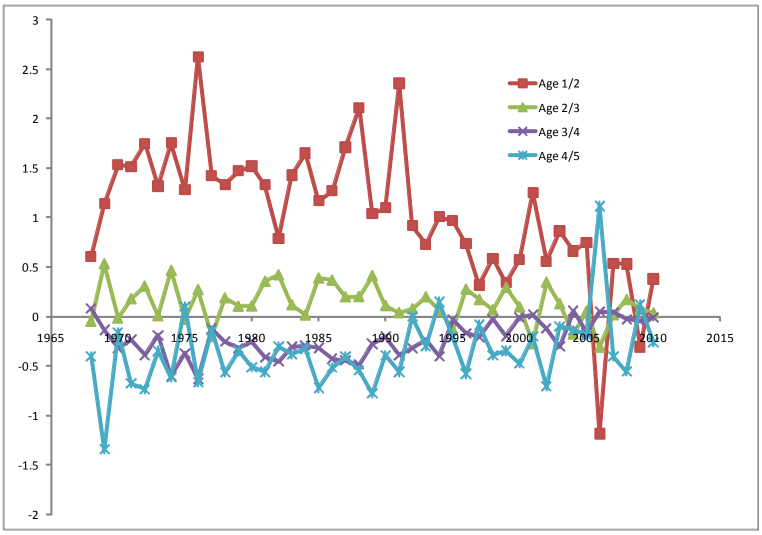


Figure 6.2.4. Cod in VIIa. Separable VPA residuals.

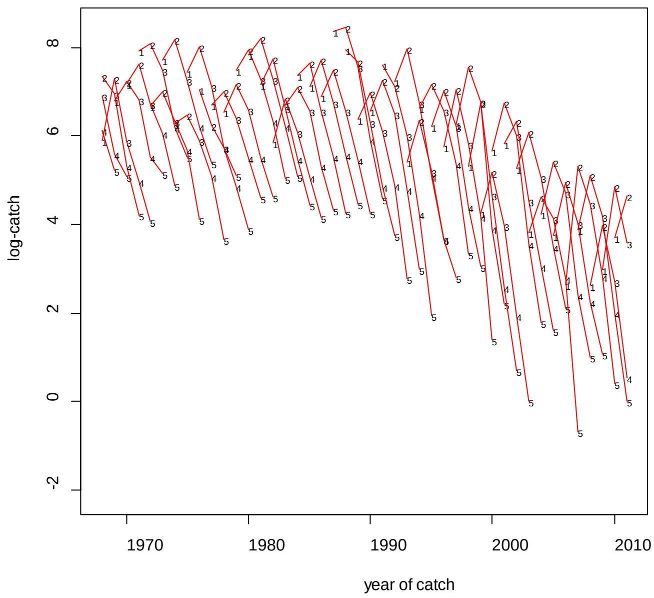


Figure 6.2.5. Cod in VIIa. Log landings data at age by cohort, illustrating the decreased selection at age 1 since the 1990s and the rapid decline in numbers-at-age down the cohorts across the whole time period.

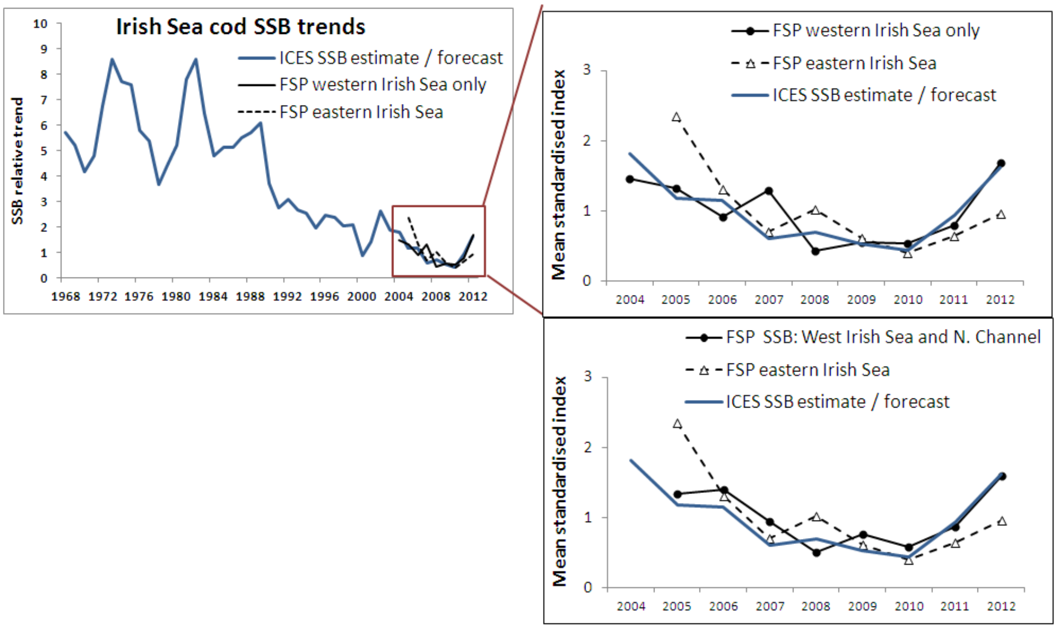


Figure 6.2.6. Cod in VIIa. Trends in SSB of cod given by the FSP surveys of the western and eastern Irish Sea and the ICES (2011) assessments. The two right hand plots show the comparisons using the SSB index for the western Irish Sea only (excluding North Channel) and the index including the North Channel (no data for 2004).

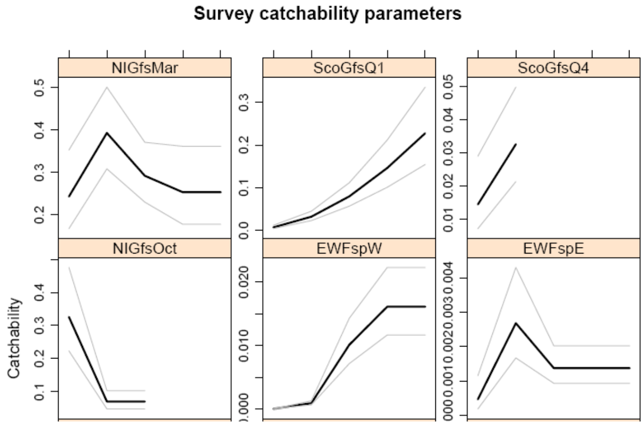


Figure 6.2.7. Cod in ICES Division VIIa: SAM estimated survey catchability-at-age.

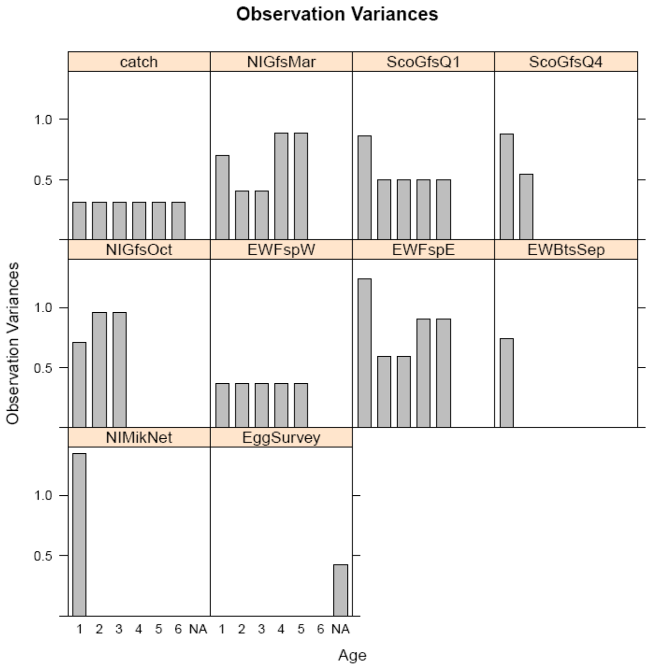


Figure 6.2.8. Cod in ICES Division VIIa: SAM estimated paired parameter variance at age.

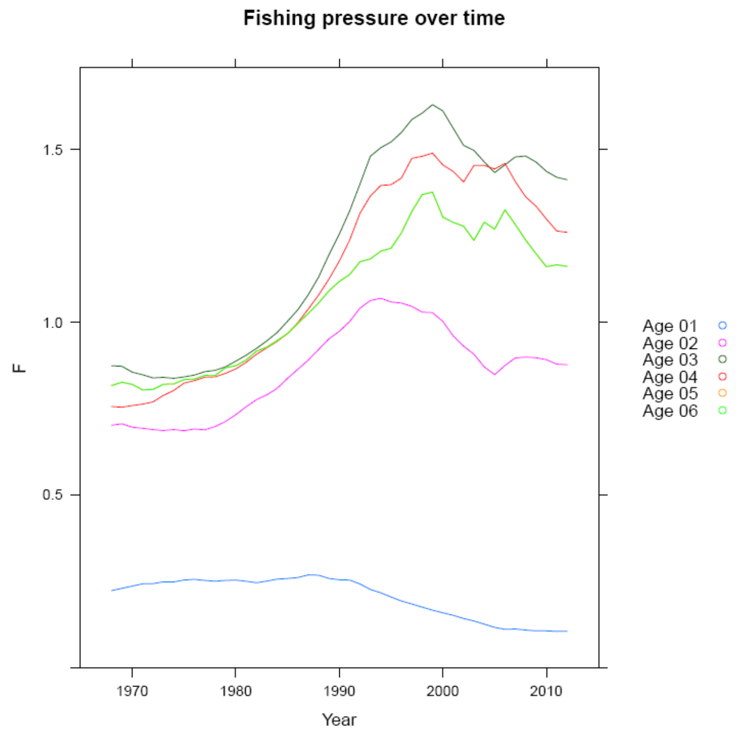


Figure 6.2.9. Cod in ICES Division VIIa: SAM estimated fishing mortality-at-age (age 5=age 6)

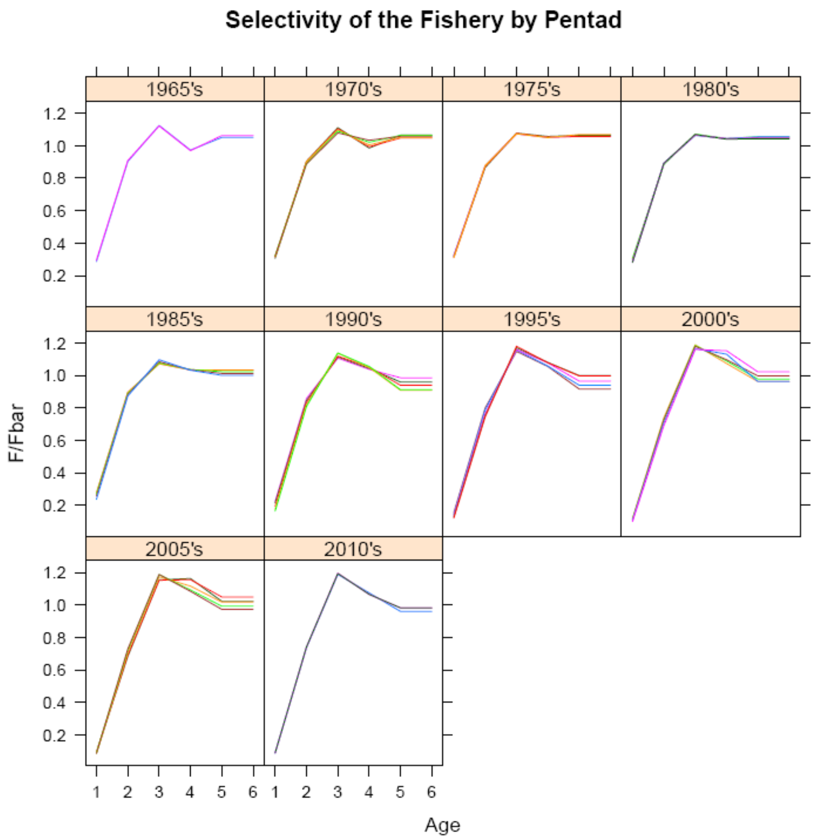


Figure 6.2.10. Cod in ICES Division VIIa: SAM estimated fishery selectivity-at-age.

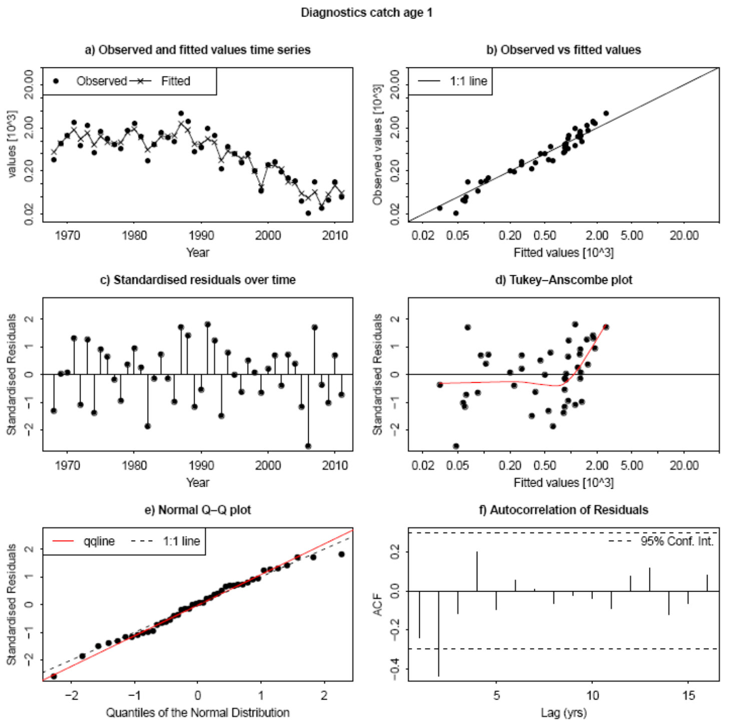


Figure 6.2.11a. Cod in ICES Division VIIa: SAM estimated catch residuals for age 1.

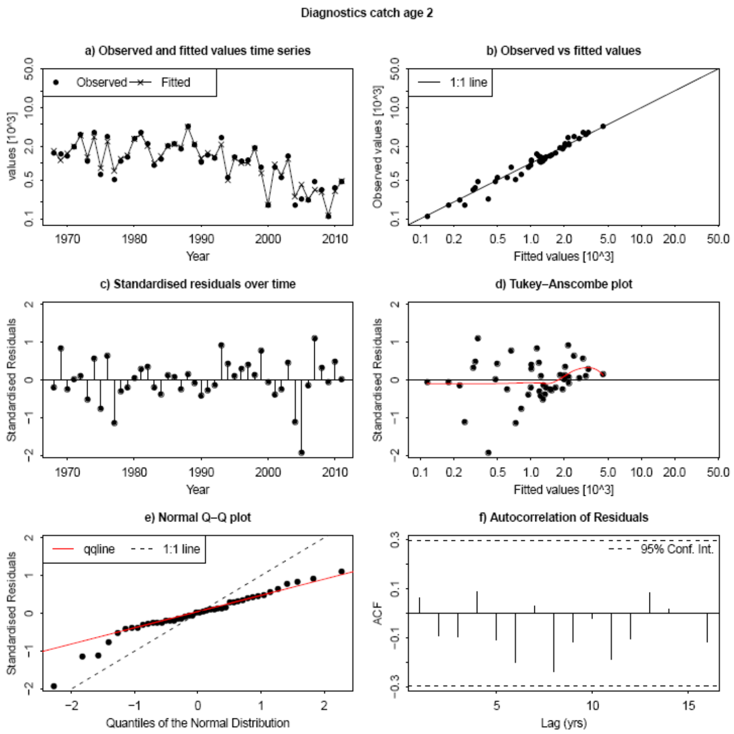
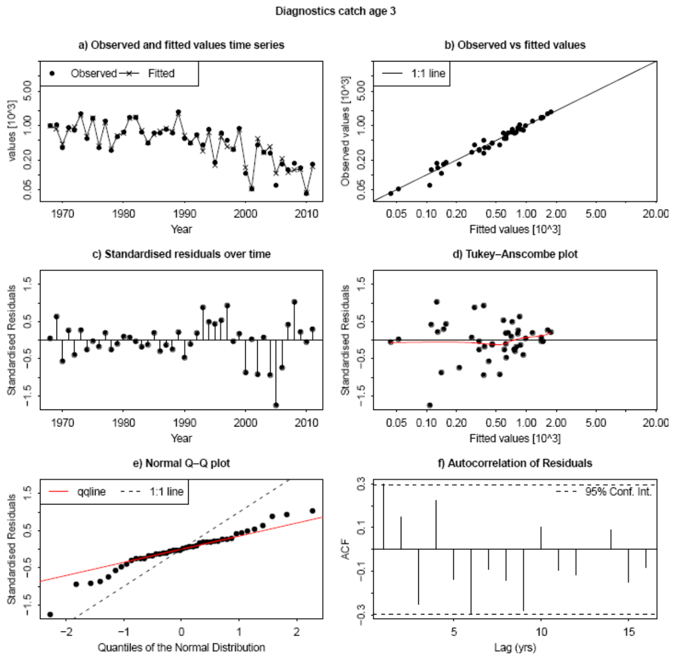
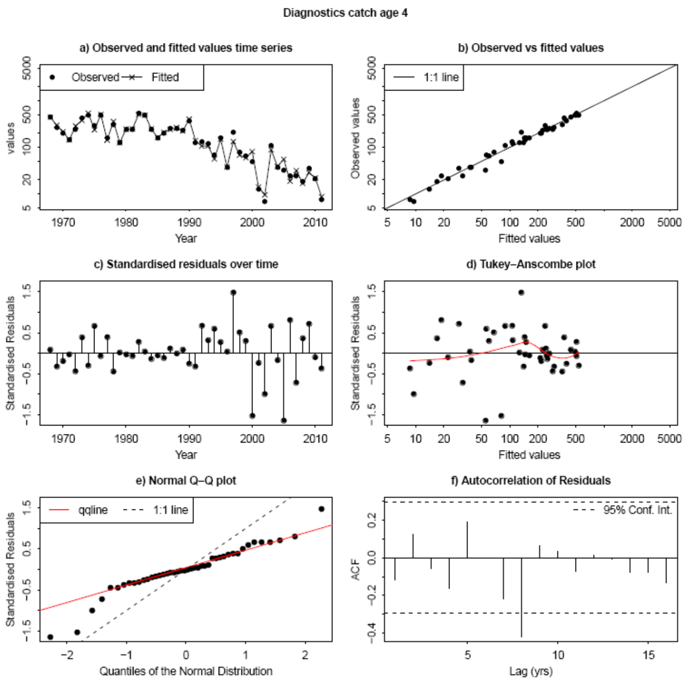


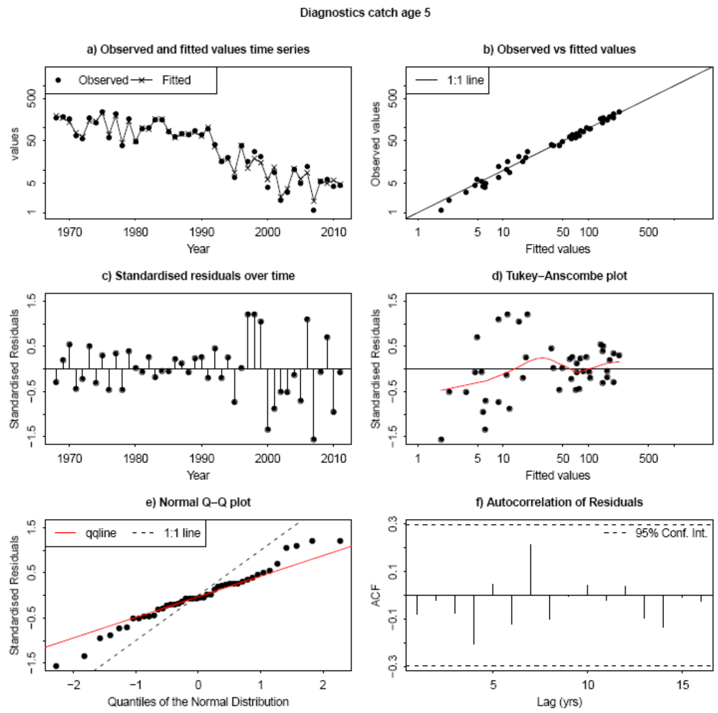
Figure 6.2.11b. Cod in ICES Division VIIa: SAM estimated catch residuals for age 2.



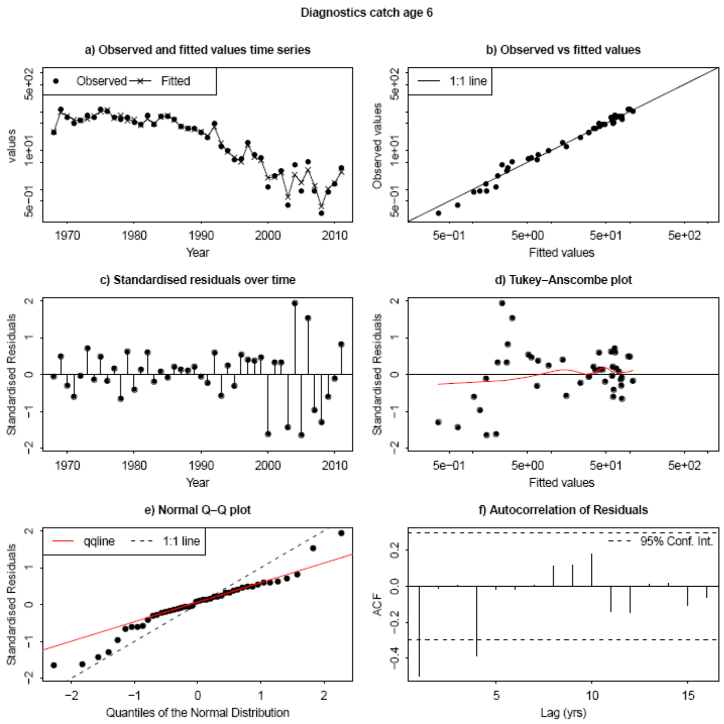
Figures 6.2.11c. Cod in ICES Division VIIa: SAM estimated catch residuals for age 3.



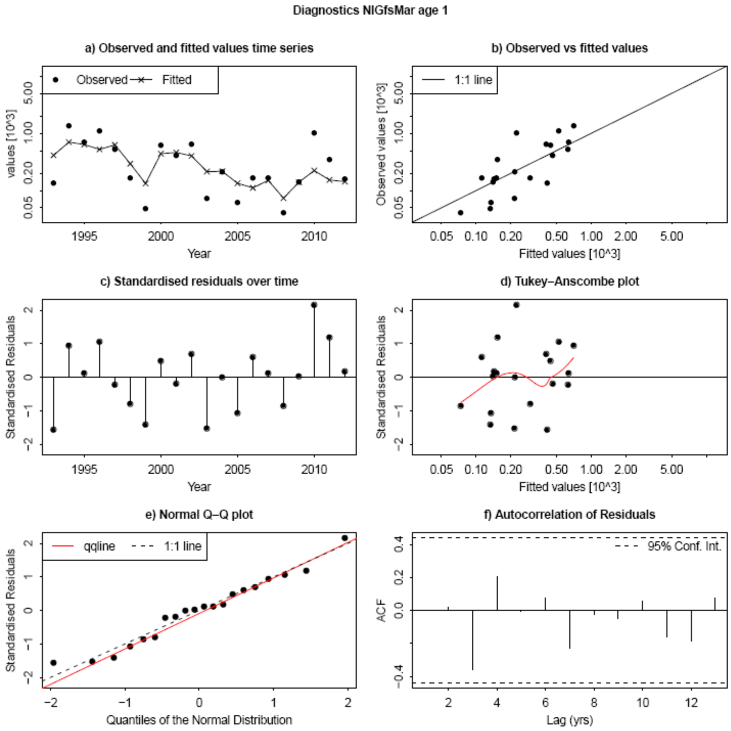
Figures 6.2.11d. Cod in ICES Division VIIa: SAM estimated catch residuals for age 4.



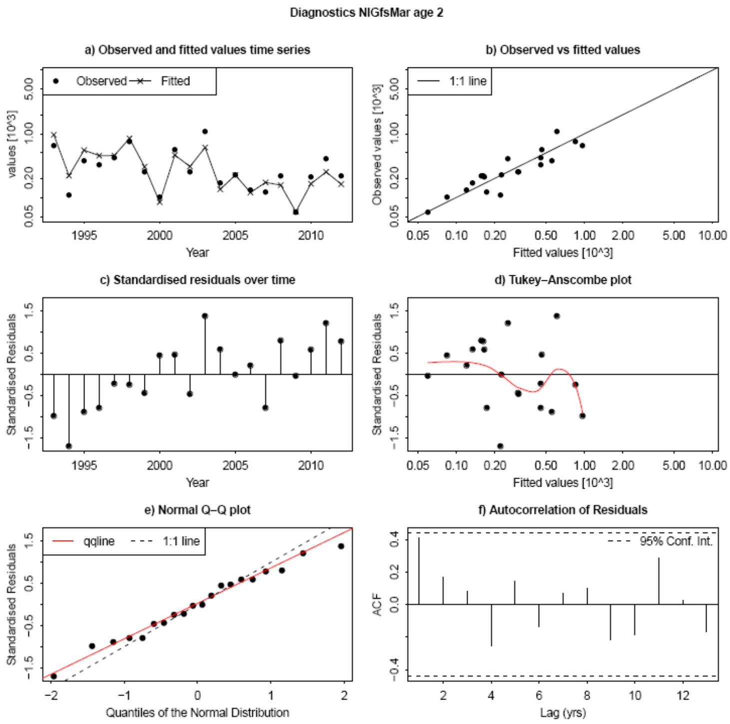
Figures 6.2.11e. Cod in ICES Division VIIa: SAM estimated catch residuals for age 5.



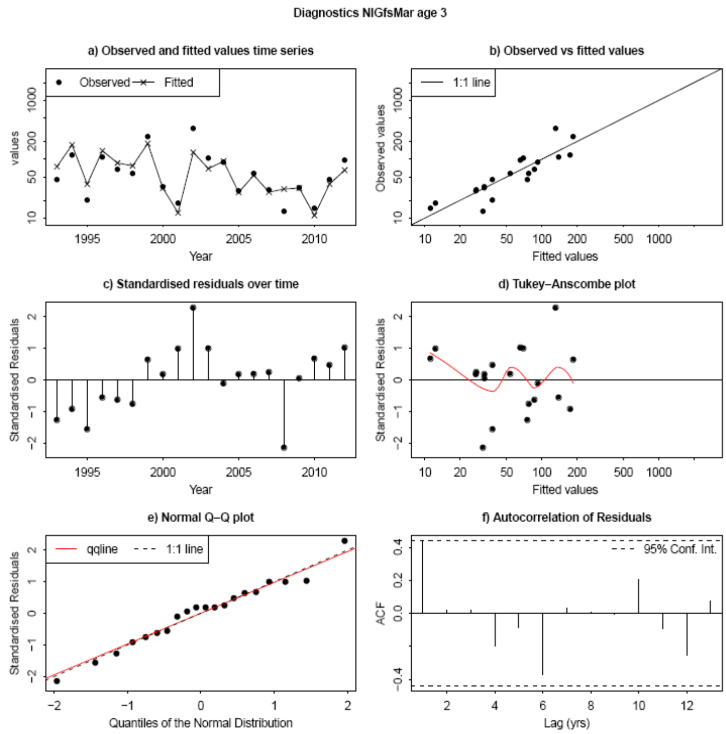
Figures 6.2.11f. Cod in ICES Division VIIa: SAM estimated catch residuals for age 6+.



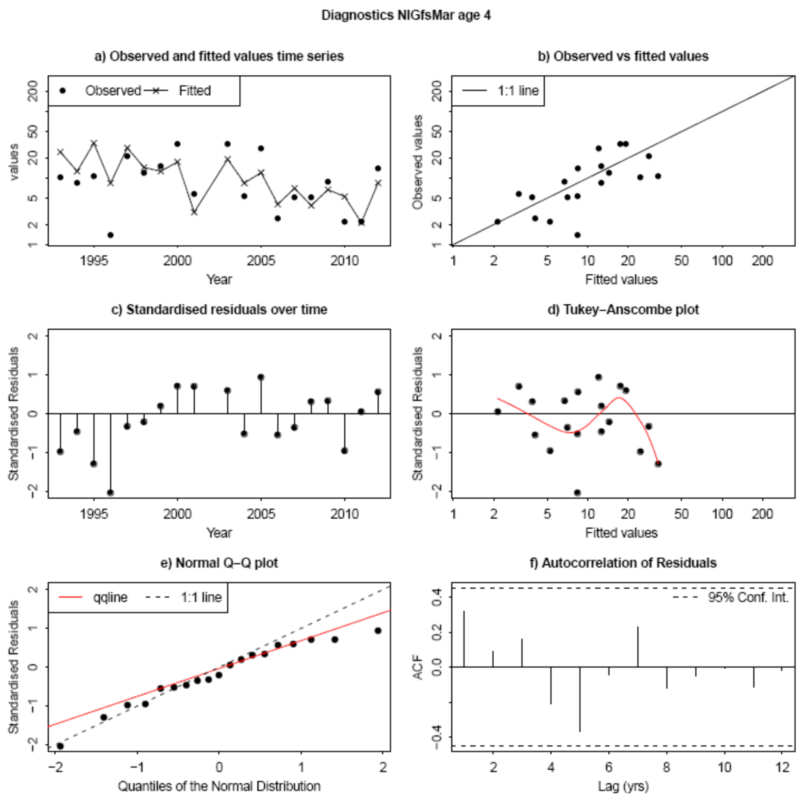
Figures 6.2.12a. Cod in ICES Division VIIa: SAM estimated Northern Ireland groundfish survey index residuals for age 1.



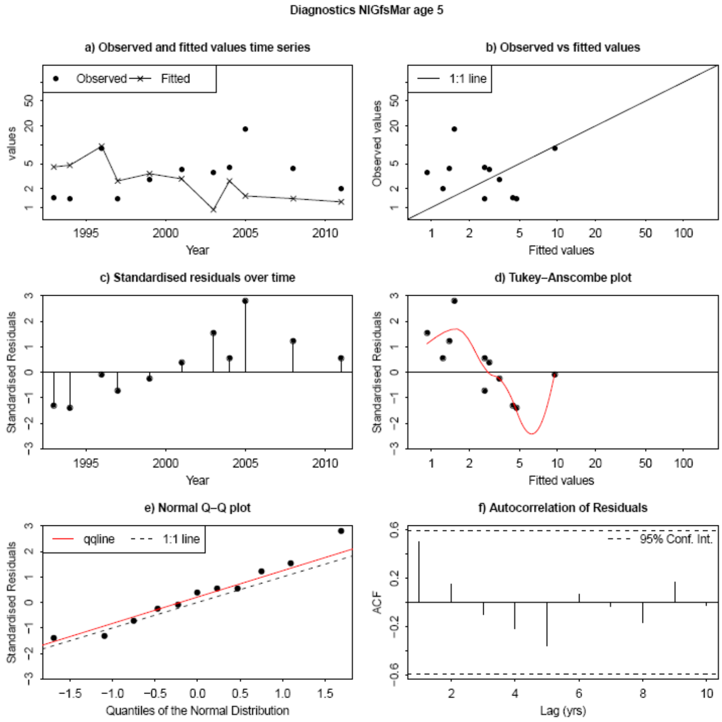
Figures 6.2.12b. Cod in ICES Division VIIa: SAM estimated Northern Ireland March groundfish survey index residuals for age 2.



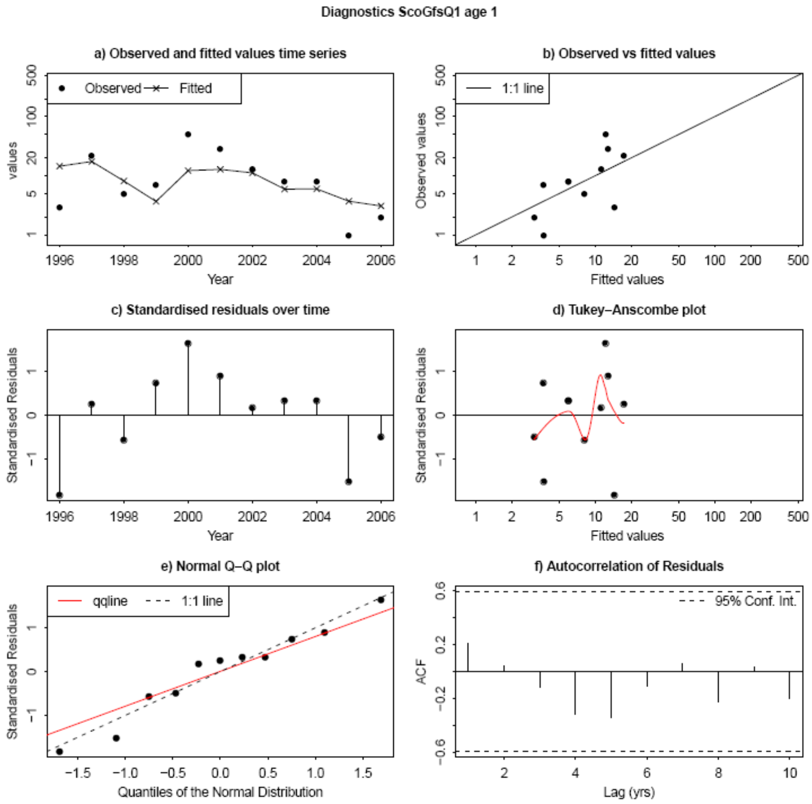
Figures 6.2.12c. Cod in ICES Division VIIa: SAM estimated Northern Ireland March groundfish survey index residuals for age 3.



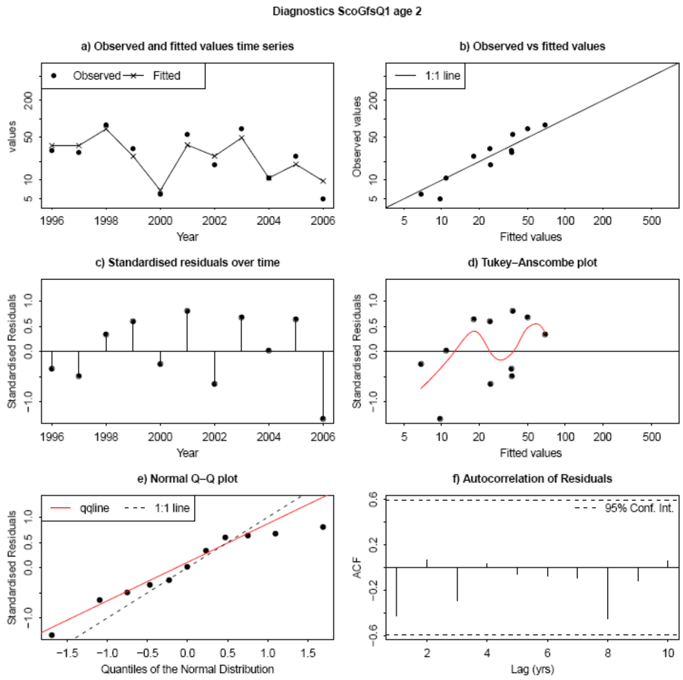
Figures 6.2.12d. Cod in ICES Division VIIa: SAM estimated Northern Ireland March groundfish survey index residuals for age 4.



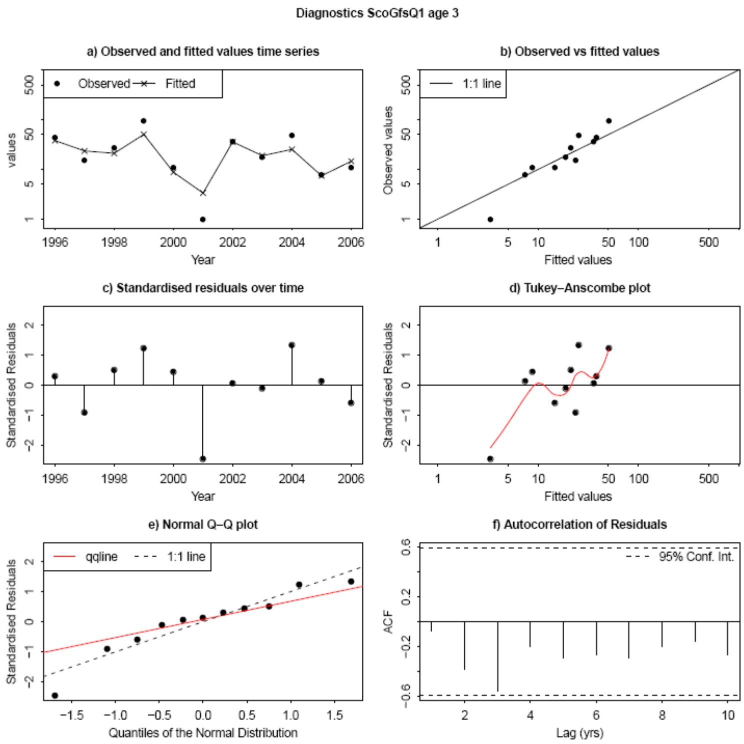
Figures 6.2.12e. Cod in ICES Division VIIa: SAM estimated Northern Ireland March groundfish survey index residuals for age 5.



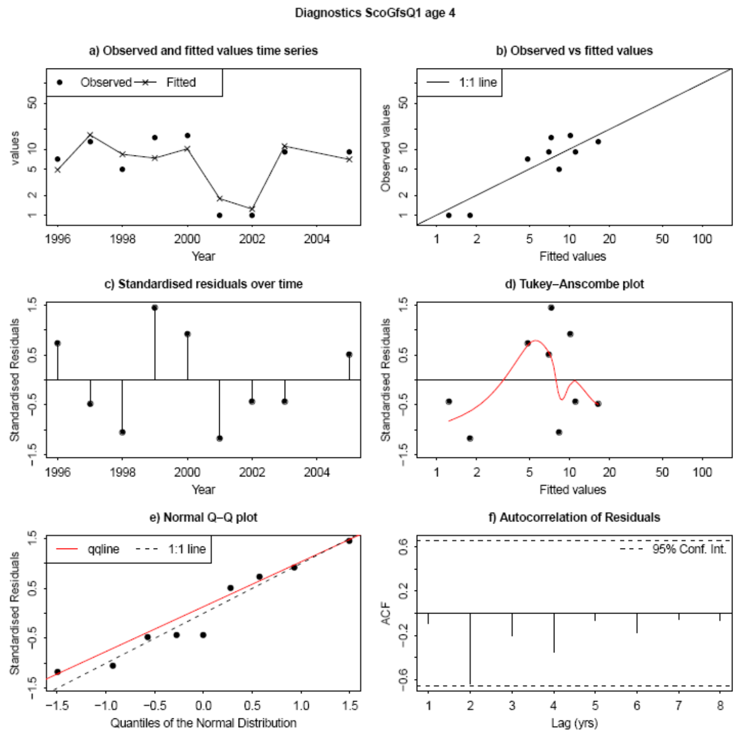
Figures 6.2.13a. Cod in ICES Division VIIa: SAM estimated Scottish quarter 1 groundfish survey index residuals for age 1.



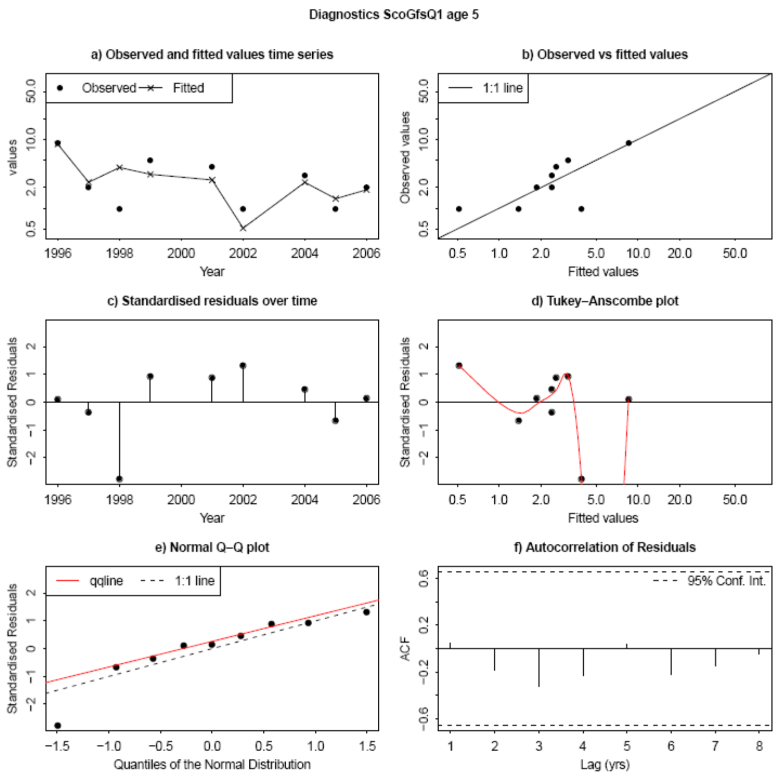
Figures 6.2.13b. Cod in ICES Division VIIa: SAM estimated Scottish quarter 1 groundfish survey index residuals for age 2.



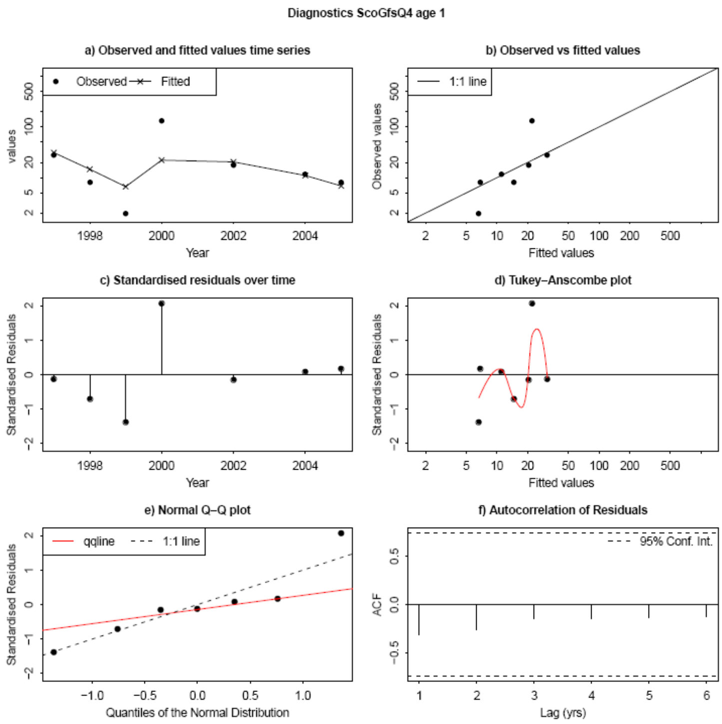
Figures 6.2.13c. Cod in ICES Division VIIa: SAM estimated Scottish quarter 1 groundfish survey index residuals for age 3.



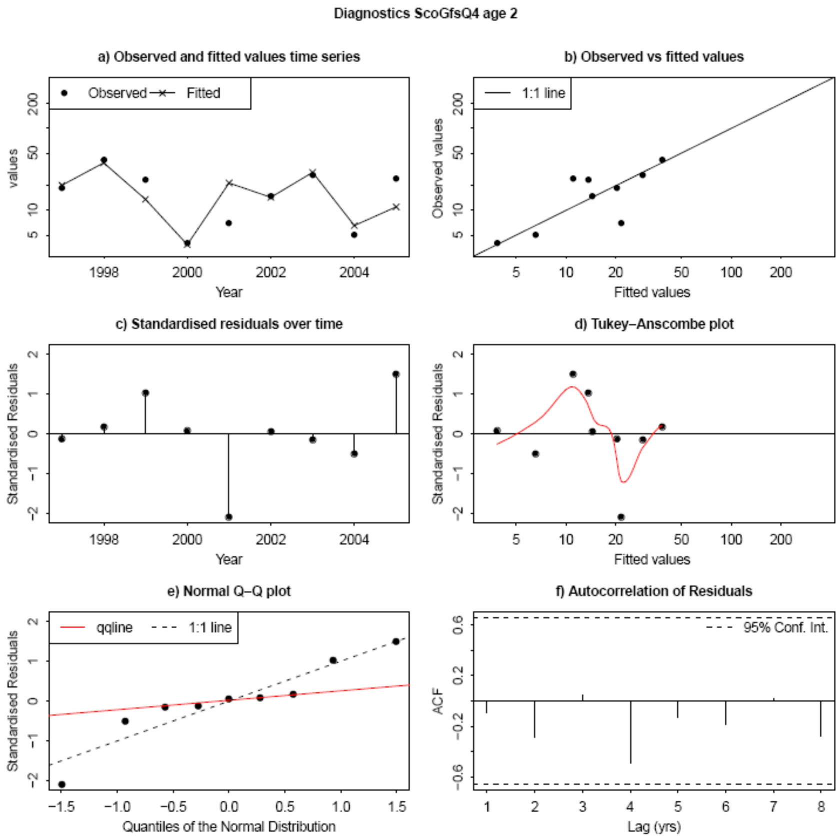
Figures 6.2.13d. Cod in ICES Division VIIa: SAM estimated Scottish quarter 1 groundfish survey index residuals for age 4.



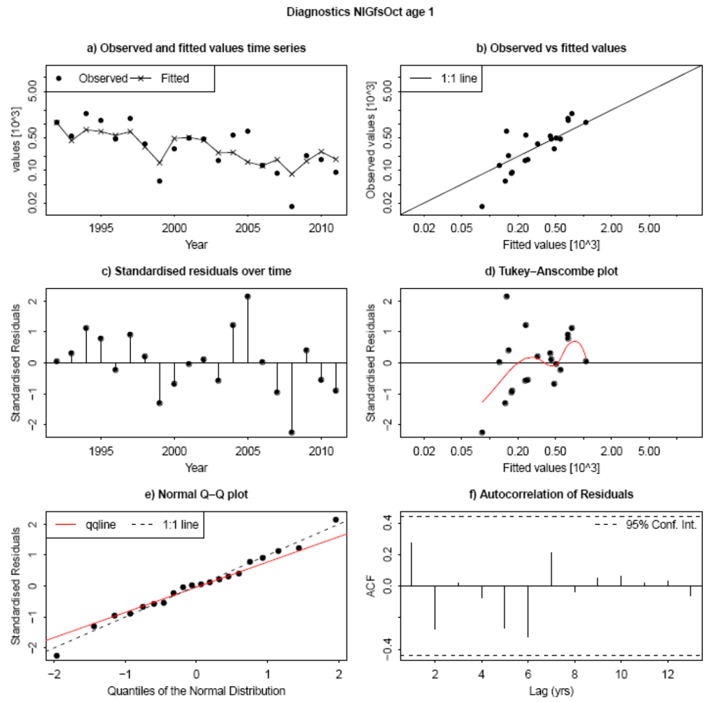
Figures 6.2.13e. Cod in ICES Division VIIa: SAM estimated Scottish quarter 1 groundfish survey index residuals for age 5.



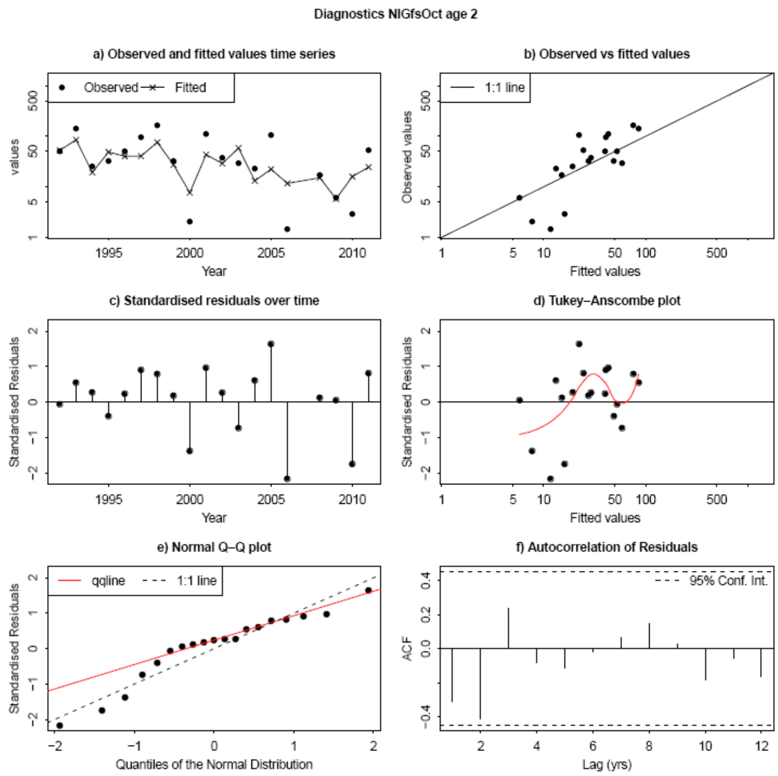
Figures 6.2.14a. Cod in ICES Division VIIa: SAM estimated Scottish quarter 4 groundfish survey index residuals for age 1.



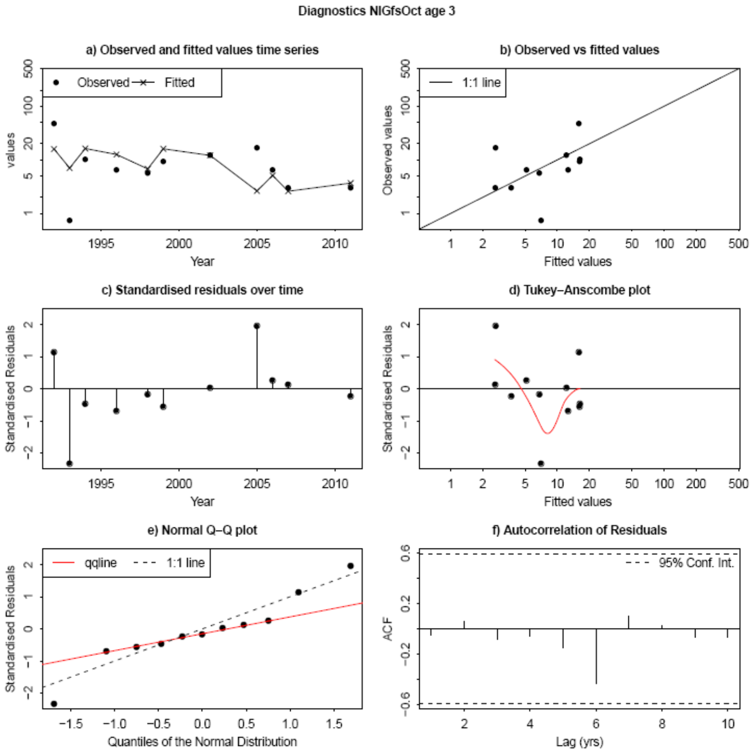
Figures 6.2.14b. Cod in ICES Division VIIa: SAM estimated Scottish quarter 4 groundfish survey index residuals for age 2.



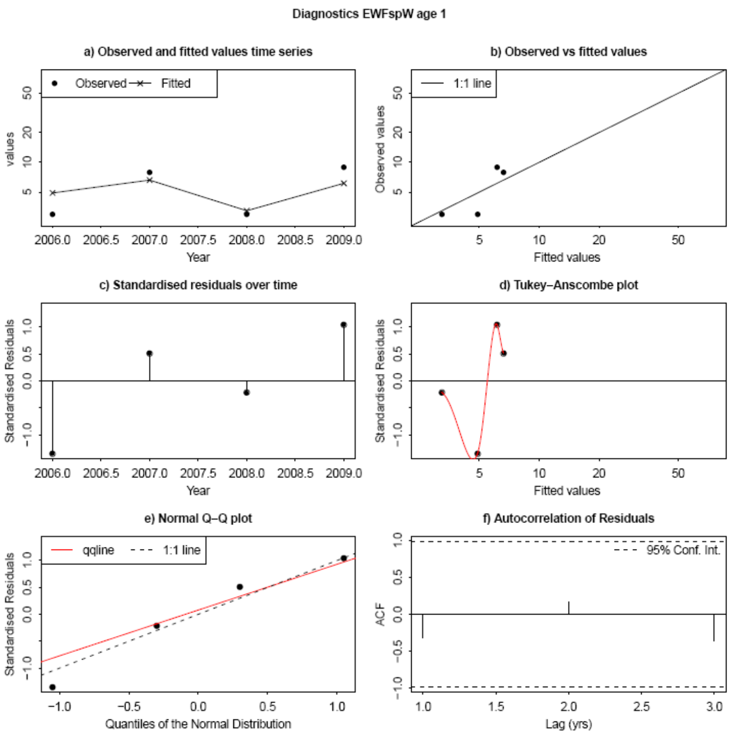
Figures 6.2.15a. Cod in ICES Division VIIa: SAM estimated Northern Ireland October groundfish survey index residuals for age 1.



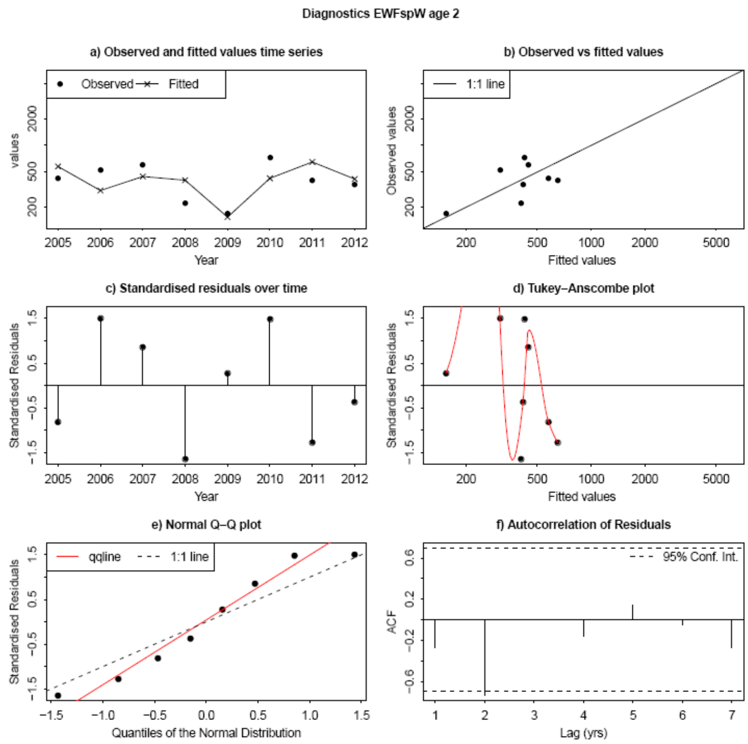
Figures 6.2.15b. Cod in ICES Division VIIa: SAM estimated Northern Ireland October groundfish survey index residuals for age 2.



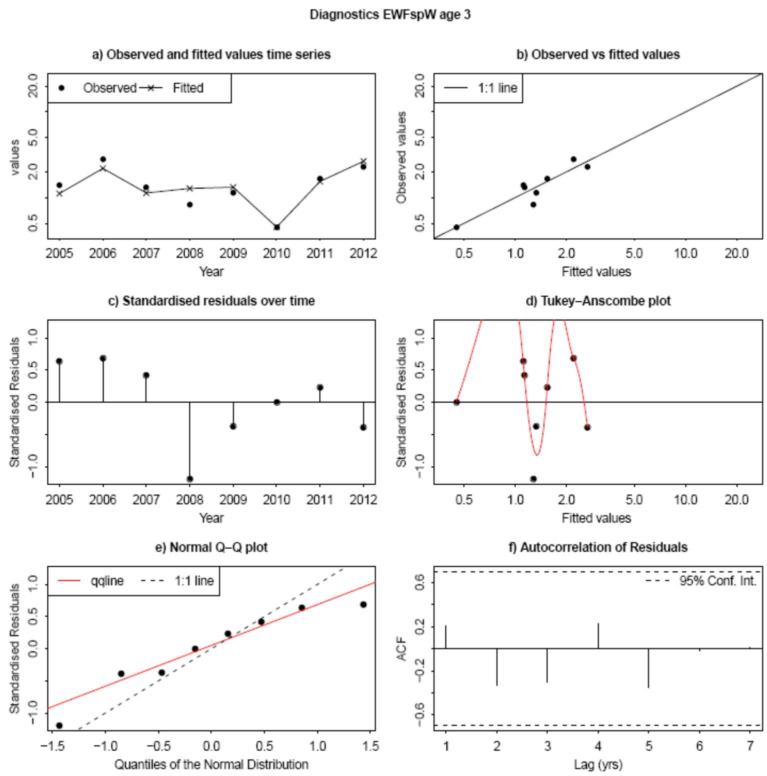
Figures 6.2.15c. Cod in ICES Division VIIa: SAM estimated Northern Ireland October groundfish survey index residuals for age 3.



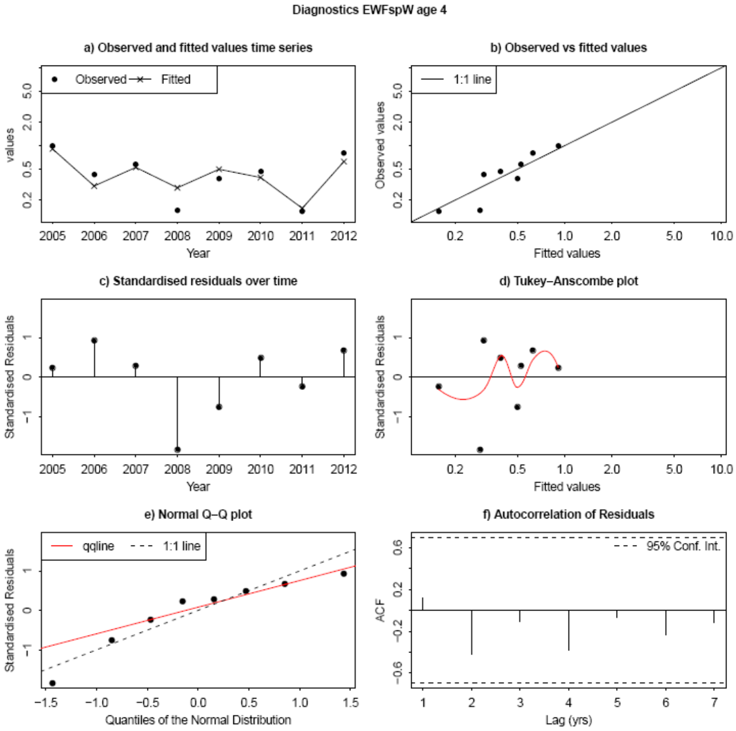
Figures 6.2.16a. Cod in ICES Division VIIa: SAM estimated UK(E&W) FSP west survey index residuals for age 1.



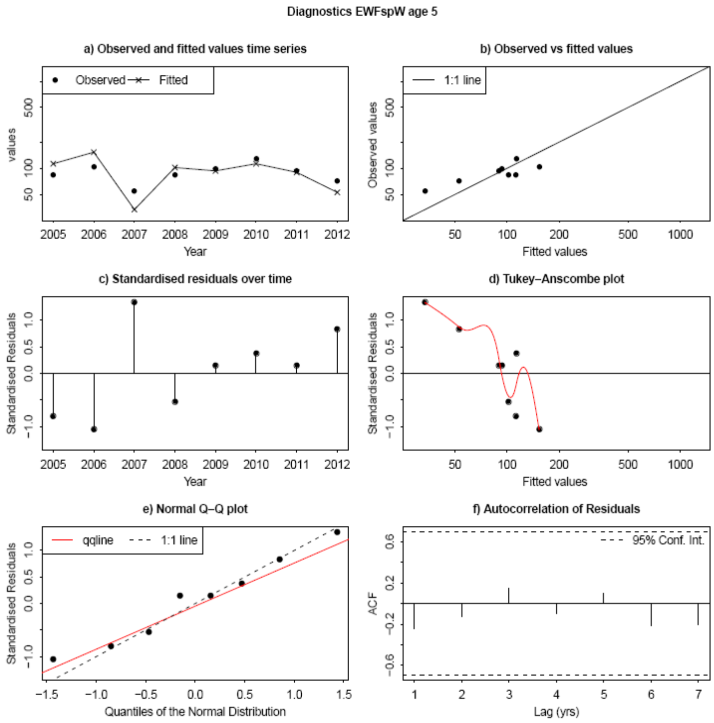
Figures 6.2.16b. Cod in ICES Division VIIa: SAM estimated UK(E&W) FSP west survey index residuals for age 2.



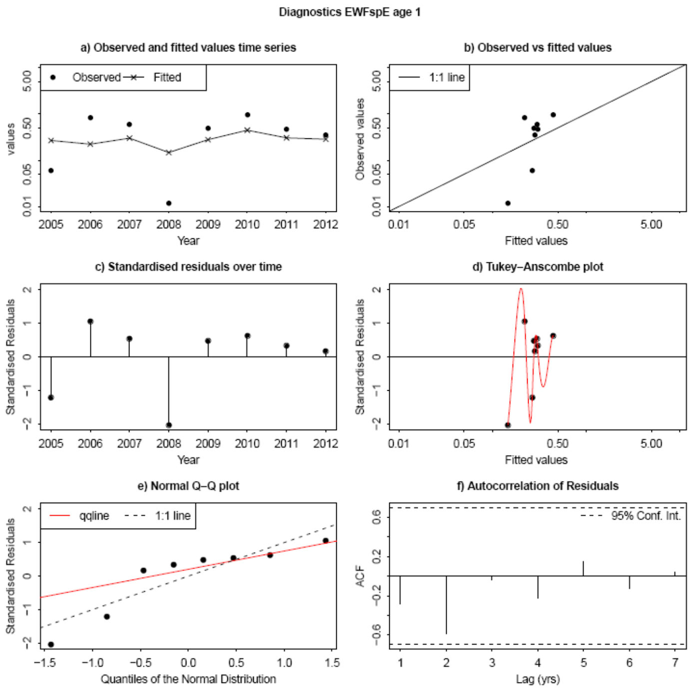
Figures 6.2.16c. Cod in ICES Division VIIa: SAM estimated UK(E&W) FSP west survey index residuals for age 3.



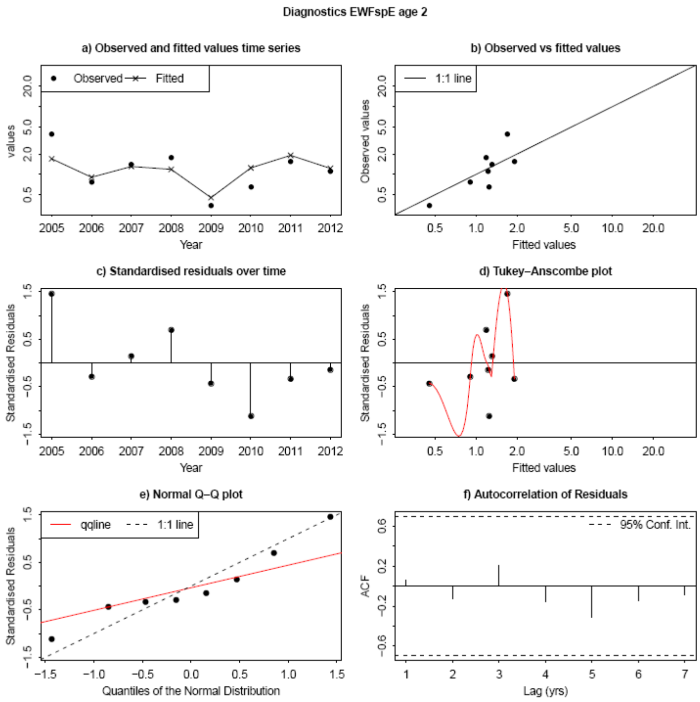
Figures 6.2.16d. Cod in ICES Division VIIa: SAM estimated UK(E&W) FSP west survey index residuals for age 4.



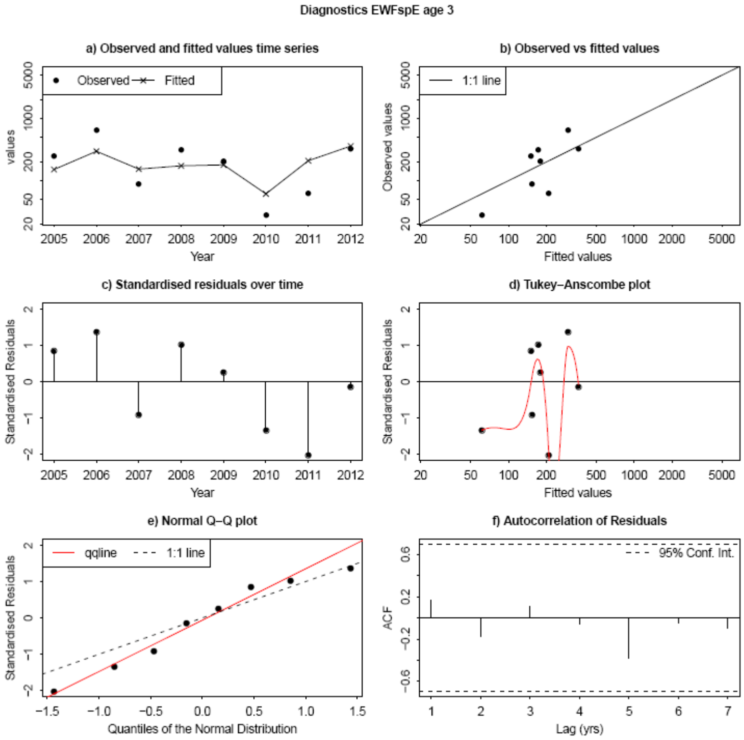
Figures 6.2.16e. Cod in ICES Division VIIa: SAM estimated UK(E&W) FSP west survey index residuals for age 5.



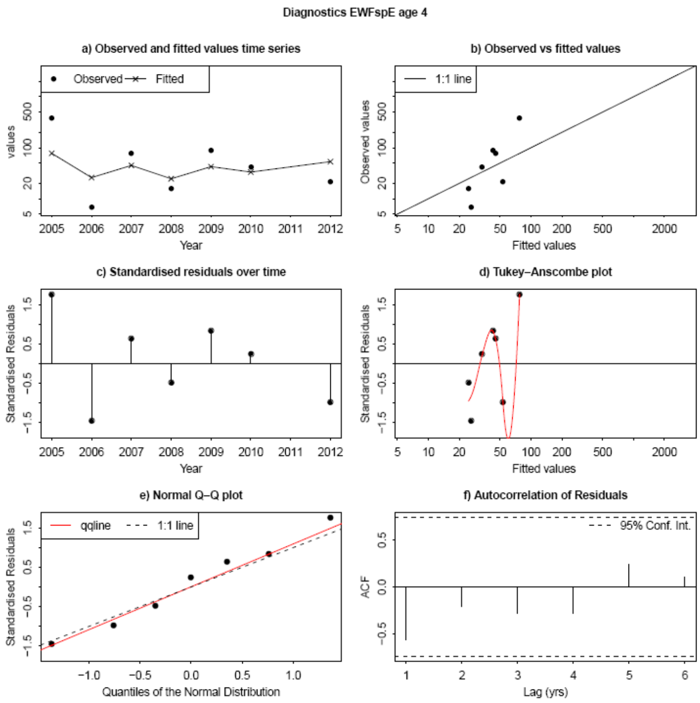
Figures 6.2.17a. Cod in ICES Division VIIa: SAM estimated UK(E&W) FSP east survey index residuals for age 1.



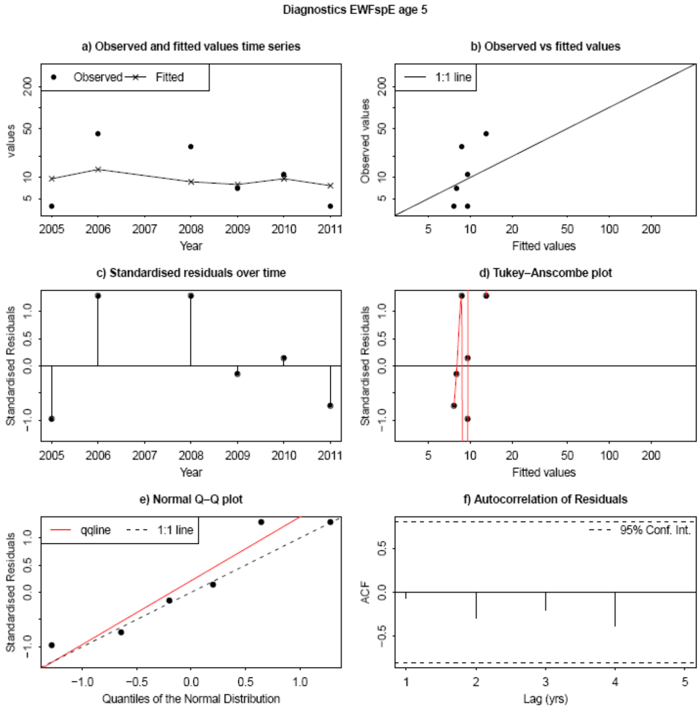
Figures 6.2.17b. Cod in ICES Division VIIa: SAM estimated UK(E&W) FSP east survey index residuals for age 2.



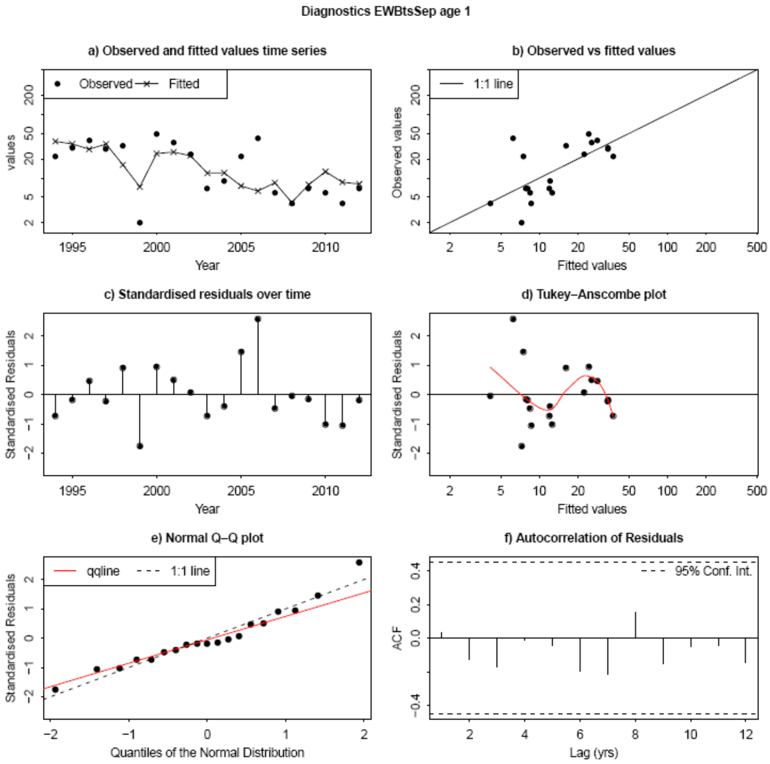
Figures 6.2.17c. Cod in ICES Division VIIa: SAM estimated UK(E&W) FSP east survey index residuals for age 3.



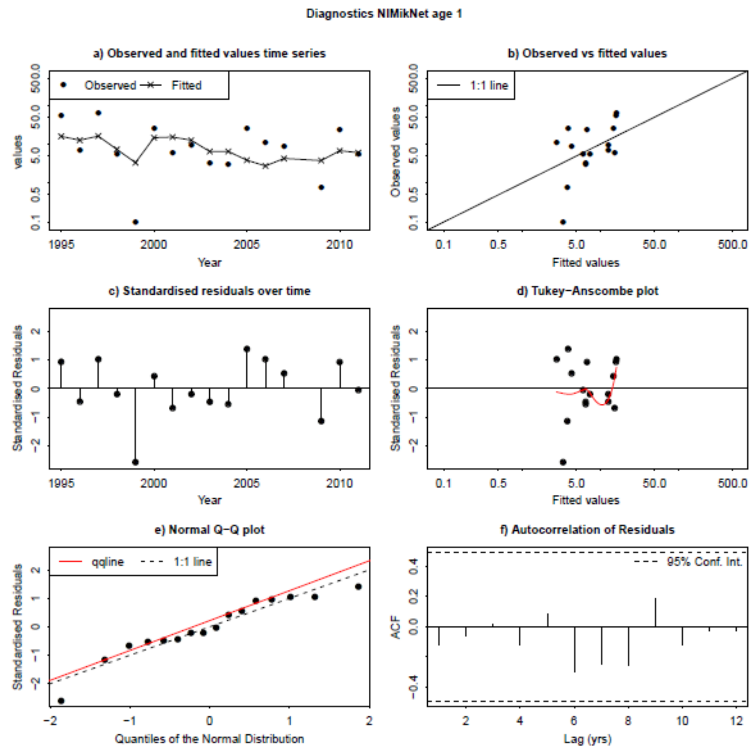
Figures 6.2.17d. Cod in ICES Division VIIa: SAM estimated UK(E&W) FSP east survey index residuals for age 4.



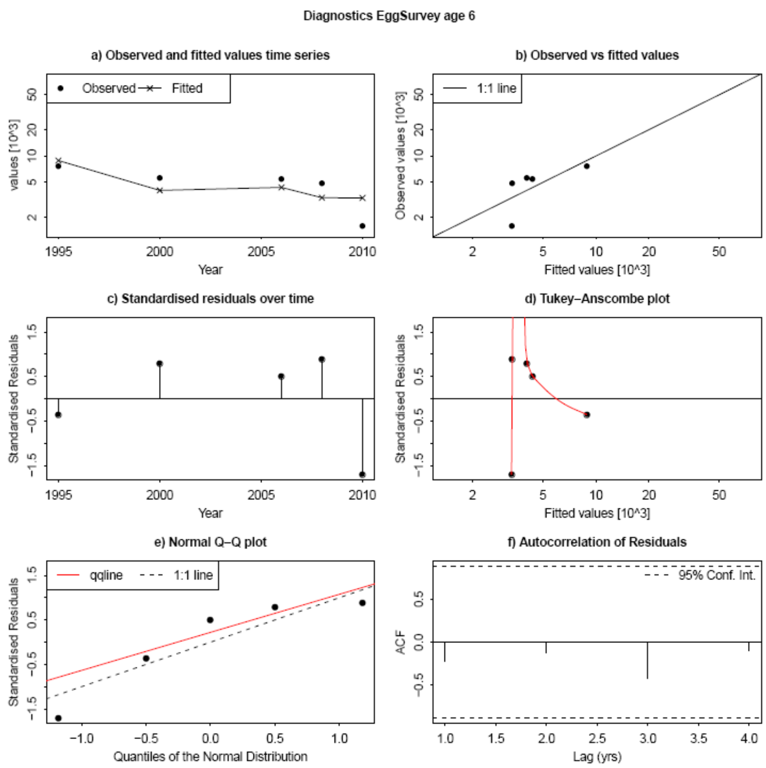
Figures 6.2.17e. Cod in ICES Division VIIa: SAM estimated UK(E&W) FSP east survey index residuals for age 5.



Figures 6.2.18. Cod in ICES Division VIIa: SAM Run 3 estimated UK(E&W) beam-trawl survey index residuals for age 1 (age 0 moved forward 1 year).



Figures 6.2.19. Cod in ICES Division VIIa: SAM estimated Northern Ireland MIKNET survey index residuals for age 1 (age 0 moved forward 1 year).



Figures 6.2.20. Cod in ICES Division VIIa: SAM estimated UK(E&W) egg biomass survey index residuals.

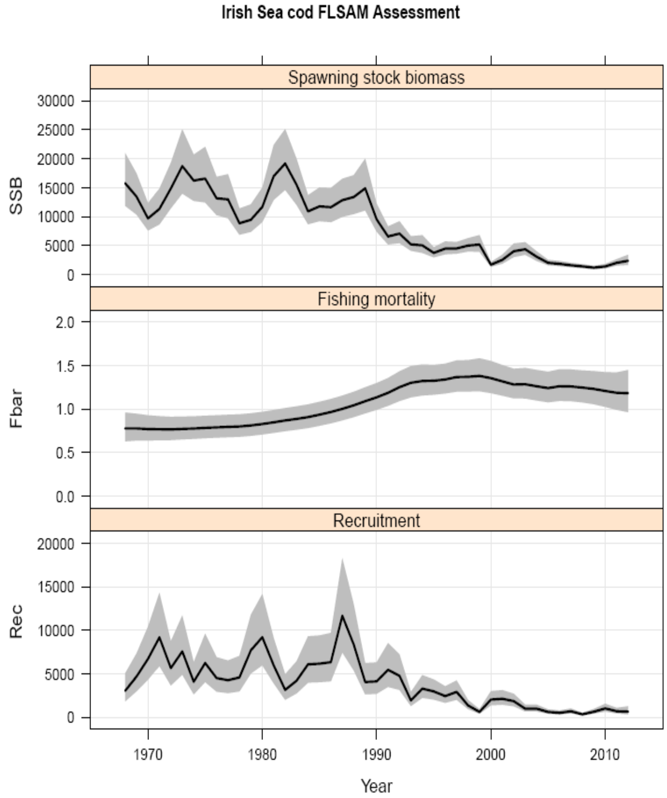


Figure 6.2.21. Cod in ICES Division VIIa: SAM model estimates of spawning–stock biomass, fishing mortality and recruitment.

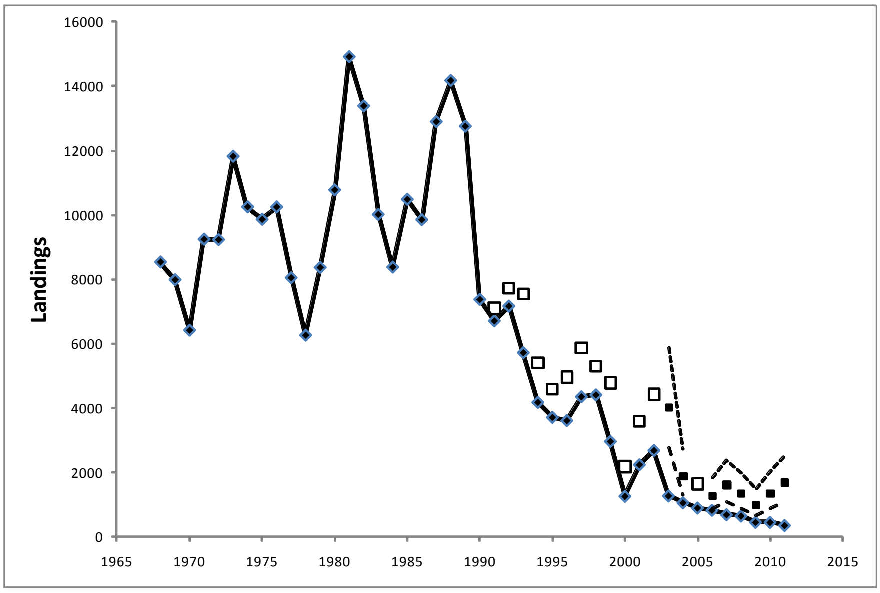


Figure 6.2.22. Cod in ICES Division VIIa: SAM model estimates of total removals including unallocated mortality. Solid line - reported landings, open squares - port based estimates of landings, closed squares model estimates of total removals for 2003, 2004 and 2006–2011 with 5 and 95% confidence intervals.

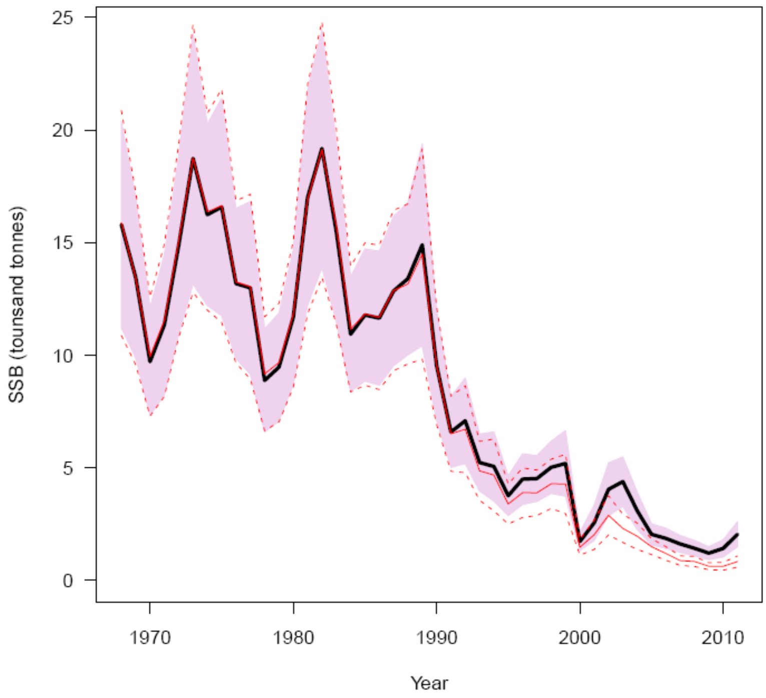


Figure 6.2.23a. Cod in ICES Division VIIa: Comparison plots for non-bootstrap SAM cod assessment estimates of spawning–stock biomass with (solid black line and shading) and without (red lines) bias estimation.

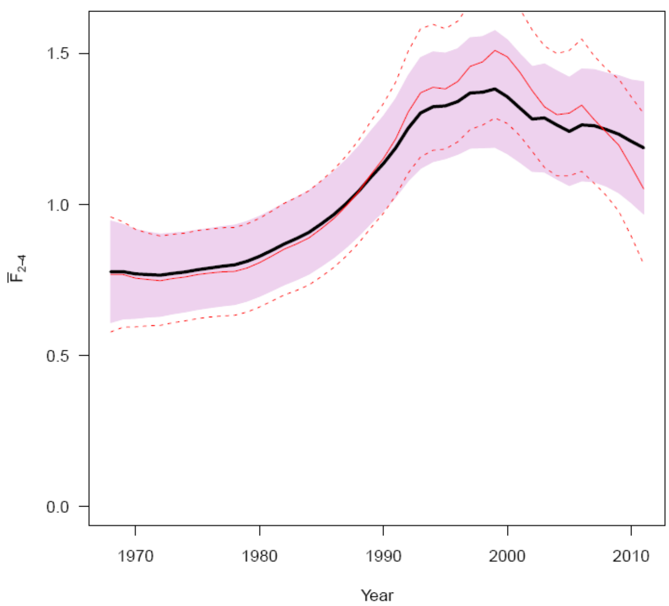


Figure 6.2.23b. Cod in ICES Division VIIa: Comparison plots for non-bootstrap SAM cod assessment estimates of fishing an unallocated mortality with (solid black line and shading) and without (red lines) bias estimation.

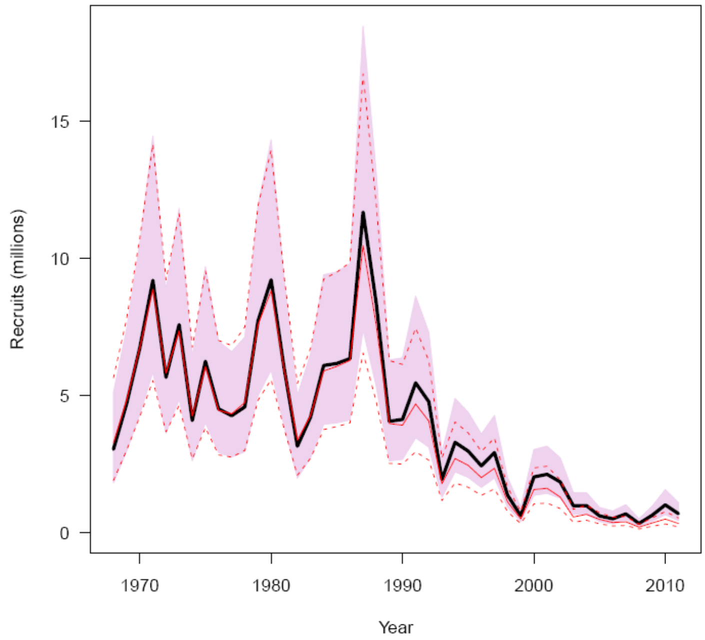


Figure 6.2.23c. Cod in ICES Division VIIa: Comparison plots for non-bootstrap SAM cod assessment estimates of recruitment at age 1 with (solid black line and shading) and without (red lines) bias estimation.

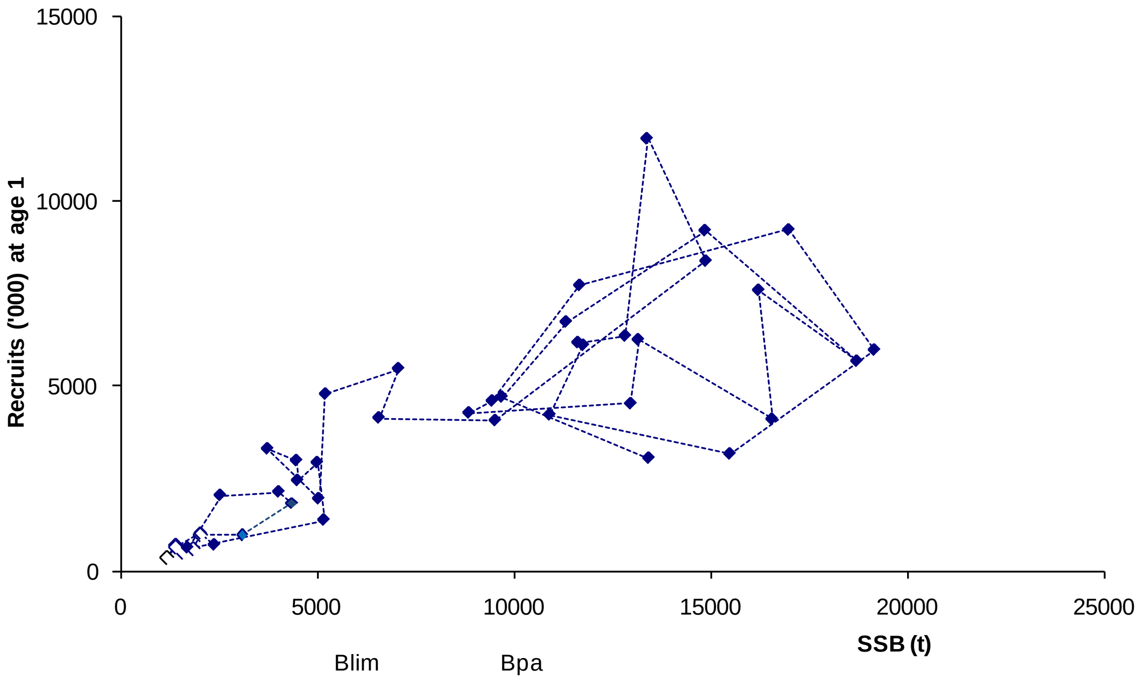


Figure 6.2.24. Cod in ICES Division VIIa: Stock–recruit data. The most recent ten year classes are indicated by open symbols.

6.3 Haddock in Division VIIa

Type of assessment

The Working Group performed an update assessment for this stock in 2012.

ICES advice applicable to 2011

In the advice for 2011, the stock status was presented as follows:

Fishing mortality	2007	2008	2009
F_{MSY}	Unknown	Unknown	Unknown
F_{PA}	Unknown	Unknown	Unknown
Spawning–stock biomass (SSB)	2008	2009	2010
MSY $B_{trigger}$	Unknown	Unknown	Unknown
B_{PA}/B_{lim}	Unknown	Unknown	Unknown

MSY approach

SSB is fluctuating widely considering the full time-series. The underlying data do not support the provision of estimates of F_{MSY}. However it is likely that current F is above F_{MSY} at the current selection pattern. Therefore, effort in fisheries that catch haddock should be reduced.

Management by TAC is inappropriate to this stock because landings-but not catches-are controlled. Management measures should be introduced in the Irish Sea to reduce discarding of small haddock in order to maximize their contribution to future yield and SSB.

PA considerations

There are no signs of impaired recruitment at recent catch levels. Therefore there should be no increase in effort relative to 2010.

ICES advice applicable to 2012

ICES advises based on precautionary considerations, that catches in 2012 should be reduced, and uptake of further technical measures to reduce discards.

Precautionary considerations

The exploitation status is unknown and SSB is fluctuating widely considering the full time series. Therefore catches should be reduced.

Management by TAC is inappropriate for this stock because landings – but not catches – are controlled. Management measures should be introduced in the Irish Sea to reduce discarding of small haddock in order to maximize their contribution to future yield and SSB.

6.3.1 General

Stock descriptions and management units

The stock and management units are both ICES Division VIIa (Irish Sea).

Management applicable to 2011 and 2012

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 2011 and 2012 are given below:

2011

Species: Haddock *Melanogrammus aeglefinus*		Zone: VIIa (HAD/07A.)
Belgium	21	
France	95	
Ireland	570	
United Kingdom	631	
EU	1 317	
TAC	1 317	Analytical TAC

2012

Species: Haddock *Melanogrammus aeglefinus*		Zone: VIIa (HAD/07A.)
Belgium	20	
France	91	
Ireland	542	
United Kingdom	598	
Union	1 251	
TAC	1 251	Analytical TAC

The minimum landing size for haddock in the Irish Sea is 30 cm.

Fishery in 2011

The characteristics of the fishery are described in the Stock Annex. An overview of the fisheries in the Irish Sea is given in Section 6.1.

The fishery in 2011 was prosecuted by the same fleets and gears as in recent years, with directed fishing prevented inside the cod closure in spring. The targeted white-fish fishery that developed during the 1990 using semi-pelagic trawls, continued to decline during 2011.

The reported uptake of TAC has been poor since 2004, with the exception of 2007. The estimated percentage uptake of UK, Irish and Belgium vessels in 2011 were 56% (estimated 355 t of 631 t quota), 76% (434 t of 570 t) and 78% (16 t of 21 t), respectively. The French fleet had <8% uptake of the TAC. For these figures, quota swaps have, however, not been taken into account.

Table 6.3.1 gives nominal landings of haddock from the Irish Sea (Division VIIa) as reported by each country to ICES since 1984.

6.3.2 Data

An overview of the data provided and used by the WG is provided in Table 2.1. The landings of the fleets sampled by quarter comprise 68% of the international total in 2011. 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 VIIa) as reported to ICES since 1972, together with Working Group estimates. The 1993–2005 WG estimates (excl. 2003) 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.

The methods for estimating quantities and composition of haddock landings from VIIa, 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 the Irish and Northern Irish discard data, raised to the number of trips, were updated. Discard numbers-at-age for the different sampled fleets are given in Table 6.3.5. The proportions of discards-by-age for the different sampled fleets are given in Table 6.3.6. There are various issues relating to the reliability of the data, which needs to be addressed at the next benchmark assessment for this stock.

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. Discard levels from the Irish otter trawl fleet are substantially less since 2010 compared to previous years; now of similar magnitude to the estimates from the Northern Irish otter-trawl fleets.

Using preliminary total estimates of discard numbers-at-age for the fleet (to be addressed at the benchmark in 2013) and the stock weights, indicate that total tonnage of discards from the fleet could be 250–750 t per year since 2008. This equates to discad rates of 20–50% 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 was assumed as 0.2 for all ages and years, and proportion mature knife-edged at age 2 for all years.

There is evidence of a decline in mean length of adult haddock 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 and quarter one commercial landings data for 2011. The time-series of length–weight parameters indicate a reduction in expected weight-at-length since 1996 (see Stock Annex for historical data):

	Length-weight parameters		Expected weight-at-length	
Year	A	B	30 cm	40 cm
2005	0.00489	3.174	238	593
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

The following parameter estimates were obtained (last year's estimates in parentheses):

Mean LI_{yc} = 78.2 cm (79.8); K = 0.194 (0. 189); t_0 = -0.437 (-0. 442)

Year-class effects giving estimates of asymptotic length relative to the mean were as follows (2010 and 2011 data were combined as there is only one observation for the 2011 year class):

Year class	Effect	Year class	Effect
1990	1.224	2001	0.990
1991	1.158	2002	0.951
1992	1.089	2003	0.897
1993	1.103	2004	0.826
1994	1.117	2005	0.846
1995	1.089	2006	0.833
1996	1.002	2007	0.840
1997	0.978	2008	0.885
1998	0.989	2009	0.899
1999	0.943	2010/2011	0.930
2000	0.962		

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. The close fit of the model to observed length-at-age data is shown by year class in Figure 6.3.1. The resultant stock weights-at-age are given in Table 6.3.7. 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 6.3.8. 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 1992–2012). Acronym changed from NIGFS-Mar to 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 2011). Acronym changed from NIGFS-Oct to NIGFS-WIBTS-Q4.
- UK (NI) Methot–Isaacs–Kidd (MIK) net survey in June (age 0; years 1994–2011).
- UK Fishery Science Partnership (FSP) Irish Sea roundfish survey, 2004–2012 (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 in 2010 and similar levels for 2011, with only the 2009 recruitment above average since 2007. Strong year classes were evident for all age groups in all surveys, indicating that the different surveys were capturing the prominent year-class signals in this stock (Figure 6.3.3). The strength of the 2011 year class is uncertain with the 0-gp survey indices indicating weaker recruitment than the quarter 1 survey at age 1 (Figure 6.3.3) used in the assessment. Correlation between survey indices by age is positive for all surveys and show high consistency within each fleet, but patchy consistency 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 obvious 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 (excl. 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 two years.

Commercial cpue

Commercial cpue data are available for this stock but are not currently used in the assessment.

Other relevant data

An IBTS-coordinated UK trawl survey started in the Irish Sea in November/December 2004. Survey index data from this survey have not yet been provided to the Working Group.

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 used last year, as described in the Stock Annex.

SURBA 3.0 was used for the assessment and model settings (similar to last year's assessment) are given below:

	WGCSE 2012
Year range:	1992–2012
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 quite large retrospective patterns in SSB (Figure 6.3.6) during the early 2000s, probably related to an overestimation of the 2001 year class. There are also large retrospective patterns in mortality estimates, highlighting the difficulty in estimating mortality for this stock.

The 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 6.3.9. The SURBA index of Z generally follows the much noisier empirical estimates. 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 since 2009. There is a slight increase in the 2012 SSB estimate following the stronger 2009–2010 recruitment. The recruitment estimates at age 1 indicate an average recruitment in 2011, following two years of above average recruitment. The strength of the 2011 year class is uncertain with conflicting survey indices (Figure 6.3.3), with the survey used in the assessment estimating recruitment to be higher than the 0-gp survey indices. 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

The perception of the stock has not changed since last year's assessment. Figure 6.3.9 compares the relative trends between the SURBA fitted estimates from this year's to last year's assessment. The two series show similar trends. The most recent SSB estimate indicates that the stock has increased following increased recruitment in 2009-10. The relative SSB estimate for 2011 is below the series average.

State of the stock

Stock trends indicate an increase in SSB over the time-series. SSB trend is declining since 2008, but is showing an increase in the last two years. The stock is characterized by highly variable recruitment. The model indicates above average recruitment for the 2009–2010 year class after below average recruitment for the 2007 and 2008 year classes. Recruitment in 2011 is uncertain due to conflicting survey indices. Total mortality remains stable.

WKLIFE explorations

WKLIFE classified this stock into category 4; stocks for which survey based analyses or indices indicate trends. The survey data show very coherent year-class signals and appear to give a very clear picture of the development of the stock. The SSB indices appear to respond dynamically to the very variable recruitment, as would be expected given the steep age profile in the surveys. Mortality indices are stable, but absolute scale of fishing mortality is unknown. WKLIFE did not recommend any specific procedure for category 4 stocks, which still require some future development. Some additional explorations were carried out at WGCSE 2012 to aid this process, but also mindful that the stock will be benchmarked next year.

Applying the survey rule proposed by the EU policy paper on fisheries management (17 May 2010, COM(2010) 241) the SSB in the last two years is 18% lower than the SSB in the three years previous to that and would suggest no change in TAC required. Subsequent simulation testing (WKLIFE) of this rule suggests that a change of 15% TAC if the 20% threshold change is met, will only keep the stock at its current level but will not be adequate if the stock is exploited well below or above F_{MSY}. Given the uncertainty in mortality estimates discussed above and conflicting signals of possible levels of mortality (steep age profile vs. proportion of catch to egg production SSB estimates), it is difficult to access the current level of exploitation in relation to reference points.

DCAC

Depletion corrected average catch, DCAC, is available in the NOAA toolbox (http://nft.nefsc.noaa.gov/DCAC.html). It is a "simple formula for estimating sustainable yields in data-poor situations" as stated in the original article on this model (MacCall, 2009). The formula is an extension of the potential yield formula, and it provides useful estimates of sustainable yield for data-poor fisheries on long-lived species. Wetzel and Punt (2011) simulation tested a number of methods used to set harvest levels for data-poor and data-limited stocks, including DCAC, and found that DCAC was fairly robust to mis-specification of M and F_{MSY}/M, but not to mis-specification of depletion (=$B_{current}/B_{virgin}$). They found that harvest levels set by DCAC were no longer conservative and led to overfishing when an overly optimistic depletion levels were assumed. So caution is needed when setting values for depletion in the application of DCAC.

WGCSE carried out a number of explorations with DCAC, although the method is probably inappropriate for such a dynamic stock. The model was insensitive to F_{MSY}/M values (ranging from 0.8–1.5, the later in associated with F_{MSY} estimates of other haddock stock of around 0.3) and a high depletion ratio of 0.5 (given the historic abundance trends of haddock in the Irish Sea and current SSB estimates being around the time-series average). The B_{MSY}/B_0 was taken to be 0.4 in line with the recommendations. The average DCAC was 1200–1350 t, which is around current TAC levels.

6.3.4 Short-term projections

No short-term forecast has been performed for this stock. This year the WG projected the SSB for 2013 using the 2012 survey information. Since maturity for the stock is considered as knife-edge at age 2, all the age classes that will comprise the 2013 SSB are already represented by the 2012 quarter one survey index. SSB for 2013 was projected using an average of the last three years total mortality from the SURBA model, a three year average of stock weights (2010–2012) and ten year geometric mean recruitment.

The projected SSB trend is illustrated in Figure 6.3.10, indicating a small decrease in SSB compared to 2012. SURBA fitted recruitment estimates are also compared to recruitment from the 0-gp indices (NIGF-WIBTS-Q4 and NIMIK), indicating that the model estimates might overestimate the strength of the 2009 and 2010 year classes, but the relative strengths of these year classes have been confirmed by subsequent surveys.

6.3.5 MSY evaluations

MSY evaluations have been performed by the 2010 Working Group and these have not been updated. The MSY evaluations were performed on a very limited dataset. Input data were taken from the last accepted catch-at-age assessment in 2002 from the ICES network (similar input data to the yield-per-recruit analysis presented in Table 6.3.11). The analysis was performed using the srmsymc ADMB package. The evaluation was based on this historical catch-at-age data, including the underlying problems with the accuracy of the data.

The three stock–recruit relationships fitted by srmsymc are illustrated in Figure 6.3.11. The high uncertainty around these fits reflects the shortage of information within the limited dataseries to inform any stock–recruit relationship. The data are very noisy with relatively high rejection rates for the Ricker and Beverton–Holt models. Mathematically there is very little to distinguish between the three models, based on the AIC values that indicate equal fits (Table 6.3.10). F reference points are poorly defined with wide distributions and very high levels of uncertainty (cv values are high for all three models). F_{MSY} values falls within the range of F_{crash} in all cases (Table 6.3.10).

Stock–recruit relationships are generally poorly defined for haddock stocks. These models assume a positive relationship between spawning–stock size and recruitment. However, haddock is characterized by sporadic high recruitment even at low spawning–stock levels making any relationship difficult to define. Recent trends within the Irish Sea haddock stock showed that an increase in spawning–stock biomass depends on these impulses of high recruitment, i.e. recruit–stock. Density-dependent growth is also evident by year class, which will have an effect on the overall yield of large year classes. This all makes an evaluation for the stock at equilibrium very difficult.

The Working Group is thus unable to provide absolute values for F_{MSY} or F_{MSY} proxies, as there are insufficient data to derive absolute estimates of F_{MSY} with any degree of precision.

There are some additional considerations in relations to exploitation levels to maximize long-term yield, which might indicate that current F might be above F_{MSY}:

- The stock has a high growth rate with considerable growth potential. Estimates of 0-gp and 1-gp discards are high, thus any improvement in the selectivity pattern would result in increased future yield.
- The age structure is narrow and is not recovering despite a significant decrease in overall effort from the midwater pelagic fleet.

6.3.6 Biological reference points

Precautionary approach reference points

There is currently no biological basis for defining appropriate reference points, in view of the rapid expansion of the stock size over a short period (ACFM, October 2002). ACFM (2007) proposed that F_{PA} be set at 0.5 by association with other haddock stocks, however, the Working Group no longer considers an F_{PA} value determined in association with other haddock stocks as appropriate. The absolute level of F in this stock at present is poorly known.

Yield and biomass-per-recruit

Yield-per-recruit (YPR) and SSB per recruit (SPR) for the Irish Sea stock were calculated by the 2004 WGNSDS, conditional on the exploitation pattern for landings in 2000–2002 given for ages 0 to 5+ by XSA, using MFYPR software. Long-term (1993–2003) catch weights and stock weights-at-age were used. Input data are given in Table 6.3.11, and the summary output is given in Table 6.3.12. The YPR and SPR curves are plotted in Figure 6.3.12. The deterministic output from this model is, however, highly uncertain. Figure 6.3.12 illustrates the uncertainty in the yield-per-recruit curve. Any estimate from the analysis is highly uncertain (high cv values in Table 6.3.10) implying poorly defined F reference point as well as the absolute level of yield. The main problem with the historical yield-per-recruit analysis is the absence of discard fishing mortality and should be addressed at the next benchmark.

6.3.7 Management plans

There is no specific management plan for haddock in the Irish Sea. Due to the bycatch of cod in the haddock fishery, the regulations affecting Irish Sea haddock remain linked to those implemented under the cod management plan (Council Regulation (EC) 1342/2008).

6.3.8 Uncertainties and bias in assessment and forecast

This assessment is based on survey trends only as recent levels of catch are uncertain. After a period of poor sampling of landings for length and age, the sampling levels and coverage since 2007 are adequate to allow compilation of catch-at-age data. Discard sampling levels also increased significantly in the last three years. The highly variable and very large estimates of discarding for this fleet observed by previous WG are still evident. Historical landings data for this stock are uncertain, but sample-based estimates of landings suggest that the accuracy of officially reported landings has improved substantially since 2006. The recent catch-at-age data (2003–2006) are still considered too inaccurate, due to poor sampling information, to form the basis for a traditional analytical assessment based on catch-at-age data.

The narrow age range in the haddock stock and the resulting small numbers caught at older ages in the surveys restricted the number of age classes that could be used in the model. This and the differences in catchability-at-age between surveys make the total mortality difficult to estimate. The survey data used in the assessment are quite consistent both internally and between fleets, probably due to the very large data contrast between year-class strengths as well as the restricted distribution of the stock. The recruitment pattern for this stock since the early 1990s is relatively well established and can be tracked fairly consistently through both the surveys and commercial catches. Hence it can be established with some confidence how, qualitatively, the catch and stock is likely to be impacted in the short term by recent year classes.

Knowledge of basic biology of Irish Sea haddock is expanding through data on growth, maturity and distribution obtained during trawl surveys. Patterns of movement within the Irish Sea and between the Irish Sea and surrounding areas are poorly understood, and it is assumed that the Irish Sea stock is essentially self-sustaining at present. Trends in length and weight-at-age in the stock over time are apparent and reduced growth appears to have coincided with the growth of the stock. This may represent density-dependent growth effects (although other environmental factors may contribute) that will affect any forecast and lead to overoptimistic forecast estimates unless correctly predicted.

The projected survey estimate of biomass should only be used for interpreting trends rather than a relative estimate. F/Z is poorly estimated and currently unknown. The problem is with using Z-M as a proxy for F in the SURBA-based assessment, when total mortality from the model is poorly defined. The SURBA Z-values are only a relative measure and do not mean anything unless the catchability-at-age in the survey(s) are quantified. The SURBA Z-values cannot be taken as an absolute, which makes effort based management very difficult, especially measured against a non-stock specific reference point.

The Annual Egg Production (AEMP) survey estimates of haddock SSB confirm the trend in SSB from the assessment. The absolute estimates in 2006 and 2008 (8.8 kt and 9.4 with CV of 32% and 24%, respectively) are very large compared to the WG landings of 650 and 870 t for these years. Even when discard estimates at age 2+ are taken into account the total catch estimates are ~1000–1200 t (from raised discard estimates by fleet Table 6.3.5 and stock weights) during this period. This would imply a much lower mortality than given by the age profile in the groundfish surveys (which indicate Z of around 1.5). There is, however, no evidence from any fishery data for an age composition that would reflect low mortality. The AEMP estimate for 2010 is in contrast to the 2006 and 2008 estimates, substantially lower at 870 t (CV of 26%) corresponding to landing of 940 t and catch estimates of ~1100 t.

The additional recruitment survey indices indicate low recruitment in the last year, which is in conflict with the above average recruitment indicated by the survey based assessment. The NIGFS-WIBTS-Q4 survey has good internal consistency (see Stock Annex) and both 0-gp indices appear to indicate relative year-class strength well historically (Figure 6.3.2 and 6.3.3).

The perception of the stock from this year's assessment does not differ qualitatively from that obtained last year.

6.3.9 Recommendations for next benchmark assessment

The primary concern with this stock is that recent catch-at-age data are considered inaccurate to form the basis for a traditional analytical assessment based on catch-at-age data. This has been attributed to poor sampling information, which has improved in the last two years. The absence of reliable discard estimates is also serious deficiency that must be addressed if management is to be based on catch-at-age analysis. Levels of discard sampling have increased substantially in the last three years and reliable discards-at-age matrix could be formulated over the next few years.

The problems in terms of generating reliable catch-at-age numbers for this stock are not likely to be solved in the short term. Furthermore, with the sharp decline in whitefish directed effort in the Irish Sea, sampling opportunities for haddock from landings, are not likely to improve.

Given the availability of data other than those used in the survey assessment (other survey data; egg production estimates; discards data) there is an urgent need for a data compilation workshop and benchmark assessment for this stock to establish a more comprehensive evidence base and a robust quantitative procedure for developing management advice. Benchmarking alongside the haddock VIIb–k stock would be beneficial.

6.3.10 Management considerations

Following decades of very low recruitment and biomass as indicated by very low fishery catches, this stock grew substantially in the 1990s following sudden 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 2000–2011, 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. The current directed fishery for haddock in the Irish Sea is likely to generate bycatches of cod in the same area.

Sampling schemes 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 70–89 mm mesh nets. Samples from whitefish vessels since the introduction of 100+ mm mesh and other recent technical measures are too few to form a basis for evaluation of discards in that fleet. Discard rates could be reduced by using more selective fishing gears in the small mesh fisheries. The decline in growth rate might also result in discarding occurring at progressively older ages. However, any measures to reduce discards will result in increased future yield.

ICES notes that there have been a number of industry and national initiatives to reduce discarding associated with *Nephrops* fisheries. The Northern Irish fleet have developed a novel square mesh panel designs (Briggs, 2010), which has been evaluated by STECF. STECF concluded that based on the experimental trials, the proposed gear should lead to a large reduction in the discarding of haddock and whiting <20 cm (STECF, 2012). The Irish *Nephrops* fleet have expanded the use of sorting grids and separator trawls as the use of more species selective is now mandatory. Such initiatives, if implemented, should lead to significant reductions in discards if effectively implemented into the fisheries. It is important that the effectiveness of these devices and their impact on discards and landings are monitored and evaluated.

Current TAC management measures are not responsive enough considering the dynamic nature of changes in stock abundance. Under the assumption of constant effort, the increase in abundance from 2005–2008, created increased catch opportunities. During this period the TAC remained relatively constant and resulted in increased discarding of older fish (particularly in 2007). The TAC for 2009 was increased based on the increasing trend of stock abundance, despite evidence of weaker recruitment and possible decreasing abundance.

Landings data have not been used in the assessment. Landings data for this stock are uncertain because of species misreporting, which has been estimated from quayside observations in one country only. 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 very 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.

Table 6.3.1. Nominal landings (t) of HADDOCK in Division VIIa, 1984–2011, 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 (England & Wales)[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 (England & Wales)[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
Belgium	15	22	23	30	15	7	9	16*
France	20	36	20	11	6	3	2	9*
Ireland	296	139	184	477	319	388	333	432*
Netherlands	-	-		-	-	-	-	-
UK (England & Wales)[1]	421	344	419	559	521	446	593	
UK (Isle of Man)	-	-	-	-	1	1	-	-
UK (N. Ireland)	…	…	…	…	…	…	…	…
UK (Scotland)	9	6	9	1	17	1	2	
United Kingdom								354*
Total	761	547	655	1078	879	846	939	813*

* Preliminary.

[1] 1989–2011 Northern Ireland included with England and Wales.

n/a = not available.

Table 6.3.2. Haddock in VIIa. Total international landings of haddock from the Irish Sea, 1972–2011, 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.

Year	Official landings	WG landings
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	1043
1995	841	1753
1996	1453	3023
1997	1925	3391
1998	3015	4902
1999	2370	4129
2000	2447	1380
2001	2229	2498
2002	1115	1972
2003	674	n/a
2004	761	1278
2005	547	699
2006	655	647
2007	1078	1066
2008	879	872
2009	846	843
2010	939	942
2011	n/a	813

Table 6.3.3. Haddock in VIIa: Catch numbers-at-age (=landings number-at-age; no discard data included).

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
AGE																			
0	0	0	0	0	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0
1	94	30	1341	109	1285	100	91	459	597	120	n/a	54	38	7	13	111	93	18	23
2	1250	123	1322	4619	700	6427	519	915	2263	632	n/a	203	523	340	918	391	590	365	713
3	18	861	107	735	2411	292	4462	238	1116	1853	n/a	751	133	631	695	802	686	484	318
4	1	3	222	16	203	539	49	374	80	196	n/a	76	219	74	141	239	185	524	103
+gp	1	2	5	30	16	35	72	28	127	28	n/a	97	43	78	52	67	56	116	128
0 TOTALNUM	1364	1019	2997	5509	4615	7393	5193	2014	4183	2829	n/a	1181	956	1130	1819	1610	1610	1507	1284
TONSLAND	813	1043	1753	3023	3391	4902	4129	1380	2498	1971	n/a	1278	699	647	1066	872	843	942	813
SOPCOF %	100	100	100	100	95	100	100	97	100	100	n/a	100	99	100	100	100	100	100	100

Table 6.3.4. Haddock in VIIa: 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
	AGE																			
0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1		0.351	0.346	0.361	0.346	0.348	0.19	0.325	0.329	0.3	0.279	0.367	0.401	0.273	0.244	0.240	0.300	0.306	0.327	0.305
2		0.596	0.56	0.545	0.474	0.592	0.53	0.416	0.474	0.452	0.357	0.411	0.519	0.417	0.354	0.440	0.377	0.427	0.399	0.490
3		1.688	1.103	0.898	0.917	1.002	1.13	0.802	0.786	0.859	0.749	0.700	1.007	0.697	0.505	0.638	0.534	0.507	0.534	0.643
4		2.52	2.73	1.983	2.034	1.349	2	2.064	1.573	1.243	1.361	1.098	1.940	1.256	0.872	0.786	0.743	0.779	0.728	0.853
	+gp	2.52	2.522	2.178	2.682	1.955	2.55	2.854	2.365	1.869	2.107	1.789	2.544	2.268	1.841	1.987	1.261	1.266	1.304	1.286
0	SOPCOFAC	0.9995	1.0008	1.0007	1.0029	0.9465	0.9958	0.9996	0.9675	1.0002	0.9991									

***calculated from average (1999–2002) catch weight–stock weight ratio by age (see Section 9.3 WGNSDS 2004).**

Table 6.3.5. Haddock in VIIa: Estimates of Irish Sea haddock discards 1995–2011. Data are numbers ('000 fish) discarded by the fleet, estimated from numbers per sampled trip raised to total fishing effort by each fleet, for the range of quarters indicated. Tables (b) and (d) represent estimates from limited observer sampling of N.Ireland vessels also included within the self-sampling estimates for N.Ireland trawlers catching Nephrops (Table (a)). Table (f) is the total for sampled fleets and quarters, excluding missing quarters or fleets. Table (e) is the revised figures supplied to the 2005 WG.

a) Self sampling scheme: N.Ireland single trawl Nephrops vessels. Estimates are extrapolated to all N.Ireland vessels catching *Nephrops* (single and twin trawl)

	1996 Q1-4	1997 Q1-4	1998 Q1-4	1999 Q1-4	2000 Q1-4	2001 Q1-4	2002 Q1-4	2003 Q1	2004	2005	2006	2007	2008 Q2-4	2009 Q1-4	2010 Q1-4	2011 Q1-4
Age	43 trips	39 trips	48 trips	39 trips	44 trips	43 trips	35 trips	8 trips					114	136	100	86
0	4485	100	1552	1274	110	1083	851	0	n/a	n/a	n/a	n/a	1312	7058	3830	5393
1	229	1209	318	342	2384	140	1073	62	n/a	n/a	n/a	n/a	601	1015	2219	5389
2	179	88	210	69	253	199	37	28	n/a	n/a	n/a	n/a	156	651	83	1162
3	0	0	0	0	0	0	11	0	n/a	n/a	n/a	n/a	5	253	11	16

(b) Observer scheme: N.Ireland vessels catching *Nephrops* (single trawl only) (*not raised to fleet level – no. of fish)

	1999 Q3-4	2000 Q1-3	2001 Q1	2006 Q3-4*	2007 Q1-4	2008 Q1-4	2009 Q1-4	2010 Q1-4	2011 Q1-4
Age	4 trips	6 trips	1 trip	9 trips	29 trips	55 trips	30 trips	36 trips	24 trips
0	2185	210	0	8391	901	625	1609	924	909
1	22	280	1677	809	1553	295	284	763	448
2	0	57	1593	60	681	124	101	16	77
3	0	0	0	15	74	16	23	1	1
4	0	0	0	0	0	1	0	0	0

(c) Observer scheme: N.Ireland midwater trawl

	1997 Q2-4	1998 Q1-3	1999 Q3-4	2000 Q1	2001 Q1	2008 Q4	2009 Q2	2010 Q1,2,4	2011
Age	n/a	n/a	5 trips	4 trips	2 trips	1 trip	1 trip	3 trip	0 trips
0	0	0	68	0	0	0	0	0	
1	178	316	96	20	0.4	7	1	33	
2	19	1342	35	83	19	15	39	28	
3	4	0	2	5	0	2	19	4	

(d) Observer scheme: N.Ireland twin trawl (*not raised to fleet level – no. of fish)

	1997 Q2-4	1998 Q1-3	1999 Q4	2000 Q1-4	2001 Q1	2006 Q3-4*	2007 Q1-4	2008 Q1-4	2009 Q1-4	2010 Q1-4	2011 Q1-4
Age	n/a	n/a	1 trips	10 trips	2 trips	2 trip	14 trips	16 trips	18 trips	21 trips	14 trips
0	34	4	26	10	0	363	369	676	3219	493	157
1	284	205	3	13	3	59	275	183	315	1849	298
2	6	382	0	10	19	9	77	70	600	277	197
3	0.5	0	0	0	0	0	9	6	200	39	3
4	0	0	0	0	0	0	0	0	1	3	1

Table 6.3.5 (Cont). Haddock in VIIa: Estimates of Irish Sea haddock discards 1995–2011.

(e) Observer scheme: Republic of Ireland otter trawlers

	1996 Q1-4	1997 Q1-4	1998 Q1-4	1999 Q1-4	2000 Q1-4	2001 Q1-4	2002 Q1-4	2003 Q1-4	2004 Q1-4	2005 Q1-4	2006 Q1-4	2007 Q1-4	2008 Q1-4	2009 Q1-4	2010 Q1-4	2011 Q1-4
Age	8 trips	8 trips	7 trips	4 trips	10 trips	2 trips	1 trip	9 trips	11 trips	8 trips	5 trips	16 trips	18 trips	18 trips	4 trips	6 trips
0	3808	165	565	87	182	5349	47	1169	5663	776	3966	1122	322	5759	233	885
1	713	11396	1973	58	2193	7354	31	1747	6566	2350	10140	8735	1226	5654	374	647
2	297	303	3564	59	580	140	0	1178	2301	996	3856	3995	783	334	105	311
3	0	0	0	0	0	15	0	10	225	120	132	435	44	72	57	3
4	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0

(f) Observer scheme: Republic of Ireland GEAR TECH otter trawlers (using grids)

	2010	2011
Age	9 trips	4 trips
0	43	256
1	125	67
2	43	11
3	26	0
4	1	0

(g) Total for sampled fleets and quarters: NI self sampling scheme (a); NI midwater trawl (c); ROI otter trawl (e)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008*	2009*	2010*	2011*
Age	51 trips	n/a	n/a	48 trips	58 trips	47 trips	36 trips	17 trips	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
0	8293	265	2117	1429	292	6432	898	1169	n/a	n/a	n/a	n/a	1291	10092	2653	4292
1	942	12783	2607	496	4597	7494	1104	1809	n/a	n/a	n/a	n/a	1681	6304	2023	3632
2	476	410	5116	163	916	358	37	1206	n/a	n/a	n/a	n/a	938	749	225	941
3	0	4	0	2	5	15	11	10	n/a	n/a	n/a	n/a	57	229	93	11
4	0	0	0	0	0	0	0	0	n/a	n/a	n/a	n/a	3	0	1	0

* provisional - total discards to be reconstructed during benchmark in 2013 (= avg(a+b) +c+e+f (for 2008-11)

Table 6.3.6. Haddock in VIIa: Proportion by number-at-age discarded by sampled fleets.

		Proportion discarded			
Fleet	Period	age 0	age 1	age 2	age 3
Midwater trawl	Q2-Q4 1997		0.93	0.37	0.02
Midwater trawl	Q1-Q3 1998		0.99	0.16	0.00
Midwater trawl	Q3-Q4 1999	1.00	0.79	0.31	0.00
Midwater trawl	Q1 2000		1.00	0.44	0.04
Midwater trawl	Q1 2001		1.00	0.30	
Midwater trawl	Q4 2008	1.00	0.97	0.90	0.30
Midwater trawl	Q2 2009		-	0.44	0.14
Midwater trawl	Q1-2,4 2010	1.00	0.92	0.22	0.03
Single Nephrops	Q3-Q4 1999	1.00	0.94		
Single Nephrops	Q1-Q3 2000	1.00	0.97	0.45	
Single Nephrops	Q1 2001		1.00	0.49	
Single Nephrops	Q3-Q4 2006	1.00	1.00	0.96	0.50
Single Nephrops	Q1-Q4 2007	1.00	1.00	0.94	0.79
Single Nephrops	Q1-Q4 2008	1.00	0.99	0.78	0.18
Single Nephrops	Q1-Q4 2009	1.00	1.00	0.88	0.46
Single Nephrops	Q1-Q4 2010	1.00	1.00	0.96	0.68
Single Nephrops	Q1-Q4 2011	1.00	1.00	0.94	0.21
Twin trawl	Q2-Q4 1997	1.00	1.00	0.61	0.04
Twin trawl	Q1-Q3 1998	1.00	1.00	0.76	0.00
Twin trawl	Q4 1999	1.00	1.00		
Twin trawl	Q1 – Q4 2000	1.00	0.96	0.28	
Twin trawl	Q1 2001		1.00	0.12	
Twin trawl	Q3-Q4 2006	1.00	1.00	0.81	0.00
Twin trawl	Q1-Q4 2007	1.00	1.00	0.91	0.63
Twin trawl	Q1-Q4 2008	1.00	0.95	0.50	0.05
Twin trawl	Q1-Q4 2009	1.00	0.99	0.95	0.75
Twin trawl	Q1-Q4 2010	1.00	1.00	0.85	0.42
Twin trawl	Q1-Q4 2011	1.00	1.00	0.80	0.08
OTB	Q1-Q4 2007	1.00	1.00	0.93	0.65
OTB	Q1-Q4 2008	1.00	0.97	0.90	0.17
OTB	Q1-Q4 2009	1.00	1.00	0.62	0.24
OTB	Q1-Q4 2010	1.00	0.99	0.59	0.29
OTB	Q1-Q4 2011	1.00	0.99	0.63	0.03

Table 6.3.7. Haddock in VIIa: stock weights-at-age.

Stock 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
AGE																				
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.097	0.086	0.088	0.085	0.072	0.061	0.058	0.049	0.053	0.057	0.051	0.042	0.032	0.035	0.034	0.035	0.04	0.042	0.049	0.043
2	0.437	0.351	0.361	0.376	0.369	0.263	0.233	0.236	0.208	0.222	0.239	0.204	0.172	0.133	0.146	0.139	0.144	0.168	0.176	0.198
3	1.12	0.993	0.802	0.805	0.887	0.755	0.574	0.518	0.554	0.481	0.493	0.522	0.464	0.389	0.307	0.327	0.321	0.332	0.382	0.386
4	1.846	2.108	1.709	1.314	1.432	1.389	1.283	0.964	0.922	0.969	0.793	0.81	0.903	0.792	0.682	0.516	0.58	0.557	0.567	0.632
+gp	2.625	3.109	3.191	2.481	2.129	1.992	2.111	1.929	1.597	1.456	1.39	1.173	1.238	1.347	1.263	1.04	0.858	0.889	0.844	0.826

Table 6.3.8. Haddock in VIIa: Available tuning data (file name: h7ani.tun).

```
IRISH SEA haddock,2012 WG,ANON,COMBSEX,TUNING DATA(effort, nos at age)
104
NIGFS-WIBTS-Q1
1992 2012
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
```

Fleets below not included in assessment

```
NIGFS-WIBTS-Q4
1991 2011
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
NIMIK
1994 2011
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
```

Table 6.3.9. Haddock in VIIa: SURBA 3.0 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	0.346	0.013	0	0	0	0.636	0.688	1.099	1.299	1.299
1993	0.055	0.183	0.007	0	0	0.829	0.897	1.432	1.693	1.693
1994	0.395	0.024	0.075	0.002	0	0.998	1.079	1.724	2.037	2.037
1995	5.558	0.146	0.008	0.013	0	1.280	1.385	2.212	2.614	2.614
1996	0.459	1.545	0.037	0.001	0.001	0.909	0.983	1.570	1.856	1.856
1997	9.134	0.185	0.578	0.008	0	1.227	1.327	2.120	2.506	2.506
1998	0.726	2.678	0.049	0.069	0.001	1.212	1.311	2.094	2.475	2.475
1999	2.893	0.216	0.722	0.006	0.006	1.187	1.283	2.05	2.423	2.423
2000	5.546	0.883	0.06	0.093	0.001	1.078	1.166	1.863	2.202	2.202
2001	1.195	1.886	0.275	0.009	0.01	1.186	1.283	2.049	2.422	2.422
2002	6.885	0.365	0.523	0.035	0.001	0.806	0.872	1.393	1.646	1.646
2003	2.131	3.075	0.153	0.130	0.007	0.982	1.063	1.697	2.006	2.006
2004	6.859	0.798	1.063	0.028	0.018	1.100	1.190	1.901	2.246	2.246
2005	10.073	2.283	0.243	0.159	0.003	1.068	1.155	1.845	2.181	2.181
2006	6.538	3.463	0.72	0.038	0.018	0.929	1.004	1.604	1.896	1.896
2007	10.671	2.583	1.269	0.145	0.006	0.964	1.043	1.666	1.969	1.969
2008	3.130	4.069	0.911	0.240	0.020	1.179	1.276	2.038	2.409	2.409
2009	2.112	0.962	1.137	0.119	0.022	1.195	1.292	2.064	2.440	2.440
2010	6.140	0.64	0.264	0.144	0.010	1.138	1.230	1.966	2.323	2.323
2011	6.589	1.968	0.187	0.037	0.014	1.266	1.369	2.187	2.585	2.585
2012	4.863	1.858	0.501	0.021	0.003	1.199	1.297	2.072	2.449	2.449
Stock summary										
Year	Recruits (age 1)	log SE (rec)	SSB	TSB	Z(2-3)	SE (Z)				
1992	0.346	0.344	0.006	0.040	0.893	0.364				
1993	0.055	0.281	0.087	0.093	1.164	0.26				
1994	0.395	0.253	0.086	0.120	1.401	0.204				
1995	5.558	0.269	0.083	0.572	1.798	0.179				
1996	0.459	0.236	0.614	0.653	1.277	0.200				
1997	9.134	0.249	0.592	1.250	1.724	0.172				
1998	0.726	0.247	0.839	0.883	1.703	0.169				
1999	2.893	0.247	0.485	0.653	1.667	0.168				
2000	5.546	0.240	0.330	0.602	1.515	0.171				
2001	1.195	0.253	0.570	0.633	1.666	0.170				
2002	6.885	0.229	0.368	0.761	1.132	0.175				
2003	2.131	0.237	0.923	1.031	1.380	0.174				
2004	6.859	0.243	0.761	1.049	1.545	0.171				
2005	10.073	0.242	0.652	0.975	1.500	0.170				
2006	6.538	0.235	0.795	1.024	1.304	0.173				
2007	10.670	0.235	0.873	1.235	1.354	0.174				
2008	3.130	0.246	1.008	1.118	1.657	0.171				
2009	2.112	0.254	0.591	0.675	1.678	0.168				
2010	6.140	0.266	0.285	0.543	1.598	0.171				
2011	6.589	0.310	0.451	0.774	1.778	0.181				
2012	4.863	0.387	0.577	0.786	1.685	0.038				

Table 6.3.10. Haddock VIIa: Estimates of biomass and fishing mortality reference levels derived from the fit of three stock and recruit relationships and the yield per recruit F_{MSY} proxies.

Stock name
Had-7a
Sen filename
had-7a.sen
pf, pm
0 0
Number of iterations
1000
Simulate variation in Biological parameters
TRUE
SR relationship constrained
TRUE

Ricker
767/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta	AIC
Deterministic	1.45	0.46	4629	2523	1.15	0.30	4.04	0.00022	34.25
Mean	1.36	0.55	7784	4833	1.70	0.44	8.15	0.00033	
5%ile	0.44	0.21	1594	1414	0.74	0.07	2.29	5.00E-05	
25%ile	0.72	0.33	2507	2195	1.07	0.24	3.65	0.00018	
50%ile	1.07	0.47	3441	2778	1.42	0.42	5.49	0.00031	
75%ile	1.68	0.65	5575	3732	2.02	0.60	8.96	0.00044	
95%ile	3.36	1.22	17254	8047	3.43	0.93	21.81	0.0007	
CV	0.67	0.62	4.86	5.25	0.61	0.61	1.13	0.61	

Beverton-Holt
813/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta	AIC
Deterministic	2.80	0.29	7030	2580	0.44	0.80	7964	1111	34.12
Mean	1.15	0.20	58936	9346	0.45	1.31	41130	22121	
5%ile	0.31	0.07	2363	848	0.05	0.63	3484	153	
25%ile	0.51	0.14	4913	1657	0.22	0.89	5903	1014	
50%ile	0.82	0.19	9186	2574	0.38	1.12	9186	2705	
75%ile	1.46	0.25	19246	4389	0.59	1.45	16093	6579	
95%ile	3.15	0.36	129006	17393	1.00	2.31	70557	40158	
CV	0.82	0.43	7.6	8.4	1.27	0.80	11.25	13.45	

Smooth hockeystick
918/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta	AIC
Deterministic	0.87	0.41	5359	2661	0.49	0.92	1.27	2727	34.55
Mean	0.90	0.38	10384	3359	0.60	0.99	1.56	2941	
5%ile	0.33	0.14	2439	1534	0.30	0.49	0.78	1439	
25%ile	0.50	0.28	3943	2304	0.43	0.66	1.13	1960	
50%ile	0.69	0.37	5546	3010	0.56	0.95	1.45	2797	
75%ile	1.04	0.47	8645	4073	0.71	1.30	1.85	3830	
95%ile	2.05	0.66	22638	6218	1.06	1.64	2.76	4840	
CV	0.77	0.42	2.44	0.48	0.41	0.38	0.41	0.38	

Per recruit

	F35	F40	F01	Fmax	Bmsypr	MSYpr	Fpa	Flim
Deterministic	0.24	0.20	0.20	0.41	0.77	0.38	0	0
Mean	0.20	0.17	0.18	0.39	1.20	0.39		
5%ile	0.05	0.04	0.05	0.15	0.39	0.28		
25%ile	0.15	0.12	0.14	0.29	0.55	0.34		
50%ile	0.20	0.17	0.19	0.38	0.71	0.38		
75%ile	0.26	0.22	0.23	0.48	0.97	0.44		
95%ile	0.34	0.29	0.29	0.67	2.20	0.55		
CV	0.44	0.43	0.39	0.43	2.06	0.22		

Table 6.3.11. Haddock in VIIa: Input for yield/Recruit.

MFYPR version 2a
Run: Had7a_2004WG_yield
Had7a_2004WG_yieldMFYPR Index file 11/05/2004
Time and date: 10:55 13/05/2004
Fbar age range: 2-4

Age	M	Mat	PF	PM	SWt	Sel	CWt
0	0.2	0	0	0	0.000	0.000	0.000
1	0.2	0	0	0	0.061	0.140	0.322
2	0.2	1	0	0	0.302	0.544	0.492
3	0.2	1	0	0	0.754	1.118	0.967
4	0.2	1	0	0	1.377	1.057	1.814
5	0.2	1	0	0	2.259	1.057	2.308

Weights in kilograms

Table 6.3.12. Haddock in VIIa: Yield per recruit output table.

MFYPR version 2a
Run: Had7a_2004WG_yield
Time and date: 10:55 13/05/2004
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	5.8695	3.6979	5.8200	3.6979	5.8200
0.1000	0.0906	0.2211	0.3492	4.4167	3.5229	2.5980	3.4733	2.5980	3.4733
0.2000	0.1813	0.3298	0.4658	3.8781	2.4296	2.0593	2.3801	2.0593	2.3801
0.3000	0.2719	0.3951	0.5037	3.5564	1.8139	1.7377	1.7644	1.7377	1.7644
0.4000	0.3626	0.4390	0.5098	3.3412	1.4279	1.5225	1.3783	1.5225	1.3783
0.5000	0.4532	0.4709	0.5022	3.1861	1.1681	1.3674	1.1186	1.3674	1.1186
0.6000	0.5439	0.4952	0.4888	3.0683	0.9843	1.2496	0.9347	1.2496	0.9347
0.7000	0.6345	0.5146	0.4735	2.9752	0.8490	1.1564	0.7995	1.1564	0.7995
0.8000	0.7252	0.5305	0.4580	2.8993	0.7464	1.0805	0.6969	1.0805	0.6969
0.9000	0.8158	0.5438	0.4431	2.8358	0.6666	1.0171	0.6170	1.0171	0.6170
1.0000	0.9065	0.5552	0.4293	2.7818	0.6030	0.9631	0.5535	0.9631	0.5535
1.1000	0.9971	0.5651	0.4167	2.7350	0.5515	0.9163	0.5019	0.9163	0.5019
1.2000	1.0878	0.5739	0.4052	2.6939	0.5090	0.8751	0.4594	0.8751	0.4594
1.3000	1.1784	0.5817	0.3947	2.6573	0.4733	0.8386	0.4238	0.8386	0.4238
1.4000	1.2691	0.5887	0.3853	2.6245	0.4431	0.8057	0.3936	0.8057	0.3936
1.5000	1.3597	0.5951	0.3768	2.5947	0.4172	0.7760	0.3676	0.7760	0.3676
1.6000	1.4503	0.6009	0.3692	2.5676	0.3946	0.7489	0.3451	0.7489	0.3451
1.7000	1.5410	0.6063	0.3622	2.5427	0.3749	0.7240	0.3253	0.7240	0.3253
1.8000	1.6316	0.6113	0.3559	2.5197	0.3574	0.7010	0.3079	0.7010	0.3079
1.9000	1.7223	0.6159	0.3501	2.4983	0.3418	0.6796	0.2923	0.6796	0.2923
2.0000	1.8129	0.6202	0.3449	2.4784	0.3278	0.6597	0.2783	0.6597	0.2783

Reference point	F multiplier	Absolute F
Fbar(2-4)	1.0000	0.9065
FMax	0.3811	0.3455
F0.1	0.2074	0.188
F35%SPR	0.2494	0.2261

Weights in kilograms

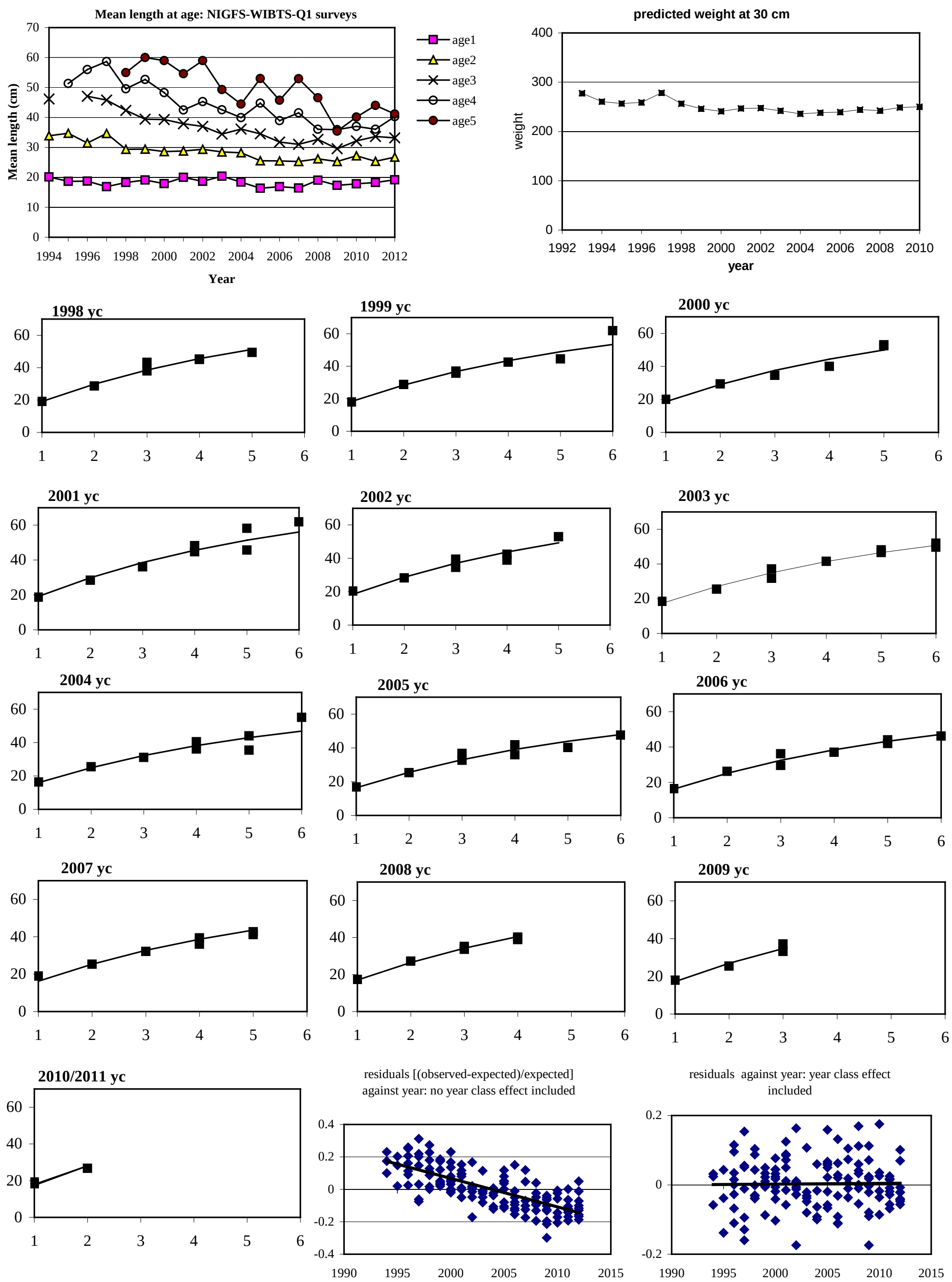


Figure 6.3.1. Haddock in VIIa: Growth of haddock in the Irish Sea. Top two panels: mean length-at-age in UK(NI) groundfish surveys in March (NIGFS-WIBTS-Q1), by year and age, and expected mean weight-at-length based on length–weight parameters from each survey. Lower panels: mean length-at-age from March 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.

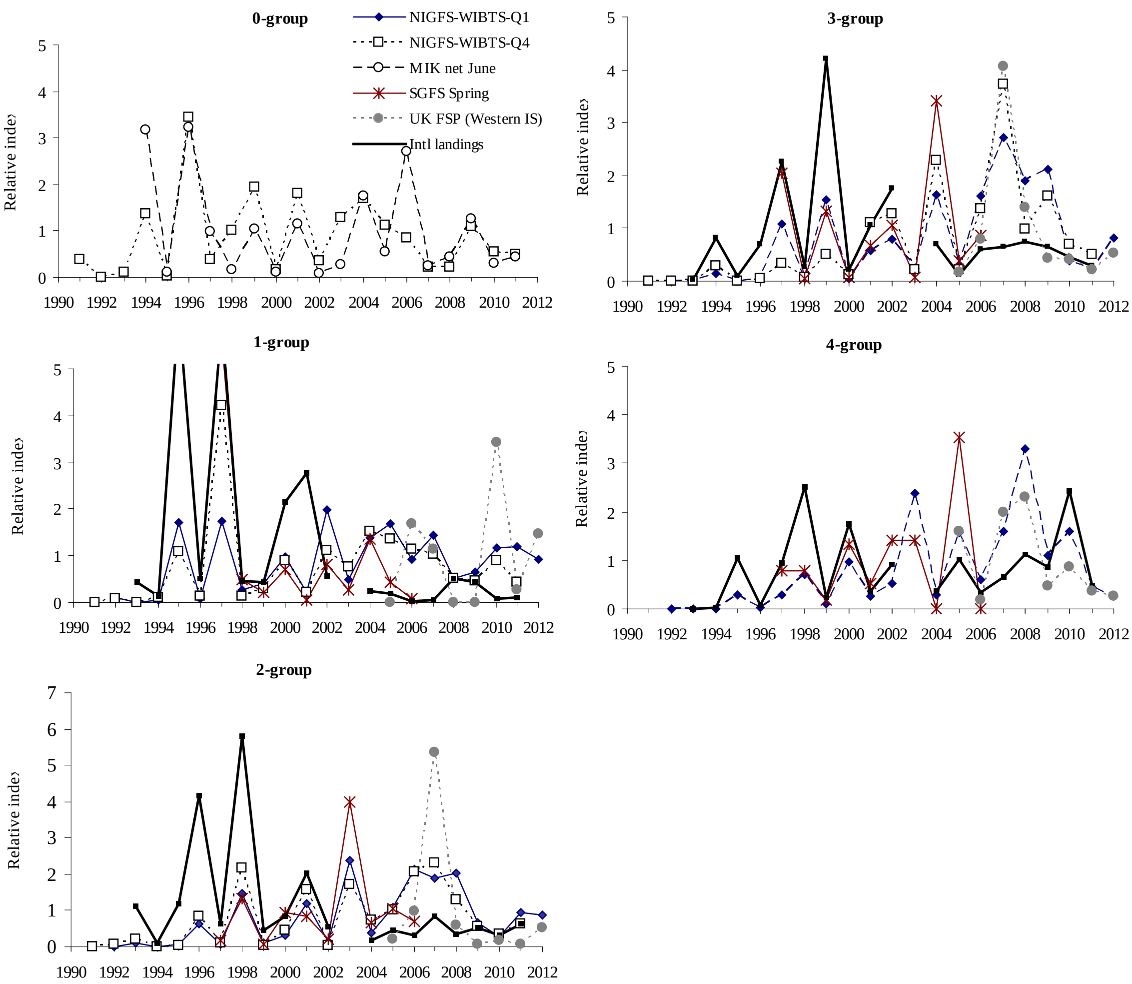


Figure 6.3.2. Haddock in VIIa: Trends in raw survey indices compared with international landings, by age class and year. All values are standardised to the mean for years common to all series in each plot (except for short FSP series).

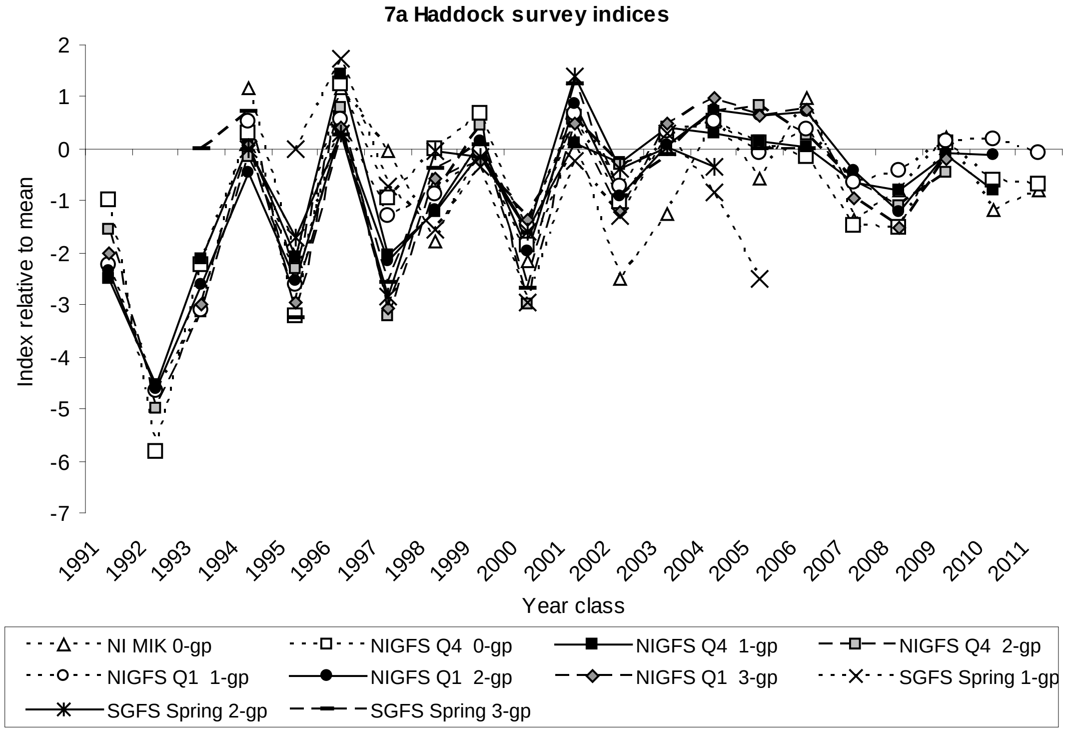


Figure 6.3.3. Haddock in VIIa: Time-series plots of the logarithms of survey indices at age by year class, after standardising by dividing by the series mean for years from 1991. Data have only been illustrated for the most abundant ages for comparison of year-class signals.

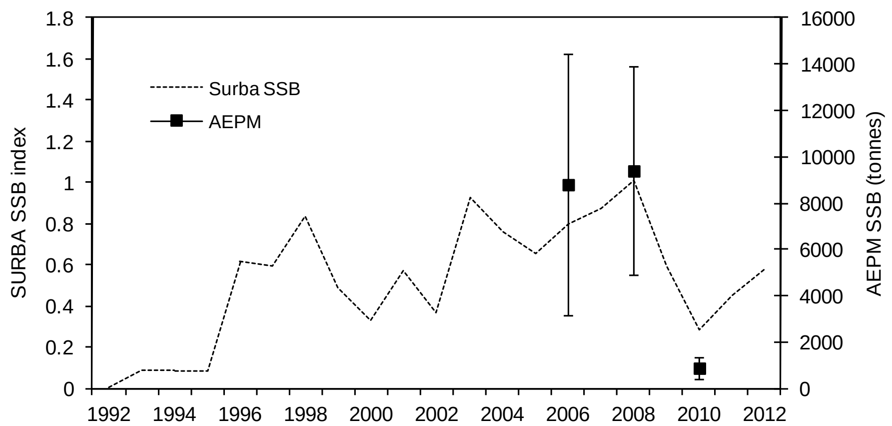


Figure 6.3.4. Haddock in VIIa: Comparison in the relative trends of SSB form 2012 SURBA run and the Irish Sea annual egg production method survey estimates of SSB (+ 2 SE).

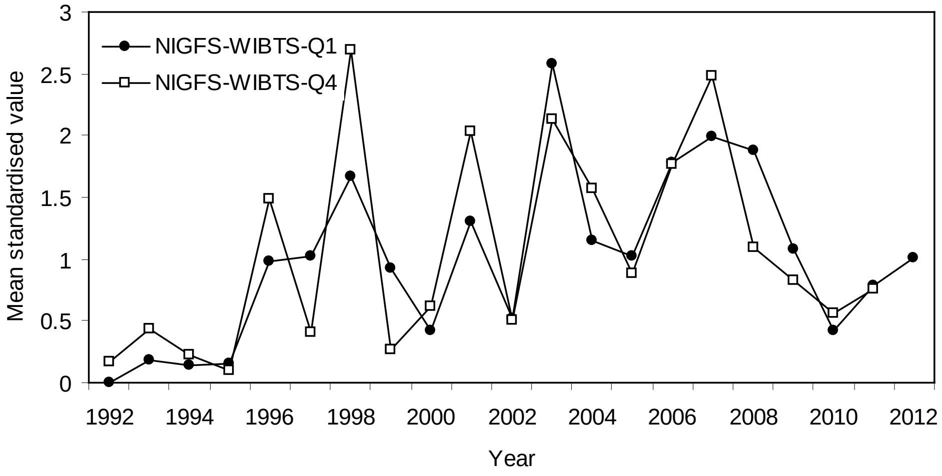
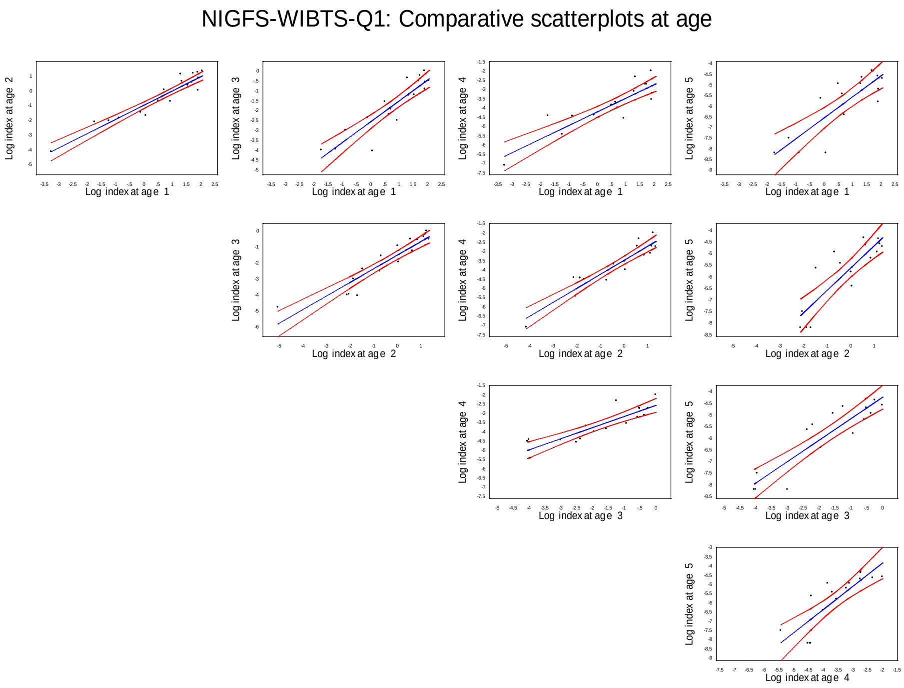
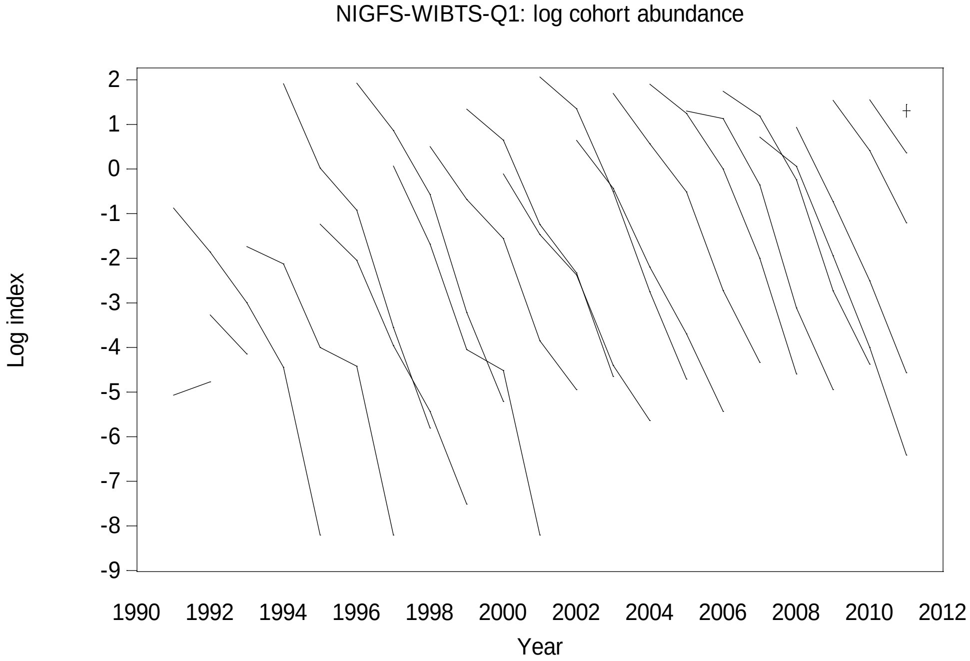
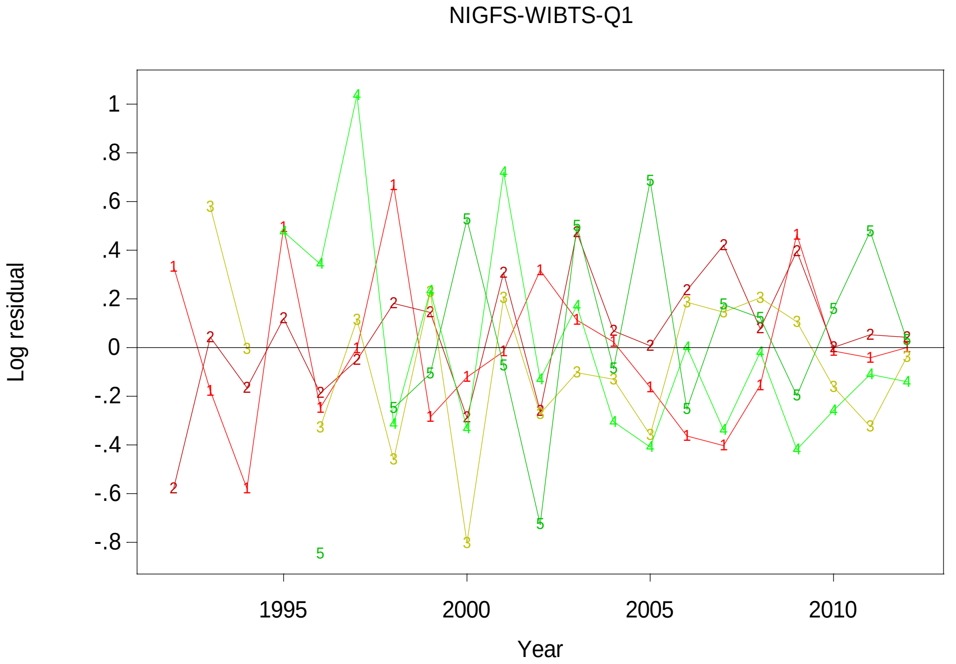


Figure 6.3.5. Haddock in VIIa: Mean Standardised empirical SSB indices from the NIGFS-WIBTS-Q1 and NIGFS- WIBTS-Q4 surveys, based on raw indices up to age 6.


NIGFS-WIBTS-Q1: Comparative scatterplots at age
Log index at age 2
Log index at age 3
Log index at age 4
Log index at age 5
Log index at age 1
Log index at age 2
Log index at age 3
Log index at age 4


NIGFS-WIBTS-Q1: log cohort abundance
Log index
Year


NIGFS-WIBTS-Q1
Log residual
Year

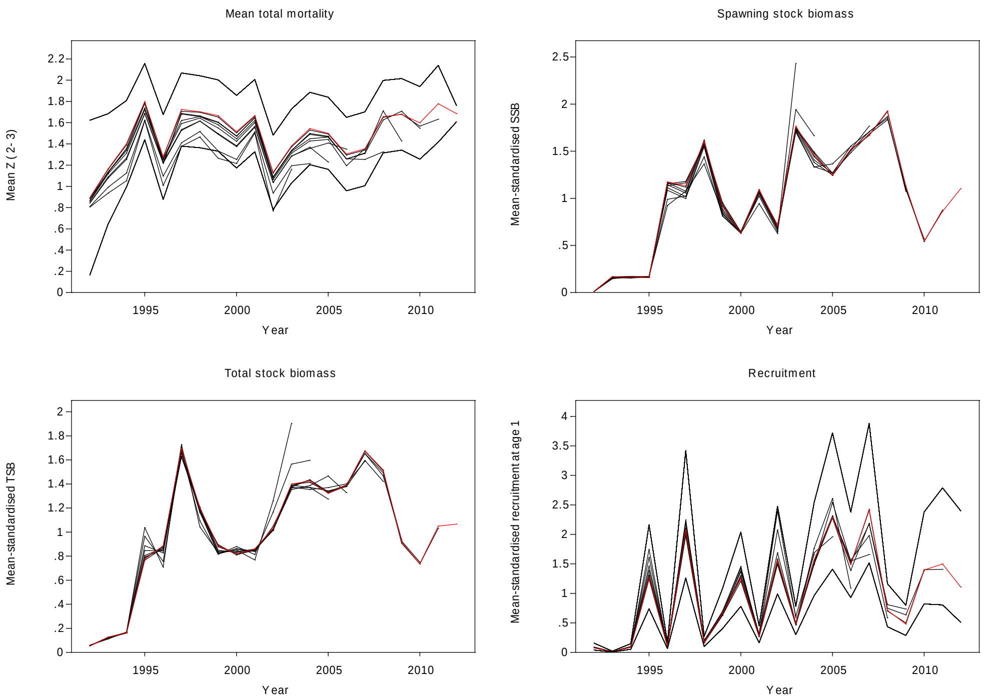


Figure 6.3.6. Haddock VIIa: SURBA 3.0 Residuals-at-age (top panel) and retrospective plots (bottom panel) for the NIGFS-WIBTS-Q1 survey.

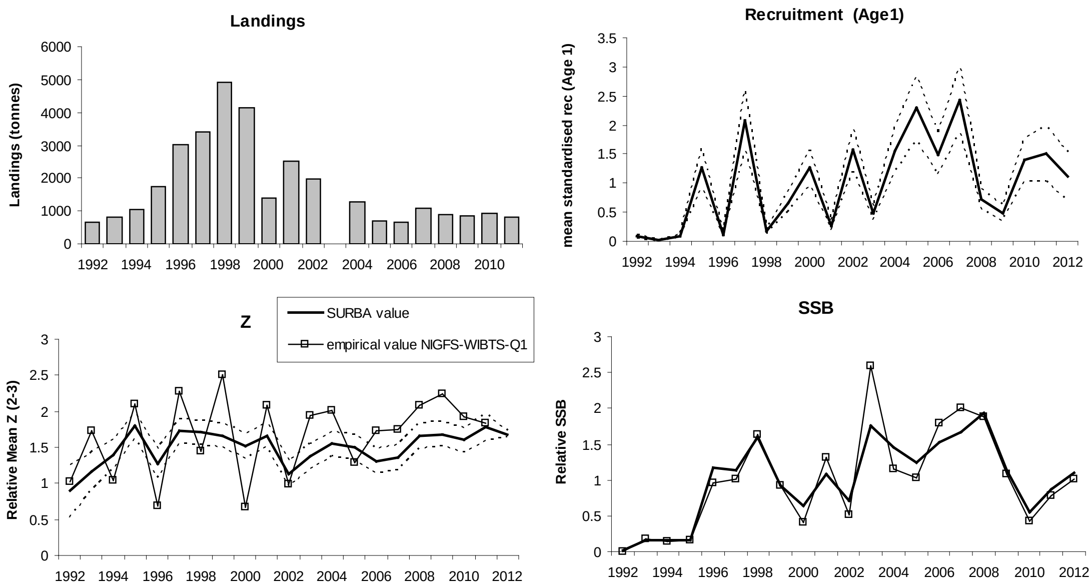


Figure 6.3.7. Haddock VIIa: Summary plots of landings and results of final SURBA 3.0 run using the NIGFS-WIBTS-Q1 survey data. Dotted lines are +/- 1SE. Empirical estimates of SSB and Z given by SURBA from the raw survey data are also shown.

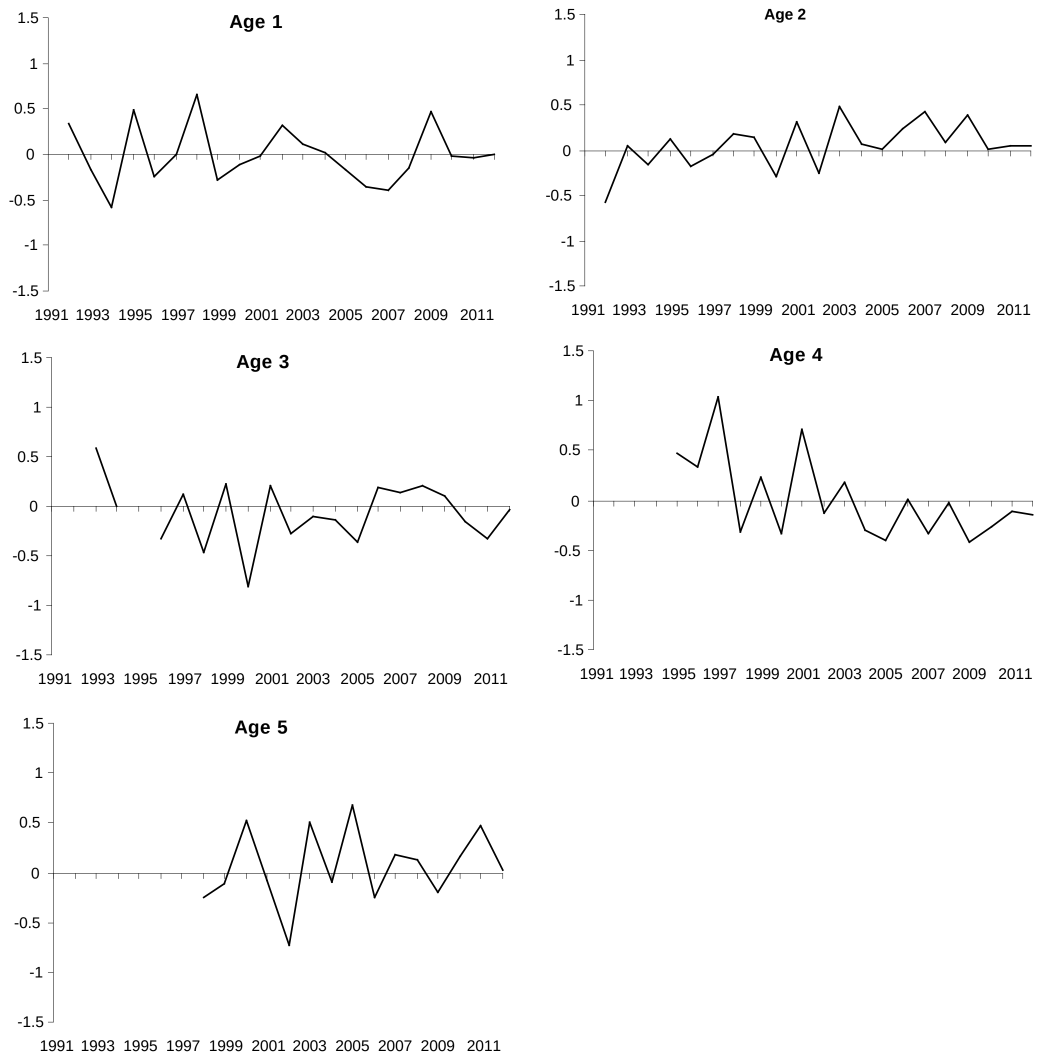


Figure 6.3.8. Haddock VIIa: SURBA 3.0 Residuals-at-age for final run using the NIGFS-WIBTS-Q1 survey data.

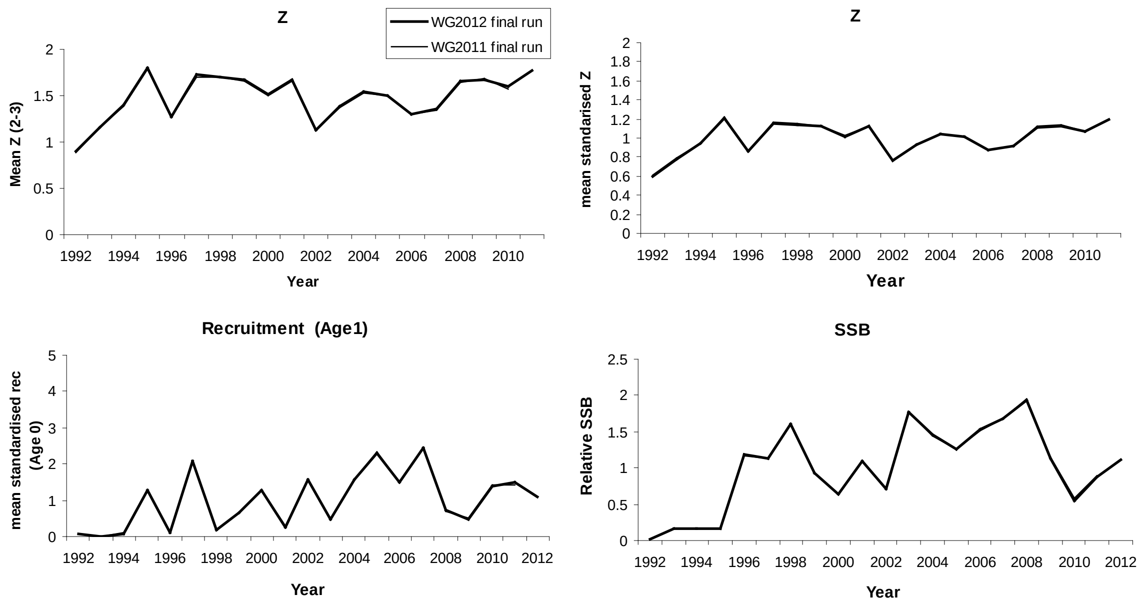


Figure 6.3.9. Haddock VIIa: Trends in SSB, recruitment and Z(2-3) from the 2011 and 2012 SURBA. SSB and recruitment are standardised to the mean for years common to all series (1992–2011) in each plot.

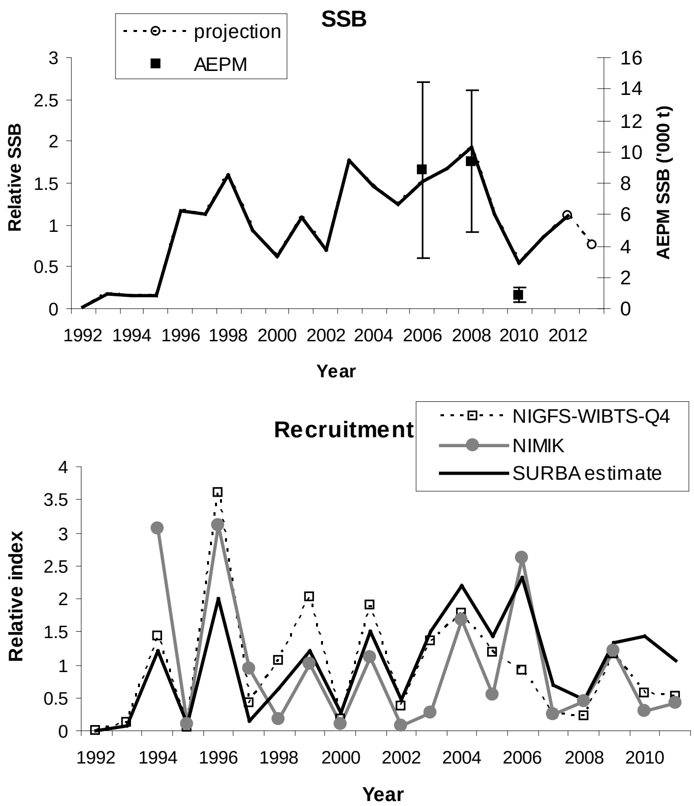


Figure 6.3.10. Haddock VIIa: Trend in SSB form 2012 SURBA projected to 2013 compared to the Irish Sea annual egg production method survey estimates of SSB (+ 2 SE) (top panel) and SURBA estimate of recruitment compared to available 0-gp indices (bottom panel). SSB and recruitment are standardised to the mean for years common to all series (1994–2012) in each plot.

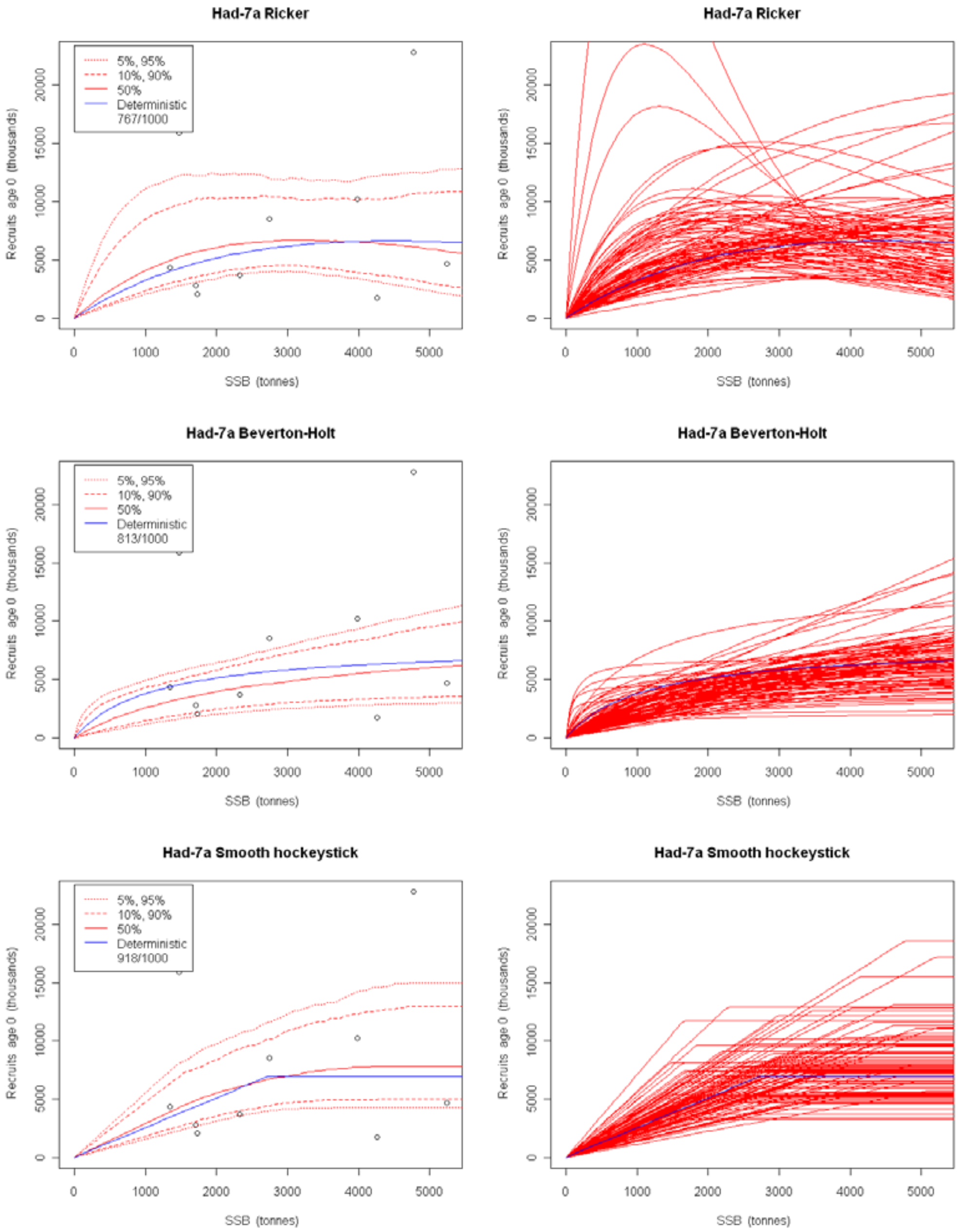


Figure 6.3.10. Haddock VIIa: MSY fitted stock and recruitment relationships. Left hand panels: blue line indicates the deterministic estimate; red line median and percentiles of curves with converged estimates of F_{MSY}. Right hand panels : curves plotted from the first 100 MCMC re-samples with converged F_{MSY} estimates. The legends for each recruitment model show the number of converged values of F_{MSY} from the 1000 re-samples.

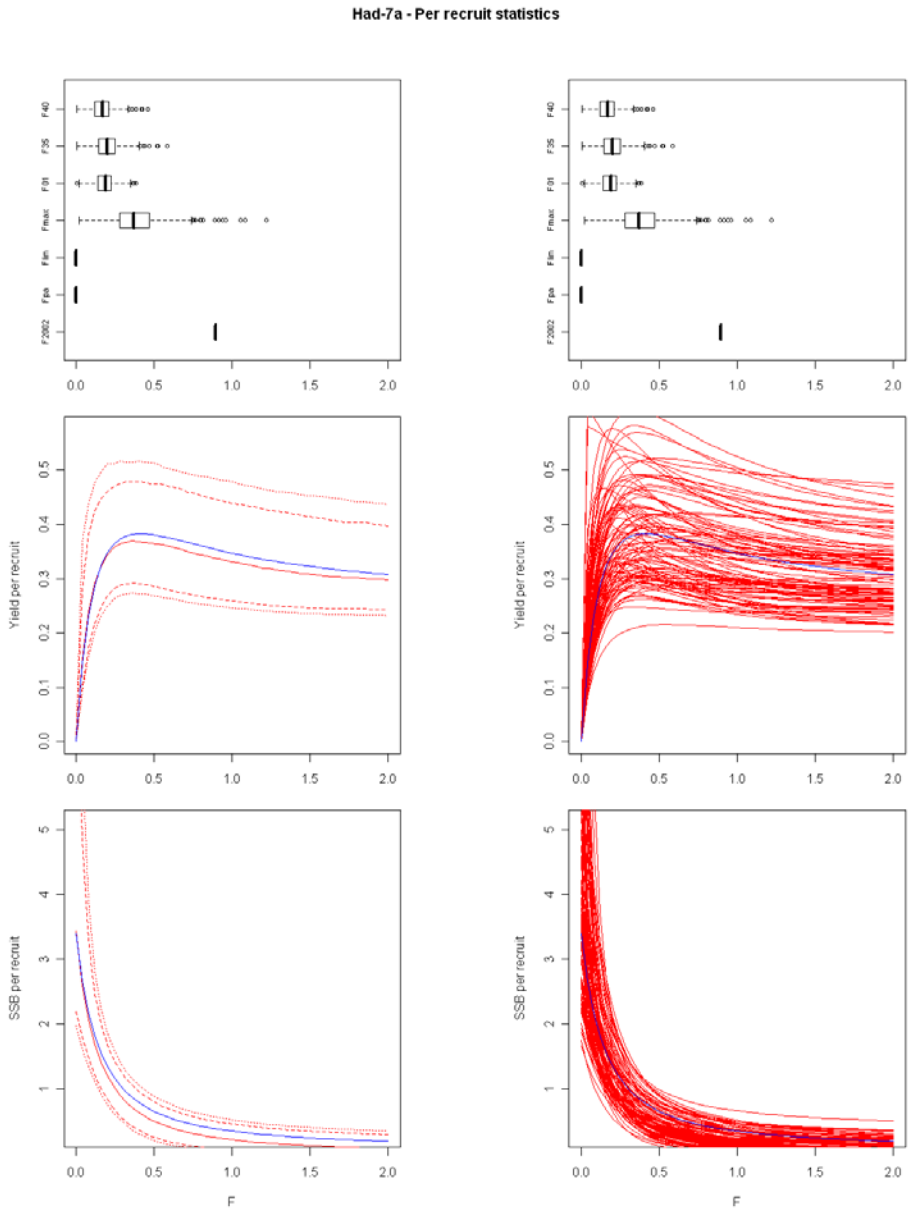
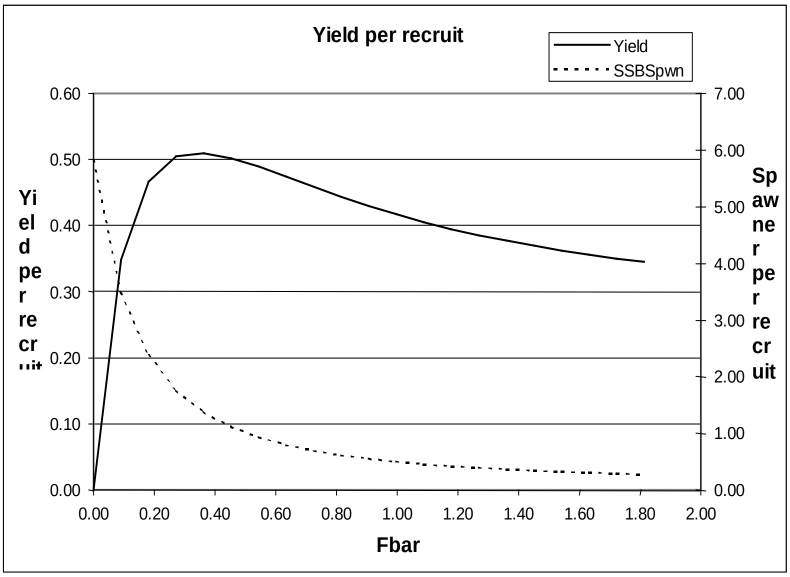


Figure 6.3.11. Haddock VIIa: Fitted yield per recruit F reference points, yield per recruit and SSB per recruit against fishing mortality with confidence intervals estimated by parametric re-sampling of the selection, weight-at-age, natural mortality and maturity estimates and their c.v. Left hand panels: blue line indicates the deterministic estimate, red lines the median and percentiles. Right hand panels: the first 100 re-samples.



MFYPR version 2a
Run: Had7a_2004WG_yield
Time and date: 10:55 13/05/2004

Reference point	F multiplier	Absolute F
Fbar(2-4)	1.0000	0.9065
FMax	0.3811	0.3455
F0.1	0.2074	0.1880
F35%SPR	0.2494	0.2261

Weights in kilograms

Figure 6.3.12. Haddock VIIa: Yield per recruit based on analysis carried out in 2004.

6.4 *Nephrops* in Division VIIa (Irish Sea East, FU14)

Type of assessment in 2012

UWTV survey data are used to calculate a fishery independent absolute abundance estimate for 2011 and catch options following the process defined by WKNEPH (2009). Also an update of trends in total landings, lpue, size composition, and biological data from the commercial fisheries is given for this FU.

The 2011 RG report contained some technical comments and attempts have been made to address these in the present report.

ICES advice applicable to 2011

The advice was for a transition to an MSY approach with caution at low stock size implying landings of less than 680 t.

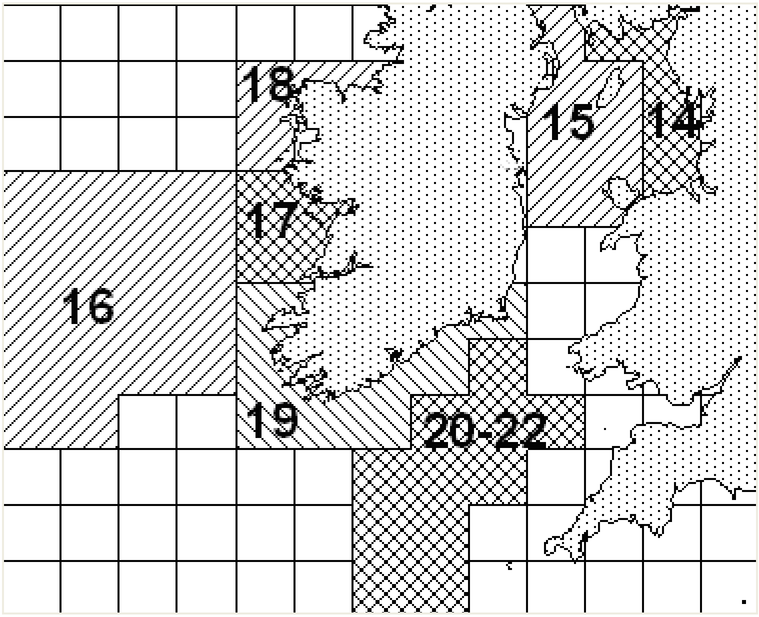
ICES advice applicable to 2012

Following the ICES MSY framework implies the harvest ratio to be no more than 9.8%, resulting in landings of 960 t.

6.4.1 General

Stock description and management units

The Irish Sea East *Nephrops* stock (FU14) is in ICES Subarea VII which includes the Irish Sea West (FU15) stock; the Porcupine Bank (FU16); Aran Grounds (FU17); northwest Irish Coast (FU18), southeast and southwest Irish Coast (FU19); and the Celtic Sea stock (FU20–22). The TAC is set for the whole of Subarea VII which does not correspond to the areas occupied by these stocks.



Functional units in VIIa.

Management applicable in 2011 and 2012

The TAC is currently set for the larger TAC Area VII. The TAC for 2012 was 21 759 t, exactly the same value defined for 2011. 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.

In 2011 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 Ireland. Details of all regulations including effort controls in place are provided in the Stock Annex.

The fishery

Between 1999 and 2003 the number of vessels fishing for *Nephrops* in FU14 declined by 40% to a fleet of around 50 vessels. This was largely due to the reduction in the number of visiting UK vessels and the decommissioning of part of the Northern Ireland and local English fleets. Since then, the number of vessels fishing the area has returned to and settled at around 80 vessels over the last four years mainly from Northern Ireland. Currently, just under 30 of these vessels, between 9 and 21 m in length, have their 'home' ports in Whitehaven, Maryport and Fleetwood, England. The rest of the fleet is generally made up of larger vessels from Northern Ireland, where the main port of landings is Kilkeel.

Whitehaven (England) has always been the main fishing port, contributing usually in between 70% to 80% of the total landings (1999–2009), but in these last two years landings have dropped in this port to 60% in 2010 and 58% in 2011. Parallel the two second main ports, Kilkeel (Northern Ireland) and Maryport (England), had an increase in the landings for 2010 and 2011. This shift has been mainly created by the Northern Ireland vessels that for 2010 and 2011 have landed around 43% in Kilkeel. Fleetwood, that usually accounted with an average of 10% of the landings in the past ten years, in 2011 drop to less than 1%. Over half of the Northern Ireland and a few of the English vessels use twin or triple trawls and between 2006 and 2011 account for 30% to 40% of the *Nephrops* landings.

During the years 2010 and 2011, the Walney (UK) Offshore Windfarms Ltd. has constructed the Walney 1 and Walney 2 offshore wind farms, located approximately 15 km off Walney Island, Cumbria, in the Irish Sea. Entering into commercial operation at the beginning of 2012, these two offshore wind farms were the world's largest offshore wind farms ever installed with a total capacity of 367.2 MW. The wind farm location site covers an area of what is acknowledged to be extremely good trawling ground for both *Nephrops* and whitefish. In the past this area has been fished by vessels from Fleetwood, Cumbrian ports and Northern Ireland and now the lost opportunity to work this ground will almost certainly have a financial impact in the *Nephrops* fishery in the East Irish Sea.

6.4.2 Data available

An overview of the data collected during 2011 is provided in Table 2.1 (Biological sampling levels by stock and country). Although these sampling levels were considered insufficient to derive catch and discard length frequencies for this year. As a result none of the length derived metrics have been updated for 2011.

InterCatch

Data for 2011 were successfully uploaded into InterCatch prior the 2012 WG meeting. Uploaded data was worked-up in InterCatch to generate 2011 raised international length–frequency distributions, although it was considered insufficient to derive catch and discard length frequencies for 2011.

Landings

Official landings as reported to ICES from FU 14 are presented in Table 6.4.1 and were updated for 2011 data. Landings for 2010 were also updated, since there were some additionally reported landings for Ireland.

Historically there are reported landings since 1973 for this functional unit with a minimum and maximum of 178.7 t (in 1974) and 960.5 t (in 1978), respectively. Between 1987 and 2006 landings from FU 14 appeared relatively stable fluctuating around a long-term average of about 550 t (Figure 6.4.1 and Table 6.4.1). Landings in 2011 (561 t) were 4% down on the 2010 level and over 58% down on the peak of 2007 (959 t). 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 UK vessels have landed, on average, 87% 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 lower than 9%. In 2011 the Irish vessels accounted with 5.5% of the total landings (Table 6.4.2).

Length composition

Not updated in 2011 due to insufficient sampling levels.

Quarterly length compositions of landings, catch and discards were available from the UK England and Wales for most of the period 1992–2009. In 2010 the *Nephrops* catch sampling programme crashed and no samples of length were provided and only five samples were made as part of the English discard observer programme for this year. In 2011 there was an attempt to reinstate the *Nephrops* catch sampling programme but it wasn't very successful. This sampling programme was usually completed with the cooperation of the North Eastern Sea Fisheries Committee but due to transition to NW Inshore Fisheries and Conservation Authority (IFCA) in 2011 the entire financial system changed making difficult the payment to skippers. Thus, for 2011 only two samples were collected from this catch sampling programme. Also the collection of these samples was very restricted to weather conditions and the operation of the patrol vessel that faced severe technical problems over the past years. Efforts have been made in 2012 to re-establish the sampling programme and also one discard observer is now covering this part of the coast. Next year is expected an increase of length, catch and discard data.

For 2010 and 2011 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 and 2011.

Historical trends in length distributions are shown in Figure 6.4.5. Discard rates have been estimated from the same figures and have declined in the terminal six years from 24% to 4% of total catch by weight and 43% and 8% by number. Females generally have a higher discard rate because they are generally smaller. The sharp decline in the discard rate from 2008 to 2009 particularly for males might suggest a change in discard practice but the shift to the right for the catch distribution in 2009 and the minimum observed size suggests something else. This could be partly a sampling artefact. Only ten observer trips were carried out in 2009, around a third of the number carried out in 2008. These observer trips have been the only source for catch and discard data in recent years. The landings were still well sampled so these concerns are only limited to defining the discarded component of the catch in 2009.

A summary of the historical mean size information is provided in Table 6.4.5. The mean sizes in the catch and landings appear relatively stable. The increasing lpue of the <35 mm CL categories and decline in mean size of the landings (Figures 6.4.1 and 6.4.3) and the increase in the range of sizes in the catch (Figure 6.4.5) up to 2007 could be indicative of good recruitment. This is supported by the local enforcement agency who noted an increase in the proportion of tails landed in 2007. In 2009 the same agency remarked on improved catches of good sized prawns and better fishing than had been seen for some time. The mean size in the landings remains relatively stable.

Commercial cpue

A 10% TAC increase in 2006 followed by a 17% increase in 2007 coupled with the implementation in the UK of buyers and sellers regulations effective from and throughout 2006, has improved the accuracy of reported landings information. This appears to have reduced the reasons to misreport, despite the declines in TAC form 2009 to 2011 in Area VII and the legislation provides the quality control. The introduction of the buyers and sellers legislation for 2006 complicates the interpretation of any prior trends. Landings do not appear to have exceeded the advised TAC for this Functional Unit. UK *Nephrops* directed effort fluctuated around a downward trend starting in 1978. After a period of relative stability between 2002 and 2007 effort started declining, showing in 2011 the lowest value since 1974. Quarterly effort plots show a predominance of effort in the 2nd and 3rd quarters (Figure 6.4.2).

The UK lpue series is based on a combination of directed *Nephrops* voyages by English and Welsh (E&W) vessels landing to Fleetwood and Whitehaven, where the mesh size is 70–99 mm and where the weight of *Nephrops* landed is more than 25% of the total landing; and all trips by visiting Northern Irish (NI) vessels which target *Nephrops* (Table 6.4.4). The lpue trends of the E&W fleet compared to the NI fleet are broadly similar in their inter-annual trends although there are several step-changes in absolute level (Figure 6.4.1). There is little correspondence between the lpue of the Republic of Ireland vessels and the UK (Table 6.4.4) except that the Northern Irish vessels are now reporting lpues at generally the same level as the Republic of Ireland vessels. In 2011, with the exception of the E&W directed vessels, the lpue increased.

Lpue between gear-types for targeted trips (Figure 6.4.4) also shows divergence in the trends. English twin trawls underwent a gradual decline in lpue between 1997 and 2006 before rising sharply whilst the single trawls fluctuated without trend. Northern Irish lpues were similar in magnitude between 1994 and 2003 and have recently diverged. Northern Irish lpue is generally higher than English lpue. The step change in lpue around the time of the introduction of buyers and sellers legislation in 2006 is considered to be driven by a change in reporting levels more than a change in biological productivity.

Historically, male *Nephrops* have predominated in the landings and the annual proportion of females appears highly dependent on the fishing effort in the third quarter (Figure 6.4.2) but due to the low sampling levels in 2010 and 2011 these data have not been updated. Lpues for males and females <35 mm CL (Figure 6.4.3) appear to exhibit the same general trends. Minima in 2003 were followed by upward trends to the highest values in both series in 2007. They have both since declined but still remain above any other values in the series. The lpue of the larger males (>35 mm, the length beyond which the effects of recruitment pulses and discarding are considered to be negligible) has been increasing since 2002 and continues to rise. The quarterly pattern of availability to the fishery of females >35 mm, means that meaningful statistics for this portion of the population are highly dependent upon the level of fishing and the sampling effort deployed in the 3rd quarter.

Surveys

In August of 2007–2011 the UK and the Republic of Ireland carries 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. This survey was not reviewed at WKNEPH 2009 but the protocols and standardised process has been adopted (see Stock Annex). FU14 will be reviewed in the next Inter-benchmark in 2013.

In 2007 poor visibility hampered the survey and despite repeated attempts at over 15 stations, turbidity scores precluded the use of some of the counts. On first analysis only 20 were initially considered usable, however following reanalysis in 2010 these data were considered too unreliable. 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.

The survey area is shown in Figure 6.4.6 giving the survey stations. The boundary used to define the ground limits for absolute abundance runs close to the outer survey stations.

Due to the construction of the Walney Offshore wind farm in the south part of the ground three stations were already abandoned from the grid (Figure 6.4.6) and one more is very close to being abandoned as well. Also the VMS data indicated vessels are avoiding that part of the ground as the wind farm is still in construction and fishing is not allowed around the construction side. This might have implications in the future regarding the total area being fished in this ground and the total area available for running the UWTV survey.

In 2011 three new exploratory stations were added (Figure 6.4.6.) 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.

The algorithm used to determine the distance towed on each station changed in the WG of 2011. GPS measurements are recorded at one second intervals during each tow. Prior to 2011 the distance towed was determined by summing up the distance travelled between each positional record. As the GPS transceiver is mounted high up on the research vessel, the positional data generated will be influenced by the sea-state far more than the sledge. Close examination of the GPS points showed that rolling of the vessel was recorded and this motion is not transmitted to the sledge. In order to reduce the influence of ship-motion on the sledge distance, a smooth spline model of position was fitted to each tow with sufficient flexibility to capture large, slow movements whilst capable of smoothing through the short frequency movement cause by wave action. The previous practice of determining distance travelled by summing up the distance between each recorded "ping" appears to have significantly over-estimate the distance travelled (typically +30%) which translated into a reduced density of burrows.

6.4.3 Data analyses

Exploratory analyses of survey data

The TV abundance estimate is since the WG 2011 made using a geostatistical approach, as opposed to the approach used before which calculated the mean density of non-zero counts which was raised to the total fished area. The former approach ignored the spatial distribution of the counts and was highly sensitive to the total area used for raising. The geostatistical procedure takes the spatial position of the burrow density estimates and fits a semi-variogram model to describe the how variance changes with distance. The results of this model are then used in a Krigging process to produce a 3D surface of burrow density on a 500 m*500 m grid, bounded by a polygon defined by the outermost survey stations. The area within the polygon is 1032 km^2. Additionally the Wigtown Bay area (small ground on the top of the grid, see Figure 6.4.6) is included. The Wigtown Bay area is 1.9% of the area of the main patch, so the survey abundance number is simply inflated by that proportion. This will provide a most accurate unbiased estimate. Uncertainty estimation of the overall abundance estimate is performed by bootstrapping the counts (re-sampling with replacement), re-fitting the semi-variogram and re-estimating the surface.

In the WG 2012 abundance estimations were reviewed and recalculated using a more accurate field of view (0.75 m) and a bias of 1.2 (Table 6.4.6.). The new estimates show a decrease of around 10% in abundance compared with last year's estimations for the dataseries.

The surveys show a clear spatial pattern of distribution, 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 6.4.7).

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. Consequently the time-series of abundance estimates is too short for any meaningful comparison with lpue trends. The lpue trends (Figures 6.4.1 and 6.4.4) of the different fleet components are contradictory in terms of the direction of change in the last three years with some increasing, some flat and some declining.

The use of the UWTV surveys for the provision of *Nephrops* management advice was extensively reviewed by WKNEPH (2009). A number of potential biases were highlighted including those due to edge effects; species burrow misidentification and burrow occupancy. Using the same process adopted at WKNEPH, a cumulative bias correction 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 6.4.6 and Figure 6.4.7 have been adjusted to account for this estimation bias since 2008.

6.4.4 Short-term projections

A landings prediction for 2013 was made for FU14 using the approach agreed at the Benchmark Workshop (WKNEPH, 2009). As the length–frequency data for 2010 and 2011 (and to a lesser extent 2009) have been poorly represented by sampling, the Length Cohort Analysis (LCA) presented in WGNSSK 2010 (using lengths 2006–2008) continues to be used as the basis for determining Harvest Rates as proxies for F_{MSY}.

The text table below shows landings predicted for 2013 at a range of harvest ratios including those equivalent to fishing at F_{MSY} proxies for the fishery as well as $F_{current}$. Only the Harvest Rates associated with the male and combined sex F_{MSY} proxies are identified in the table as they are considered more appropriate for this stock (see below). The inputs to the landings forecast were as follows (Table 6.4.7):

Mean weight in landings (2006–2008) = 28.9 g

Discard rate based on sampling (2006–2008) = 27.9%

Survey bias = 1.2.

			Implied fishery	
	Harvest Rate	Bias corrected abundance (Millions)	Retained number (Millions)	Landings (tonnes)
	0%	431.0	0.0	0
	2%		6.2	180
	4%		12.4	359
	6%		18.6	539
Fcurrent_2011	6.25%		19.4	561
Fsq_2009-2011	7.52%		23.4	675
	8%		24.9	718
F0.1Male	9.62%		29.9	864
F0.1Comb	9.81%		30.5	881
	10%		31.1	898
	12%		37.3	1078
F35%Male	12.50%		38.8	1123
F35%Comb	13.00%		40.4	1167
	14%		43.5	1257
	15.00%		46.6	1347
FmaxMale	15.79%		49.1	1418
	16%		49.7	1437
FmaxComb	16.40%		51.0	1473

		Source
Landings Mean Weight (kg)	0.0289	Sampling 2006–2008
Survey Overestimate Bias	1.2	As per WKNEPH 2009 (See Annex)
Survey Numbers (Millions)	517.2	UWTV Survey 2011
Prop of removals retained by the fishery	0.721	Sampling 2006–2008

6.4.5 Medium-term projection

No medium-term projection was performed for this stock.

6.4.6 Biological reference points

Biological reference points have not been updated since 2010 as the current sampling levels are considered too low for reliable length frequency determination. MSY $B_{trigger}$ is not defined for this stock as the time series of abundance estimates is too short.

The results of the Length Cohort Analysis model in the text-table below show the F multipliers required to achieve the potential F_{MSY} proxies, the harvest rates that correspond to those multipliers and the resulting level of spawner per recruit as a percentage of the virgin level.

		Fbar 20–40 mm		Harvest Rates	SPR	
		Female	Male		Female	Male
F0.1	Combined	0.10	0.14	9.8%	44.6%	42.6%
	Female	0.11	0.15	10.2%	43.5%	41.4%
	Male	0.10	0.14	9.6%	45.3%	43.3%
F35%Spr	Combined	0.14	0.20	13.0%	35.9%	33.4%
	Female	0.15	0.21	13.5%	34.7%	32.2%
	Male	0.14	0.19	12.5%	37.1%	34.6%
Fmax	Combined	0.20	0.28	16.4%	28.9%	26.2%
	Female	0.21	0.30	17.4%	27.3%	24.5%
	Male	0.19	0.26	15.8%	30.0%	27.2%

- Compared to other *Nephrops* fisheries in ICES Area VII the absolute population density of this stock is relatively low.
- The area covered by this fishery is relatively small and the confidence intervals for the abundance estimate are large for a geostatistical survey due to the sample density (Figure 6.4.8). The differences in the spatial distribution (Figure 6.4.7) suggest some degree of variation between years.
- The perception in the Irish Sea is that the growth rates in the eastern Irish Sea are similar to those in the western Irish Sea but the mean sizes (mm CL) in each fishery are markedly different, eastern Irish Sea *Nephrops* being the larger.
- This fishery is highly seasonal, in effect a spring to summer fishery, where the landings are predominantly male. Landings are around 60% male by weight and have ranged from 55 to 75% over the last ten years.
- The annual variability of lpue for the smaller component of the catch, plus the recent lack of recruit signals in the length frequencies suggest that recruitment to this fishery, though apparently high in 2007, is quite variable.
- Current Harvest Ratio for 2011 was estimated at 6.25% and the F_{sq} (2009–2011) at around 7.52% both are below the F_{MSY} proxy.

Only the combined sex F_{MSY} and male proxies are considered here to limit the potential of over-fishing the males to meet a female MSY, in a seasonal male dominant fishery.

According to the guidelines Section 2.2, the limited time-series in the abundance indices, the poor biological sampling in 2010 and 2011, the uncertainties about the stability of the stock over the reference period and uncertainties about the variability in recruitment might suggest that $F_{0.1}$ should be used as a proxy.

6.4.7 Management plans

A number of cod recovery measures have been introduced since 2000 to promote recovery of Irish Sea cod stocks. These include a closure of the western Irish Sea cod spawning grounds from mid February to end of April since 2000, with a later extension to the eastern Irish Sea. Despite a partial derogation for *Nephrops* vessels during the closed period the distribution of effort on *Nephrops* has been affected by this management plan. There have also been various decommissioning schemes to reduce fishing effort. A 25% effort reduction on cod is in hand along with technical measures to reduce cod bycatch.

6.4.8 Uncertainties and bias in assessment and forecast

There are several key uncertainties and bias sources in the method proposed (these are discussed further in WKNEPH 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). 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 (WKNEPH 2009).

The cumulative bias estimates for FU 14 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.

6.4.9 Quality of assessment

The length composition and sex ratio of catches have generally been well sampled until 2009 by E&W. However the variability in the discard rate and discard selectivity within this fishery would suggest that sampling needs to be carried out at a high level to improve on discard estimates.

The quality of landings data has improved in the last four years but because of concerns over the accuracy of earlier years, this limits the period we can be confident about 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 2008–2011.

The revised algorithm used to derive distance covered by the sledge is considered as significantly more robust than the previous algorithm.

The abundance estimations were improved for the dataseries when recalculated using a more accurate field of view (0.75 m).

6.4.10 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 confer controls to ensure effort and catch were in line with the scale of the resource.

In view of uncertainties about historical catch statistics interpretation of trends in lpue prior to 2006 should be treated with caution. Recent catch, effort and historical trends in size still offer some reference to the status of the stock. The reliability of landings statistics has improved and effort appears to be decreasing since 2008 probably as a result in the decrease in number of vessels directed to targeting *Nephrops*. There are no explicit recruitment indices.

The new UWTV survey data allows for the provision of catch options and also to adopt the MSY approach. The UWTV surveys are conducted annually and a benchmarked process has been adopted. 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.

Table 6.4.1. Irish Sea: Landings (tonnes) by FU, 2000–2011. 2011* refers to preliminary landings data.

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	23.1	9568
2011*	561	10159	61	10781

Table 6.4.2. Irish Sea East (FU14): Landings (tonnes) by country, 2000–2011.

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

Table 6.4.3. Irish Sea East (FU14): Effort ('000 hours trawling) and lpue (kg/hour trawling) of *Nephrops* directed voyages by UK trawlers, 2000–2011.

Year	Effort	LPUE
2000	10.4	19.5
2001	10.1	17.9
2002	8.1	20.3
2003	6.9	15.9
2004	6.7	20.4
2005	6.6	20.1
2006	7.4	21.4
2007	6.3	24.0
2008	6.1	26.8
2009	5.6	25.8
2010	5.8	27.9
2011	5.78	27.36

Table 6.4.4. Irish Sea East (FU14): Effort ('000 hours trawling) and lpue (kg/hour trawling) of *Nephrops* directed voyages by Republic of Ireland trawlers, 2000–2011.

Year	Effort	LPUE
2000	2.5	43.6
2001	0.5	43.9
2002	3.3	57.1
2003	1.1	37.6
2004	1.4	39.7
2005	0.8	40.6
2006	0.7	53.7
2007	1.7	49.3
2008	0.6	41.6
2009	0.4	40.1
2010	0.7	60.5
2011	0.5	66.6

Table 6.4.5. Irish Sea East (FU14): Mean sizes (mm CL) of male and female *Nephrops* from UK vessels landing in England and Wales, 2000–2009.

	Catch		Landings	
Year	Males	Females	Males	Females
2000	29.2	28.3	33.7	32.3
2001	31.6	29.2	34.2	32.5
2002	32	29.2	35.1	32
2003	36.4	30.7	38.4	34.5
2004	32.2	29.4	35.2	33.1
2005	32.8	29.9	34.6	32.3
2006	33.8	31.4	36.1	32.6
2007	31.7	30	33.5	32.1
2008	33	30	34	31.4
2009	34.5	31.3	34.6	31.8

Table 6.4.6. Irish Sea East (FU14): Results from NI/ROI/E&W collaborative UWTV surveys of *Nephrops* grounds in 2007–2011. Abundance is corrected for bias (1.2) and Wigtown Bay area (1.9% of the main area).

Year	No stations	Mean station density (no./m²)	Mean Krigged density (no./m²)	Bias-corrected abundance (millions)	95% CI	Landings	Removals (millions)	Harvest Rate
2007				Unreliable data				
2008	32	0.34	0.38	407.6	63.0	676	32.4	7.96%
2009	32	0.28	0.33	350.0	76.0	707	33.9	9.69%
2010	26	0.33	0.4	422.0	103.0	582	27.9	6.62%
2011	26	0.36	0.41	431.0	109.0	561	26.9	6.25%

Table 6.4.7. Irish Sea East (FU14): Catch option table inputs. Data used for 2012 catch prediction are shaded. Mean weight in landings (2006–2008) = 28.9 g; Discard rate based on sampling (2006–2008) = 27.9%.

Year	Landings in Number (millions)	Discards in Numbers (millions)	Removals in Number (millions)	Prop Removals Retained	Adjusted Survey (millions)	Harvest Ratio	Landings (t)	Discards (t)	Dead discard rate	Mean Weight in landings (gr)
2003	9.6	8.7	18.4	0.52			376.7	151	0.48	39.2
2004	14.9	11.3	26.2	0.57			472.2	150	0.43	31.6
2005	18.5	8.6	27.1	0.68			569.7	128	0.32	30.7
2006	19.8	6.9	26.7	0.74			627.3	111	0.26	31.6
2007	34.1	13.7	47.8	0.71			958.5	178	0.29	28.1
2008	24.2	9.8	34.0	0.71	407.6	0.080	676.0	138	0.29	27.9
2009	22.5	1.8	24.3	0.92	350.0	0.097	694.5	33	0.08	30.9
2010					422.0	0.066	582			
2011					431.0	0.062	561			

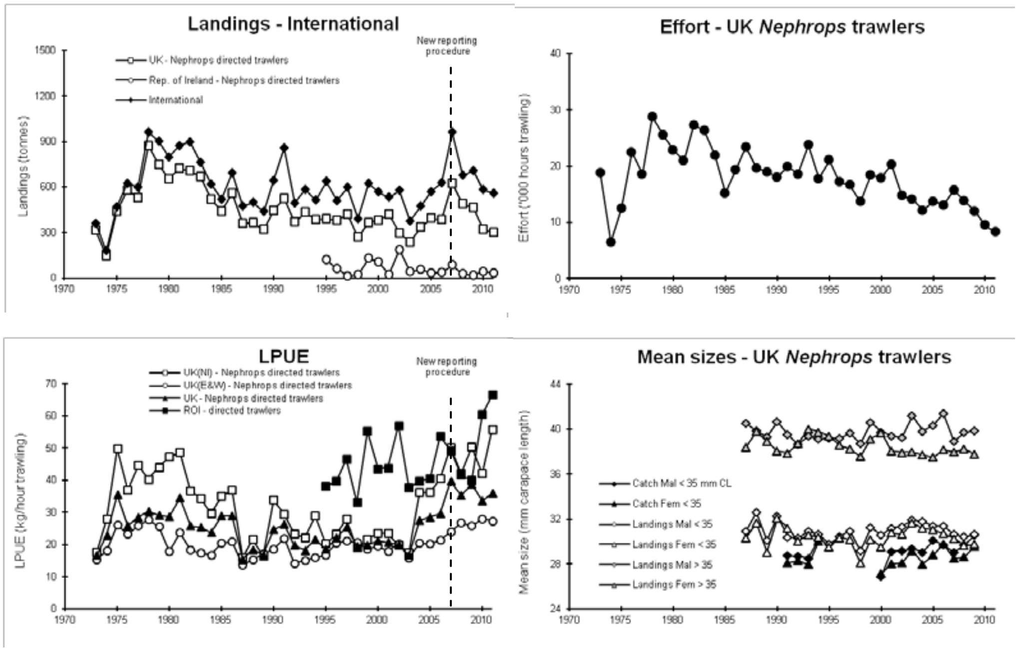


Figure 6.4.1. Irish Sea East (FU 14): Long-term trends in landings, effort, lpues and mean sizes of *Nephrops*. Note that mean sizes were not updated in 2011 due to insufficient sampling levels. The introduction of the buyers and sellers legislation in 2006 by the UK precludes direct comparison with previous years as reported levels are considered to have significantly improved.

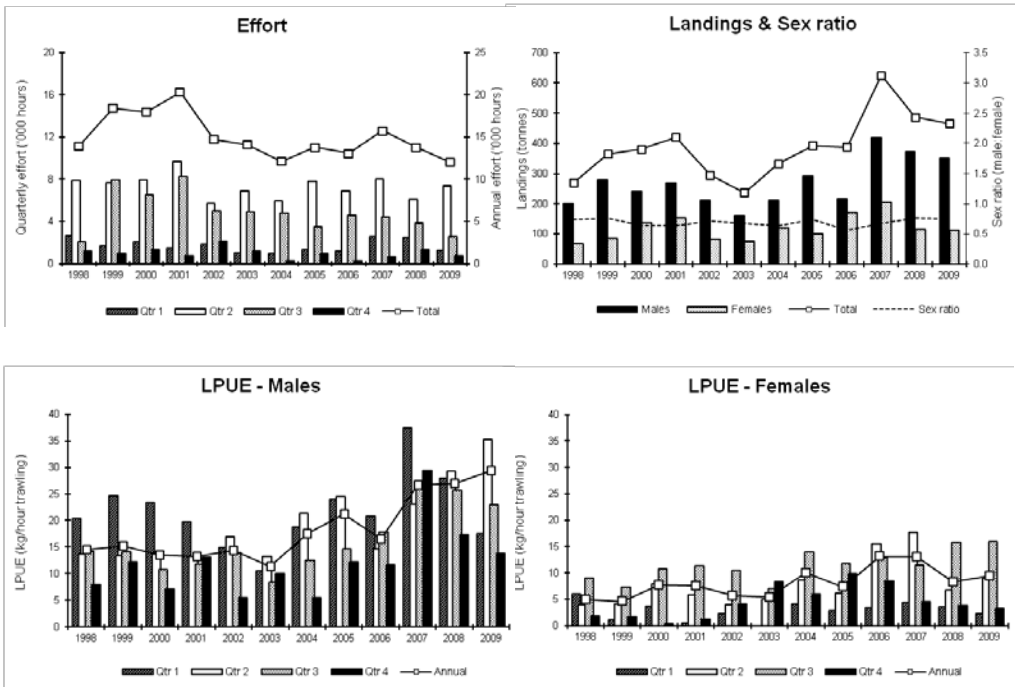


Figure 6.4.2. Irish Sea East (FU 14): Landings, effort and lpues by quarter and sex from UK *Nephrops* directed trawlers. Not updated in 2011 due to insufficient sampling levels. The introduction of the buyers and sellers legislation in 2006 by the UK precludes direct comparison with previous years as reported levels are considered to have significantly improved.

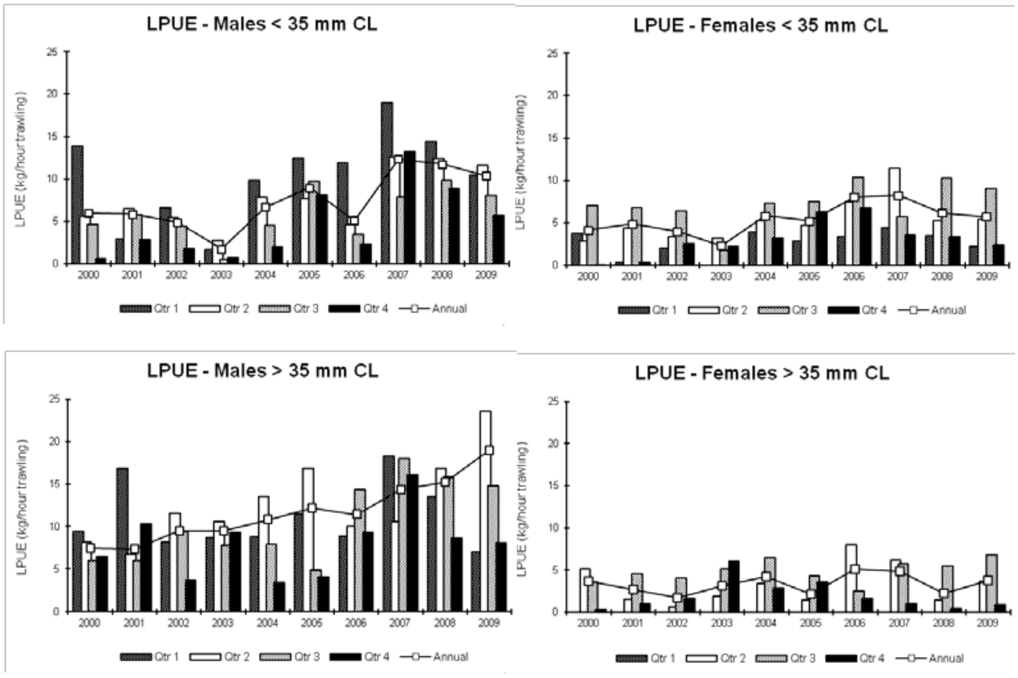


Figure 6.4.3. Irish Sea East (FU 14): lpues by sex and quarter for selected size groups, UK *Nephrops* directed trawlers. Not updated in 2011 due to insufficient sampling levels. The introduction of the buyers and sellers legislation in 2006 by the UK precludes direct comparison with previous years as reported levels are considered to have significantly improved.

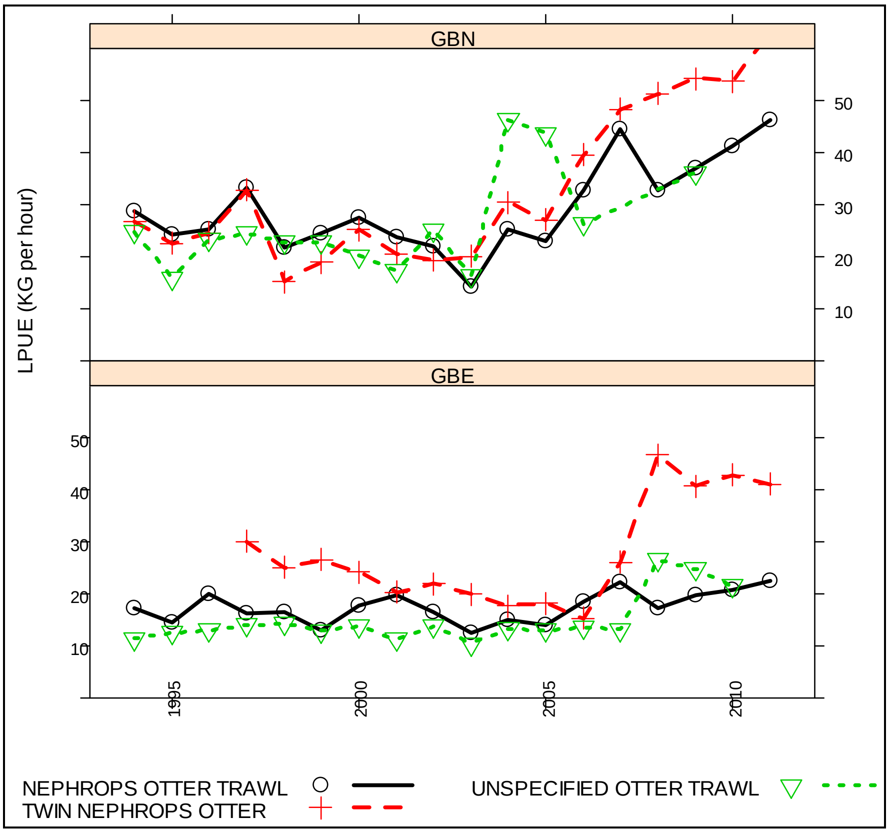


Figure 6.4.4. Lpue (Kg per hour) by gear type for English (GBE) and Northern Irish (GBN) vessels targeting *Nephrops* (>25% *Nephrops* in landings, using towed gears 70–99 mm mesh).

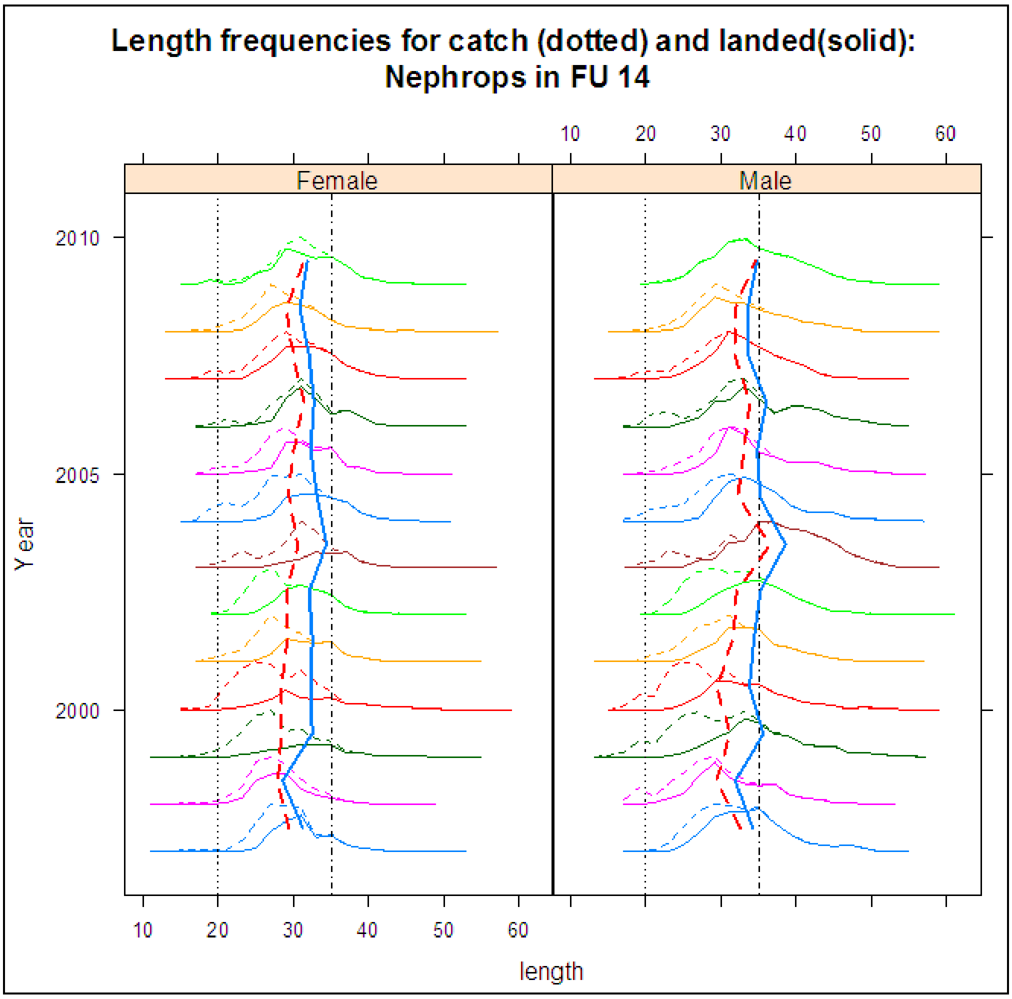


Figure 6.4.5. Irish Sea East (14): Length–frequency distributions of male and female landings and catch, 1997–2009. Figure shows a vertical display of MLS (20 mm CL) and 35 mm CL levels. Not updated in 2010 and 2011 due to insufficient sampling levels.

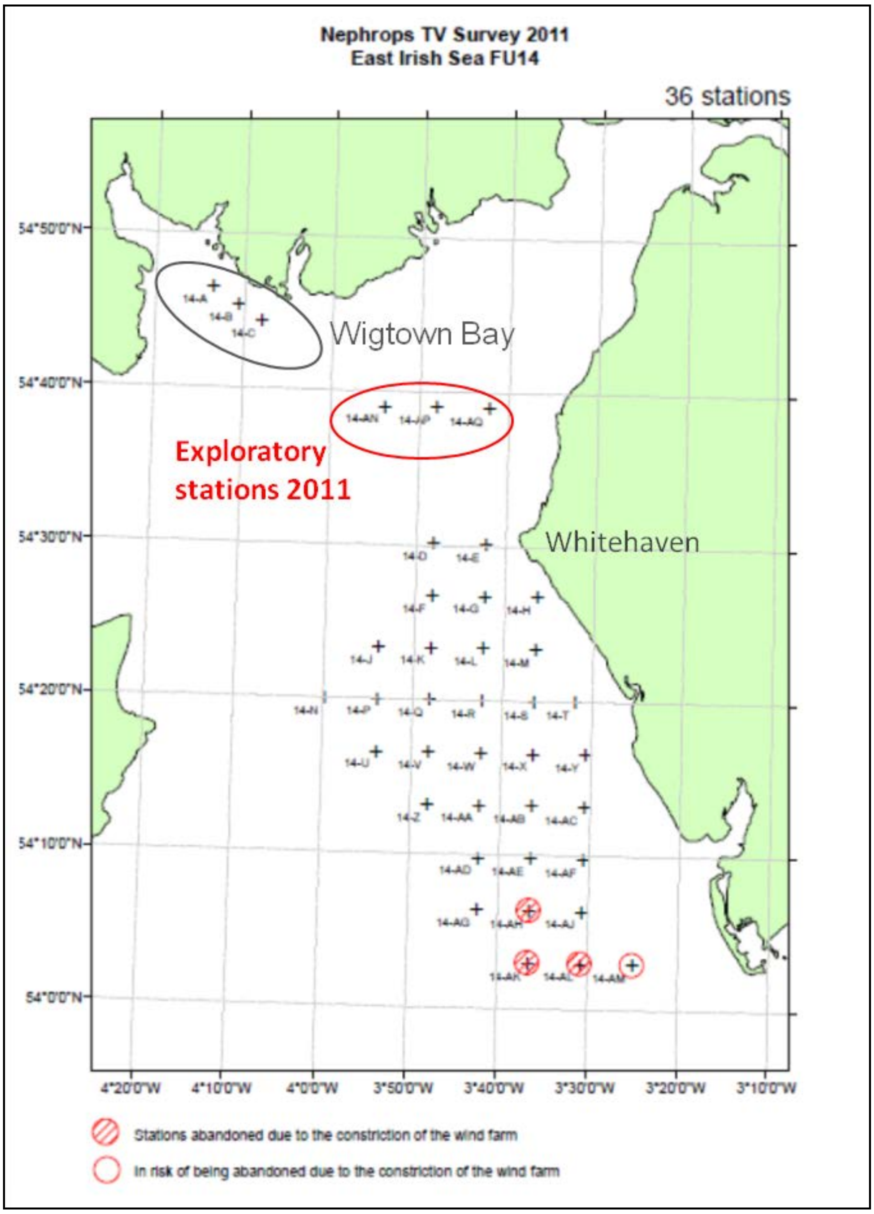


Figure 6.4.6. Irish Sea East (FU14): UWTV Survey stations, showing the Wigtown Bay area, the southern abandoned stations and the main fishing port (Whitehaven). In 2011 three new exploratory stations were added, but not included in the analysis.

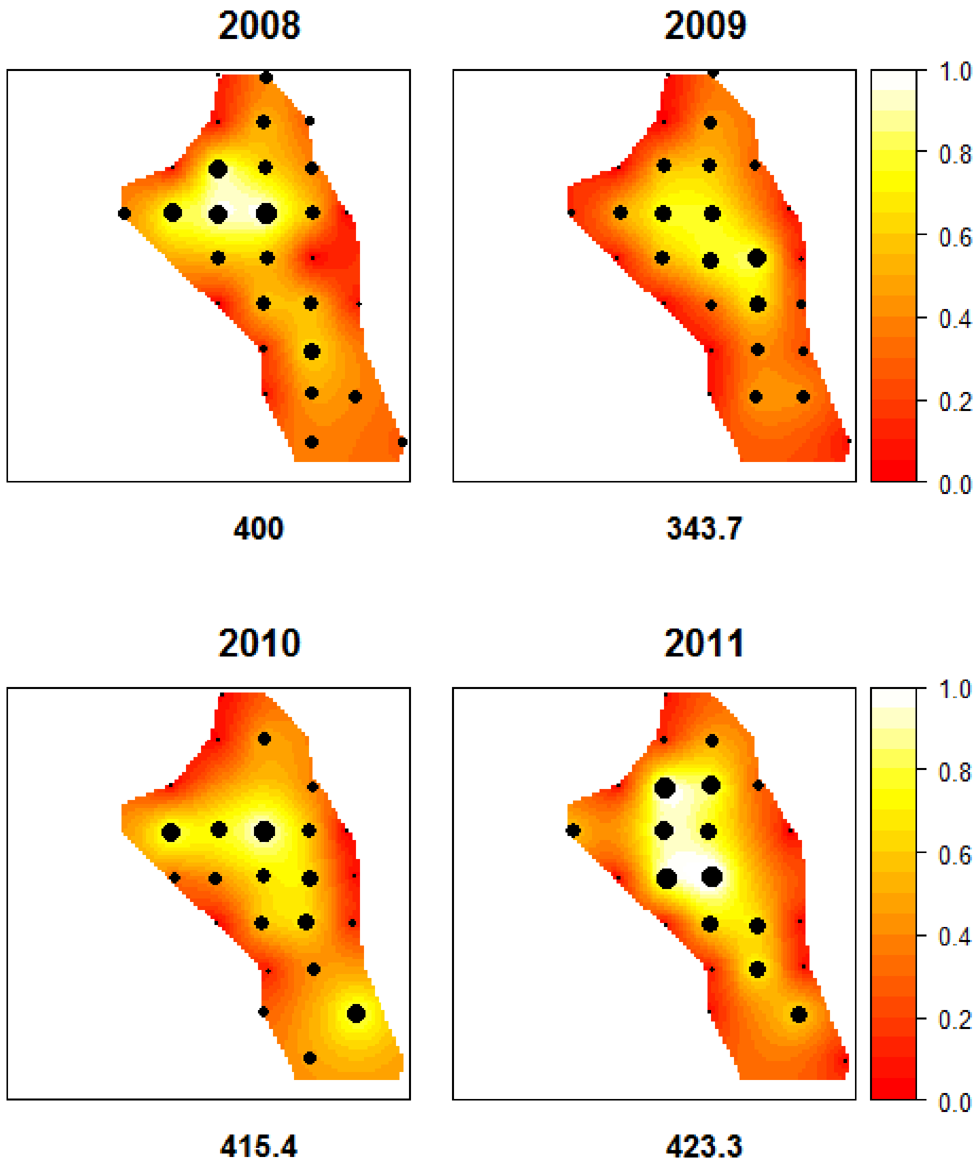


Figure 6.4.7. Irish Sea East (FU14): Burrow density estimates from the UWTV Survey 2008–2011. Abundance estimates given at the bottom of each plot are bias-adjusted (but does not contain the additional 1.9% for Wigtown Bay).

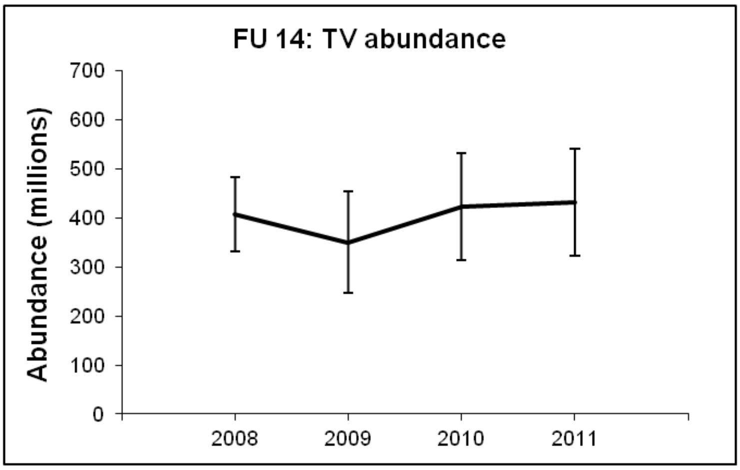


Figure 6.4.8. Irish Sea East (FU14): Burrow density estimates from the UWTV Survey 2008–2011. Abundance estimates given at the bottom of each plot are bias-adjusted and contains the additional 1.9% for Wigtown Bay.

6.5 Irish Sea West, FU15

6.5.1 General

Type of assessment in 2012

The assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the general process defined by WK*NEPH* (2009) described in the Stock Annex.

Stock description and management units

A TAC is in place for ICES Areas VII 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 seven separate Functional Units (Figure 6.1.1, FU15 is shaded light yellow). There are also some smaller catches from areas outside these Functional Units. The ICES statistical rectangles covered by the Functional Units in ICES Area VII are listed in the table below.

FU no.	Name	ICES Divisions	Statistical rectangles
14	Irish Sea East	VIIa	35–38E6; 38E5
15	Irish Sea West	VIIa	36E3; 35–37 E4–E5; 38E4
16	Porcupine Bank	VIIb,c,j,k	31–36 D5–D6; 32–35 D7–D8
17	Aran Grounds	VIIb	34–35 D9–E0
19	Ireland SW and SE coast	VIIa,g,j	31–33 D9–E0; 31E1; 32E1–E2; 33E2–E3
21–20	Celtic Sea	VIIg,h	28–30 E1; 28–31 E2; 30 E3
22	Smalls	VIIg	31-32 E3, 31 E4

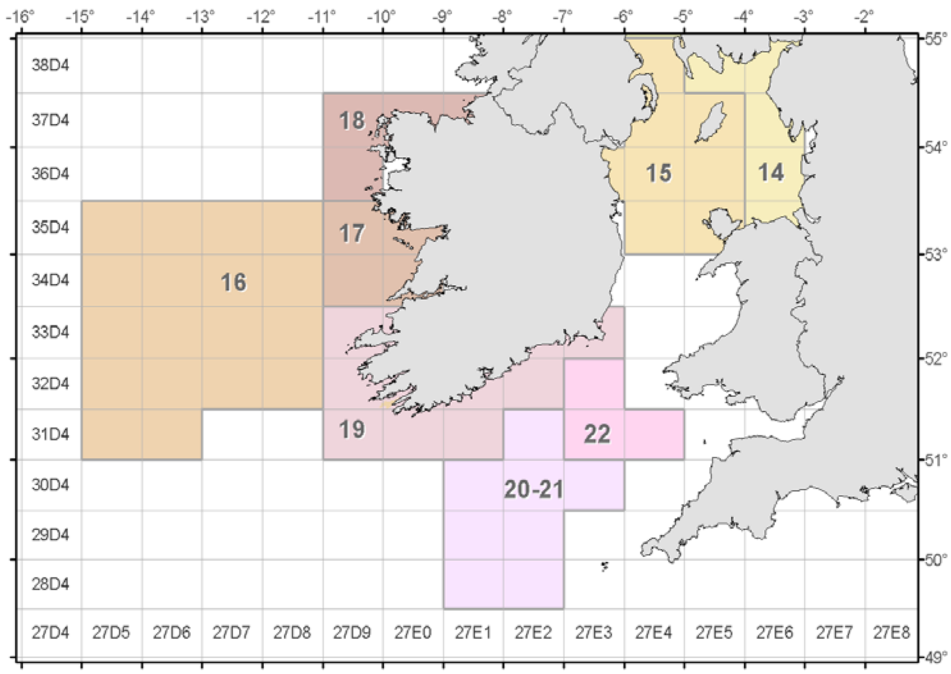


Figure 6.1.1. ***Nephrops*** **Functional Units in Subarea VII. The TAC covers all of Subarea VII.**

Management applicable to 2011 and 2012

TAC in 2011

Species: Norway lobster *Nephrops norvegicus*		**Zone:** VII (NEP/07.)
Spain	1 306 (1)	
France	5 291 (1)	
Ireland	8 025 (1)	
United Kingdom	7 137 (1)	
EU	21 759 (1)	
TAC	21 759 (1)	Analytical TAC

(1) Of which no more than the following quotas may be taken in VII (Porcupine Bank – Unit 16) (NEP/*07U16):

Spain	75
France	305
Ireland	463
United Kingdom	411
EU	1 254

TAC in 2012

Species: Norway lobster *Nephrops norvegicus*		**Zone:** VII (NEP/07.)
Spain	1 306 (1)	
France	5 291 (1)	
Ireland	8 025 (1)	
United Kingdom	7 137 (1)	
Union	21 759 (1)	
TAC	21 759 (1)	Analytical TAC Article 11 of this Regulation applies.

(1) Special condition: of which no more than the following quotas may be taken in VII (Porcupine Bank – Unit 16) (NEP/*07U16):

Spain	380
France	238
Ireland	457
United Kingdom	185
Union	1 260

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 VII (set at 25 mm).

The fishery in 2011

The *Nephrops* fishery in the Irish Sea west is economically the most important in ICES Division VIIa and is mainly prosecuted by vessels from UK (Northern Ireland) and Ireland. Working Group landings from FU 15 are presented in Table 6.5.1 and Figure 6.5.1. Total declared international *Nephrops* landings reported from FU15 in 2011 was

10 162 t and was the second highest since 2000. Ireland's landings were 3575 t, an increase of 38% from the 2010 landings. UK vessels landed 6584 t in 2011, of similar magnitude to 2010, and Northern Ireland landings contributed to over 95% of this figure.

Effort by the UK fleet remained relatively stable since 2002 following a steady decline from the early 1990s. Following a small increase in effort in 2010, there has been a decrease in effort in 2011, back to the 2009 levels (Table 6.5.2). Ireland's effort showed a marked reduction in 2009, but increased in 2011 to similar levels observed in 2008 (Table 6.5.3). The Irish fleet lpue continues to increase and remained at record high levels in 2011, whilst Northern Ireland lpue remains at similar levels since 2007. The Irish fleet shows greater mobility in terms of fishing in other areas within the TAC area, whereas the Northern Irish effort is mostly concentrated on FU15. Fishing activity from the Irish fleet in FU15 increasingly concentrates on good fishing periods during the year, resulting in a larger and increasing lpue.

The mean sizes of *Nephrops* in the catches of both the Northern Ireland and Ireland fisheries have fluctuated for the last decade (Tables 6.5.4–6.5.5, Figure 6.5.1). There has been an increasing trend in the mean size of males and females in the landings in catches over the longer term (Figure 6.5.2).

Discarding is highly variable, mainly driven by market demand, and was 34% of the catch by number in 2011 (Table 6.5.6).

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

ICES advice applicable to 2011

MSY approach

Following the ICES MSY framework implies harvest ratio to be reduced to 17.1, resulting in landings of 8700 t in 2011.

*Following the transition scheme towards the ICES MSY framework implies the harvest ratio should be reduced (0.8 x harvest ratio (F2010) + 0.2 x harvest ratio(F_{MSY}) = 19.0*0.8 + 17.1*0.2 to 18.6% resulting in landings of 9500 t in 2011.*

ICES advice applicable to 2012

MSY approach

Following the ICES MSY framework implies a harvest ratio to be less than 17.1%, resulting in landings of 9800 t in 2012.

6.5.2 Data

An overview of the data provided and used by the WG is shown in Table 2.1. Commercial size composition data for landings and discards were provided by Northern Ireland and Ireland. Other biological data used in the assessment were as listed in the Stock Annex compiled by the Benchmark meeting WK*NEPH* (2009).

Surveys

Since 2003 Ireland and Northern Ireland have jointly carried out underwater television surveys of the main *Nephrops* grounds in the western Irish Sea. These surveys were based on a randomised fixed grid design. The methods used during the surveys were similar to those employed for UWTV surveys of other *Nephrops* stocks and were as agreed by WKNEPHTV, WKNEPBID, SGNEPS and WK*NEPH*. An average of 146 valid stations was covered by the two surveys combined and the data were raised to a stock area of around 5290 x 10^{-6} km^2 as detailed in Table 6.5.7. Details of the survey methodology are available in WKNEPHTV. Figure 6.5.3 shows the distribution of stations sampled in 2011 which was a slightly offset grid from those sampled in 2010. Figure 6.5.6 is a contour plot of the krigged density estimates for FU15 over the period 2003–2011. The survey abundance estimate in 2011 is approximately 2% lower than the 2010 estimate and remains just below the average of the time-series.

The use of the UWTV surveys for the provision of *Nephrops* management advice was extensively reviewed by WK*NEPH* (ICES, 2009) and potential biases were highlighted including those due to edge effects; species burrow misidentification and burrow occupancy. A cumulative bias correction factor estimated for FU15 was 1.14 which means the TV survey is likely to overestimate *Nephrops* abundance by 14%.

In addition to UWTV surveys Northern Ireland have completed spring (April) and summer (August) *Nephrops* trawl surveys since 1994 and provide data on catch rates, size composition and biological data from fixed stations in the western Irish Sea as detailed in the Stock Annex (Figure 6.5.4). Due to reduced financial resources, the spring survey series was terminated in 2010 as part of a national rationalisation of the survey programme after considering benefits to management and stock assessment. The summer trawl survey catch rates correlate somewhat with UWTV survey abundance estimates (Figure 6.5.5), but showed a deviating trend, especially in 2010. The longer time-series of the trawl survey shows that catch rates in the last few years (2005–2009, 11) are close to the mean of the series when UWTV burrow abundances were in the range of 5–6 billion burrows. The reduction in the 2010 trawl estimate, that showed a conflicting trend to the UWTV abundance, is most likely associated with the survey taking place in suboptimal tidal conditions. Usually the trawl survey coincides with slack tides, but this was not optimal in 2010 due to availability of the ship and synchronisation with the UWTV survey.

Mean carapace length-by-sex (from the trawl survey) has remained stable over the time-series (Figure 6.5.4).

6.5.3 Assessment

Approach in 2012

The assessment approach used by WGCSE 2011 is consistent with that set out in the Stock Annex and WK*NEPH* (ICES, 2009). Since the most recent three years of sampling data were available, three year averages of mean weights in the landings and proportions retained in the fishery have been used. This is in line with the procedure used for other stocks.

Comparison with previous assessments

The assessment in 2012 is based on trends in population indicators and catch options derived from UWTV surveys as last year, i.e. same methods and similar data. As last year, mean size and discard rates were derived as an average of the most recent three years. The stock size is estimated to have changed little and harvest ratio has increased slightly in 2011 based on the UWTV survey (Figure 6.5.10).

State of the stock

This stock has sustained landings at around 9000 t for many years. The stock increased until 2003. Since then, the stock has decreased but is still at high levels.

UWTV abundance estimates suggest that the stock size has increased in 2010 and is close to average of the UWTV time-series 2003–2011 (geometric mean: 5.8 billion). Figure 6.5.10 is the stock summary plot for FU15. Recent harvest rates have fluctuated around F_{MSY}.

6.5.4 MSY explorations

No new MSY explorations were carried out at WGCSE this year for FU15. The results of the final SCA model carried out last year are given in the text table below (with differences from the previous values in brackets). YPR curves and other plots generated by the model are shown in Figure 6.5.8. The F multipliers required to achieve the potential F_{MSY} proxies, the harvest rates that correspond to those multipliers and the resulting level of spawner per recruit as a percentage of the virgin level.

		FBAR 20–40 MM	HARVEST RATE	% VIRGIN SPAWNER PER RECRUIT		
		Female	Male		Female	Male
$F_{0.1}$	Comb	0.13 (-0.01)	0.16	10.3% (-0.3)	41.0% (+0.4)	42.2% (-1.8)
$F_{0.1}$	Female	0.13	0.15 (-0.01)	9.9% (-0.3)	42.2% (+0.5)	43.3% (-1.8)
$F_{0.1}$	Male	0.14	0.16 (-0.01)	10.7% (-0.3)	39.9% (+0.4)	41.1% (-1.8)
$F_{35\%}$	Comb	0.18	0.21 (-0.01)	13.0% (-0.4)	33.5% (+0.4)	34.5% (-0.7)
$F_{35\%}$	Female	0.17	0.20	12.7%	34.3% (-0.4)	35.4% (-2.5)
$F_{35\%}$	Male	0.18 (-0.01)	0.21 (-0.02)	13.4% (-0.7)	32.8% (+0.8)	33.8% (-0.8)
F_{MAX}	Comb	0.25 (+0.01)	0.30 (+0.01)	17.2% (+0.1)	25.0% (-0.5)	25.7% (-2.3)
F_{MAX}	Female	0.25 (+0.01)	0.30 (+0.01)	17.2% (+0.1)	25.0% (-0.5)	25.7% (-2.3)
F_{MAX}	Male	0.25 (+0.01)	0.30 (+0.01)	17.2% (+0.1)	25.0% (-0.5)	25.7% (-2.3)

WGCSE took into account the following considerations:

- Compared to other *Nephrops* fisheries in the ICES area the population density of FU15 is the highest of all stocks >~1/m^2 (Figure 6.5.9). These high densities are observed throughout time and space. The high observed density implies intense competition for space and food on the seabed and that sperm limitation is not likely to be a problem.
- The seven year time-series of UWTV data for FU15 and the 2009 survey shows the stock is relatively stable. Trawl survey cpue since 1994 indicates that abundance has been at high levels over the last seven years (assuming constant survey catachability).
- The growth rate of *Nephrops* in this stock is known to be slow and they exhibit a relatively small size of maturity (McQuaid *et al*., 2009). There appears to be little change is the size composition in catches despite over 40 years of intensive fishing (Lordan, 2010, WD2).
- This fishery occurs throughout the year and does not exhibit major inter annual changes seasonal pattern. Landings have fluctuated around 9000 t for over the 35 years.
- Larval production studies show that over 440 x 10^9 larvae were produced in 1995 (Briggs *et al*., 2002). This >70 times more larvae produced annual than current stock size estimates. The high larval production is coupled with a strong retention mechanism and depositional environment due to

the western Irish Sea gyre ensures continued good recruitment (Hill *et al*., 1994, 1996).

- The harvest rate in recent years is thought to have been above F_{MAX} (note: harvest rates prior to 2007 are lower bounds as landings may have been under reported) with no apparent affect on the stock (Figure 6.5.10).

The WG and Review Group concluded that a combined sex F_{MAX} was a suitable F_{MSY} proxy for this stock. This corresponds to a harvest rate of 17.1% (2010 value). On the basis of the MSY explorations carried out in 2011 WGCSE concluded that there was no need to adjust the harvest rate proposed in 2010 as estimates differed by only 0.1%

6.5.5 Short-term projections

A landings prediction for 2012 was made for FU15 using the approach agreed at the Benchmark Workshop (WK*NEPH* ICES, 2009). Catch option table inputs are given in (Table 6.5.8).

Table 6.5.9 shows landings predictions at various harvest ratios, including those equivalent to fishing within the range of $F_{0.1}$ to F_{MAX}. The F_{2011} for the western Irish Sea is estimated to be above the F_{MSY} proxy proposed by ICES.

6.5.6 Biological reference points

The cpue data from the trawl surveys was scaled to the UWTV index to provide a $B_{trigger}$ approximation based on the mean of the five lowest survey catch rates in the time-series (Figure 6.5.5). Harvest ratios equating to a range of fishing mortalities including $F_{0.1}$, $F_{35\%}$ and F_{MAX} are provided above. These calculations assumed that the TV survey has a knife-edge selectivity at 17 mm and that the supplied length frequencies represented the population in equilibrium. The WG concluded that a combined sex F_{MAX} was a suitable F_{MSY} proxy for this stock. This corresponds to a harvest rate of 17.1%.

6.5.7 Management plans

A number of cod recovery measures have been introduced since 2000 to promote recovery of Irish Sea cod stocks. These include a closure of the western Irish Sea cod spawning grounds from mid February to end of April since 2000, with a later extension to the eastern Irish Sea closure. Despite a partial derogation for *Nephrops* vessels during the closed period the distribution of effort on *Nephrops* has been affected by this management plan. There have also been decommissioning schemes to reduce fishing effort.

6.5.8 Uncertainties in the assessment and forecast

Uncertainties in the survey, mean weight in the landings and discard rates are not taken into account in the deterministic catch option. There is some variability in these over time.

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). These have lead to a revision in the historical time-series of survey abundance estimates for FU15, which was presented to last year's Working Group.

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 was more accurate but no more precise (WK*NEPH* 2009). The survey estimates themselves are very precisely estimated (CVs 2–5%) given the homogeneous distribution of burrow density and the modelling of spatial structuring. The cumulative bias estimates for FU15 are largely based on expert opinion (see Stock Annex). The precision of these bias corrections cannot yet be characterised but is likely to be higher 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. These parameters are quite variable (Table 6.5.8). In future years the uncertainty in these key parameters should be estimated.

There is a gap of 16 months between the survey and the start of the year for which the assessment is used to set management levels. It is assumed that the stock is in equilibrium during this period (i.e. recruitment and growth balance mortality) although this is rarely the case. The effect of this assumption on realised harvest rates has not been investigated but remains a key uncertainty.

The quality of landings data has improved since 2007 with the implementation of sales notes and buyers and sellers legislation. Prior to that there were concerns that landings were underreported. The harvest ratio may be under estimated prior to 2007.

6.5.9 Management considerations

The FU15 *Nephrops* fishery first developed in the late 1950s. Since then it has sustained landings of around 9000 t for more than 35 years. Fishing effort in the past has been very high but has declined somewhat in recent years. The environment in the Western Irish Sea is very suitable for *Nephrops* with a large mud patch and gyre which retains the larvae over the mud patch thus ensuring good recruitment. The ground can be characterised as an area of very high densities of small *Nephrops*. All available information indicates that size structure of catches appears to have changed little since the fishery first began.

The *Nephrops* trawl fisheries take bycatches of other species, especially juvenile whiting but also cod. Catches of these species should be reduced to as low as possible a level because of the poor status of these stocks.

The cod long-term plan was introduced in 2009 (EC 1342/2008). Annual effort in *Nephrops* trawl fisheries (Effort group TR2 OTB 70–99 mm) in Division VIIa has been reduced by 25% annually since 2009. The implementation of the cod long-term plan is expected to cause large changes in fishing patterns as effort allocations become more restrictive. There are provisions in the cod long-term plan to be exempt from these effort restrictions, or have it reduced, making the impact of this regulation on overall effort difficult to assess. Since 2009, four Irish vessels have been using "Swedish grids" in the fishery to reduced bycatches of cod, whiting and haddock. The number increased to seven towards the end of 2011. A conditional national licence has been introduced by Ireland since March 2012 making the use of grids or separator panels mandatory for all TR2 boats fishing in the Irish Sea.

ICES has repeatedly advised that management should be at a smaller scale than the ICES Subarea VII. Management at the Functional Unit level could provide the controls to ensure that catch opportunities and effort are at the same scale as the resource.

6.5.10 References

Briggs, R.P., Armstrong, M.J., Dickey-Collas, M., Allen, McQuaid, N. and Whitmore, J. 2002. Estimation of *Nephrops* Biomass in the Western Irish Sea from Annual Larval Production. ICES Journal of Marine Research, 59: 109–119.

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Table 6.5.1. Irish Sea West (FU15): Landings (tonnes) by country, 2000–2011.

Year	Rep. of Ireland	Isle of Man	UK	Other countries	Total
2000	3,433	0	4937	0	8370
2001	2,689	3	4749	0	7441
2002	2,291	1	4501	0	6793
2003	2,709	4	4352	0	7065
2004	2,786	13	4470	1	7270
2005	2,133	0	4420	0	6554
2006	2,051	1	5508	1	7561
2007	2,767	0	5724	0	8491
2008	3,132	50	7323	2	10508
2009	2,343	1	6855	0	9198
2010	2,578	0	6384	0	8963
2011*	3,575	2	6584	0	10162

* provisional

Table 6.5.2. Irish Sea West (FU15):Landings (tonnes), effort ('000 hours trawling), and lpue (kg/hour trawling) of Northern Ireland *Nephrops* trawlers, 2000–2011.

Year	Effort	Landings	LPUE
2000	168.7	4758	28.2
2001	163.7	4587	28.0
2002	130.8	4495	34.4
2003	136.1	4146	29.0
2004	144.3	4273	29.6
2005	138.4	4235	30.6
2006	144.1	5356	37.2
2007	126.9	5512	43.4
2008	141.4	7056	49.9
2009	134.7	6487	48.2
2010	141.1	5888	41.7
2011*	132.7	5952	44.9

* provisional

Table 6.5.3. Irish Sea West (FU15): Catches and landings (tonnes), effort ('000 hours trawling), cpue and lpue (kg/hour trawling) Republic of Ireland *Nephrops* Directed Trawlers 2000–2011.

Year	Effort	Landings	LPUE
2000	61.1	3160	51.7
2001	52.4	2475	47.2
2002	49.0	2238	45.7
2003	45.4	2680	59.1
2004	51.5	2535	49.3
2005	48.6	2062	42.4
2006	50.6	1959	38.7
2007	48.0	2578	53.7
2008	47.1	3076	65.3
2009	34.0	2290	67.3
2010	36.1	2481	68.8
2011*	46.6	3486	74.8

* provisional

Table 6.5.4. Irish Sea West (FU15): Mean sizes (mm CL) of male and female *Nephrops* in Northern Ireland catches, landings and discards, 2000–2011.

Year	Catches		Landings		Discards	
	Males	Females	Males	Females	Males	Females
2000	27.7	24.5	29.4	26.3	22.5	22.6
2001	25.7	23.6	26.1	24.4	21.7	21.2
2002	26.7	24.1	26.7	24.9	21.8	21.7
2003	na	na	na	na	na	na
2004	na	na	na	na	na	na
2005	na	na	na	na	na	na
2006	na	na	na	na	na	na
2007	na	na	na	na	na	na
2008	25.9	24.6	26.9	25.5	21.4	21.5
2009	27.7	25.1	29.3	26.5	23.6	23.2
2010	28.3	25.6	29.5	26.3	23.2	22.8
2011*	27.6	26.0	29.3	27.7	22.6	22.8

* provisional na = not available

Table 6.5.5. Irish Sea West (FU15): Mean sizes (mm CL) of male and female *Nephrops* in Republic of Ireland catches, landings and discards, 2000–2011.

Year	Catches		Landings		Discards	
	Males	Females	Males	Females	Males	Females
2000	29.1	27.1	32.2	29.7	24.3	24.0
2001	26.7	24.8	28.6	27.0	23.0	22.2
2002	28.9	25.4	30.2	27.8	24.6	23.6
2003	27.7	24.9	29.7	26.9	24.0	23.1
2004	28.1	26.1	29.7	27.8	23.9	23.7
2005	28.5	26.8	30.1	29.1	23.9	23.2
2006	27.7	25.5	29.5	27.1	23.8	23.1
2007	27.7	25.4	29.8	27.9	24.0	23.3
2008	27.4	24.6	28.9	26.6	22.0	21.4
2009	28.5	26.3	30.5	29.2	24.3	23.4
2010	28.0	25.9	29.6	27.6	23.8	23.3
2011*	27.0	25.7	28.8	27.3	23.7	23.5

* provisional

Table 6.5.6. Irish Sea West (FU15): Proportion discarded by weight and number from FU15. (note a 10% survivorship of discards is assumed in HR and forecast calculations).

Year	Discards By Weight	Discards by number
1986	0.14	0.27
1987	0.14	0.24
1988	0.07	0.15
1989	0.08	0.16
1990	0.03	0.07
1991	0.03	0.08
1992	0.13	0.22
1993	0.17	0.29
1994	0.13	0.25
1995	0.18	0.32
1996	0.14	0.27
1997	0.12	0.23
1998	0.15	0.27
1999	0.21	0.35
2000	0.22	0.36
2001	0.22	0.36
2002	0.20	0.31
2003	0.27	0.42
2004	0.22	0.34
2005	0.18	0.31
2006	0.23	0.36
2007	0.28	0.42
2008	0.12	0.20
2009	0.24	0.37
2010	0.15	0.24
2011	0.21	0.34
Max	0.28	0.42
Min	0.03	0.07
Average	0.16	0.28

Table 6.5.7. Irish Sea West (FU15): Results from NI/ROI collaborative UWTV surveys of *Nephrops* grounds in 2003–2011.

Ground	Year	Number of stations	Mean Density (No./M^2)	Domain Area (km^2)	Estimate (billions)	CV on Burrow estimate
Western Irish Sea	2003	160	1.12	5295	6.3	3%
	2004	147	1.13	5310	6.3	3%
	2005	141	1.16	5281	6.5	4%
	2006	138	1.10	5194	6.2	4%
	2007	148	1.06	5285	5.9	3%
	2008	141	0.88	5287	4.9	3%
	2009	142	0.95	5267	5.3	3%
	2010	149	1.02	5307	5.7	3%
	2011	149	1.00	5289	5.6	2%

Table 6.5.8. Irish Sea West (FU15): Catch option table inputs. Data used for 2012 catch prediction are shaded. (note a 10% survivorship of discards is assumed in the calculation of removals and HR).

Year	Landings in Number (millions)	Discards in Number (millions)	Removals in Number (millions)	Prop Removals Retained	Adjusted Survey (billions)	Harvest Ratio	Landings (t)	Discards (t)	Mean Weight in landings (gr)
1986	740	268	981				9,978	1,680	
1987	774	242	992				9,753	1,608	
1988	576	104	669				8,586	639	
1989	644	121	753				8,147	673	
1990	678	53	726				8,308	276	
1991	792	65	850				9,566	345	
1992	525	151	661				7,547	1,079	
1993	679	275	926				8,102	1,622	
1994	619	203	801				7,606	1,185	
1995	554	260	787				7,796	1,724	
1996	469	170	622				7,247	1,202	
1997	731	214	924				9,971	1,330	
1998	616	229	822				9,128	1,560	
1999	710	388	1060				10,780	2,913	
2000	533	298	801				8,370	2,293	
2001	573	315	857				7,438	2,112	
2002	491	223	692				6,792	1,732	
2003	404	291	666	0.61	5.5	0.12	7,052	2,659	17.5
2004	416	218	612	0.68	5.5	0.11	7,267	1,993	17.5
2005	346	157	488	0.71	5.7	0.09	6,530	1,412	18.9
2006	467	261	701	0.67	5.4	0.13	7,534	2,285	16.1
2007	511	375	848	0.60	5.1	0.16	8,424	3,246	16.5
2008	755	191	927	0.81	4.3	0.22	10,478	1,421	13.9
2009	567	335	868	0.65	4.6	0.19	9,199	2,934	16.2
2010	572	180	733	0.78	5.0	0.15	8,963	1,539	15.7
2011	644	332	943	0.68	4.9	0.19	10,162	2,683	15.8
Max	792	388	1060	0.81	5.67	0.22	10,780	3,246	18.9
Min	346	53	488	0.60	4.29	0.09	6,530	276	13.9
Average	592	228	797	0.69	5.14	0.15	8,489	1,698	16.4
Avg. 09–11				0.70					15.90

Table 6.5.9. Irish Sea West (FU15): Catch options at various harvest ratios.

			Implied fishery	
			Implied fishery	
Harvest rate		Survey Index (Millions)	Retained number (Millions)	Landings (tonnes)
MSY framework	17%	4,871	587	9,336
	0%	4,871	0	0
	2%	4,871	69	1,092
	4%	4,871	137	2,184
	6%	4,871	206	3,276
	8%	4,871	275	4,368
	10%	4,871	343	5,460
Male $F_{0.1}$	11%	4,871	376	5,985
	12%	4,871	412	6,552
Combined $F_{35\%}$	13.4%	4,871	460	7,312
	14%	4,871	481	7,644
	16%	4,871	560	8,900
Combined F_{MAX}	17.1%	4,871	587	9,336
F2009–2011	17.6%	4,871	605	9,614
	18%	4,871	618	9,828
F_{2011}	19.4%	4,871	665	10,566
	20%	4,871	687	10,920
	22%	4,871	755	12,012
	24%	4,871	824	13,104

		Basis
Landings Mean Weight (KG)	0.0159	Sampling 2009–2011
Survey Overestimate Bias	1.14	WKNEPH 2009
Survey Numbers (Millions)	5553	UWTV Survey 2011
Prop of removals retained by the Fishery	0.70	Sampling 2009–2011

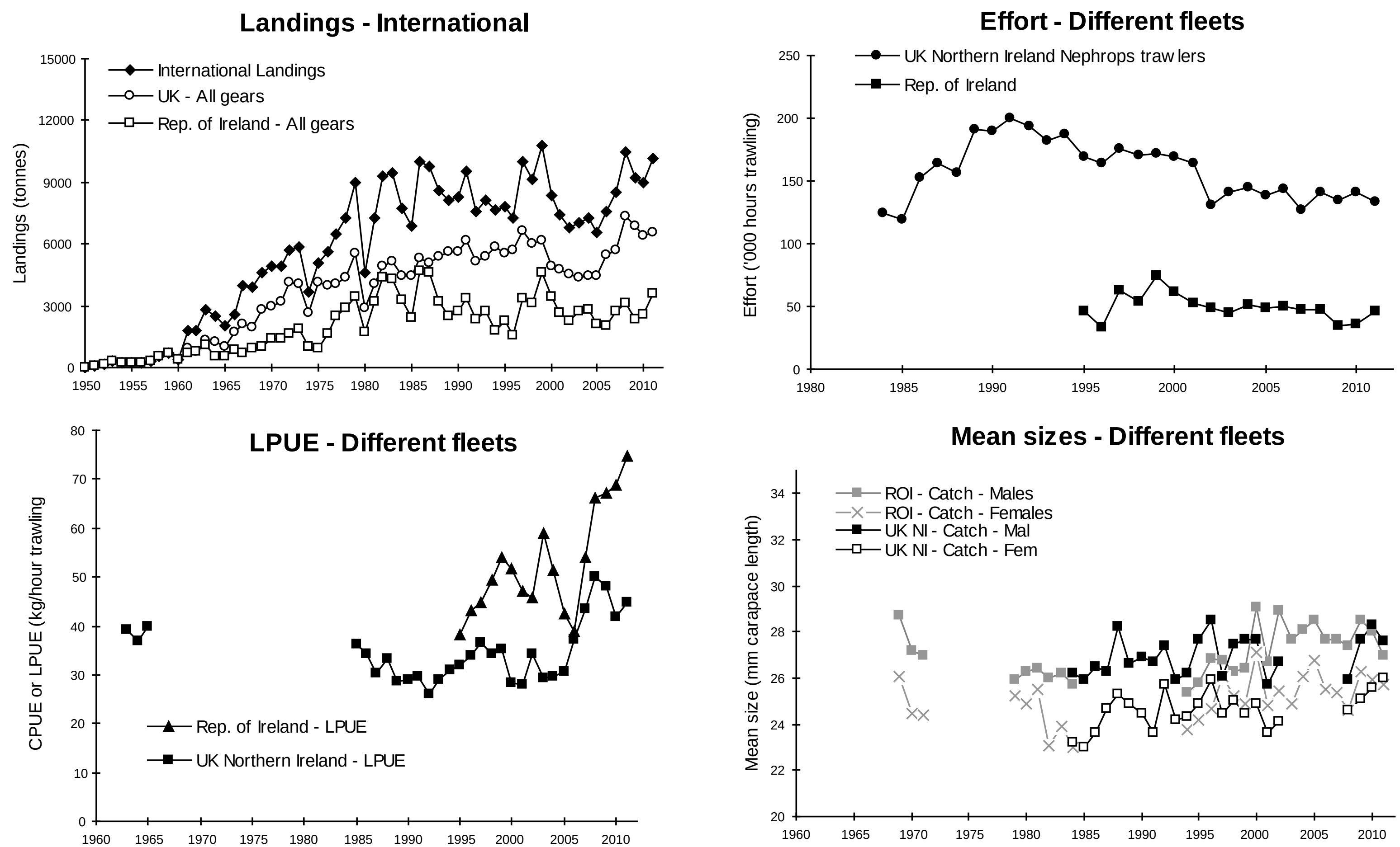


Figure 6.5.1. Irish Sea West (FU15): Long-term trends in landings, effort, cpues and/or lpues, and mean sizes of *Nephrops*. [The quality of landings data has improved since 2007 with the implementation of sales notes and buyers and sellers legislation, which result in misleading lpue trend plots pre and post 2007].

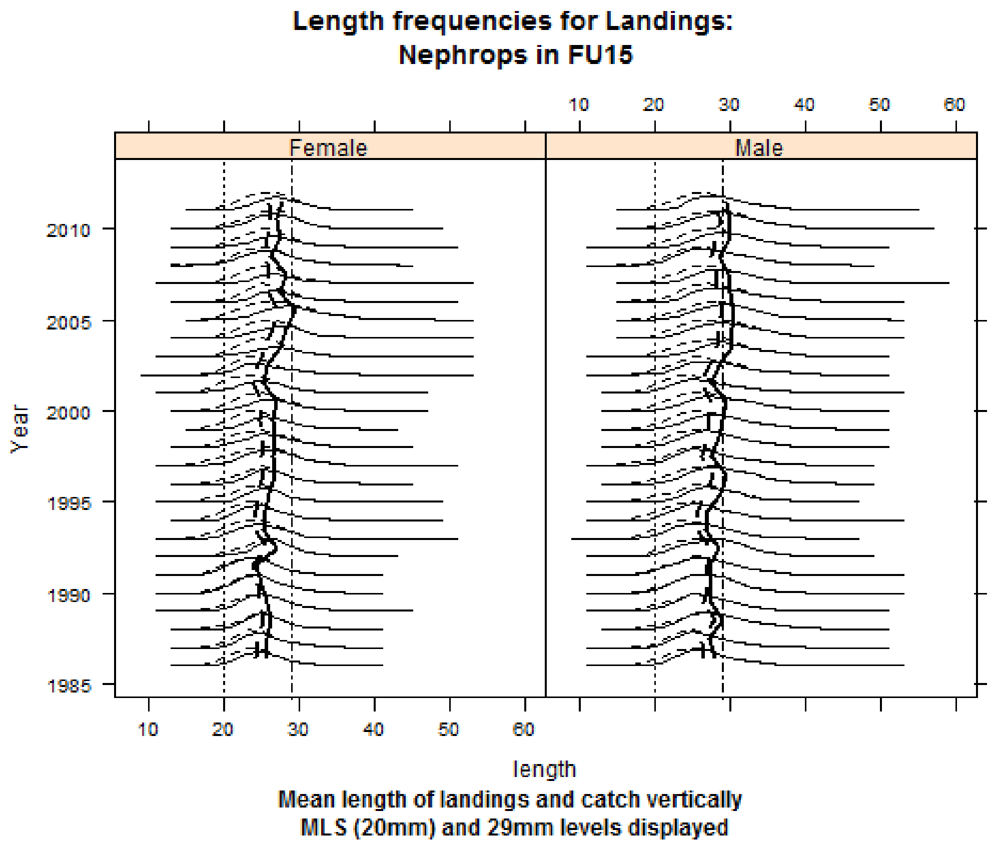


Figure 6.5.2. Irish Sea West (FU15): Length distributions in the landings (solid) and catches (dotted) 1986–2011 females (left) and females (right).

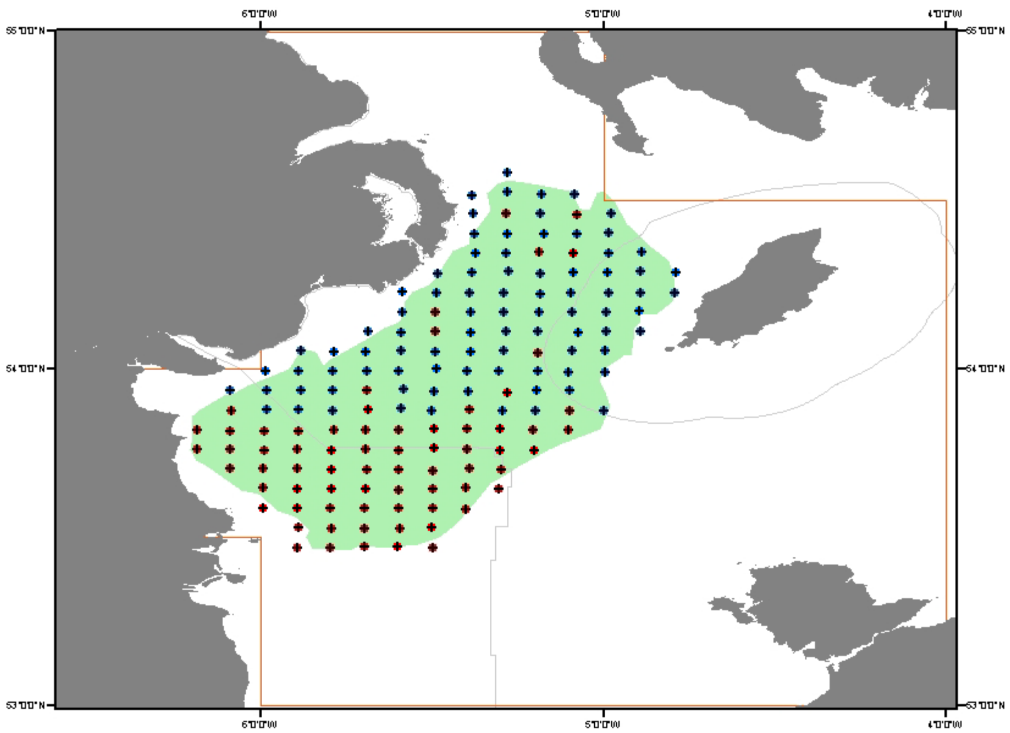
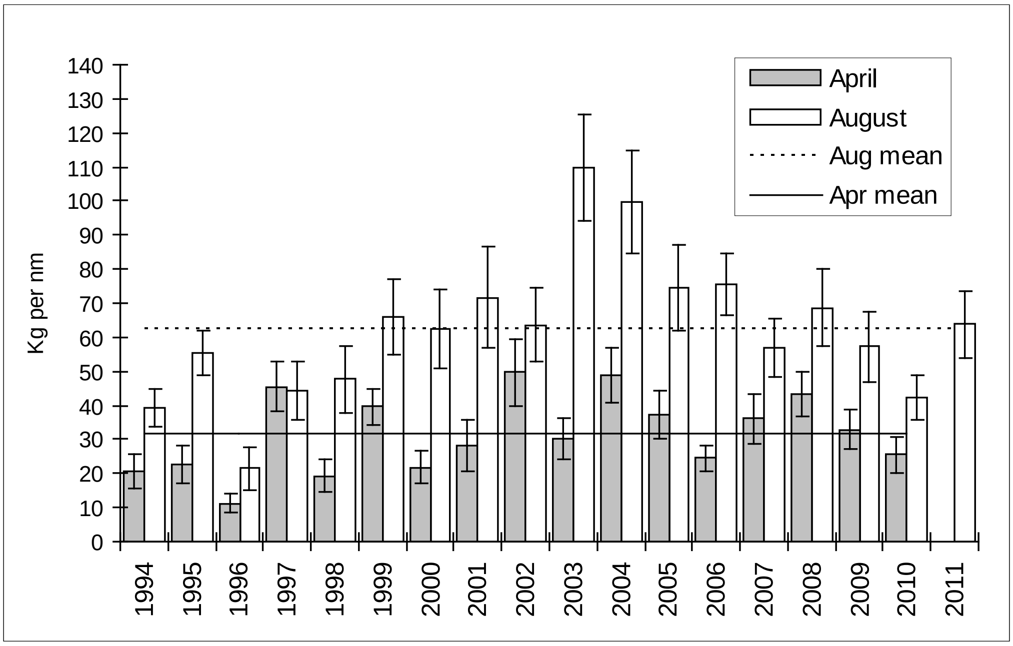


Figure 6.5.3. Irish Sea West (FU15): 2011 UWTV survey stations



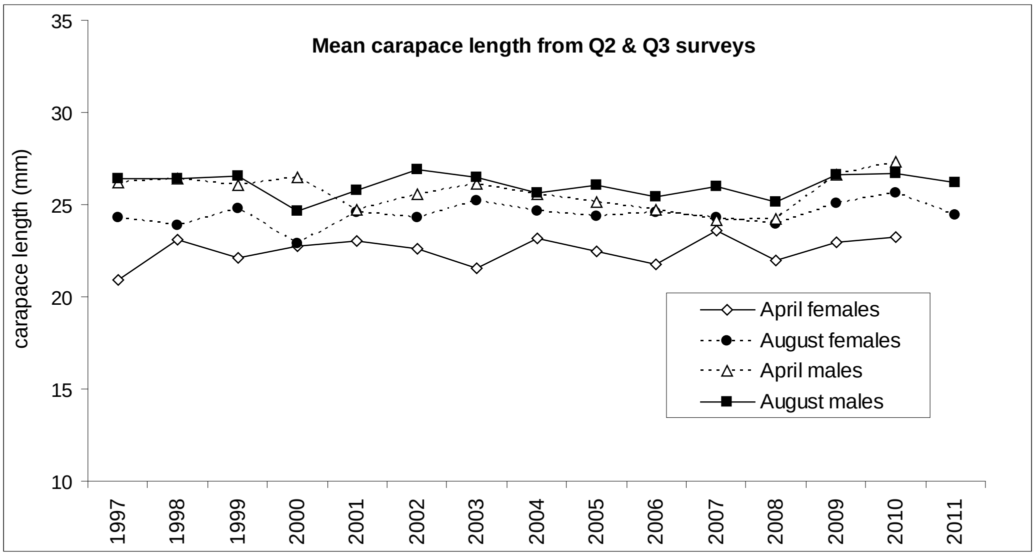


Figure 6.5.4. Irish Sea West (FU15): *Nephrops* catches, sex specific mean size from NI trawl surveys.

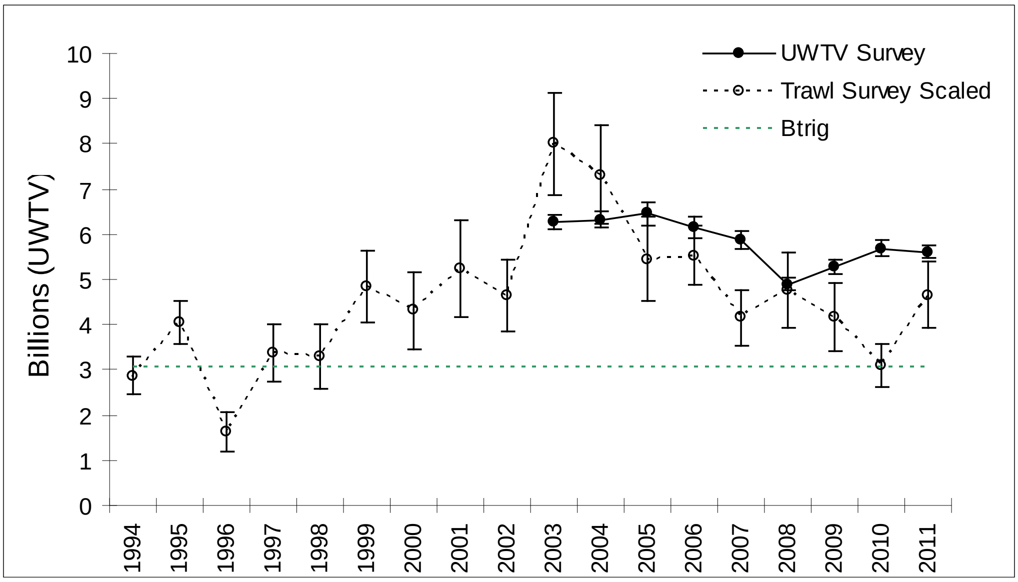


Figure 6.5.5. Irish Sea West (FU15): Revised UWTV index and scaled trawl survey. Cpue along with $B_{trigger}$ based upon mean of five lowest trawl survey values

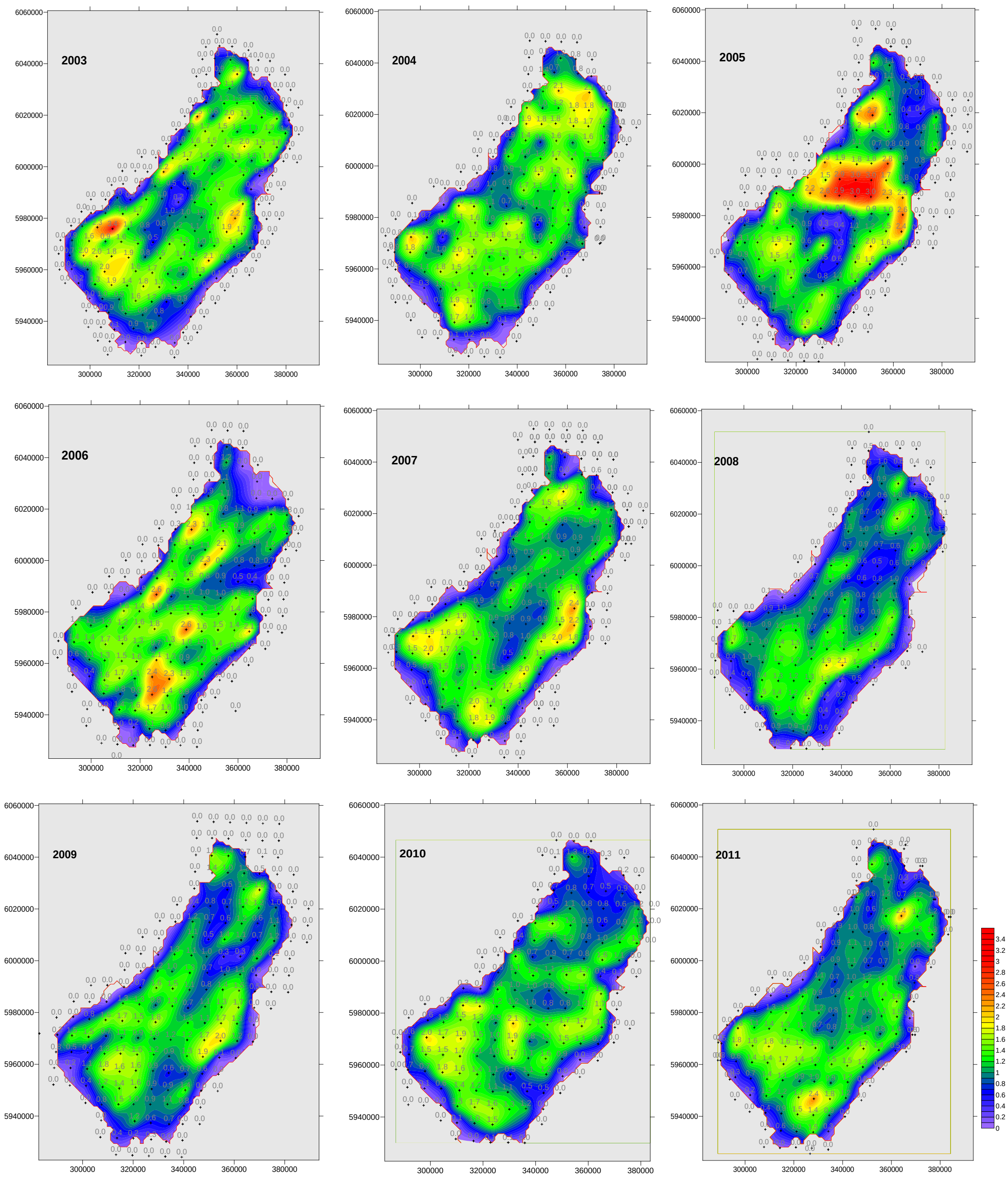


Figure 6.5.6. Irish Sea West (FU15): Contour plots of the krigged density estimates for the Irish Sea from 2003–2011.

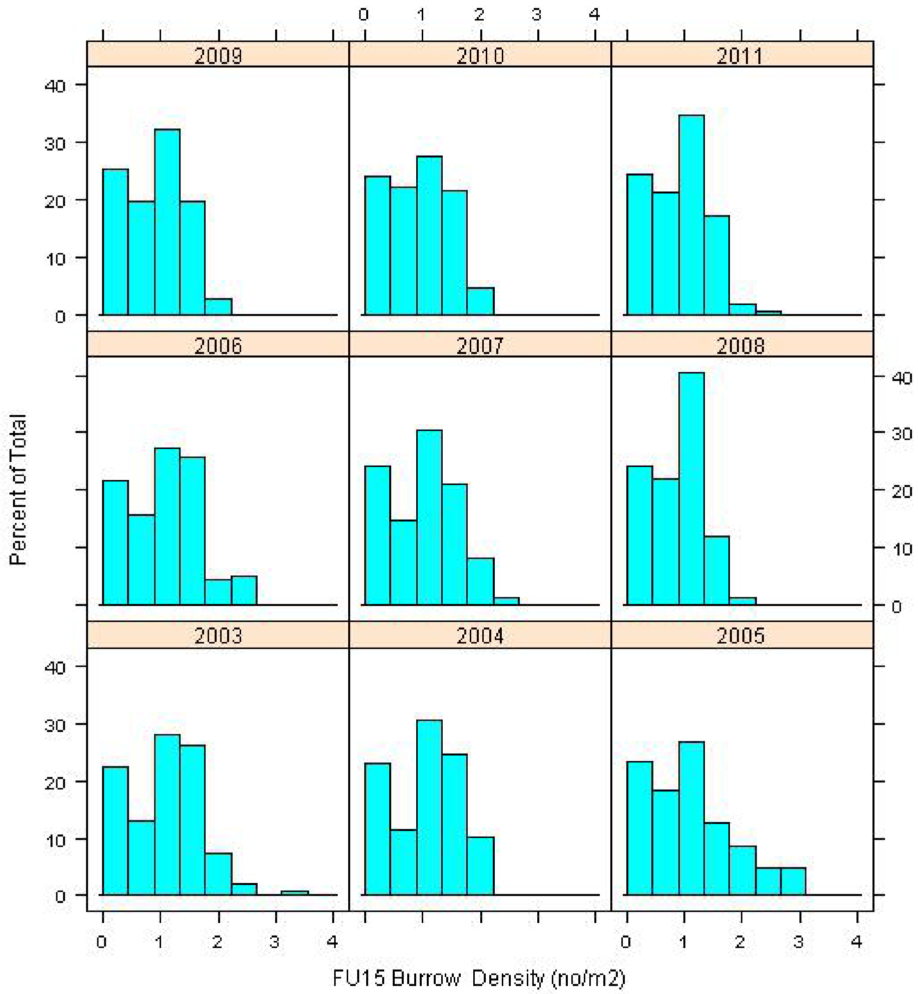


Figure 6.5.7. Irish Sea West (FU15): Burrow density distributions 2003–2011.

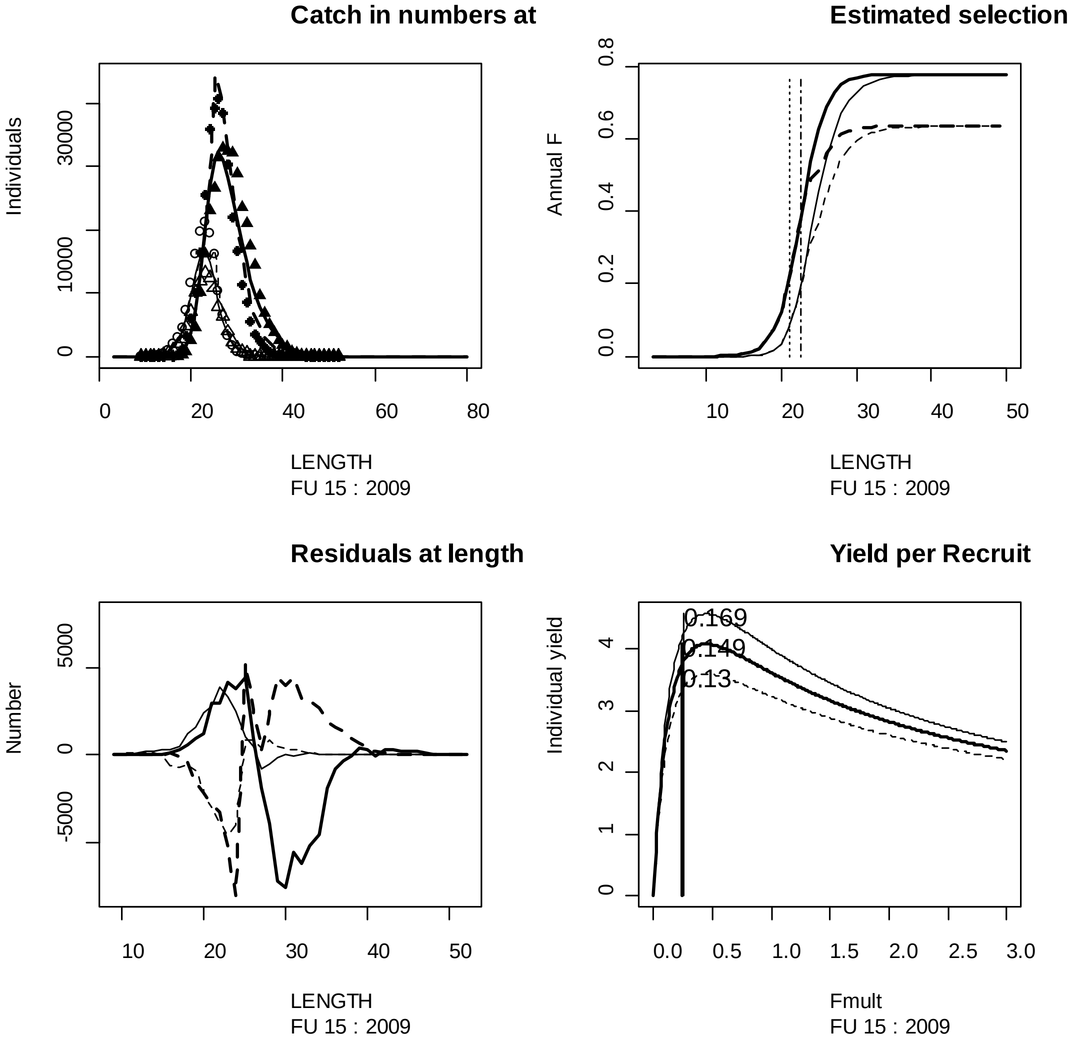


Figure 6.5.8. Irish Sea West (FU15): Separable Cohort analysis (SCA) model fit from 2010 analysis. Solid lines are for males, dashed lines are females, thick lines represent the landings component, the thin lines represent the discarded component. The top left panel gives observed and predicted numbers-at-length in the discards and landings, top right gives the fishing mortality-at-length with the vertical lines representing length at 25% selection and 50% selection. Bottom left shows residual numbers (observed - expected) at length. The bottom right gives the Yield Per recruit against fishing mortality, the thick solid line gives the combined value and vertical lines represent $F_{0.1}$ for the three curves.

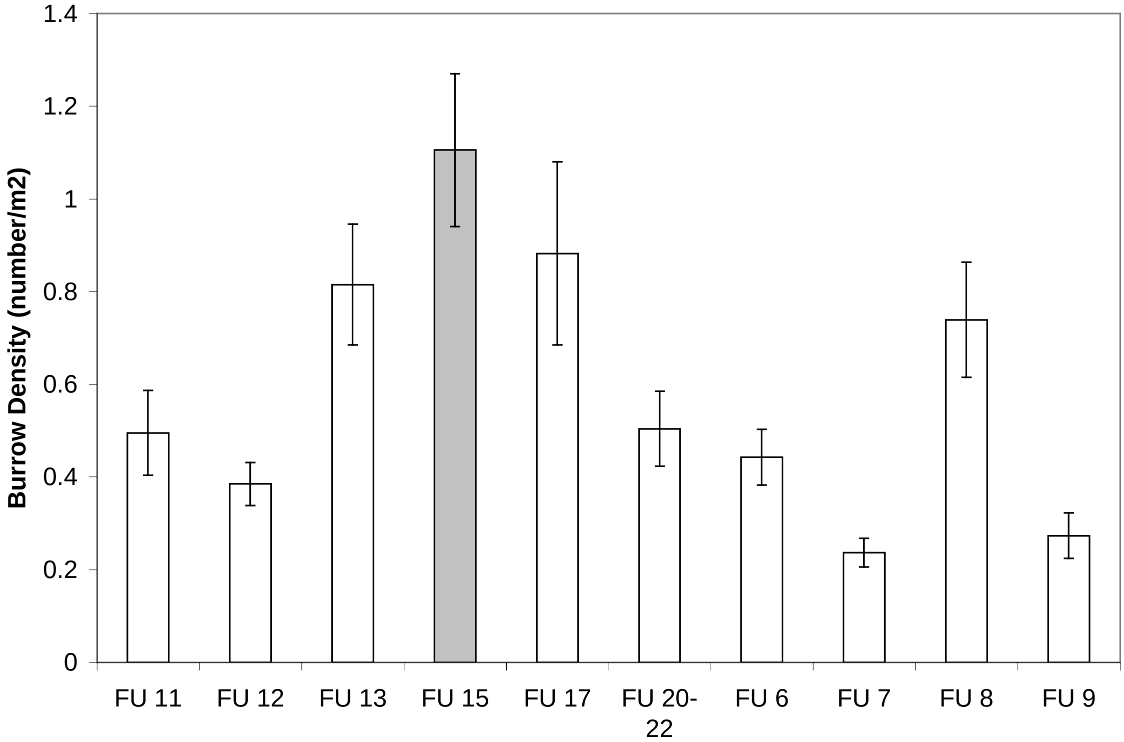


Figure 6.5.9. Irish Sea West (FU15): Estimated burrow density compared with most recent density estimates from surveys carried out on other *Nephrops* populations.

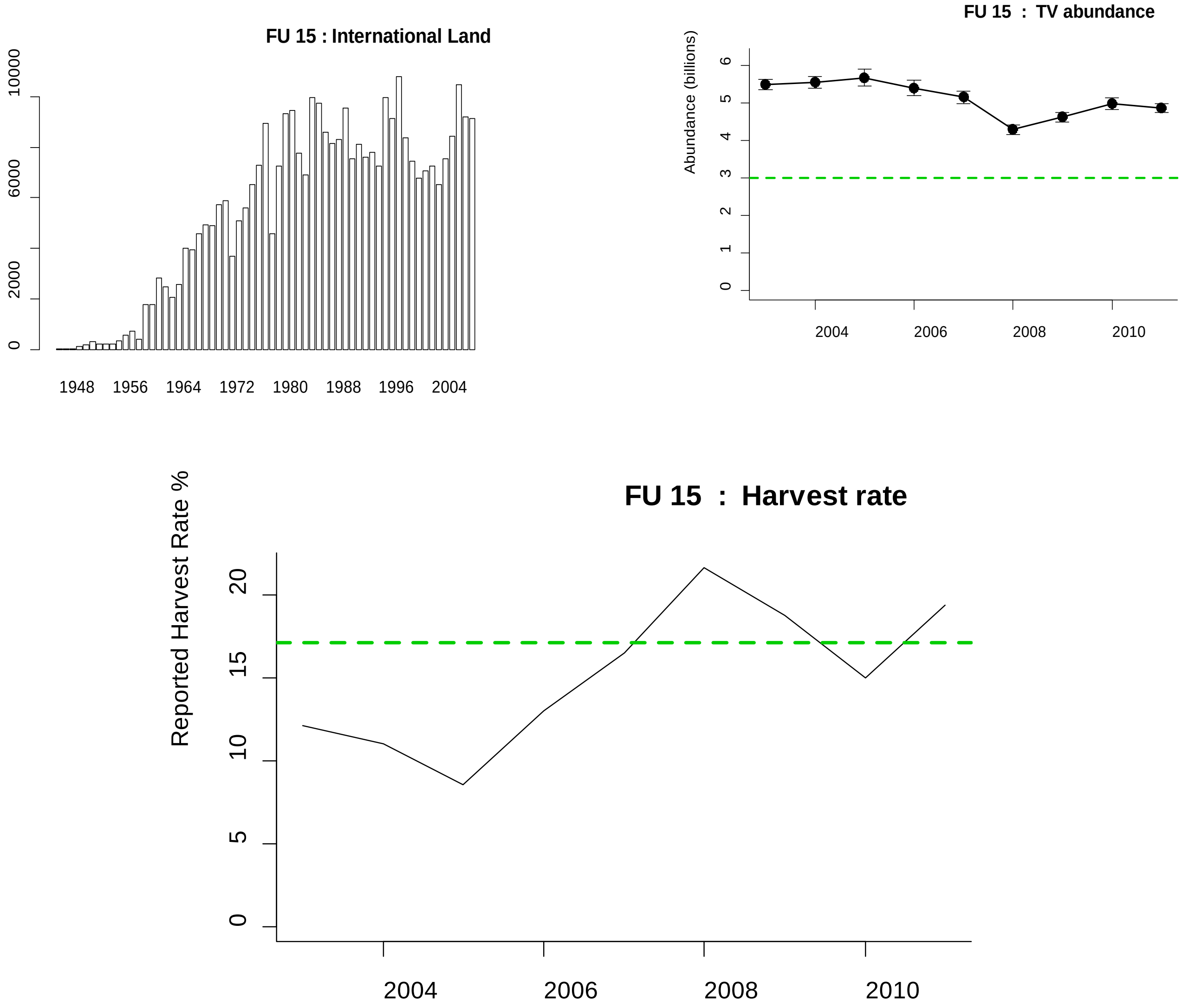


Figure 6.5.10. Irish Sea West (FU15): Stock summary plot of landings (tonnes), UWTV abundance and harvest rate (ratio).

6.6 Whiting in VIIa

Type of assessment

This year single fleet SURBA runs were carried out for two of the main surveys assessing this stock, the NIGFS-WIBTS-Q1 and NIGFS-WIBTS-Q4 surveys to provide trends in the stock. Overall it is clear that the stock is in a state of decline. Landings have decreased, and have been at low levels in recent years (≤200 t). The survey results indicate a decline in SSB to low levels in recent years. Total mortality has been variable over the time-series.

ICES advice applicable to 2011

In the advice for 2011, the stock status was presented as follows:

Fishing mortality	2007	2008	2009
F_{MSY}	Unknown	Unknown	Unknown
F_{PA}/F_{lim}	Unknown	Unknown	Unknown
Spawning–Stock Biomass (SSB)	2008	2009	2010
MSY $B_{trigger}$	Unknown	Unknown	Unknown
B_{PA}/B_{lim}	Unknown	Unknown	Unknown

MSY approach

SSB has declined to a very low level. The underlying data do not support the provision of estimates of F_{MSY}. However it is likely that current F is above F_{MSY}. Therefore, catches (mainly discards) of whiting should be reduced.

Management by TAC is inappropriate for this stock because landings – but not catches – are controlled. Further management measures should be introduced in the Irish Sea to reduce discarding of small whiting in order to maximize their contribution to future yield and SSB.

PA considerations

ICES considers that catches should be reduced to the lowest possible levels in 2011.

ICES advice applicable to 2012

ICES advises on the basis of precautionary considerations that catches should be reduced to the lowest possible levels and uptake of further technical measures to reduce discards.

In the advice for 2012, the stock status was presented as follows:

Fishing mortality	2008	2009	2010
F_{MSY}	Unknown	Unknown	Unknown
F_{PA}/F_{lim}	Unknown	Unknown	Unknown
Spawning–Stock Biomass (SSB)	2009	2010	2011
MSY $B_{trigger}$	Unknown	Unknown	Unknown
B_{PA}/B_{lim}	Unknown	Unknown	Unknown

Precautionary considerations

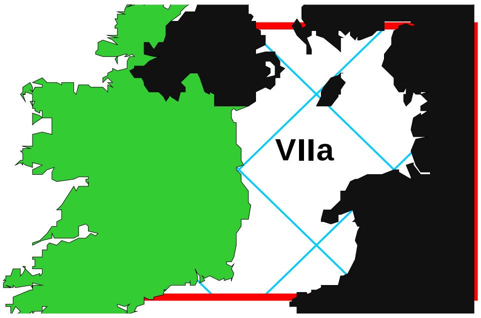
SSB has declined to a very low level. The underlying data do not support the provision of estimates of F_{MSY}. However it is likely that current F is above F_{MSY}. Therefore, catches (mainly discards) of whiting should be reduced to the lowest possible levels.

Management by TAC is inappropriate for this stock because landings – but not catches – are controlled. Further management measures should be introduced in the Irish Sea to reduce discarding of small whiting in order to maximize their contribution to future yield and SSB.

6.6.1 General

Stock description and management units

The stock and the management unit are both ICES Division VIIa (Irish Sea).



Red Box-TAC/Management Area
Blue Shading– Assessment Area

Management applicable to 2011 and 2012

The minimum landing size of whiting is 27 cm. The 2012 TAC for whiting VIIa has been reduced from 118 t to 89 t. This TAC has not been considered restrictive, with officially reported VIIa landings totalling 74 t in 2011.

TAC 2011

Species: Whiting *Merlangius merlangus*		Zone: VIIa (WHG/07A.)
Belgium	0	
France	4	
Ireland	68	
The Netherlands	0	
United Kingdom	46	
EU	118	
TAC	118	Analytical TAC

TAC 2012

Species: Whiting *Merlangius merlangus*		Zone: VIIa (WHG/07A.)
Belgium	0	
France	3	
Ireland	52	
The Netherlands	0	
United Kingdom	34	
Union	89	
TAC	89	Analytical TAC

Fishery in 2011

ICES officially reported landings for Division VIIa and landings as used by the Working Group are given in Table 6.6.1. In recent years the values provided to the WG are very similar to officially reported landings. In 2011 international landings provided to the Working Group have decreased by 39% from the previous year to 74 t.

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, 70–89 mm and 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 smaller range however 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 2011 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 Irish and UK NI *Nephrops* fishery shows a peak in activity in summer months, after the reopening of the Irish Sea cod box.

Since late 2009, a number of Irish vessels operating within the Irish Sea *Nephrops* fishery incorporated a Swedish grid into otter trawls, as part of the cod long-term management plan. It is expected that this will reduce the whiting catches of these vessels by ~60% in weight.

In recent years, Irish East Coast *Nephrops* vessels have moved away from their traditional Irish Sea grounds to the Smalls grounds (FU22; VIIg), which is not controlled by effort limitation and generally better prices are obtained for their catch.

During 2008 Ireland introduced a further decommissioning scheme with the aim of removing 11 140 GT from the fleet register. This was targeted at vessels over ten years and >18 m. Of the decommissioned vessels 29 operated within the Irish Sea, primarily targeting *Nephrops* landing into east, and to a lesser extent south coast ports.

6.6.2 Data

An overview of the data provided and used by the WG is shown in Table 2.1 in the WGCSE Report.

Fishery landings

Table 6.6.1 gives the nominal landings of VIIa whiting as reported by each country to ICES. The officially reported landings have declined since 1996. Landings remained at a very low level in 2011. 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. No revisions were made to last year's Working Group estimate of landings. Discard estimates from the IR-OTB fleet are available since 2003 and from the NI *Nephrops* fishery since 2009 are also presented in Table 6.6.1 but are imprecise.

There is evidence that officially reported landings of whiting in the past (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.

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.

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 onboard observer trips carried out in 2011 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 landing whiting show over 11 million whiting, greater than

1000 t in weight, were discarded in 2011. This focused on the two youngest ages, and to a lesser extent age 2. In some years up to age 4 fish are discarded. The following discard data were available for this stock:

- Discard numbers-at-age from 1980–2002 estimated from the NI *Nephrops* fishery and raised to the International Fleet (from the NI self sampling scheme).
- Discard numbers-at-age from the Irish Otter Trawl Fleet from 1996–2011, including length–frequency data. Note the data in 2010 is not thought to be fully representative of discarding in the Irish Sea for the Irish OTB fleet as there were only four trips sampled.
- Discard Length Frequencies for the UK (E and W) fleet, 2004–2011, raised to trip.
- Discard numbers-at-age for the NI fleet for 1997–2001, and 2006, 2007, 2009 and 2010, raised to trip, including length frequency data from the NI observer scheme.

Methods for estimating quantities and composition of discards from UK (NI) and Irish *Nephrops* trawlers are described in the Stock Annex Section B.1.2. Irish otter trawl fleet discard estimates (1996–2010), raised according to the methods described in Borges *et al.* (2005) were available to the Working Group (Table 6.6.11).

Numbers-at-age and mean weights-at-age for the Irish otter-trawl fleet are also presented in Figure 6.6.4.

The length frequency of discards of national sampled fleets in 2011 is given in Figure 6.6.5. There appears to be a distinct bimodal distribution in the length frequencies in the Northern Irish fleet indicating tracking of the year classes.

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.

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 March 2011 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.

WGNSDS 2006 also provides information on the distribution of whiting less than MLS in the Irish Sea up to 2006.

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). Although effort data were provided for the UK(E&W) and Ireland, it was decided not to include this data in the Report as it was considered not to be indicative of lpue trends due to the low levels of landings and changes in discard practices.

6.6.3 Historical stock development

No assessment was carried out for this stock in 2011. The last assessment for this stock was a survey based assessment in 2007.

Catch-at-age data was not updated and commercial catch data was not explored in 2011.

Data screening

The general methodology is outlined in Section 2.

Final update assessment

Single fleet survey based runs were carried out on the NIGFS-Mar and NIGFS-Oct surveys using SURBA (version 2.2). Default values were used for both catchability and smoothing settings.

Log-mean standardised indices and scatter plots of log-index at age for the NIGFS-WIBTS-Q1 survey are presented in Figures 6.6.6(a) and 6.6.7(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 scatter-plots indicates poor correlation between age classes. Corresponding figures for the NIGFS-Oct are plotted in Figures 6.6.6(b) and 6.6.7(b). There is some indication of tracking for the 1991, 1994 and 1995 year class but scatterplots at age are noisy and do not show strong positive correlations.

Catch curves for the NIGFS-Mar and NIGFS-Oct survey are plotted in Figures 6.6.8(a) and (b). Both surveys show a steep decline in log-numbers-at-age over time.

Empirical SSB estimates are presented in Figure 6.6.9 for the NIGFS-WIBTS-Q1 and the NIGFS-WIBTS-Q4 surveys. The NIGFS-WIBTS-Q1 survey shows a slightly increased SSB levels in the terminal year whilst the NIGFS-WIBTS-Q4 survey shows a decline in the terminal year. Overall SSB is still at low levels compared to earlier on in the time-series.

Figure 6.6.10 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 6.6.11. 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 for most years. Figure 6.6.12 shows the retrospective summary plot for the NIGFS-WIBTS-Q1 survey. SSB is declining since 2002 and shows a further decline in 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 2008. Recruitment is also variable and shows a declining trend in recent 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 2012 data.

Residual plots by age for the NIGFS-WIBTS-Q4 survey are shown in Figure 6.6.13. Residuals are quite noisy for all ages apart from age 0. Figure 6.6.14 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 6.6.15) 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. Recruitment shows a slight increase in 2011. No strong retrospective bias is evident in F, SSB or recruitment.

The state of the stock

The decline in fishery landings to under 1000 t since 2000 has been interpreted in all assessment models as a collapse in biomass, despite the absence of an analytical assessment. Generally, trends in biomass have been declining in recent years. Recruitment also appears to have declined recently. 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 lead to uncertain catch data in recent years. This data does 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 Biological reference points

Precautionary approach reference points

Precautionary reference points for this stock have remained unchanged since 1998.

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

Before a benchmark can be recommended, it is first necessary to construct international catch numbers/weights-at-length and age for the main fleets engaged in the fishery since 2003. Effort data for the main fleets engaged in whiting VIIa fisheries are required to provide a time-series of trends in commercial lpue. None of these issues will be resolved in the short term and a benchmark assessment of this stock in the near future is unlikely.

6.6.11 Management considerations

Technical measures applied to this stock include a minimum landing size (≥27 cm) and minimum mesh sizes applicable to the mixed demersal fisheries. These measures are set depending on areas and years by several regulations.

Whiting are caught within a number of different fisheries as a non-target species, primarily within demersal otter trawl fisheries. Significant decline of the mixed gadoid directed fishery has occurred within the Irish Sea to minimal levels. Bycatches also occur within flatfish and ray beam trawl fisheries.

Management by TAC is inappropriate for this stock because landings, but not catches, are controlled. Discarding of this stock is a major consideration and efforts should be made to reduce catches of undersized fish through technical considerations. Since late 2009, a number of Irish vessels operating within the Irish Sea *Nephrops* fishery incorporated a Swedish grid into otter trawls, as part of the cod long-term management plan.

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 will prove beneficial to the whiting stock.

Whiting has a low market value, which is likely to contribute to discarding rates.

Table 6.6.1. Nominal catch (t) of Whiting in Division VIIa, 1988–2011, as officially reported to ICES and Working Group.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Belgium	90	92	142	53	78	50	80	92	80	47	52
France	1,063	533	528	611	509	255	163	169	78	86	81
Ireland	4,394	3,871	2,000	2,200	2,100	1,440	1,418	1,840	1,773	1,119	1,260
Netherlands									17	14	7
UK(Engl. & Wales)[a]	1,202	6,652	5,202	4,250	4,089	3,859	3,724	3,125	3,557	3,152	1,900
Spain											
UK (Isle of Man)	15	26	75	74	44	55	44	41	28	24	33
UK (N.Ireland)	4,621										
UK (Scotland)	107	154	236	223	274	318	208	198	48	30	22
UK											
Total human consumption	11,492	11,328	8,183	7,411	7,094	5,977	5,637	5,465	5,581	4,472	3,355
Estimated Nephrops fishery discards used by the WG[b]	1,611	2,103	2,444	2,598	4,203	2,707	1,173	2,151	3,631	1,928	1,304
Estimated Discards from IR-OTB fleet[c]											
Estimated Discards from NI Nephrops fishery[d]											
Working Group Estimate of Landings	10245	11305	8212	7348	8588	6523	6763	4893	4335	2277	2229
Working Group Estimates	11,856	13,408	10,656	9,946	12,791	9,230	7,936	7,044	7,966	4,205	3,533

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Belgium	46	30	27	22	13	11	10	4.2	3	2	2
France	150	59	25	33	29	8	13	3.7	3	2	
Ireland	509	353	482	347	265	96	94	55.3	187	68	78
Netherlands	6	1									
UK(Engl. & Wales)[a]	1,229	670	506	284	130	82	47	21.7	3	11	20
Spain					85						
UK (Isle of Man)	5	2	1	1	1	1			1	1	
UK (N.Ireland)											
UK (Scotland)	44	15	25	27	31	6	<0.5	<0.5	<0.5		
UK											
Total human consumption	1,989	1,130	1,066	714	554	204	164	84.9	197	84	100
Estimated Nephrops fishery discards used by the WG[b]	1,092	2,118	1,012	740	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Estimated Discards from IR-OTB fleet[c]					524	680	201	223	1545	585	892
Estimated Discards from NI Nephrops fishery[d]											1019
Working Group Estimate of Landings	1670	762	733	747	676	184	158	86	196	81	102
Working Group Estimates	2,762	2,880	1,745	1,487	1200	864	359	309	1740	666	2013

Country	2010	2011*
Belgium	5	4
France	3	3
Ireland	97	94
Netherlands		
UK(Engl. & Wales)[a]	16	6
Spain		
UK (Isle of Man)	<0.5	<0.5
UK (N.Ireland)		
UK (Scotland)		
UK		
Total human consumption	121	108
Estimated Nephrops fishery discards used by the WG[b]		
Estimated Discards from IR-OTB fleet[c]	330	269
Estimated Discards from NI Nephrops fishery[d]	704	903
Working Group Estimate of Landings	121	74
Working Group Estimates	1,154	1,246

[a] 1989-onwards Northern Ireland included with England and Wales.
[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).

Table 6.6.2. Whiting in VIIa. Survey data available to WGCSE 2012. Updated Survey Titles highlighted in bold.

NIGFS-WIBTS-Q4: Northern Ireland October Groundfish Survey - Irish Sea West - Nos. per 3 nm

1994	2011						
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

NIGFS-WIBTS-Q1: Northern Ireland March Groundfish Survey - Irish Sea West - Nos. per 3 nm

1994	2012					
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

Table 6.6.2 (cont'd). Whiting in VIIa. Survey data available to WGCSE 2012.

NIGFS-WIBTS-Q4-EAST: Northern Ireland October Groundfish Survey - Irish Sea East - Nos. per 3 nm

1994	2011						
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

NIGFS-WIBTS-Q1-EAST: Northern Ireland March Groundfish Survey - Irish Sea East - Nos. per 3 nm

1993	2012					
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

Table 6.6.2 (cont'd). Whiting in VIIa. Survey data available to WGCSE 2012.

UK (E&W)-BTS-Q3: Corystes Irish Sea Beam Trawl Survey (Sept) - Prime stations only - Effort and numbers at age (per km towed)

1988	2011		
1	1 0.75	0.79	
0	1		
1	326	134	1988
1	226	66	1989
1	316	242	1990
1	494	74	1991
1	451	596	1992
1	297	197	1993
1	196	133	1994
1	1952	74	1995
1	172	207	1996
1	406	277	1997
1	905	186	1998
1	581	153	1999
1	321	139	2000
1	596	197	2001
1	283	103	2002
1	520	184	2003
1	908	339	2004
1	845	293	2005
1	1019	222	2006
1	369	90	2007
1	826	85	2008
1	397	385	2009
1	206	31	2010
1	540	347	2011

NIGFS-WIBTS-Q4-EAST & WEST: Northern Ireland October Groundfish Survey - Irish Sea East & West - Nos. per 3 nm

1992	2011						
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

Table 6.6.2 (cont'd). Whiting in VIIa. Survey data available to WGCSE 2012.

NIGFS-WIBTS-Q1-EAST & WEST: Northern Ireland March Groundfish Survey- Irish Sea East & West - Nos. per 3 nm

1992	2012						
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

NIMIK : Northern Ireland MIK Net Survey

1994	2011	
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

Table 6.6.2 (cont'd). Whiting in VIIa. Survey data available to WGCSE 2012.

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

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

Table 6.6.2 (cont'd). Whiting in VIIa. Survey data available to WGCSE 2012.

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

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

Table 6.6.2 (cont'd). Whiting in VIIa. Survey data available to WGCSE 2012.

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	

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 1996–2011.

Age	1996 Numbers ('000)	1996 Weight (kg)	1997 Numbers ('000)	1997 Weight (kg)	1998 Numbers ('000)	1998 Weight (kg)	1999 Numbers ('000)	1999 Weight (kg)	2000 Numbers ('000)	2000 Weight (kg)	2001 Numbers ('000)	2001 Weight (kg)	2002 Numbers ('000)	2002 Weight (kg)
0	5631.20	0.015	4110.63	0.027	5073.57	0.027	187.26	0.036	7850.12	0.033	20981.54	0.016	29017.16	0.021
1	5925.33	0.035	8361.19	0.044	5939.53	0.064	276.50	0.102	3098.24	0.047	8883.11	0.054	12097.93	0.033
2	1802.90	0.111	3243.45	0.120	3826.20	0.107	150.99	0.174	137.80	0.153	1413.48	0.126	576.17	0.112
3	144.34	0.217	696.18	0.200	440.05	0.185	43.70	0.235	30.31	0.229	479.38	0.133	152.95	0.105
4	6.02	0.206	68.71	0.241	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
5	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	22.95	0.136	17.66	0.123
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
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
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
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
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
Total weight (t)		520.8		1024.1		1010.3		71.6		434.3		1054.5		1100.9

Sampling Information	1996	1997	1998	1999	2000	2001	2002
Number of Trips	8	8	7	4	10	2	1
Number of Hauls	48	44	58	40	111	34	7

Age	2004 Numbers ('000)	2004 Weight (kg)	2005 Numbers ('000)	2005 Weight (kg)	2006 Numbers ('000)	2006 Weight (kg)	2007 Numbers ('000)	2007 Weight (kg)	2008 Numbers ('000)	2008 Weight (kg)	2009 Numbers ('000)	2009 Weight (kg)	2010 Numbers ('000)	2010 Weight (kg)
0	17091.56	0.018	442.07	0.010	1534.97	0.016	5138.89	0.043	4585.77	0.025	13319.29	0.028	1406.81	0.016
1	7347.29	0.034	2531.84	0.035	1483.43	0.060	23000.16	0.038	7879.78	0.040	12913.10	0.036	4513.61	0.038
2	731.35	0.101	783.68	0.091	621.58	0.133	3282.67	0.095	1485.70	0.093	712.51	0.081	1383.11	0.084
3	142.50	0.165	129.28	0.159	99.02	0.218	916.09	0.145	161.03	0.119	2.60	0.175	129.68	0.133
4	96.30	0.218	40.12	0.154	16.82	0.312	10.96	0.276	13.46	0.130	0.89	0.257	5.41	0.163
5	0.00	0.000	24.48	0.371	0.00	0.000	1.92	0.304	0.00	0.000	0.00	0.000	0.47	0.167
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
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
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
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
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
Total weight (t)		680.3		201.3		223.2		1544.7		585.3		892.3		329.8

Sampling Information	2004	2005	2006	2007	2008	2009	2010
Number of Trips	11	8	5	15	18	12	4
Number of Hauls	122	96	56	90	91	55	29

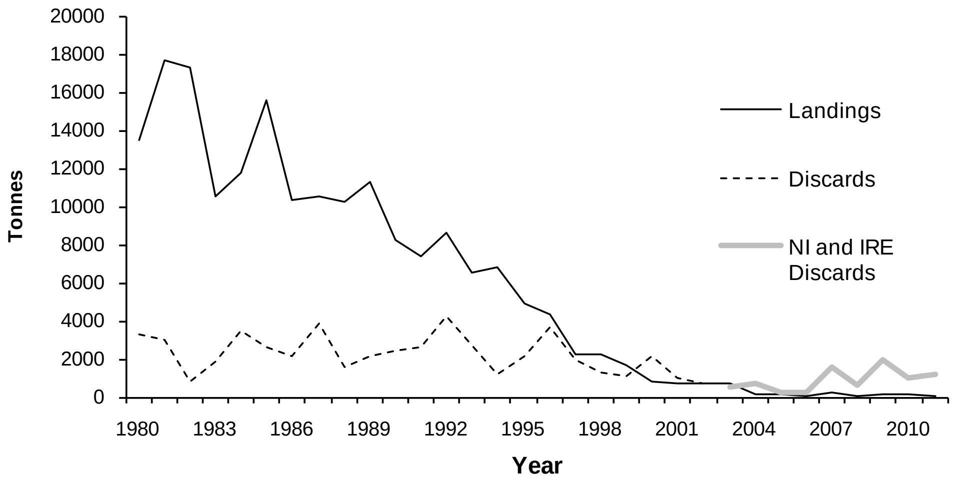


Figure 6.6.1. Whiting VIIa. Working group estimates of International Landings 1980–2011 and Discards 1980–2002. Between 2003–2008 only partial estimates discards were available. Since 2009–2011 discard estimates are for the main Irish and NI fleets.

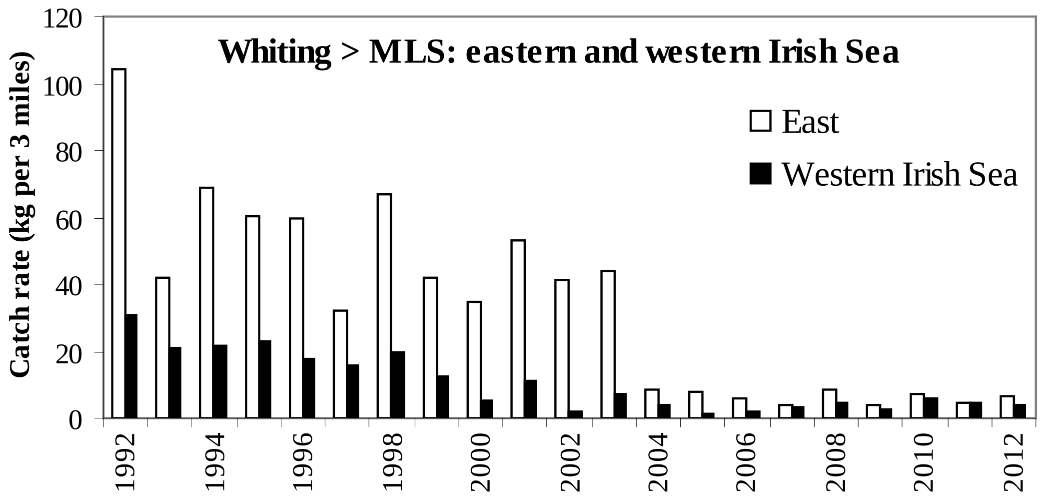
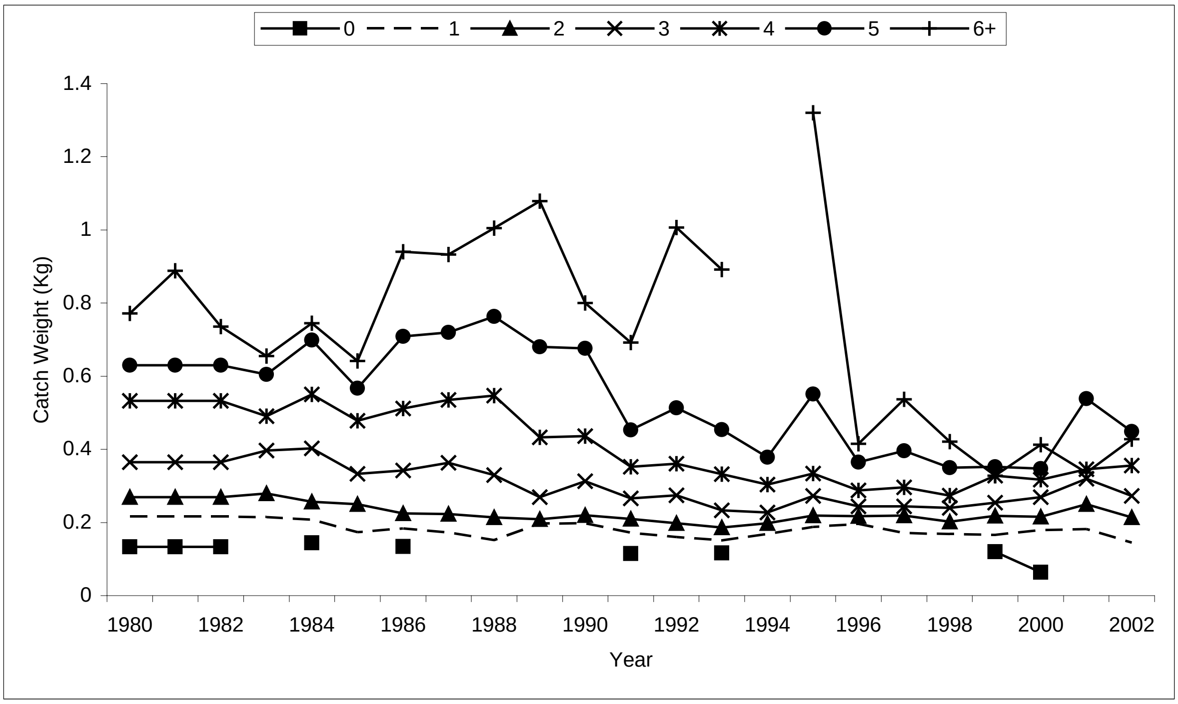


Figure 6.6.2. Eastern and western VIIa whiting mean catch rates in kg per 3-mile tow, for fish at and above the minimum landing size (27 cm) for NIGFS-WIBTS-Q1 survey in March 1992–2012.

a)



b)

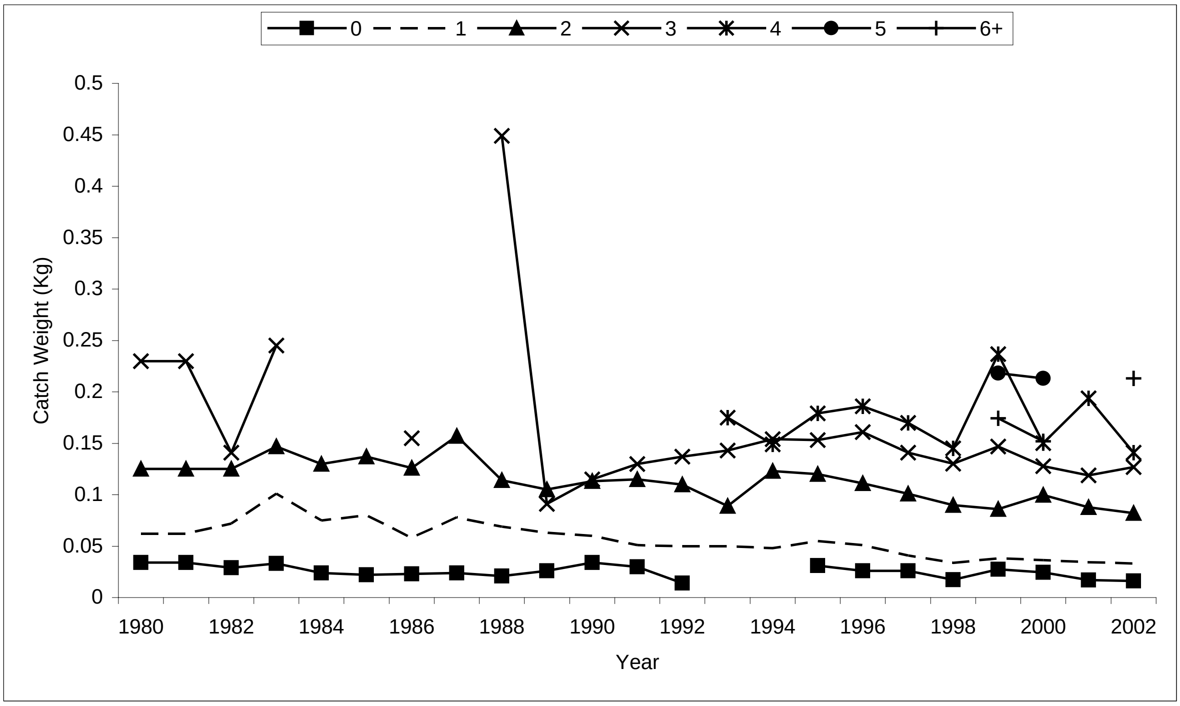


Figure 6.6.3. VIIa whiting International mean weights-at-age in (a) landings (Human Consumption Fishery) and (b) discards, 1980–2002.

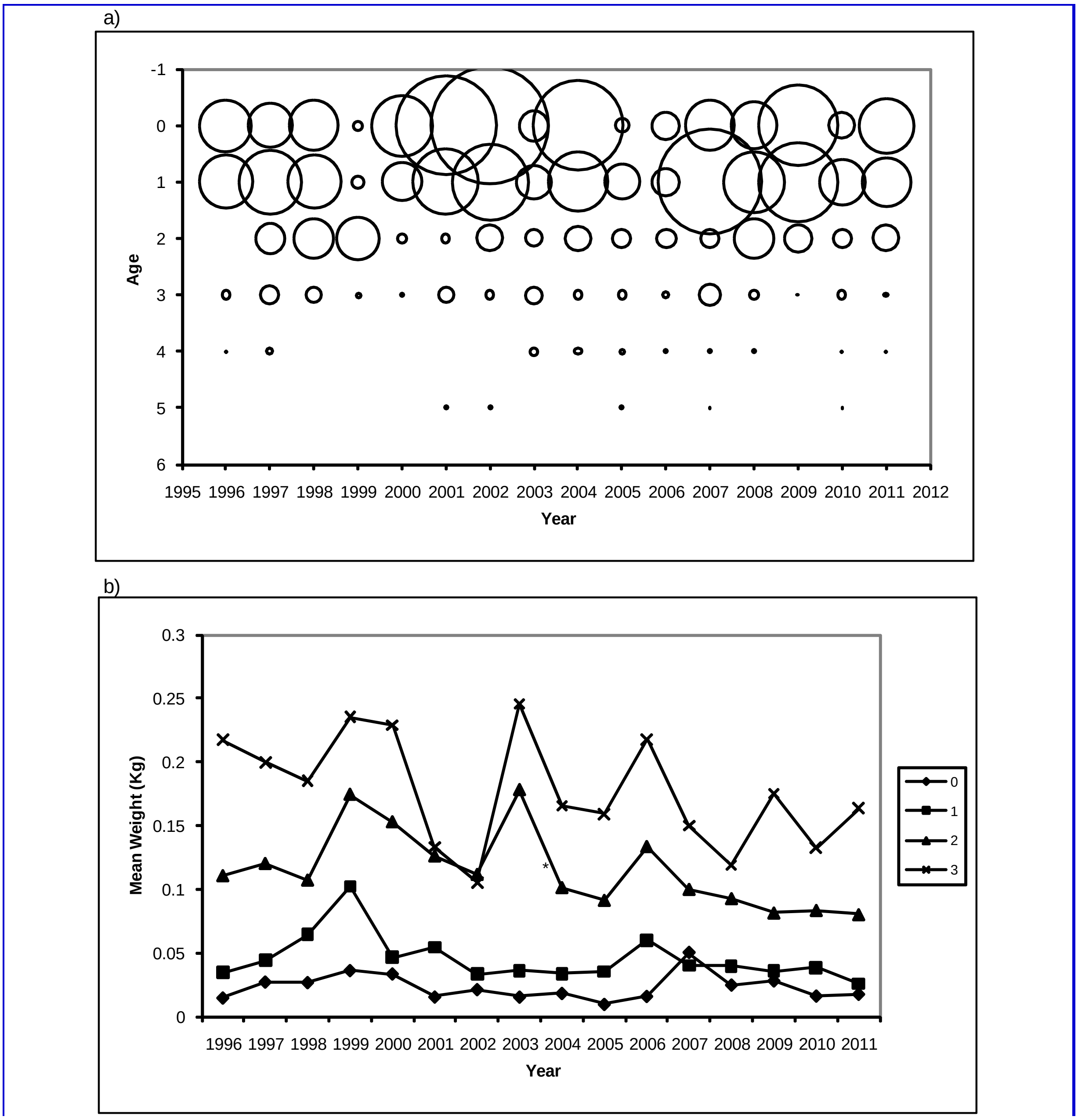


Figure 6.6.4. VIIa whiting discard information for the Irish commercial otter board trawl fleet (a) numbers-at-age and (b) mean weights-at-age, 1996–2011.

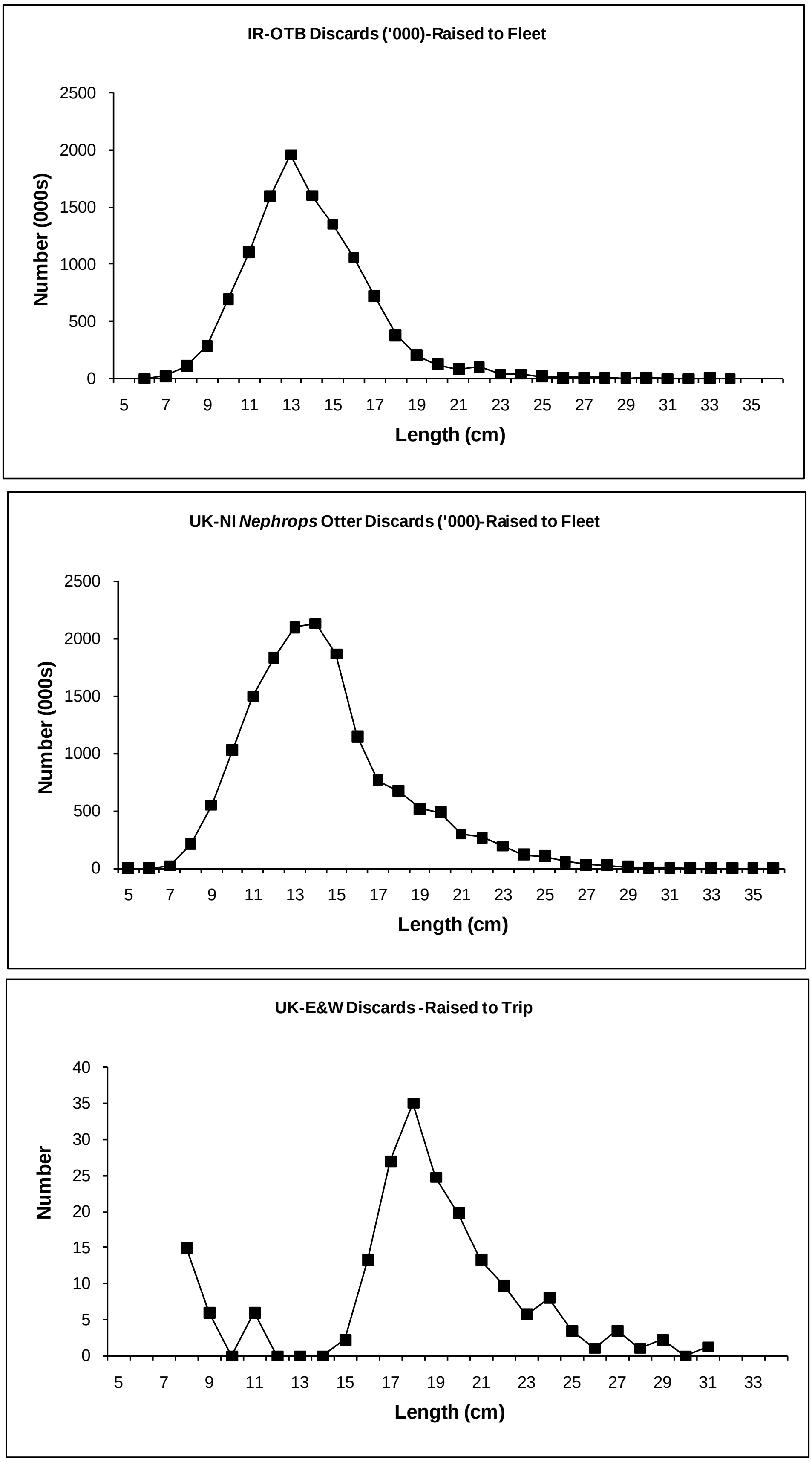
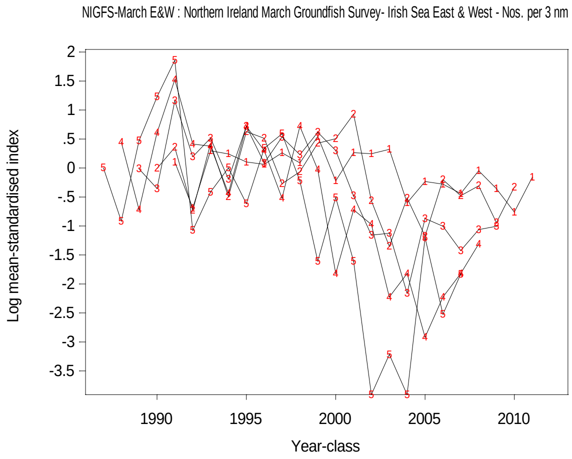
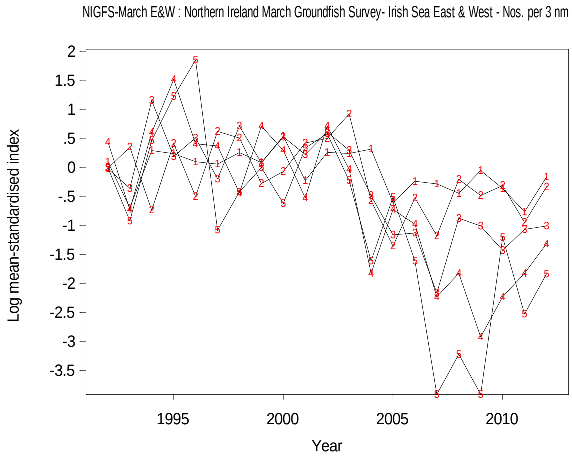


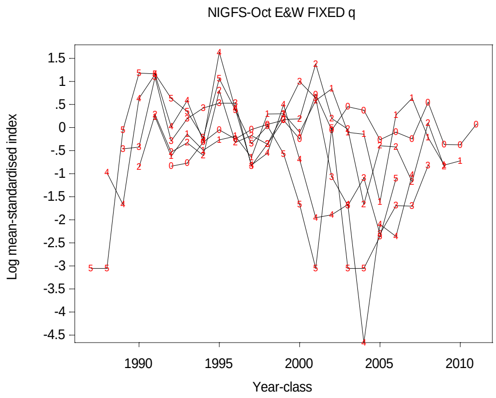
Figure 6.6.5. VIIa Whiting discard length frequency by national fleets in 2011. Note due to low levels of retained catch, and hence low sampling, this data is not presented.

A)





B)



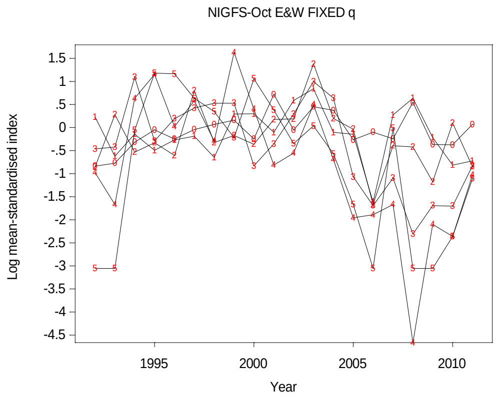
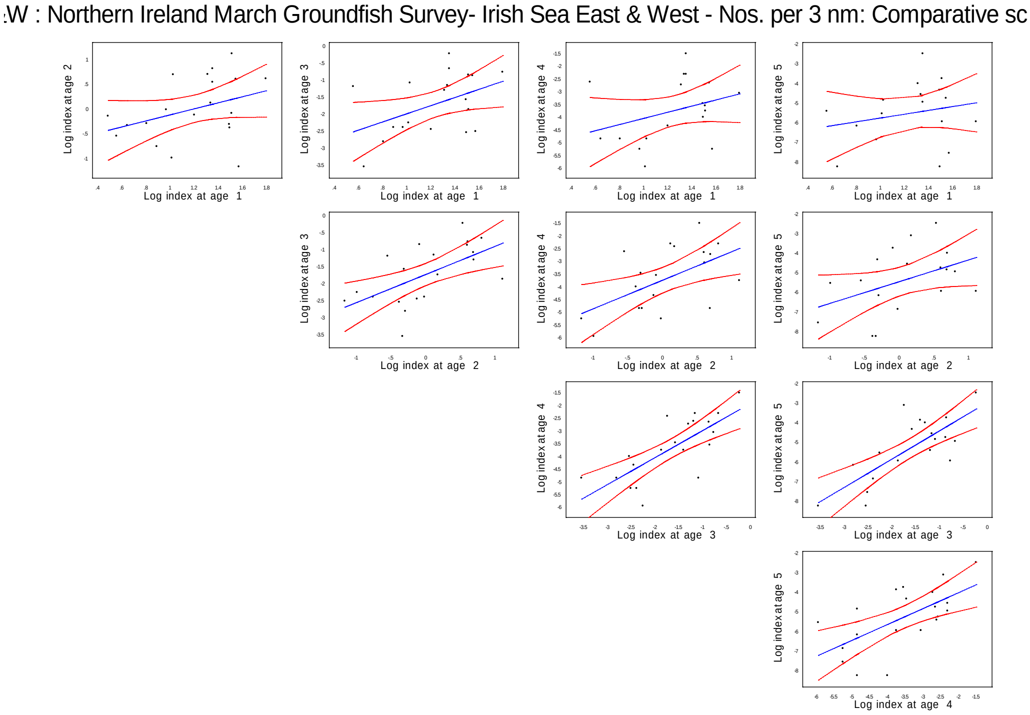


Figure 6.6.6. Log Mean Standardized Indices for (a) NIGFS-WIBTS-Q1 and (b) NIGFS-WIBTS-Q4 by year class and year.

a)



b)

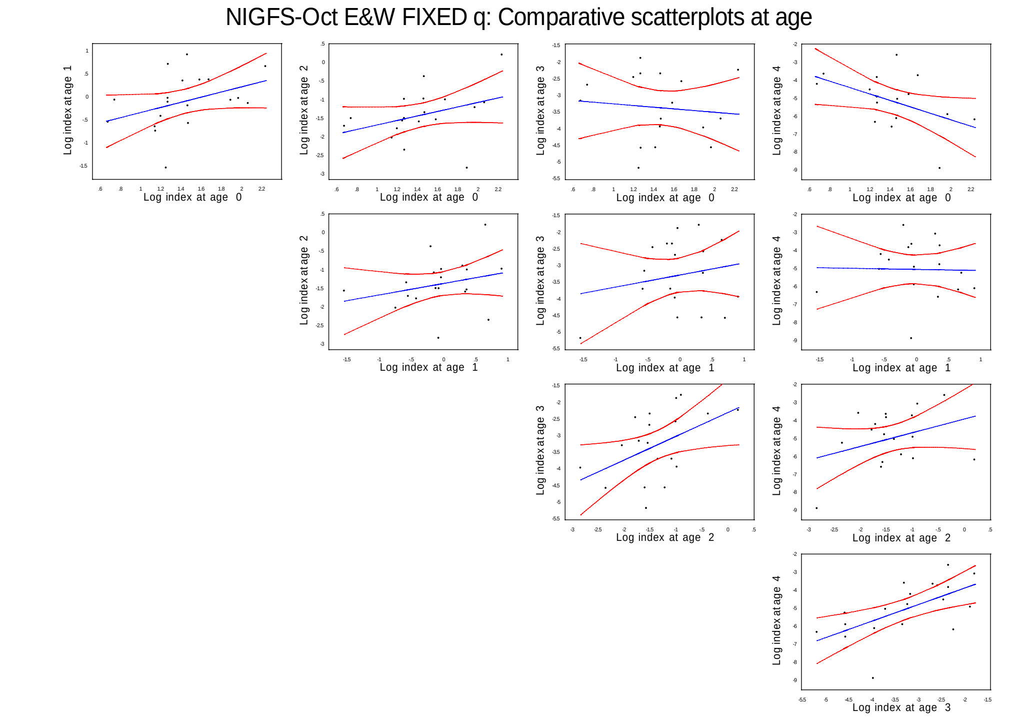
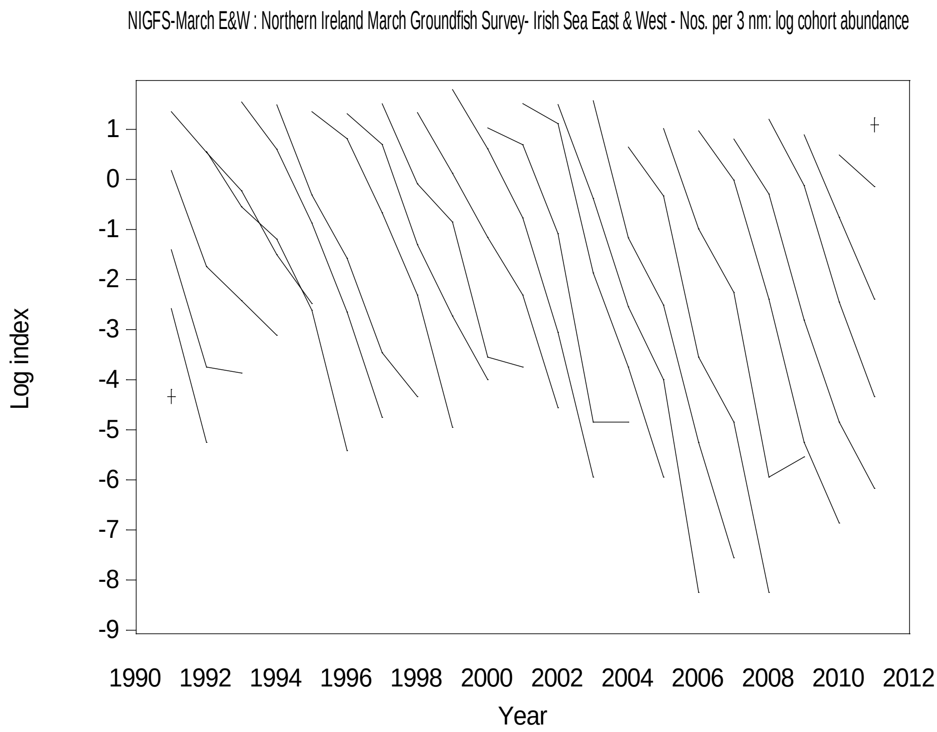


Figure 6.6.7. Scatter Plots of Log index-at-age for the NIGFS-WIBTS-Q1 (a) and NIGFS-WIBTS-Q4 (b) surveys.

a)



b)

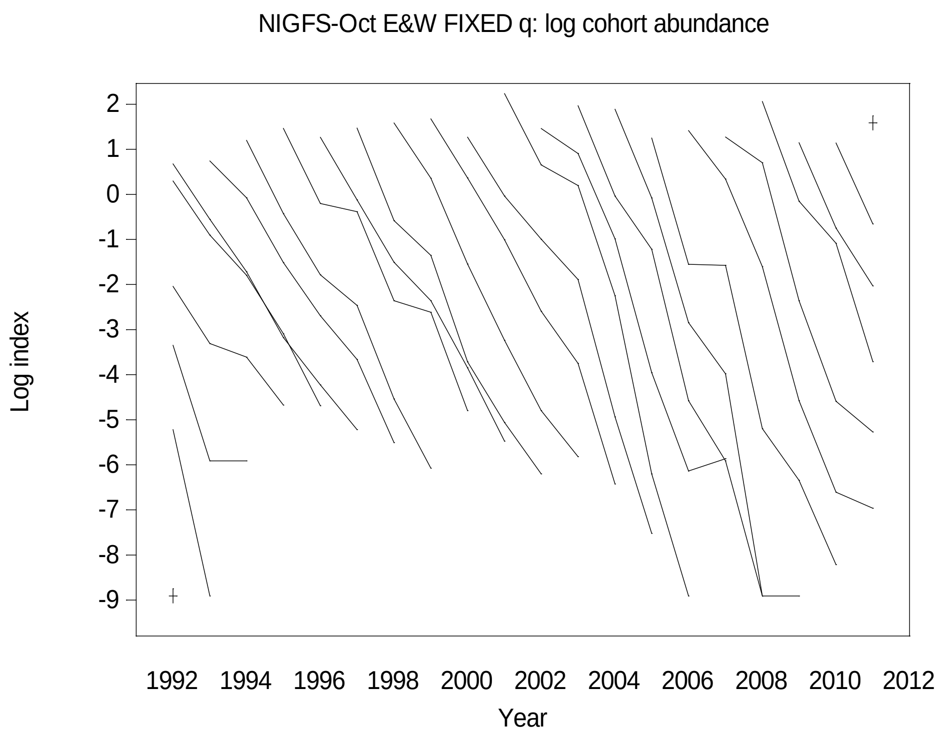
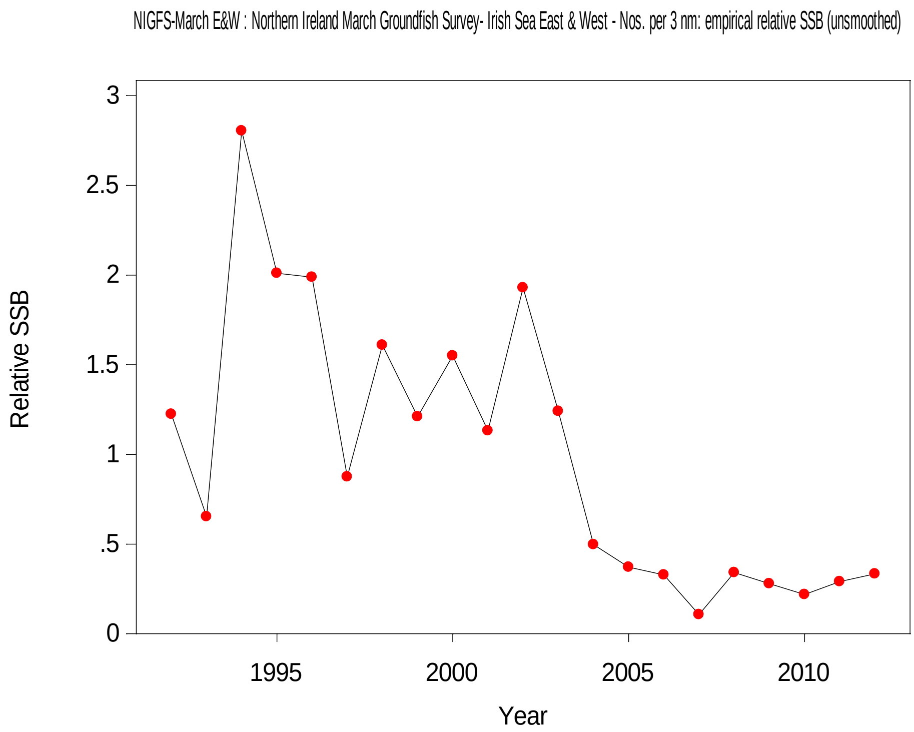


Figure 6.6.8. Catch Curves for NIGFS-WIBTS-Q1 (a) and NIGFS-WIBTS-Q4 (b) surveys.

a)



b)

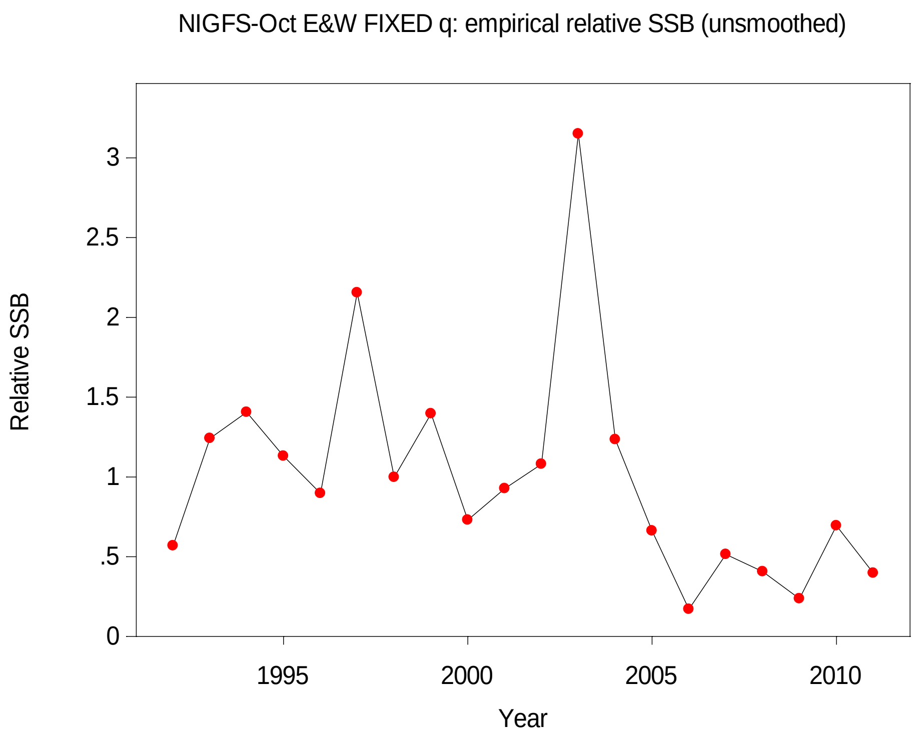


Figure 6.6.9. Empirical Estimates of SSB for NIGFS-WIBTS-Q1 (a) and NIGFS-WIBTS-Q4 (b) surveys.

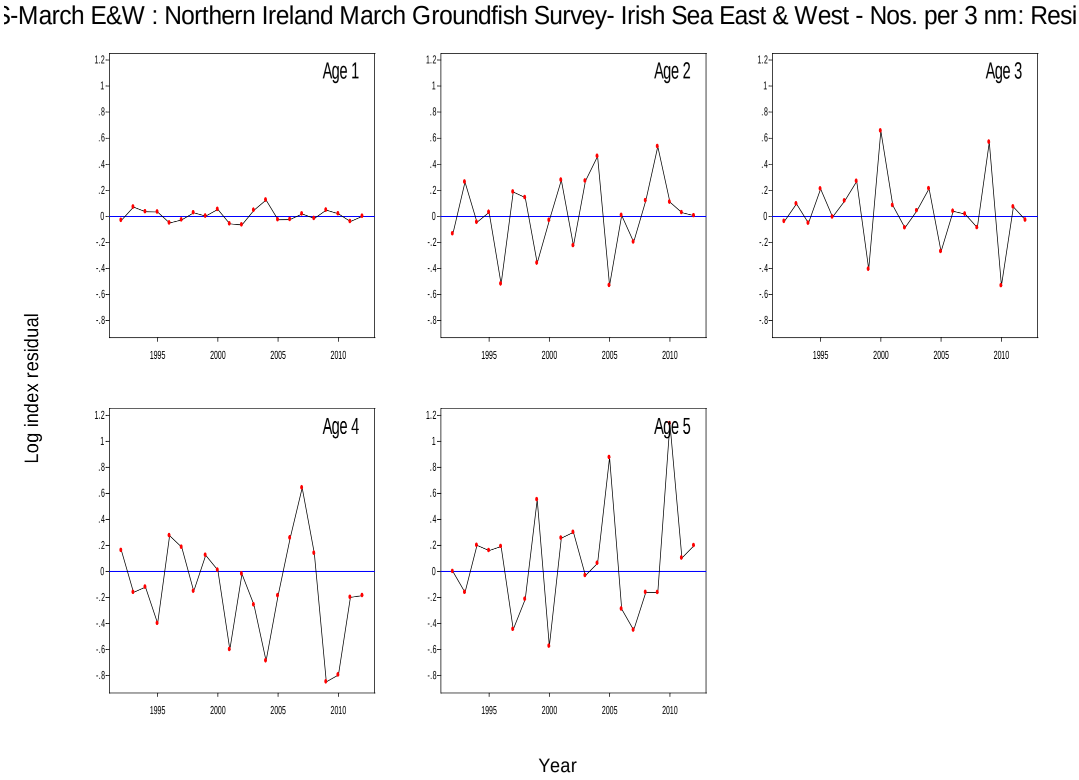


Figure 6.6.10. Residual Plots by Age of the NIGFS-WIBTS-Q1 survey.

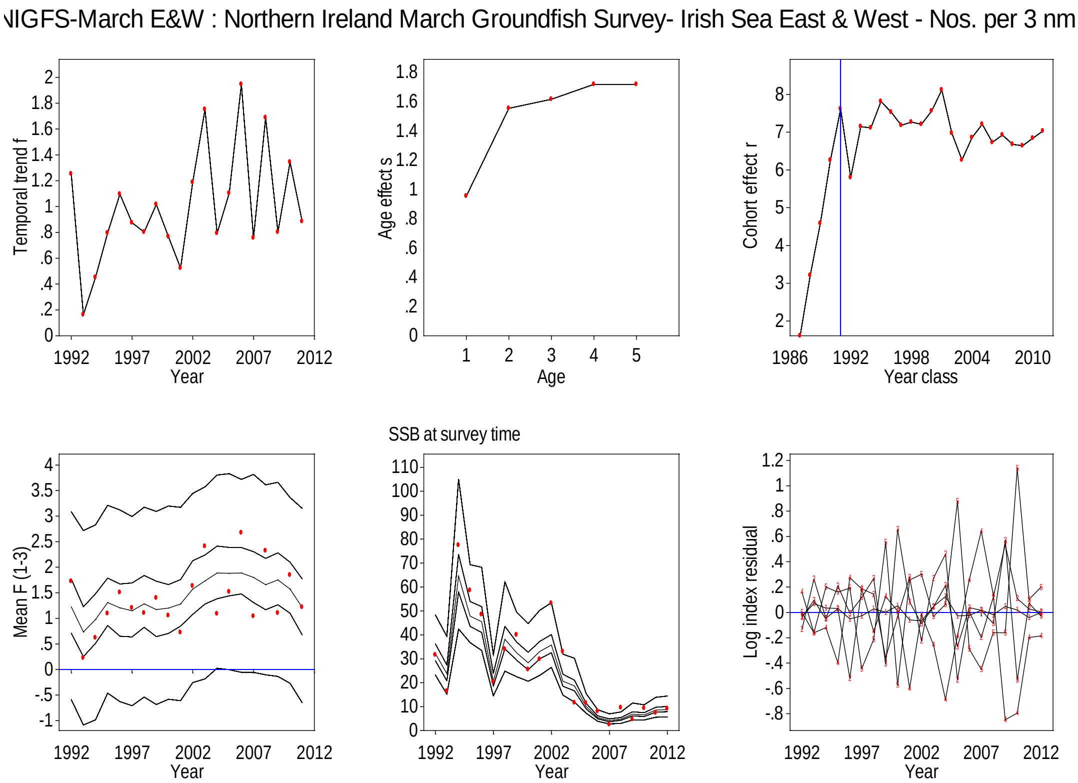


Figure 6.6.11. Stock Summary of the SURBA model fit for the NIGFS-WIBTS-Q1 survey. Empirical SSB (red dots) with model estimates of SSB (black line) are shown in bottom centre panel.

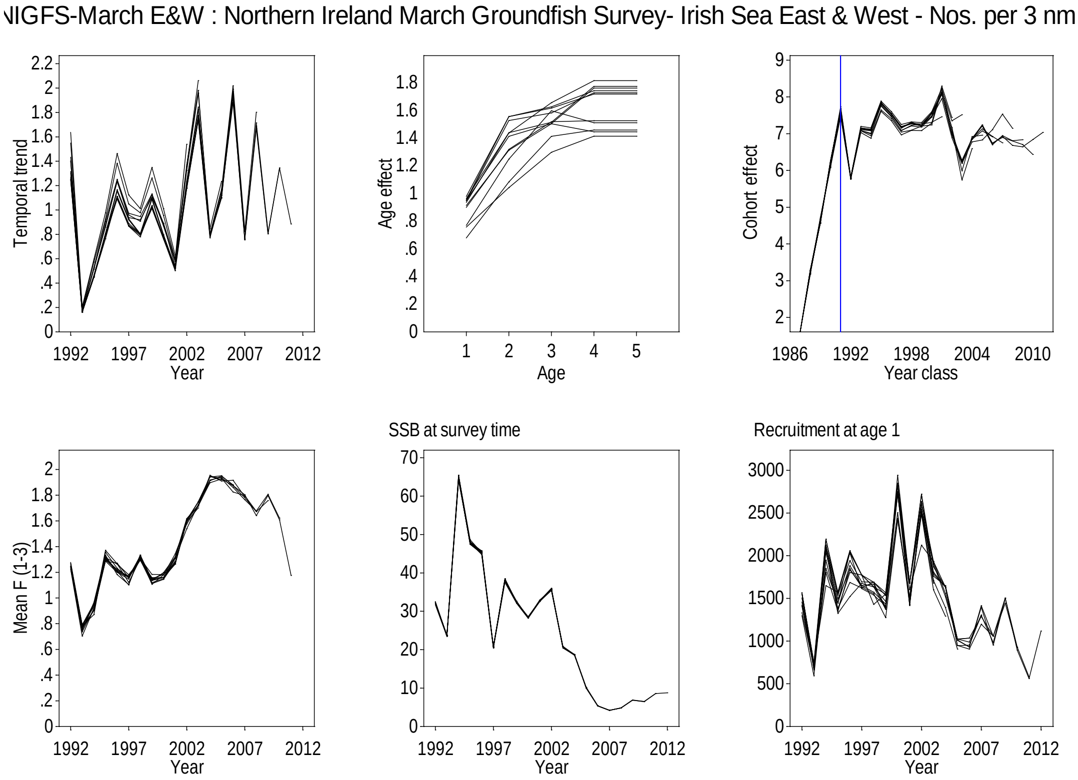


Figure 6.6.12. Retrospective pattern of Single fleet SURBA run for NIGFS-WIBTS-Q1 survey.

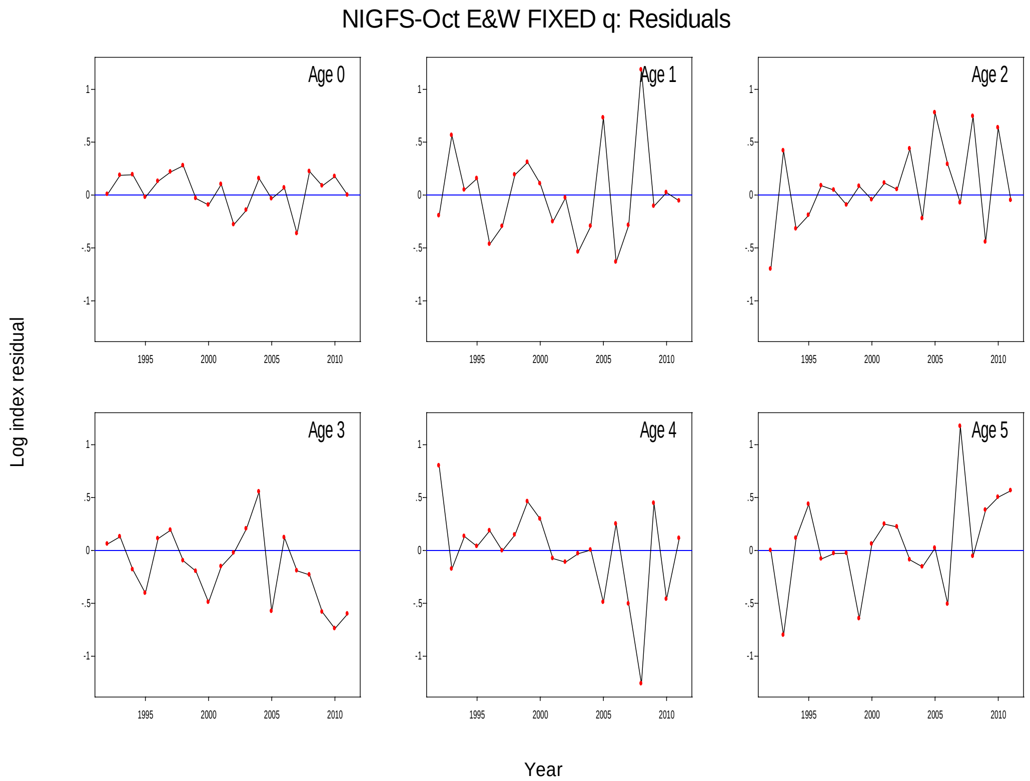


Figure 6.6.13. Residual Plots by Age of the NIGFS-WIBTS-Q4 survey.

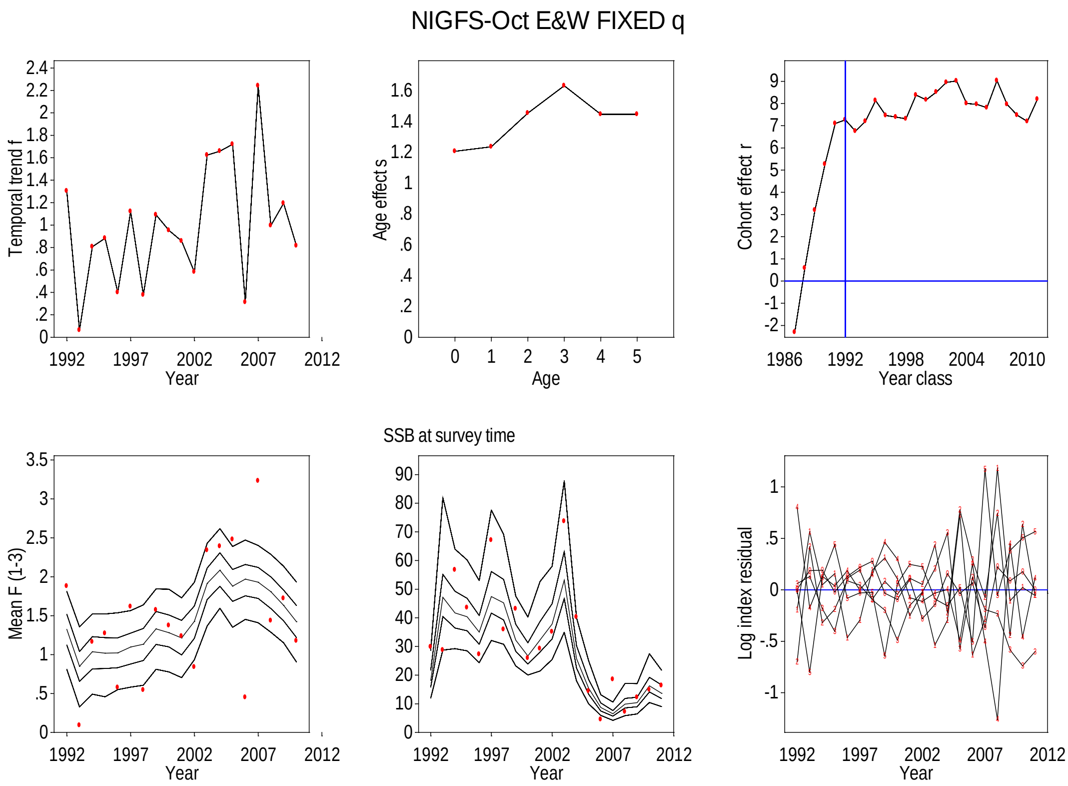


Figure 6.6.14. Stock Summary of the SURBA model fit for the NIGFS-WIBTS-Q4 survey. Empirical SSB (red dots) with model estimates of SSB (black line) are shown in bottom centre panel.

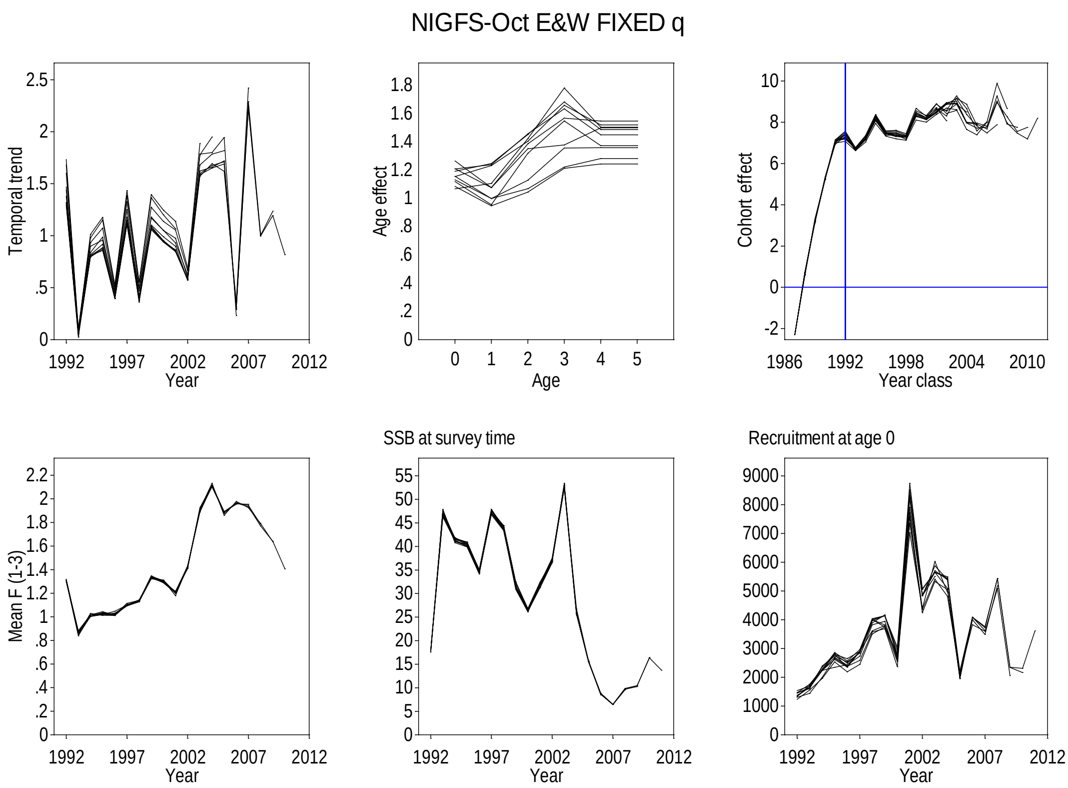


Figure 6.6.15. Retrospective pattern of Single fleet SURBA run for NIGFS-WIBTS-Q4 survey.

6.7 Plaice in Division VIIa (Irish Sea)

Type of assessment in 2012

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, due to the short time-series of discard data available 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 2011

Effort should be consistent with no increase in catches.

ICES advice applicable to 2012

Effort should be consistent with no increase in catches.

6.7.1 General

Stock description and management units

The stock assessment area and the management unit are both division VIIa (Irish Sea).

Management applicable in 2011 and 2012

Management of plaice in Division VIIa 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 VIIa are detailed in the tables below.

2011

Species: Plaice *Pleuronectes platessa*		**Zone:** VIIa (PLE/07A.)
Belgium	42	
France	18	
Ireland	1 063	
The Netherlands	13	
United Kingdom	491	
EU	1 627	
TAC	1 627	Analytical TAC

2012

Species: Plaice *Pleuronectes platessa*		**Zone:** VIIa (PLE/07A.)
Belgium	42	
France	18	
Ireland	1 063	
The Netherlands	13	
United Kingdom	491	
EU	1 627	
TAC	1 627	Analytical TAC

The fishery in 2011

National landings data reported to ICES and Working Group estimates of total landings are given in Table 6.7.2.1.

The TAC in 2011 was 1627 tonnes and the working group estimate of landings in 2011 was 594 tonnes, which is a 57% increase in landings comparable to 2010 and only 37% of the TAC in 2011. This shortfall in estimated landings relative to the TAC has occurred in previous years, increasing steadily from 7% of the TAC in 2003 to a peak shortfall of 70% in 2008 and 2009. It seems unlikely that the poor uptake of the quota is a consequence of an inability to catch sufficient quantities of plaice greater than the MLS; rather the shortfall in the uptake of the TAC is likely due to limited consumer 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 56%, 17%, 8% and 20% respectively of total landings in 2011. The landings of plaice are split evenly between beam trawlers (primarily Belgian vessels then Irish vessels) targeting sole, and otter trawlers (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 6.6) 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. 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), despite the fact that high numbers of younger fish are caught by the beam trawl survey, suggesting that the selection pattern and/or discarding behaviour of the fleets has changed over time. The procedures used to determine the total international landings figures are documented in the stock annex. The landings-at-age matrix alone is not representative of the true catch (Figure 6.7.2.2).

Discards

Prior to 2010, indications were that discard rates, although variable, were substantial. During WKFLAT 2010, discard data from the countries participating in the fishery was raised and collated to the total international level for the years 2004 – 2011 (Table 6.7.2.1). Discard information was available for Belgium, Ireland, N. Ireland and UK(E+W).

Routine 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 by Belgium since 2003. Length distributions (LD) of landed and discarded fish estimates are presented for UK(E&W) (Figure 6.7.2.3), Irish (Figure 6.7.2.4) and Belgian fleets (Figure 6.7.2.5). While, the discarding pattern is dominated by discarding of small fish (below MLS) in some years the Irish and Belgian fleets have discarded a small number of fish of a much greater size (e.g. 2004). Both, the UK(E&W) and Belgian observer data indicate overall mean (2004–2010) lengths of discarded and retained plaice at 23 cm and 30 cm respectively. However, the UK(E&W) data show that the mean length of discarded fish between 2007 and 2009 was 1 cm below the overall mean. Although variable, the Irish annual discard sampling LDs indicate that the overall mean (2004–2010) length of fish discarded is 19 cm, while the mean length of the retained component is 33 cm. However, in 2010, the mean length of both discarded and retained fish in the Irish data was ~3 cm greater (22 cm and 35 cm).

The UK estimates were raised to incorporate equivalent levels of discards for Ireland and N. Ireland on the basis of similar gear types and given the limitations of their data. 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. The total estimates (Table 6.7.2.1) confirm the perception of the significant level of discarding; discards were therefore included within the assessment for the first time in the 2010 assessment. WG estimates of the combined, raised, level of discards are available from 2004 and they have shown a steady increase in time to levels higher than landings between 2006 and 2010 (Figure 6.7.2.8).

However, discarding in 2011 dropped markedly to the level of the landings. The beam trawl survey (UK(E&W)-BTS-Q3) shows the strong 2006 year-class at ages 1, 2 and 3 (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 for which no international raised discards are available. Work is ongoing on the issue of raising additional samples from Irish and N. Irish observer programmes.

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 and since 1995 are no longer altered by fitting a quadratic model. The stock weights are taken as the landings weights. However, prior to 1995 the data have not yet been revised to remove the quadratic smoother. Discard weights-at-age are given in Table 6.7.2.7 and modified 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 6.7.2.3 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 Georges Channel.

Inspection of UK (E&W)-BTS-Q3 mean standardised cpue plots (Figures 6.7.2.6) indicates that the survey has fair internal consistency and also suggests increasing abundance of plaice of both sexes in the eastern Irish Sea (ISE and ISN). In the western Irish Sea the cohort strength was high during 1995–2002 and fell thereafter. For the entire Irish Sea, the biomass index of age 1–4 fish calculated from the UK (E&W)-BTS-Q3 also indicates an upwards trend since 1993 with a small decrease since 2010, which is due the decrease in biomass in the western Irish Sea (Figures 6.7.2.2 and 6.7.2.9). Although the UK (E&W)-BTS-Q3 and the NIGFS-WIBTS surveys show similar increases in biomass between 1993 and 2003, low biomass values were recorded between 2004 and 2007 in the autumn index of the NIGFS-WIBTS surveys and between 2004 and 2009 in the spring index. Nevertheless, the autumn (Q4) index has been at high levels since 2009 and the spring (Q1) index since 2010.

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
1995	9081
2000	13 303
2006	14 417
2008	14 352
2010	15 071

The results confirm that SSB of plaice in the Irish Sea is 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-Q4 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 is no longer considered informative.

Other relevant data

Table 6.7.2.2 and Figure 6.7.2.1 show that effort levels have decreased between 2008 and 2009 for all fleets. Both the UK otter and beam trawl fleets are at 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 VIIa. Belgian vessels operating in Division VII 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 2011, landings by the Belgian fleet increased by 194 tonnes relative to 2010 landings, similarly landings by Ireland increased by 29 tonnes. Landings by UK(E&W, including NI) were constant. The Irish fishery landings in 2010 were split between otter trawlers (49%), and beam trawlers (50%). The beam trawl component is mostly taken as part of a mixed fishery, and some of the landings also come as bycatch from the *Nephrops* fishery.

Landings by the Belgian fleet in 2011 were split relatively evenly across quarters 1–3 (34%, 24%, 30% each). Landings by UK(E&W) were largely taken in the second and third quarters (32% and 49% respectively). Landings by the Irish fleet were high in the third and fourth quarters (39% and 34%).

6.7.3 Historical stock development

Model: Aarts and Poos (AP)

Software: R version 2.10.1 (2009-12-14) with additional packages (version in parenthesis):

FLCore (3.0); stats4 (2.10.1); grid (2.10.1); splines (2.10.1); boot (1.2-4); mvtnorm (0.9-9); MASS (7.2-46).

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 is 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 2011; discard estimates for 2011 and survey data for 2011 for the following surveys: UK (E&W)-BTS-Q3, NIGFS-WIBTS-Q1 and NIGFS-WIBTS-Q4. Minor revisions were made to discard estimates for previous years due to updates to the raw data.

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		2011	2012
Assessment model		AP	AP
Tuning fleets	UK (E&W)-BTS-Q3	Series omitted	Series omitted
	Extended UK (E&W)-BTS-Q3	1993–2010, ages 1–6	1993–**2011**, ages 1–6
	UK(E&W) BTS Mar	Survey omitted	Survey omitted
	UK(E&W) OTB	Series omitted	Series omitted
	UK(E&W) BT	Series omitted	Series omitted
	IR-OTB	Series omitted	Series omitted
	NIGFS-WIBTS-Q1	1993–2010	1993–**2011**
	NIGFS-WIBTS-Q4	1993–2010	1993–**2011**
Time series weights		n/a	n/a
Num yrs for separable		n/a	n/a
Reference age		n/a	n/a
Terminal S		n/a	n/a
Catchability model fitted		n/a	n/a
SRR fitted		n/a	n/a
Selectivity model		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)
Landings num at age, range:		1–9+	1–9+
Discards N at age, yrs, ages:		2004–2010, ages 1–5	2004–**2011**, ages 1–5

The estimated selectivity patterns split into the landed and discarded components is 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 (Figures 6.7.2.11 and 6.7.2.12). 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). 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 2008 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 (the model underestimates discards greatly in this year).

The estimated SSB from the AP model shows an increasing trend until 2003, after which time the SSB stabilises and this is largely in agreement with independent SSB estimates from the Annual Egg Production Method (AEPM, Figure 6.7.2.17). 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 low UK (E&W)-BTS-Q3 biomass estimate in 2010–2011 partly reflects the limited age range of plaice selected (1 to 4); however, this survey does appear to show a potential decline in both sexes.

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.

No retrospective analysis can be performed for this assessment due to limited discard data. A general trend of increasing SSB and decreasing fishing mortality during the 1990s to stable levels is evident.

Comparison with previous assessments

Comparisons between this year's and last year's AP assessment and the previous ICA assessment are shown in Figure 6.7.2.19. The two AP assessments models perform similarly in terms of temporal trends in SSB, recruitment (other than the initial year) and F_{BAR} during the 1990s. However, in the previous ICA assessment the F and SSB did not stabilise from 2003 due to the lack of discard information.

State of the stock

Trends in F_{BAR}, SSB, recruitment and landings, for the full time-series, are shown in Table 6.7.3.4 and Figure 6.7.2.18. The update assessment 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. The estimate of F in the final year is greatly overestimated due to the poor fit of the model to the discard data in 2010 and 2011. Estimated recruitments are highly variable but stable since 2000. 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 2004 and 2010 (Figure 6.7.2.18). However, the observer data indicate much lower discards in 2011.

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

There have been no biological reference points determined for this stock since discards have been included in the assessment. Previously reference points were proposed by the 1998 working group as below:

F_{lim}	No proposal	
F_{pa}	0.45	(on the basis of Fmed and long term considerations)
B_{lim}	No proposal	
B_{pa}	3100 t	(on the basis of Bloss and evidence of high recruit ments at low SSBs)

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

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 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 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

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.

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.	2013	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. 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 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 *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.

Table 6.7.2.1. Nominal landings of Plaice in Division VIIa as officially reported to ICES.

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011[1]
Belgium	321	128	332	327	344	459	327	275	325	482	636	628	431	566	343	194	157	197	138	332
France	42	19	13	10	11	8	8	5	14	9	8	7	2	9	2	2	2	0.4	0.2	0.28
Ireland	1,355	654	547	557	538	543	730	541	420	378	370	490	328	272	179	194	102	73	89	118
Netherlands	-	-	-	-	69	110	27	30	47	-	-	-	-	-	-	-	-	-	-	-
UK (Eng.&Wales)[2]	1,381	1,119	1,082	1,050	878	798	679	687	610	607	569	409	369	422	413	412	300	185	148	145
UK (Isle of Man)	24	13	14	20	16	11	14	5	6	1	1	1	0	0	0	0	1	…	0.5	0.25
UK (Scotland)	70	72	63	60	18	25	18	23	21	11	7	9	4	1	0	0	1	2	3	0
Total	3,193	2,005	2,051	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
Discards	-	-	-	-	-	-	-	-	-	-	-	-	628	1210	1254	1743	1270	1131	2560	604
Unallocated	74	-9	15	-150	-167	-83	-38	34	-72	-15	32	15	9	11	-5	3	1	2	0	0
Total figures used by the Working Group for stock assessment	3,267	1,996	2,066	1,874	1,707	1,871	1,765	1,600	1,371	1,473	1,623	1,559	1,771	2,491	2,186	2,548	1,833	1,591	2,938	1,198

[1] **Provisional.**

[2] **Northern Ireland included with England and Wales.**

{UK (Total) excludes Isle of Man data}.

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[3]	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	152	3.97	9.50	5.0			78.9	21.5		24.4		
1994	128	225	137	4.90	7.79	9.2			43.0	20.1	0.0	31.6		
1995	134	169	111	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	113	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	153	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	148	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	155	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	170	5.02	13.04	7.8	2.0	13.8	27.0	6.3	0.0	27.0	82.7	11.4
2001		281	151	3.35	8.33	9.2	2.5	10.8	33.0	12.5	0.0	41.9	77.5	13.1
2002		340	199	5.66	5.46	7.4	2.8	7.9	24.8	8.0	0.0	52.5	77.9	17.7
2003		503	245	2.60	3.76	7.5	4.1	9.5	23.9	14.0	0.0	48.7	73.8	18.7
2004		540	248	3.17	4.20	11.2	2.1	8.6	23.5	7.4	0.0	36.1	72.5	14.2
2005		367	176	4.85	4.67	12.8	2.0	8.0	16.7	11.6	1.0	42.1	68.3	14.7
2006		356	164	6.50	2.19	10.8	1.37	6.3	5.2	4.6	10.9	28.9	64.9	11.9
2007		432	187	17.94	4.22	6.9	1.20	6.1	4.4	3.2	12.6	23.8	73.2	14.0
2008		416	186	9.03	4.47	9.5	0.90	5.2	2.7	1.3	11.5	12.4	58.8	9.5
2009		467	196	6.46	1.21	10.1	1.03	3.8	1.5	0.46	10.0	14.7	41.5	7.6
2010		400	156	11.55	14.39	7.9	0.98	4.5	1.0	0.19	9.2	15.2	45.8	9.4
2011		417	149	4.35	11.95	17.29	1.17	5.5	0.69	1.56	8.58	16.40	54.5	8.1

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

Fishing power corrections are detailed in Appendix 2 of the 2000 working group report

Table 6.7.2.3. Irish Sea plaice: NIGFS-WIBTS indices of relative SSB trends by region.

UK(NI) GFS	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
UK(NI) GFS	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	17.57	6.94	20.70	5.32	3.07	6.84

Table 6.7.2.4. 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

Biomass tuning indices from the NIGFS-WIBTS: DARDS is the Q1 spring index and DARDA the Q4 autumn index

Irish Sea Plaice SSB indices.

2 21 2

Year	DARDS	DARDA
1992	**9.59**	**4.83**
1993	**13.27**	**4.64**
1994	**10.09**	**9.2**
1995	**7.59**	**4.77**
1996	**7.96**	**8.69**
1997	**13.73**	**8.22**
1998	**12.5**	**5.39**
1999	**9.37**	**6.9**
2000	**15.79**	**10.5**
2001	**13.52**	**13.93**
2002	**13.36**	**9.98**
2003	**26.79**	**18.65**
2004	**10.55**	**8.49**
2005	**15.86**	**11.58**
2006	**9.57**	**7.2**
2007	**8.73**	**8.48**
2008	**6.33**	**11.28**
2009	**11**	**14.83**
2010	**22.67**	**17.61**
2011	**23.68**	**17.54**
2012	**17.87**	

UK BT SURVEY (Sept-Trad) - Prime stations only

1989 2011

1 1 0.75 0.85

1 8

129.710 309 441 530 77 13 44 3 0

128.969 1688 405 176 90 54 30 3 1

123.780 591 481 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 840 722 411 178 83 59 16

126.004 2667 1255 525 417 196 95 45 37

122.298 1293 1893 628 339 243 76 55 33

126.004 1460 1083 1225 310 189 251 65 31

126.004 1806 1407 670 505 185 173 100 60

122.298 2213 1432 663 315 347 122 101 87

UK(E+W)TRAWL FLEET (calculated using ABBT age compositions)

1987 2011

1 1 0 1

1 14

130.597 24.4 1475.8 1434.6 1593.3 409.0 291.2 31.4 46.8 16.9 24.2 11.2 1.4 3.2 3.6

131.950 22.0 1374.8 1421.0 455.0 295.5 142.5 78.9 8.1 28.9 6.7 9.6 3.5 4.1 1.1

139.521 10.6 771.5 2102.0 801.1 235.2 99.8 48.0 37.6 13.7 11.0 6.3 6.7 3.2 1.7

117.058 8.2 501.0 1094.3 983.9 217.0 82.8 60.0 17.5 15.9 4.5 3.2 6.7 3.0 2.2

107.288 94.3 949.9 451.3 419.5 245.0 99.7 35.2 38.7 12.1 11.1 0.6 3.6 1.8 1.5

96.802 80.8 851.1 907.2 181.3 114.6 82.4 28.6 8.3 17.8 7.3 5.4 0.4 1.3 0.8

78.945 12.9 387.7 519.1 367.7 63.5 55.7 69.5 21.8 5.2 10.7 2.6 1.1 0.0 0.2

42.995 38.8 408.3 534.9 142.5 92.5 18.2 12.3 15.9 7.3 1.8 1.3 2.2 0.5 0.0

43.146 7.3 350.1 512.5 255.7 88.9 46.1 10.9 4.8 8.3 2.4 1.7 0.7 0.2 0.2

42.239 10.9 326.5 280.3 198.7 80.5 32.9 15.3 4.8 2.0 10.0 2.1 0.7 0.6 0.1

39.886 11.2 250.6 214.7 125.2 74.2 37.5 12.8 12.4 1.8 0.8 1.4 0.4 0.2 0.7

36.902 1.6 202.7 318.6 105.3 40.6 37.6 16.5 9.8 4.5 0.5 0.5 1.0 0.3 0.2

22.903 17.6 139.2 200.5 120.0 35.0 14.0 9.0 5.4 1.6 0.8 0.2 0.1 0.1 0.0

26.967 0.0 107.1 233.3 185.0 95.5 18.5 14.4 9.8 5.9 2.7 2.1 0.9 0.4 .01

32.964 5.5 65.9 130.4 124.0 108.7 53.2 17.4 10.6 7.1 3.0 0.5 0.7 0.1 0.1

24.762 0.5 78.6 175.8 95.3 58.6 33.0 23.8 3.3 2.5 1.4 0.4 0.4 0.0 0.1

23.851 0.0 34.1 79.6 88.7 35.6 16.1 12.3 7.4 2.3 0.4 0.3 0.2 0.0 0.2

23.456 1.5 34.8 149.1 103.1 60.6 27.0 8.7 5.8 4.3 1.2 0.7 0.2 0.1 0.0

16.683 0.0 32.6 52.6 108.1 95.1 40.0 17.8 7.5 5.4 1.7 1.3 0.6 0.2 0.1

5.218 0.8 15.1 46.9 34.8 55.1 23.4 13.9 4.9 2.6 1.9 0.7 0.6 0.1 0.0

4.404 0.0 2.5 33.7 94.5 58.4 50.4 17.3 16.7 2.2 1.5 0.5 0.3 0.1 0.0

2.710 0.1 5.8 27.8 37.9 40.9 23.9 15.4 7.3 2.9 1.1 0.5 0.2 0.1 0.0

1.535 0.0 0.2 4.1 8.7 7.4 6.6 3.1 2.0 0.8 0.5 0.1 0.1 0.0 0.0

1.424 0.0 0.1 1.6 7.5 7.4 4.5 3.4 1.9 1.3 0.5 0.4 0.2 0.0 0.0

0.686 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

UK(E+W)BEAM TRAWL FLEET

1987 2011

1 1 0 1

1 14

21.997 0.0 1.1 27.1 113.1 36.0 31.3 2.9 6.7 1.9 3.1 0.6 0.1 0.2 0.1

18.564 0.0 2.0 48.0 23.7 24.4 13.2 8.5 1.4 2.6 1.6 1.5 0.6 0.8 0.3

25.291 3.1 132.8 297.5 163.4 52.6 42.4 25.1 16.1 4.3 5.3 3.3 5.7 2.6 1.1

31.003 2.2 136.2 391.9 361.1 78.2 30.2 17.2 8.4 3.6 1.5 1.9 3.8 1.4 0.5

25.838 17.3 282.5 182.9 174.5 91.8 35.9 11.2 11.8 3.5 4.7 0.2 1.0 0.6 0.3

23.399 3.9 141.5 335.6 79.6 64.6 45.5 18.6 8.0 12.2 7.1 4.0 0.2 0.7 1.0

21.503 0.6 73.4 112.8 95.2 23.3 24.2 32.0 11.8 4.5 7.1 2.2 1.2 0.0 0.4

20.145 13.4 151.8 186.1 39.9 26.0 6.8 6.6 7.8 3.5 1.2 0.9 1.2 0.2 0.0

20.932 5.2 183.4 229.1 100.6 33.1 16.1 3.9 1.7 3.3 1.0 0.9 0.5 0.1 0.2

13.320 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

10.760 0.9 98.6 69.5 39.0 30.2 13.5 3.7 3.2 0.5 0.4 0.3 0.2 0.1 0.1

10.386 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

11.016 4.8 51.3 124.4 80.4 24.4 12.5 10.5 5.6 0.9 0.8 0.2 0.2 0.2 0.1

6.275 0.0 25.2 61.4 46.6 27.9 7.3 6.5 4.5 1.9 0.7 0.7 0.7 0.1 0.1

12.495 1.5 20.6 47.5 56.6 42.7 20.8 7.0 4.5 2.5 1.2 0.4 0.1 0.1 0.0

8.017 0.0 11.5 33.1 21.0 18.8 14.9 8.0 2.3 1.3 1.4 0.4 0.4 0.0 0.0

13.996 0.0 11.4 45.5 47.7 20.9 10.0 8.7 5.4 1.7 0.3 0.0 0.3 0.0 0.1

7.396 0.2 18.0 29.4 11.7 11.9 5.1 1.7 1.4 1.0 0.3 0.2 0.1 0.0 0.0

11.406 0.1 6.5 11.0 24.0 20.7 9.2 3.4 1.6 1.3 0.4 0.4 0.1 0.1 0.0

4.649 0.2 2.7 8.1 4.9 8.2 3.8 2.6 0.9 0.6 0.5 0.2 0.2 0.1 0.0

3.197 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

1.300 0.0 0.0 1.4 3.5 3.9 2.1 1.7 0.8 0.3 0.1 0.1 0.0 0.0 0.0

0.462 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 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 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

1.564 0.0 0.7 5.8 6.8 13.7 8.0 4.3 2.8 1.1 1.0 0.5 0.4 0.2 0.0

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

IR-OTB : Irish Otter trawl - Effort in hours - VIIa Plaice numbers at age – Year

note gear measures introduces in the OTB fleet in 2011

1995 2011

1 1 0 1

2 12

70682	5	84	263	202	51	29	24	10	5	1	1
58166	4	94	157	227	97	26	8	6	4	2	1
75029	27	136	197	147	74	74	21	12	16	3	2
81073	49	140	176	124	104	128	64	29	21	10	5
93221	51	129	152	126	71	46	32	19	4	2	1
64320	11	92	98	88	24	10	8	3	1	4	0
77541	55	90	97	104	100	38	16	11	3	1	0
77863	6	67	179	122	90	53	22	11	6	1	0
73854	18	177	278	174	102	48	19	5	3	1	13
72507	25	105	116	90	31	23	16	12	1	4	0
68336	1	45	89	129	80	43	17	10	8	1	2
64876	4	40	34	51	40	37	19	12	12	4	0
73157	14	47	77	58	40	17	11	5	2	1	0
58812	4	16	35	45	23	11	6	2	1	1	1
42829	2	24	27	21	22	8	8	2	2	1	0
45451	2	20	24	21	24	9	9	2	2	1	0
54536	2	8	21	27	33	18	12	7	4	2	1

Table 6.7.2.5. Irish Sea plaice: Landings number-at-age 1 to 15+ (thousands), where rows are years 1964–2010 and columns are ages 1 to 15+.

IRISH SEA PLAICE
1 2
1964 2011
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
97	1146	2173	1309	644	318	245	134	86	18	6	9	6	1	3
21.2	960.8	1702.7	1935.7	764.1	318.2	137.9	70	46.7	22.6	8.9	4.5	0.8	0.7	2.9
37	855.7	1345.2	1196.2	943.4	370	128.3	43.9	25.1	36.7	14	7	4.8	1.1	2.5
27.8	829.6	1589.6	1513.4	1002.6	482.3	285.1	139.1	42.3	52.6	12.3	6.7	1.3	2.2	0.8
5.5	691.4	1739.2	1024.7	611.6	475.7	403	176.9	91.2	51.6	24.7	17.5	19.2	2.1	1.3
68.2	802.6	1504.8	1293.6	695.5	280.4	196.4	117	68.9	43.4	5.6	4.3	1.2	0.4	1
0	450	1174.3	1283.7	685.5	211.8	219.3	101.9	55.5	19.1	13.7	7.1	2.4	1.6	2
13.9	374.2	1138.1	1083	767	408.6	178.5	90.3	45.4	17.6	6.3	2.4	3.7	0.3	0.4
1.1	205.6	939.8	1481.7	842.2	538.9	317.7	95.9	48.4	17.3	4.4	3.1	0.3	0.2	0.3
0	285.7	1030.9	1314.1	706.7	415	252.7	127.2	48.4	22.3	12.4	7.4	1	2.6	0.2
7.5	198.3	966.8	1104.2	705	246.5	114.3	87.7	74.2	10.7	10.8	1.1	1	0.4	0.3
6.4	228.4	708.4	1177.2	889.5	461.1	204	91.8	54.6	36.7	11.5	11.5	4.4	1.5	0.8
4.5	180.3	619.8	550.2	684	346.4	220	86.9	53.4	46.4	20.2	6.5	1.8	1.3	1.1
0	64.2	350.5	859.9	506.6	401.2	150.5	114.2	27	14.3	5	2.9	0.5	0.4	0.02
0.6	98.5	385.5	388.6	409.3	214.6	141.3	61	36.4	9.2	6.9	3.3	0.8	1.2	0
0	12.6	204.3	373.9	351.2	272.4	116.5	73.3	26	12.1	3.6	2	0.9	1.1	0.7
0	7.2	74.3	269.8	305.6	192.8	159.6	57.3	31.2	13.1	8.3	3.3	1	0.3	0.5
2	53	199	357	483	305	194	101	43	27	10	6	3	0	1

Table 6.7.2.6. Irish Sea plaice: Landings weight-at-age 1 to 15+ (kg) (unsmoothed from 1995, bold).

Plaice in VIIa
1 3
1964 2011
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
0.201	**0.229**	**0.266**	**0.312**	**0.366**	**0.429**	**0.501**	**0.581**	**0.670**	**0.768**	**0.874**	**0.990**	**1.114**	**1.246**	**1.387**
0.144	**0.203**	**0.268**	**0.338**	**0.414**	**0.496**	**0.584**	**0.677**	**0.776**	**0.881**	**0.992**	**1.108**	**1.230**	**1.358**	**1.492**
0.134	**0.184**	**0.239**	**0.299**	**0.362**	**0.430**	**0.502**	**0.579**	**0.660**	**0.745**	**0.834**	**0.928**	**1.027**	**1.129**	**1.236**
0.202	**0.222**	**0.252**	**0.294**	**0.346**	**0.410**	**0.484**	**0.569**	**0.665**	**0.773**	**0.891**	**1.020**	**1.160**	**1.310**	**1.472**
0.174	**0.213**	**0.257**	**0.309**	**0.366**	**0.430**	**0.501**	**0.577**	**0.661**	**0.751**	**0.847**	**0.949**	**1.058**	**1.174**	**1.296**
0.000	**0.222**	**0.257**	**0.302**	**0.357**	**0.422**	**0.497**	**0.581**	**0.676**	**0.780**	**0.894**	**1.018**	**1.152**	**1.296**	**1.450**
0.142	**0.205**	**0.269**	**0.337**	**0.407**	**0.479**	**0.554**	**0.632**	**0.712**	**0.795**	**0.880**	**0.968**	**1.058**	**1.151**	**1.247**

0.185	**0.225**	**0.271**	**0.324**	**0.383**	**0.449**	**0.521**	**0.600**	**0.685**	**0.776**	**0.874**	**0.978**	**1.089**	**1.206**	**1.329**
0.000	**0.244**	**0.289**	**0.340**	**0.395**	**0.455**	**0.520**	**0.590**	**0.665**	**0.745**	**0.830**	**0.920**	**1.014**	**1.114**	**1.219**
0.207	**0.230**	**0.261**	**0.300**	**0.348**	**0.404**	**0.468**	**0.542**	**0.623**	**0.713**	**0.811**	**0.918**	**1.033**	**1.157**	**1.289**
0.172	**0.212**	**0.254**	**0.299**	**0.345**	**0.394**	**0.445**	**0.499**	**0.554**	**0.612**	**0.672**	**0.734**	**0.799**	**0.865**	**0.934**
0.227	**0.232**	**0.249**	**0.278**	**0.320**	**0.374**	**0.440**	**0.518**	**0.609**	**0.712**	**0.827**	**0.954**	**1.094**	**1.246**	**1.410**
0.000	**0.215**	**0.247**	**0.283**	**0.325**	**0.371**	**0.422**	**0.479**	**0.540**	**0.606**	**0.677**	**0.753**	**0.834**	**0.920**	**1.011**
0.000	**0.224**	**0.233**	**0.252**	**0.280**	**0.318**	**0.365**	**0.421**	**0.486**	**0.560**	**0.644**	**0.737**	**0.840**	**0.951**	**1.072**
0.000	**0.174**	**0.224**	**0.272**	**0.315**	**0.355**	**0.391**	**0.424**	**0.453**	**0.478**	**0.499**	**0.517**	**0.531**	**0.542**	**0.549**
0.000	**0.354**	**0.313**	**0.294**	**0.297**	**0.321**	**0.367**	**0.434**	**0.523**	**0.634**	**0.767**	**0.921**	**1.096**	**1.294**	**1.513**
0.259	**0.262**	**0.272**	**0.289**	**0.313**	**0.345**	**0.384**	**0.430**	**0.483**	**0.544**	**0.612**	**0.687**	**0.770**	**0.859**	**0.956**

Table 6.7.2.7. Plaice VIIa: 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 2011
1 14
1

0.061	0.122	0.143	0.161	0.201	0.290	0.423	0.669	0.615	0.000	0.000	0.000	0.000	0.000
0.065	0.117	0.133	0.176	0.172	0.255	0.539	0.414	0.447	0.000	0.000	0.000	0.000	0.000
0.127	0.112	0.141	0.144	0.161	0.205	0.269	0.201	0.447	0.000	0.000	0.000	0.000	0.000
0.047	0.083	0.113	0.140	0.149	0.200	0.208	0.258	0.591	0.000	0.000	0.000	0.000	0.000
0.077	0.103	0.117	0.134	0.151	0.190	0.259	0.222	0.205	0.000	0.000	0.000	0.000	0.000
0.034	0.082	0.117	0.152	0.169	0.214	0.217	0.289	0.375	0.000	0.000	0.000	0.000	0.000
0.074	0.096	0.121	0.143	0.158	0.174	0.183	0.201	0.323	0.000	0.000	0.000	0.000	0.000
0.044	0.087	0.105	0.134	0.148	0.161	0.170	0.173	0.229	0.000	0.000	0.000	0.000	0.000

Table 6.7.2.8. Irish Sea plaice: New stock weights-at-age modified to include discard element (kg) (unsmoothed from 1995, bold).

IRISH SEA PLAICE, COMBSEX, PLUSGROUP, NEW stock weights (modified to inc disc element)
1 4
2004 2011 (not smoothed)
1 14
1

0.062	0.128	0.167	0.222	0.271	0.357	0.505	0.594	0.360	0.760	0.751	0.817	1.693	2.000
0.069	0.128	0.153	0.223	0.224	0.314	0.501	0.441	0.130	0.543	0.184	0.913	0.974	0.807
0.127	0.119	0.159	0.174	0.236	0.302	0.376	0.342	0.284	0.585	0.554	0.838	1.415	1.139
0.047	0.085	0.125	0.170	0.216	0.305	0.339	0.347	0.621	0.530	0.900	0.846	0.976	0.878
0.077	0.106	0.129	0.157	0.193	0.282	0.375	0.280	0.560	0.700	0.833	1.122	0.430	1.320
0.034	0.082	0.125	0.180	0.219	0.280	0.319	0.408	0.465	0.524	0.571	0.591	0.760	0.576
0.074	0.097	0.128	0.160	0.186	0.218	0.268	0.277	0.479	0.530	0.560	0.509	0.882	1.908
0.048	0.103	0.142	0.187	0.234	0.293	0.373	0.394	0.565	0.554	0.628	0.531	0.644	0.986

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

Mon May 09 13:02:24 2011	
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	114.3935968
negative log.likelihood Landings	2.059401367
negative log.likelihood Discards	48.74612755
negative log.likelihood UK-BTS	-2.438968412
negative log.likelihood NI-GFSs	66.02703627
AIC	390.7871935
Nparameters	81
Nobservations	368
Final parameter values	
Ftrend 1	0.737479
Ftrend 2	0.680758
Ftrend 3	0.562274
Ftrend 4	0.377829
Ftrend 5	0.459386
Ftrend 6	0.35994
Ftrend 7	0.234305
Ftrend 8	0.194211
Ftrend 9	0.184653
Ftrend 10	0.174307
Ftrend 11	0.156334
Ftrend 12	0.116667
Ftrend 13	0.147104
Ftrend 14	0.113115

Ftrend 15	0.125402
Ftrend 16	0.103478
Ftrend 17	0.096925
Ftrend 18	0.104284
Ftrend 19	0.221525
sel.C 1	-2.34656
sel.C 2	18.20064
sel.C 3	-10.275
sel.C 4	2.569851
sel.C 5	0.078792
sel.C 6	0.95303
sel.C 7	-0.65677
sel.C 8	-0.06997
logrecruitment 1	18.83716
logrecruitment 2	17.51861
logrecruitment 3	16.09643
logrecruitment 4	14.19515
logrecruitment 5	13.06908
logrecruitment 6	11.74075
logrecruitment 7	10.7975
logrecruitment 8	10.29811
logrecruitment 9	10.08301
logrecruitment 10	10.13463
logrecruitment 11	10.3918
logrecruitment 12	10.46522
logrecruitment 13	10.24655
logrecruitment 14	10.19468
logrecruitment 15	10.54777
logrecruitment 16	10.52794
logrecruitment 17	10.62917
logrecruitment 18	10.37009
logrecruitment 19	10.62786
logrecruitment 20	10.32099
logrecruitment 21	10.42467
logrecruitment 22	10.62926
logrecruitment 23	10.19293
logrecruitment 24	10.29799
Logrecruitment 25	10.52787
Logrecruitment 26	10.59647
Catchability 1	-8.559
sel.U 1	5.394388
sel.U 2	-1.28747
sel.U 3	-0.22861
sel.U 4	-1.0508
b1	5.209377
b2	0.664839

b3	-0.43368
b4	-0.56489
b5	0.284779
b6	0.053928
b7	0.102998
b8	0.123254
b9	0.003464
b10	0.031687
b11	0.016017
b12	0.012685
sds.land1	-2.16988
sds.land2	-1.6609
sds.land3	3.086217
sds.disc1	-0.33636
sds.disc2	-0.47606
sds.disc3	0.538566
sds.tun1	-2.14355
sds.tun2	2.04155
sds.tun3	-0.22384
sds.biotun1	0.820665
sds.biotun2	-1.18947

Table 6.7.3.2. Irish Sea plaice: Estimated landed numbers-at-age (thousands).

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2009	2011
1	54	31	23	19	19	10	5	5	4	3	2	1	1	1	1	0	0	0	0
2	1405	949	756	712	1053	923	547	403	484	398	368	165	211	105	85	61	29	20	32
3	1697	2188	1533	1238	1614	1699	1547	1075	971	1347	1094	777	668	601	354	245	241	99	142
4	1305	1483	1868	1250	1334	1246	1337	1312	1130	1142	1355	930	1215	713	797	402	382	339	312
5	499	669	747	902	861	649	632	689	870	837	677	693	901	707	522	473	310	270	517
6	519	272	348	356	631	403	292	271	378	521	364	253	485	330	368	218	260	175	367
7	361	247	139	159	262	322	199	147	172	272	259	159	203	189	179	157	99	110	146
8	179	159	118	54	115	131	157	106	101	135	153	140	169	105	149	119	105	73	169
9+	123	129	87	91	118	208	125	101	76	74	94	98	121	131	50	58	47	58	90

Table 6.7.3.3. Irish Sea plaice: Estimated discarded numbers-at-age (thousands).

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	1015	714	666	703	919	608	438	551	523	585	486	457	451	485	612	345	428	573	1338
2	15095	8914	6426	5671	8129	7155	4407	3488	4670	4423	4885	2708	4420	2909	3209	3276	2279	2451	6083
3	6171	6333	3673	2555	2987	2935	2594	1821	1729	2626	2428	2042	2165	2500	1963	1887	2689	1662	3738
4	1490	1421	1554	932	923	826	879	884	807	893	1199	963	1522	1117	1615	1090	1431	1814	2462
5	261	319	334	386	363	276	278	322	443	476	441	530	831	806	755	889	777	927	2491
6	0	0	0	0	0	0	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	0	0	0	0	0	0
8	0	0	0	0	0	0	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	0	0	0	0	0	0

Table 6.7.3.4. Irish Sea plaice: Estimated population numbers-at-age (thousands).

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	29676	23933	25201	32591	35074	28185	26760	38093	37344	41323	31891	41269	30363	33680	41327	26714	29673	37342	39993
2	38718	25314	20526	21703	28227	30225	24416	23317	33261	32626	36096	27825	36170	26505	29415	36077	23368	25915	32580
3	15629	18902	13217	11475	13263	16429	19230	17004	17026	24657	24407	27078	21977	27728	20674	22992	28860	18556	20660
4	5663	6511	8795	6848	6623	7453	10225	13169	12360	12564	18136	18338	21366	16829	21677	16159	18388	22841	14802
5	1680	2411	3058	4597	4028	3760	4667	6988	9616	9143	9232	13685	14485	16377	13206	16958	12928	14604	18234
6	1306	779	1214	1700	2869	2426	2466	3284	5247	7295	6875	7138	10987	11219	13102	10512	13759	10444	11826
7	869	672	436	751	1174	1952	1773	1912	2658	4299	5981	5756	6092	9289	9640	11274	9118	11958	9099
8	433	433	365	257	516	796	1429	1386	1558	2196	3557	5061	4955	5212	8060	8381	9851	7994	10503
9+	298	352	270	437	531	1258	1139	1323	1175	1202	2189	3556	3545	6478	2703	4087	4386	6289	5589

Table 6.7.3.5. Irish Sea plaice: Estimated fishing mortality-at-age.

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	0.039	0.034	0.029	0.024	0.029	0.024	0.018	0.016	0.015	0.015	0.016	0.012	0.016	0.015	0.016	0.014	0.015	0.016	0.036
2	0.597	0.53	0.461	0.372	0.421	0.332	0.242	0.194	0.179	0.17	0.167	0.116	0.146	0.128	0.126	0.103	0.111	0.107	0.222
3	0.756	0.645	0.538	0.43	0.456	0.354	0.259	0.199	0.184	0.187	0.166	0.117	0.147	0.126	0.126	0.103	0.114	0.106	0.222
4	0.734	0.636	0.529	0.411	0.446	0.348	0.261	0.194	0.182	0.188	0.162	0.116	0.146	0.122	0.126	0.103	0.11	0.105	0.221
5	0.648	0.566	0.467	0.352	0.387	0.302	0.231	0.166	0.156	0.165	0.137	0.1	0.135	0.103	0.108	0.089	0.093	0.091	0.192
6	0.544	0.46	0.361	0.25	0.265	0.193	0.134	0.091	0.079	0.079	0.058	0.038	0.048	0.032	0.03	0.022	0.02	0.018	0.034
7	0.577	0.49	0.41	0.254	0.269	0.192	0.126	0.085	0.071	0.069	0.047	0.03	0.036	0.022	0.02	0.015	0.012	0.01	0.017
8	0.572	0.49	0.417	0.249	0.269	0.192	0.123	0.085	0.071	0.068	0.047	0.03	0.037	0.022	0.02	0.015	0.011	0.01	0.017
9+	0.572	0.49	0.417	0.249	0.269	0.192	0.123	0.085	0.071	0.068	0.047	0.03	0.037	0.022	0.02	0.015	0.011	0.01	0.017

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 lower	F med	F upper	D (t) lower	D (t) med	D (t) upper	R (000s) lower	R (000s) med	R (000s) upper
1993	6030	7894	10397	0.559	0.669	0.796	1714	2883	4785	22971	29963	38872
1994	5617	7005	8600	0.493	0.579	0.670	1497	2242	3278	19336	23961	30410
1995	5850	7105	8682	0.401	0.472	0.551	1145	1617	2220	20721	25235	31681
1996	6557	7975	9769	0.301	0.362	0.434	943	1304	1795	27204	32655	39759
1997	6882	8364	10350	0.315	0.386	0.474	1241	1660	2155	28736	35005	42694
1998	8098	10119	12672	0.235	0.297	0.377	1127	1472	1884	23160	28107	34694
1999	8853	11481	14786	0.168	0.220	0.291	840	1120	1446	22169	26855	33162
2000	9971	13093	17124	0.121	0.162	0.218	683	909	1186	31286	38122	47158
2001	12707	16935	22407	0.109	0.151	0.201	773	1048	1324	30749	37460	45763
2002	14913	19947	26458	0.114	0.155	0.209	892	1164	1507	33872	41473	50502
2003	17852	24171	32137	0.097	0.131	0.177	933	1237	1590	26062	31987	39267
2004	15697	21566	28891	0.068	0.092	0.125	698	898	1150	34076	41246	50252
2005	16433	22121	29549	0.086	0.119	0.162	994	1272	1596	25255	30450	37601
2006	17425	23561	31868	0.072	0.096	0.128	819	1050	1335	27831	33744	41189
2007	14402	19415	25970	0.071	0.097	0.130	663	848	1083	33814	41278	50522
2008	16231	21771	28877	0.058	0.079	0.107	667	854	1070	21931	26787	33445
2009	15767	20934	27577	0.064	0.084	0.113	670	856	1080	24216	29760	37621
2010	15217	19935	26000	0.059	0.080	0.109	805	1054	1351	29420	37811	47764
2011	17276	22436	29277	0.120	0.167	0.230	1424	1893	2416	30448	40265	52755

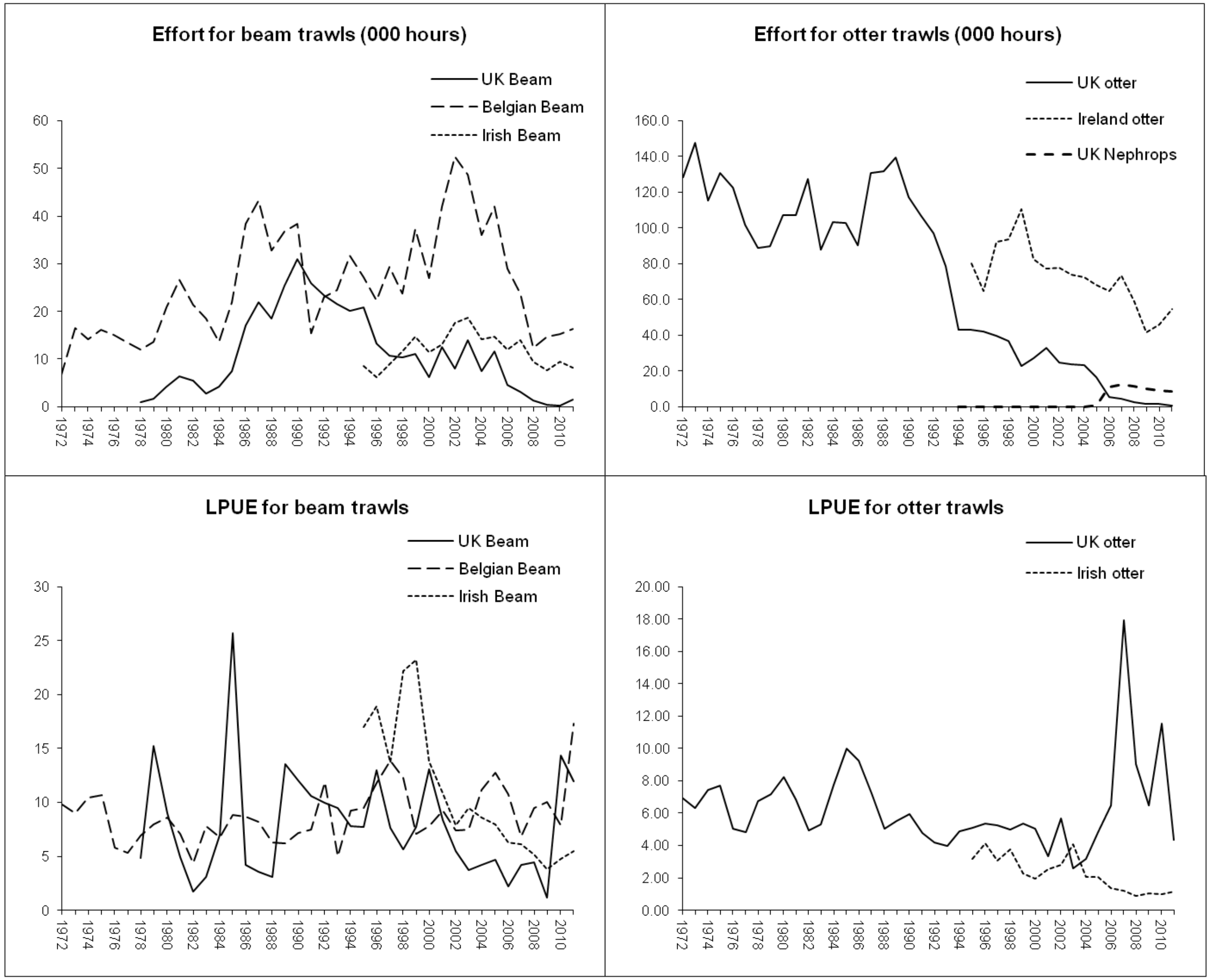


Figure 6.7.2.1. Irish Sea plaice: Effort and lpue for commercial fleets (note addition of effort by UK *Nephrops* trawlers).

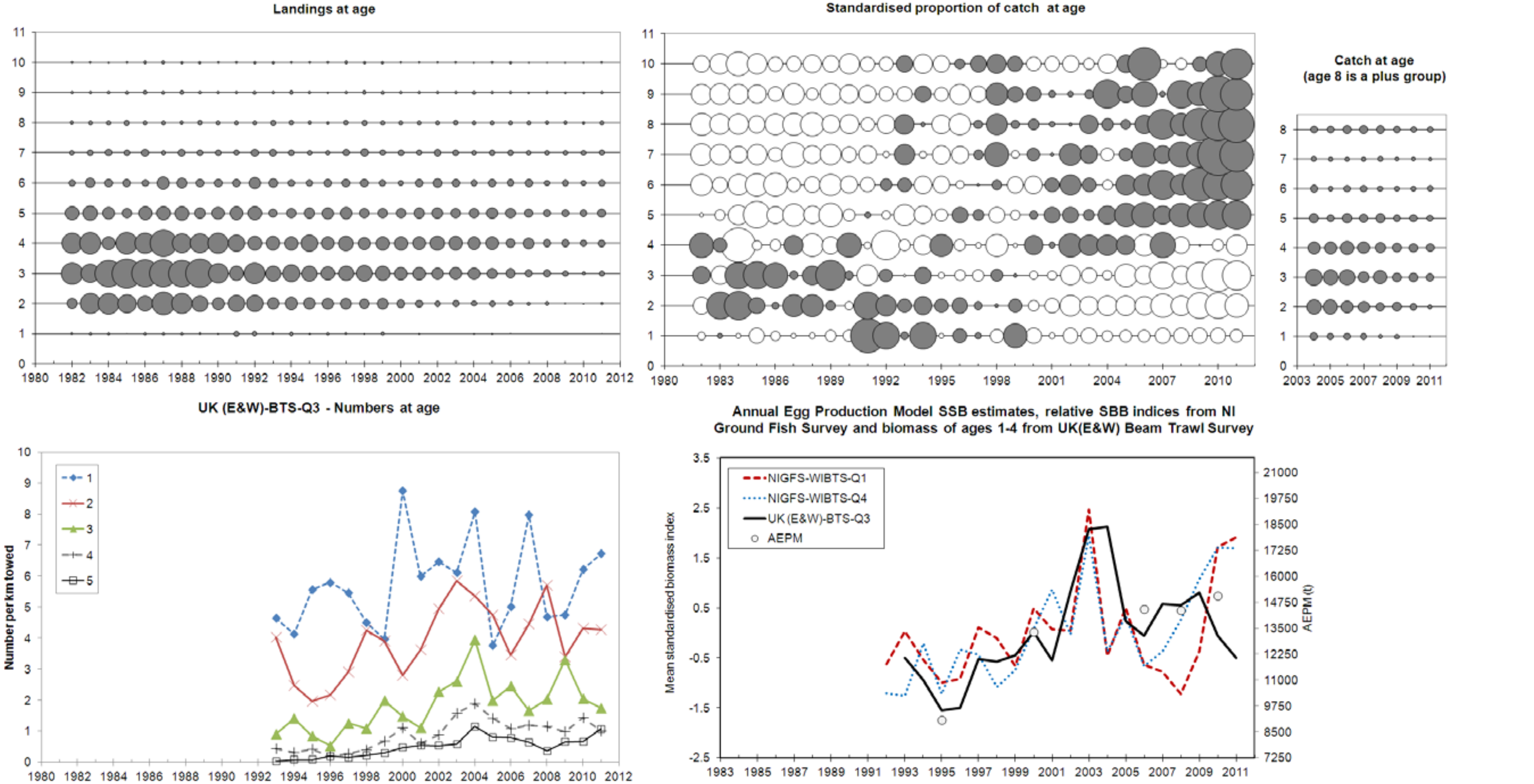


Figure 6.7.2.2. Catch and survey data: raw landings-at-age data (top left), mean standardised proportion-at-age (top centre, grey bubbles are positive values and white bubbles are negative); raw catch-at-age data (discards plus landings, top right); UK(E&W)-BTS-Q3 (extended area) cpue (bottom left); 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).

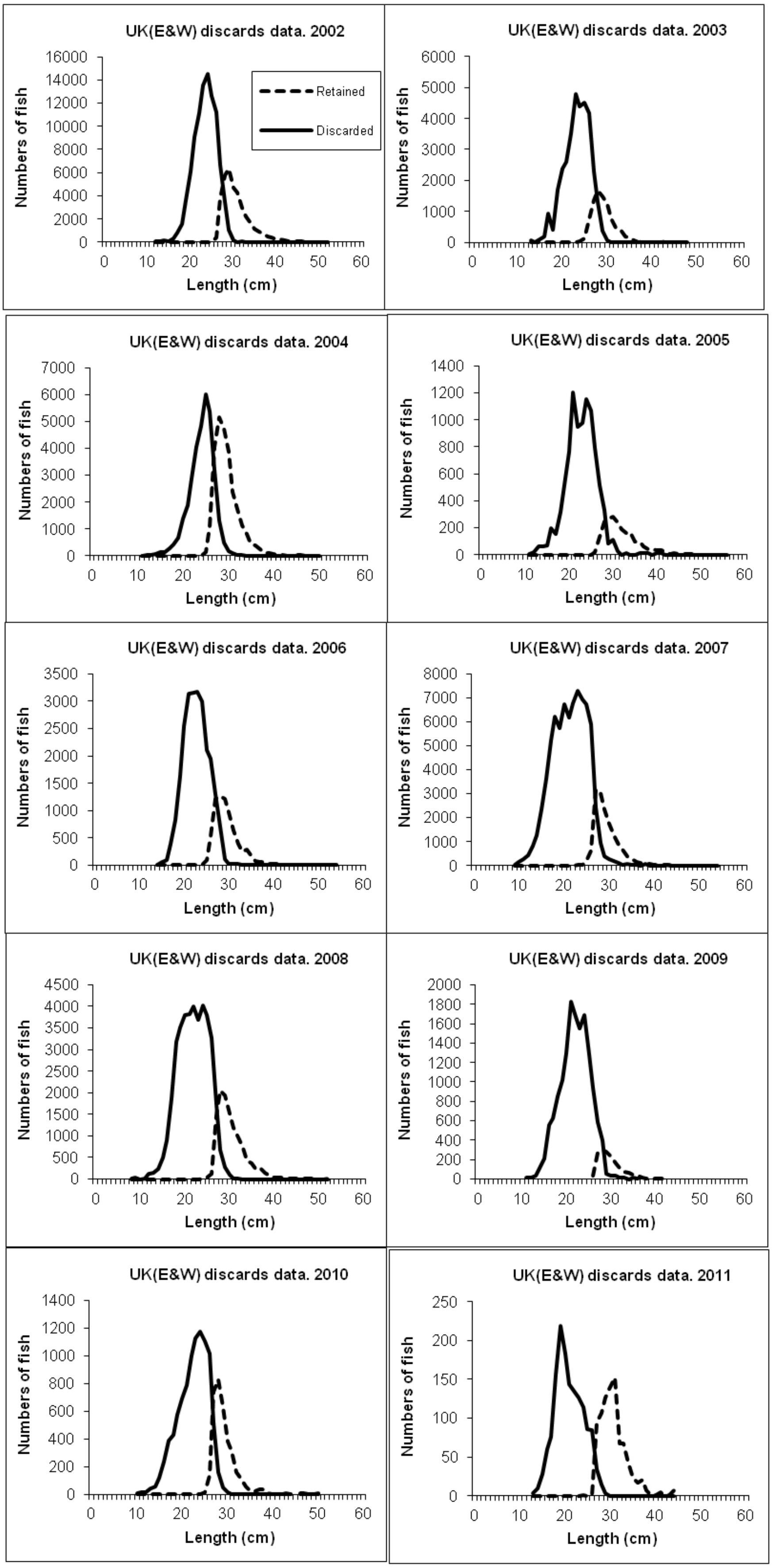


Figure 6.7.2.3. Length distributions of discarded and retained catches from UK(E&W).

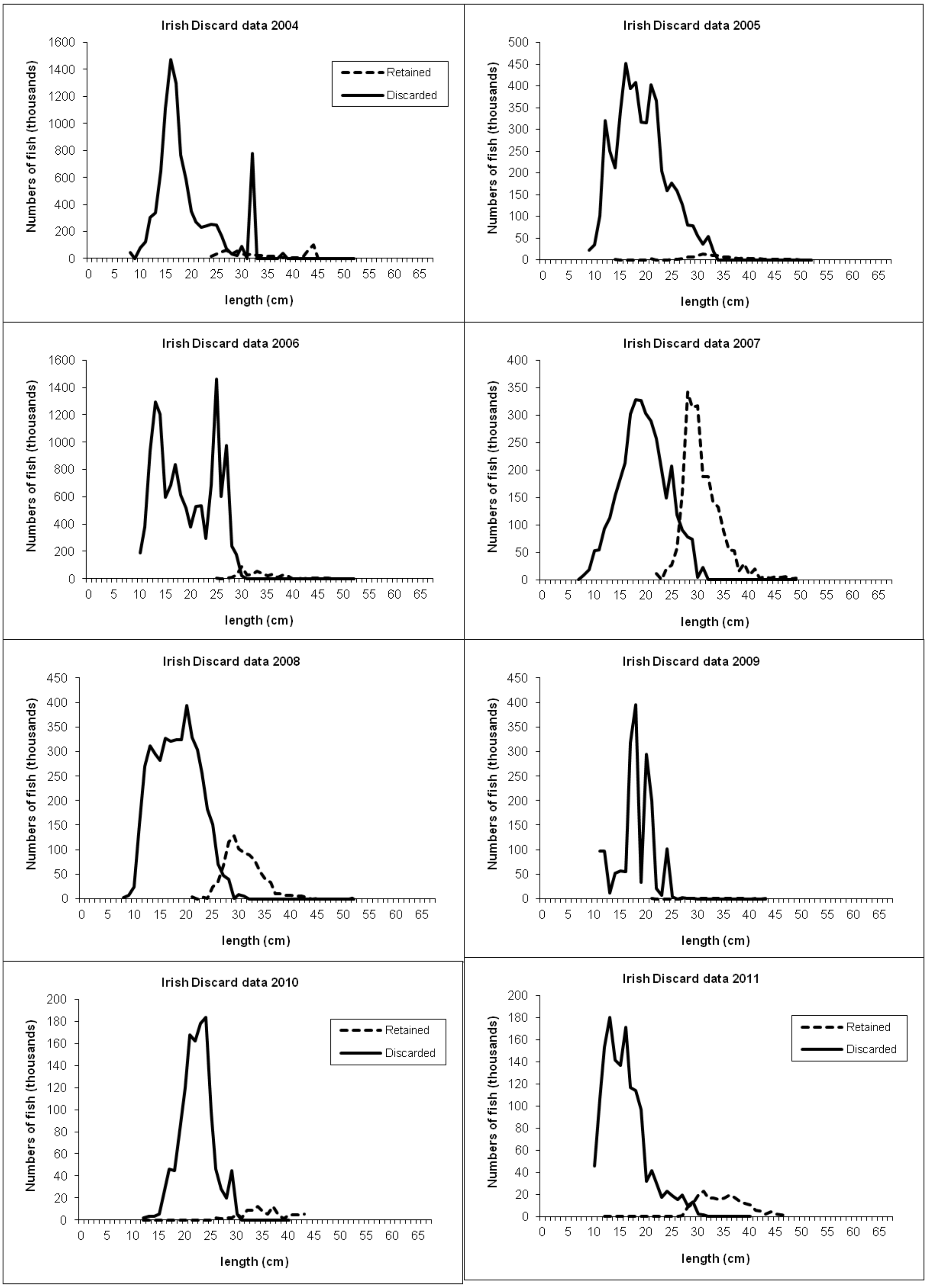


Figure 6.7.2.4. Length distributions of discarded and retained catches from Ireland.

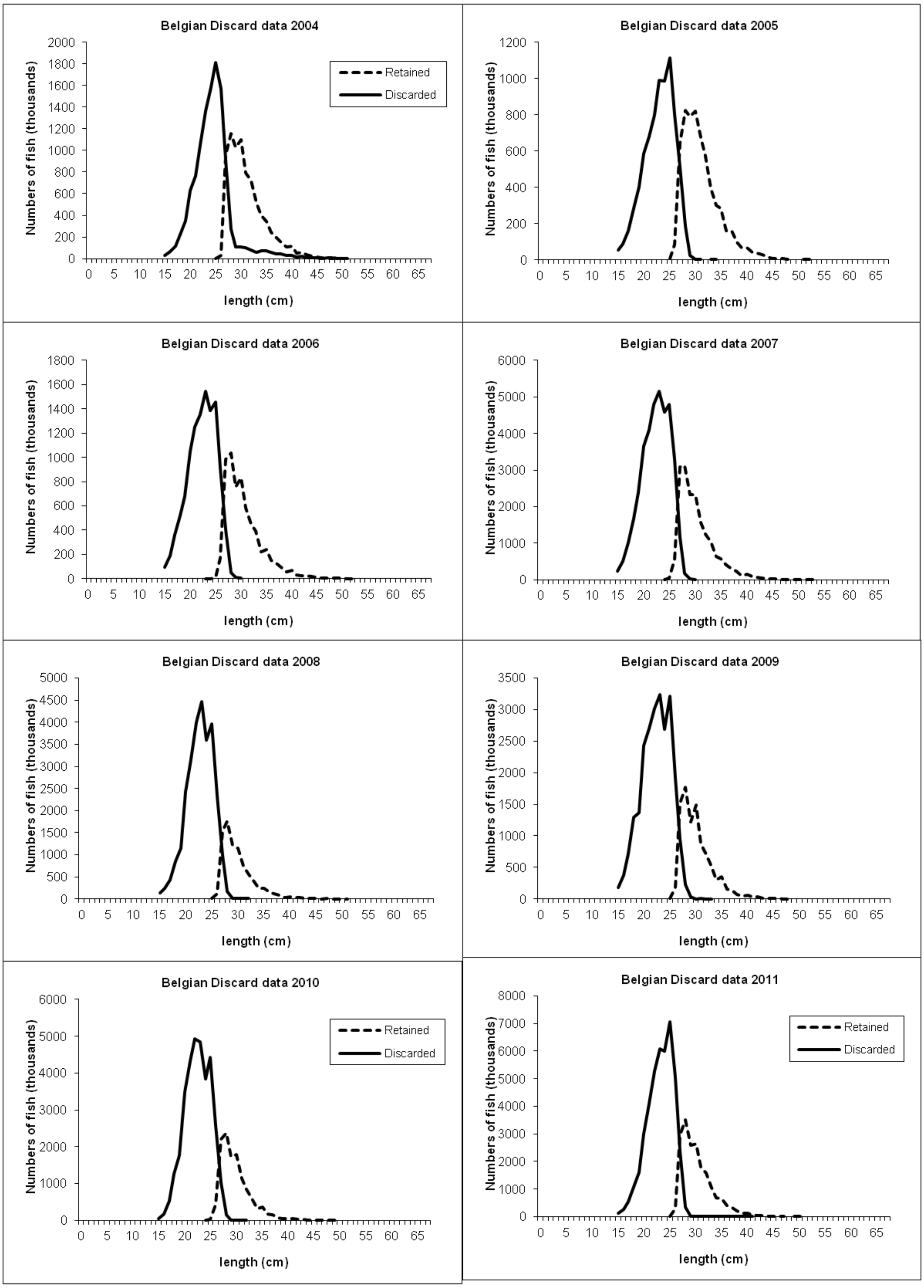


Figure 6.7.2.5. Length distributions of discarded and retained catches from Belgium.

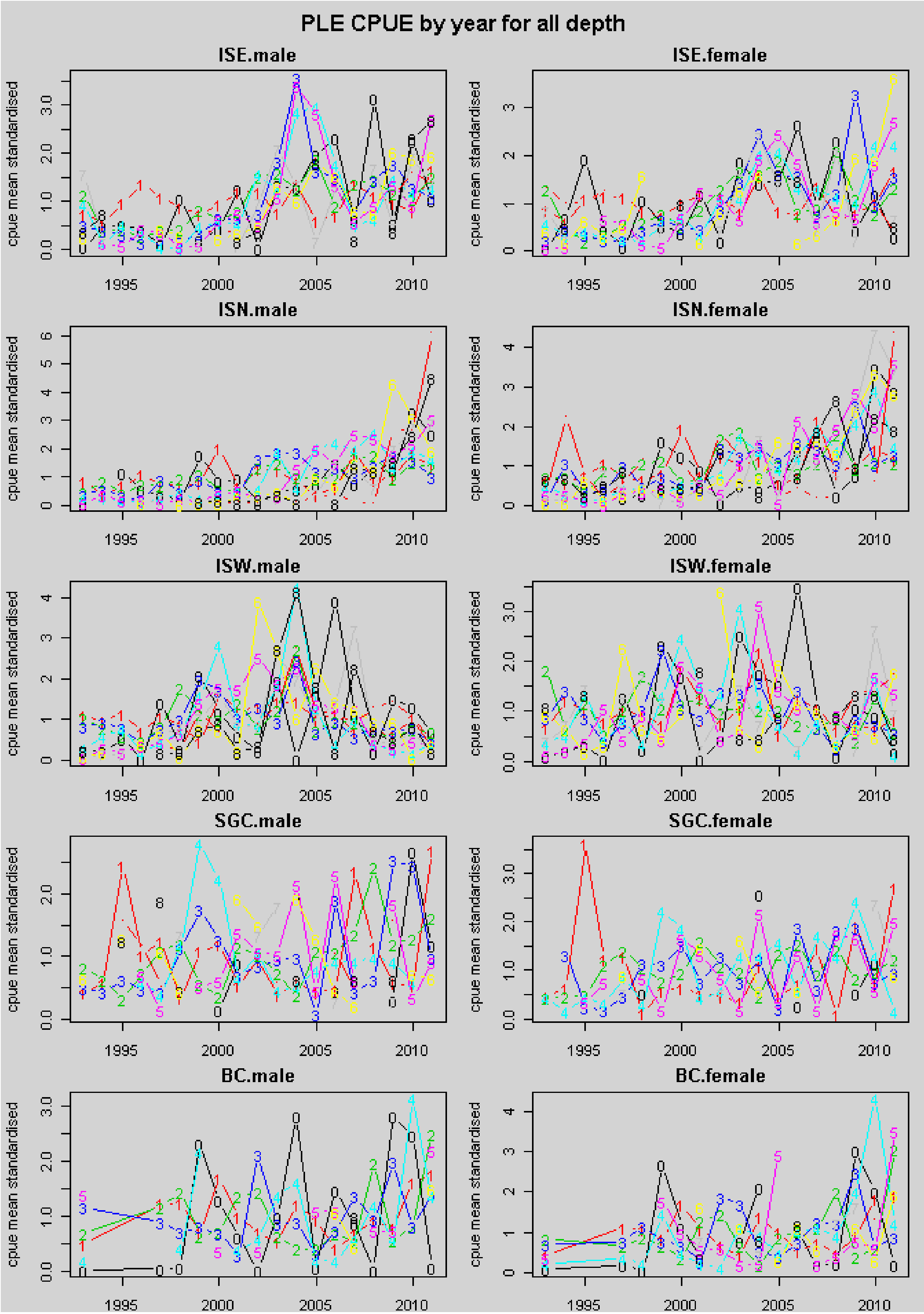


Figure 6.7.2.6. UK (E&W)-BTS-Q3 mean standardised cpue by age by year. Mean standardised by age = cpue age i / mean(cpue age i over all years).

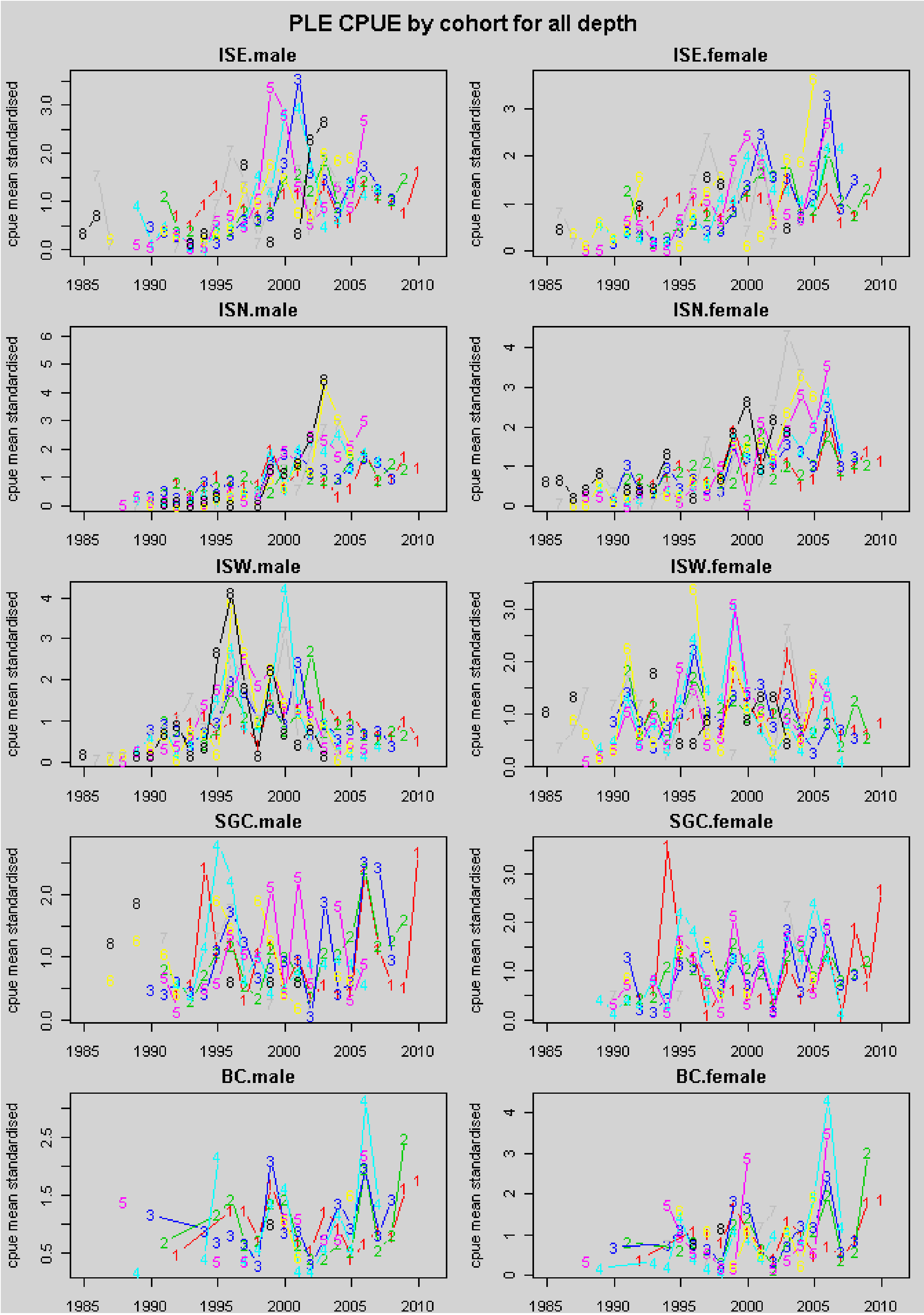


Figure 6.7.2.6. UK (E&W)-BTS-Q3 mean standardised cpue by age by year-class. Mean standardised by age = cpue age i / mean (cpue age i over all years).

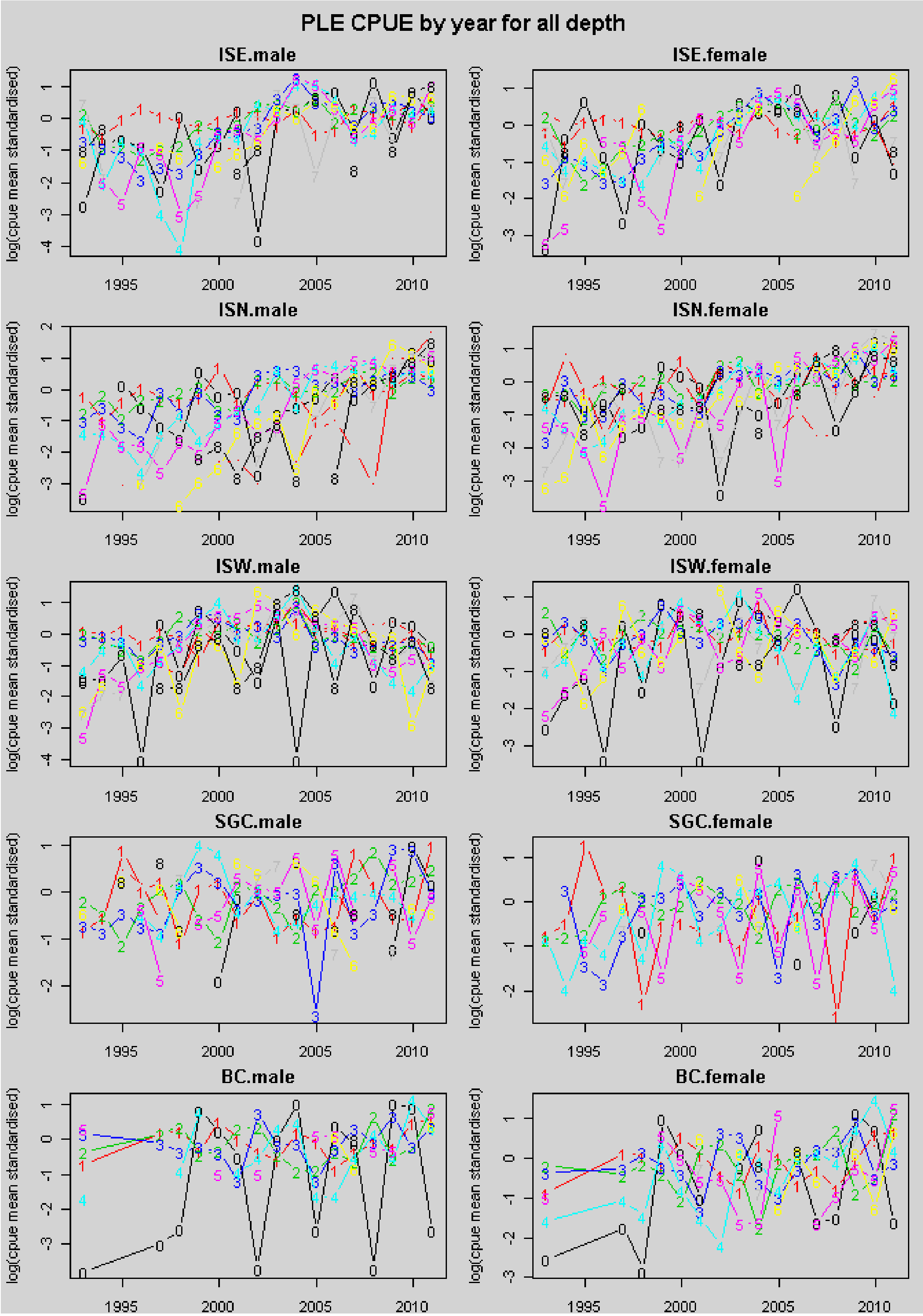


Figure 6.7.2.6 cont. log(mean standardised cpue) by age for UK (E&W)-BTS-Q3 by year. Mean standardised by age = cpue age i / mean (cpue age i over all years).

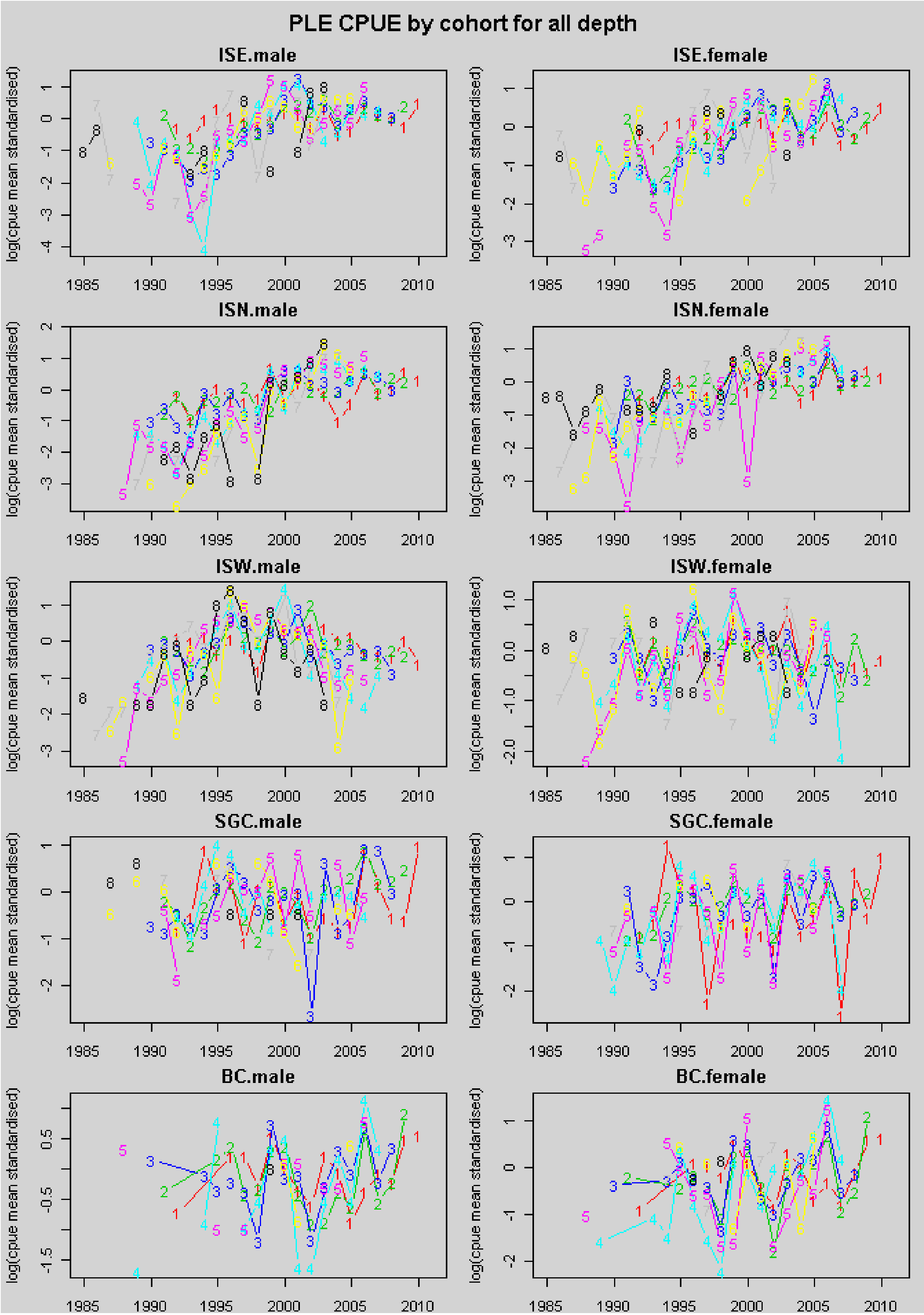


Figure 6.7.2.6 cont. log(mean standardised cpue) by age for UK (E&W)-BTS-Q3 by year class. Mean standardised by age = cpue age i / mean (cpue age i over all years).

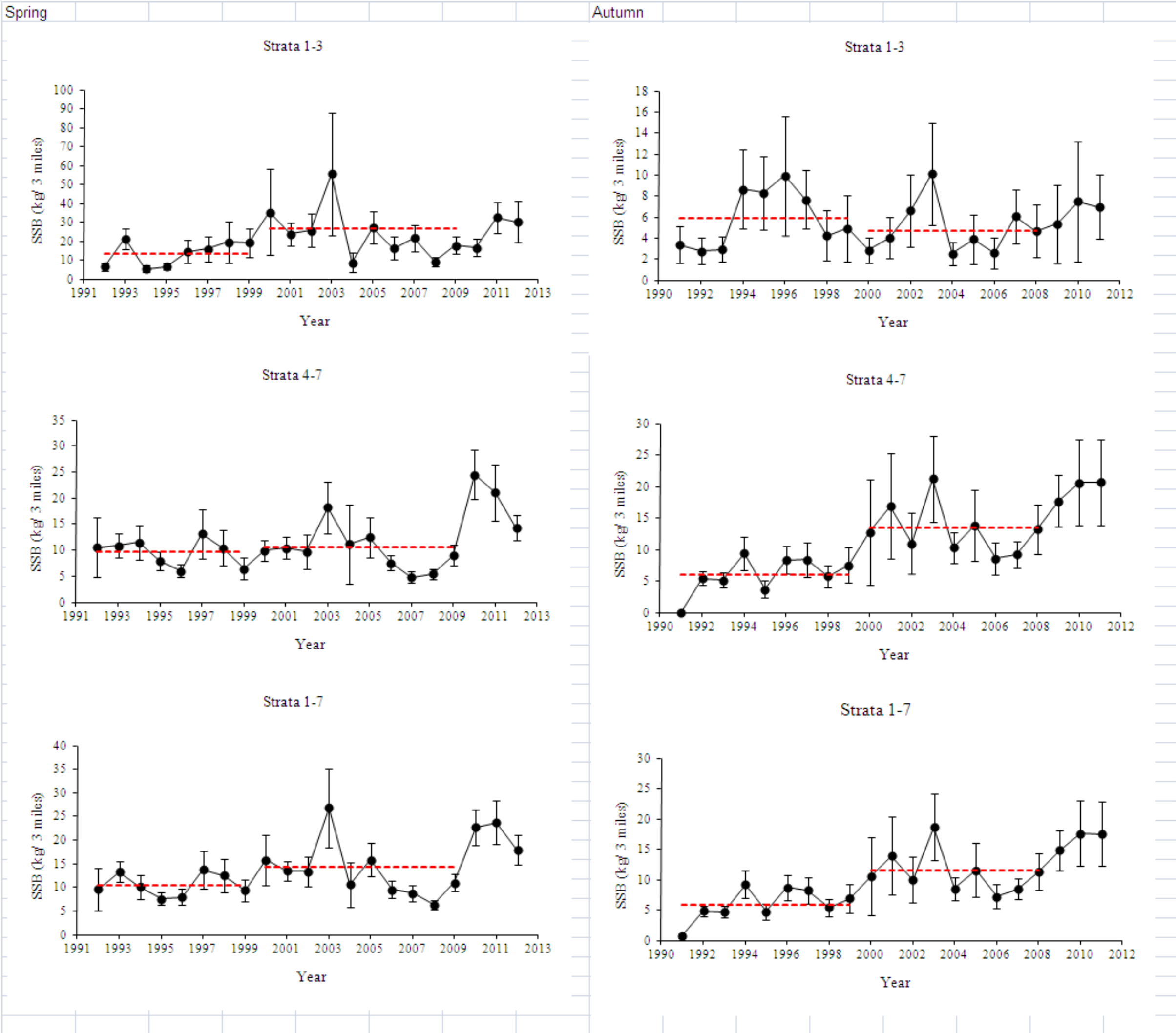


Figure 6.7.2.7. Northern Irish groundfish survey SSB indices split into spring (left hand panels) and autumn (right hand panels) sampling by western strata (1–3), eastern strata (4–7) and total survey area (strata 1–7) with confidence intervals (± 1 standard error, vertical lines) and mean biomass (kg/3 miles, dashed horizontal lines) for periods identified by statistical breakpoint analysis (see WGCSE 2010). Note the different scale on the y-axis in the top-left panel.

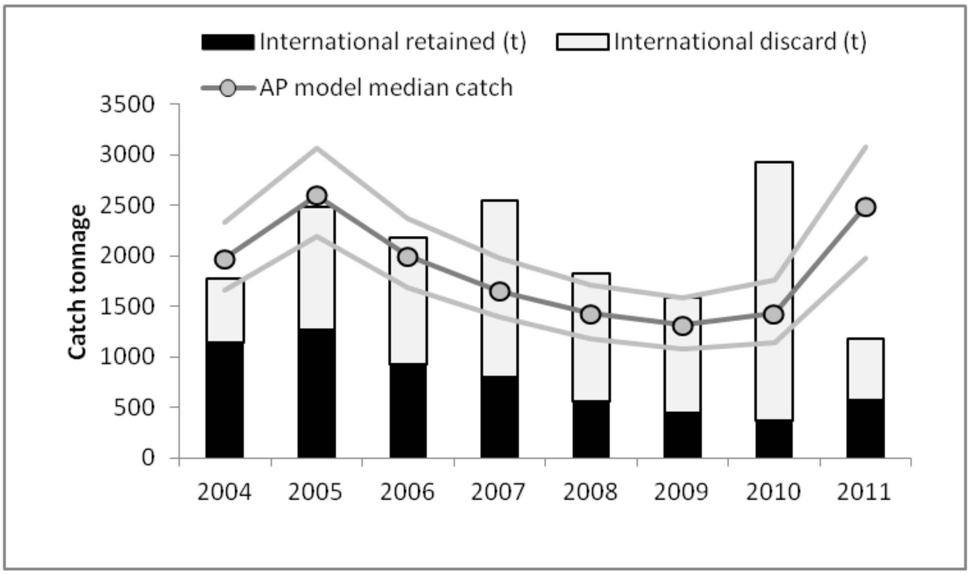
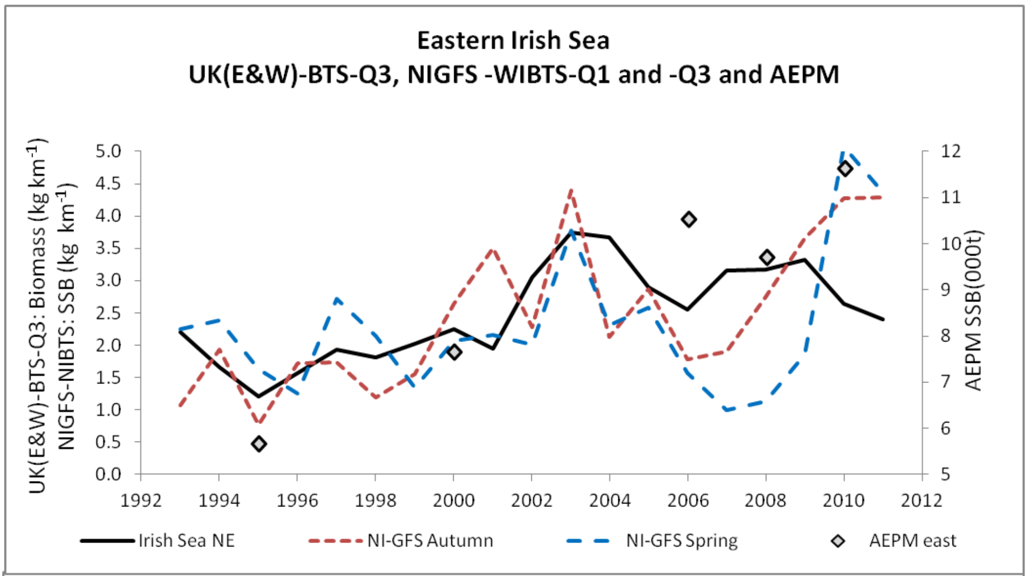


Figure 6.7.2.8. Plaice in VIIa: WG raised international catch tonnage vs. AP model estimates with uncertainty bounds.



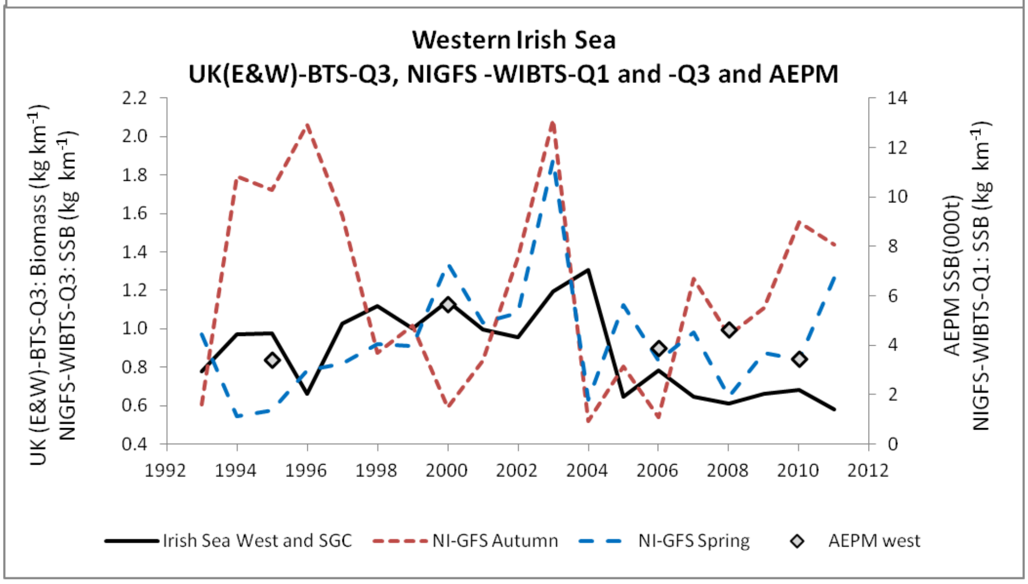


Figure 6.7.2.9. Trends in SSB indices (kg per km towed) from the UK (E&W)-BTS-Q3 (black line) and the NIGFS-WIBTS-Q1 and -Q3 (blue and red dashed lines respectively) in the eastern Irish Sea (top) and the western and southern Irish Sea (bottom). Also shown (grey diamonds, right axis) are the estimates of SSB from the Annual Egg Production Method (AEPM) from Armstrong *et al.* (2011).

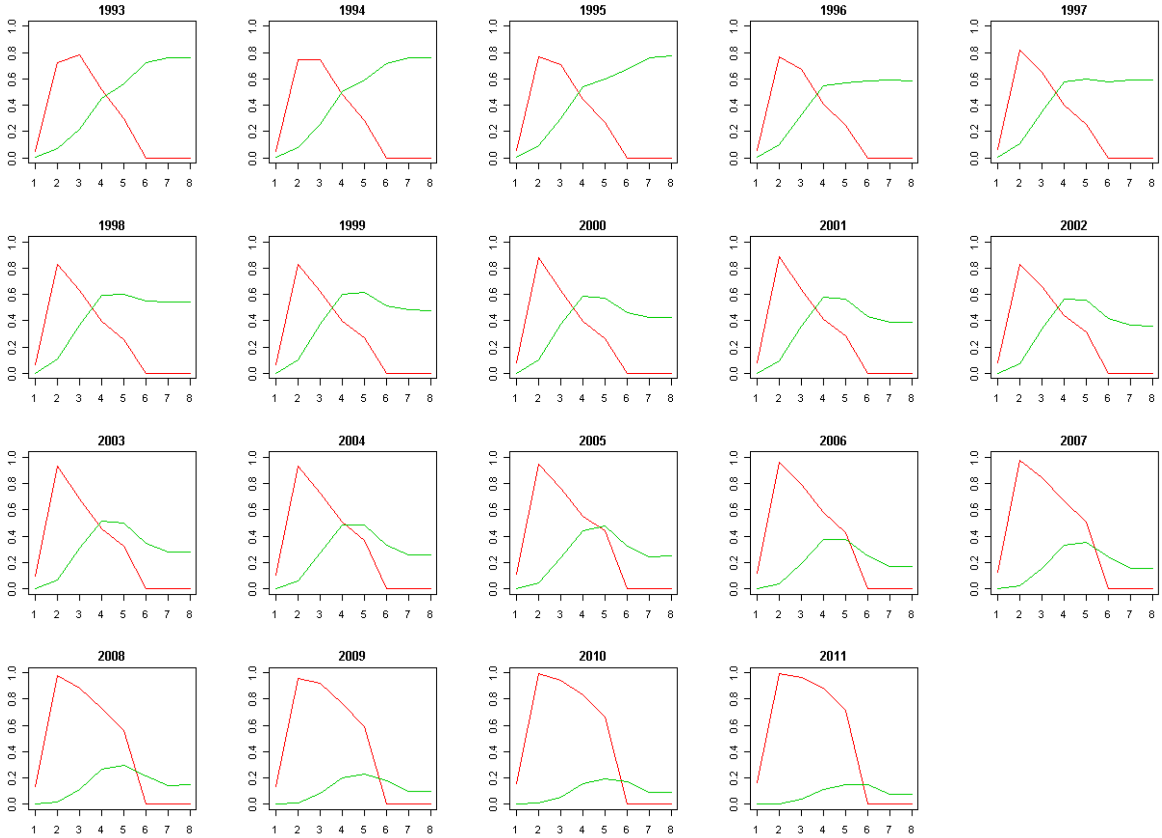


Figure 6.7.2.10. Selectivity of the fishery split into the landed (green) and discarded (red) components as estimated by the AP model, where the x-axis shows age and the y-axis gives the fishing mortality-at-age scaled so that the maximum value is 1 and split by the proportion of fish (by number) discarded and landed-at-age.

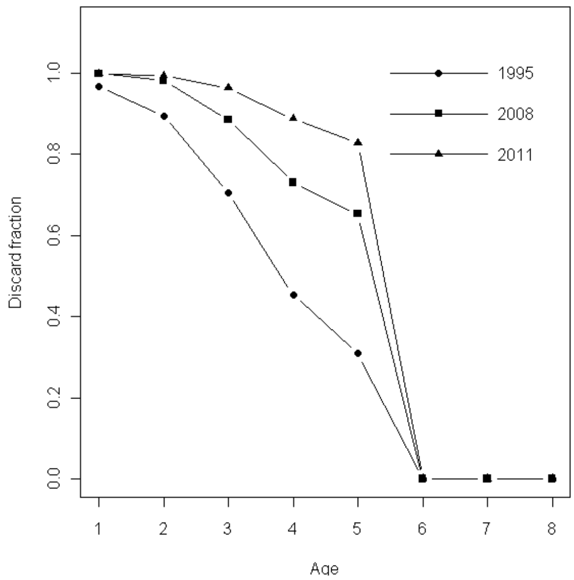


Figure 6.7.2.11. Change in the discard fraction at age over time as estimated by the AP model.

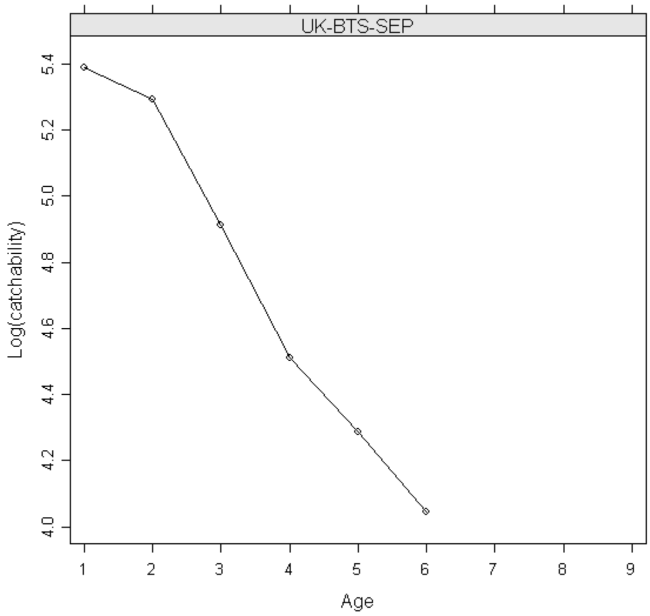


Figure 6.7.2.12. Log catchability for the UK (E&W)-BTS-Q3 extended index as estimated by the AP model.

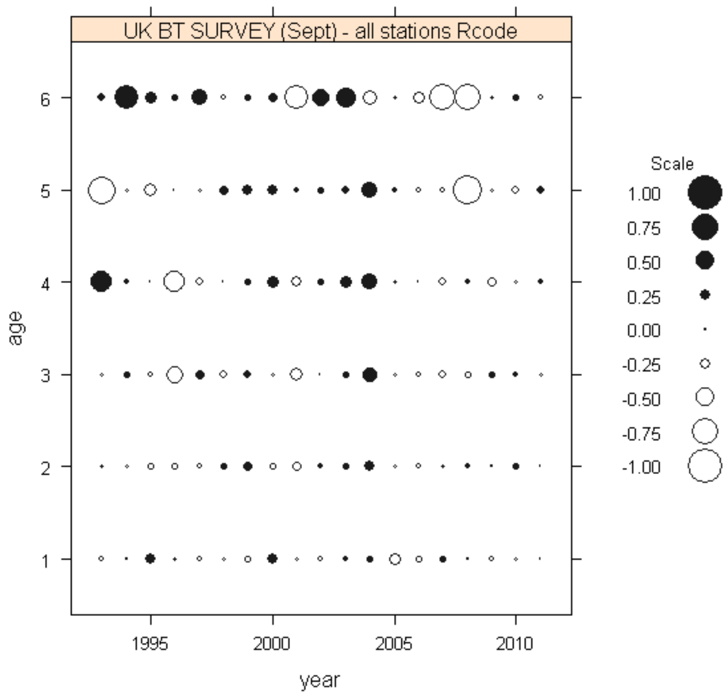


Figure 6.7.2.13. Residual plot (left) for the UK (E&W)-BTS-Q3extended area index. Bubbles are log(observed) – log(expected). Expected values were estimated by the AP model.

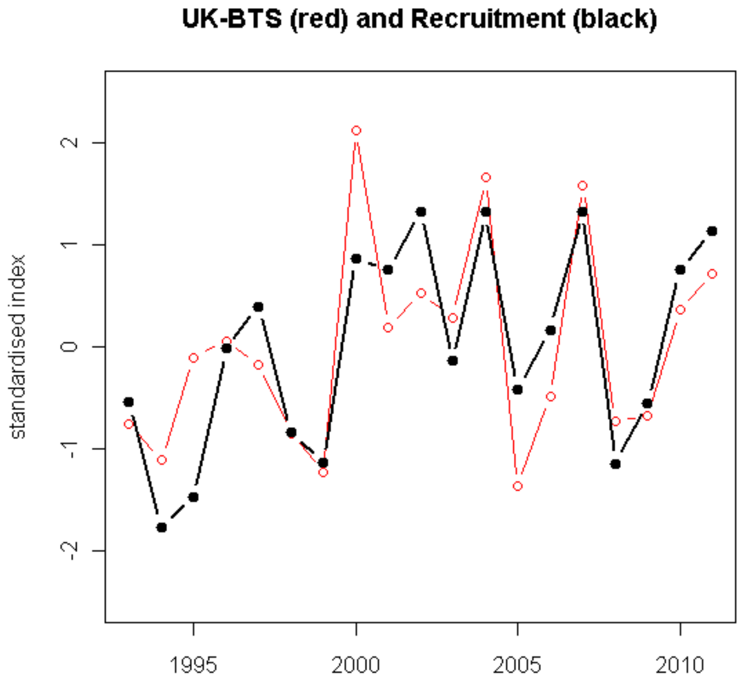
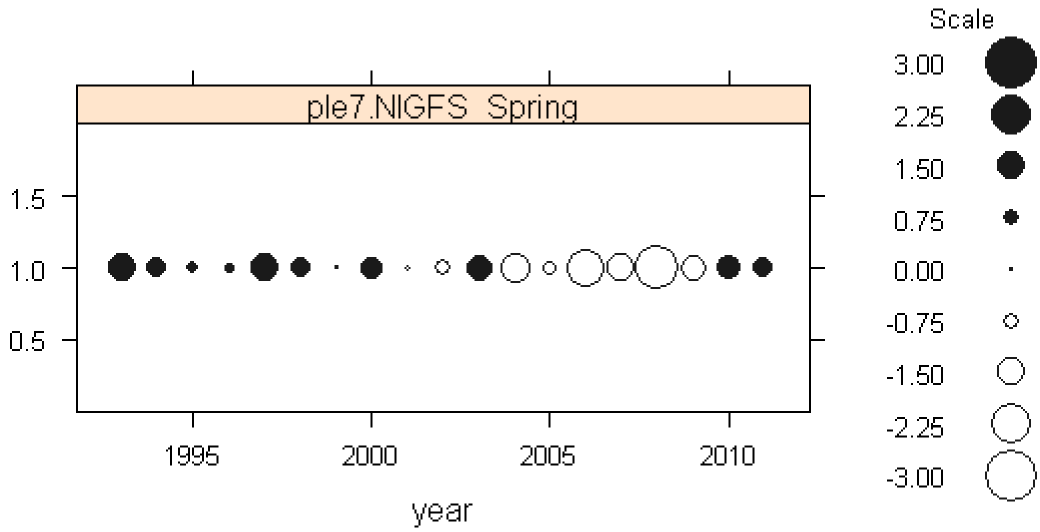


Figure 6.7.2.14. Age 1 index from the UK (E&W)-BTS-Q3 extended area index (red and crosses) and recruitment (black and circles) estimated by the AP model.



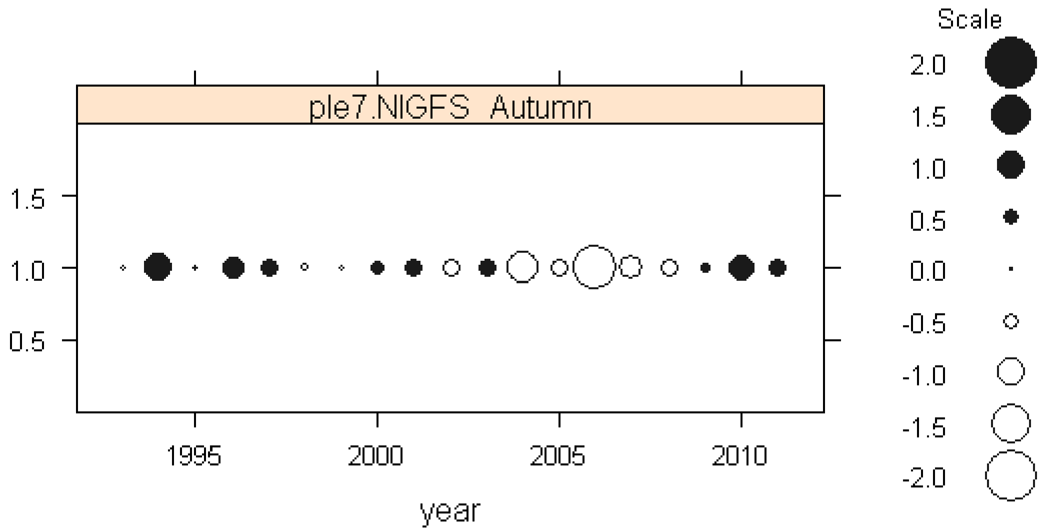


Figure 6.7.2.15. Residual plots for the NIGFS-WIBTS-Q1 (top) and –Q4 (bottom). Bubbles are (observed mean standardised SSB) – (expected mean standardised SSB). Expected values were estimated by the AP model.

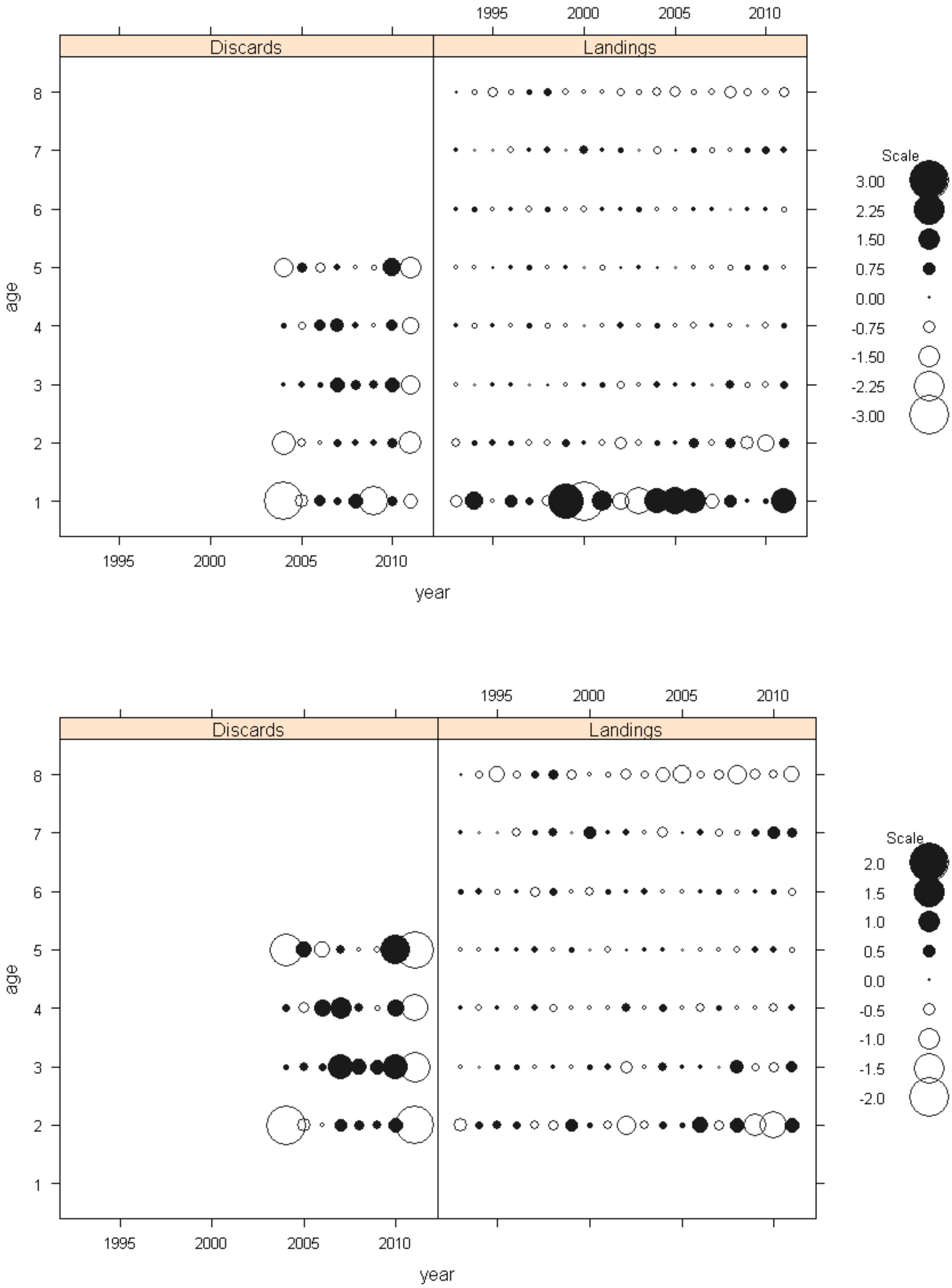


Figure 6.7.2.16. Residual plots for discards (left) and landings (right) with (bottom) and without (top) bubbles drawn for age 1. Bubbles are log(observed) – log(expected). Expected values were estimated by the AP model.

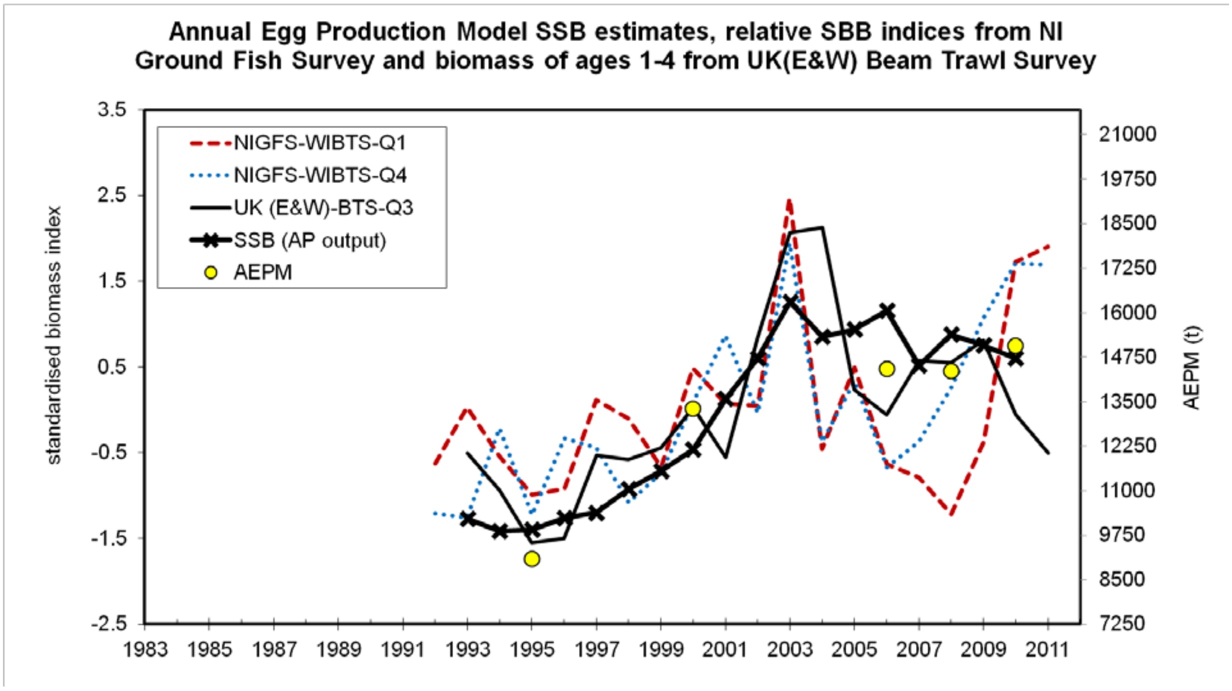


Figure 6.7.2.17. AP model estimates of mean standardised SSB (black line) overlain with standardised NI-GFS in spring (blue) and autumn (green) relative SSB indices, standardised (minus mean and divide by standard deviation) biomass (ages 1–4) from the UK(E&W)-BTS (grey line) and AEPM SSB index (circles, right axis).

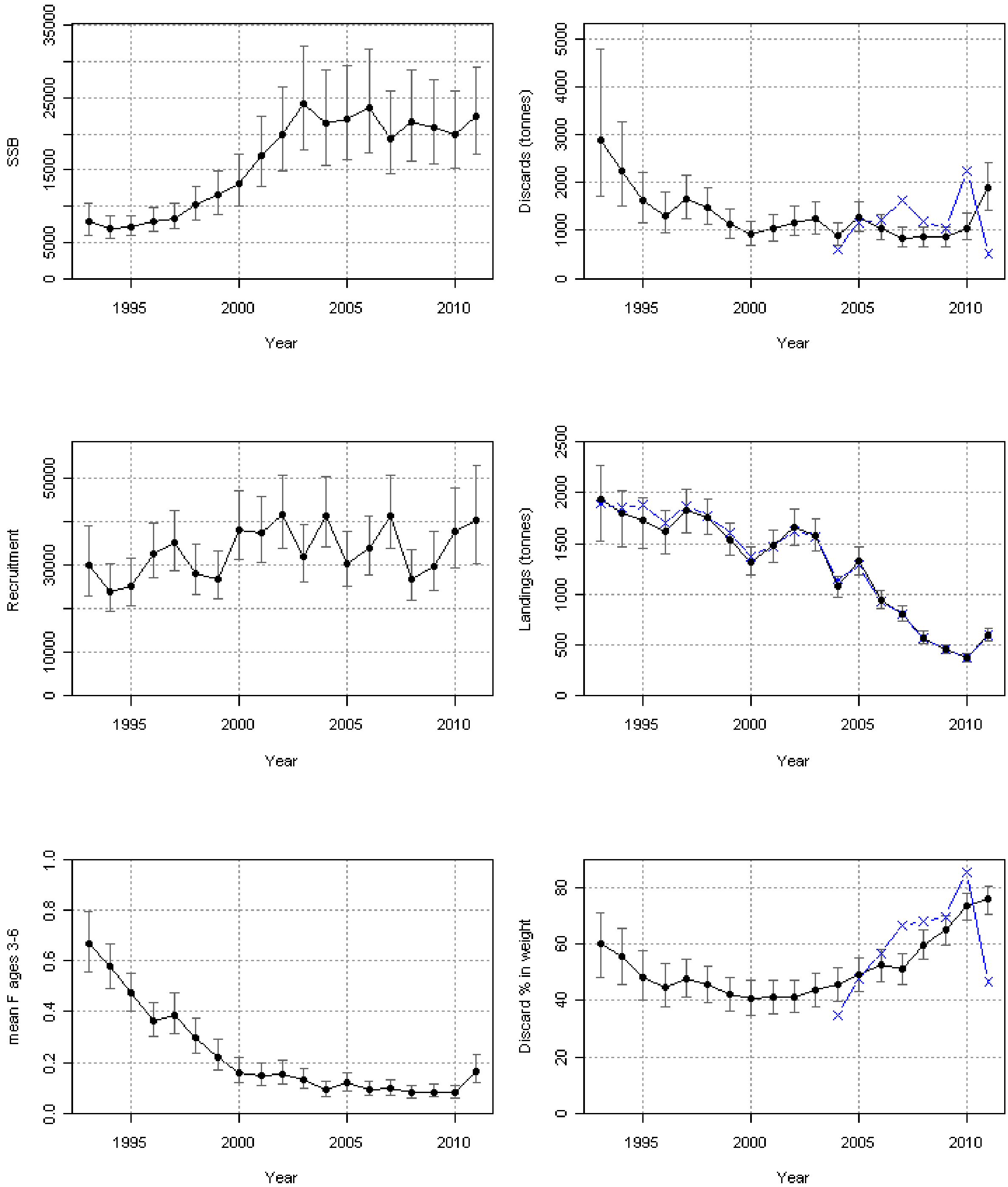


Figure 6.7.2.18. Modelled SSB (tonnes, top left), recruitment (thousands, centre left), F_{bar} (ages 3–6, bottom left) discard tonnage (top right), landed tonnage (centre right) and % discarded by weight (bottom right). Modelled using the AP model. Raw data shown in blue with crosses.

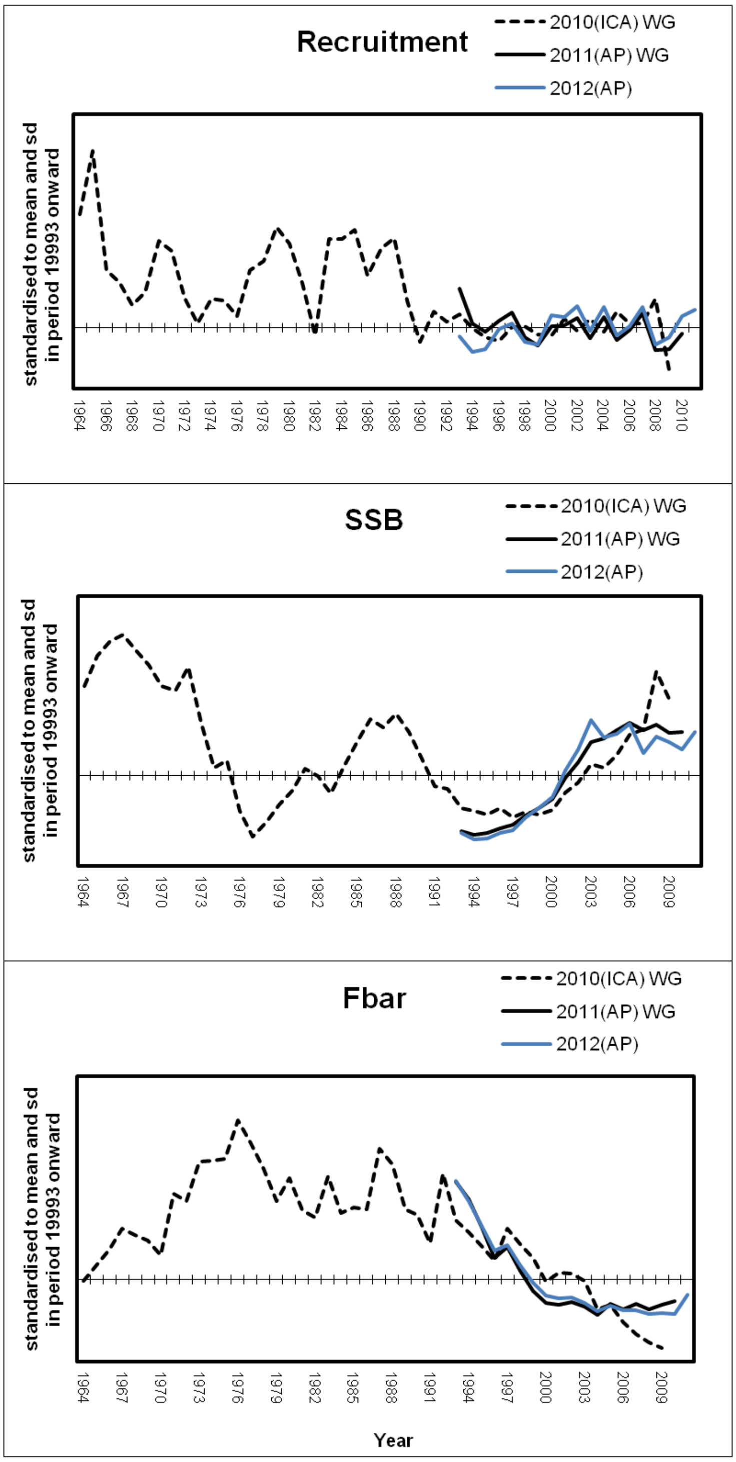


Figure 6.7.2.19. Comparison of recruitment (age 1), SSB and F_{bar} (ages 3–6) between 2010 (WGCSE 2010, ICA model, dashed lines) and WGCSE 'AP model' assessments in 2011 (black) and 2012 (blue).

6.8 Sole in Division VIIa (Irish Sea)

Type of assessment in 2011

This assessment is an Update Assessment.

ICES advice applicable to 2011

In 2011 the stock status was presented as follows:

Fishing mortality	**2007**	**2008**	**2009**
F_{MSY}	Above	Above	Above
F_{PA}/F_{lim}	Between	Between	Below
Spawning–Stock Biomass (SSB)	2008	2009	2010
MSY $B_{trigger}$	Below	Below	Below
B_{PA}/B_{lim}	Below	Below	Below

MSY approach

*Following the transition scheme towards the ICES MSY framework implies fishing mortality of (0.8*F(2010)) + (0.2*(FMSY*0.55) = 0.24 for 2011. This results in landings of 390 t in 2011. This is expected to lead to an SSB of 2200 in 2012.*

PA approach

Given the low SSB and low recruitment since 2000, it is not possible to identify any non-zero catch which would be compatible with the precautionary approach. ICES recommends a closure of the fishery in 2011 and a recovery plan should be developed and implemented as a prerequisite to reopening the fishery.

ICES advice applicable to 2012

In 2012 the stock status was presented as follows:

F (Fishing Mortality)				
	2008	2009	2010	
MSY (FMSY)	✗	✗	✗	Above target
Precautionary approach (F_{PA}, F_{lim})	✓	✗	✓	Harvested sustainably

SSB (Spawning–Stock Biomass)				
	2009	2010	2011	
MSY ($B_{trigger}$)	✗	✗	✗	Below trigger
Precautionary approach (B_{PA}, B_{lim})	✗	✗	✗	Reduced reproductive capacity

MSY approach

Following the ICES MSY framework implies fishing mortality to be reduced to 0.07 (56% lower than FMSY because SSB is 56% below MSY Btrigger), resulting in landings of less than 80 t in 2012. This is expected to lead to a SSB of 1520 t in 2013.

Following the transition scheme towards the ICES MSY framework implies fishing mortality of 0.19 for 2012. This results in landings of 200 t in 2012. This is expected to lead to an SSB of 1390 in 2013.

PA approach

Given the low SSB and low recruitment since 2000, it is not possible to identify any non-zero catch which would be compatible with the precautionary approach.

Technical comments made by the Review Group (RGCS)

1) The WG Report does not provide any ecosystem information and the Stock Annex reports that there is "no information" on Ecosystem aspects. This is deficiency in the assessment report and an inaccuracy in the Stock Annex.

The fishery effect on benthos and fish communities has been described in the report and a more detailed overview of the Irish sea ecosystem has been added in the stock annex.

2) The assessment notes that the historic catch-at-age data (pre-2000) is possibly of lower quality (Section 6.8.7) than the most recent data. The change in assessment approach to dispense with time-series weighting seems to be inconsistent with this deficiency in the data. Future assessments should assess this particular change in model formulation independent of any other changes to ascertain the impact on the assessment and its retrospective performance.

The linear time weighting (over 20 years) applied in the assessments of Irish Sea sole before the benchmark in 2011, produced a moderate retrospective pattern in F and SSB. As there was no reason to question the quality of the survey-indices over time and year-class strength, WKFLAT 2011 decided to investigate other taper time weightings. Bisquare, tricubic and uniform (no taper) time weightings were tested. Retrospective runs produced the best results when no taper weighting was applied. Therefore WKFLAT 2011 decided to use no taper for further analysis.

3) The assessment notes that the new model formulation has "resolved the retrospective pattern seen in the previous assessment". However, retrospective plots still indicate a substantial downwards revision in SSB, and upwards revision in fishing mortality, as a percentage of the recent estimates of each value (the text describing the scale of these discrepancies seems at odds with the Figure). An assessment run using the same procedure as used prior to the benchmark assessment would establish whether the retrospective patterns arise due to the addition of the most recent data, or due to the change in model formulation.

The introduction of the new settings agreed by WKFLAT 2011, improved the retrospective pattern seen in the previous assessment where there was an apparent downwards revision of SSB. Fishing mortality also showed a slightly improved retrospective pattern. The recruitment levels were consistently estimated throughout the retrospective period. The results of the retrospective analysis of the 2011WG, were consistent with the outcome of WKFLAT 2011. The percentages of the recent estimates of each value, mentioned in the WGCSE 2011 report are not applicable to the retrospective analysis. They are quantifying the difference between the estimates of last year's assessment values and the results of the most recent assessment. So therefore, the comment on the discrepancies between the text describing a comparison with previous assessment and the figure showing the retrospective analysis is not applicable. In order to address the cause of the retrospective pattern in F and SSB, an XSA run (including the 2010 data and using the same procedure as conducted prior to the benchmark assessment) was performed (available in ICES files). A comparison of the estimates of last year's assessment with the assessment run suggested by the RGCS, shows that recruitment trends are very similar, whereas the historical estimates of F show a substantial difference compared to the 2011 WG assessment. The difference in SSB estimates from the additional assessment run is somewhat smaller. This indicates that the change in model formulation causes a considerable modification of the estimates for F and SSB and not the addition of the 2010 data. The retrospective pattern in F and SSB seen in the 2011WG is slightly better than the one requested by the RGCS. The overestimation of F and the underestimation in SSB is less pronounced due to the introduction of the WKFLAT settings. Furthermore, those more optimistic estimates of SSB resulting from the settings prior to the WKFLAT would have less impact on the management advice and would lead to a more substantial depletion of the stock in the future.

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. 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 Skaggerak and Kattegat, ICES zone IV, EC waters of ICES zone IIa, ICES zone VIId, ICES zone VIIa, ICES zone VIa and EC waters of ICES zone Vb. The grouping of fishing gear concerned are: bottom trawls, Danish seines and similar gear, excluding beam trawls of mesh size: TR1 (≥100 mm) – TR2 (≥70 and <100 mm) – TR3 (≥16 and <32 mm); Beam trawl of mesh size: BT1 (≥120 mm) – BT2 (≥80 and <120 mm); gillnets excluding trammelnets: GN1; trammelnets: GT1 and longlines: LL1.

For 2010, 2011 and 2012, Council Regulation (EC) N°53/2010, Council Regulation (EC) N°57/2011 and Council Regulation (EC) N°43/2012 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. (see Section 1.2.1 for complete list).

Management applicable to 2010 and 2011

TAC 2011

Species: Common sole *Solea solea*		Zone: VIIa (SOL/07A.)
Belgium	179	
France	2	
Ireland	73	
The Netherlands	56	
United Kingdom	80	
EU	390	
TAC	390	Analytical TAC

TAC 2012

Species: Common sole *Solea solea*		Zone: VIIa (SOL/07A.)
Belgium	131	
France	2	
Ireland	67	
The Netherlands	41	
United Kingdom	59	
Union	300	
TAC	300	Analytical TAC

Fishery in 2011

A full description of the fishery is provided in the Stock Annex, Section A2.

The Working Group estimated the total international landings at 330 t in 2011 (Table 6.8.1), which is about 15% below the 2011 TAC (390 t) and 2% above last year's forecast of 323 t.

The main countries fishing for Irish Sea sole are Belgium, Ireland and UK(E&W).

The Belgian beam trawl effort has declined since 2002, however for the last four years it remains stable at around the lowest level in the time-series. After a peak in 2003, the Irish beam trawl effort has shown a declining trend that has stabilized in the most recent years. After the historically lowest value reported in 2009, the Irish otter trawl effort has increased in 2010 and 2011. Since the beginning of the nineties the UK beam trawl effort has continued to decline.

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 the last four years.

The WG estimated the total international landings at 330 t in 2011 (Table 6.8.1), of which 76% (250 t) was landed by Belgium, 15% (48 t) by Ireland, 7% (23 t) by the UK(E&W) and the remainder by Northern Ireland, Scotland, Isle of Man and France. These landing-figures are about the lowest in the time-series, corresponding to an international uptake of 85% of the agreed TAC in 2010 (390 t).

The working group estimate of the 2010 landings was slightly revised upwards due to minor (0.9%) revisions of the landings by Belgium and Scotland, and had a negligible impact on the assessment results.

There is no accurate information on the level of misreporting, but given the partial uptake (50–90%) of the agreed TAC in recent years, misreporting is not considered a problem for this stock (Table 6.8.1).

Data

Quarterly age compositions for 2011 were available from the countries that take the major part of the international landings (97%) (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 France, Northern Ireland, Isle of Man and Scotland to obtain the catch numbers-at-age for 2011 (Table 6.8.2). Annual length distributions of the three major countries involved are given in Table 6.8.3.

Sampling levels for the countries providing age data are given in Table 2.1.

Catch weights-at-age for 2011 were taken from the combined age–weight key (Table 6.8.4).

Stock weights-at-age for 2011 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, Scotland, Isle of Man 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. Moreover, the landings of Northern Ireland, Scotland and Isle of Man are aggregated as "UK" as for the moment no country code is available for those countries in InterCatch.

Discards

The available discard data indicate that discarding is not a major problem in the Irish Sea sole fishery. Discard rates (Table 6.8.6) in the various fisheries targeting sole are generally less than 8% in weight (and often even smaller than 2%). For 2011 discard rates from the beam trawl fleets are 4% for Belgium and 0.3% for Ireland. The discard rates for the Irish fleets were derived from the Irish length distributions and the combined length–weight relationship.

Length distributions of retained and discarded catches of sole for 2010 from samples taken onboard Belgian (beam trawl), UK (all gears except beam trawl) and Irish (beam trawl and otter trawl) vessels are given in Figure 6.8.1a–c. It should be noted that the number of sampled trips is low.

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) (1988–2011) and the UK(E&W) March beam trawl survey (UK(E&W)-BTS-Q1) (1993–1998) (Tables 6.8.7 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 2010 (28 kg/100 Km fished), whereas in 2011 it has increased slightly.

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. The lpue and effort values from Irish otter trawlers have been slightly revised for 2010.

Trends in lpue and effort are given in Table 6.8.7 and Figure 6.8.2–3.

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, whereas in 2011 it has increased a little. 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 four last years, it remained at around the lowest level in the time-series. The effort of the Irish beam trawlers show a slow decline since 2003 back to the levels of the mid-nineties. 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 now at the lowest level in 2011. The Irish otter trawlers have also shown a striking reduction in effort since 1999. However, in 2011 it has increased slightly.

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 there has been a small increase in lpue. However, in 2011 the UK beam trawl lpue has dropped to a remarkable low level in the time-series. Irish beam trawl lpue shows a diminishing trend over the whole time-series. The lpue of UK otter trawlers shows a decline over the whole time-series, whereas the lpue of Irish otter trawlers has reached a substantial higher level in 2011.

Historical stock development

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 provides information for years 1993 up to 1999 and therefore no longer contributes 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 the retrospective pattern showed a slight improvement. 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 in ICES files.

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 in ICES files.

Final update assessment

The model settings for the final assessment are summarized below.

Assmnt Year	:2010	:2011	: 2012
Assmnt Model	: XSA	:XSA	:XSA
Fleets	:	:	:
Bel Beam Trwl	: omitted	:omitted	:omitted
UK Trawl	: omitted	:omitted	:omitted
UK Sept BTS	:1988–2009 2-7	:1988–2010 2-7	:1988–2011 2-7
UK Mar BTS	:1993–1999 2-7	:omitted	:omitted
Time Ser. Wts	: linear 20 yrs	:no taper weighting	:no taper weighting
Power Model	: none	:none	:none
Q plateau	: 7	:4	:4
Shk se	:1.5	:1.5	:1.5
Shk age-yr	: 5 yrs 3 ages	: 5 yrs 3 ages	: 5 yrs 3 ages
Pop Shk se	: 0.3	: 0.3	: 0.3
Prior Wting	: none	: none	: none
Plusgroup	: 8	: 8	: 8
F_{bar}	: 4–7	: 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 2011 data to the time-series, together with the minor revisions for 2010 did not cause any additional anomalies compared to last year. The log catchability residual pattern showed no trends and only a minor year effect in 2010 for the UK(E&W)-BTS-Q3 fleet (negative residuals).

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 in either fishing mortality, SSB or recruitment estimation. The recruitment and SSB of 2010 is slightly underestimated, whereas the estimate for the 2010 fishing mortality appears to be almost identical.

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.

In last year's assessment, fishing mortality and SSB for 2010 were estimated to be 0.27 and 1218 t respectively; this year's estimates for 2010 are 0.27 and 1290 t, no revision for F and an upward revision of 6% for SSB. The estimated recruitment by XSA in 2010 (843 thousand fish) was revised upward by 48% in 2011 (1246 thousand fish).

Trends in fishing mortality and SSB are very similar. In the recent years, the recruitment estimates from the updated assessment are somewhat overestimated compared to the 2011WG assessment.

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 (275t) in 2010, followed by a small increase in 2011 (330 t). SSB has been at a higher level until the late eighties. Since then SSB has been fluctuating around B_{PA} and since 2005 it dropped below B_{lim}. In 2011 SSB declined to the lowest estimate of the time-series (1137 t). High fishing mortalities were observed during the late eighties until the mid nineties. Thereafter fishing mortality declined to a level fluctuating around F_{lim} and since 2007 to around F_{PA}. The decline in F is supported by a reduction in effort observed for the Belgian beam trawlers, UK(E&W) beam and otter trawlers and Irish otter trawlers. Since 2001 recruitment has been well below the mean (6188 thousand fish) and the 2011 recruitment (year class 2009) is estimated to be the lowest in the time-series (541 thousand fish).

6.8.3 Short-term projections

Estimating year-class abundance

The 2009 year class is now estimated at 541 thousand fish at age 2, which is 68% lower than the RCT3-value (1679 thousand fish) used in last year's forecast. The current estimate of the 2009 year class is solely coming from the UK(E&W)-BTS-Q3 and this survey has the lowest catch numbers in the time-series for age 2 in 2011 (35 fish).

The 2010 year class (age 2 in 2012) was estimated using RCT3 (input in Table 6.8.13, output in Table 6.8.14). The RCT3 estimate (2748 thousand fish) was used as it incorporates additional information of age 1 fish from the UK(E&W)-BTS-Q3 survey that is not included in the XSA.

The short-term GM (2002–2010, 2224 thousand fish) recruitment was assumed for the 2011 and subsequent year classes.

The working group estimates of year-class strength used for prediction can be summarised as follows:

Year Class	XSA	GM 70–08	GM 02–10	RCT3
2009	473	4568	-	-
2010	-	5120	-	2748
2011 & 2012	-	5120	2224	-

The input for the short-term catch predictions and sensitivity analysis is given in Table 6.8.15. Fishing mortality was calculated as the mean of 2009–2011. Catch and stock weights-at-age were also averages for the years 2009–2011. Population numbers at the start of 2012 for ages 3 and older were taken from the XSA output.

The short-term management option table is given in Table 6.8.16, a detailed output is presented in Table 6.8.17. A short-term forecast plot is shown in Figure 6.8.8.

Assuming *status quo* F, implies a catch of around 279 t in 2012 (the agreed TAC is 300 t) and 298 t in 2013. Assuming *status quo* F will result in a SSB of 1113 t in 2013 and 1225 t in 2014.

Assuming *status quo* F, the proportional contributions of recent year classes to the predicted landings and SSB are given in Table 6.8.17. Given the low stock size, predictions become more dependent on the assumed incoming recruitment. The RCT3 value and the assumed GM recruitment accounts for about 7% and 36% respectively of the landings in 2013 and about 5% and 50 % respectively of the 2014 SSB.

Results of a sensitivity analysis are presented in Figure 6.8.9 (probability profiles). The approximate 90% confidence intervals of the expected *status quo* yield in 2013 are 210 t and 425 t. There is 100% probability that at current fishing mortality SSB will fall below B_{lim} (2200 t in 2014).

6.8.4 MSY explorations

Investigations for possible F_{MSY} candidates for this stock were carried out at WGCSE 2010. ACOM adopted an F_{MSY} value of 0.16, based on stochastic simulations using a Ricker model (PLOTMSY program). $B_{trigger}$ was set to the B_{PA} value of 3100 t. No further work was carried out this year.

6.8.5 Biological reference points

Precautionary approach reference points

Biological reference points are:

$\mathbf{B}_{lim}$ = 2200 t	Basis: $\mathbf{B}_{lim}$=$\mathbf{B}_{loss}$	Changed in ACFM 2007 (from 2800 to 2200 t). The lowest observed spawning stock, fol lowed by an increase in SSB.
$\mathbf{B}_{pa}$ = 3100t	Basis: $\mathbf{B}_{pa}$ ~ $\mathbf{B}_{lim}$ * 1.4	Changed in ACFM 2007 (from 3800 to 3100 t).
$\mathbf{F}_{lim}$=0.4	Basis: $\mathbf{F}_{lim}$=$\mathbf{F}_{loss}$	Although poorly defined, based that there is evidence that fishing mortality in excess of 0.4 has led to a general stock decline and is only sustainable during periods of above average recruitment.
$\mathbf{F}_{pa}$=0.3	Basis: $\mathbf{F}_{pa}$ be set at 0.30	This F is considered to have a high probabil ity of avoiding $\mathbf{F}_{lim}$.
$\mathbf{F}_{max}$=0.60 (2012WG)		Using MFDP program and PLOTMSY pro gram $\mathbf{F}_{MSY}$=0.16 Using PLOTMSY program.

Yield per recruit analysis

Yield-per-recruit results, long-term yield and SSB, conditional on the present exploitation pattern and assuming *status quo* F in 2012, are given in Table 6.8.19 and Figure 6.8.8. Current fishing mortality (0.32) is well above F_{MSY} (0.16). F_{max} is calculated by this year's assessment to 0.60, but was considered to be not well defined given 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 major fleets fishing for Irish Sea sole are sampled. Sampling is considered to be at a reasonable level. Under the DCF there is an initiative to co-ordinate sampling across the three countries involved in the fishery. One of the problems in this assessment may well be the quality of historic catch-at-age data (before the introduction of the combined age distribution in 2000).

Landings

There is no reliable information on the accuracy of the landing statistics. Nevertheless, the total TAC uptake since 2005 was only in the range of 50–90%. In this context, misreporting is not considered to be a major problem in recent years.

Discards

The absence of discard data is unlikely to affect the quality of the assessment as information from recent years indicates that discarding ranges by weight vary between 0 and 8%.

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.

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. In the WG of 2007 the model settings were changed which had a considerable impact on the estimates of SSB and fishing mortality. Due to these major revisions, ACFM changed the biomass reference points at its meeting of 2007. In the next two update assessments (2008–2009) no major changes were apparent. In last year's assessment, the settings were changed according to the outcome of the WKFLAT 2011. This year's assessment is an update of the 2011 assessment.

6.8.8 Recommendations for next Benchmark

There are no recommendations for the next Benchmark at present (sole Irish Sea was Benchmarked in February 2011).

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 6.8.10).

SSB in 2011 is estimated to be well below B_{lim}. Recruitment at age 2 has been well below average since 2001, and in 2011 is estimated to be the lowest in the time-series. XSA indicates that fishing mortality has fallen over the last couple of years (as did effort for most fleets fishing for Irish Sea sole), and is now just above F_{pa}.

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.

Given the successive recent low recruitment, predictions become more dependent on the assumed incoming recruitment and 50% of the predicted SSB in 2014 is based on that assumption. The short-term GM (02–10) recruitment used for year classes 2011 and 2012 is a more realistic assumption given the consecutive low recruitments in recent years.

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 substrates 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.

Table 6.8.1. Sole in VIIa. 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
2010	217	<1	47	-	12	<1	.	n/a	277	0	277	402
2011	250	<1	48	-	31	<1	.	n/a	330	0	330	390

[1] 1989 onwards: N. Ireland included with England & Wales.

Table 6.8.2 - Sole in VIIa. 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**
2	111	171	99	92	22	17
3	666	356	354	414	336	225
4	645	348	191	333	233	401
5	202	243	196	146	177	176
6	112	86	157	132	65	97
7	150	41	56	127	72	54
+gp	377	298	210	162	158	122
TOTALNUM	2263	1543	1263	1406	1063	1092
TONSLAND	569	492	332	325	277	330
SOPCOF %	101	100	100	100	100	100

Table 6.8.3 - Sole in VIIa. Annual lenght distributions by country (2011)

Length (cm)	UK (England & Wales) All gears	Belgium All gears	Ireland All gears
20			
21			57
22	333	295	57
23	574	9596	517
24	4957	61810	1092
25	6504	101033	2299
26	8721	91393	3966
27	8041	99214	4138
28	8140	88438	6897
29	7635	66820	8736
30	6974	71811	10231
31	4386	56760	10805
32	4250	52603	10288
33	2745	38749	11035
34	3367	28667	8794
35	2868	29290	6552
36	2707	18468	6322
37	1838	15578	6954
38	1107	12242	5230
39	746	9193	3908
40	372	6037	2644
41	281	3115	2414
42	316	2740	1207
43	232	1812	920
44	64	928	690
45	168	957	575
46	21	411	345
47	63	358	287
48		212	172
49		62	0
50		56	0
51		44	0
52		26	57
53			
Total	77412	868722	117192

Table 6.8.4 - Sole in VIIa. 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**
2	0.179	0.172	0.148	0.141	0.166	0.215
3	0.194	0.224	0.189	0.195	0.193	0.213
4	0.224	0.296	0.248	0.229	0.266	0.276
5	0.297	0.36	0.279	0.279	0.285	0.362
6	0.293	0.38	0.291	0.277	0.321	0.413
7	0.318	0.429	0.386	0.261	0.308	0.368
+gp	0.3494	0.4785	0.3919	0.2767	0.3353	0.3635
SOPCOF %	1.0057	0.9989	0.9963	0.9993	1.0002	0.9992

Table 6.8.5 - Sole in VIIa. 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
2	0.152	0.156	0.134	0.129	0.158	0.167
3	0.177	0.2	0.181	0.17	0.165	0.188
4	0.213	0.24	0.236	0.208	0.228	0.231
5	0.276	0.284	0.288	0.263	0.256	0.31
6	0.289	0.336	0.324	0.278	0.3	0.343
7	0.315	0.354	0.383	0.276	0.292	0.344
+gp	0.348	0.419	0.424	0.319	0.305	0.340

Table 6.8.6. Sole in VIIa. Discard rates for the main fleets operational in the Irish Sea (Belgian, UK and Irish beam trawl, UK otter trawl, UK and Irish *Nephrops* trawl).

Country	Gear	Landings (t)	Ratio discarded /catch	years	Landings (t) 2010	Ratio discarded		
/catch 2010	Landings (t) 2011	Ratio discarded /catch 2011						
BEL	TBB	716	0.05	2007–2009	209	0.04	249.911	0.04
UK	TBB	284	0.08	2002,2005–2007	1.721	na	13.662	na
	OTB	61	0.05	2002–2009	1.071	0.00	2.866	0.02
	TWIN OTB	4	0.01	2003,2004,2007	0.014	na	0.050	na
	NEPH OTB	25	0.08	2003,2006–2009	3.329	0.05	5.201	0.00
	TWIN NEPH	6	0.02	2002,2003,2008	0.501	na	0.414	na
	other	na	na	Na	0.741	na	0.821	na
IRL	TBB	427	0.02	2003–2009	38.3	0.05	32.712	0.003
	NEPH OTB	16	0.56*	2003–2009	9.0	0.29*	15.697	0.00

*** It should be noted that the 56% discard rate for the year range 2003–2009 and 29% discard rate for 2010 of the Irish *Nephrops* fleet only accounts for respectively 0.4% and 3.3% of the total international landings.**

Table 6.8.7 - Sole in VIIa. Effort and LPUE series.

	LPUE							Effort				
	Belgium [1]	UK(E&W) [3]		UK [5]		Ireland		Belgium [2]	UK(E&W) [4]		Ireland [6]	
	beam	beam	otter	beam survey		otter	beam	beam	beam	otter	otter	beam
Year	Whole year	Whole year	Whole year	Sept	March	Whole year	Whole year	Whole year	Whole year	Whole year	Whole Year	Whole Year
1972	-	-	1.06	-	-	-	-	-	-	128.4	-	-
1973	-	-	1.06	-	-	-	-	-	-	147.6	-	-
1974	-	-	1.09	-	-	-	-	-	-	115.2	-	-
1975	21.4	-	1.39	-	-	-	-	28.4	-	130.7	-	-
1976	23.1	-	0.94	-	-	-	-	24.9	-	122.3	-	-
1977	19.8	-	0.80	-	-	-	-	22.1	-	101.9	-	-
1978	18.1	34.32	1.04	-	-	-	-	17.5	0.9	89.1	-	-
1979	33.4	32.01	1.43	-	-	-	-	20.4	1.7	89.9	-	-
1980	28.2	31.70	1.01	-	-	-	-	32.0	4.3	107.0	-	-
1981	22.2	21.32	0.75	-	-	-	-	36.5	6.4	107.1	-	-
1982	22.0	29.94	0.53	-	-	-	-	26.5	5.5	127.2	-	-
1983	13.9	37.31	0.57	-	-	-	-	28.7	2.8	88.1	-	-
1984	22.5	16.24	0.71	-	-	-	-	17.5	4.1	103.1	-	-
1985	20.6	17.34	0.56	-	-	-	-	27.0	7.4	102.9	-	-
1986	19.1	19.23	0.84	-	-	-	-	44.5	17.0	90.3	-	-
1987	17.7	14.82	0.77	-	-	-	-	51.6	22.0	130.6	-	-
1988	21.3	11.81	0.46	158.7	-	-	-	38.2	18.6	132.0	-	-
1989	21.9	9.17	0.70	145.9	-	-	-	42.2	25.3	139.5	-	-
1990	17.5	9.52	0.61	190.1	-	-	-	42.4	31.0	117.1	-	-
1991	18.7	10.43	1.12	170.5	-	-	-	17.1	25.8	107.3	-	-
1992	19.2	9.50	1.02	158.3	-	-	-	25.1	23.4	96.8	-	-
1993	20.0	7.60	0.54	97.3	104.7	-	-	23.9	21.5	78.9	-	-
1994	19.1	11.76	0.74	107.7	91.9		-	32.5	20.1	43.0	-	-
1995	18.1	14.96	0.95	89.5	79.3	0.38	12.69	28.6	20.9	43.1	80.3	8.64
1996	17.7	9.44	0.53	86.8	-	0.25	14.94	23.2	13.3	42.2	64.8	6.26
1997	16.6	10.49	0.73	151.2	63.3	0.23	8.53	30.7	10.8	39.9	92.2	9.86
1998	19.0	8.42	0.48	140.8	89.3	0.38	7.77	24.7	10.4	36.9	93.5	11.58
1999	19.5	9.94	0.60	107.3	-	0.29	9.22	22.7	11.0	22.9	110.3	14.67
2000	15.5	12.90	0.44	122.6	-	0.29	8.49	26.0	6.3	27.0	82.7	11.42
2001	15.0	11.72	0.15	96.9	-	0.38	7.86	36.8	12.5	32.8	77.5	13.13
2002	15.0	16.73	1.48	76.0	-	0.32	4.67	47.0	8.0	24.8	77.9	17.67
2003	14.8	13.20	0.15	88.6	-	0.34	4.20	43.6	14.0	23.9	73.9	18.70
2004	15.4	13.86	0.17	98.9	-	0.14	4.31	32.0	7.4	23.5	72.5	14.19
2005	16.7	9.14	0.19	48.9	-	0.16	4.70	37.5	11.4	16.7	68.3	14.67
2006	15.2	7.83	0.52	52.6	-	0.16	6.00	24.6	4.6	5.2	66.2	12.22
2007	13.7	16.38	0.42	53.0	-	0.37	6.37	19.4	3.2	4.4	74.1	14.18
2008	19.5	15.25	0.30	50.7	-	0.20	6.08	9.6	1.3	2.7	58.8	9.54
2009	20.2	18.88	0.22	45.8	-	0.28	4.53	11.1	0.5	1.5	42.8	7.59
2010	18.0	13.90	0.46	27.8	-	0.19	4.09	11.1	0.2	1.4	45.8	9.42
2011*	17.6	4.45	0.18	37.0	-	0.30	4.13	12.5	1.6	0.7	54.5	8.12

All LPUE values in Kg/hr except UK beam survey (Kg/100 km)

[1] Kg/000'hr

[2] 000' hours fishing

[3] Kg/000'hr fished (GRT corrected > 40' vessels)

[4] 000'hours fished (GRT corrected > 40' vessels)

[5] Kg/100km fished

[6] 000'hours

* Provisional

Table 6.8.8 - Sole in VIIa. 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	2011										
	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**	**64**	**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	**125**	**60**	**21**	**43**	**23**	**6**	2	9		
126.004		57	**150**	**68**	**39**	**23**	**30**	**12**	7	1		
126.004		25	**59**	**73**	**37**	**16**	**5**	**10**	9	3		
122.298		89	**35**	**62**	**68**	**35**	**12**	**4**	13	6		

Table 6.8.8 - Sole in VIIa. 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	2011												
	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

UK(E&W)-C0T UK Commercial Otter trawl

	1991	2011												
	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

Table 6.8.8 - Sole in VIIa. Continued (values in bold are used in the assessment)

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 VIIa. Diagnostics

Lowestoft VPA Version 3.1

2/05/2012 13:55

Extended Survivors Analysis

IRISH SEA SOLE 2012 WG COMBSEX PLUSGROUP.

CPUE data from file SOL7ATUN.TXT

Catch data for 42 years. 1970 to 2011. Ages 2 to 8.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
UK (E&W)-BTS-Q3	1988	2011	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 22 iterations

1

Regression weights

	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2	0.069	0.162	0.088	0.204	0.091	0.101	0.051	0.039	0.019	0.034
3	0.282	0.576	0.474	0.448	0.372	0.411	0.279	0.278	0.176	0.241
4	0.507	0.469	0.433	0.681	0.482	0.302	0.358	0.408	0.223	0.293
5	0.436	0.443	0.286	0.658	0.428	0.298	0.247	0.452	0.351	0.233
6	0.291	0.284	0.265	0.381	0.554	0.289	0.285	0.234	0.331	0.293
7	0.191	0.153	0.18	0.374	0.281	0.356	0.276	0.35	0.173	0.446

1

XSA population numbers (Thousands)

YEAR	AGE 2	3	4	5	6	7
2002	2.34E+03	3.97E+03	4.28E+03	2.19E+03	2.38E+03	1.53E+03
2003	3.07E+03	1.98E+03	2.71E+03	2.33E+03	1.28E+03	1.61E+03
2004	3.70E+03	2.37E+03	1.01E+03	1.53E+03	1.35E+03	8.73E+02
2005	3.05E+03	3.06E+03	1.33E+03	5.91E+02	1.04E+03	9.39E+02
2006	1.34E+03	2.25E+03	1.77E+03	6.10E+02	2.77E+02	6.43E+02
2007	1.87E+03	1.11E+03	1.41E+03	9.90E+02	3.60E+02	1.44E+02
2008	2.08E+03	1.53E+03	6.67E+02	9.40E+02	6.65E+02	2.44E+02
2009	2.52E+03	1.79E+03	1.05E+03	4.22E+02	6.64E+02	4.52E+02
2010	1.25E+03	2.19E+03	1.23E+03	6.29E+02	2.43E+02	4.76E+02
2011	5.41E+02	1.11E+03	1.66E+03	8.89E+02	4.01E+02	1.58E+02

Estimated population abundance at 1st Jan 2012

0.00E+00	4.73E+02	7.87E+02	1.12E+03	6.37E+02	2.71E+02

Taper weighted geometric mean of the VPA populations:

4.69E+03	4.34E+03	3.23E+03	1.97E+03	1.18E+03	6.95E+02

Standard error of the weighted Log(VPA populations) :

0.7726	0.7133	0.7489	0.769	0.7842	0.7798

1

Log catchability residuals.

Fleet : UK (E&W)-BTS-Q3

Age	1988	1989	1990	1991
2	0.05	0.04	0.41	0.51
3	0.59	0.37	-0.12	-0.3
4	0.08	0.15	-0.18	-0.85
5	-0.32	0.04	1.03	-0.56
6	-0.19	-0.2	0.32	-0.16
7	-0.11	0.08	0.16	-0.22

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	-0.05	-0.27	0.16	0.19	-0.27	0.08	0.42	-0.16	0	-0.04
3	0.47	-0.27	-0.05	0.29	-0.67	-0.07	0.08	-0.02	-0.22	-0.23
4	0.51	-0.03	-0.21	0.11	-0.19	-0.08	-0.7	0.36	0.36	-0.43
5	0.04	-0.28	0.08	-0.52	-0.18	0.07	-0.69	0.39	-0.1	-0.12
6	0.2	-0.04	0.54	0	-0.15	-0.14	-0.27	0.39	0.18	-0.08
7	-0.2	-0.13	0.17	-0.39	-0.18	0.24	0.18	0.17	-0.16	-0.03

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2	-0.89	0.15	0.04	-0.02	0.27	-0.21	-0.04	-0.08	-0.33	0.02
3	-0.23	-0.17	0.42	-0.37	0.11	0.24	0.05	-0.02	-0.23	0.37
4	0.13	0.29	-0.03	-0.15	-0.04	0.28	0.11	0.28	-0.08	0.32
5	-0.36	0.24	0.49	-0.01	0.76	0.3	0.39	0.7	-0.14	0.23
6	0.07	0.01	0.06	0.19	0.26	-0.01	0.14	0.34	-0.37	0
7	-0.04	-0.26	0.33	-0.05	-0.22	-0.05	-0.21	-0.1	-0.48	-0.04

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	-7.4621	-7.7872	-8.0032	-8.0032	-8.0032	-8.0032
S.E(Log q)	0.2879	0.3086	0.3284	0.434	0.2313	0.2108

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	0.88	1.699	7.54	0.9	24	0.24	-7.46
3	1.01	-0.053	7.79	0.78	24	0.32	-7.79
4	0.95	0.554	7.99	0.85	24	0.32	-8
5	1.15	-1.206	8.04	0.74	24	0.49	-7.94
6	1.03	-0.491	7.99	0.93	24	0.24	-7.96
7	0.98	0.329	8.04	0.95	24	0.2	-8.07
1							

Terminal year survivor and F summaries :

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2009

Fleet	Esti Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3□	485	0.3	0	0	1	0.96	0.033
F shrinkage mean	260	1.5				0.04	0.06

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
473	0.29	0.12	2	0.422	0.034

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2008

Fleet	Esti Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3□	793	0.217	0.35	1.61	2	0.974	0.239
F shrinkage mean	602	1.5				0.026	0.304

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
787	0.22	0.25	3	1.145	0.241

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2007

Fleet	Esti Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3□	1127	0.183	0.162	0.89	3	0.978	0.292
F shrinkage mean	894	1.5				0.022	0.355

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1121	0.18	0.13	4	0.729	0.293

Age 5 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2006

Fleet	Esti Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3	644	0.172	0.065	0.38	4	0.978	0.231
F shrinkage mean	391	1.5				0.022	0.356

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
637	0.17	0.07	5	0.391	0.233

1

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2005

Fleet	Esti Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3	272	0.163	0.075	0.46	5	0.978	0.292
F shrinkage mean	228	1.5				0.022	0.34

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
271	0.16	0.07	6	0.412	0.293

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2004

Fleet	Esti Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3	90	0.155	0.134	0.86	6	0.976	0.451
F shrinkage mean	163	1.5				0.024	0.274

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
91	0.16	0.13	7	0.812	0.446

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Table 6.8.10 - Sole in VIIa. Fishing mortality

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
2	0.0083	0.0117	0.0103	0.0299	0.0045	0.0421	0.0079	0.0148	0.0076	0.0129	0.0395
3	0.1196	0.148	0.0809	0.1436	0.0847	0.1575	0.0704	0.135	0.0743	0.1426	0.1333
4	0.2956	0.3988	0.3518	0.3621	0.3157	0.3032	0.4193	0.3255	0.2867	0.3645	0.3926
5	0.4445	0.5545	0.5058	0.4394	0.4722	0.4844	0.4816	0.4072	0.4036	0.6323	0.5666
6	0.4292	0.3671	0.493	0.4873	0.5435	0.3973	0.3793	0.3752	0.3816	0.4261	0.9482
7	0.3909	0.4416	0.4517	0.431	0.4453	0.3962	0.4281	0.3704	0.3583	0.4759	0.6385
+gp	0.3909	0.4416	0.4517	0.431	0.4453	0.3962	0.4281	0.3704	0.3583	0.4759	0.6385
FBAR 4-7	0.39	0.4405	0.4506	0.43	0.4442	0.3953	0.4271	0.3696	0.3575	0.4747	0.6365

Age/Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
2	0.0165	0.0034	0.007	0.0449	0.0099	0.0062	0.0585	0.0095	0.0435	0.1106	0.1138
3	0.1486	0.095	0.0809	0.1801	0.1332	0.2725	0.1772	0.1702	0.295	0.3937	0.3438
4	0.3283	0.4762	0.3823	0.2416	0.3587	0.4169	0.5551	0.3625	0.4429	0.6635	0.4755
5	0.5102	0.4067	0.5306	0.3776	0.3182	0.5481	0.7447	0.5447	0.5178	0.6448	0.3807
6	0.602	0.436	0.3908	0.4309	0.3252	0.3337	1.2326	0.6984	0.5951	0.5746	0.4752
7	0.4818	0.4411	0.436	0.351	0.335	0.4343	0.8483	1.0383	0.6361	0.6009	0.5692
+gp	0.4818	0.4411	0.436	0.351	0.335	0.4343	0.8483	1.0383	0.6361	0.6009	0.5692
FBAR 4-7	0.4806	0.44	0.4349	0.3503	0.3343	0.4332	0.8452	0.661	0.548	0.621	0.4752

Age/Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	0.0791	0.014	0.0243	0.0713	0.0253	0.1011	0.0248	0.0605	0.0268	0.056	0.0687
3	0.2824	0.1462	0.29	0.2293	0.3427	0.4102	0.2976	0.1958	0.2332	0.2775	0.2819
4	0.3971	0.3446	0.4193	0.5108	0.4584	0.6098	0.4562	0.327	0.2272	0.3049	0.5071
5	0.5884	0.3977	0.454	0.5057	0.475	0.4847	0.6959	0.5228	0.2284	0.2515	0.4365
6	0.392	0.5103	0.4787	0.5216	0.5524	0.462	0.365	0.6916	0.4834	0.276	0.2911
7	0.6238	0.811	0.4942	0.3686	0.4802	0.6713	0.3621	0.236	0.7486	0.4563	0.191
+gp	0.6238	0.811	0.4942	0.3686	0.4802	0.6713	0.3621	0.236	0.7486	0.4563	0.191
FBAR 4-7	0.5004	0.5159	0.4615	0.4767	0.4915	0.5569	0.4698	0.4444	0.4219	0.3222	0.3564

Age/Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	FBAR 08-10
2	0.1615	0.0876	0.204	0.0908	0.1012	0.0512	0.0392	0.0187	0.0336	0.0305
3	0.5756	0.4743	0.4476	0.3722	0.4106	0.2792	0.2783	0.176	0.2405	0.2316
4	0.4694	0.4335	0.6812	0.4822	0.3016	0.3582	0.4077	0.2226	0.2928	0.3077
5	0.4434	0.2864	0.6582	0.4279	0.2984	0.2473	0.4524	0.3506	0.2334	0.3455
6	0.2843	0.2653	0.3814	0.554	0.2894	0.2854	0.2343	0.3306	0.2934	0.2861
7	0.1525	0.1802	0.3744	0.2812	0.3559	0.2765	0.35	0.1733	0.4459	0.323
+gp	0.1525	0.1802	0.3744	0.2812	0.3559	0.2765	0.35	0.1733	0.4459	
FBAR 4-7	0.3374	0.2913	0.5238	0.4363	0.3113	0.2919	0.3611	0.2693	0.3164	

Table 6.8.11 - Sole in VIIa. 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	13136	5872	6681	3857	15776	9044	8858	5076	4509	2474
3	8349	3316	9102	2853	11536	5289	5796	3463	14064	8122	7912	4415	4014
4	4145	6703	2587	7596	2237	9591	4089	4888	2738	11814	6372	6266	3443
5	1368	2791	4071	1647	4785	1476	6408	2433	3194	1860	7425	3893	4083
6	4389	794	1450	2221	960	2700	823	3582	1465	1930	894	3812	2115
7	939	2586	498	802	1235	505	1642	509	2227	905	1141	313	1889
+gp	8212	5534	4321	3418	2829	3221	2222	2193	2042	1714	2536	2368	1165
TOTAL	31098	31902	25215	31673	29453	29463	24838	32844	34774	35203	31356	25578	19184

Age/Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	5579	15603	16411	24106	3495	3540	4419	5665	12872	5020	6282	5345	2017
3	2231	5013	13499	14702	21678	2983	3173	3828	4589	10395	4197	5605	4721
4	3303	1862	3788	10692	10130	16430	2277	2137	2336	2944	7091	3281	3795
5	1935	2039	1323	2394	6376	5261	10346	1323	996	1314	1791	4546	1952
6	2460	1030	1265	871	1252	2740	2761	5578	628	616	660	1089	2613
7	1238	1506	606	827	564	330	1233	1378	2841	353	377	359	610
+gp	2101	1971	2721	2520	1474	832	566	1079	1106	2093	1289	1406	1189
TOTAL	18845	29024	39612	56112	44971	32117	24775	20987	25369	22735	21686	21631	16897

Age/Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
2	2525	8628	7160	5388	7081	4637	2343	3073	3697	3053	1345	1868	2084
3	1699	2228	7057	6320	4589	6238	3967	1979	2366	3065	2253	1111	1528
4	3396	1092	1337	4741	4702	3288	4276	2708	1007	1332	1772	1405	667
5	2060	1943	537	767	3094	3389	2194	2330	1532	591	610	990	940
6	1065	1159	1083	242	411	2228	2385	1283	1353	1041	277	360	665
7	1403	555	661	680	110	230	1529	1613	873	939	643	144	244
+gp	952	1135	1459	1157	511	777	1303	2552	1133	1234	1612	1043	912
TOTAL	13102	16740	19293	19296	20498	20787	17998	15539	11962	11256	8513	6921	7039

Age/Year	2009	2010	2011	2012	GMST 70-**	AMST 70-**
2	2515	1246	541	0	5120	6452
3	1792	2189	1106	473	4568	5776
4	1045	1227	1661	787	3368	4383
5	422	629	889	1121	2072	2711
6	664	243	401	637	1261	1623
7	452	476	158	271	728	937
+gp	575	1042	355	297		
TOTAL	7466	7051	5111	3586		

Table 6.8.12 - Sole in VIIa. Summary

	RECRUITS Age 2	TOTALBIO	TOTSPBIO	LANDING	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	5011	1450	0.2894	0.4506
1973	13136	6554	5123	1428	0.2787	0.43
1974	5872	6190	5069	1307	0.2579	0.4442
1975	6681	6230	5360	1441	0.2688	0.3953
1976	3857	5503	4890	1463	0.2992	0.4271
1977	15776	5511	4491	1147	0.2554	0.3696
1978	9044	6246	5093	1106	0.2172	0.3575
1979	8858	6890	5686	1614	0.2838	0.4747
1980	5076	6433	5516	1941	0.3519	0.6365
1981	4509	5916	5172	1667	0.3223	0.4806
1982	2474	4756	4339	1338	0.3083	0.44
1983	5579	4933	4109	1169	0.2845	0.4349
1984	15603	6829	4628	1058	0.2286	0.3503
1985	16411	7920	5681	1146	0.2017	0.3343
1986	24106	9624	7025	1995	0.284	0.4332
1987	3495	8675	7263	2808	0.3866	0.8452
1988	3540	6119	5635	1999	0.3548	0.661
1989	4419	5322	4767	1833	0.3845	0.548
1990	5665	4443	3771	1583	0.4198	0.621
1991	12872	4632	3323	1212	0.3648	0.4752
1992	5020	4582	3561	1259	0.3536	0.5004
1993	6282	3978	3339	1023	0.3064	0.5159
1994	5345	5145	4197	1374	0.3274	0.4615
1995	2017	4125	3677	1266	0.3443	0.4767
1996	2525	3203	2830	1002	0.3541	0.4915
1997	8628	3574	2605	1003	0.3851	0.5569
1998	7160	4448	3178	911	0.2867	0.4698
1999	5388	4519	3483	863	0.2478	0.4444
2000	7081	4080	3274	818	0.2499	0.4219
2001	4637	4502	3740	1053	0.2816	0.3222
2002	2343	4233	3785	1090	0.288	0.3564
2003	3073	3832	3429	1014	0.2957	0.3374
2004	3697	2912	2424	709	0.2925	0.2913
2005	3053	2634	2183	855	0.3917	0.5238
2006	1345	1994	1736	569	0.3277	0.4363
2007	1868	1741	1480	492	0.3324	0.3113
2008	2084	1680	1416	332	0.2344	0.2919
2009	2515	1450	1152	325	0.2821	0.3611
2010	1246	1528	1290	277	0.2148	0.2693
2011	541	1270	1137	330	0.2903	0.3164
2012	2748 [1]	1356 [2]	1063 [2]			0.3156 [3]
Arith. Mean	6188	4867	4012	1213	0.3026	0.4428
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

[1] RCT3

[2] Forecast

[3] Mean F 2009-2011

Table 6.8.13 – Sole in VIIa. 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	
1971	13136	-11	-11
1972	5872	-11	-11
1973	6681	-11	-11
1974	3857	-11	-11
1975	15776	-11	-11
1976	9044	-11	-11
1977	8858	-11	-11
1978	5076	-11	-11
1979	4509	-11	-11
1980	2474	-11	-11
1981	5579	-11	-11
1982	15603	-11	-11
1983	16411	-11	-11
1984	24106	-11	-11
1985	3495	-11	-11
1986	3540	196	-11
1987	4419	304	118
1988	5665	534	218
1989	12872	1286	1712
1990	5020	309	148
1991	6282	330	220
1992	5345	408	83
1993	2017	154	60
1994	2525	126	246
1995	8628	577	886
1996	7160	716	1158
1997	5388	293	539
1998	7081	464	385
1999	4637	284	354
2000	2343	61	91
2001	3073	210	205
2002	3697	240	242
2003	3053	165	406
2004	1345	110	53
2005	1868	93	107
2006	2084	125	125
2007	2515	150	126
2008	-11	59	57
2009	-11	35	25
2010	-11	-11	89

S2
S1

Table 6.8.14 - Sole in VIIa.

Analysis by RCT3 ver3.1 of data from file :

INPUT.txt

Irish Sea sole recruits - age 2

Data for 2 surveys over 40 years : 1971 - 2010

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .00
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2009

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
S2	.83	3.68	.22	.871	22	3.58	6.66	.276	.718
S1	.79	4.00	.48	.610	21	3.26	6.57	.572	.167
					VPA Mean =		8.54	.686	.116

Yearclass = 2010

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
S2									
S1	.79	4.00	.48	.610	21	4.50	7.56	.523	.632
					VPA Mean =		8.54	.686	.368

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2009	957	6.86	.23	.43	3.40		
2010	**2748**	**7.92**	**.42**	**.48**	**1.31**		

Table 6.8.15 - Sole in VIIa
Input for catch forecast and Fmsy analysis

Input: F mean 09-11 not rescaled to F2011
Catch and stock weights are mean 09-11
Recruits age 2 in 2013 and 14 GM (02-10)

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N2	2748	0.48	WS2	0.151	0.13
N3	473	0.29	WS3	0.174	0.07
N4	787	0.25	WS4	0.222	0.06
N5	1121	0.18	WS5	0.276	0.11
N6	637	0.17	WS6	0.307	0.11
N7	271	0.16	WS7	0.304	0.12
N8	297	0.16	WS8	0.321	0.06
H.cons selectivity			Weight in the HC catch		
sH2	0.031	0.35	WH2	0.174	0.22
sH3	0.232	0.22	WH3	0.200	0.05
sH4	0.308	0.30	WH4	0.257	0.10
sH5	0.346	0.32	WH5	0.309	0.15
sH6	0.286	0.17	WH6	0.337	0.21
sH7	0.323	0.43	WH7	0.312	0.17
sH8	0.323	0.43	WH8	0.325	0.14
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		
HF12	1	0.1	K12	1	0.1
HF13	1	0.1	K13	1	0.1
HF14	1	0.1	K14	1	0.1
Recruitment in 2013 and 2014					
R13	2224	0.35			
R14	2224	0.35			

Table 6.8.16 Sole in VIIa - Management option table

MFDP version 1a
Run: S7A
IRISH SEA SOLE,2012 WG
Time and date: 09:23 11/05/2012
Fbar age range: 4-7

2012 Biomass	SSB	FMult	FBar	Landings
1356	1063	1.0000	0.3156	279

2013 Biomass	SSB	FMult	FBar	Landings	2014 Biomass	SSB
1449	1113	0.0000	0.0000	0	1834	1508
.	1113	0.1000	0.0316	34	1802	1476
.	1113	0.2000	0.0631	66	1770	1445
.	1113	0.3000	0.0947	98	1739	1414
.	1113	0.4000	0.1262	129	1709	1385
.	1113	0.5000	0.1578	159	1680	1356
.	1113	0.6000	0.1894	189	1651	1329
.	1113	0.7000	0.2209	217	1624	1302
.	1113	0.8000	0.2525	245	1597	1275
.	1113	0.9000	0.2840	272	1570	1250
.	1113	1.0000	0.3156	298	1545	1225
.	1113	1.1000	0.3471	324	1520	1201
.	1113	1.2000	0.3787	349	1496	1177
.	1113	1.3000	0.4103	373	1472	1154
.	1113	1.4000	0.4418	397	1450	1132
.	1113	1.5000	0.4734	420	1427	1110
.	1113	1.6000	0.5049	442	1406	1089
.	1113	1.7000	0.5365	464	1385	1069
.	1113	1.8000	0.5681	485	1364	1049
.	1113	1.9000	0.5996	506	1344	1029
.	1113	2.0000	0.6312	526	1325	1010

Input units are thousands and kg - output in tonnes

Fmult corresponding to Fpa = 0.951

.	1113	0.951	0.3001	286	1557	1237

Fmult corresponding to FMSY = 0.507

.	1113	0.507	0.16	161	1678	1354

Fmult corresponding to FHCR-MSY = 0.184

.	1113	0.181	0.0571	60	1776	1451

Fmult corresponding to FHCR-MSY transition = 0.452

.	1113	0.45	0.142	144	1694	1371

Bpa = 3100 t

Table 6.8.17 Sole in VIIa. Detailed results

MFDP version 1a
Run: S7A
Time and date: 09:23 11/05/2012
Fbar age range: 4-7

Year: 2012		F multiplier: 1		Fbar:	0.3156				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
2	0.0305	79	14	2748	416	1044	158	1044	158
3	0.2316	93	19	473	82	336	59	336	59
4	0.3077	199	51	787	175	763	170	763	170
5	0.3455	313	96	1121	310	1099	304	1099	304
6	0.2861	151	51	637	196	637	196	637	196
7	0.3231	71	22	271	82	271	82	271	82
8	0.3231	78	25	297	95	297	95	297	95
Total		984	279	6334	1356	4447	1063	4447	1063

Year: 2013		F multiplier: 1		Fbar:	0.3156				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
2	0.0305	64	11	2224	337	845	128	845	128
3	0.2316	475	95	2412	420	1712	299	1712	299
4	0.3077	86	22	340	75	329	73	329	73
5	0.3455	146	45	523	145	513	142	513	142
6	0.2861	170	57	718	220	718	220	718	220
7	0.3231	114	36	433	132	433	132	433	132
8	0.3231	98	32	372	120	372	120	372	120
Total		1153	298	7022	1449	4923	1113	4923	1113

Year: 2014		F multiplier: 1		Fbar:	0.3156				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
2	0.0305	64	11	2224	337	845	128	845	128
3	0.2316	385	77	1952	340	1386	242	1386	242
4	0.3077	437	112	1731	385	1679	373	1679	373
5	0.3455	63	19	226	62	221	61	221	61
6	0.2861	80	27	335	103	335	103	335	103
7	0.3231	129	40	488	148	488	148	488	148
8	0.3231	139	45	527	169	527	169	527	169
Total		1296	332	7484	1545	5482	1225	5482	1225

Input units are thousands and kg - output in tonnes

Table 6.8.18 Sole VIIa
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	2008	2009	2010	2011	2012
Stock No. (thousands) of 2 year-olds	1246	541	2748	2224	2224
Source	XSA	XSA	RCT3	GM02-10	GM02-10
Status Quo F:					
% in 2012 landings	34.5	18.3	6.8	5.0	-
% in 2013 landings	19.1	15.1	7.4	31.9	3.7
% in 2012 SSB	28.6	16.0	5.5	14.8	-
% in 2013 SSB	19.7	12.7	6.6	26.8	11.5
% in 2014 SSB	12.1	8.4	5.0	30.5	19.8

GM : geometric mean recruitment

Sole VIIa : Year-class % contribution to

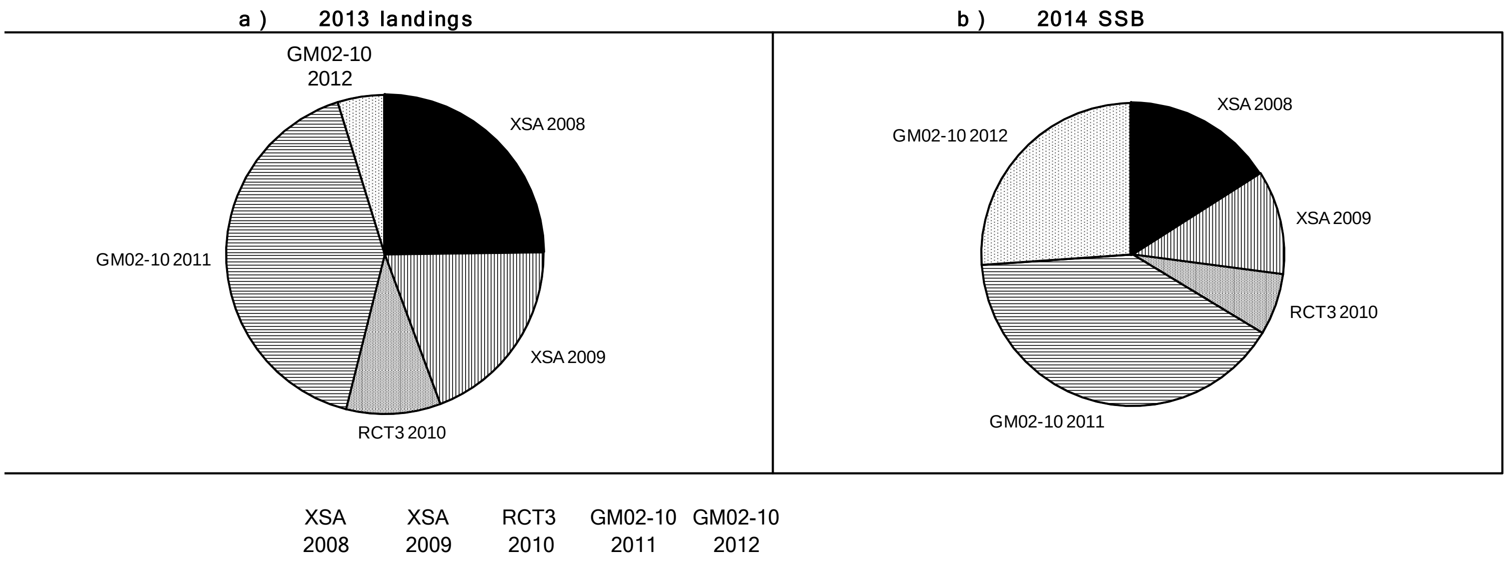


Table 6.8.19 - Sole in VIIa Yield per recruit summary table

MFYPR version 2a
Run: S7A
Time and date: 09:55 11/05/2012
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	10.5083	2.9394	9.5866	2.7902	9.5866	2.7902
0.1000	0.0316	0.2159	0.0654	8.3513	2.2525	7.4318	2.1039	7.4318	2.1039
0.2000	0.0631	0.3475	0.1036	7.0381	1.8365	6.1208	1.6884	6.1208	1.6884
0.3000	0.0947	0.4362	0.1281	6.1537	1.5580	5.2384	1.4103	5.2384	1.4103
0.4000	0.1262	0.5001	0.1447	5.5169	1.3587	4.6037	1.2115	4.6037	1.2115
0.5000	0.1578	0.5484	0.1565	5.0361	1.2093	4.1250	1.0625	4.1250	1.0625
0.6000	0.1894	0.5862	0.1651	4.6600	1.0932	3.7508	0.9469	3.7508	0.9469
0.7000	0.2209	0.6166	0.1715	4.3576	1.0006	3.4503	0.8547	3.4503	0.8547
0.8000	0.2525	0.6417	0.1763	4.1089	0.9250	3.2035	0.7796	3.2035	0.7796
0.9000	0.2840	0.6627	0.1800	3.9008	0.8623	2.9972	0.7172	2.9972	0.7172
1.0000	0.3156	0.6806	0.1828	3.7239	0.8094	2.8221	0.6647	2.8221	0.6647
1.1000	0.3471	0.6960	0.1849	3.5717	0.7642	2.6716	0.6199	2.6716	0.6199
1.2000	0.3787	0.7095	0.1865	3.4392	0.7252	2.5409	0.5812	2.5409	0.5812
1.3000	0.4103	0.7213	0.1877	3.3229	0.6913	2.4262	0.5476	2.4262	0.5476
1.4000	0.4418	0.7318	0.1886	3.2199	0.6614	2.3248	0.5181	2.3248	0.5181
1.5000	0.4734	0.7412	0.1892	3.1280	0.6350	2.2344	0.4921	2.2344	0.4921
1.6000	0.5049	0.7496	0.1897	3.0454	0.6115	2.1534	0.4689	2.1534	0.4689
1.7000	0.5365	0.7572	0.1900	2.9709	0.5904	2.0804	0.4481	2.0804	0.4481
1.8000	0.5681	0.7642	0.1901	2.9032	0.5714	2.0142	0.4294	2.0142	0.4294
1.9000	0.5996	0.7705	0.1902	2.8414	0.5542	1.9539	0.4125	1.9539	0.4125
2.0000	0.6312	0.7764	0.1901	2.7849	0.5386	1.8987	0.3972	1.8987	0.3972

Reference poin	F multiplier	Absolute F
Fbar(4-7)	1.0000	0.3156
FMax	1.9005	0.5998
F0.1	0.5416	0.1709
F35%SPR	0.572	0.1805

Figure 6.8.1a - Sole VIIa - BE Length distributions of discarded and retained fish from discard sampling studies

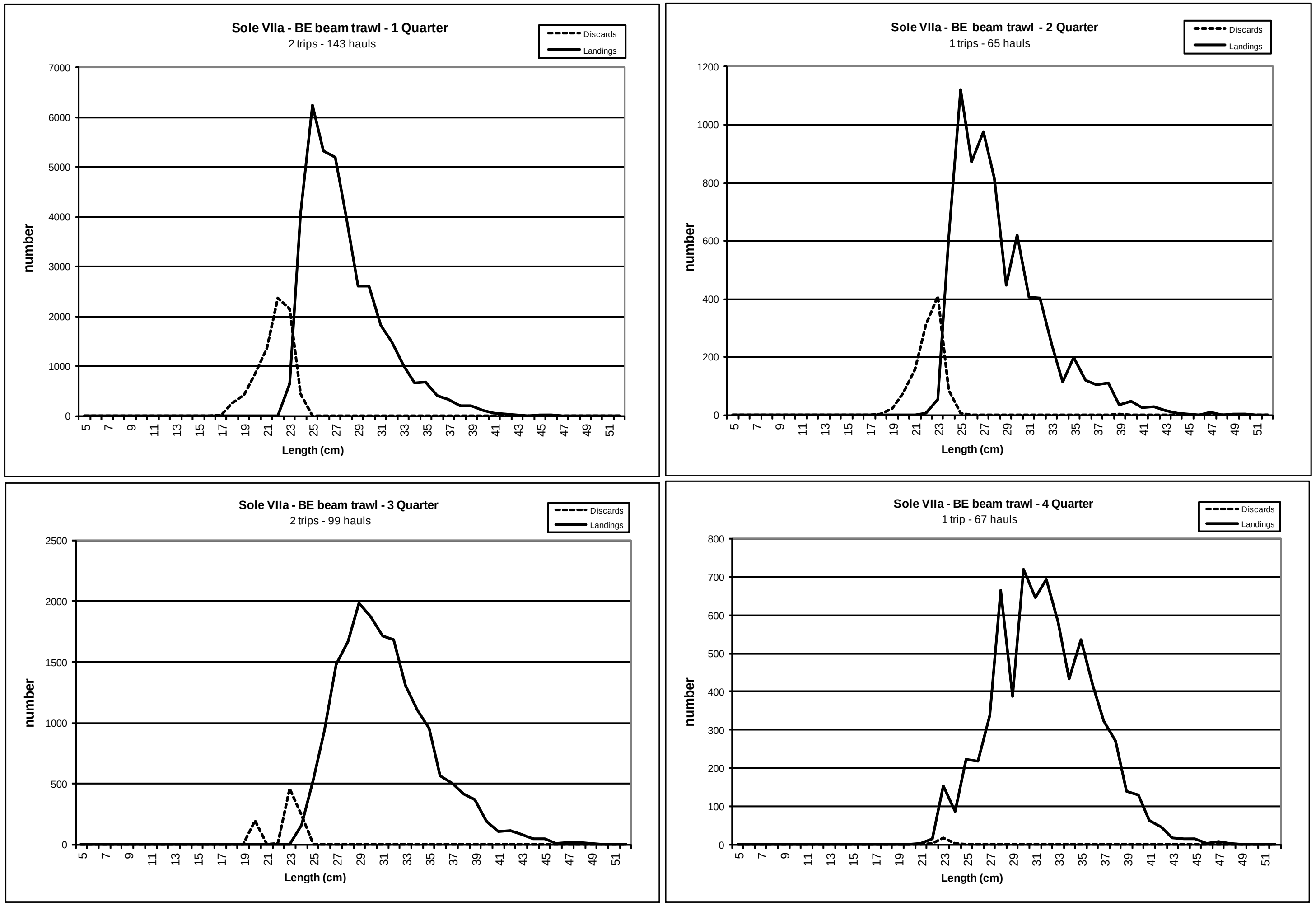


Figure 6.8.1b - Sole VIIa - UK Length distributions of discarded and retained fish from discard sampling studies

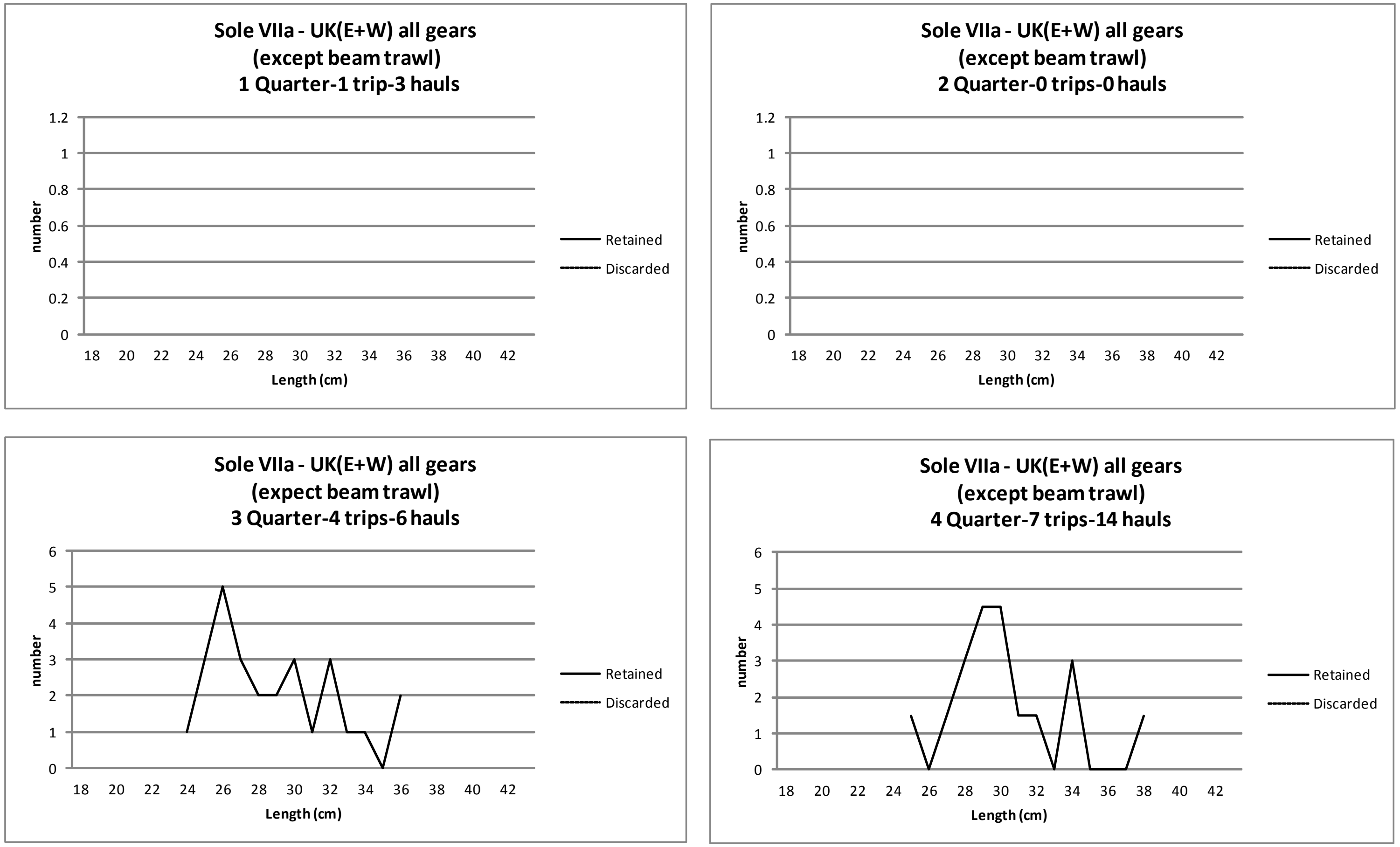


Figure 6.8.1c - Sole VIIa - IRL Length distributions of discarded and retained fish from discard sampling studies

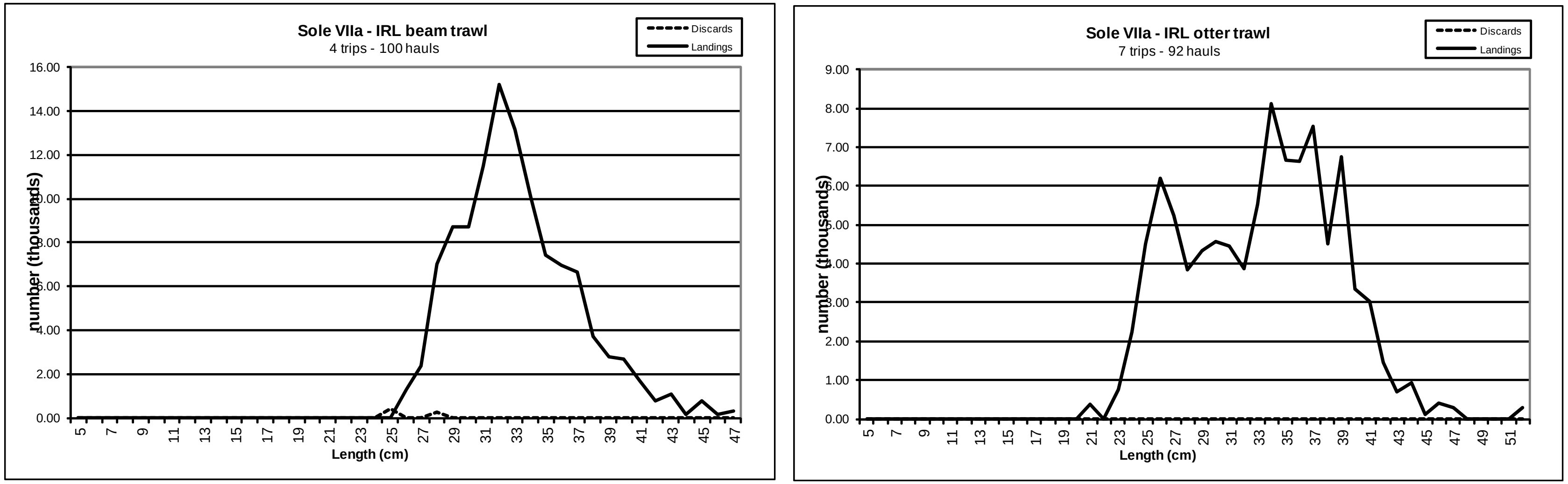


Figure 6.8.2a Sole in VIIa. Effort series

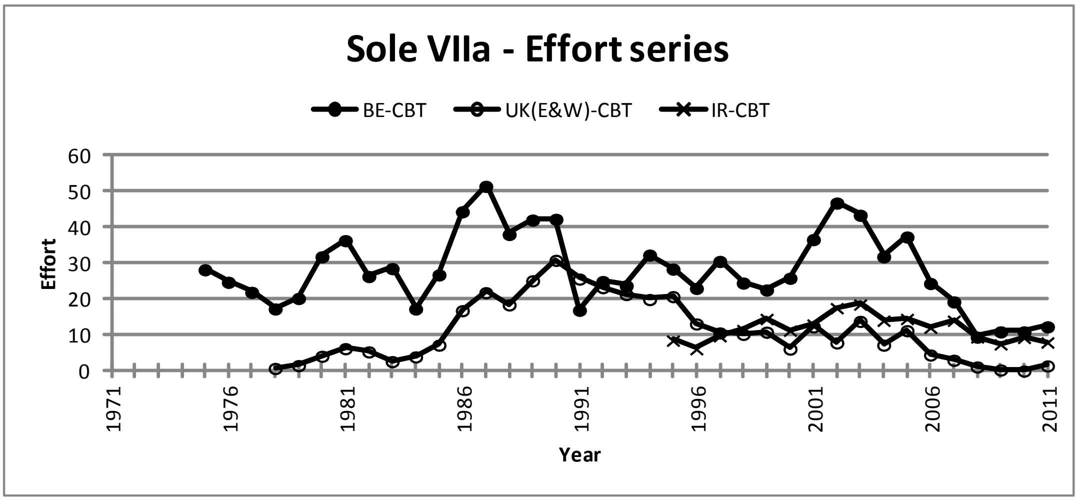


Figure 6.8.2b Sole in VIIa. Relative effort series

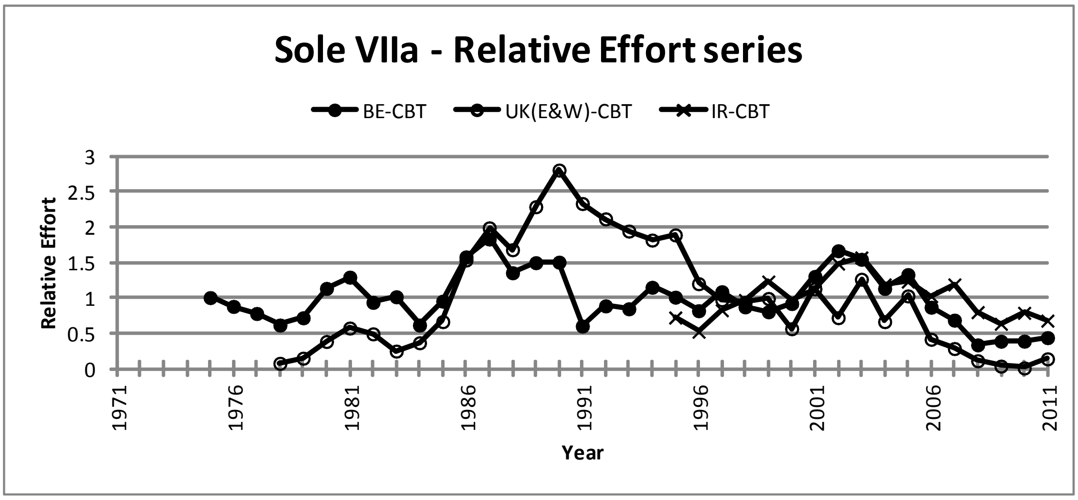


Figure 6.8.2c Sole in VIIa. Relative LPUE series

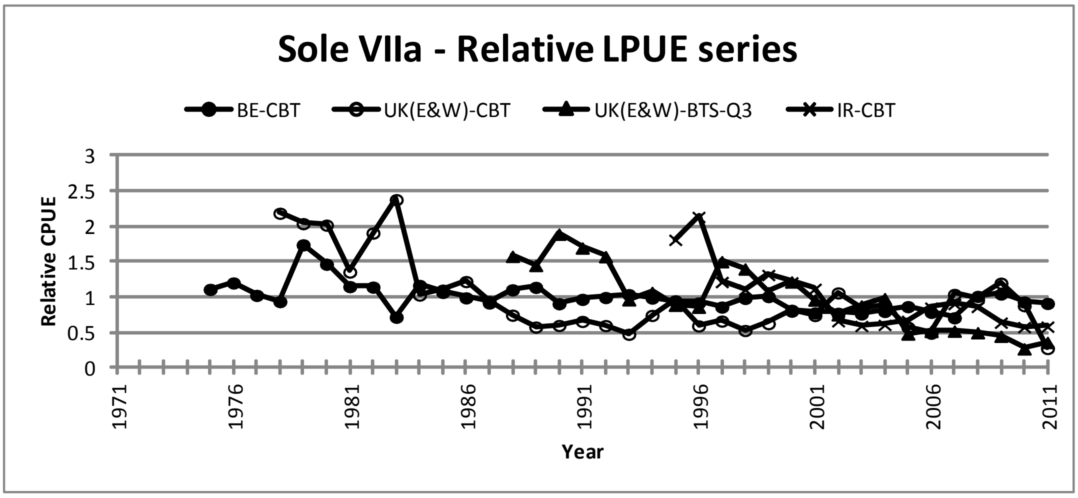


Figure 6.8.3a Sole in VIIa. Effort series

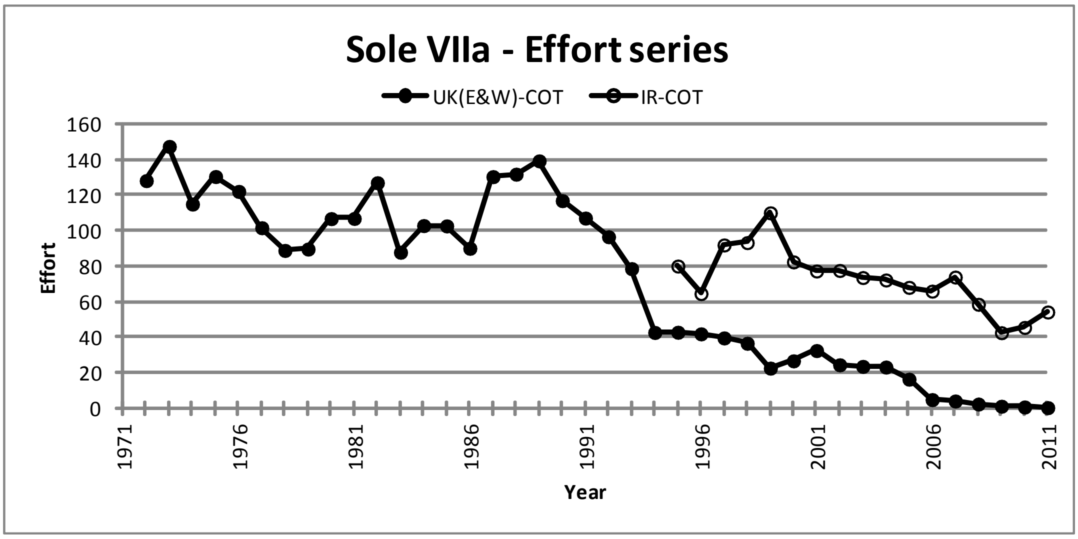


Figure 6.8.3b Sole in VIIa. Relative effort series

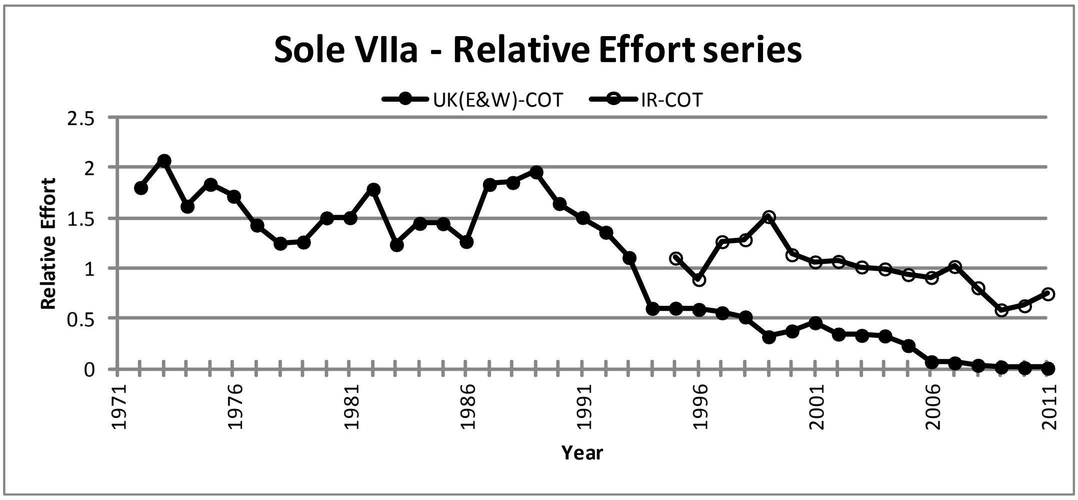


Figure 6.8.3c Sole in VIIa. Relative LPUE series

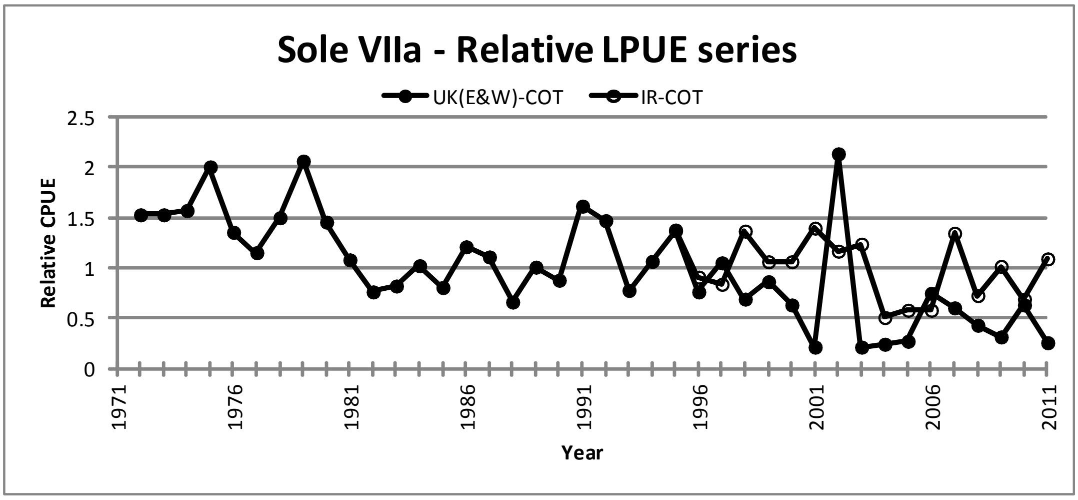
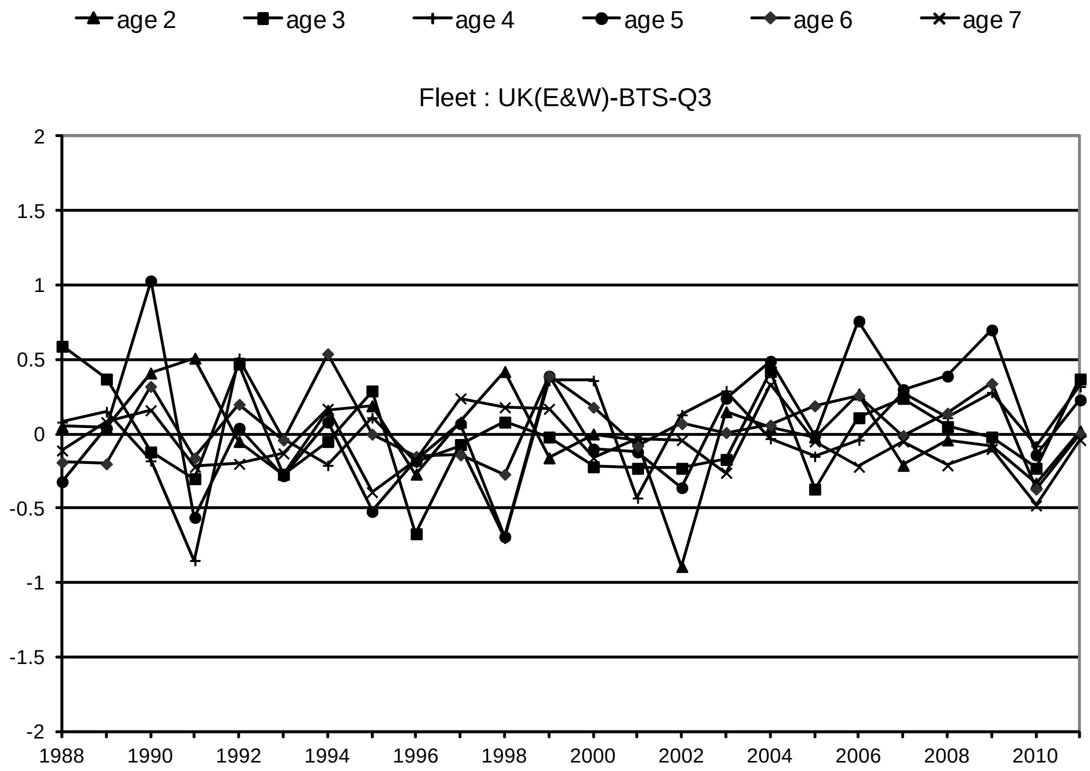


Figure 6.8.4 - VIIa SOLE LOG CATCHABILITY RESIDUAL PLOTS - Final XSA



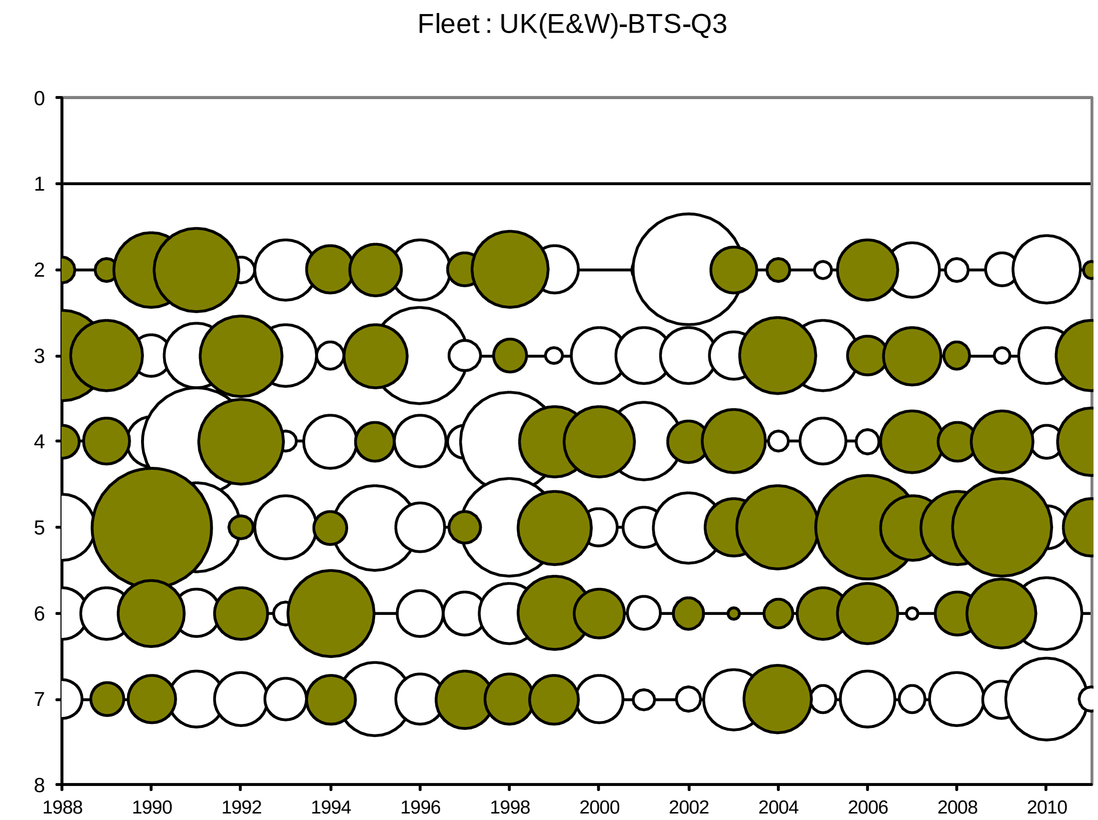


Figure 6.8.5 Sole in VIIa. Summary plots

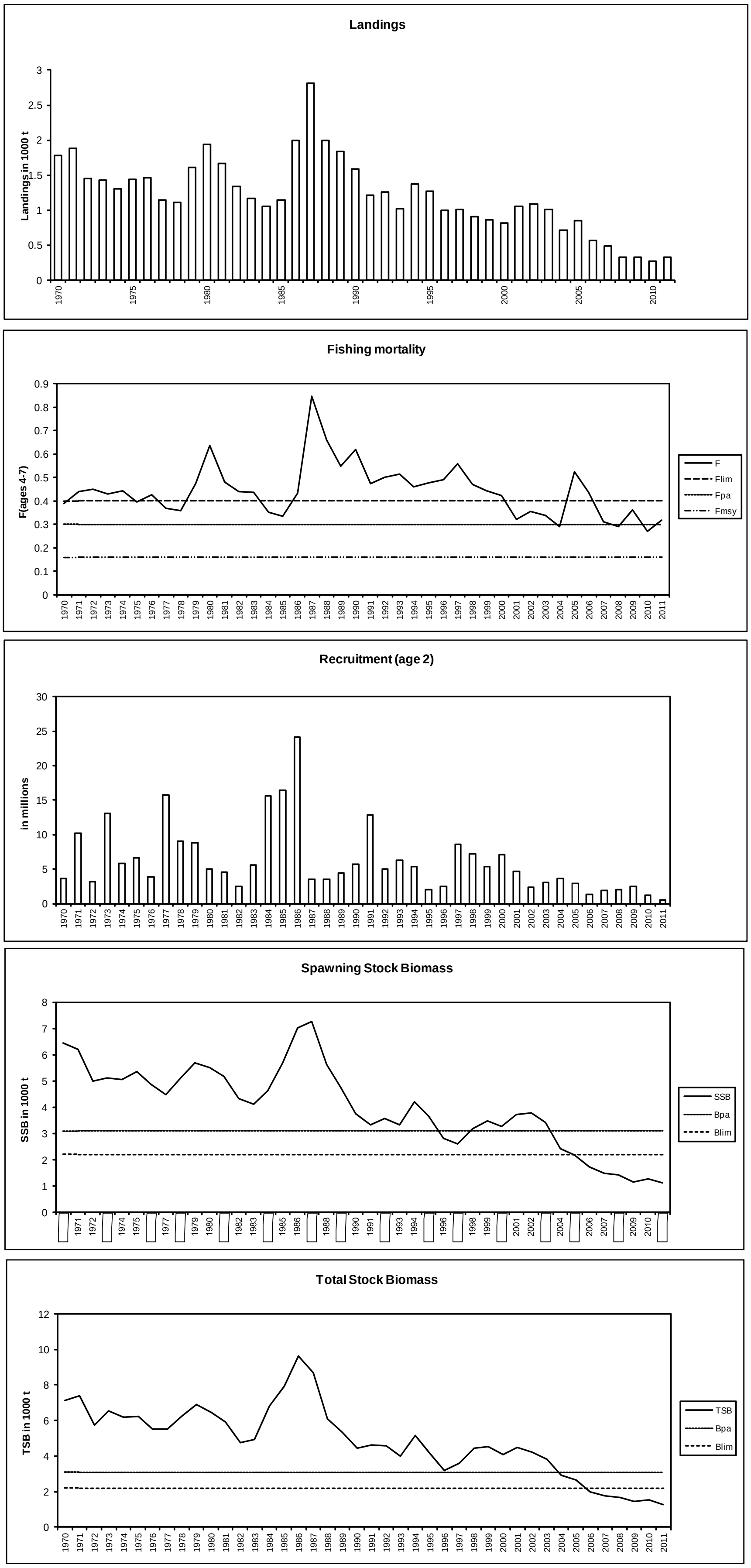


Figure 6.8.6 - Sole VIIa retrospective XSA analysys (shinkage SE=1.5)

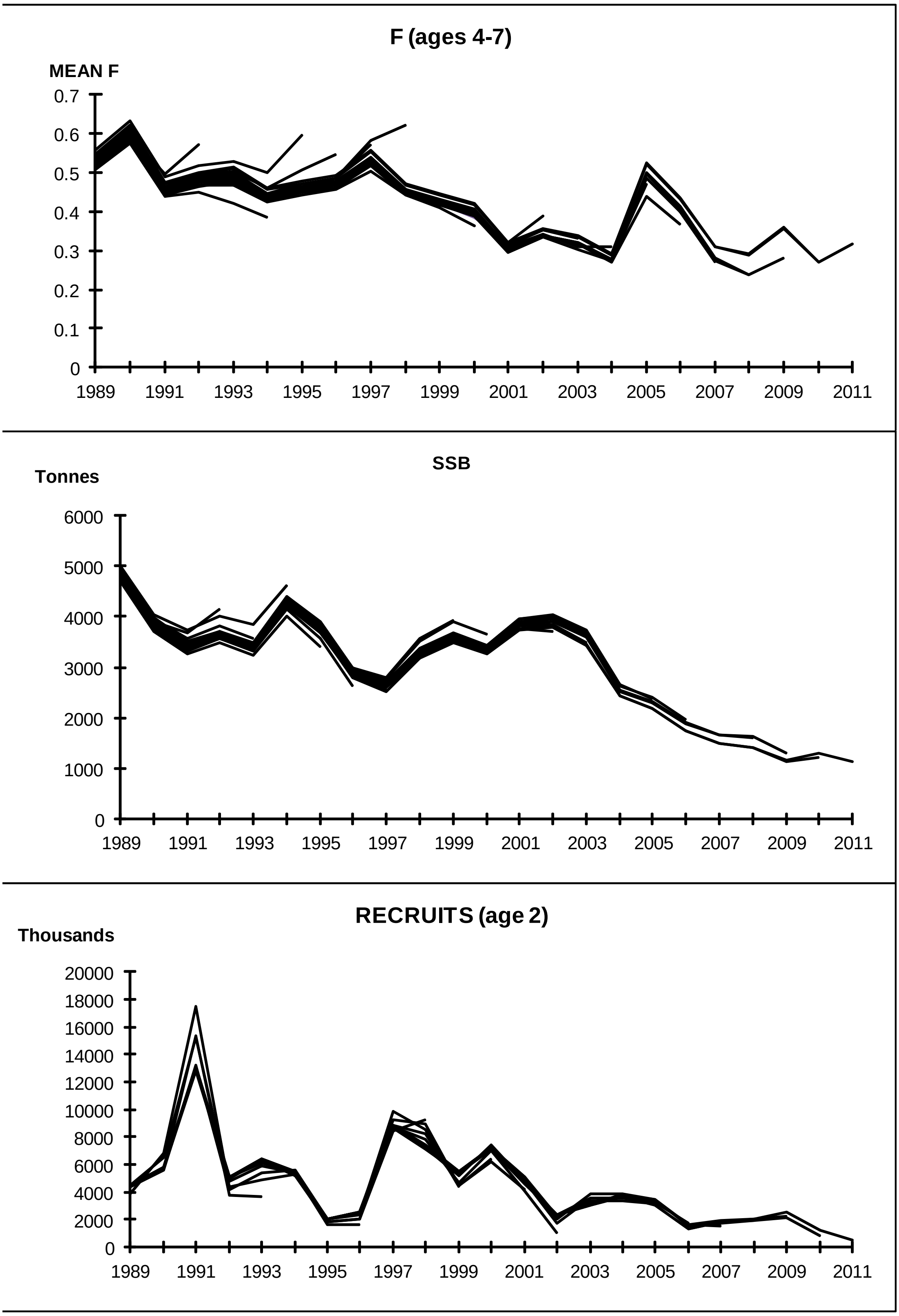


Figure 6.8.7 - Sole VIIa comparison with last year's assessment

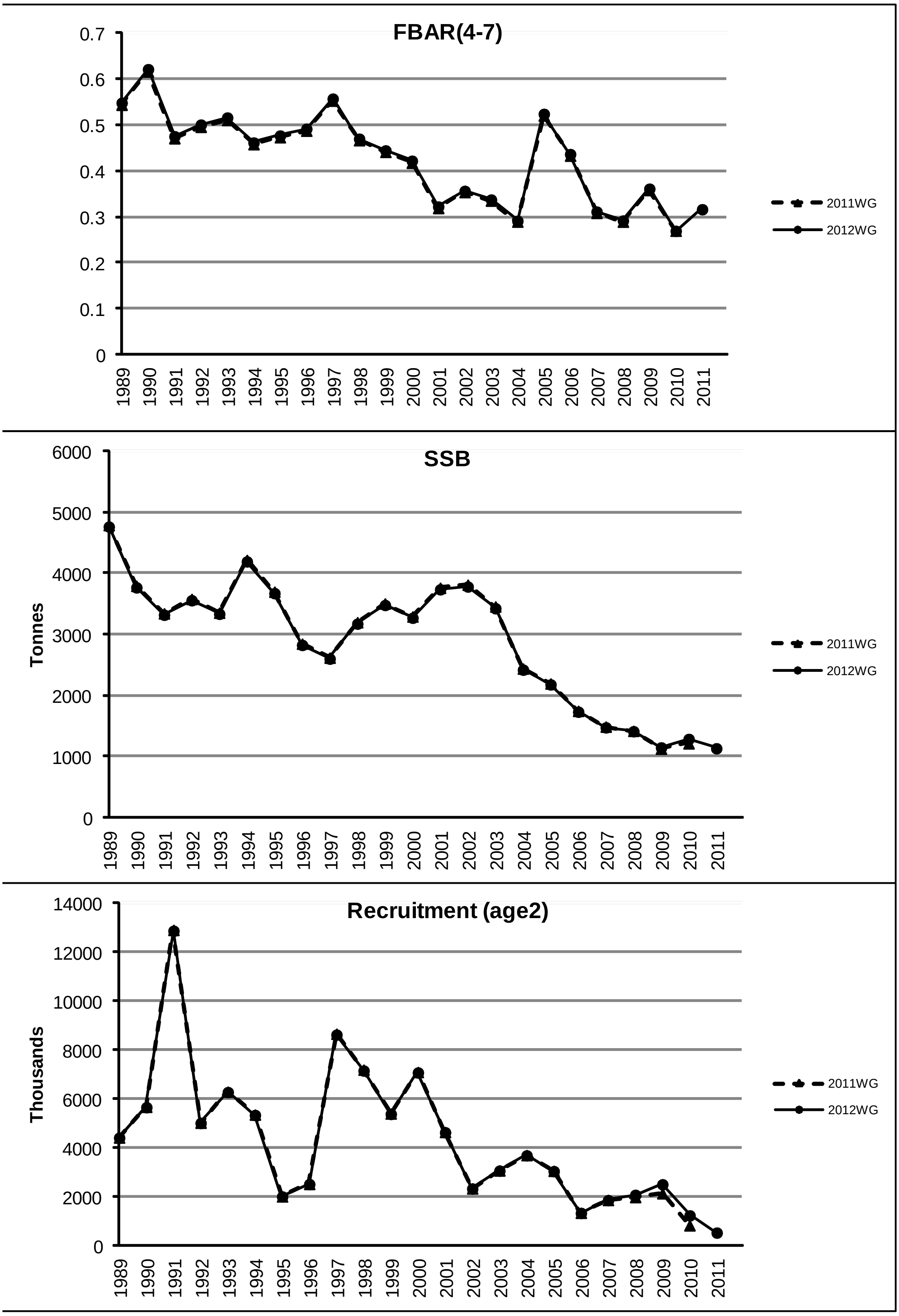
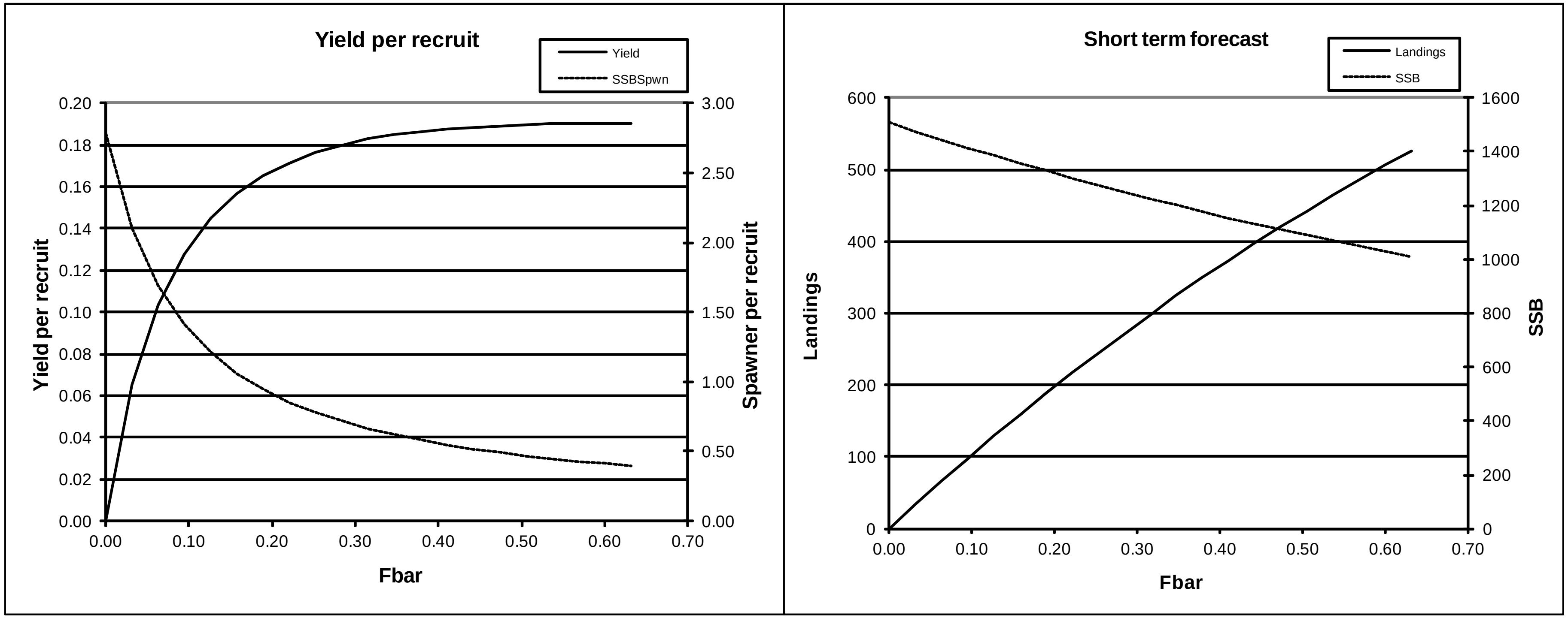


Figure 6.8.8 - Sole in VIIa Yield per recruit and short term forecast plots



MFYPR version 2a
Run: S7A
Time and date: 09:55 11/05/2012

Reference point	F multiplier	Absolute F
Fbar(4-7)	1.0000	0.3156
FMax	1.9005	0.5998
F0.1	0.5416	0.1709
F35%SPR	0.5720	0.1805

MFDP version 1a
Run: S7A
IRISH SEA SOLE,2012 WG
Time and date: 09:23 11/05/2012
Fbar age range: 4-7

Input units are thousands and kg - output in tonnes

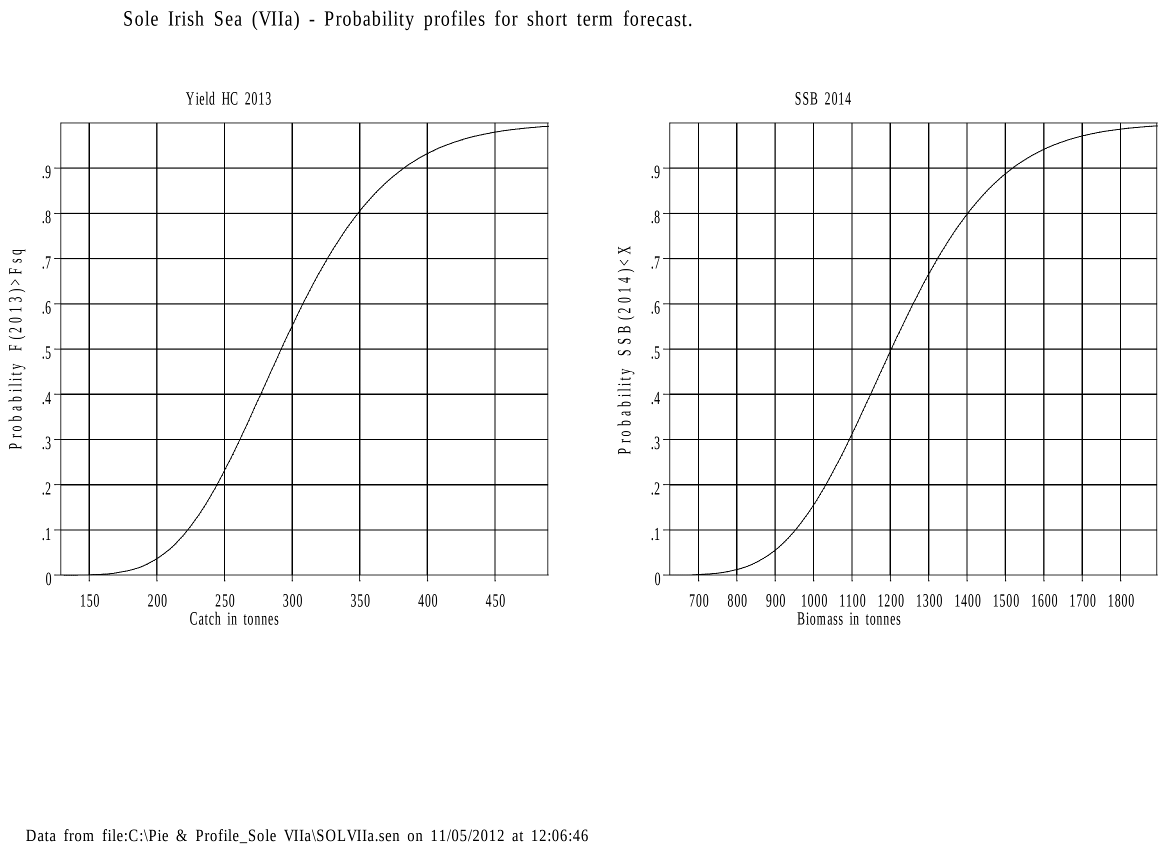


Figure 6.8.9. Sole VIIa-probability profiles for short-term forecast.

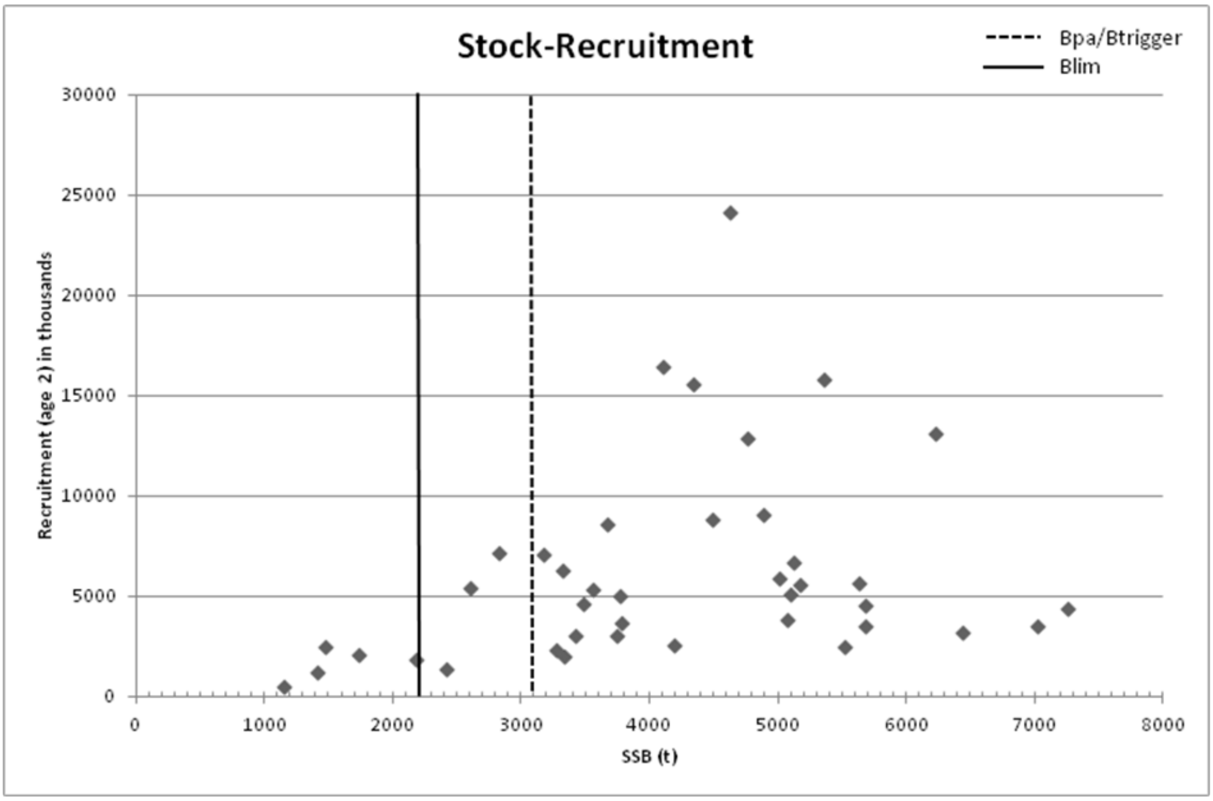


Figure 6.8.10. Sole VIIa- Stock–recruitment plot.

7.1 Celtic Sea overview

There is no overview.

7.2 Cod in Division VIIe–k (Celtic Sea)

Type of assessment in 2012

Full analytical assessment

This stock has been benchmarked at WKROUND in February 2012. While XSA was kept as the assessment model, substantial changes have been done to time-series and parameters:

- A reduction in the number of tuning indices as it appeared many of them were adding more noise than information to the assessment. Only one commercial index and one combined survey index were kept as tuning fleet;
- The combination of FR-IBTS Q4 and IR-GFS Q4 into one single survey index;
- The use of a new French commercial indices based on otter trawler catching more than 40% of gadoids per trip;
- The use of mortality-at-age rather than M=0.2;
- The assumption that full selectivity occurs at age 3 rather than age 5.

At the end of the benchmark, the new assessment method was considered suitable to carry out a full analytical assessment including forecasts.

ICES advice applicable to 2011

"ICES advises that catches of cod should be reduced although it is not possible to determine the appropriate scale of such reduction."

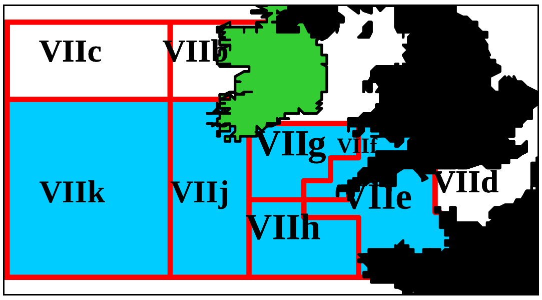
ICES advice applicable to 2012

"*The strong 2009 year class is expected to bring the SSB above $MSY_{Btrigger}$. Based on the MSY framework, ICES advises that F in 2012 be set at F_{MSY}=0.40, resulting in landings of 10 000 t in 2012.*"

7.2.1 General

Stock description and management units

The 2012 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 the 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).



Red Boxes-TAC/Management Areas. Blue Shading-Assessment Area.

Management applicable in 2011 and 2012

TAC 2011

Initial TAC (Council regulation 57/2011)

Species: Cod *Gadus morhua*		**Zone:** VIIb, VIIc, VIIe-k, VIII, IX and X; EU waters of CECAF 34.1.1 (COD/7XAD34)
Belgium	167	
France	2 735	
Ireland	825	
The Netherlands	1	
United Kingdom	295	
EU	4 023	
TAC	4 023	Analytical TAC Article 13 of this Regulation applies.

Revised TAC (Council regulation 1106/2011)

'Species: Cod *Gadus morhua*		**Zone:** VIIb, VIIc, VIIe-k, VIII, IX and X; EU waters of CECAF 34.1.1 (COD/7XAD34)
Belgium	233	
France	3 811	
Ireland	923	
The Netherlands	1	
United Kingdom	411	
EU	5 379	
TAC	5 379'	Analytical TAC Article 12 of this Regulation applies.

TAC 2012 (Council regulation 43/2012)

Species: Cod *Gadus morhua*		**Zone:** VIIb, VIIc, VIIe-k, VIII, IX and X; EU waters of CECAF 34.1.1 (COD/7XAD34)
Belgium	449	
France	7 357	
Ireland	1 459	
The Netherlands	1	
United Kingdom	793	
Union	10 059	
TAC	10 059	Analytical TAC Article 11 of this Regulation applies.

Fishery in 2011

Landings data used by the WG are shown in Table 7.2.1. No revision was required.

Landings in 2011 (4737 t) are the highest since 2007 because of the strong recruitment of year class 2009 which subsequently led to an increase of TAC to 5379 t during the autumn 2011 and a further increase of the TAC to 10 500 t in 2012.

The 2011 landings are substantially than those from 2009 and 2010 which were around 3200 t and were about 60% of the average of the time-series (7700 t).

The contribution of landings by country remained unchanged in 2011. France generally accounts for 70% of the international landings followed by Ireland (27%), United Kingdom (10%) Belgium (2%). Most of the quotas were either almost entirely taken or exceeded. France has taken 81% of its quota, Ireland 130%, UK 98% and Belgium 52%. This high uptake rate for all countries is the consequence of 1) a highly limiting TAC in 2011 (despite its revision in autumn) in regards to the magnitude of the recruitment of the 2009 year class and 2) the fact that cod catches are part of mixed fisheries and therefore any fishing effort in the Celtic Sea in this situation was likely to bring cods and increase the national uptake for all fleets.

There is no information on the absolute level of misreporting for this stock but there is evidence that misreporting has increased from 2002 when quotas became restrictive with a maximum in 2008. Misreporting has decreased since then. Irish landings data in some years have been corrected for area misreporting into the southern rectangles of VIIa. These misreporting estimates are summarized in the table below.

Year	2004	2005	2006	2007	2008	2009	2010	2011
Mis alloc (t)	108	54	103	527	558	193	143	147

This year, the WG observed highgrading occurring in all countries because of the strong recruitment of the 2009 year class and a limiting TAC leading to an exceptionally high level of discards above the MLS (35 cm). Based on the information from sampling at sea on all fleets, it appeared that more than 70% in weight of the "non-landed" fraction of the catch was over the official MLS for the main metiers. The remaining 30% are mainly age 1 cods (year class 2010) caught by Irish trawlers. It was estimated that 2524 t of cod were discarded which would imply that highgrading accounted for around 1766 t.

The level of highgrading was different per country and metier which makes it difficult to provide accurate estimates of its magnitude. The proportion of highgraded fish among the discards was 60% for Ireland and France, 90% for UK and 100% for Belgium (because of its higher MLS at 50 cm).

Highgrading over the last decade was taken account of in the assessment when the magnitude of this phenomena was considered important. The procedure explaining how the WG has treated highgrading information before this year is in the stock annex appended to this report.

The times-series of estimates of highgrading is summarized in the table below:

Year	2003	2004	2005	2006	2007	2008	2009	2010	2012
HG (t)	210	148	74	432	592	322	25	7	1766

Both assumed Irish area misreporting and French high grading estimates since 2003 in percentages of the landings are summarized in the table below:

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
%	3	7	4	14	23	22	7	5	26

Fishery-science partnerships

French self-sampling programme

In 2009, the French self-sampling program was extended to several "métiers". The programme is voluntary under the auspices of the main Fishermen Organization P.M.A (Pêcheurs de Manche et Atlantique). In 2009, six otter trawlers participated, providing data for métiers targeting either gadoids (OTB or OTTPD), *Nephrops* (OTTLN) or benthic species such as monkfish, megrim, rays, john dory (OTB or OTTPB). In 2010, four otter trawlers participated. In 2011, three otter trawlers have participated.

38 trips were sampled in 2008, 88 in 2009, 43 in 2010 and 82 in 2011. Many trips of the métier targeting benthic species of fish have been sampled though its contribution to the cod catches or landings is generally small. The reasons are both the voluntary basis of the program and the shorter duration of the trips of that métier, seven days at sea instead of 12–14 days for the other métiers.

Gear Code	Q1	Q2	Q3	Q4	Total	Métier	2009
OTBPB	7	15	14	7	43	BENTH= OTBPB+OTTPB	
OTBPD	6	5			11	GADI= OTBPD+OTTPD	
OTTLN	1	3	1		5	NEPH= OTTLN	
OTTPB	1		3	2	6		
OTTPD	8	6	5	4	23		
Total	23	29	23	13	88		
Gear Code	Q1	Q2	Q3	Q4	Total	Métier	2010
OTBPB	9	11	5		25	BENTH= OTBPB+OTTPB	
OTBPD	4	6	3		13	GADI= OTBPD+OTTPD	
OTCRU			5		5	NEPH= OTTLN	
Total	13	17	13		43		
Gear Code	Q1	Q2	Q3	Q4	Total	Métier	2011
OTBPB	14	17	19	4	54	BENTH= OTBPB+OTTPB	
OTBPD	6	8	5	1	20	GADI= OTBPD+OTTPD	
OTCRU		5	2	1	8	NEPH= OTTLN	
Total	20	30	26	6	82		

Gear code	Q1	Q2	Q3	Q4	Total	Métier
2009						
OTDEF	22	26	22	13	83	Otter trawl targeting gadoids
OTCRU	1	3	1		5	Otter trawl targeting nephrops
Total	23	29	23	13	88	
2010						
OTDEF	13	17	8		38	Otter trawl targeting gadoids
OTCRU			5		5	Otter trawl targeting nephrops
Total	13	17	13		43	
2011						
OTDEF	20	25	24	5	74	Otter trawl targeting gadoids
OTCRU		5	2	1	8	Otter trawl targeting nephrops
Total	20	30	26	6	82	

Several métiers can be fished during a single trip by changing fishing grounds (from fish to *Nephrops* for instance). Métiers have been identified by targeted species indicated by the skippers for each haul carried out.

During 2009, 2883 hauls have been sampled from 6022 carried out in the trips involved in the self-sampling programme. The sampling level for the Gadoid métier has fluctuated between 34 and 49% of hauls carried out on the sampled trips. There is no sampling in the first quarter from the *Nephrops* trawlers because the methodology was more difficult and more time consuming to use in hauls where fish and *Nephrops* were always mixed. Results were better during the *Nephrops* season (Q2&3) and poor in quarter 4 because of the heavy sea conditions. The number of hauls carried out and sampled is indicated in the text table below.

Métier	Q1	Q2	Q3	Q4	Total 2009
BENTH Total	925	960	669	307	2861
BENTH sampled	231	559	501	266	1557
GADI Total	1147	1164	446	294	3051
GADI sampled	393	545	189	145	1272
NEPH Total	31	45	34	3	110
NEPH sampled	0	29	24	1	54
three hauls targeting *Nephrops* in a GADI trip					
Métier	Q1	Q2	Q3	Q4	Total 2010
BENTH Total	321	454	179	-	954
BENTH sampled	172	432	178	-	782
GADI Total	207	275	140	-	622
GADI sampled	83	249	140	-	472
NEPH Total	-	-	219	-	219
NEPH sampled	-	-	217	-	217

In 2010, 1471 hauls catching cod have been sampled from 1795 hauls carried out. Number of hauls sampled was not available in 2011 at the time of the working group.

Retained and discarded parts of the catch have been scrutinized in each haul sampled. Overall 17 215 cod have been measured in 2009, 15 310 belonging to the retained part and 1905 to the discarded part. In 2010, 12 381 cods have been measured, 9709 in the retained part and 2672 in the discarded part of the catch (Figure 7.2.2).

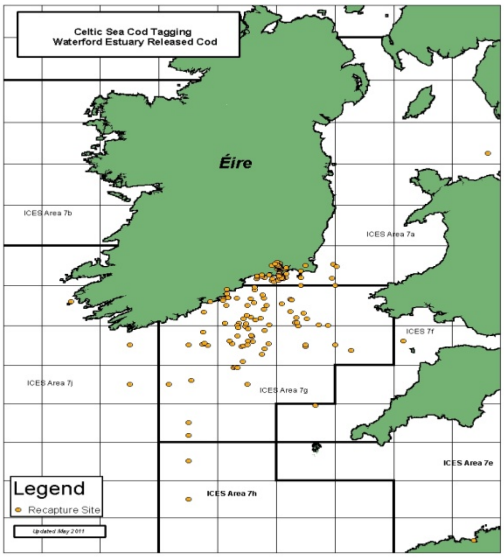
In 2011, 36 234 cods have been measured with 35 570 in the retained part and 664 in the discarded part of the catch. The participating vessels have not exhibited highgrading practice. This figure is contrary to the perception of strong highgrading occurring in all fleets but may more reflect the habits of those participating vessels rather than the whole picture of the fleet behaviour.

Since 2010, these sampling data are provided by the Professional Organization (P.M.A) in a database currently located at Ifremer/Lorient. Motivation of the crew or the vessel owners could become a problem in future. The reasons are that 1) the effort of the industry to provide more biological data is not linked with incentives in setting TAC and quotas, 2) there has been in 2009 and after a pragmatic fit between the quota set and the fleet effort by change of métier or decommissioning which led to an under-consumption of the agreed quota. In addition, the reduction of personnel among scientific staff which used to manage or deal with the data flows from the industry adds additional problems to have the information made available in time for the working group.

Ireland–UK tagging programme in the Irish and Celtic Seas

The tagging programme focuses on both nursery areas and spawning aggregations of cod in the Irish and Celtic Seas, and involves conventional (plastic) tags and sophisticated electronic data storage tags. The programme in the Celtic Sea commenced in 2007 and is ongoing. The main objectives are to examine the movements of cod in relation to closed areas and in respect to stock mixing; to determine fine-scale movements and behaviour of cod during spawning; to examine vertical distribution (in relation to catchability) and thermal experiences (in relation to gonad development). Results of tagging work to date were presented to the ICES ASC in 2009 (Bendall *et al.*, 2009). These results describe fundamental features of cod spatial ecology in the Irish and Celtic Sea, such as the location of feeding and spawning grounds (and the migratory pathways between them), the seasonality of migration and habitat occupation and the potential impact upon substock structure. Recaptures to date of juvenile cod tagged in the south of VIIa (Waterford estuary) shows that the majority of recaptures have occurred in VIIg mainly (O'Cuaig, Pers. comm.)

During March 2010 the Marine Institute in conjunction with the Irish South and East Fishermen's Organisation tagged and released a further 2110 cod in the Celtic Sea Ecoregion. Of these, 242 cod were adult cod released on the offshore spawning grounds while the rest (1868) were juvenile cod caught and released in the nursery grounds of Waterford Estuary. This brings the total Celtic Sea Cod released to date by the Marine Institute to 9098. Currently the overall recapture rate stands at 10.9%. The higher recapture rate of 13.3% associated with the offshore released fish is expected as these fish are in an area of higher fishing effort.



The recapture positions associated with the juvenile cod confirms the need to include some of VIIa South Cod in any analysis of the Celtic Sea Cod stock. The map below illustrates the recapture positions to date.

Preliminary results from the DST (data storage tag) returns show that the cod migrate in a clockwise pattern from the spring spawning area to the summer feeding grounds to the east (The Smalls) before returning the spawning area of initial release. This pattern is the pattern that local fishermen would have suggested from their own experience of working with the stock.

While no further tagging was carried out by the Marine Institute in 2011 due to funding constraints, it is hoped that more will be carried out in the future. As returns to date show that cod can be recaptured up to three years after initial release 2011 will continue to gather data for this project.

Irish industry–science partnership quarter 1 cod survey

ICES (2009) notes that "given the uncertainty in the landings, the surveys represent the main source of information for estimating the historical trends in the stock." However, the current IBTS survey is conducted in quarter 4 when the stock is widely dispersed resulting in poor ability to track abundance due to low catch rates. ICES notes that "changing the surveys' design or programming additional stations are not thought to be relevant solutions, given the implications on other survey objectives" and ICES (2009) conclude that "adding a survey in quarter 1 would be the best solution, in order to monitor both the concentration of fish and the maturity during the spawning period." In recognition of this advice, the Marine Institute and the Federation of Irish Fishermen, in 2010 initiated an annual Q1 fishery-independent survey for Celtic Sea Cod. The survey uses a commercial vessel and a dedicated survey trawl specification, based on a commercial design and in accordance with the criteria laid down in the ICES Study Group on Survey Trawl Standardisation (SGSST, 2009). The survey stations (Figure 7.2.1) are based on both Irish and foreign fleet VMS and/or logbook data. Using the VMS and logbook data, the Celtic Sea has been divided into areas of low, medium and high commercial catches and the survey sites have been randomly selected within these three categories (survey strata) with around 50% of the effort in the high areas and 30 and 20% in the medium and low.

The first of such surveys was carried out by the Marine Institute from 14–23rd March 2010 and is the first in an annual series that aims to track the abundance of Celtic Sea cod by targeting them when they are aggregated for spawning. The survey will provide fishery-independent data on the relative abundance of adult and juvenile cod which will form a 'time-series' that will allow interannual variation in abundance, biomass, recruitment and mortality to be assessed. This type of information can be used on its own to provide an estimate of stock size and overall mortality or as a 'tuning index' to drive the ICES stock assessment.

The survey should be considered primarily as a starting point in a time-series that provides an index of abundance to facilitate the assessment of the cod stock in the Celtic Sea. However, to provide a crude approximation of the size of the cod stock, the data from the survey (cod/km^2 caught) was raised to the entire area. However, this assumes that all cod in the trawl path were caught (100% catchability), which in practice is unlikely, therefore the stock size estimate given is likely to be an underestimate. For this work to fulfil its potential it is critical that the survey is combined with a programme to obtain better commercial catch data on the weight and age structure of landings and discards.

Landings

Figure 7.2.3 shows the annual length structure of the landings per métier and country. Figure 7.2.4 shows the evolution of the age structure of the landings.

It is noticeable that this stock has always been composed of a few age classes. The catch number-at-age table (Table 7.2.2) shows the catch was mainly composed of age 2 over the period 2005–2008. In 2009 the proportion of 2 year old fish is comparatively low and ages 3, 4, and 5 are higher than those observed since 2005. In 2010 year class 2009 (age 1) represents 40% of the total number of landed fishes. This is the strongest recruitment since 2000. Age 2 represented 30% of the total number of landed fishes. In 2011, year class 2009 represents 63% of the fish caught and year class 2010 only 30% of the catch.

Discards

Figure 7.2.3 shows the length structure of landings and discards per country. The majority of the cod discarded results from the highgrading behaviour occurring for all countries while discarding of undersized individuals is low for all fleets. The landings/discards pattern is known to be strongly variable between fleets and years. 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 (Table 7.2.3). This relates well to the good recruitments of year class 2009 and 2010.

Discards were also available from Belgium. For these fleets, the modal distribution of discards was around 30 cm. Due to the MLS being set at 50 cm for Belgium, discards occur well above 35 cm while relatively low in numbers. Belgian MLS has switched back to 35 cm on the 1st of October 2011.

Due to the low TAC in regards of the magnitude of the recruitment of year class 2009 and 2010, all countries had unusually high discards rates in 2011, mainly (70% in weight) made of fish above the MLS.

The estimates of the discarded weight for 2011 were the following:

Country	Landings (t)	Discards (t)	Catch (t)	Discard rate %
France	3171	435	3606	12
Ireland	1011	1184	2195	54
United Kingdom	414	775	1189	65
Belgium	124	130	254	51
Other	17	unknown	unknown	n/a
Total	4737	2524	7261	35

There are uncertainties in the actual level of discards as all metiers are likely to exhibit different discarding patterns. For example for France, the observer at sea programme indicates that the discards rates for OTCRU and OTDEF métier in 2011 were both at very low levels (1 to 11% per quarter) while all the other métiers had a discard rate of 46%. It appears that fleets targeting gadoids were likely to keep older fish and discard younger individuals (e.g. Irish discards) while the other métiers tended to highgrade more maybe because they are less prone to target gadoids or because the fish caught despite its size was not marketable.

Biological

Catch in numbers-at-age and catch and stock weights are given respectively in Tables 7.2.2, 7.2.4 and 7.2.5. The final year estimates are consistent with the recent historical values.

Percentage of F before spawning and maturity ogive have been scrutinized during the 2012 WKROUND benchmark and have remained unchanged.

Values for natural mortality-at-age (previously 0.2 for all ages and years) have changed based on a new approach agreed at WKROUND 2012. Natural mortality-at-age (M) is assumed weight-dependent after Lorenzen (1996) with mortality assumed to be time invariant.

Other parameters remained unchanged and are described in the Stock Annex. Celtic Sea cod are very fast growing and early maturing compared with more northern cod stocks.

Surveys

Table 7.2.6 presents the survey dataseries. Two ongoing surveys both part of DCF IBTS Q4 (FR-EVHOE & IR-GFS7gj combined) were used to assess this stock. In order to overcome the difficulty of constructing survey-series with generally low number of cods, WKROUND 2012 tested and agreed on a combination of the two surveys into a single abundance index. Surba is no longer used to assess this stock since the last benchmark. Both surveys demonstrate the strong 2009 and 2010 year class.

Commercial cpue

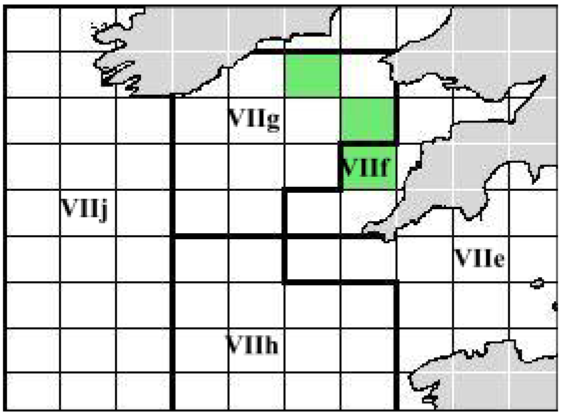
Tables 7.2.7a, b and c show the series of landings, fishing effort and lpue dataseries for four French fleets, three UK fleets and eight Irish fleets. Figure 7.2.5a and b show their trends.

A new French OTDEF demersal fleet tuning-series has been introduced during WKROUND 2012. This series is based on landings and effort data from French OTDEF vessels with 40% of the landed weight per trip of gadoids. Because of the strong recruitments of cod for 2009 and 2010, this limit of 40% has proven not reliable this year as more vessels were included which led to a suspicious increase of effort of 170%. During the WG, four indicators were used to evaluate the true relative difference in effort between 2011 and 2010, i.e. number of trips and number of days at sea in the Area VIIe–k by French trawlers and then in a restricted area including only those ICES rectangles were at least 1 ton of cod was fished during the two years (to exclude flatfish trawling areas in VIIe that could bias the estimates). The four indicators were extremely consistent giving values between -3% to +1%. The highest value (+1%) was retained for correcting the 2011 effort figure of the tuning-series.

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.

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. Irish otter shows an increasing trend over the period, the majority of this effort is directed towards *Nephrops*.

A special effort was made during the 2009 WG to combine international landings and effort datasets and produce historical distribution maps. These maps are respectively composed of France, UK, Ireland and Belgium landings (Figure 7.2.6), France and Ireland efforts (Figure 7.2.7) and lpue (Figure 7.2.8). The data are not corrected for misreporting or highgrading. The main outcome of these maps is the shrinking of the geographical area of the stock over the years. This is particularly visible in the distribution of the landings (Figure 7.2.6). The perceived decrease of landings over time is to be regarded with caution given the recent levels of misreporting and highgrading. The rectangles temporarily closed (30E4, 31E4 and 32E3) since 2005 were clearly among the most important in terms of lpue.



Green: Trevose closed areas.

7.2.2 Stock assessment

Model used: XSA.

The assessment was benchmarked in 2012 at WKROUND. The initial intent during the working group was to follow the assessment procedure agreed at WKROUND and described in the stock annex but because of the magnitude of the highgrading and abundance of cod, the group had to consider the following changes:

- Assumption that the French fishing effort only increased by 1% from 2010 to 2011;
- Inclusion of discards (under and above MLS) for all countries in 2011. It is to be noted that WKROUND encouraged WGCSE to investigate the impact of including discards in the assessment.

Those assumptions were tested against the regular assessment described in the stock annex. The following parameters were applied for all runs:

		WG 2011	WG 2012
Catch data range		1971–2010	1971–2011
Age range		1–7+	1–7+
Commercial tuning series			
	FR GADOIDSQ2+3+4	1983–2008	No longer used
	FR-NEPHROPS	1987–2008	No longer used
	UK-WECOT	1989–2010	No longer used
	IR-7JG-OT combined	1995–2008	No longer used
	FR-OTDEF Q2-Q4 VIIek Age 1-6	Not implemented	2000–2011
Scientific Surveys			
	UK-WCGFS	1992–2004	No longer used
	FR-EVHOE	1997–2010	No longer used
	IR-GFSgj	2003–2010	No longer used
	Combined FR IBTS Q4 - IR GFS Q4 Age 0-4	Not implemented	2003–2011
Taper		No	No
Age s catch dep. Stock size		None	None
q plateau		5	3
F shrinkage se		1	1
Year range		5	5
age range		3	3
age range of mean F		2–5	2–5

The tuning indices used are in Table 7.2.9.

Exploratory XSA

A set of runs have been carried out changing the initial value of effort in 2011 for the French OTDEF tuning fleet. This value was initially 1.7 times the fishing effort measured in 2010 while information on activity suggested only an increase of 1% in comparison of the 2010 value (see section on commercial cpue).

Several simulations were carried out ranging from 25% to 125% of the value of the 2011 fishing time. Only the 2011 value of effort (fishing time) was changed from one simulation to the other. This value is summarized in the table below:

Simulation	Fishing time 2011 (hours)
2011 estimate of fishing time	170 458
25% of the 2011 estimate	42 615
50%	85 229
75%	127 844
125%	213 073

Final run: increase of 1% of 2010 estimate	101 251

It is worth noting that considering an increase of 1% of the effort since 2010 would correspond to 58% of the value of 2011 estimate made on the basis of trips landing more than 40 % (by weight) of gadoids . Considering that effort is likely to have increased in 2011 as cod was abundant, it implies than any simulation below that threshold might not be realistic as fishing effort for those runs is equal or lower to the 2010 value.

The change of fishing effort in 2011 does not qualitatively change the outputs from the model and residuals for all runs do not highlight any problem with the model fit. It has little impact on residuals but the assessment is sensitive to the change of effort. All runs show a peak of recruitment in 2011 (Figure 7.2.7) but the scenarios with higher effort in 2011 result in a lower peak in recruitment in this year. The "125%" run has 10 millions recruits in 2010 while the "25%" run has twice that number. A lower effort also implies a lower fishing mortality. F has decreased to less than F_{MAX} (0.4) in 2011 for all runs with effort below 75% of the initial 2011 value. As a consequence of lower fishing mortality, SSB is higher. The "25% run" estimates a 13 000 t SSB while the 125% only implies a 6350 t SSB.

Given those results and further evidences (see section on commercial cpue), the group considered a 1% increase of effort since 2010 was the most realistic option and this value was used for the final assessment.

Final XSA

Because of the magnitude of highgrading this year, the group decided to include this year discards in 2011 for all countries. Catch number-at-age, stock and catch weight-at-age tables were updated to include the distribution of discards. Age compositions of discards were based on the quarterly age–length keys built from the sampling at fishmarket and during the French survey.

Diagnostics tables are in Tables 7.2.10. Output Tables are 7.2.11–13. Residuals (Figure 7.2.8) and diagnostics do not highlight any problem regarding the input data and model fit.

Summary plots (Figure 7.2.9) show that fishing mortality has decreased since 2005 (0.95) and in 2011 is close to 0.40 which is the F_{MAX} value and F_{MSY} candidate. Given that the shape of the yield per recruit curve for this stock has a large plateau, and considering the uncertainties this year on effort and level of discards, it is impossible to estimate if fishing mortality is actually slightly above or below the F_{MSY} threshold. But the decrease of fishing mortality is both the consequence of the good recruitment of year classes 2009 and 2010 and a decreasing trend in fishing effort in the major fleets exploiting this stock.

Recruitment in 2011 was estimated to be 8113 thousands individuals. This is less than in 2010 but still well above the average of the times-series (6428 thousands individuals) and about twice the level of recruitments estimated during the last decade. This is consistent with the observations made during both French and Irish surveys.

This leads to an increase of SSB to around 11 450 t in 2011. This is slightly above the long-term average (10 912 t) but more than twice the estimates since 2004. SSB in 2011 is the highest value since 1998. With two years of good recruitment and a decreasing fishing mortality, SSB is likely to reach a higher value this year. Based on survivors estimates from XSA SSB reaches a value of 24 580 tonnes in 2012.

The assessment does not exhibit suspicious patterns regarding retrospective patterns (Figure 7.2.10). Fishing mortality does not show any particular trend of over or underestimation. Recruits are slightly overestimated some years as well as SSB but the magnitude of this is low in both cases.

7.2.3 Short-term projections

The short-term prognosis was carried out with both FLSTF (FLR package) and MFDP.

The exploitation pattern used was the mean F-at-age over the period 2009–2011, scaled by the F_{BAR}(2–5) to the level of last year. The weights used for prediction were the average over the last three years. It was assumed F_{2012} is constrained by the TAC for 2012 (10 059 t). This was chosen by the WG, although it deviates from the benchmark procedure. Input to the short term predictions are presented in Table 7.2.14 and results in Tables 7.2.15–16.

The assumption of recruitment was the geometric mean of the time-series minus the two last years. This implies a recruitment for 2012–2014 of 4652 thousands individuals. SSB in 2012 is estimated to be 25 461 t. Short-term projections assuming *status quo* F have also been provided (Tables 7.2.15b–16b).

It is believed that the high TAC for 2012 (10 095 t) should prevent further highgrading. Projection for 2013 was subsequently based upon a quota entirely taken in 2012 and no discards which implies the hypothesis that landings will be 10 059 t and F_{2012} equal to 0.405.

This will result in a spawning–stock biomass of 27 567 tonnes in 2013 which is above $B_{MSYtrigger}$ (10 300 t). Based on the MSY framework, F in 2013 should be set at 0.4 resulting in landings of 10 240 t and a spawning–stock biomass of 26 530 t in 2014.

7.2.4 Medium-term projection

No medium-term projections were carried out.

7.2.5 Biological reference points

WKROUND in 2009 has suggested that, unless there is an investigation on the possible change in the maturity ogive, there was no solid reason to change the biological reference points. There was no further progress at WKROUND 2012 and the biological reference points remained unchanged (see table below) until WGCSE 2012 where it was admitted that they were no longer suitable to accommodate the changes made to the parameters used in the assessment.

Former precautionary reference point (prior WGCSE 2012):

Ref. point	ACFM 1998	WG 1999*	ACFM 1999	WG 2004	ACFM 2004
F_{lim}	0.90 (F_{loss} WG98)	0.90 (history WG99)	0.90 (history WG99)		0.90 (history WG99)
F_{pa}	0.68 (5th perc F_{loss} WG98)	0.65 (F_{lim}*0.72)	0.68 (5th perc F_{loss} WG98)		0.68 (5th perc F_{loss} WG98)
B_{lim}	4500 t (B_{loss} =B76 WG98)	5400 t(B_{loss}=B76 WG99)	5400 t (B_{loss}=B76 WG99)	6300 t (B_{loss}=B76 WG04)	6300 t (B_{loss}=B76 WG04)
B_{pa}	8000 t (B_{lim}*1.65)	9000 t (B_{lim}*1.65)	10 000 t (history)	Reject – no SR relation	8800 t (B_{pa} = B_{lim} * 1.4)

With the addition of last year's data, the WG considered F_{lim} and F_{pa} were no longer appropriate to characterize that stock and proposed new estimates of B_{pa}, B_{lim}, F_{MSY} and MSY $B_{trigger}$.

The advice and forecasts this year are based on the following reference points:

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$	10 300 t	Provisionally set at B_{pa}.
Approach	F_{MSY}	0.40	Provisional proxy based on F_{MAX} (ICES, 2011).
	B_{lim}	7300 t	B_{lim} = B_{loss} (B76), the lowest observed spawning–stock biomass.
Precautionary	B_{pa}	10 300 t	B_{pa} = B_{lim} * 1.4. Biomass above this value affords a high probability of maintaining SSB above B_{lim}, taking into account the variability in the stock dynamics and the uncertainty in assessments.
Approach	F_{lim}		Undefined.
	F_{pa}		Undefined

Yield and spawning biomass per Recruit F-reference points (2012):

	Fish Mort	Yield/R	SSB/R
	Ages 2–5		
Average last three years	0.54	1.40	2.67
F_{MAX}	0.37	1.45	4.03
$F_{0.1}$	0.20	1.33	6.79
F_{MED}	0.74	1.32	1.85

The group emphasizes that new reference points needs to be reviewed but given the current state of the stock, they are believed to have no impact on the advice.

7.2.6 Management plans

A long-term management plan has been under discussion for this stock and an effort based management system in the Celtic Sea (VIIfg) is being discussed by member states and the EC.

7.2.7 Uncertainties and bias in assessment and forecast

The major sources of uncertainties were discard estimates (including highgrading) and misreporting. These problems occurred in 2003 and subsequent years, when quotas became increasingly restrictive. The magnitude of highgrading and misreporting has decreased since 2008. Estimates of highgrading and discards have been high in 2011 and are included in this assessment. Landings have been revised to include catches from the southern part of the Irish Sea as they are believed to be part of this stock. Lpue for the French demersal fleet have been revised and are available from 2000.

Effort estimation in the main commercial tuning-series is currently based on a catch proportion threshold of 40% of gadoids per trip. With the recent strong recruitment the number of trips qualifying has increased dramatically despite no apparent change in behaviour of the fleet. The WG made the most appropriate adjustment to the effort estimate, but results are sensitive to this adjustment.

7.2.8 Management considerations

This stock which was considered to have contracted significantly according to the international landings and lpue distribution maps can extend substantially when recruitment is strong as seen with the 2009 year class when the FR-IBTS Q4 EVHOE survey started to catch cod in the southern part of the Bay of Biscay in 2010. This stock has had a very truncated age structure with age 2 fish having been the most numerous in landings over many years. The historical dynamics of Celtic Sea cod have been "recruitment driven", i.e. the stock increased in the past in response to good recruitments and decreased rapidly during times of poor recruitment. Recruitment before 2009 was poor. The 2009 and 2010 year classes have been strong. Fishing mortality should be reduced in the longer term to maximize the contributions of recruitment to future SSB and yield and will result in reduced risk to the stock.

Cod in Divisions VIIe–k are caught in a range of fisheries including gadoid trawlers, *Nephrops* trawlers, otter trawlers, beam trawlers, and gillnetters. Other commercial species that are caught by these fisheries include haddock, whiting, *Nephrops*, plaice, sole, anglerfish, hake, megrim, and elasmobranchs.

Over the last decade, there have been indications of an underreporting of cod landings in some fleets. The introduction of the buyers and sellers legislation in the UK and Ireland may have reduced this, but may also have increased discards. Measures aimed at reducing discarding and improving the fishing pattern should be encouraged. These might include spatial and temporal changes in fishing practices or technical measures. These measures would need to be evaluated in the context of other species caught in mixed fisheries.

The exclusion of ICES Division VIId in the TAC area since 2009 makes the management area more in line with the boundaries of the stock as the stock in VIId is considered as an extension of the cod population in the North Sea.

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) with the objective of reducing fishing mortality on cod. At an annual resolution, maps of international effort distribution do not show evidence that this closure has redistributed effort of otter trawlers to other areas.

There have been major changes in fleet dynamics over the period of the assessment. Effort in the French otter trawlers has been declining since 1999 and a decommissioning plan has occurred in 2008 and a new plan is ongoing since 2009. A consequence of the Trevose closure is that a part of the effort displayed by the French otter trawlers in the three rectangles before or after the closure has been reported to the allowed area where the catch of mixed species (mainly gadoids) is still profitable, particularly in the rectangles neighbouring the closed area (rectangles 32E4, 32E2, 31E2, 31E3, 30E3, 29E3, 29E4) or in a more distant and still shallower rectangle 31E1. Another part of the effort is displayed in the rectangles 29E1, 28E1, meaning that this effort is then targeting *Nephrops*, monkfish, megrim, *Nephrops* and elasmobranch. Overall, a part of the French bottom trawlers has not changed their activity with the closed period and continue to target gadoid fish in the neighbouring rectangles of the closed area. Another part of them target benthic species (anglerfish, megrim and john dory) in more distant rectangles 28E1, 29E1.

Irish otter trawl effort in VIIg,j has been stable over the last six years. During this period there has been a fleet modernisation and several decommissioning schemes in Ireland both within the national whitefish fleet and beam trawl fleet.

Reference points are no longer appropriate due to the recent change of parameters at WKROUND 2012. The group emphasizes that new reference points needs to be reviewed but given the current status of the stock, they are believed to have no impact on the advice.

7.2.9 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.

Table 7.2.1. Nominal landings of Cod in Divisions VII e–k used by the Working Group.

Year	Belgium	France	Ireland	UK	Others	Total								
1971						5782								
1972						4737								
1973						4015								
1974						2898								
1975						3993								
1976						4818								
1977						3058								
1978						3647								
1979						4650								
1980						7243								
1981						10596								
1982						8766								
1983						9641								
1984						6631								
1985						8317								
1986						10475								
1987						10228								
1988	554	13863	1480	1292	2	17191								
1989	910	15801	1860	1223	15	19809								
1990	621	9383	1241	1346	158	12749								
1991	303	6260	1659	1094	20	9336								
1992	195	7120	1212	1207	13	9747								
1993	391	8317	766	945	6	10425								
1994	398	7692	1616	906	8	10620								
1995	400	8321	1946	1034	8	11709								
1996	552	8981	1982	1166	0	12680								
1997	694	8662	1513	1166	0	12035								
1998	528	8096	1718	1089	0	11431	French Highgrading		WKROUND		WGCSE 2011		WGCSE	
1999	326	5488	1883	897	0	8594	based on UK data		HG based on		HG based on		HG +	
2000	208	4281	1302	744	0	6535			2008 FR		2009-2010 FR		all countries	
2001	347	6033	1091	838	0	8309			self sampling		self sampling data			
2002	555	7368	694	618	0	9235	HG FR	Total	HG FR	Total	HG FR	Total	HG	DIS
2003	136	5222	517	346	0	6221	210	6431						
2004	153	2425	663	282	0	3523	148	3671						
2005	186	1623	870	309	0	2988	74	3062						
2006	103	1896	959	368	0	3326			432	3758				
2007	108	2509	1210	412	0	4239			592	4831				
2008	65	2064	1221	289	0	3639			322	3961				
2009	49	2080	870	264	0	3263					25	3288		
2010	51	1853	1034	289	2	3229					7	3236		
2011	124	3171	1011	414	17	4737							1766	758

*** Provisional.**

Scaled landings 1971–1987 (SSDS WG 1999).

Table 7.2.2. Cod in Divisions VIIe–k. 2011 Landings number-at-age (note: 2011 values represents actual catch).

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

Table 7.2.3. Cod in Divisions VIIe–k. 2011 Landings, Discards and Catch number-at-age.

Age	Landings		Discards		SOP corr. Catch	
	Numbers					
		Weight-at-age	Numbers	Weight-at-age	Numbers	Weight-at-age
0			9860	0.030	10075	0.030
1	45235	0.829	1453542	0.518	1531442	0.527
2	1815904	1.680	1299531	1.100	3183335	1.438
3	183356	4.445	49057	4.418	237479	4.439
4	39282	7.442	12895	7.873	53314	7.549
5	28834	9.605	2114	8.055	31623	9.499
6	6802	10.081	1865	12.481	8856	10.597
7	1641	12.783	159	12.400	1839	12.749
8			115	10.595	117	10.595
9						
10						
Lan/Dis/Catch	Reported	SOP	Reported	SOP	Reported	SOP
(tons)	4737	4563	2524	2544	7261	7261

Table 7.2.4. Cod in Divisions VIIe–k. Catch 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	9.06	12.75	13.822	19.232	19.232	19.232
1982	0.945	2.242	4.474	7.797	10.25	12.465	15.074	16.908	18.538	20.949
1983	0.979	2.525	4.961	7.457	9.965	12.01	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	7.44	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	0.88	2.3	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	16.53	16.53
1994	0.874	2	4.492	7.926	10.092	12.212	13.072	15.865	15.865	15.865
1995	0.806	1.973	4.589	7.56	9.75	11.152	13.983	14.147	14.147	14.147
1996	0.787	1.877	4.639	6.997	9.854	11.407	13.04	10.363	10.363	10.363
1997	0.771	2.039	4.516	7.389	9.719	11.82	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	14.02
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	10.66	11.746	14.476	14.72	14.72
2001	0.794	2.029	5.112	7.858	9.832	11.423	13.206	14.879	16.311	16.311
2002	0.757	1.88	4.728	6.764	9.36	10.774	12.876	13.463	13.719	14.3
2003	0.889	1.844	4.274	6.667	9.506	11.064	12.04	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	13.47	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	14.56
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

Table 7.2.5. 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	0.46	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	12.18	14.181	16.733	16.733	16.733
1985	0.581	2.07	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	4.39	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	4.6	6.558	9.342	11.285	12.322	14.77	14.77	14.77
1993	0.703	1.385	4.278	6.574	8.066	10.815	11.945	13.421	16.53	16.53
1994	0.605	1.754	4.189	7.72	9.722	12.101	12.844	15.859	15.859	15.859
1995	0.612	1.444	4.346	7.452	9.14	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	0.47	1.41	4.079	7.112	9.044	11.156	13.73	13.623	13.623	13.623
1998	0.421	1.314	4.34	6.676	9.303	11.172	12.369	14.205	17.161	14.02
1999	0.778	1.542	4.252	7.126	8.7	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	0.63	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	9.4	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	11.68	13.85	13.85	13.85
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	6.99	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

Table 7.2.6. Cod in Divisions VIIe–k. Series of surveys indices scrutinized at WGCSE.

IR – GFS : Irish Groundfish Survey (IBTS 4th Qtr) – VIIj Cod number at age (Effort Standardised to 1hr)									
2003	2011								
1	1	0.79	0.92						
0	7								
1	0.0	0.2	0.2	0.2	0.0	0.0	0.0	0.0	2003
1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	2004
1	0.0	1.8	0.0	0.1	0.0	0.0	0.0	0.0	2005
1	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	2006
1	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.0	2007
1	0.0	0.1	0.3	0.1	0.0	0.0	0.0	0.0	2008
1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	2009
1	0.2	3.5	0.2	0.0	0.1	0.0	0.0	0.0	2010
1	0.0	0.9	1.8	0.1	0.1	0.0	0.0	0.0	2011

FR-EVHOE Groundfish Oct-Nov survey in VIIf,g,h,j, numbers per 30 mn							
1997	2011						
1	1	0.75	1				
1	6						
1	0.213	0.095	0.246	0.117	0.048	0	1997
1	0.212	0.52	0.207	0.045	0.045	0	1998
1	0.155	0.184	0.283	0.015	0.03	0.015	1999
1	1.046	0.041	0.118	0.064	0.013	0	2000
1	0.716	0.18	0.029	0.038	0.018	0.007	2001
1	0.033	0.313	0.148	0	0.015	0	2002
1	0.052	0.041	0.142	0.061	0.008	0	2003
1	0.066	0.144	0.072	0.122	0.046	0	2004
1	0.255	0.12	0.055	0	0.026	0	2005
1	0.125	0.139	0	0.048	0.045	0	2006
1	0.321	0.206	0.117	0.033	0	0	2007
1	0.217	0.141	0.117	0.096	0	0	2008
1	0.237	0.092	0.132	0.078	0	0.023	2009
1	1.805	0.21	0.028	0.094	0	0	2010
1	0.792	1.119	0.095	0.031	0.011	0	2011

Table 7.2.7a. Cod in Divisions VIIe–k. Time-series of landings, effort and lpue.

	France											
	Fr gadoid trawlers VIIfgh			Fr Nephrops trawlers VIIfgh			Fr Otter trawlers VIIe-k			Fr Otter trawlers VII e		
Year	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue
1978	Q2+Q3+Q4 for			Q2+Q3+Q4 for								
1979	consistency with			consistency with			includes Fr gadoid trawlers and					
1980	box closure			box closure			Fr Nephrops trawlers					
1981	during Q1 2005			during Q1 2005								
1982	and Feb–March 2006 to 2008			and Feb–March 2006 to 2008								
1983	1453	75.0	19.4	630	190.5	3.3	5443	904.3	6.0	472	210.6	2.2
1984	2002	60.6	33.1	671	170.5	3.9	4881	654.9	7.5	189	118.4	1.6
1985	1667	73.4	22.7	1023	150.7	6.8	6262	847.6	7.4	351	154.1	2.3
1986	2086	85.3	24.5	774	132.6	5.8	8046	932.0	8.6	431	220.4	2.0
1987	2804	107.8	26.0	778	145.7	5.3	8215	886.0	9.3	835	167.6	5.0
1988	6243	184.4	33.9	1726	144.1	12.0	13739	963.6	14.3	1320	199.4	6.6
1989	5171	166.3	31.1	1496	157.7	9.5	15715	1066.0	14.7	983	217.4	4.5
1990	3045	155.2	19.6	1138	206.3	5.5	9018	1073.3	8.4	383	198.6	1.9
1991	2096	127.1	16.5	690	186.2	3.7	5878	1013.2	5.8	335	177.7	1.9
1992	2304	133.0	17.3	1223	226.2	5.4	6709	1060.6	6.3	325	179.1	1.8
1993	2566	155.5	16.5	1236	205.3	6.0	8302	1095.6	7.6	295	238.4	1.2
1994	1725	121.8	14.2	1245	225.1	5.5	7353	959.7	7.7	306	185.1	1.7
1995	2598	128.2	20.3	1606	200.5	8.0	8248	1010.8	8.2	520	215.2	2.4
1996	2455	123.0	20.0	1450	181.6	8.0	8667	954.6	9.1	460	188.5	2.4
1997	2830	168.2	16.8	1246	152.6	8.2	8307	1057.5	7.9	584	258.3	2.3
1998	1707	139.3	12.3	805	111.1	7.2	5765	743.383*	7.76*	150*	28.2*	5.33*
1999	1271	138.8	9.2	546	114.6	4.8	5445	1047.3	5.2	647	298.4	2.2
2000	938	115.3	8.1	711	125.3	5.7	4254	1051.9	4.0	542	312.5	1.7
2001	1911	138.5	13.8	916	141.7	6.5	5957	1010.4	5.9	584	281.3	2.1
2002	2412	121.8	19.8	1083	147.6	7.3	7389	974.8	7.6	654	317.4	2.1
2003	1110	92.0	12.1	972	169.9	5.7	5157	1025.7	5.0	619	366.2	1.7
2004	469	83.1	5.6	462	128.2	3.6	2379	952.1	2.4	193	353.6	0.5
2005	483	79.1	6.1	343	113.3	3.0	1577	874.2	1.7	239	333.9	0.7
2006	430	55.6	7.7	376	108.3	3.5	1834	866.8	2.1	359	334.8	1.1
2007	678	63.4	10.7	509	85.1	6.0	2438	805.7	3.0	445	311.5	1.4
2008	496	54.0	9.2	445	78.1	5.7	1958	655.3	3.0	399	242.5	1.6
2009 2010	Incomplete datasets/not usable											

Units: landings in Tonnes live weight, Effort in 000s hours fished, lpue in Kg/hour fished.

	Fr gadoid trawlers VIIfgh			Fr *Nephrops* trawlers VIIfgh			Fr Otter trawlers VIIe-k		
	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue
FR- Highgrading input									
2003	1155	92.0	12.6	1011	169.9	6.0	5367	1025.7	5.2
2004	498	83.1	6.0	491	128.2	3.8	2527	952.1	2.7
2005	506	79.1	6.4	359	113.3	3.2	1651	874.2	1.9
2006	548	55.6	9.8	465	108.3	4.3	2229	866.8	2.6
2007	886	63.4	14.0	630	85.1	7.4	2995	805.7	3.7
2008	591	54.0	11.0	534	78.1	6.8	2284	655.3	3.5
2009 2010	Incomplete datasets/not usable								

	French OTDEF fleet VIIe-k Q2-Q4 (2000-ongoing)		
Year	Effort	Landings	lpue
2000	217480	1360798	6.3
2001	223428	2297415	10.3
2002	191161	2521943	13.2
2003	184878	1594331	8.6
2004	164607	693554	4.2
2005	132472	589933	4.5
2006	117259	571192	4.9
2007	115878	816211	7.0
2008	113485	652236	5.7
2009	113348	550406	4.9
2010	100332	635002	6.3
2011	101251	925373	9.1

Table 7.2.8b. Cod in Divisions VIIe–k. Time-series of landings, effort and lpue. Units: landings in tonnes live weight, Effort in 000s hours fished, lpue in Kg/hour fished.

	IRELAND			IRELAND			IRELAND			IRELAND		
	Ir Otter trawlers VIIj			Ir Beam trawlers VIIj			Ir Scottish seiners VIIj			Ir Gillnet VIIj		
	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue
1995	338.5	93.7	3.6	0.1	0.2	0.2	75.5	5.3	14.4	179.6	21.3	8.4
1996	326.4	70.2	4.6	8.7	1.5	5.9	124.5	8.2	15.3	65.0	5.2	12.4
1997	352.8	83.2	4.2	3.4	1.8	1.9	115.8	10.7	10.8	45.5	8.3	5.5
1998	262.3	89.6	2.9	19.2	5.2	3.7	103.4	6.6	15.6	59.1	16.0	3.7
1999	76.7	40.6	1.9	27.6	7.4	3.7	9.6	1.4	6.8	25.0	8.7	2.9
2000	95.5	64.6	1.5	21.2	6.9	3.1	23.7	3.5	6.8	14.0	7.2	2.0
2001	140.4	67.7	2.1	10.4	3.0	3.5	28.0	4.4	6.3	12.7	6.6	1.9
2002	150.1	90.4	1.7	5.4	3.1	1.7	24.7	8.9	2.8	12.3	8.1	1.5
2003	78.5	111.3	0.7	8.8	9.0	1.0	14.7	9.2	1.6	6.2	11.1	0.6
2004	36.1	92.0	0.4	2.5	2.2	1.2	11.6	9.2	1.3	4.2	6.1	0.7
2005	40.6	73.9	0.5	4.7	2.4	1.9	17.8	6.1	2.9	3.3	6.3	0.5
2006	42.7	65.9	0.6	2.0	1.5	1.3	15.6	5.3	2.9	7.2	7.3	1.0
2007	39.0	80.5	0.5	7.8	2.4	3.3	9.8	3.5	2.8	6.5	10.5	0.6
2008	33.5	66.5	0.5	2.6	1.1	2.3	9.5	2.8	3.3	6.5	7.9	0.8
2009	26.6	73.1	0.4	4.7	2.8	1.7	8.9	3.3	2.7	8.0	10.9	0.7
2010	52.5	85.5	0.6	1.7	1.0	1.7	17.0	4.4	3.9	8.4	9.4	0.9
2011	57.7	62.6	0.9	1.7	0.6	2.7	21.6	4.6	4.7	16.8	8.0	2.1

	IRELAND			IRELAND			IRELAND			IRELAND		
	Ir Otter trawlers VIIg			Ir Beam trawlers VIIg			Ir Scottish seiners VIIg			Ir Gillnet VIIg		
	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue
1995	429.9	63.6	6.8	85.8	20.8	4.1	111.3	6.4	17.3	114.9	6.3425	18.1
1996	569.3	60.0	9.5	112.6	26.8	4.2	164.9	9.7	16.9	338.8	6.2245	54.4
1997	401.9	65.1	6.2	131.6	28.3	4.7	215.2	16.1	13.3	52.8	1.9	27.7
1998	450.6	72.3	6.2	166.9	35.3	4.7	264.1	14.9	17.7	87.3	3.5	24.8
1999	300.9	51.7	5.8	190.6	40.9	4.7	64.6	8.0	8.1	211.9	8.3795	25.3
2000	279.4	60.6	4.6	180.7	37.0	4.9	106.0	9.9	10.7	157.0	10.1420	15.48
2001	339.5	69.4	4.9	96.6	39.7	2.4	111.1	16.3	6.8	108.0	8.7678	12.3
2002	213.0	77.7	2.7	57.9	31.6	1.8	70.8	20.9	3.4	34.7	7.7	4.5
2003	167.4	86.8	1.9	57.1	49.3	1.2	38.1	20.9	1.8	31.3	11.1	2.82
2004	190.2	97.0	2.0	74.3	54.9	1.4	54.9	19.4	2.8	62.0	13.5	4.59
2005	294.9	124.4	2.4	118.7	49.7	2.4	66.1	14.8	4.5	77.7	10.9	7.14
2006	390.0	119.2	3.3	128.6	60.5	2.1	91.0	14.8	6.2	63.7	7.8	8.1
2007	323.0	136.5	2.4	96.2	55.9	1.8	58.5	15.8	3.7	85.4	9.4	9.1
2008	349.9	125.8	2.8	85.4	37.2	2.3	55.6	11.7	4.8	88.0	14.1	6.24
2009	405.9	137.1	3.0	74.4	38.0	2.0	34.6	8.2	4.2	81.1	13.8	5.86
2010	524.8	140.8	3.7	94.7	40.2	2.4	54.3	9.7	5.6	76.0	14.0	5.42
2011	438.4	120.1	3.7	82.5	35.3	2.3	60.1	14.6	4.1	76.6	11.4	6.75

Table 7.2.8c. Cod in Divisions VIIe–k. Time-series of landings, effort and lpue. Units: landings in tonnes live weight, Effort in 000s hours fished, lpue in Kg/hour fished.

	UNITED KINGDOM (England + Wales)								
	Uk Otter trawlers VIIe-k			Uk Beam trawlers VIIe-k			Uk Otter trawlers VIIe		
Year	Landings	Effort	lpue	Landings	Effort	lpue	Landings	Effort	lpue
1972	355.1	117.1	3.0				80.4	64.6	1.2
1973	222.7	118.5	1.9				57.6	69.5	0.8
1974	191.5	91.6	2.1				55.1	50.1	1.1
1975	136.0	100.3	1.4				38.2	54.7	0.7
1976	96.6	88.2	1.1				31.7	56.1	0.6
1977	118.6	88.5	1.3				78.3	55.4	1.4
1978	116.3	83.2	1.4	6.4	24.7	0.3	70.2	48.8	1.4
1979	130.0	73.5	1.8	13.8	44.0	0.3	73.7	49.9	1.5
1980	227.6	85.6	2.7	38.8	76.7	0.5	83.6	50.0	1.7
1981	323.6	104.3	3.1	62.9	87.6	0.7	76.0	46.9	1.6
1982	361.9	104.7	3.5	84.4	115.0	0.7	65.2	38.5	1.7
1983	163.3	82.1	2.0	84.0	135.3	0.6	73.1	52.6	1.4
1984	236.9	86.7	2.7	128.6	131.5	1.0	76.8	52.9	1.5
1985	249.4	90.3	2.8	145.1	152.5	1.0	64.1	57.7	1.1
1986	233.2	84.7	2.8	163.7	135.7	1.2	80.2	49.5	1.6
1987	221.4	84.3	2.6	246.4	177.1	1.4	95.7	45.1	2.1
1988	270.1	89.1	3.0	248.2	194.9	1.3	155.3	53.4	2.9
1989	186.2	84.1	2.2	230.4	198.2	1.2	105.0	54.7	1.9
1990	314.4	99.5	3.2	307.3	207.6	1.5	128.0	53.1	2.4
1991	242.7	76.7	3.2	257.6	203.2	1.3	83.6	40.8	2.0
1992	232.1	86.4	2.7	256.0	196.1	1.3	80.6	39.9	2.0
1993	181.1	61.9	2.9	220.4	208.4	1.1	42.7	39.2	1.1
1994	78.7	53.7	1.5	173.9	220.0	0.8	41.4	38.8	1.1
1995	114.9	52.3	2.2	238.8	243.1	1.0	55.0	35.5	1.5
1996	119.9	60.5	2.0	303.1	260.8	1.2	59.2	30.5	1.9
1997	148.8	66.7	2.2	299.2	264.8	1.1	79.2	33.3	2.4
1998	119.2	62.1	1.9	265.1	254.6	1.0	62.3	29.8	2.1
1999	90.4	98.4	0.9	256.7	251.4	1.0	46.5	27.5	1.7
2000	110.6	104.1	1.1	187.3	259.0	0.7	52.4	30.5	1.7
2001	109.5	85.3	1.3	256.2	272.7	0.9	59.0	31.9	1.8
2002	79.7	82.7	1.0	129.9	249.5	0.5	33.9	28.3	1.2
2003	58.0	72.3	0.8	103.0	282.1	0.4	23.9	25.1	1.0
2004	44.0	75.7	0.6	96.0	273.9	0.4	15.0	25.6	0.6
2005	41.0	76.4	0.5	102.0	270.3	0.4	17.2	21.1	0.8
2006	55.2	83.3	0.7	90.9	252.0	0.4	13.5	21.1	0.6
2007	49.5	87.6	0.6	110.9	239.9	0.5	21.5	22.4	1.0
2008	49.2	71.2	0.7	70.9	216.9	0.3	24.2	19.9	1.2
2009	27.5	73.8	0.4	67.1	190.9	0.4	12.5	21.4	0.6
2010	31.0	77.6	0.4	65.3	195.9	0.3	15.2	26.1	0.6
2011	47.6	66.9	0.7	98.7	231.1	0.4	25.8	25.2	1.0

Units: landings in Tonnes live weight, Effort in 000s hours fished, lpue in Kg/hour fished.

Table 7.2.9. Cod in Divisions VIIe–k. Tuning indices used for exploratory XSA.

Cod in Divisions VIIe-k, tuning fleets,WGCSE10

```
102
FR-OTDEF Q2+3+4 trawlers in VIIe-k
2000    2011

1       1       0.25    1
1       10
217479  200742  93804   59384   35784   11253   5683    3988    545     356     0
223427  119879  383175  45401   44844   34907   11427   5256    2109    0       0
191161  188306  472476  144332  38748   16046   9760    4317    4212    252     0
184878  22380   134512  138065  59698   7928    7313    4455    847     424     0
164606  12412   54908   41644   21032   13420   1720    208     0       0       208
132472  13489   132632  10525   6207    8814    2861    367     54      237     0
117259  24447   148506  27730   3716    1912    1282    845     0       0       0
115878  265362  409573  76766   13367   2099    684     818     235     60      0
113485  77385   252690  44372   16057   4178    624     236     447     0       8
113348  106600  58211   46807   14017   5042    1939    894     353     0       19
100332  206831  103580  15881   8766    4600    678     102     0       17      0
101251 6870   1145981 92577   22801   17131   3074    551   0       0       0
IR-GFS FR-EVHOE Q4 combined indices

2003    2011
1       1       0.79    0.92
0       6
1       0.0     9.9     13.8    14.4    3.6     0.0     0.0
1       3.0     18.7    7.7     3.5     4.8     2.3     0.0
1       1.3     48.3    5.8     2.9     0.0     0.0     0.0
1       1.0     31.6    15.2    2.5     0.0     0.0     0.5
1       0.0     55.0    16.8    7.4     1.5     0.0     0.0
1       0.0     19.0    23.4    6.4     3.2     0.0     0.0
1       1.1     45.8    5.5     6.9     2.7     0.0     0.3
1       2.1     254.8   26.9    2.6     2.7     4.4     0.0
1       0.0     69.8    16.1    7.1     2.8     1.1     0.1
```

Table 7.2.10. Cod in Divisions VIIe–k. Final XSA. diagnostics.

```
Lowestoft VPA Version 3.1
   18/05/2012  11:01
 Extended Survivors Analysis
 Cod in Divisions VIIe-k,WKROUND2012,index file

 CPUE data from file fleets-xsa-final.txt

 Catch data for  41 years. 1971 to 2011. Ages  1 to   7.
      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 FR-OTDEF Q2+3+4 traw,   2000, 2011,   1,     6,   .250,  1.000
 IR-GFS FR-EVHOE Q4 c,   2003, 2011,   0,     6,   .790,   .920

 Time series weights :
      Tapered time weighting not applied

 Catchability analysis :
      Catchability independent of stock 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 =   1.000
      Minimum standard error for population
      estimates derived from each fleet =    .300
      Prior weighting not applied

 Tuning converged after   23 iterations


 Regression weights
       , 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000

 Fishing mortalities
    Age,  2002,  2003,  2004,  2005,  2006,  2007,  2008,  2009,  2010,  2011
      1,  .132,  .108,  .162,  .096,  .109,  .174,  .106,  .065,  .036,  .276
      2,  .814,  .870,  .714,  .760,  .747,  .930,  .618,  .505,  .332,  .415
      3, 1.087, 1.216,  .945, 1.126,  .911, 1.020,  .772,  .701,  .509,  .349
      4,  .869, 1.030, 1.026,  .973,  .698,  .648,  .875,  .648,  .478,  .473
      5,  .516,  .545, 1.004,  .970,  .853,  .636,  .638, 1.088,  .726,  .328
      6,  .261,  .267,  .675,  .527,  .920,  .671,  .698,  .641,  .938,  .344

XSA population numbers (Thousands)

                                 AGE
 YEAR ,   1,         2,         3,         4,         5,         6,
 2002 ,    2.19E+03, 4.46E+03, 1.55E+03, 1.26E+02, 9.26E+01, 5.86E+01,
 2003 ,    1.30E+03, 1.15E+03, 1.37E+03, 3.86E+02, 4.04E+01, 4.32E+01,
 2004 ,    2.94E+03, 7.02E+02, 3.33E+02, 2.99E+02, 1.05E+02, 1.83E+01,
 2005 ,    4.17E+03, 1.50E+03, 2.38E+02, 9.56E+01, 8.20E+01, 3.02E+01,
 2006 ,    4.60E+03, 2.27E+03, 4.85E+02, 5.69E+01, 2.76E+01, 2.43E+01,
 2007 ,    3.98E+03, 2.47E+03, 7.45E+02, 1.44E+02, 2.16E+01, 9.19E+00,
 2008 ,    1.58E+03, 2.01E+03, 6.75E+02, 1.98E+02, 5.76E+01, 8.95E+00,
 2009 ,    3.29E+03, 8.52E+02, 7.48E+02, 2.30E+02, 6.31E+01, 2.38E+01,
 2010 ,    1.93E+04, 1.85E+03, 3.56E+02, 2.74E+02, 9.20E+01, 1.66E+01,
 2011 ,    8.11E+03, 1.12E+04, 9.18E+02, 1.58E+02, 1.30E+02, 3.48E+01,

 Estimated population abundance at 1st Jan 2012
    ,     0.00E+00, 3.69E+03, 5.11E+03, 4.78E+02, 7.52E+01, 7.30E+01,

 Taper weighted geometric mean of the VPA populations:
    ,     4.88E+03, 2.48E+03, 8.48E+02, 2.91E+02, 1.10E+02, 4.32E+01,

 Standard error of the weighted Log(VPA populations) :
    ,        .7843,    .7709,    .6992,    .6227,    .6309,    .6704,
1
```

Log catchability residuals.

Fleet : FR-OTDEF Q2+3+4 traw

Age	2000	2001
1	-.01	-.40
2	-.38	-.57
3	-.44	-.01
4	-.41	.30
5	-.49	.49
6	.02	.24

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	1.58	-.01	-1.27	-1.36	-.73	1.85	1.52	1.08	.08	-2.32
2	-.07	.09	-.28	.08	-.11	.94	.51	-.17	-.35	.30
3	.00	.19	.37	-.35	-.10	.57	.00	-.09	-.42	.29
4	1.05	.49	-.18	-.08	-.11	.23	.25	-.17	-.79	.70
5	.26	.44	.39	.41	.03	.25	-.01	.34	-.21	.52
6	.06	.12	-.11	.03	-.21	.00	-.03	.10	-.30	.11

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

Age	1	2	3	4	5	6
Mean Log q	-8.8916	-6.7187	-6.8054	-6.8054	-6.8054	-6.8054
S.E(Log q)	1.3122	.4218	.3152	.5156	.3759	.1499

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	2.43	-1.221	9.61	.07	12	3.11	-8.89
2	.91	.648	6.80	.82	12	.39	-6.72
3	.86	.982	6.75	.84	12	.27	-6.81
4	1.25	-.737	7.06	.47	12	.64	-6.70
5	.99	.079	6.58	.80	12	.32	-6.60
6	.89	1.976	6.40	.97	12	.12	-6.80

1

Fleet : IR-GFS FR-EVHOE Q4 c

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	99.99	-.29	-.42	.12	-.39	.36	.17	.28	.20	-.02
2	99.99	.73	.51	-.49	.04	.22	.49	-.20	.47	-1.78
3	99.99	.49	.26	.56	-.48	.27	.01	-.08	-.48	-.56
4	99.99	.18	.72	99.99	99.99	-.03	.60	.09	-.23	.35
5	99.99	99.99	.99	99.99	99.99	99.99	99.99	99.99	1.54	-.53
6	99.99	99.99	99.99	99.99	.85	99.99	99.99	.12	99.99	-1.61

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

Age	1	2	3	4	5	6
Mean Log q	-4.0595	-4.0992	-3.7488	-3.7488	-3.7488	-3.7488
S.E(Log q)	.2974	.7698	.4288	.4279	1.3484	1.2907

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	.91	.701	4.42	.90	9	.28	-4.06
2	3.43	-2.917	-4.21	.17	9	1.90	-4.10
3	1.05	-.154	3.63	.61	9	.48	-3.75
4	.94	.148	3.62	.55	7	.35	-3.51
5	-.19	-6.852	4.99	.97	3	.04	-3.08
6	-.22	-2.802	3.16	.84	3	.13	-3.96

```
 Fleet disaggregated estimates of survivors :

 Age  1   Catchability constant w.r.t. time and dependent on age
 Year class = 2010
 FR-OTDEF Q2+3+4 traw
        Age,         1,
   Survivors,      362.,
 Raw Weights,      .407,


 IR-GFS FR-EVHOE Q4 c
        Age,         1,
   Survivors,     3606.,
 Raw Weights,     7.717,


 Fleet,         Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,         Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FR-OTDEF Q2+3+4 traw, 362.,  1.366,    .000,    .00,    1,  .045,    1.446
 IR-GFS FR-EVHOE Q4 c,3606.,   .314,    .000,    .00,    1,  .846,     .282

F shrinkage mean  ,     11228.,   1.00,,,,                      .110,     .099

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      3686.,       .29,      .44,    3,   1.516,   .276



 Age  2   Catchability constant w.r.t. time and dependent on age
 Year class = 2009
 FR-OTDEF Q2+3+4 traw
        Age,         2,         1,
   Survivors,     6886.,      5540.,
 Raw Weights,     3.428,       .342,

 IR-GFS FR-EVHOE Q4 c
        Age,         2,         1,
   Survivors,      866.,      6233.,
 Raw Weights,     1.003,      6.482,


Fleet,          Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,         Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FR-OTDEF Q2+3+4 traw,6752., .418,       .062,    .15,   2,  .308,     .329
 IR-GFS FR-EVHOE Q4 c,4784., .292,       .672,   2.30,   2,  .611,     .438

   F shrinkage mean  ,       2945.,   1.00,,,,                          .082,
.638

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      5112.,       .23,      .29,    5,   1.225,   .415



 Age  3   Catchability constant w.r.t. time and dependent on age
 Year class = 2008
 FR-OTDEF Q2+3+4 traw
        Age,         3,         2,         1,
   Survivors,      640.,       338.,      1413.,
 Raw Weights,     6.556,      2.628,       .254,




 IR-GFS FR-EVHOE Q4 c
        Age,         3,         2,         1,
   Survivors,      274.,       763.,       631.,
 Raw Weights,     3.454,       .769,      4.826,
```

```
 Fleet,    Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,    Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FR-OTDEF Q2+3+4 traw,  547.,   .261,       .230,    .88,   3,  .484,     .310
 IR-GFS FR-EVHOE Q4 c,  467.,   .250,       .297,   1.19,   3,  .464,     .356

 F shrinkage mean  ,    164.,   1.00,,,,                        .051,     .795

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       478.,       .18,      .18,    7,   1.030,   .349



Age  4  Catchability constant w.r.t. time and age (fixed at the value for age)
 Year class = 2007
 FR-OTDEF Q2+3+4 traw
        Age,         4,          3,          2,          1,
   Survivors,      152.,        49.,        64.,       344.,
 Raw Weights,     2.164,      3.481,      1.174,       .109,

 IR-GFS FR-EVHOE Q4 c
        Age,         4,          3,          2,          1,
   Survivors,      107.,        47.,        62.,        89.,
 Raw Weights,     2.978,      1.834,       .343,      2.070,


 Fleet,        Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,        Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FR-OTDEF Q2+3+4 traw, 76.,   .248,       .308,   1.24,   4,  .457,     .471
 IR-GFS FR-EVHOE Q4 c, 80.,   .241,       .195,    .81,   4,  .477,     .450

   F shrinkage mean  , 47.,   1.00,,,,                        .066,     .678

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        75.,       .17,      .16,    9,    .912,   .473



Age  5   Catchability constant w.r.t. time and age (fixed at the value for age)
 Year class = 2006
 FR-OTDEF Q2+3+4 traw
        Age,         5,          4,          3,          2,          1,
   Survivors,      122.,        33.,        67.,       121.,       463.,
 Raw Weights,     4.707,      1.551,      2.058,       .620,       .054,

 IR-GFS FR-EVHOE Q4 c
        Age,         5,          4,          3,          2,          1,
   Survivors,       43.,        58.,        67.,       119.,       105.,
 Raw Weights,      .297,      2.134,      1.084,       .181,      1.021,


 Fleet,        Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,        Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FR-OTDEF Q2+3+4 traw, 86.,   .239,       .256,   1.07,   5,  .611,     .286
 IR-GFS FR-EVHOE Q4 c, 69.,   .262,       .139,    .53,   5,  .321,     .344

F shrinkage mean  ,    23.,   1.00,,,,                        .068,     .798

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        73.,       .18,      .17,   11,    .950,   .328


Age  6   Catchability constant w.r.t. time and age (fixed at the value for age)
 Year class = 2005
 FR-OTDEF Q2+3+4 traw
  Age,          6,          5,          4,          3,          2,          1,
Survivors,     22.,        16.,        16.,        19.,        50.,         9.,
```

```
Raw Weights, 7.880,      2.241,       .623,       .770,       .170,       .016,


 IR-GFS FR-EVHOE Q4 c
  Age,        6,          5,          4,          3,          2,          1,
Survivors,    4.,        91.,        21.,        20.,        24.,        13.,
Raw Weights, .319,       .142,       .857,       .406,       .050,       .299,


Fleet,       Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,      Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FR-OTDEF Q2+3+4 traw,    20.,   .219,       .079,    .36,   6,  .792,     .332
 IR-GFS FR-EVHOE Q4 c,    17.,   .332,       .336,   1.01,   6,  .140,     .392

F shrinkage mean  ,       17.,   1.00,,,,                        .068,     .386

Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        20.,       .19,      .10,   13,    .499,   .344
```

Table 7.2.11. Cod in Divisions VIIe–k. Final XSA. Fishing mortality-at-age.

	YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	AGE											
1		0.2183	0.0056	0.1656	0.0015	0.1559	0.0337	0.0113	0.0975	0.0894	0.0666	0.0824
2		0.6839	0.5183	0.7318	0.209	0.3674	0.8366	0.5702	0.4326	0.3401	0.5141	0.78
3		0.6335	0.3972	0.5532	0.2912	0.3129	0.3267	0.3521	0.4058	0.5122	0.6024	0.991
4		0.5485	0.5681	0.4373	0.4088	1.1602	0.3327	0.1353	0.3234	0.4328	0.8985	0.8938
5		0.3581	0.5857	0.4422	0.5971	0.8714	0.716	0.3376	0.2876	0.5853	0.7681	0.5825
6		0.5182	0.5219	0.4819	0.4361	0.7909	0.4625	0.2768	0.3415	0.5149	0.7652	0.8325
	+gp	0.5182	0.5219	0.4819	0.4361	0.7909	0.4625	0.2768	0.3415	0.5149	0.7652	0.8325
0	FBAR 2- 5	0.556	0.5173	0.5411	0.3765	0.678	0.553	0.3488	0.3624	0.4676	0.6958	0.8118

	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
	AGE											
1		0.0475	0.2743	0.1535	0.173	0.1828	0.1499	0.2141	0.2676	0.1221	0.1702	0.1717
2		0.673	0.7465	0.619	0.5713	0.747	0.6025	0.6901	0.7646	0.9293	0.8653	0.7859
3		0.6457	0.9862	0.4998	0.6179	0.8743	0.7645	0.4964	1.0063	0.948	0.8688	0.9481
4		0.6351	0.8604	0.5144	0.4993	0.9728	1.1753	0.6048	0.5085	0.9601	1.1727	0.7239
5		0.5796	0.7406	0.4966	0.4447	0.5315	0.7336	0.7619	0.9745	0.6066	1.0183	0.9479
6		0.6267	0.8732	0.5083	0.5256	0.8024	0.9025	0.6276	0.84	0.8486	1.0338	0.8843
	+gp	0.6267	0.8732	0.5083	0.5256	0.8024	0.9025	0.6276	0.84	0.8486	1.0338	0.8843
0	FBAR 2- 5	0.6333	0.8334	0.5325	0.5333	0.7814	0.8189	0.6383	0.8135	0.861	0.9813	0.8514

	YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	AGE											
1		0.1004	0.1348	0.1162	0.113	0.1651	0.1784	0.316	0.229	0.1733	0.1322	0.1076
2		0.6558	0.5349	0.81	0.7392	0.8281	0.9145	0.7796	0.7759	0.8209	0.8143	0.8704
3		0.9071	1.0663	0.5859	0.9961	1.0434	0.9631	0.972	0.9331	0.6557	1.0866	1.2155
4		0.7042	0.7916	0.9183	0.6135	0.8285	1.0615	0.7587	0.6718	0.6548	0.869	1.0297
5		0.725	0.6018	0.5834	1.0543	0.4987	0.8131	0.8403	0.5265	0.7206	0.5159	0.5448
6		0.7881	0.83	0.7037	0.8993	0.7997	0.9583	0.8678	0.6587	0.4786	0.2614	0.2666
	+gp	0.7881	0.83	0.7037	0.8993	0.7997	0.9583	0.8678	0.6587	0.4786	0.2614	0.2666
0	FBAR 2- 5	0.748	0.7487	0.7244	0.8508	0.7997	0.9381	0.8377	0.7268	0.713	0.8215	0.9155

	YEAR	2004	2005	2006	2007	2008	2009	2010	2011	FBAR **-**
	AGE									
1		0.1622	0.0958	0.1091	0.1736	0.1059	0.0653	0.0362	0.2764	0.126
2		0.7142	0.7603	0.7469	0.9297	0.6179	0.5048	0.3318	0.4147	0.4171
3		0.9447	1.1258	0.9105	1.0199	0.7719	0.7014	0.509	0.3486	0.5197
4		1.0264	0.9732	0.6981	0.6477	0.8748	0.648	0.4785	0.4727	0.5331
5		1.0038	0.9701	0.8527	0.636	0.6381	1.0878	0.7263	0.3275	0.7139
6		0.6753	0.5271	0.9204	0.6712	0.6975	0.6405	0.9377	0.3436	0.6406
	+gp	0.6753	0.5271	0.9204	0.6712	0.6975	0.6405	0.9377	0.3436	
0	FBAR 2- 5	0.9235	0.9585	0.8021	0.8083	0.7242	0.7335	0.5074	0.3894	

Table 7.2.12 Cod in Divisions VIIe–k. Final XSA. Stock numbers-at-age.

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE											
1	4774	929	2810	888	6021	1986	2871	2738	6619	12215	5145
2	1119	2300	554	1427	532	3088	1151	1701	1489	3627	6849
3	1382	391	948	184	802	255	926	450	764	733	1501
4	260	541	194	402	102	432	136	480	221	338	296
5	132	115	234	96	204	24	237	91	266	110	105
6	47	72	50	118	41	67	9	132	53	116	40
+gp	30	46	32	112	66	21	78	76	88	29	23
Total	7744	4394	4822	3228	7768	5873	5406	5669	9499	17168	13960

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE											
1	2115	6918	6690	5904	5034	25442	12267	3664	4046	11364	11740
2	2839	1209	3151	3439	2976	2513	13126	5935	1680	2146	5744
3	2173	1003	397	1174	1344	976	952	4556	1912	459	625
4	411	841	276	178	467	414	335	428	1229	547	142
5	93	167	272	126	82	135	98	140	197	360	129
6	46	41	62	129	63	38	51	36	41	84	101
+gp	12	21	14	41	34	28	19	21	31	24	32
Total	7689	10198	10861	10990	10001	29545	26847	14780	9136	14983	18514

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE											
1	3704	13726	9693	7458	10047	5053	2365	10685	8857	2190	1304
2	5926	2008	7189	5172	3992	5105	2533	1033	5094	4464	1150
3	1812	2129	814	2213	1709	1207	1416	804	329	1551	1369
4	179	540	541	334	603	444	340	395	233	126	386
5	53	68	187	165	138	201	117	122	154	93	40
6	39	20	29	81	45	66	70	40	56	59	43
+gp	32	33	11	7	12	14	26	32	55	53	33
Total	11744	18523	18463	15431	16546	12090	6867	13111	14779	8536	4326

YEAR	2004	2005	2006	2007	2008	2009	2010	2011	2012	GMST	AMST
AGE										71-**	71-**
1	2941	4170	4605	3980	1581	3289	19370	8113	0	4651	6098
2	702	1499	2271	2472	2005	852	1847	11183	3686	2400	3130
3	333	238	485	745	675	748	356	918	5112	865	1089
4	299	96	57	144	198	230	274	158	478	296	354
5	105	82	28	22	58	63	92	130	75	110	131
6	18	30	24	9	9	24	17	35	73	45	54
+gp	16	5	9	9	9	5	4	8	24		
Total	4415	6120	7478	7381	4535	5211	21960	20541	9449		

Table 7.2.13 Cod in Divisions VIIe–k. Final XSA Summary table.

	Recruitment-at-age 1 (thousands)	TSB (tonnes)	SSB (tonnes)	Landings (tonnes)	Yield/SSB	Mean F age 2-5
1971	4774	15358	10100	5782	0.57	0.556
1972	929	12830	9314	4737	0.51	0.517
1973	2810	11710	8625	4015	0.47	0.541
1974	888	10719	8330	2898	0.35	0.377
1975	6021	12574	7518	3993	0.53	0.678
1976	1986	12209	7307	4818	0.66	0.553
1977	2871	12543	8839	3059	0.35	0.349
1978	2738	13780	9688	3647	0.38	0.362
1979	6619	16323	9835	4650	0.47	0.468
1980	12215	22794	10329	7243	0.7	0.696
1981	5145	20623	11177	10597	0.95	0.812
1982	2115	18826	13451	8766	0.65	0.633
1983	6918	18539	13004	9641	0.74	0.833
1984	6690	17142	9568	6631	0.69	0.532
1985	5904	21773	13082	8317	0.64	0.533
1986	5034	21028	13752	10475	0.76	0.781
1987	25442	28586	11472	10228	0.89	0.819
1988	12267	41509	16629	17191	1.03	0.638
1989	3664	37673	26382	19809	0.75	0.813
1990	4046	25249	19240	12749	0.66	0.861
1991	11364	19519	10845	9336	0.86	0.981
1992	11740	21914	9073	9747	1.07	0.851
1993	3704	20978	12278	10425	0.85	0.748
1994	13726	26270	14367	10620	0.74	0.749
1995	9693	26049	13043	11709	0.9	0.724
1996	7458	26461	15950	12681	0.8	0.851
1997	10047	23529	14167	12035	0.85	0.8
1998	5053	19828	12721	11431	0.9	0.938
1999	2365	16393	11218	8594	0.77	0.837
2000	10685	15681	7993	6536	0.82	0.727
2001	8857	19435	8996	8308	0.92	0.713
2002	2190	16398	11245	9236	0.82	0.822
2003	1304	11575	9106	6420	0.7	0.916
2004	2941	7362	4768	3672	0.77	0.924
2005	4170	7656	3495	3062	0.88	0.959
2006	4605	9066	3850	3776	0.98	0.802
2007	3989	10635	5204	4830	0.93	0.808
2008	1581	9216	5601	3961	0.71	0.724
2009	3293	9781	5361	3292	0.61	0.733
2010	19370	23145	5337	3229	0.61	0.507
2011	8113	23358	11451	LAN: 4737	0.63	0.389
2012	4652		25453			
Mean	6428	18440	10912	7728	0.73	0.704

Table 7.2.14. Cod in Divisions VIIe–k. Short-term forecast input table.

2012

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	4652	0.51	0.00	0.00	0.00	0.710	0.099	0.769
2	3689	0.37	0.39	0.00	0.00	1.422	0.328	2.020
3	5122	0.30	0.87	0.00	0.00	4.145	0.407	4.529
4	479	0.27	0.93	0.00	0.00	6.927	0.416	7.250
5	75	0.25	1.00	0.00	0.00	9.427	0.557	9.465
6	75	0.23	1.00	0.00	0.00	11.090	0.501	11.043
7	25	0.22	1.00	0.00	0.00	12.780	0.501	11.760

2013

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	4652	0.51	0.00	0.00	0.00	0.710	0.099	0.769
2		0.37	0.39	0.00	0.00	1.422	0.328	2.020
3		0.30	0.87	0.00	0.00	4.145	0.407	4.529
4		0.27	0.93	0.00	0.00	6.927	0.417	7.250
5		0.25	1.00	0.00	0.00	9.427	0.557	9.465
6		0.23	1.00	0.00	0.00	11.090	0.501	11.043
7		0.22	1.00	0.00	0.00	12.780	0.501	11.760

2014

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	4652	0.51	0.00	0.00	0.00	0.710	0.099	0.769
2		0.37	0.39	0.00	0.00	1.422	0.328	2.020
3		0.30	0.87	0.00	0.00	4.145	0.407	4.529
4		0.27	0.93	0.00	0.00	6.927	0.417	7.250
5		0.25	1.00	0.00	0.00	9.427	0.557	9.465
6		0.23	1.00	0.00	0.00	11.090	0.501	11.043
7		0.22	1.00	0.00	0.00	12.780	0.501	11.760

Table 7.2.15a Cod in Divisions VIIe–k. Short-term forecast. Single option output table. F_{2012} based on landings equal to TAC (10 059 t).

Year:	2012	F multiplier:	1	Fbar:	0.427				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.099	345	265	4652	3303	0	0	0	0
2	0.328	871	1759	3689	5246	1439	2046	1439	2046
3	0.407	1495	6769	5122	21231	4456	18471	4456	18471
4	0.416	144	1045	479	3318	445	3086	445	3086
5	0.557	29	271	75	707	75	707	75	707
6	0.501	27	294	75	832	75	832	75	832
7	0.501	9	105	25	320	25	320	25	320
Total		2919	10510	14117	34956	6515	25461	6515	25461

Year:	2013	F multiplier:	1	Fbar:	0.427				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.099	345	265	4652	3303	0	0	0	0
2	0.328	597	1207	2530	3598	987	1403	987	1403
3	0.407	536	2426	1836	7608	1597	6619	1597	6619
4	0.416	760	5512	2526	17496	2349	16271	2349	16271
5	0.557	92	873	241	2274	241	2274	241	2274
6	0.501	12	131	33	371	33	371	33	371
7	0.501	17	203	48	617	48	617	48	617
Total		2360	10617	11866	35267	5256	27556	5256	27556

Year:	2014	F multiplier:	1	Fbar:	0.427				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.099	345	265	4652	3303	0	0	0	0
2	0.328	597	1207	2530	3598	987	1403	987	1403
3	0.407	367	1664	1259	5218	1095	4540	1095	4540
4	0.416	272	1975	905	6270	842	5831	842	5831
5	0.557	486	4602	1272	11991	1272	11991	1272	11991
6	0.501	38	422	108	1194	108	1194	108	1194
7	0.501	14	166	40	506	40	506	40	506
Total		2121	10302	10765	32079	4343	25464	4343	25464

Input units are thousands and kg - output in tonnes.

Table 7.2.15b Cod in Divisions VIIe–k. Short-term forecast. Single option output table. *Status quo F*.

Year:	2012	F multiplier:	0.9486	Fbar:	0.405				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0939	328	252	4652	3303	0	0	0	0
2	0.3111	832	1681	3689	5246	1439	2046	1439	2046
3	0.3861	1431	6481	5122	21231	4456	18471	4456	18471
4	0.3946	138	1001	479	3318	445	3086	445	3086
5	0.5284	28	261	75	707	75	707	75	707
6	0.4752	26	282	75	832	75	832	75	832
7	0.4752	9	101	25	320	25	320	25	320
Total		2791	10059	14117	34956	6515	25461	6515	25461

Year:	2013	F multiplier:	1	Fbar:	0.427				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.099	345	265	4652	3303	0	0	0	0
2	0.328	600	1213	2543	3616	992	1410	992	1410
3	0.407	545	2467	1867	7738	1624	6732	1624	6732
4	0.416	776	5629	2579	17866	2399	16615	2399	16615
5	0.557	94	892	246	2323	246	2323	246	2323
6	0.501	12	135	34	382	34	382	34	382
7	0.501	18	208	50	633	50	633	50	633
Total		2391	10809	11971	35861	5345	28096	5345	28096

Year:	2014	F multiplier:	1	Fbar:	0.427				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.099	345	265	4652	3303	0	0	0	0
2	0.328	597	1207	2530	3598	987	1403	987	1403
3	0.407	369	1672	1265	5245	1101	4563	1101	4563
4	0.416	277	2009	921	6377	856	5930	856	5930
5	0.557	496	4699	1299	12244	1299	12244	1299	12244
6	0.501	39	432	110	1219	110	1219	110	1219
7	0.501	15	171	41	520	41	520	41	520
Total		2139	10455	10818	32506	4393	25880	4393	25880

Input units are thousands and kg - output in tonnes.

Table 7.2.16a Cod in Divisions VIIe–k. Short-term forecast. Management options output. F_{2012} based on landings equals to TAC (10 059 t).

2012				
Biomass	SSB	FMult	FBar	Landings
34956	25461	0.9486	0.405	10059

2013					2014	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
35861	28096	0	0	0	45683	38340
	28096	0.1	0.0427	1280	44113	36851
	28096	0.2	0.0854	2512	42606	35423
	28096	0.3	0.1281	3695	41158	34052
	28096	0.4	0.1708	4834	39768	32736
	28096	0.5	0.2135	5929	38433	31473
	28096	0.6	0.2562	6982	37150	30261
	28096	0.7	0.2989	7995	35918	29098
	28096	0.8	0.3416	8969	34735	27981
	28096	0.9	0.3843	9907	33598	26909
	28096	1	0.427	10809	32506	25880
	28096	1.1	0.4697	11677	31457	24892
	28096	1.2	0.5124	12512	30448	23944
	28096	1.3	0.5551	13316	29479	23033
	28096	1.4	0.5978	14090	28548	22159
	28096	1.5	0.6405	14836	27654	21319
	28096	1.6	0.6832	15553	26794	20513
	28096	1.7	0.7259	16244	25967	19739
	28096	1.8	0.7686	16909	25173	18996
	28096	1.9	0.8113	17549	24409	18282
	28096	2	0.854	18166	23675	17596

Input units are thousands and kg - output in tonnes.

Table 7.2.16b Cod in Divisions VIIe–k. Short-term forecast. Management options output. *Status quo* F.

2012				
Biomass	SSB	FMult	FBar	Landings
34956	25461	1	0.427	10510

2013					2014	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
35267	27556	0	0	0	45034	37706
.	27556	0.1	0.0427	1257	43491	36244
.	27556	0.2	0.0854	2467	42009	34841
.	27556	0.3	0.1281	3629	40586	33494
.	27556	0.4	0.1708	4747	39219	32201
.	27556	0.5	0.2135	5823	37907	30960
.	27556	0.6	0.2562	6857	36646	29770
.	27556	0.7	0.2989	7852	35435	28626
.	27556	0.8	0.3416	8810	34271	27529
.	27556	0.9	0.3843	9731	33153	26476
.	27556	1	0.427	10617	32079	25464
.	27556	1.1	0.4697	11470	31048	24494
.	27556	1.2	0.5124	12290	30056	23561
.	27556	1.3	0.5551	13080	29103	22667
.	27556	1.4	0.5978	13841	28188	21807
.	27556	1.5	0.6405	14573	27308	20982
.	27556	1.6	0.6832	15278	26462	20190
.	27556	1.7	0.7259	15957	25649	19429
.	27556	1.8	0.7686	16610	24868	18699
.	27556	1.9	0.8113	17240	24117	17997
.	27556	2	0.854	17846	23395	17323

Input units are thousands and kg - output in tonnes.

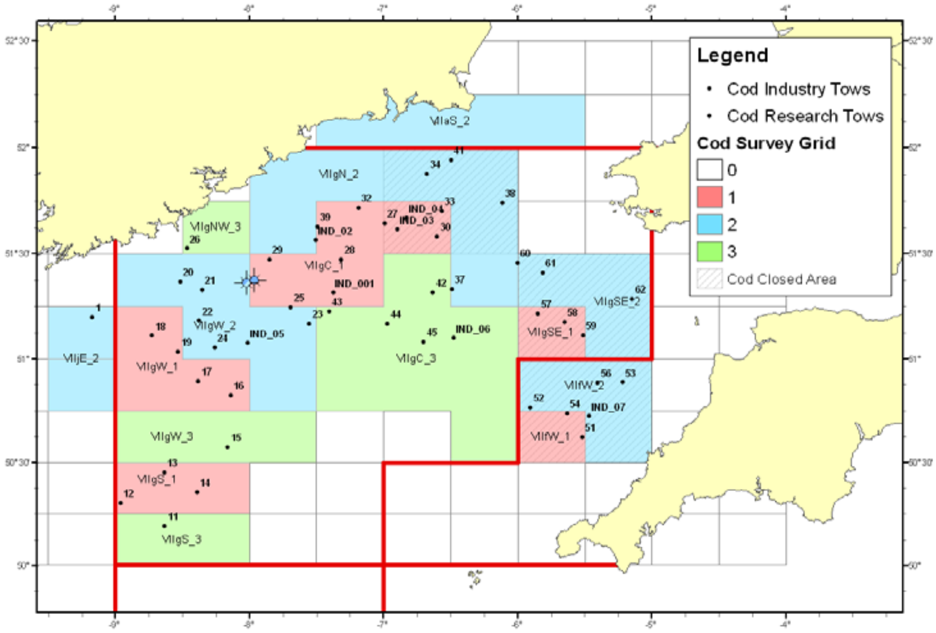


Figure 7.2.1. Irish industry and science survey. Map of sampled stations.

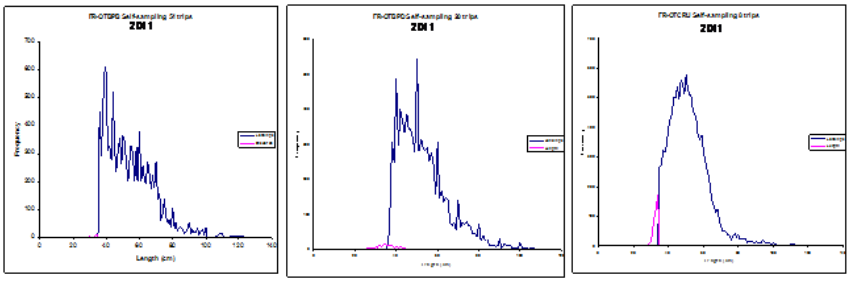


Figure 7.2.2. Annual length compositions of sampling and discards from the French self sampling programme.

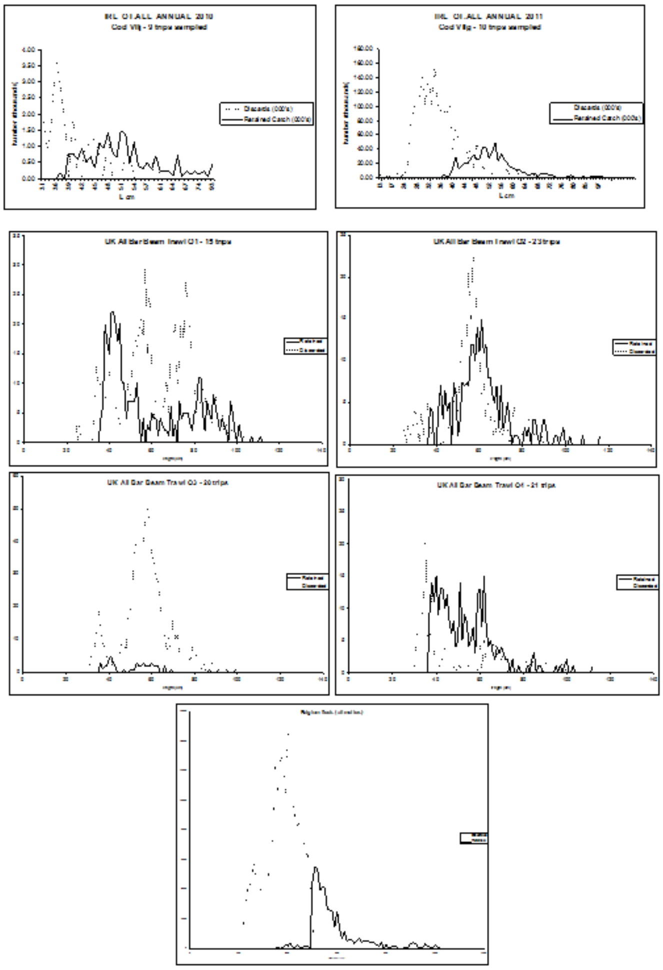


Figure 7.2.3a. Cod in Divisions VIIe–k. 2011 Quarterly or annual length compositions of UK, Irish discards raised using effort ratio for Irish data, from hauls sampled for UK. Quarterly or annual length compositions of Belgian discards from observers at sea.

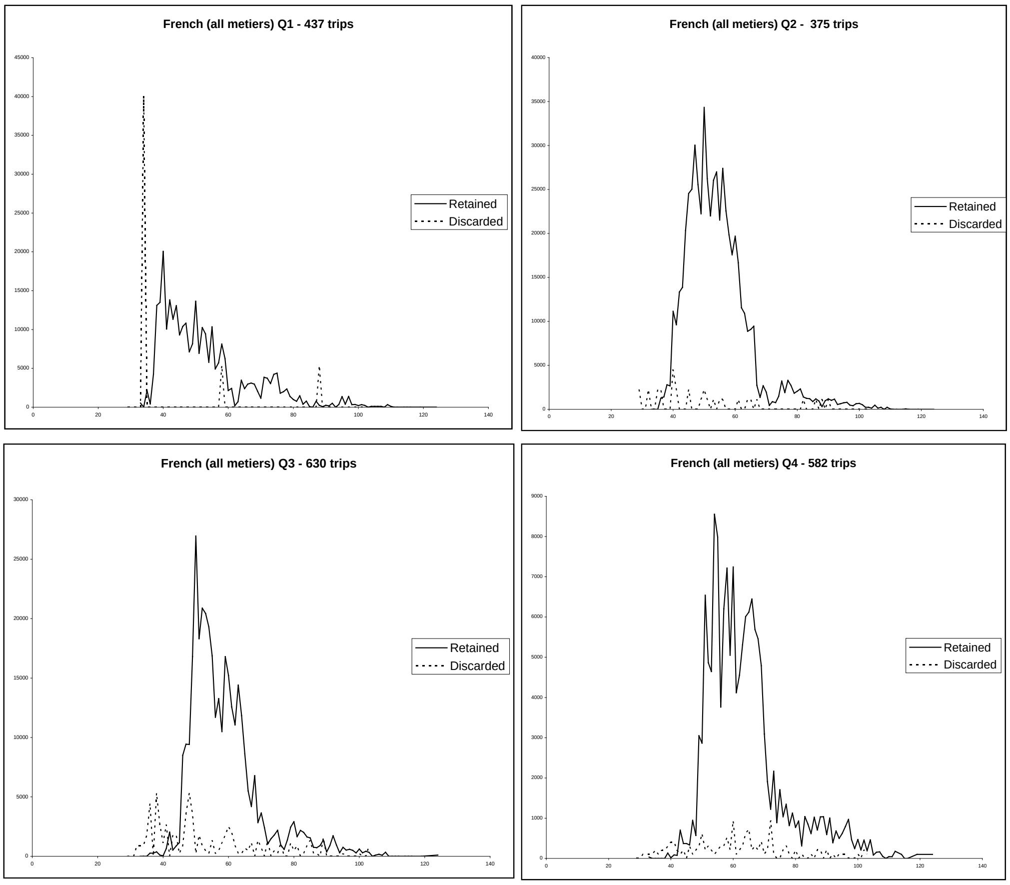


Figure 7.2.3b. Cod in Divisions VIIe–k. 2010 Annual length composition of French landings and discards available from hauls sampled by observers at sea.

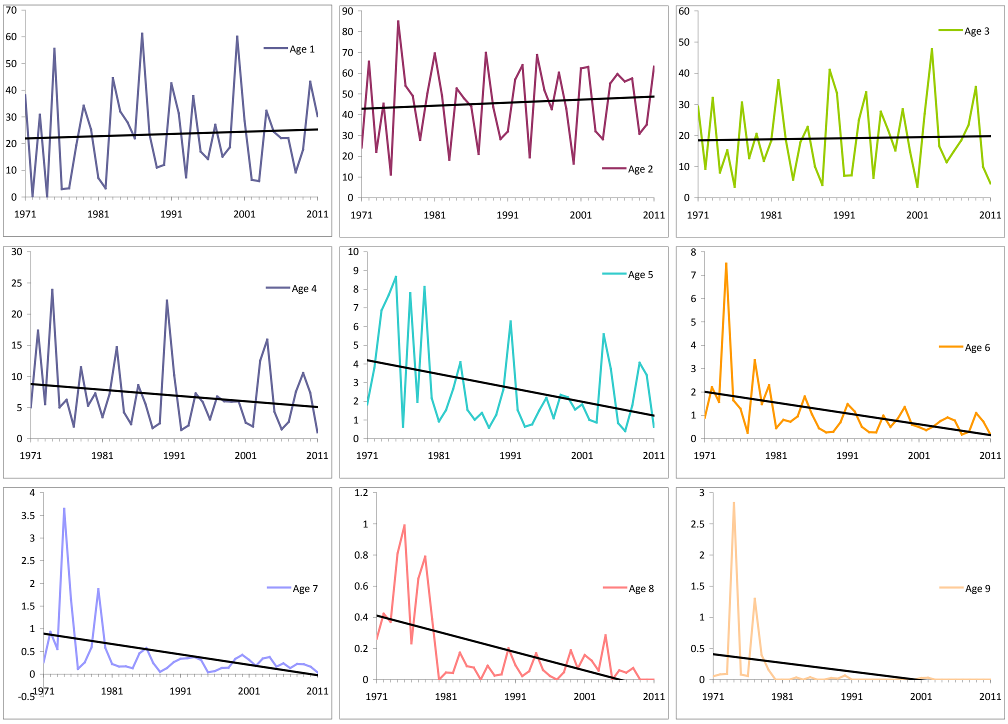
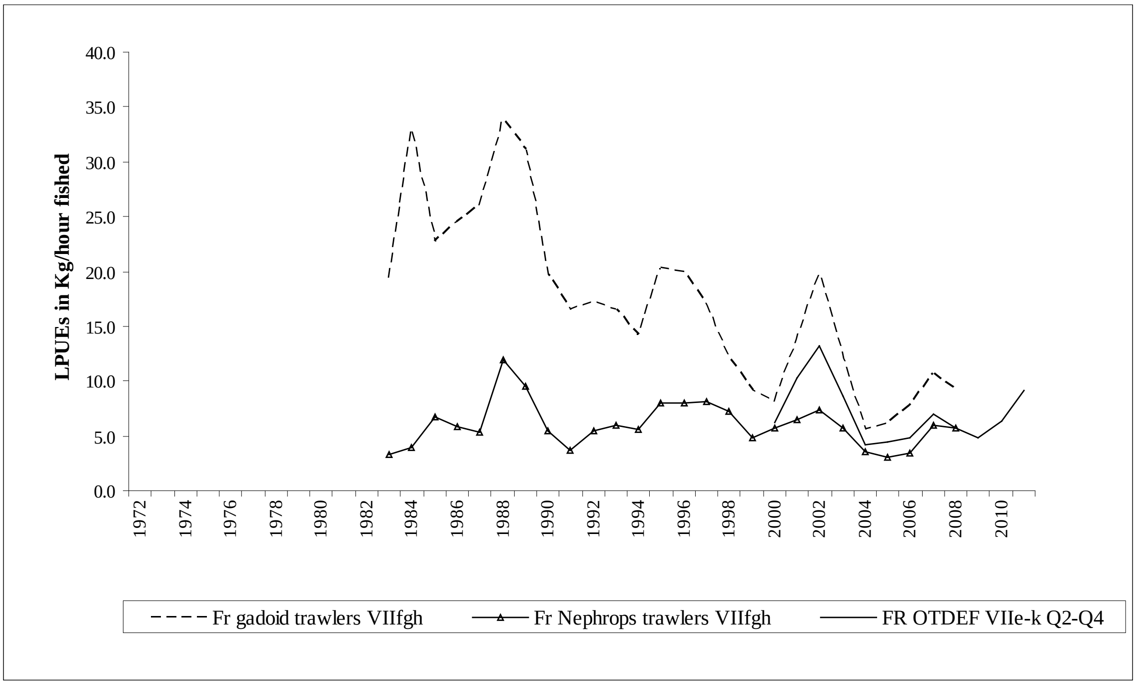


Figure 7.2.4.Cod in Divisions VIIe–k. Percentage of landings accounted for by each age class in Celtic Sea cod over the time-series.



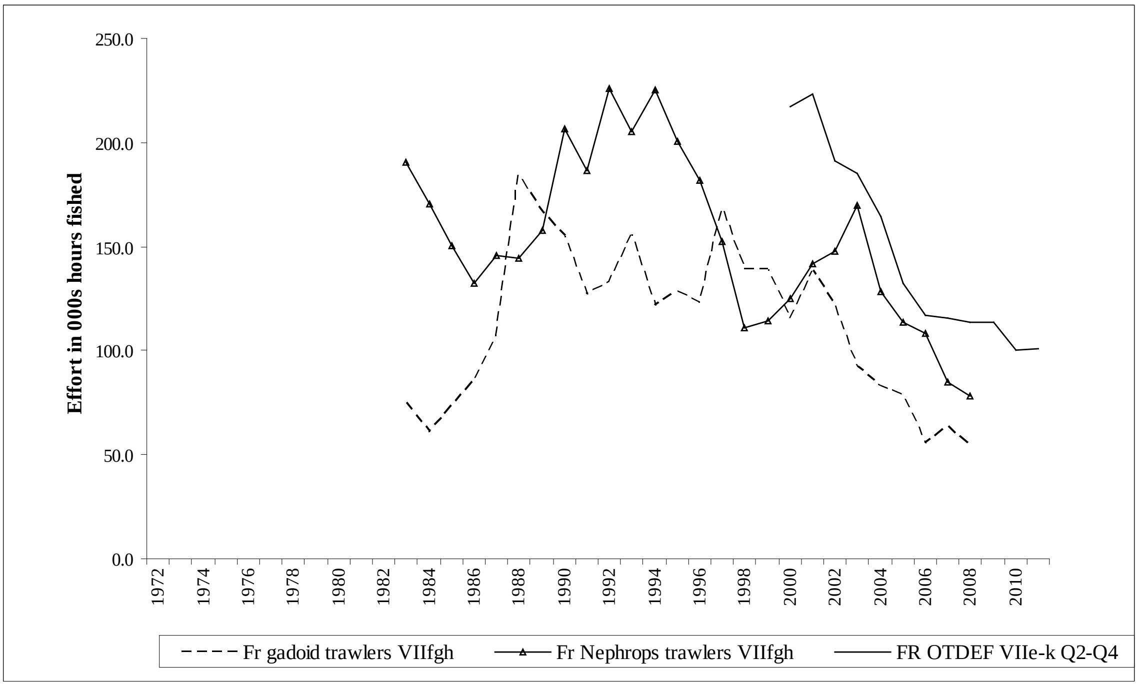
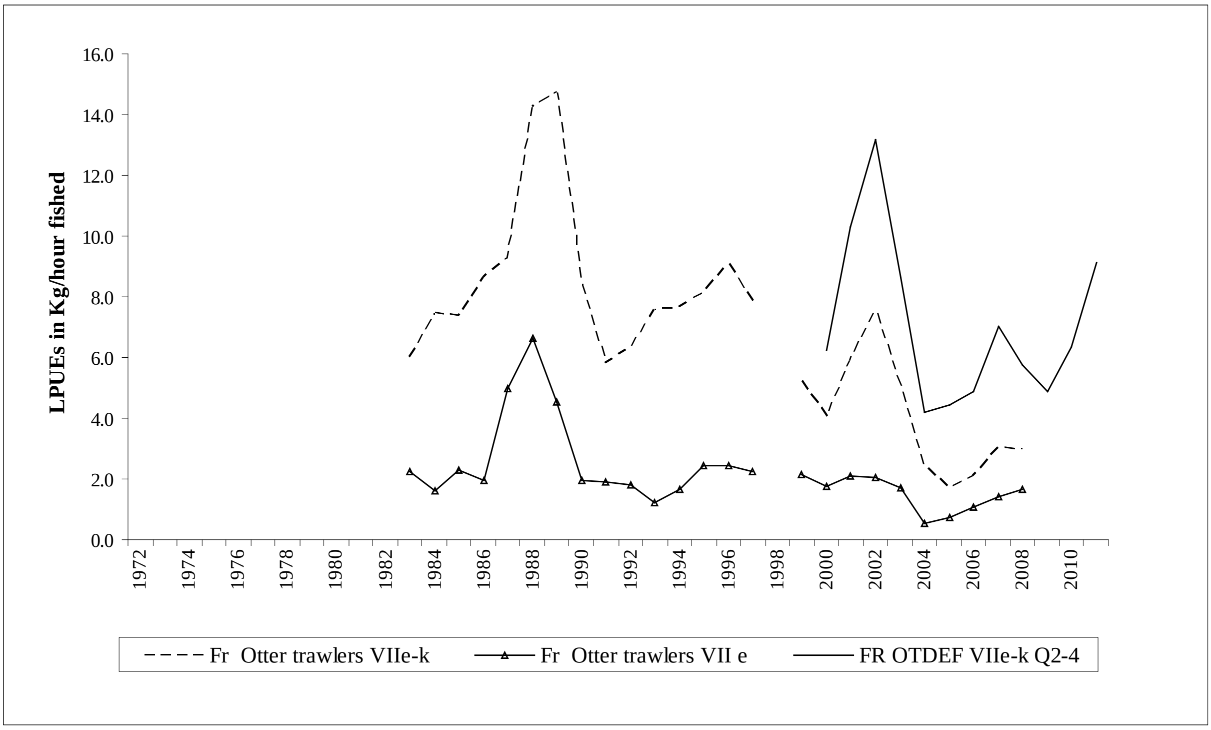


Figure 7.2.5a. Cod in Divisions VIIe–k. Trends of lpues and effort. French Gadoid trawlers and French *Nephrops* trawlers in VIIfgh.



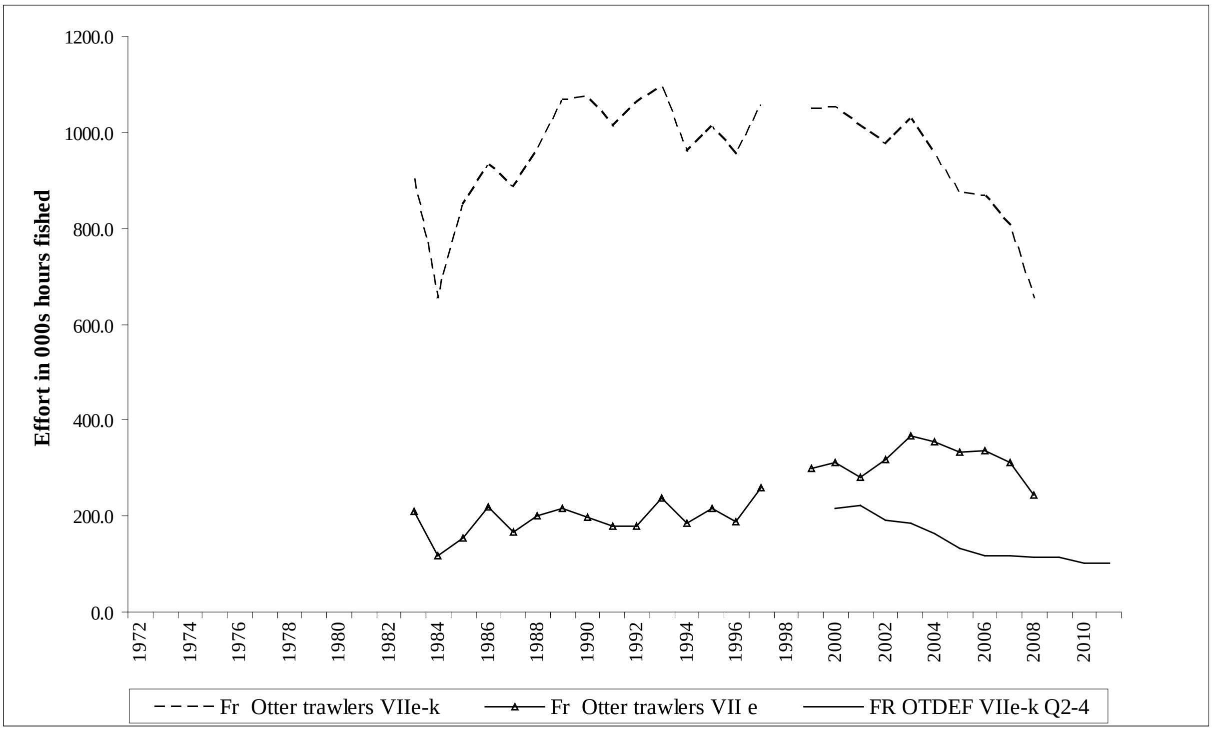
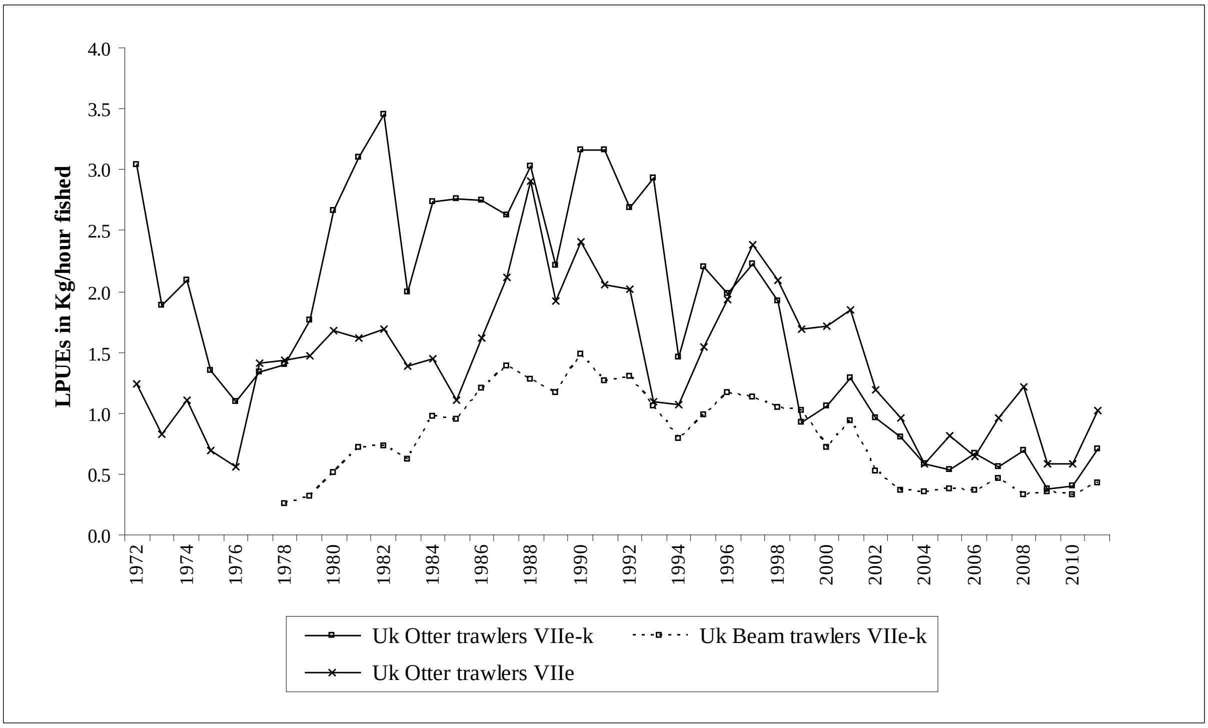


Figure 7.2.5a. Continued. Cod in Divisions VIIe–k. Trends of lpues and effort. French otter trawlers in VIIe–k (including Gadoid trawlers and *Nephrops* trawlers in VIIfgh) and French otter trawlers in VIIe.



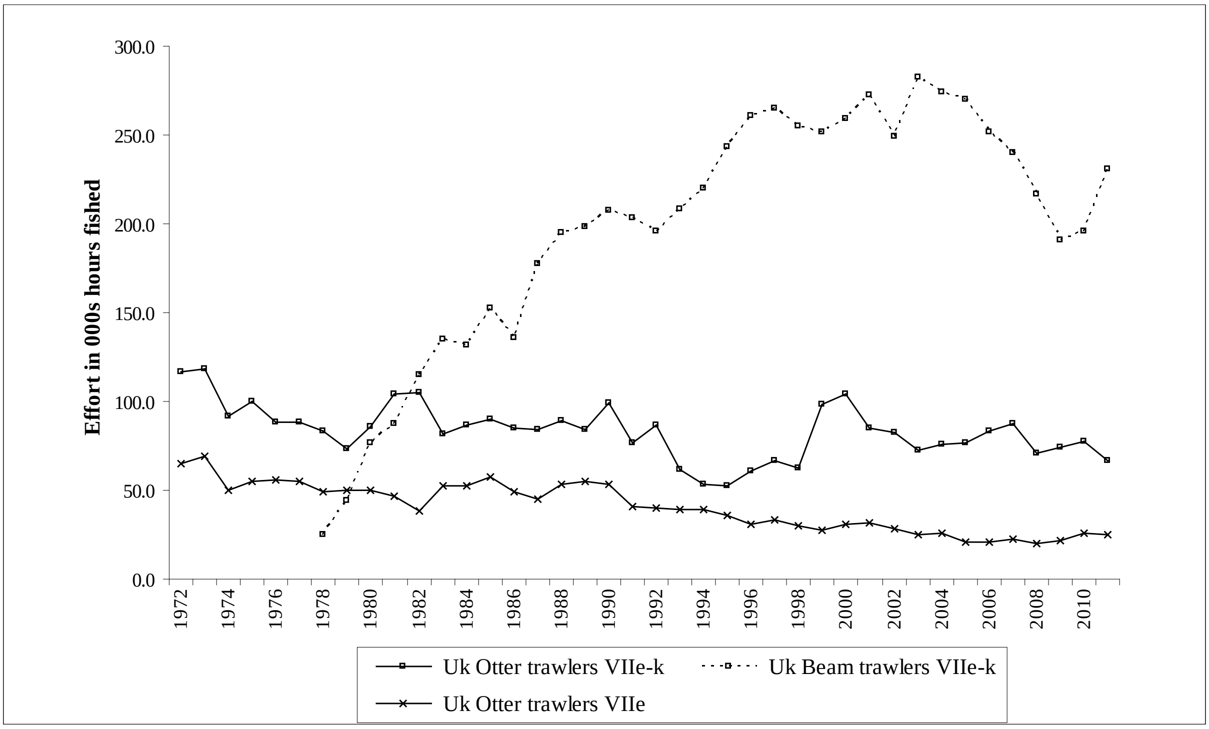
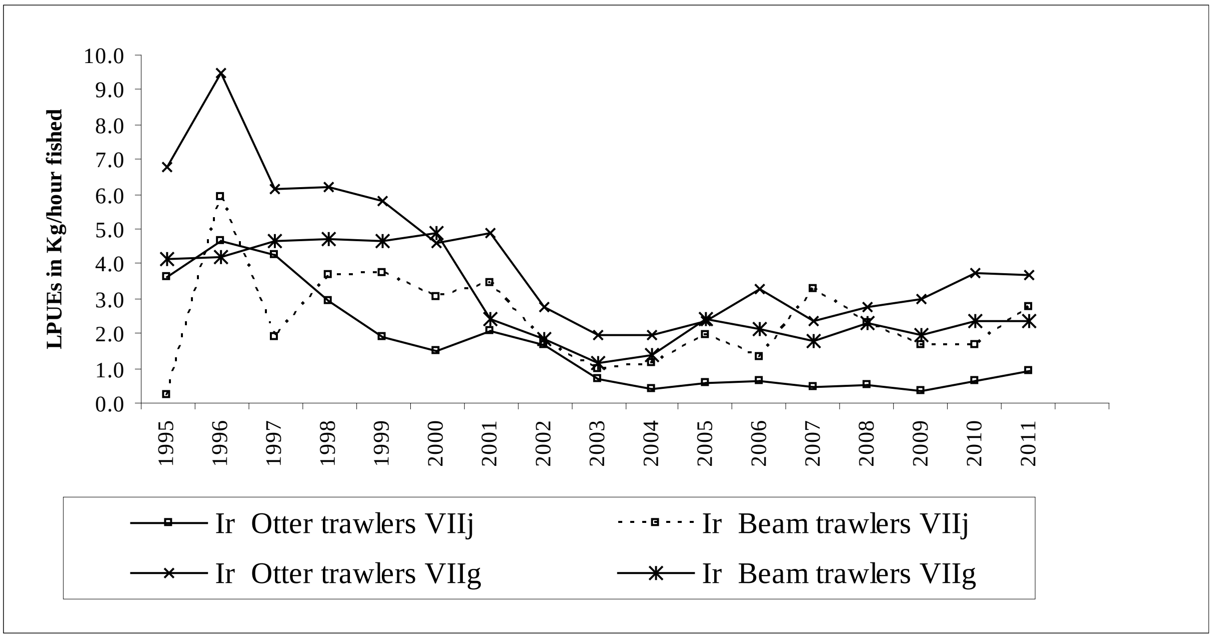


Figure 7.2.5a. Continued. Cod in Divisions VIIe–k. Trends of lpues and effort. UK otter trawlers in VIIe–k and VIIe, UK beam trawlers in VIIe–k.



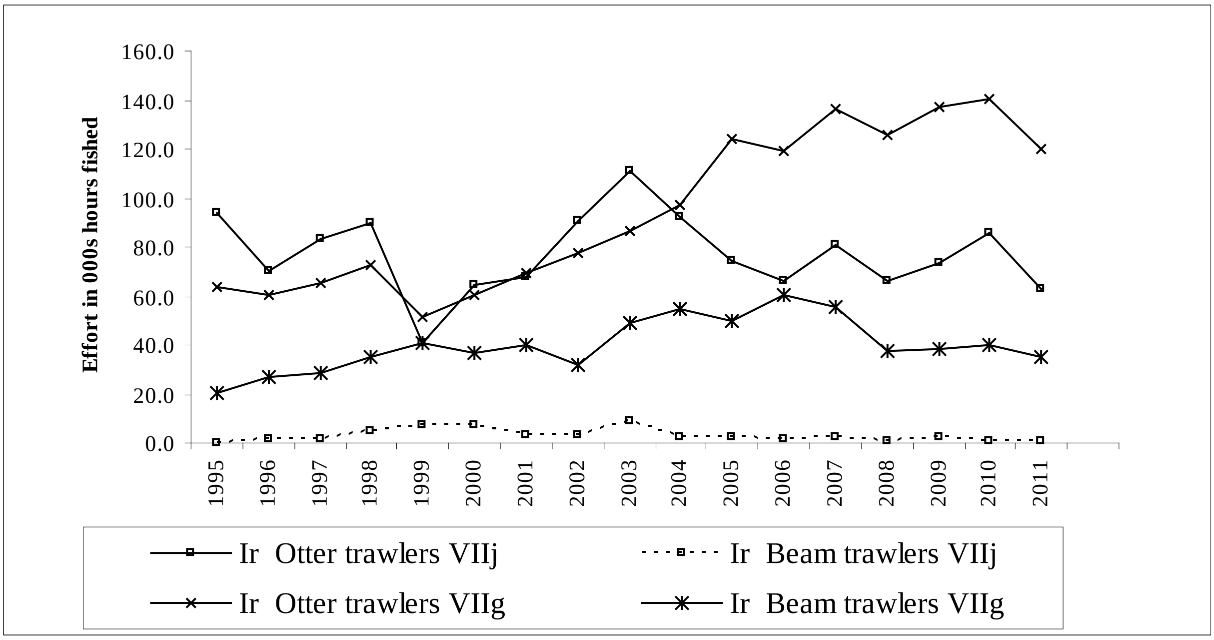
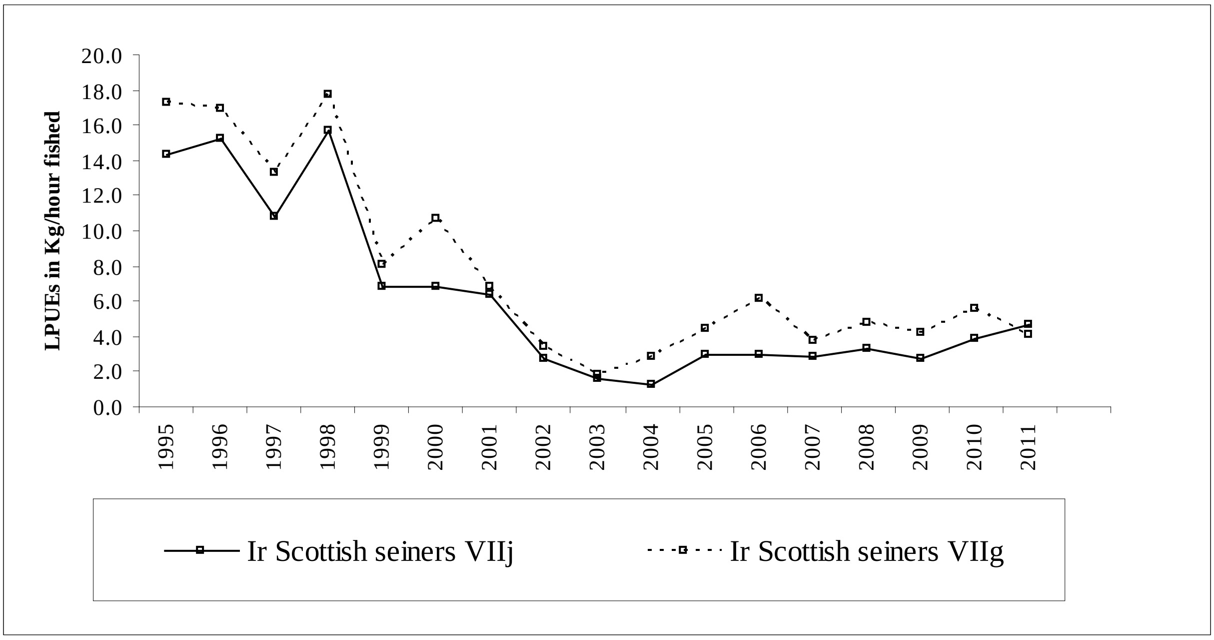


Figure 7.2.5b. Cod in Divisions VIIe–k. Trends of lpues and effort. Irish otter trawlers in VIIg and VIIj, Irish beam trawlers in VIIg and VIIj.



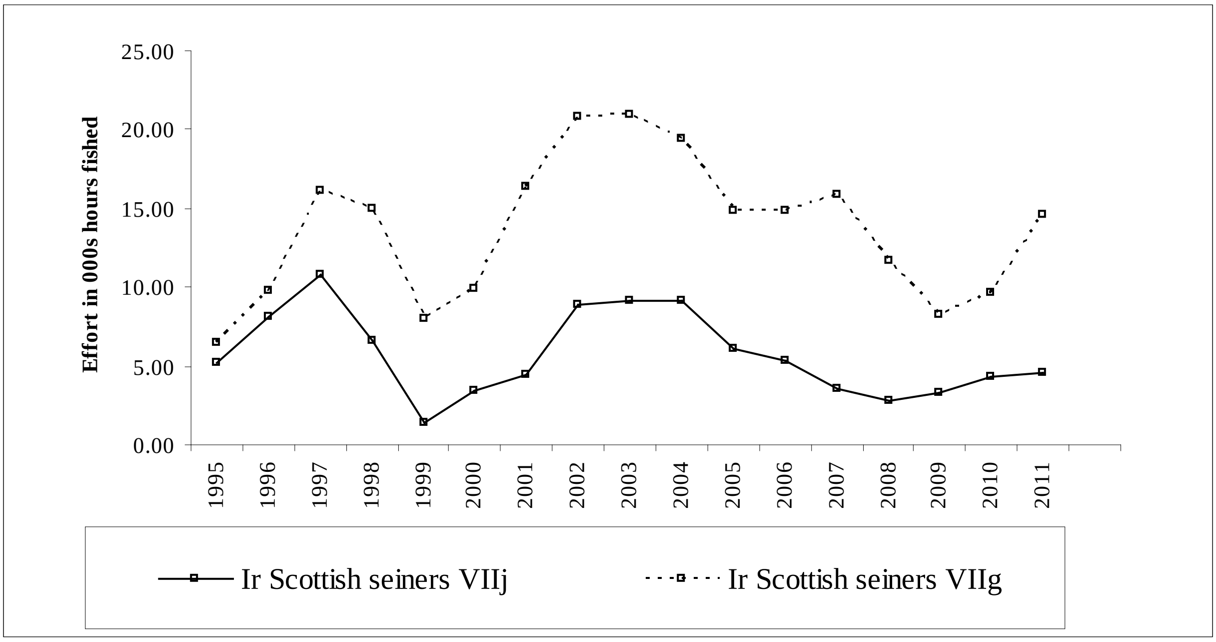


Figure 7.2.5b. Cod in Divisions VIIe–k. Trends of lpues and effort. Irish Scottish seiners in VIIg and VIIj.

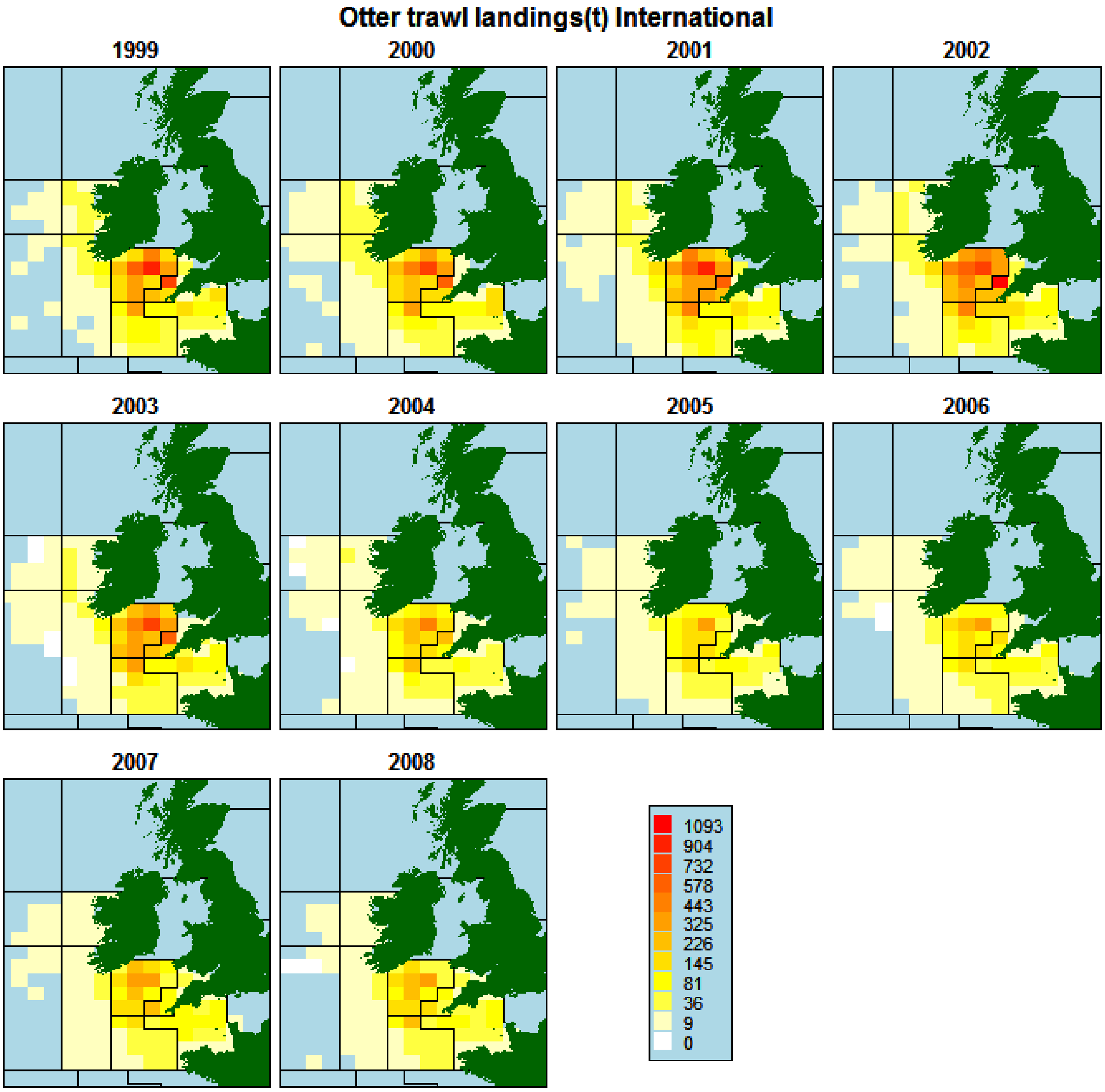


Figure 7.2.6. Cod in VII e–k. Distribution of landings by otter trawlers in the TAC area.

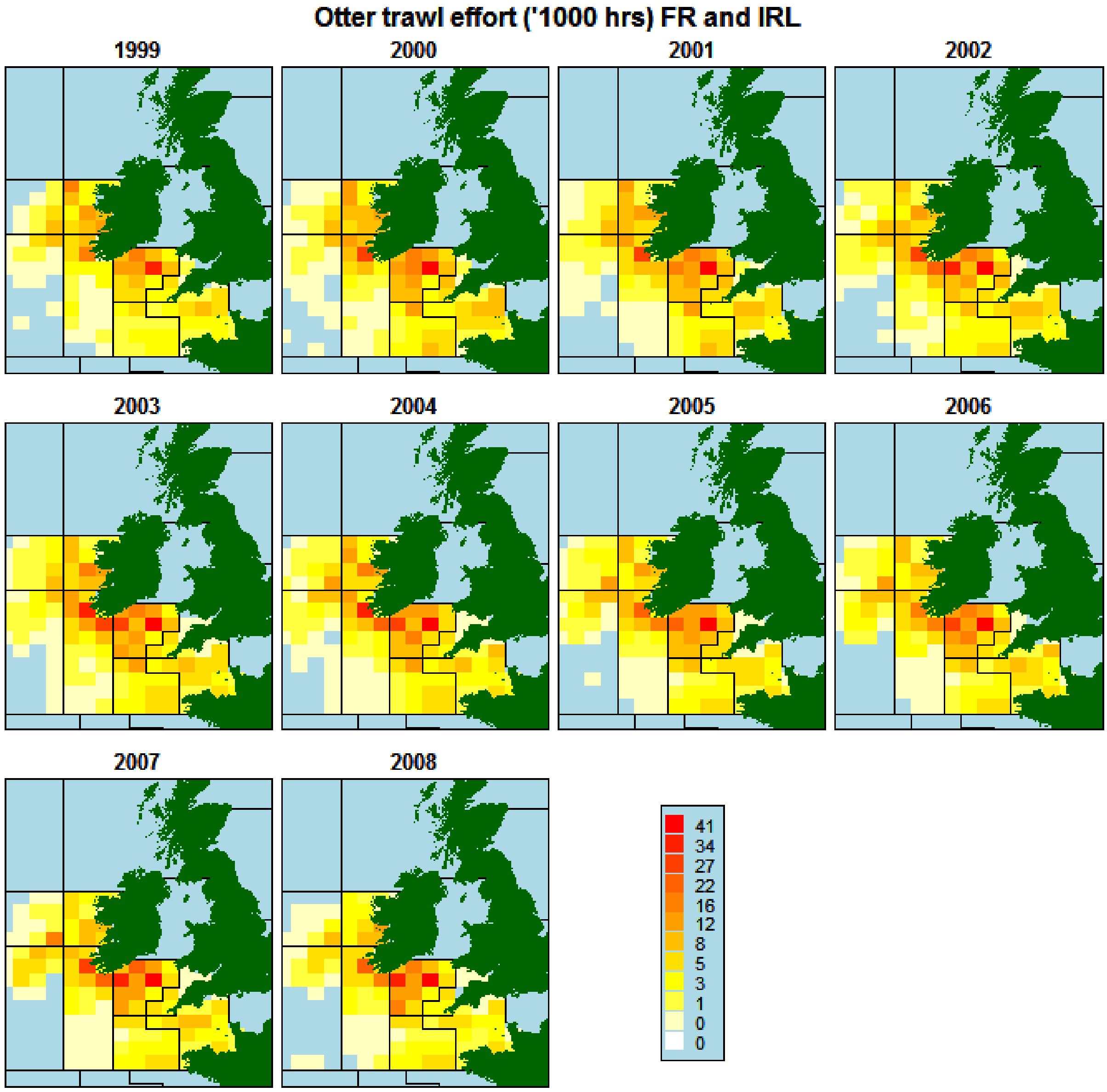


Figure 7.2.7. Cod in VII e–k. Distribution of effort by French and Irish otter trawlers in the TAC area.

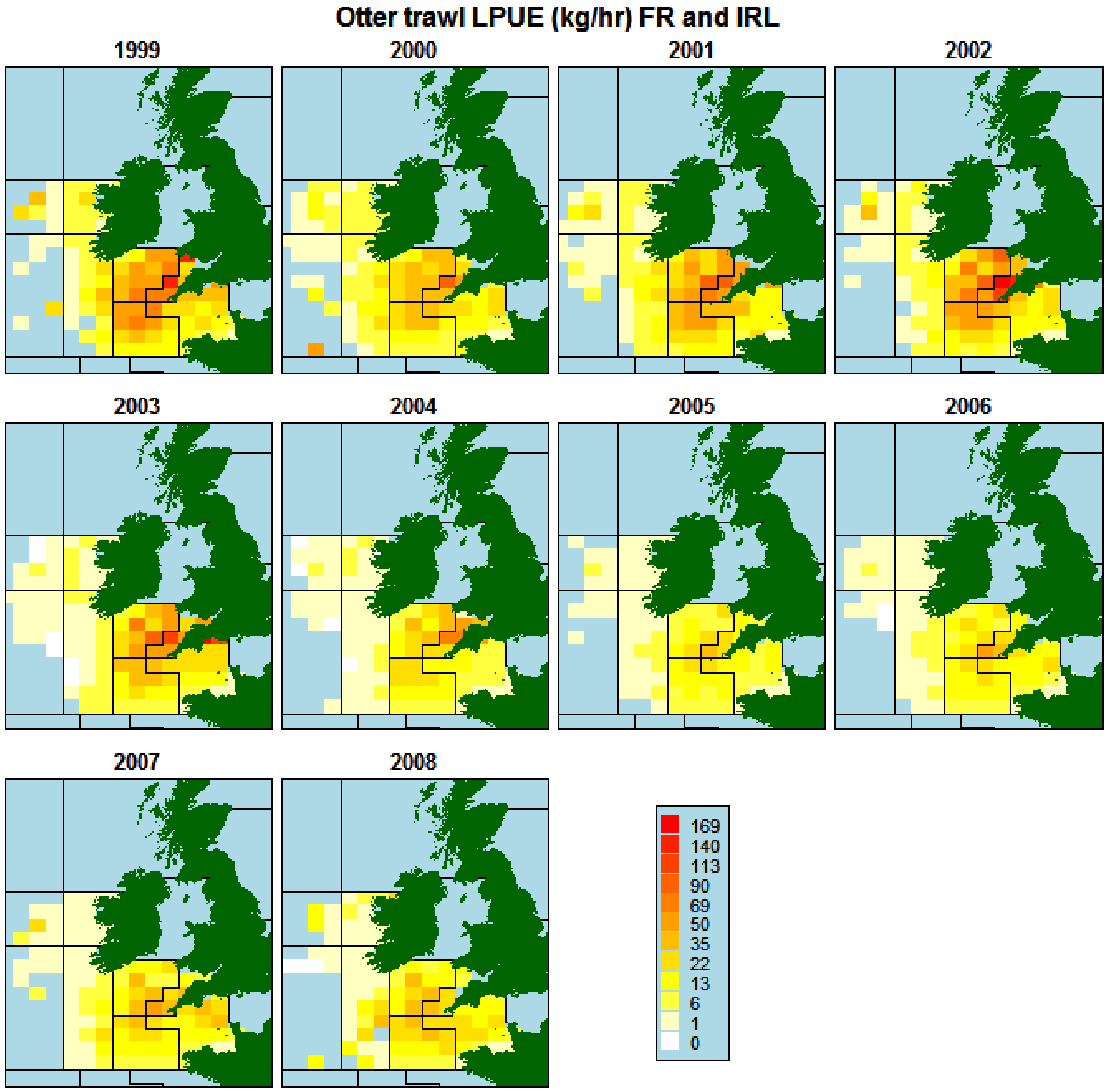


Figure 7.2.8. Cod in VII e–k. Distribution of lpues by French and Irish otter trawlers in the TAC area.

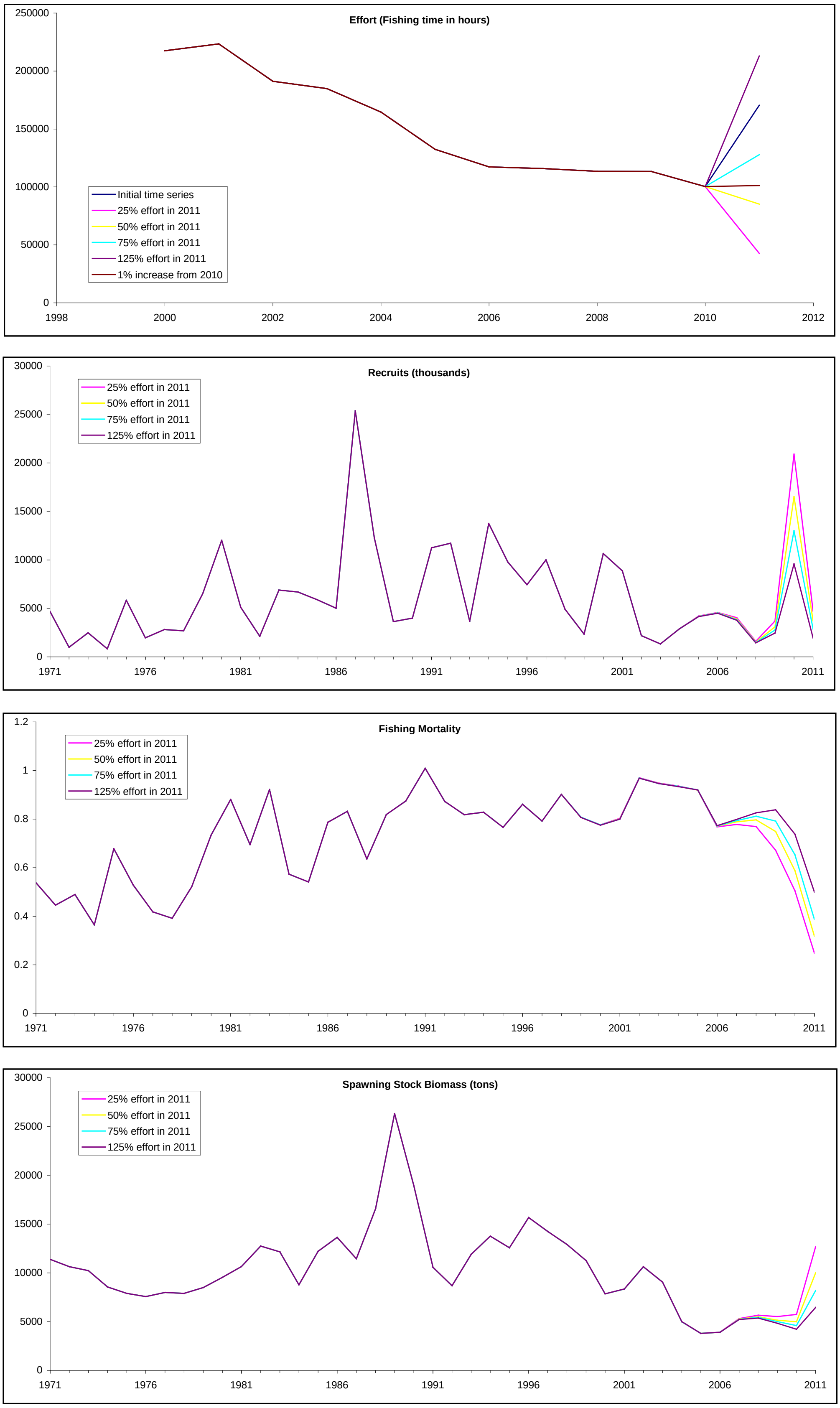


Figure 7.2.7. Celtic Sea cod in Division VIIe–k. Exploratory XSA.

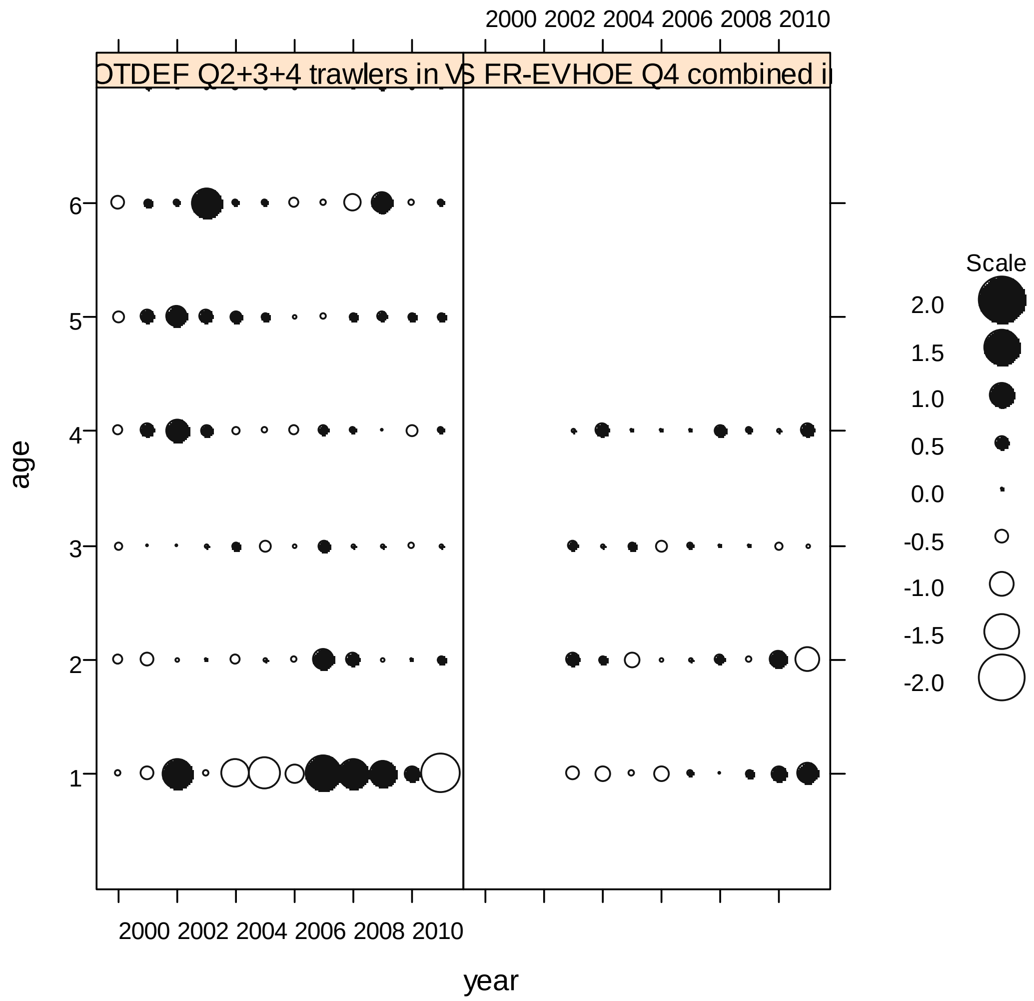


Figure 7.2.8. Celtic Sea cod in Division VIIe–k. Final XSA. Residuals (Left Panel: French OTDEF dermersal tuning fleet, Right Panel: Combined survey indices.

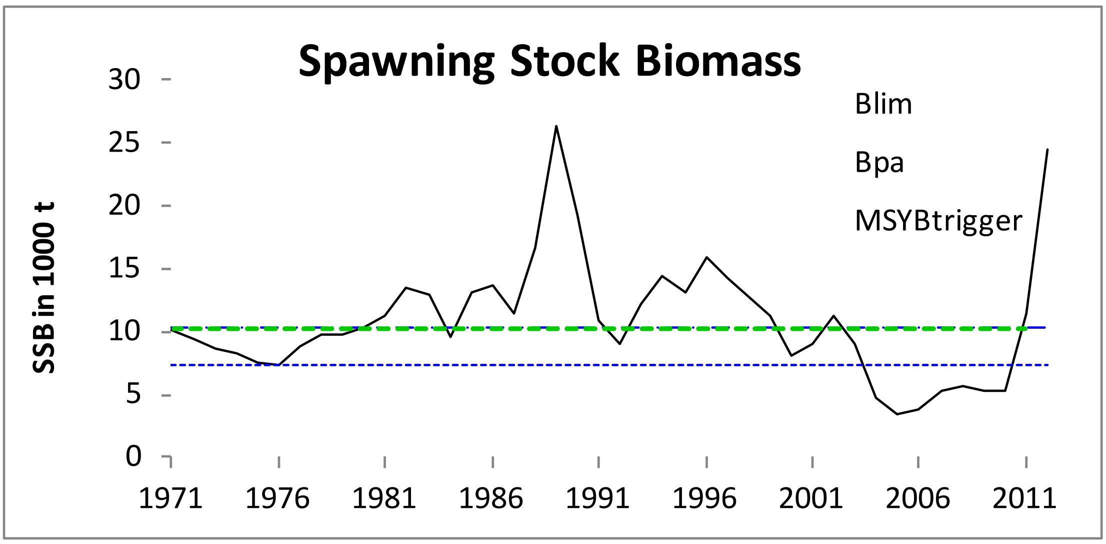


Figure 7.2.9. Celtic Sea cod in Division VIIe–k. Final XSA. Summay plots.

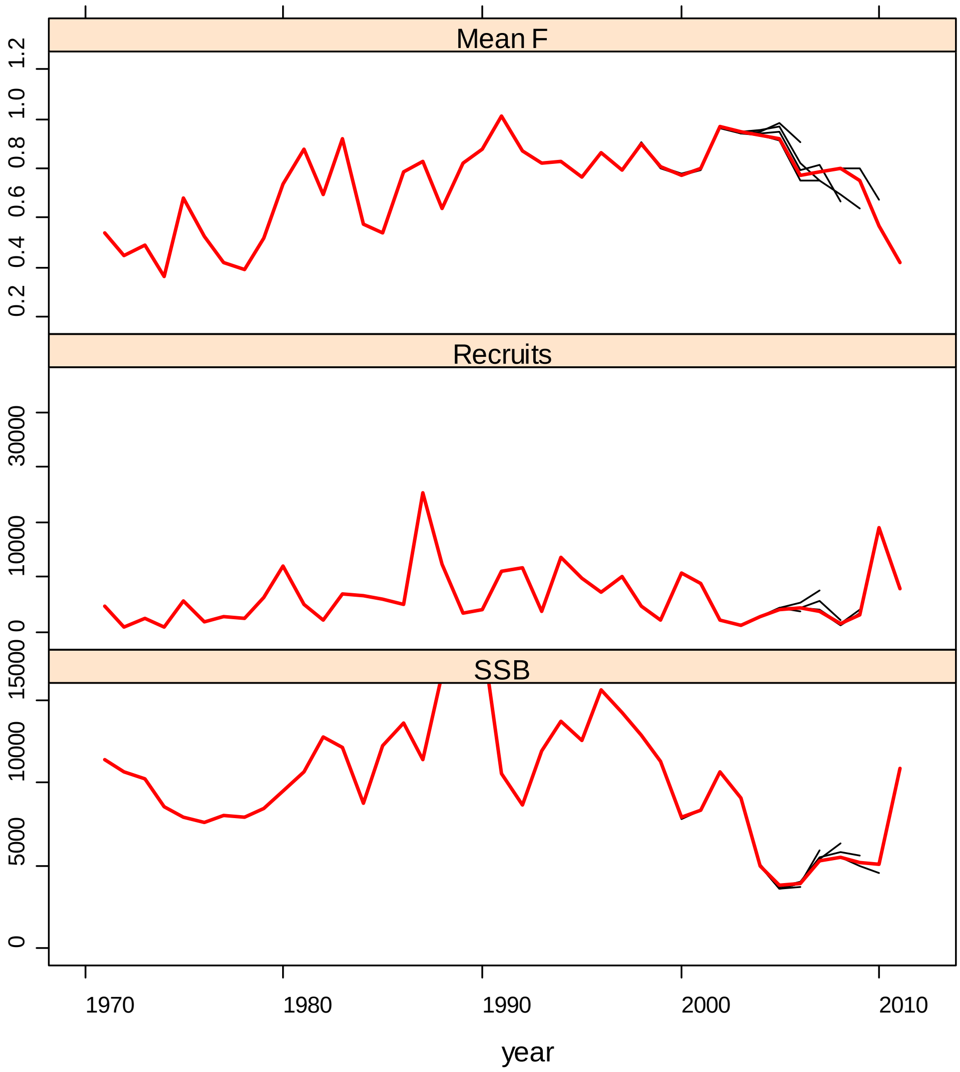


Figure 7.2.10. Celtic Sea cod in Division VIIe–k. Final XSA. Retrospective plots.

7.3 Cod in Divisions VIIb, c

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 VIIb,c for 1995–2011 as officially reported to ICES.

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003
France	91	115	71	44	…[1]	46	38	54	33
Germany	-	-	3	-	-	-	-	-	
Ireland	282	353	177	234	154	141	107	59	59
Netherlands	-	-	-	-	-	-	+	-	1
Norway	3	1	6		11	+*	1	5	
Spain	6	3		6	2	3	1	1	
UK(E/W/NI)	25	35	37	25	4	4	2	1	8
UK(Scotland)	66	12	7	9	1	-		1	1
UK									
Total	**473**	**519**	**301**	**318**	**172**	**194**	**150**	**122**	**102**

Country	2004	2005	2006	2007	2008	2009	2010	2011
France	13	13	10	18	14	5	17	42
Germany								
Ireland	60	32	16	11	18	29	37	35
Netherlands								
Norway			1	1				
Spain								
UK(E/W/NI)		0	1	2	1		1	
UK(Scotland)	10		0					
UK								
Total	**83**	**45**	**28**	**32**	**33**	**34**	**55**	**77**

7.4 Haddock in Divisions VIIb–k

Type of assessment in 2012

Update.

ICES advice applicable to 2011

"Effort should not be allowed to increase, reduce discard rates."

"The assessment is indicative of trends only. SSB shows an increasing trend over the time series. Recruitment is highly variable and in the past the SSB and catches have increased after good recruitment. Recruitment of the 2009 year class appears to be exceptionally good; however it is likely that many of these fish will be discarded before they are of a marketable size."

ICES advice applicable to 2012

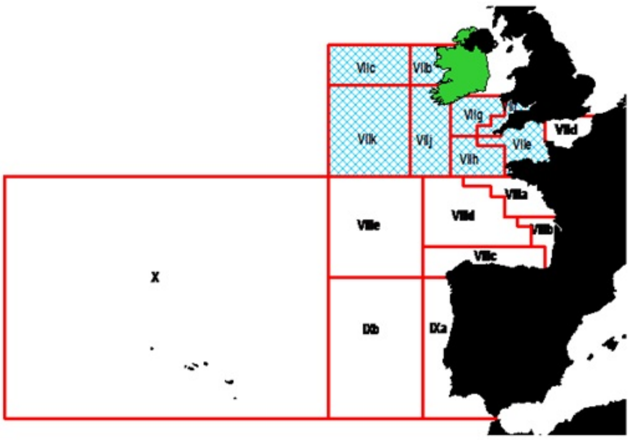
"Abundance of haddock is increasing due to a large recruiting year class, but exploitation status is unknown; therefore, ICES advises no increase in catch and technical measures to mitigate the increased discarding of the recruiting year class.

Standard short-term projections imply a TAC increase of around 300% for 2012 compared to 2011, under status quo F, although the precision is expected to be poor. Discarding rates will be high unless technical measures are implemented in 2011. During 2011 new data from surveys and the industry will be coming in that will improve the estimate of the year class strength, and this may allow changes in management in 2012."

7.4.1 General

Stock description and management units

The basis for the stock assessment Area VIIb–k is described in detail in the Stock Annex. The TAC for haddock is set for the combined Areas VIIb–k, VIII, IX and X and EU waters of CECAF 34.1.1. This does not correspond to the stock assessment area (VIIb–k). However, official international landings from VIII, IX and X have been less than 2% of all landings in the TAC area in most years since the TAC was instated.



Red Boxes-TAC/Management Areas Blue Shading– Assessment Area.

Management applicable to 2011 and 2012.

TAC table 2011

Species: Haddock *Melanogrammus aeglefinus*		Zone: VIIb-k, VIII, IX and X; EU waters of CECAF 34.1.1 (HAD/7X7A34)
Belgium	148	
France	8 877	
Ireland	2 959	
United Kingdom	1 332	
EU	13 316	
TAC	13 316	Analytical TAC Article 13 of this Regulation applies.

TAC table 2012

Species: Haddock *Melanogrammus aeglefinus*		Zone: VIIb-k, VIII, IX and X; EU waters of CECAF 34.1.1 (HAD/7X7A34)
Belgium	185	
France	11 096	
Ireland	3 699	
United Kingdom	1 665	
Union	16 645	
TAC	16 645	Analytical TAC Article 11 of this Regulation applies.

Since 2009, a separate TAC is set for VIIa haddock, previously a separate allocation for VIIa existed within the TAC for VII, VIII, IX and X.

Article 13 refers to the closure of the porcupine bank from 1 May to 31 July 2011 and 2012.

The fishery

The official landings reported to ICES and Working Group estimates of the landings and discards are given in Table 7.4.1a. The historic landings are also shown in Figure 7.4.1. Belgium provided minor revisions to the landings figures for 2010.

Before 2002, the TAC was well in excess of the landings in the TAC area (Table 7.4.1a). Between 1999 and 2003 the TAC was sequentially reduced and appeared to become restrictive for France in 2003–2004 and Ireland in 2002–2003 and perhaps after (Table 7.4.1b and Figure 7.4.1). (WGSSDS05 provided some qualitative evidence that misreporting was now a problem). During 2005–2008 the TAC was between 11 520 t and 11 579 t and the international landings in the TAC area were less than 70% of the TAC. In 2009 and 2010 the total landings were still below the TAC but the quota appeared to become restrictive again for Ireland and Belgium. In 2011 the TAC was 13 316 which is close to the total landings.

Figure 7.4.1a 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 in landings 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 where 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 2011 the landings were the second-highest on record at more than 13 000 t.

The discard estimate for 2010 was the highest on record at 16 547 tonnes (Table 7.4.1a), this was mainly a consequence of the 2009 cohort entering the fishery.

Table 7.4.2 and Figure 7.4.2 show that commercial lpue has shown an increasing trend in recent years in all available fleets suggesting improved availability of haddock. Effort in the French fleet has declined considerably since the early 2000s. French 2012 data are omitted; due to the increased availability of cod, many trips were classified as OT_DEF that would not have been classified in this métier before, this resulted in unrepresentative lpue data.

Figure 7.4.3 shows the spatial distribution of effort and lpue of the French and Irish OTB fleets in 2011. Irish effort is mainly located in VIIg while most of the French effort is north of Biscay where the haddock lpue is very low.

7.4.2 Data

An overview of the data provided and used by the WG is provided in Table 2.1 (Section 2: Data and Methods).

Numbers-at-length

Length compositions of landings from Ireland, France and the UK in 2011 are shown in Figure 7.4.4. Length compositions of the various fleets are quite similar with the exception of the UK beam trawl fleet which tends to land more small fish than the other fleets.

Discard length distributions for 2010 are shown in Figure 7.4.5. On Irish vessels most of the discarded haddock were under the MLS of 30 cm. However, about half the discarded fish from the French and UK fleets appear to have been above the MLS, which is likely to be the result of restrictive quota.

Figure 7.4.6 shows the available time-series of discard length distributions. The Irish fleet in VIIb generally catches (and discards) smaller fish than the other fleets. The French fleets tend to discard larger fish than the Irish fleets in many years.

Landings and discard numbers-at-age

Landings numbers-at-age are given in Table 7.4.3a, discard numbers-at-age are given in Table 7.4.3b. Despite 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 10 years 95% of 1-year-olds, 70% of 2-year-olds and 25% of 3-year-olds have been discarded. By number, 81% of the total catch was discarded (49% by weight; average last ten years).

Catch and stock weights-at-age are given in the ASAP input file (Table 7.4.4). Figure 7.4.8a shows 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 (Figure 7.4.8b).

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 2004–2011 (WD 03) 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 the Stock Annex. One survey index is used in the assessment: the FR-IRL-IBTS survey, which 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 scatter plot matrices of the log indices. These plots suggest that the internal consistency of the indices is reasonable. The IR-GAD index (Figure 7.4.9.a) shows an increasing trend over time, which could indicate an increase in catchability or an increase in population size.

7.4.3 Historical stock development

Model used: ASAP; (XSA is also used for quality control purposes)

Software used: ASAP V2.0.21 NOAA Fisheries toolbox (http://nft.nefsc.noaa.gov)

VPA95 (http://www.ices.dk/datacentre/software.asp)

FLR with R version 2.8.1 with packages FLCore 2.2, FLAssess 2.0.1, FLXSA 2.0 and FLEDA 2.0 (http://cran.r-project.org; 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 available in the folder 'Data\Stock\had-7b–k\DataScreening' 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 included in the landings and not supplied separately to the model.

Note that ASAP does not accommodate the inclusion of age-0 in the model, it assumes that the first age is age-1. However, because the current assessment does include 0-group fish, the first age in the ASAP input and output files is always age 0.

Figure 7.4.11 shows the residuals of that catch proportions-at-age. 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 recent years while they were generally higher than observed from 2002 to 2006.

The residuals of the index proportions-at-age are shown in Figure 7.4.12. There are no obvious patterns. The observed and predicted index cpue values are shown in Figure 7.4.13. The model closely follows the FR-IR-IBTS index and follows the general trend of the IRL-GAD index.

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 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 of that of the catch data).

Figure 7.4.15 shows the retrospective analysis. The predicted catch shows no retrospective pattern, neither does the recruitment estimate. However, the SSB has a tendency to be revised upwards as another year of data is added. F has often been overestimated and revised downwards with the addition of another year. The survey index only starts in 2003 and it is hoped that the retrospective patterns will reduce as this time-series gets longer.

Comparison with previous assessments

The stock was benchmarked in 2012, resulting in revised discard estimates and a new assessment method (ASAP). Figure 7.4.16 shows the comparison of the current ASAP assessment with previous XSA assessments. The new method produces very similar SSB estimates and while F_{BAR} estimates are similar from the late 1990s onwards, they are quite different at the start of the time-series. Note that the F_{BAR} range previous to the benchmark was over ages 2–5, this has been changed to 3–5. The perception of the trend in recruitment is unaffected but the new method estimates the absolute level of recruitment to be much higher. This is due to a change in the assumed natural mortality, which mainly affects the youngest ages.

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 XSA results are in general agreement with the ASAP results with the exception of F_{BAR} estimates at the start of the time-series. The catch has increased dramatically in the last few years which has resulted in increased discards. The SSB has more than doubled in 2011 as the very strong 2009 year class matured. However the last two years (2010 and 2011) had below-average recruitment so it is expected that the stock will decline rapidly as the 2009 year class is fished out. Fishing mortality shows a moderate downward trend but is still well above any F_{MSY} reference point that might be considered for this stock.

7.4.4 Short-term projections

Because recruitment of haddock is characterised by sporadic events, the use of geometric mean recruitment (1993–2009) for 2012–2014 provides a very uncertain estimate of future recruitment. However, the short-term predictions are expected to give a reliable prediction of SSB in 2012 and 2013.

Short-term projections were performed using MFDP1a software.

Recruitment for 2012–2014 was estimated at 294 359 (GM 93–09; thousands). Three year averages were used for F and weights-at-age. Input data for the short-term forecast are given in Table 7.4.9. Landings and discard numbers and weights were supplied separately. Table 7.4.10 gives the management options and Figure 7.4.19 shows the predicted yield and SSB at a range of F values. Estimates of the relative contribution of recent year classes to the 2013 landings and 2014 SSB are shown in Table 7.4.11. The high recruitment in 2009 accounts for 76% of the projected landings in

2013 but only 15% of the SSB in 2014. The GM recruitment assumption contributes heavily to the 2014 SSB estimate (72%).

7.4.5 MSY evaluation

No stock–recruitment relationship can be defined for this stock due to the erratic nature of recruitment. Figure 7.4.19 shows the yield-per recruit analysis. If one assumes recruitment to be independent of stock size (flat line) then $F_{MSY} = F_{MAX} = 0.28$.

7.4.6 Biological reference points

WKROUND (2012) stated that the only biomass reference point that can be suggested is an SSB of 7500 tonnes, which is the lowest (and first) in the time-series. The current SSB is more than ten times that size but it is expected to decrease rapidly.

7.4.7 Management plans

No management plan for VIIbk haddock has been agreed or proposed.

7.4.8 Uncertainties and bias in assessment and forecast

Landings

The sampling levels of landings for countries supplying data for 2011 are given in Table 2.1. 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 59 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 80–84% of the international discards (by weight; 2008–2011), there is considerable uncertainty around the historic discard estimates. However WKROUND (2012) concluded that the ASAP assessment is relatively insensitive to the discard estimates.

Although historic discard estimates are considered to be more reliable, the problem remains that the number of discard trips is very small compared to the total number of trips. The level of uncertainty due to the small sample sizes is likely to be high. The cost of increasing discard coverage would be considerable.

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 it is necessary to include this fleet due to the short time-series of the survey.

Forecast

The forecasted landings in 2013 are mainly based on the 2009 year class (68% contribution). Recruitment in 2009 was estimated with a relatively low CV of 13% and it shows no retrospective pattern, suggesting that the size of this year class is well estimated. The GM recruitment assumption does not contribute to the forecasted landings in 2013 (<1% contribution); however the 2014 SSB estimate is highly dependent on the GM recruitment assumption (72% contribution). Therefore the 2014 SSB forecast is very uncertain.

7.4.9 Recommendation for next Benchmark

Review Group comments

The review group recommended applying a statistical modelling framework. This has been done at WKROUND (2012) with the introduction of ASAP as the main assessment model.

Recommendations for future work

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.

7.4.10 Management considerations

Management by TAC is inappropriate for this stock because landings, but not catches, are controlled. Haddock are caught in a mixed fishery so TAC management can lead to discarding of over-quota fish in addition to already considerable discarding of undersized fish.

Discarding is a serious problem for this stock; over the last ten years 81% of the catch (in numbers) has been discarded (51% by weight). The TAC in 2011 appears to have been restrictive and significant numbers of fish over the MLS were being discarded (Figure 7.4.5).

Technical measures can reduce discarding and could increase the yield considerably. Improved selectivity on younger ages will reduce discarding and promote stock increase when strong year-classes occur. ICES recommends that the minimum mesh size for the demersal fleet should be at least 100 mm with a square mesh panel of at least 110 mm. Technical measures will also benefit other species (particularly whiting) caught in the mixed fishery. However technical measures are also likely to result in reduction in catch rates of marketable fish.

Table 7.4.1. (a) Haddock in VIIb–k official landings, the landings used by the working group and the TAC (tonnes). (b) The landings used by the working group, disaggregated by country and the quota (tonnes).

(a)	Official landings						Un-	Used by WG			TAC
Year	Belgium	France	Ireland	UK	Others	Total	allocated	Landings	Discards	Catch	VII - X
1993	51	1839	1262	256	0	3408	-60	3348	1208	4557	
1994	123	2788	908	240	17	4076	55	4131	1886	6017	
1995	189	2964	966	266	83	4468	2	4470	2218	6688	6000
1996	133	4527	1468	439	86	6653	103	6756	4309	11064	14000
1997	246	6581	2789	569	85	10270	557	10827	2883	13710	14000
1998	142	3674	2788	444	312	7360	308	7668	934	8603	20000
1999	51	2725	2034	278	159	5247	-365	4882	586	5468	22000
2000	90	3088	3066	289	123	6656	755	7411	2503	9913	16600
2001	165	4842	3608	422	665	9702	-1070	8632	3418	12050	12000
2002	132	4348	2188	315	106	7089	-686	6403	7073	13476	9300
2003	118	5781	1867	393	82	8241	-95	8146	9351	17497	8185
2004	136	6130	1715	313	159	8453	128	8581	6750	15331	9600
2005	167	4174	2037	292	197	6867	-312	6555	5191	11746	11520
2006	99	3190	1875	274	209	5647	-264	5383	2484	7867	11520
2007	119	4142	1930	386	52	6629	-119	6510	2739	9249	11520
2008	108	3639	1800	566	121	6234	815	7049	11187	18236	11579
2009	131	5429	2983	716	48	9307	-31	9276	9080	18356	11579[2]
2010	170	6240	2609	853	128	10000	-132	9868	16547	26415	11579[2]
2011[1]	210	8073	3311	1656	35	13285	-762	12524	14275	26799	133162

[1] preliminary data

[2] Applies to VIIb-k, VIII, IX and X

(b)	Landings used by WG (Quota in brackets)					
Year	Belgium	France	Ireland	UK	Others	Total
2002	134 (103)	3878 (6200)	2070 (2067)	301 (930)	21	6403 (9300)
2003	116 (91)	5960 (5456)	1667 (1819)	362 (819)	41	8146 (8185)
2004	137 (107)	6336 (6400)	1732 (2133)	303 (960)	73	8581 (9600)
2005	165 (128)	4096 (7680)	1991 (2560)	282 (1152)	20	6555 (11520)
2006	98 (128)	3151 (7680)	1857 (2560)	262 (1152)	14	5383 (11520)
2007	118 (128)	4073 (7680)	1925 (2560)	383 (1152)	10	6510 (11520)
2008	109 (129)	4587 (7719)	1794 (2573)	545 (1158)	14	7049 (11579)
2009	131 (129)	5455 (7719)	2986 (2573)	703 (1158)	2	9276 (11579)
2010	170 (129)	6267 (7719)	2609 (2573)	789 (1158)	34	9868 (11579)
2011	212 (148)	7365 (8877)	3323 (2959)	1510 (1332)	114	12524 (13316)

Table 7.4.2. Lpue (kg/hour fishing) of haddock and effort (hours fishing) for Irish Otter trawls in VIIb, VIIg and VIIj, the French demersal fleet in VIIfgh and effort only for UK beam and trawl fleets in VIIe–k.

	IRL OTB		IRL OTB		IRL OTB		FR OTB_DEF		UK Beam	UK Trawl
	VIIb		VIIg		VIIj		VIIfgh		VIIe-k	VIIe-k
	LPUE	Effort	LPUE	Effort	LPUE	Effort	LPUE	Effort	Effort	Effort
1983							2.18	115379	135344	82054
1984							2.02	85790	131465	86722
1985							2.83	92012	152487	90298
1986							1.64	119664	135738	84748
1987							3.20	144186	177118	84267
1988							7.27	221164	194882	89148
1989							5.28	247929	198156	84140
1990							2.23	201349	207576	99492
1991							1.94	179381	203196	76712
1992							3.74	190784	196065	86397
1993							4.23	213508	208421	61903
1994							7.95	181031	220023	53743
1995	6.47	65423	1.48	63560	2.36	93688	9.12	184067	243136	52270
1996	4.51	41496	5.36	60041	3.36	70237	15.36	170141	260817	60509
1997	5.51	49560	5.82	65105	9.12	83187	19.58	226015	264814	66707
1998	7.00	63560	4.09	72298	6.49	89610	11.62	189457	254590	62114
1999	6.51	62047	2.34	51657	4.53	40609	5.05	206601	251431	98350
2000	5.05	62758	10.43	60604	4.68	64626	8.86	170292	258962	104088
2001	4.92	60725	8.34	69427	8.34	67659	16.39	190482	272662	85338
2002	3.42	46793	3.28	77689	6.49	90446	13.61	176678	249480	83023
2003	2.56	63959	3.28	86791	4.34	111267	22.01	144180	282097	72303
2004	3.13	60446	3.45	96991	3.94	91957	31.41	119444	273871	75681
2005	3.32	47399	4.42	124395	4.59	73920	21.48	101027	270347	76361
2006	3.58	39698	4.16	119227	5.07	65856	17.74	79214	252001	83308
2007	4.73	40718	4.10	136525	4.80	80485	22.62	83904	239921	87683
2008	5.44	37338	4.57	125815	5.70	66503	31.22	70044	216909	71154
2009	6.70	37875	9.44	137115	7.91	73065			191047	73861
2010	5.18	43067	7.45	140647	6.00	85253			195877	77559

LPUE in kg/hour fishing
Effort in hours fishing

Table 7.4.3. VIIb–k haddock Landings numbers-at-age (a) and discard numbers-at-age (b).

a) Landings Numbers at Age

Year	0	1	2	3	4	5	6	7	8	9	10
1993	0	491	3291	948	810	255	129	129	42	3	0
1994	0	1277	5223	674	302	94	24	35	14	1	0
1995	0	4275	1622	1327	270	245	46	0	0	0	0
1996	0	3693	15998	818	313	93	32	10	4	3	2
1997	0	1353	9645	5553	716	354	139	144	59	48	2
1998	0	162	3077	7154	1395	298	173	84	41	9	9
1999	0	468	643	1438	2382	302	18	19	3	3	0
2000	0	2171	2961	775	733	1235	203	34	21	7	0
2001	0	3998	8036	1053	282	295	298	51	29	7	0
2002	0	872	4216	3354	760	39	88	73	19	5	2
2003	0	665	8293	1998	1149	112	42	48	41	10	0
2004	0	117	5870	4540	881	573	50	12	16	3	0
2005	0	783	833	4166	1884	436	114	4	13	3	0
2006	0	831	3313	1431	2106	376	64	7	0	0	0
2007	0	653	6198	2566	503	827	149	29	3	2	0
2008	0	1528	3854	4212	914	216	358	65	11	1	0
2009	0	777	6723	3304	1880	475	140	107	24	2	0
2010	0	1236	4615	5789	866	473	157	65	53	6	1
2011	0	172	10915	3248	3126	586	190	52	25	12	4

b) Discard Numbers-at-Age

Year	0	1	2	3	4	5	6	7	8	9	10
1993	0	7617	2816	160	6	0	0	0	0	0	0
1994	0	15120	3069	170	5	0	0	0	0	0	0
1995	0	32830	1977	91	4	0	0	0	0	0	0
1996	0	20734	8976	187	9	0	0	0	0	0	0
1997	0	12613	10022	493	5	0	0	0	0	0	0
1998	0	3580	2348	445	5	0	0	0	0	0	0
1999	0	3742	1562	100	10	0	0	0	0	0	0
2000	0	29015	2521	64	3	0	0	0	0	0	0
2001	0	25234	6772	219	2	0	0	0	0	0	0
2002	0	21624	20729	249	7	0	0	0	0	0	0
2003	0	52305	10692	338	8	0	0	0	0	0	0
2004	0	11733	21598	1395	61	0	0	0	0	0	0
2005	0	15904	10766	4315	149	0	0	0	0	0	0
2006	0	9377	4130	381	33	0	0	0	0	0	0
2007	0	6387	7066	662	34	0	0	0	0	0	0
2008	0	48764	15658	5492	330	0	0	0	0	0	0
2009	0	23561	27015	873	581	0	0	0	0	0	0
2010	0	98400	23292	2133	131	0	0	0	0	0	0
2011	0	15967	47629	1817	660	0	0	0	0	0	0

Table 7.4.4. Input data to ASAP.

```
# ASAP VERSION 2.0
# Had7b-k
#
# ASAP GUI - 15 JAN 2008
#
# Number of Years
19
# First Year
1993
# Number of Ages
9
# Number of Fleets
1
# Number of Selectivity Blocks (sum over all fleets)
1
# Number of Available Indices
2
# Fleet Names
#$LAND+DIS
# Index Names
#$FR-IRL-IBTS
#$IR-GAD
#
# Natural Mortality Rate Matrix
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
0.99  0.72  0.60  0.50  0.43  0.40  0.37  0.36  0.34
```

```
# Fecundity Option
0
# Fraction of year that elapses prior to SSB calculation (0=Jan-1)
0
# Maturity Matrix
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
0.0  0.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
# Weight at Age for Catch Matrix
0.000  0.090  0.257  0.524  0.848  1.402  1.693  2.130  2.573
0.000  0.100  0.358  0.614  0.987  1.456  1.745  2.014  2.536
0.000  0.089  0.388  0.875  1.321  1.188  1.746  0.000  0.000
0.000  0.130  0.275  0.576  0.799  1.181  1.369  1.828  1.827
0.000  0.097  0.305  0.743  1.205  1.362  1.268  1.412  1.176
0.000  0.103  0.295  0.610  0.938  0.958  1.089  1.293  1.455
0.000  0.128  0.297  0.847  1.072  1.186  1.223  0.908  1.708
0.000  0.091  0.451  1.189  1.463  1.719  1.627  1.163  1.459
0.000  0.119  0.378  0.963  1.857  1.783  1.705  2.297  1.612
0.000  0.095  0.294  0.790  1.026  1.732  1.671  1.504  1.571
0.000  0.133  0.353  0.807  1.236  1.429  1.800  1.705  1.708
0.000  0.136  0.284  0.653  1.141  1.380  1.855  1.806  2.062
0.000  0.136  0.211  0.497  0.976  1.256  1.946  2.667  1.948
0.000  0.162  0.347  0.500  0.929  1.486  2.118  2.619  4.022
0.000  0.167  0.338  0.564  0.850  1.199  1.630  1.487  2.821
0.000  0.129  0.285  0.456  0.729  1.139  1.267  1.654  1.842
0.000  0.118  0.289  0.614  0.842  1.310  1.544  1.646  2.431
0.000  0.114  0.267  0.652  1.075  1.773  1.863  1.739  1.677
0.000  0.155  0.278  0.587  0.928  1.640  2.142  1.875  1.455
# Weight at Age for Spawning Stock Biomass Matrix
0.041  0.093  0.277  0.641  0.824  1.804  2.089  2.407  2.647
```

```
0.042  0.093  0.290  0.756  1.138  2.360  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  0.100  0.313  0.719  1.246  2.046  1.773  1.950  2.145
0.043  0.098  0.287  0.579  0.904  1.145  1.263  1.631  1.795
0.037  0.096  0.274  0.655  0.870  1.005  1.017  1.252  1.377
0.028  0.102  0.264  0.790  0.962  1.149  1.205  1.349  1.484
0.027  0.108  0.303  0.926  1.326  1.548  1.605  1.765  1.942
0.022  0.101  0.310  0.922  1.329  1.633  1.672  1.839  2.023
0.021  0.109  0.312  0.842  1.402  1.677  1.895  2.084  2.292
0.023  0.119  0.278  0.731  1.202  1.611  1.944  2.138  2.352
0.032  0.133  0.251  0.629  1.224  1.676  2.315  2.547  2.802
0.037  0.139  0.253  0.526  1.073  1.606  2.172  2.421  2.663
0.043  0.149  0.269  0.501  0.955  1.451  2.110  2.564  2.821
0.041  0.147  0.287  0.495  0.835  1.363  1.820  2.203  2.423
0.048  0.137  0.271  0.523  0.802  1.203  1.666  1.891  2.080
0.048  0.120  0.253  0.534  0.834  1.306  1.546  1.824  2.006
0.041  0.129  0.257  0.562  0.892  1.384  1.780  2.096  2.305
0.036  0.133  0.255  0.551  0.916  1.535  1.852  2.131  2.344
# Weight at Age for Jan-1 Biomass Matrix
0.041  0.093  0.277  0.641  0.824  1.804  2.089  2.407  2.647
0.042  0.093  0.290  0.756  1.138  2.360  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  0.100  0.313  0.719  1.246  2.046  1.773  1.950  2.145
0.043  0.098  0.287  0.579  0.904  1.145  1.263  1.631  1.795
0.037  0.096  0.274  0.655  0.870  1.005  1.017  1.252  1.377
0.028  0.102  0.264  0.790  0.962  1.149  1.205  1.349  1.484
0.027  0.108  0.303  0.926  1.326  1.548  1.605  1.765  1.942
0.022  0.101  0.310  0.922  1.329  1.633  1.672  1.839  2.023
0.021  0.109  0.312  0.842  1.402  1.677  1.895  2.084  2.292
0.023  0.119  0.278  0.731  1.202  1.611  1.944  2.138  2.352
0.032  0.133  0.251  0.629  1.224  1.676  2.315  2.547  2.802
0.037  0.139  0.253  0.526  1.073  1.606  2.172  2.421  2.663
0.043  0.149  0.269  0.501  0.955  1.451  2.110  2.564  2.821
0.041  0.147  0.287  0.495  0.835  1.363  1.820  2.203  2.423
0.048  0.137  0.271  0.523  0.802  1.203  1.666  1.891  2.080
0.048  0.120  0.253  0.534  0.834  1.306  1.546  1.824  2.006
0.041  0.129  0.257  0.562  0.892  1.384  1.780  2.096  2.305
0.036  0.133  0.255  0.551  0.916  1.535  1.852  2.131  2.344
# Selectivity Blocks (fleet outer loop, year inner loop)
# Sel block for fleet 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 initial guess, phase, lambda, and CV
# (have to enter values for nages + 6 parameters for each block)
# Sel Block 1
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
# Selectivity Start Age by fleet
1
# Selectivity End Age by fleet
9
# Age range for average F
4  6
# Average F report option (1=unweighted, 2=Nweighted, 3=Bweighted)
1
# Use likelihood constants? (1=yes)
1
# Release Mortality by fleet
1
# Fleet 1 Catch at Age - Last Column is Total Weight
```

```
0	8107	6107	1108	816	255	129	129	42	4557
0	16396	8292	844	307	94	24	35	14	6017
0	37105	3599	1419	273	245	46	0	0	6688
0	24428	24973	1005	321	93	32	10	4	11064
0	13965	19667	6046	722	354	139	144	59	13710
0	3742	5424	7599	1400	298	173	84	41	8603
0	4210	2205	1538	2392	302	18	19	3	5468
0	31186	5482	839	735	1235	203	34	21	9913
0	29232	14808	1272	283	295	298	51	29	12050
0	22496	24945	3603	766	39	88	73	19	13476
0	52970	18984	2336	1157	112	42	48	41	17497
0	11850	27467	5935	943	573	50	12	16	15331
0	16687	11600	8481	2033	436	114	4	13	11746
0	10208	7443	1812	2139	376	64	7	0	7867
0	7041	13264	3228	537	827	149	29	3	9249
0	50292	19512	9704	1244	216	358	65	11	18236
0	24338	33738	4177	2461	475	140	107	24	18356
0	99636	27907	7923	998	473	157	65	53	26415
0	16139	58541	5064	3785	585	189	52	25	26793
# Fleet 1 Discards at Age - Last Column is Total Weight
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
# Fleet 1 Release Proportion at Age
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
```

```
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
# Index Units
2  2
# Index Month
11  7
# Index Selectivity Choice
-1  -1
# Index Selectivity Option for each Index 1=by age, 2=logisitic, 3=double lo-
gistic
1  1
# Index Start Age
1  4
# Index End Age
6  8
# Use Index? 1=yes
1  1
# Index Selectivity initial guess, phase, lambda, and CV
# (have to enter values for nages + 6 parameters for each block)
# Index-1
1              1              1              0.0001
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
```

-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 Data - Year, Index Value, CV, proportions at age and input effective sample size (only used if estimating parameters)

Index-1

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	157.0	508.3	32.6	7.1	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	19.0	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	62.0	2.1	1.9	0.8	0	0	0	40
2010	823.4	0.2	89.7	686.0	33.0	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

Index-2

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	0.7510	0.0600	0.0150	0	0	0	40
1996	1.031	0.3	0	0	0	0.6750	0.2260	0.0960	0.0350	0	0	40
1997	3.578	0.3	0	0	0	3.0860	0.3390	0.1150	0.0190	0.0190	0	40
1998	6.695	0.3	0	0	0	5.8110	0.8240	0.0330	0.0080	0.0180	0	40
1999	3.047	0.3	0	0	0	1.1470	1.7350	0.1490	0.0050	0.0110	0	40
2000	4.103	0.3	0	0	0	1.6180	1.0770	1.2040	0.2040	0	0	40
2001	3.47	0.3	0	0	0	2.9260	0.2930	0.1480	0.0930	0.0090	0	40
2002	3.996	0.3	0	0	0	3.6570	0.2660	0.0200	0.0210	0.0340	0	40
2003	2.058	0.3	0	0	0	1.2560	0.6970	0.0810	0.0090	0.0140	0	40

```
2004   4.586   0.3   0   0   0   3.3630   0.8560   0.3500   0.0100   0.0070   0   40
2005   7.122   0.3   0   0   0   4.7170   2.0890   0.2680   0.0480   0        0   40
2006   7.098   0.3   0   0   0   2.9930   3.5430   0.4870   0.0630   0.0120   0   40
2007   4.759   0.3   0   0   0   2.6940   0.6820   1.2330   0.1380   0.0120   0   40
2008   5.436   0.3   0   0   0   3.5320   1.1610   0.2560   0.4      0.0870   0   40
2009   5.846   0.3   0   0   0   2.9390   1.8140   0.5660   0.3050   0.2220   0   40
2010   9.904   0.3   0   0   0   8.2360   0.9570   0.5030   0.1530   0.0560   0   40
2011   9.565   0.3   0   0   0   3.9250   4.5770   0.7020   0.3      0.0600   0   40
# Phase Control Data
# 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
#Lambda for Each 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
0.300
0.300
0.300
0.300
0.300
0.300
0.300
0.300
0.300
0.300
0.300
0.300
0.300
0.300
0.300
0.200
0.200
0.200
0.200
# Discard Total CV by Year and Fleet
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
# Input Effective Sample Size for Catch at Age by Year & Fleet
25
```

```
25
25
25
25
25
25
25
25
50
50
50
50
50
50
50
50
50
50
# Input Effective Sample Size for Discards at Age by Year & Fleet
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 Initial unexploited Stock Size
0
# CV for Deviation from Initial unexploited Stock Size
1
# NAA for Year 1
100  90  80  70  60  50  40  30  20
# F mult in 1st year by Fleet
0.7
# Catchability in 1st year by index
1  1
# Initial unexploited Stock Size
1000
# Initial Steepness
1
# Maximum F
2.5
# Ignore Guesses
0
# Projection Control Data
# Do Projections? (1=yes, 0=no), still need to enter values even if not doing
projections
0
# Fleet Directed Flag
1
# Final Year of Projections
2013
# Year Projected Recruits, What Projected, Target, non- directed F mult
2012     -1     4     0     1
2013     0     0     0     0
```

```
# MCMC info
# doMCMC (1=yes)
0
# MCMCnyear option (0=use final year values of NAA, 1=use final year + 1 values
of NAA)
0
# MCMCnboot
1000
# MCMCnthin
200
# MCMCseed
1415963
# R in agepro.bsn file (enter 0 to use NAA, 1 to use stock-recruit relation-
ship, 2 to used geometric mean of previous years)
0
# Starting year for calculation of R
1993
# Starting year for calculation of R
2005
# Test Value
-23456
#####
# ---- FINIS ----
```

Table 7.4.5. 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. Catch selectivity was the same for all years. 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.

Age	Catch	FR-IRL-IBTS	IRL-GAD
0	0	1	-
1	0.39	1	-
2	0.97	1	-
3	1	1	0.79
4	1	1	1
5	1	1	1
6	1	-	1
7	1	-	1
8+	1	-	-

Table 7.4.6. Haddock VIIb–k. Fishing mortality (F) at age.

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Fbar3-5
1993	0.000	0.441	1.109	1.142	1.142	1.142	1.142	1.142	1.142	1.142
1994	0.000	0.445	1.118	1.152	1.152	1.152	1.152	1.152	1.152	1.152
1995	0.000	0.358	0.900	0.927	0.927	0.927	0.927	0.927	0.927	0.927
1996	0.000	0.336	0.844	0.870	0.870	0.870	0.870	0.870	0.870	0.870
1997	0.000	0.286	0.720	0.741	0.741	0.741	0.741	0.741	0.741	0.741
1998	0.000	0.302	0.760	0.783	0.783	0.783	0.783	0.783	0.783	0.783
1999	0.000	0.218	0.549	0.565	0.565	0.565	0.565	0.565	0.565	0.565
2000	0.000	0.273	0.686	0.706	0.706	0.706	0.706	0.706	0.706	0.706
2001	0.000	0.277	0.697	0.718	0.718	0.718	0.718	0.718	0.718	0.718
2002	0.000	0.508	1.278	1.316	1.316	1.316	1.316	1.316	1.316	1.316
2003	0.000	0.256	0.644	0.663	0.663	0.663	0.663	0.663	0.663	0.663
2004	0.000	0.309	0.778	0.801	0.801	0.801	0.801	0.801	0.801	0.801
2005	0.000	0.327	0.822	0.847	0.847	0.847	0.847	0.847	0.847	0.847
2006	0.000	0.210	0.528	0.544	0.544	0.544	0.544	0.544	0.544	0.544
2007	0.000	0.167	0.421	0.434	0.434	0.434	0.434	0.434	0.434	0.434
2008	0.000	0.301	0.758	0.780	0.780	0.780	0.780	0.780	0.780	0.780
2009	0.000	0.246	0.620	0.638	0.638	0.638	0.638	0.638	0.638	0.638
2010	0.000	0.254	0.639	0.658	0.658	0.658	0.658	0.658	0.658	0.658
2011	0.000	0.203	0.510	0.526	0.526	0.526	0.526	0.526	0.526	0.526
Fbar	0.000	0.301	0.757	0.780	0.780	0.780	0.780	0.780	0.780	

Table 7.4.7. Haddock VIIb–k Stock numbers-at-age (start of year) ('1000).

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8
1993	103631	48948	12080	2819	792	250	251	219	68
1994	361773	38507	15332	2188	546	164	53	55	64
1995	498846	134427	12016	2751	420	112	35	12	27
1996	136646	185360	45748	2681	660	108	30	10	11
1997	68416	50774	64495	10793	682	180	30	9	6
1998	142699	25422	18562	17231	3119	211	57	10	5
1999	387747	53024	9146	4763	4776	927	65	18	5
2000	368499	144078	20749	2899	1641	1765	353	25	9
2001	415874	136926	53393	5736	868	527	584	120	12
2002	743927	154529	50518	14597	1697	275	172	197	45
2003	201781	276426	45255	7726	2374	296	50	32	45
2004	259417	74977	104161	13046	2414	796	102	18	28
2005	247037	96393	26787	26263	3552	705	239	32	15
2006	179943	91793	33832	6459	6828	990	203	71	14
2007	654746	66863	36223	10953	2275	2579	385	81	34
2008	337842	243288	27528	13047	4306	959	1120	173	53
2009	1647390	125534	87618	7082	3626	1283	295	355	72
2010	170908	612131	47761	25878	2269	1246	454	107	158
2011	80308	63506	231089	13833	8126	764	432	163	97
2012	0	29840	25235	76140	4961	3125	303	177	108

Table 7.4.8. Stock Summary for haddock in VIIb–k. Weights in tonnes, recruitment-at-age 0 in thousands.

Year	Landings	Discards	Catch	Predicted Catch	TSB	SSB	CV	Fbar 3–5	CV	Recruits age 0	CV
1993	3348	1208	4557	4847	16288	7487	25%	1.142	28%	103631	22%
1994	4131	1886	6017	5370	26303	7528	23%	1.152	24%	361773	19%
1995	4470	2218	6688	6363	42590	6430	21%	0.927	26%	498846	16%
1996	6756	4309	11064	11706	42207	17385	19%	0.87	26%	136646	20%
1997	10827	2883	13710	12650	33562	25645	16%	0.741	26%	68416	23%
1998	7668	934	8603	8866	27096	19375	17%	0.783	24%	142699	20%
1999	4882	586	5468	5520	28212	11947	17%	0.565	29%	387747	18%
2000	7411	2503	9913	9870	40020	14511	18%	0.706	27%	368499	21%
2001	8632	3418	12050	14690	48055	25076	17%	0.718	30%	415874	18%
2002	6403	7073	13476	21654	64199	31733	21%	1.316	23%	743927	14%
2003	8146	9351	17497	15787	59366	21831	17%	0.663	27%	201781	16%
2004	8581	6750	15331	20189	57273	39000	15%	0.801	24%	259417	14%
2005	6555	5191	11746	13582	48709	26170	16%	0.847	23%	247037	13%
2006	5383	2484	7867	9798	42358	20943	15%	0.544	29%	179943	15%
2007	6510	2739	9249	7936	58870	22197	15%	0.434	27%	654746	12%
2008	7049	11187	18236	14551	70740	21193	15%	0.78	18%	337842	15%
2009	9276	9080	18356	15416	126036	31897	13%	0.638	20%	1647390	13%
2010	9868	16547	26415	24995	117937	31965	15%	0.658	21%	170908	26%
2011	12524	14275	26799	27229	87878	76541	15%	0.526	27%	80308	38%
Mean 09-11								0.607			
GM 93-09										294359	

Table 7.4.9. Input values for short-term forecast (.prd).

MFDP version 1a						
Run: MFDP						
Time and date: 16:01 04/05/2012						
Fbar age range (Total) : 3-5						
Fbar age range Fleet 1 : 3-5						
2012						
Age	N	M	Mat	PF	PM	SWt
0	294359	0.99	0	0	0	4.17E-02
1	29840	0.72	0	0	0	0.127333
2	25235	0.6	1	0	0	0.255
3	76140	0.5	1	0	0	0.549
4	4961	0.43	1	0	0	0.881
5	3125	0.4	1	0	0	1.408333
6	303	0.37	1	0	0	1.726333
7	177	0.36	1	0	0	2.017333
8	108	0.34	1	0	0	2.222333
CATCH						
Age	Sel	CWt	DSel	DCWt		
0	0	0	0	4.03E-02		
1	4.39E-03	0.342	0.229944	0.125333		
2	0.108102	0.529333	0.481565	0.221667		
3	0.440889	0.733333	0.166382	0.315667		
4	0.497551	1.073667	0.109562	0.363333		
5	0.607333	1.574333	0	0		
6	0.607333	1.849333	0	0		
7	0.607333	1.753	0	0		
8	0.607333	1.854	0	0		
2013						
Age	N	M	Mat	PF	PM	SWt
0	294359	0.99	0	0	0	4.17E-02
1	.	0.72	0	0	0	0.127333
2	.	0.6	1	0	0	0.255
3	.	0.5	1	0	0	0.549
4	.	0.43	1	0	0	0.881
5	.	0.4	1	0	0	1.408333
6	.	0.37	1	0	0	1.726333
7	.	0.36	1	0	0	2.017333
8	.	0.34	1	0	0	2.222333
CATCH						
Age	Sel	CWt	DSel	DCWt		
0	0	0	0	4.03E-02		
1	4.39E-03	0.342	0.229944	0.125333		
2	0.108102	0.529333	0.481565	0.221667		
3	0.440889	0.733333	0.166382	0.315667		
4	0.497551	1.073667	0.109562	0.363333		
5	0.607333	1.574333	0	0		
6	0.607333	1.849333	0	0		
7	0.607333	1.753	0	0		
8	0.607333	1.854	0	0		
2014						

Age	N	M	Mat	PF	PM	SWt
0	294359	0.99	0	0	0	4.17E-02
1	.	0.72	0	0	0	0.127333
2	.	0.6	1	0	0	0.255
3	.	0.5	1	0	0	0.549
4	.	0.43	1	0	0	0.881
5	.	0.4	1	0	0	1.408333
6	.	0.37	1	0	0	1.726333
7	.	0.36	1	0	0	2.017333
8	.	0.34	1	0	0	2.222333
CATCH						
Age	Sel	CWt	DSel	DCWt		
0	0	0	0	4.03E-02		
1	4.39E-03	0.342	0.229944	0.125333		
2	0.108102	0.529333	0.481565	0.221667		
3	0.440889	0.733333	0.166382	0.315667		
4	0.497551	1.073667	0.109562	0.363333		
5	0.607333	1.574333	0	0		
6	0.607333	1.849333	0	0		
7	0.607333	1.753	0	0		
8	0.607333	1.854	0	0		

Input units are thousands and kg - output in tonnes.

Table 7.4.12. Management options table (.prm).

MFDP version 1a

Run: MFDP

Time and date: 16:01 04/05/2012

Fbar age range (Total) : 3-5

Fbar age range Fleet 1 : 3-5

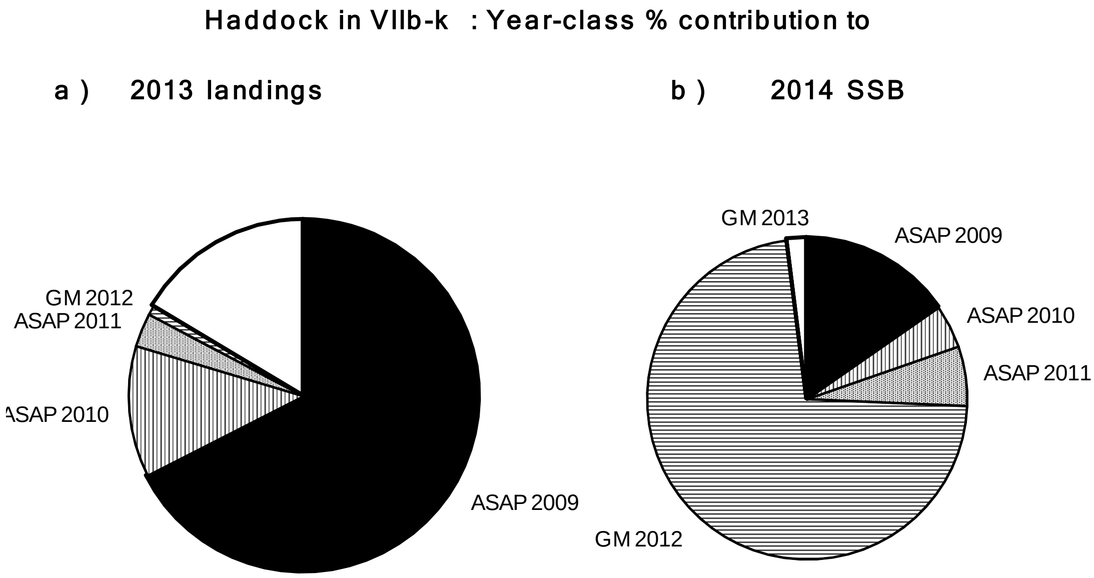
2012								
		"CATCH"	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield		
74192	58128	1	0.5153	19708	0.092	4670		
2013							2014	
		"CATCH"	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	Biomass	SSB
60425	34233	0	0	0	0	0	74360	48167
.	34233	0.1	0.0515	1571	0.0092	422	72013	45821
.	34233	0.2	0.1031	3057	0.0184	829	69793	43601
.	34233	0.3	0.1546	4462	0.0276	1222	67693	41501
.	34233	0.4	0.2061	5791	0.0368	1601	65705	39513
.	34233	0.5	0.2576	7048	0.046	1966	63824	37632
.	34233	0.6	0.3092	8238	0.0552	2319	62043	35851
.	34233	0.7	0.3607	9363	0.0644	2660	60357	34165
.	34233	0.8	0.4122	10429	0.0736	2990	58760	32568
.	34233	0.9	0.4637	11438	0.0828	3308	57247	31055
.	34233	1	0.5153	12393	0.092	3616	55814	29622
.	34233	1.1	0.5668	13297	0.1012	3913	54456	28264
.	34233	1.2	0.6183	14153	0.1104	4201	53169	26977
.	34233	1.3	0.6698	14965	0.1196	4480	51949	25757
.	34233	1.4	0.7214	15733	0.1288	4750	50792	24600
.	34233	1.5	0.7729	16462	0.138	5012	49695	23503
.	34233	1.6	0.8244	17152	0.1472	5265	48655	22462
.	34233	1.7	0.8759	17807	0.1564	5510	47667	21475
.	34233	1.8	0.9275	18427	0.1656	5748	46730	20538
.	34233	1.9	0.979	19016	0.1748	5979	45840	19648
.	34233	2	1.0305	19574	0.184	6203	44996	18804

Input units are thousands and kg - output in tonnes.

Table 7.4.11. Haddock VIIbk. 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			2009	2010	2011	2012	2013
Stock No. (thousands) of 0 year-olds			1647390	170908	80308	294359	294359
Source			ASAP	ASAP	ASAP	GM	GM
Status Quo F:							
% in	2012	landings	75.5	4.3	0.1	0.0	-
% in	2013		67.5	12.1	3.1	0.9	0.0
% in	2012	SSB	71.9	11.1	0.0	0.0	-
% in	2013	SSB	53.0	16.2	24.2	0.0	0.0
% in	2014	SSB	15.3	4.4	6.0	72.3	0.0

GM : geometric mean recruitment



a) **b)**

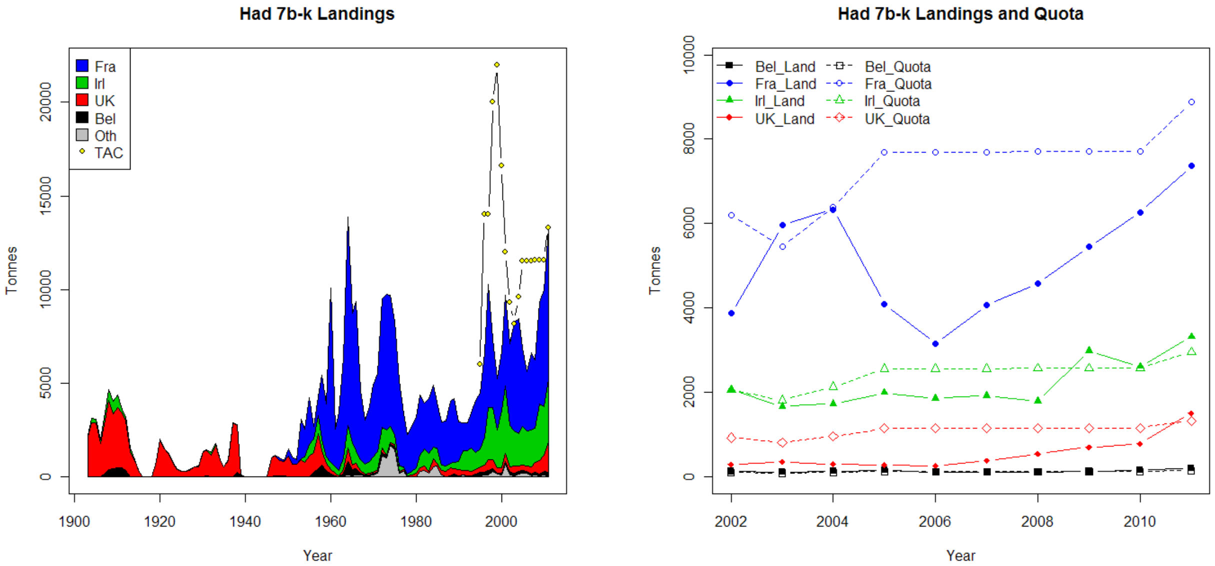


Figure 7.4.1. a) Official Ices landings and TAC of haddock in VIIb–k. b) Recent working group landings and quota by country.

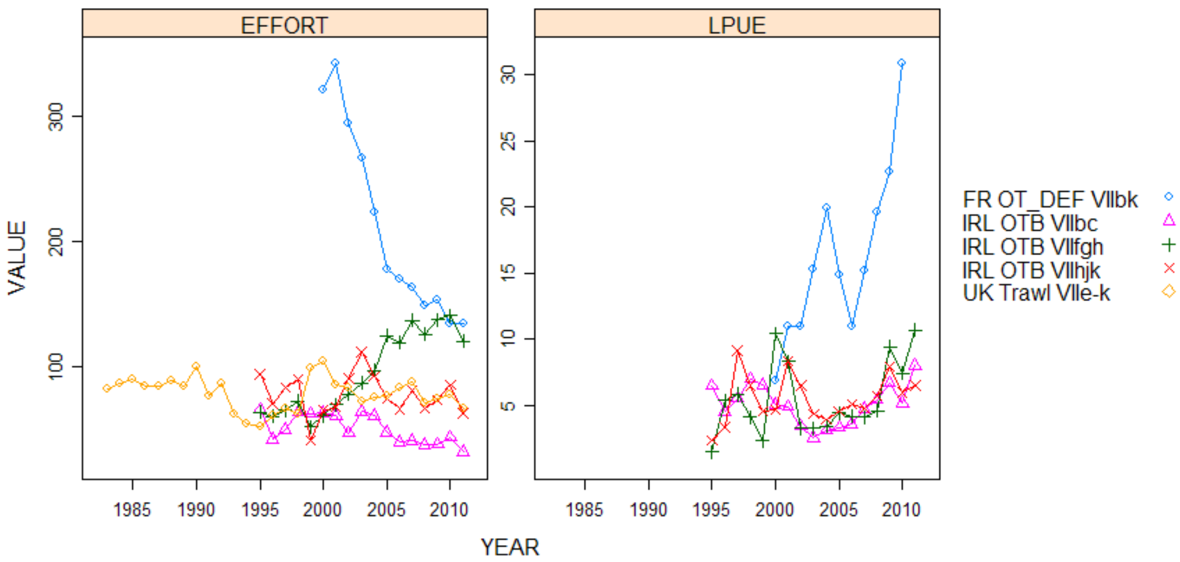


Figure 7.4.2. Effort ('1000h) of the Irish Otter trawl fleets, the French demersal otter trawl fleet and for UK trawl fleet and lpue (kg/h) for the Irish and French fleets.

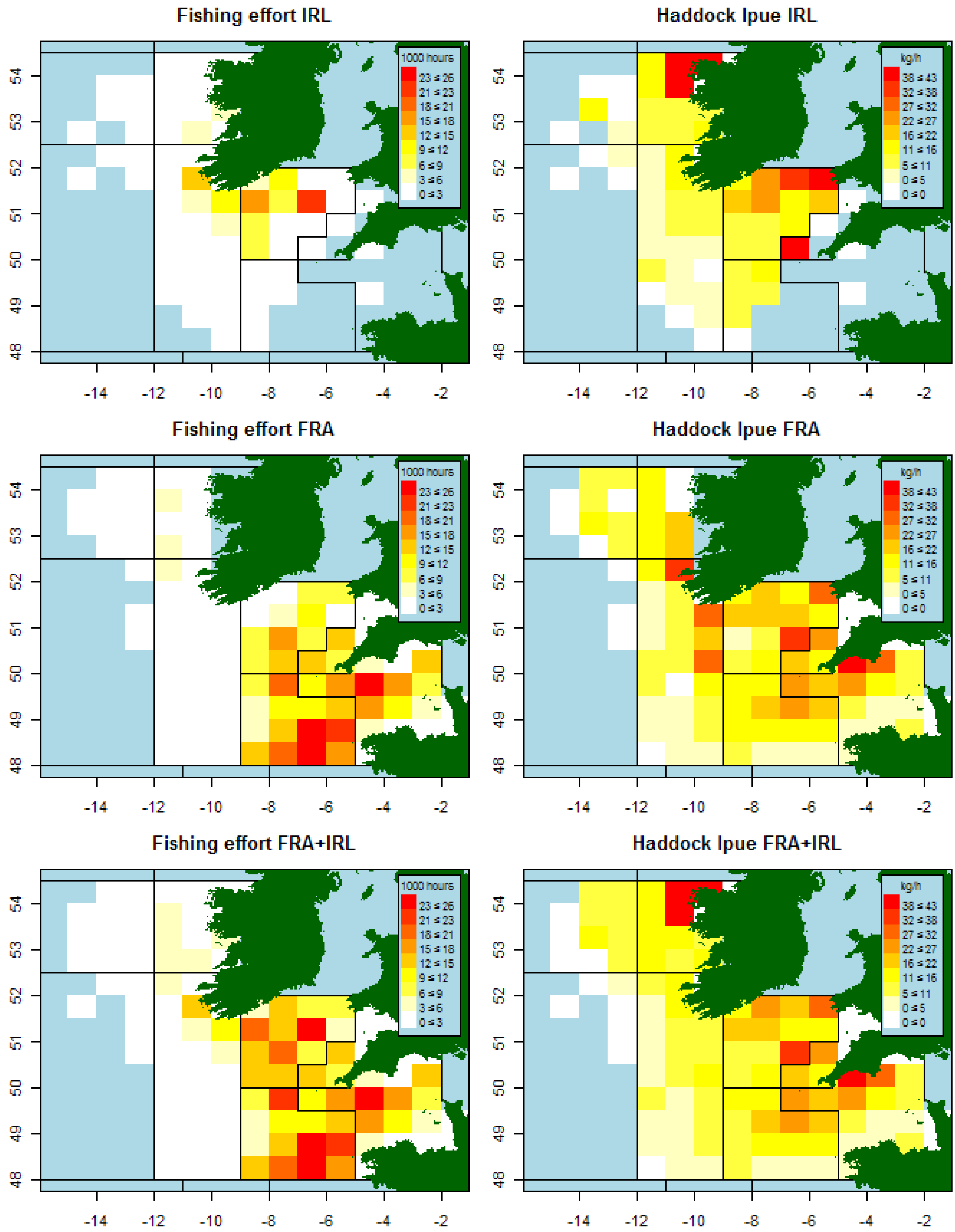


Figure 7.4.3. Effort and Lpue of the French and Irish otter trawl fleets by rectangle. These combined fleets represent 85% of the landings of haddock in VIIb–k.

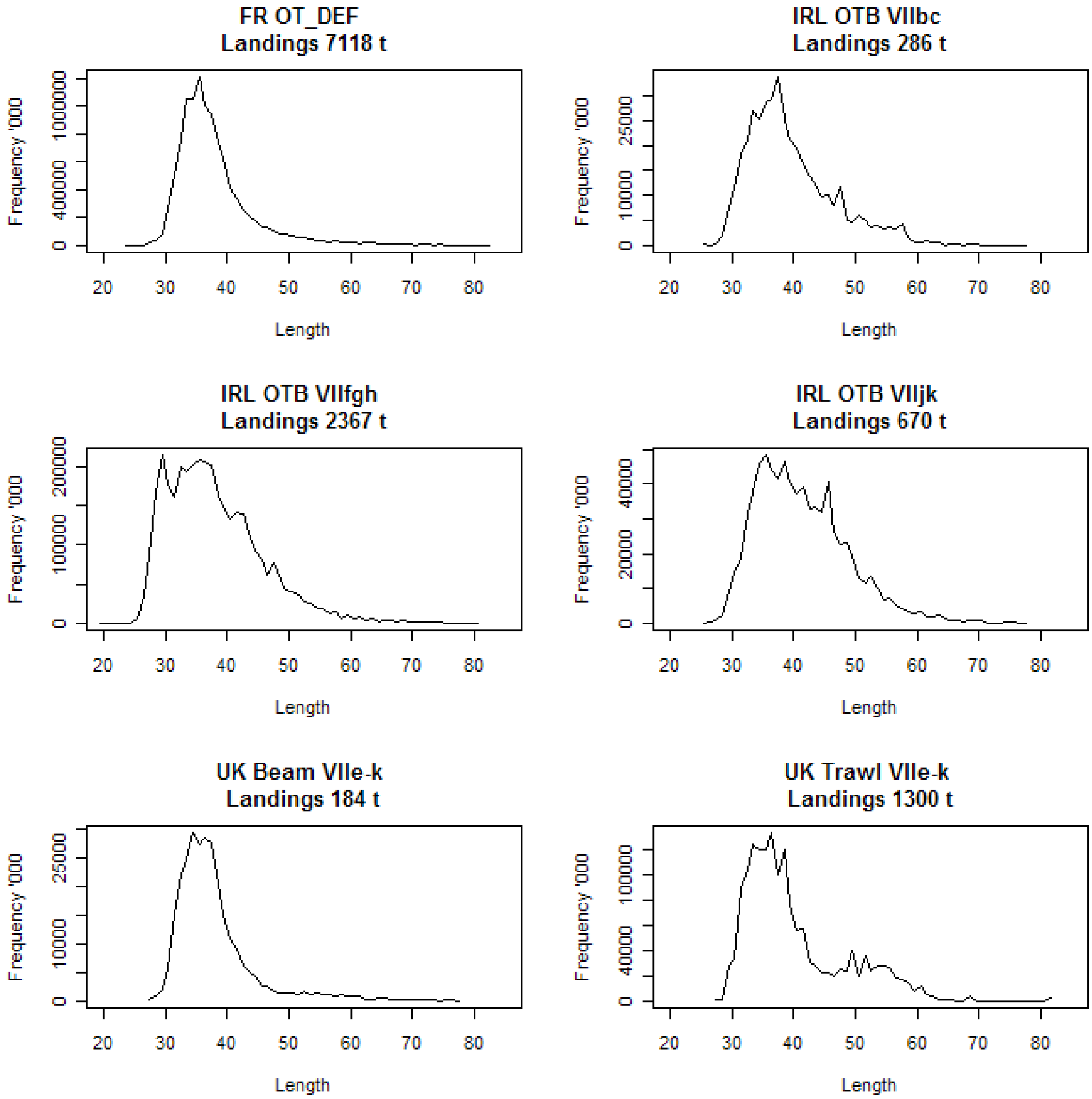


Figure 7.4.4. Length distributions of the landings of haddock in VIIb–k in 2010. FR OT_DEF is the French demersal fleet; IRL OTB is the Irish otter trawl fleet; UK beam is the UK beam trawl fleet and UK trawl consists of all other UK trawls.

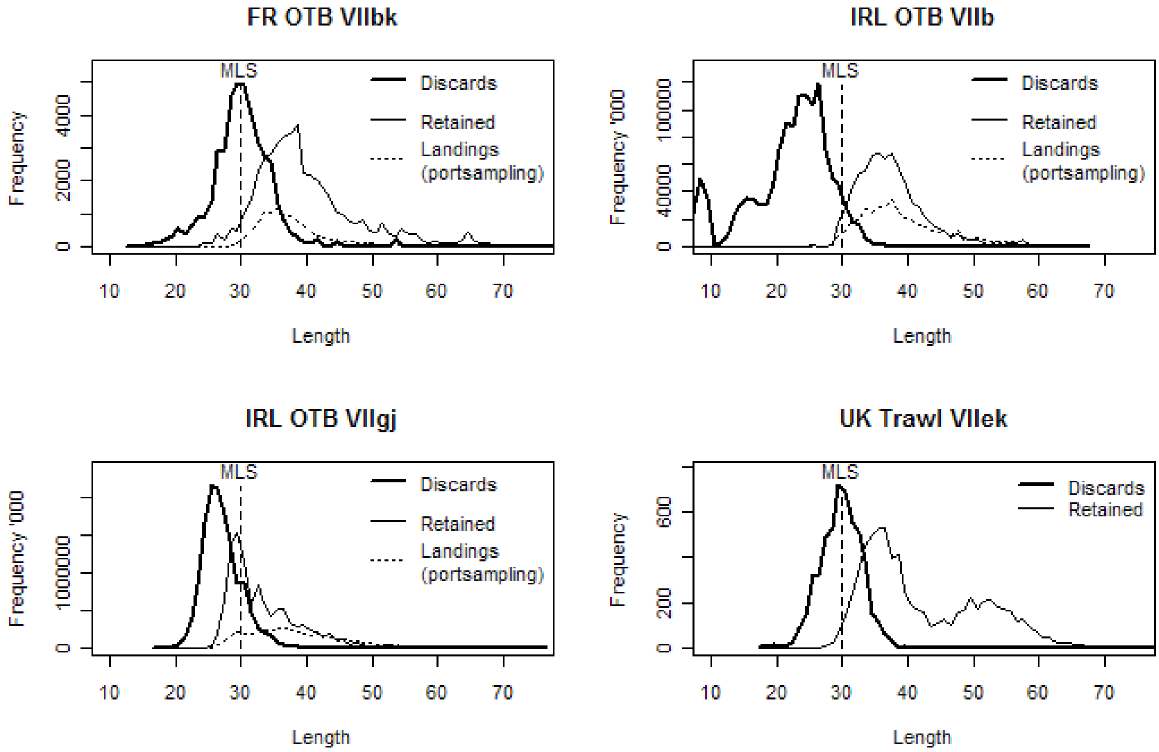


Figure 7.4.5. Length distributions of discards and the retained catch of haddock in VIIb–k in 2010. FR OTB is the French otter trawl fleet (demersal fish and *Nephrops* combined); IRL OTB is the Irish otter trawl fleet; UK trawl consists of all UK trawls except beam trawls. Irish and French data were raised to total numbers, the raised length distributions of the landings (from port sampling) is given for comparison.

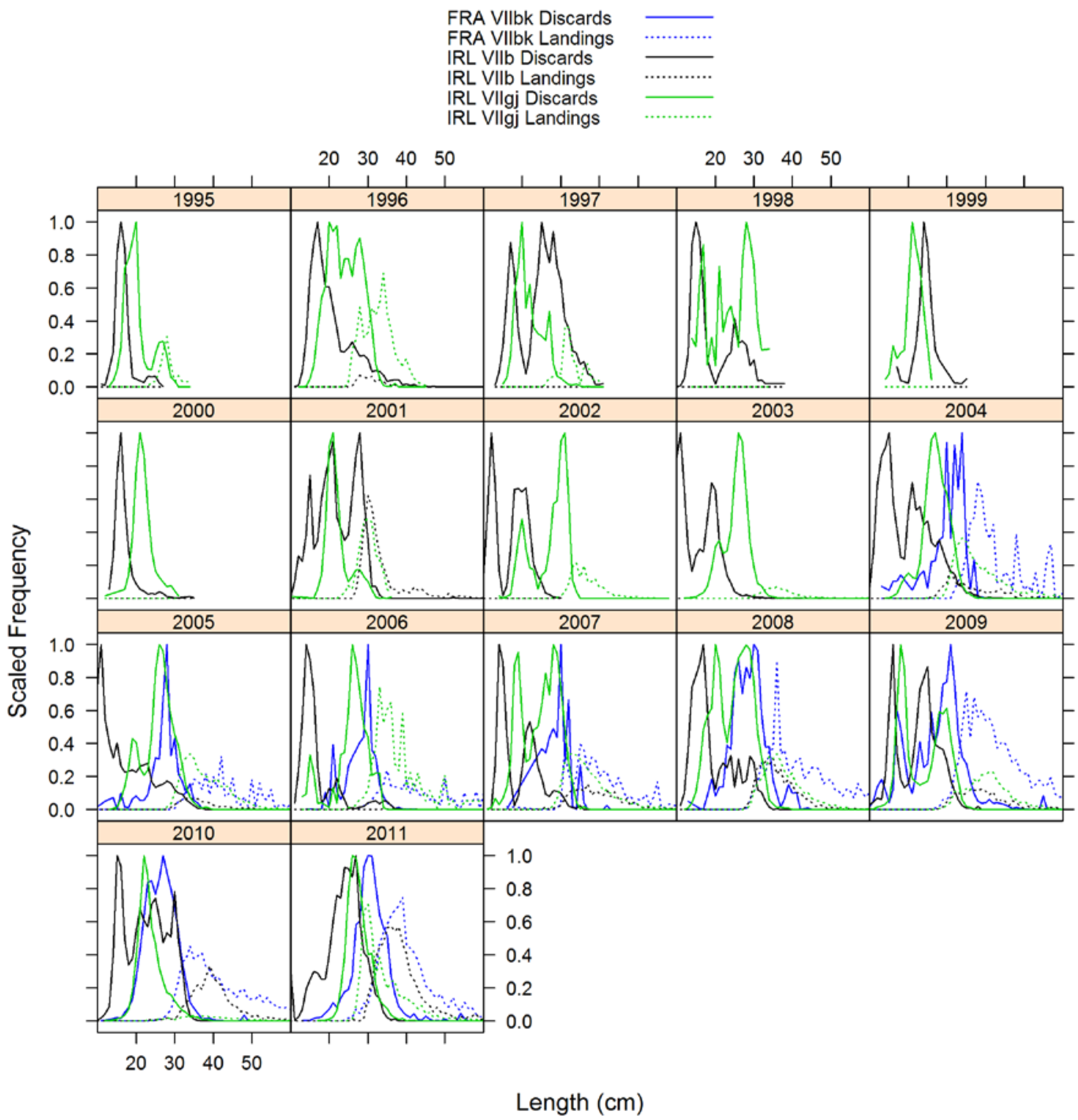


Figure7.4.6.Time-series of the length distributions of discards and the retained catch of haddock in VIIb–k.

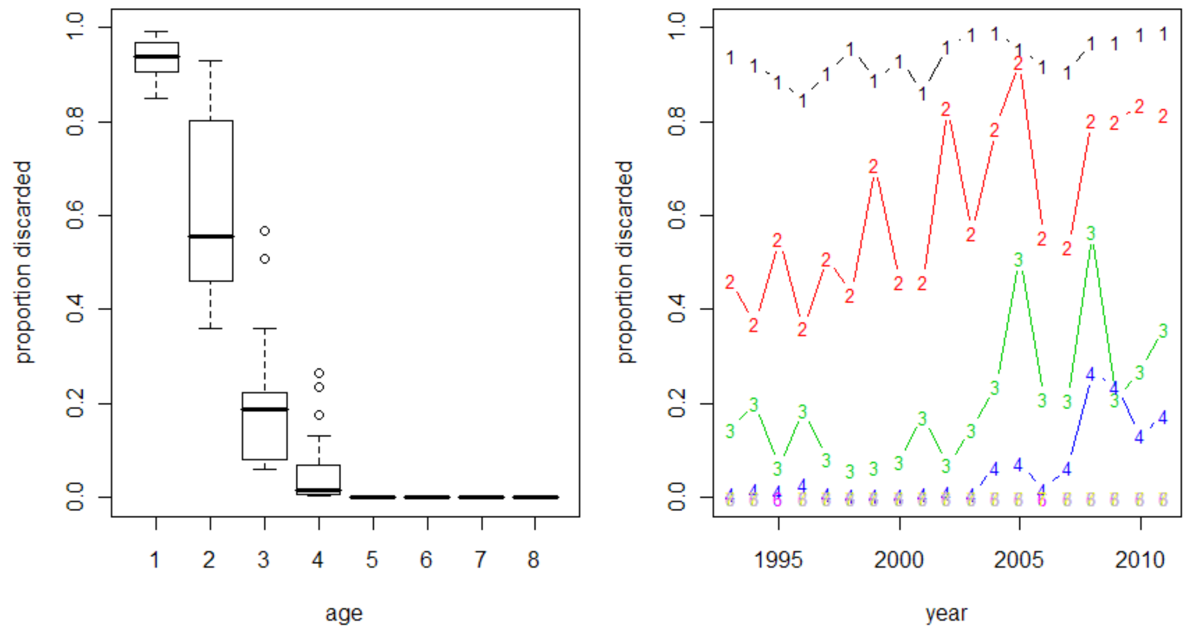


Figure7.4.7. Proportion of discards of haddock in VIIb–k by age (left) and year (right).

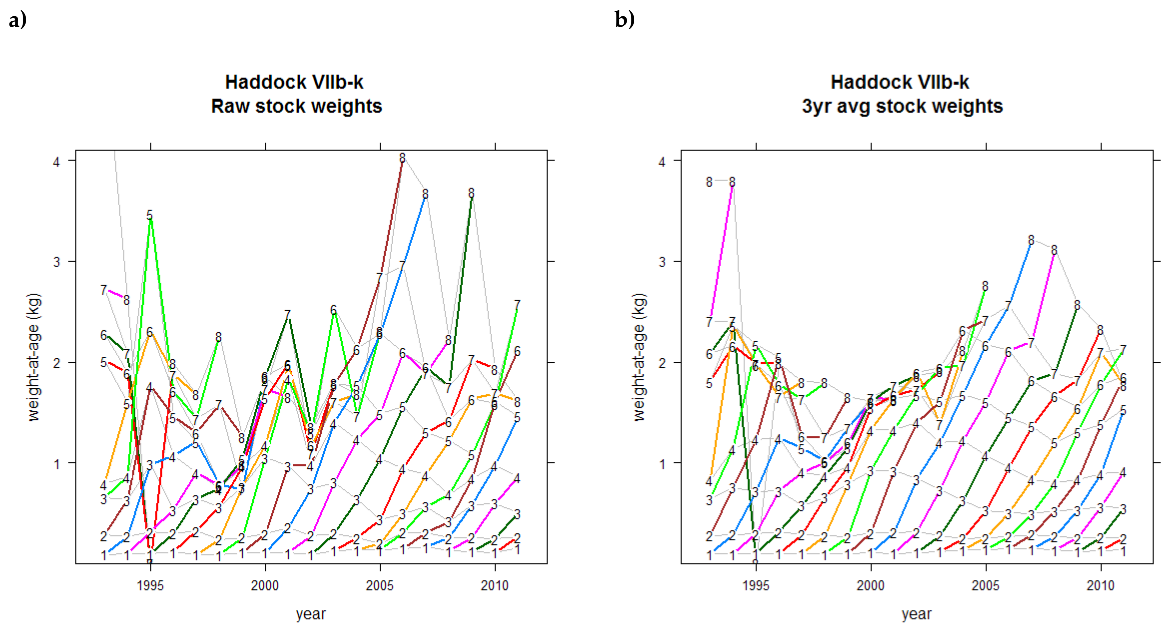
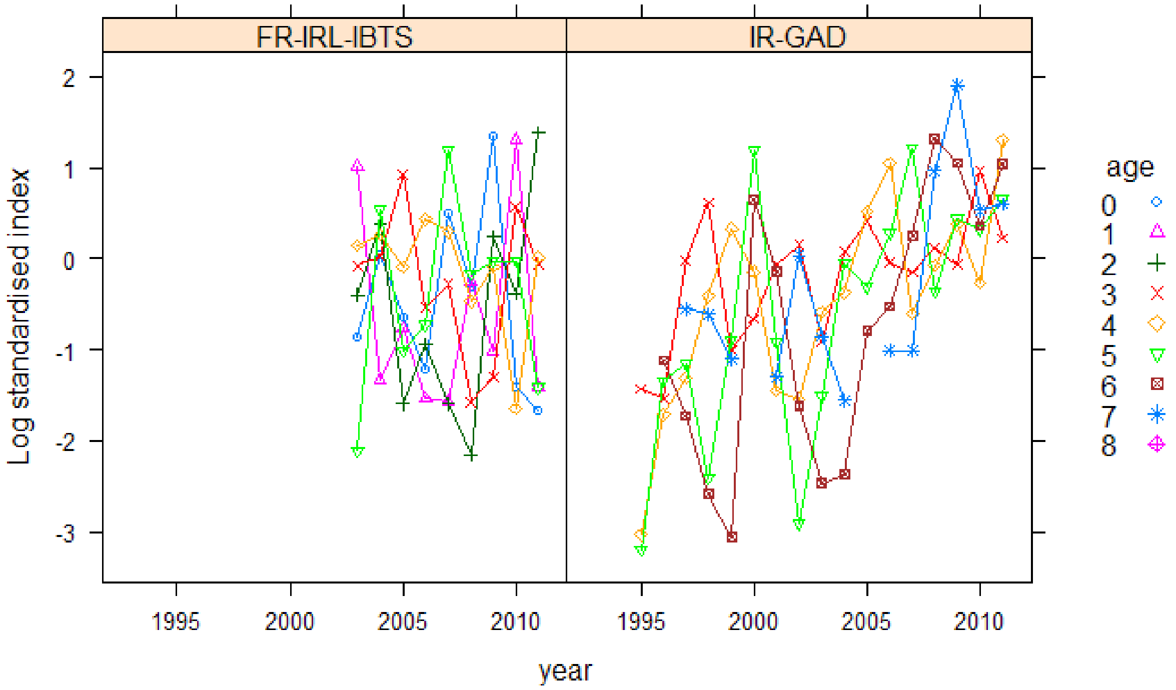


Figure7.4.8. Raw stock weights-at-age (a) and the three-year running average stock weights (b).

a)



b)

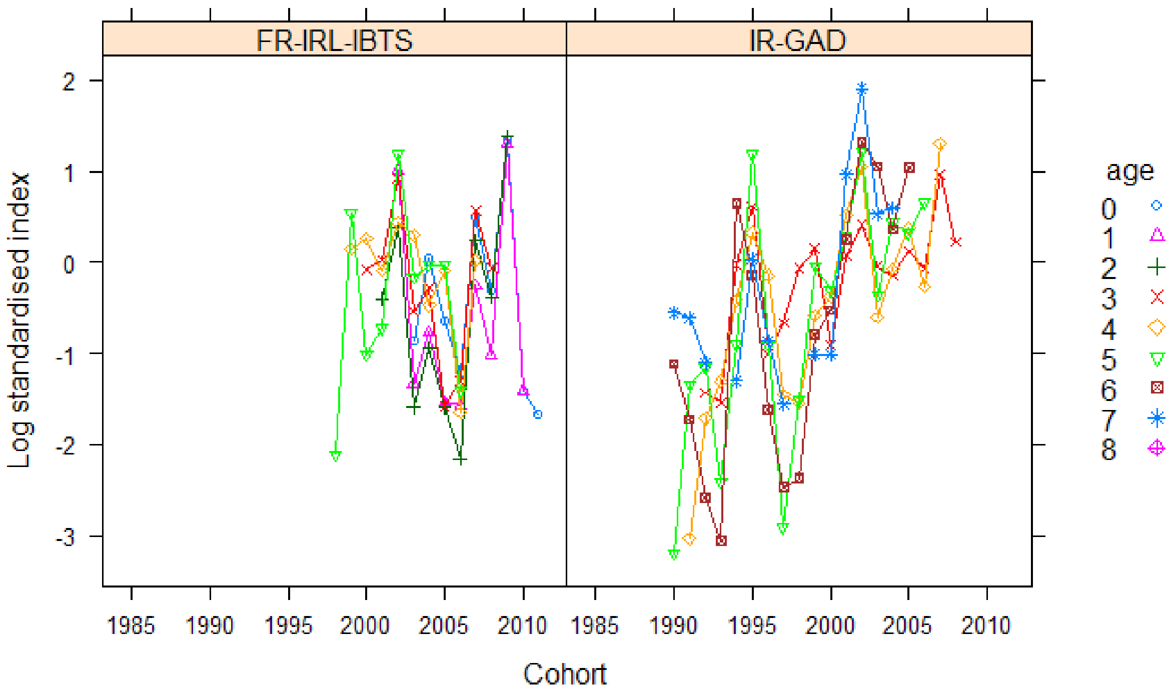


Figure 7.4.9. Log standardised indices of tuning fleets by year (a) and cohort (b).The FR-IRL-IBTS survey is the combined French EVHOE Q4 WIBTS and Irish IGFS Q4 WIBTS survey. The IR-GAD commercial tuning fleet is the Irish gadoid fleet in VIIgj.

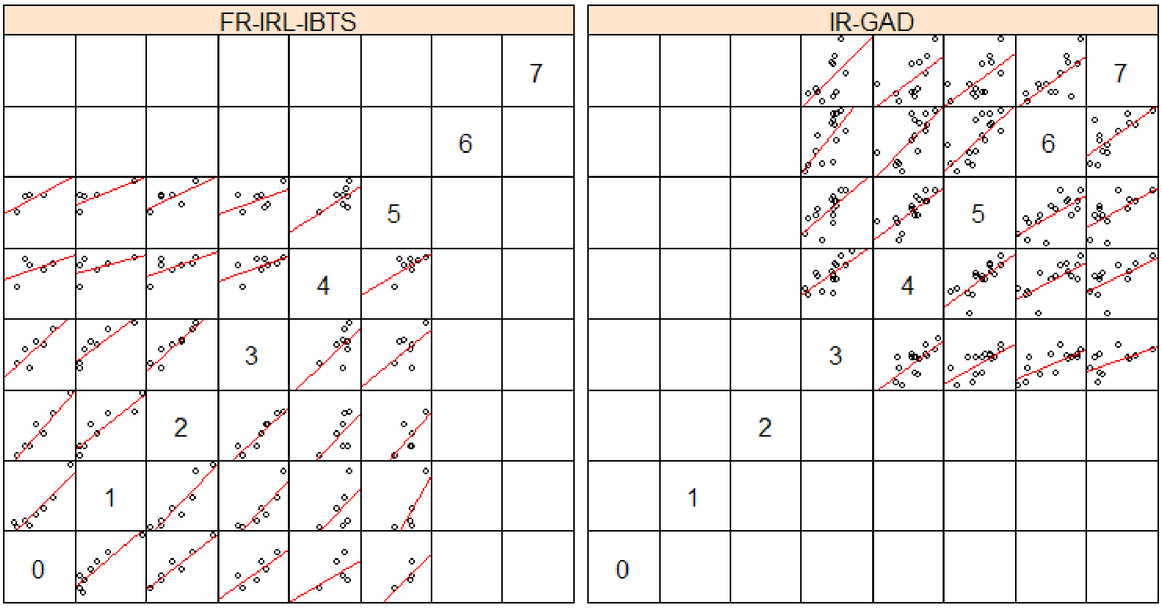


Figure 7.4.10. Scatterplot matrix of log indices of cohorts at different ages.

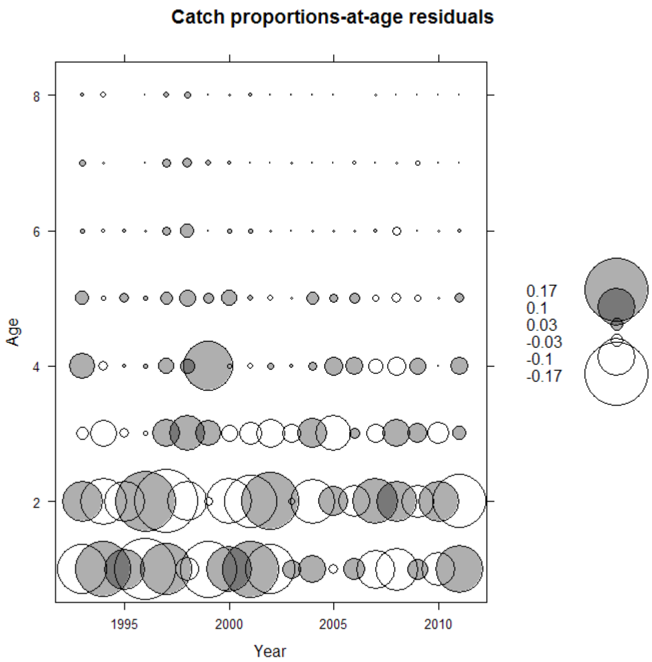


Figure 7.4.11. Catch proportions-at-age residuals (observed-predicted).

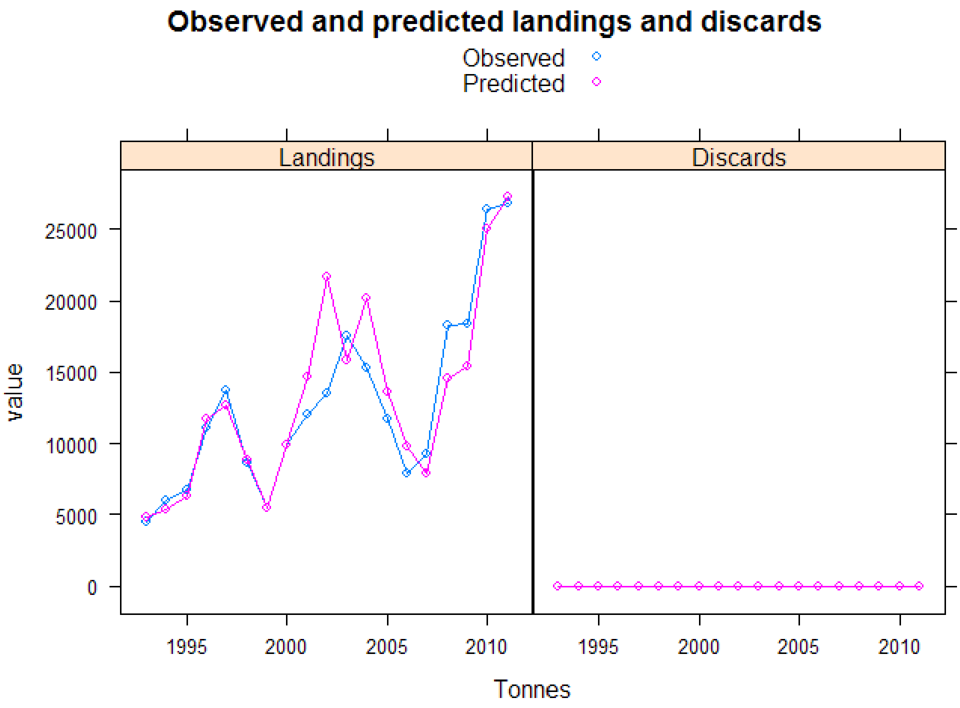


Figure 7.4.12. Observed and predicted catches (discards were included in the landings data).

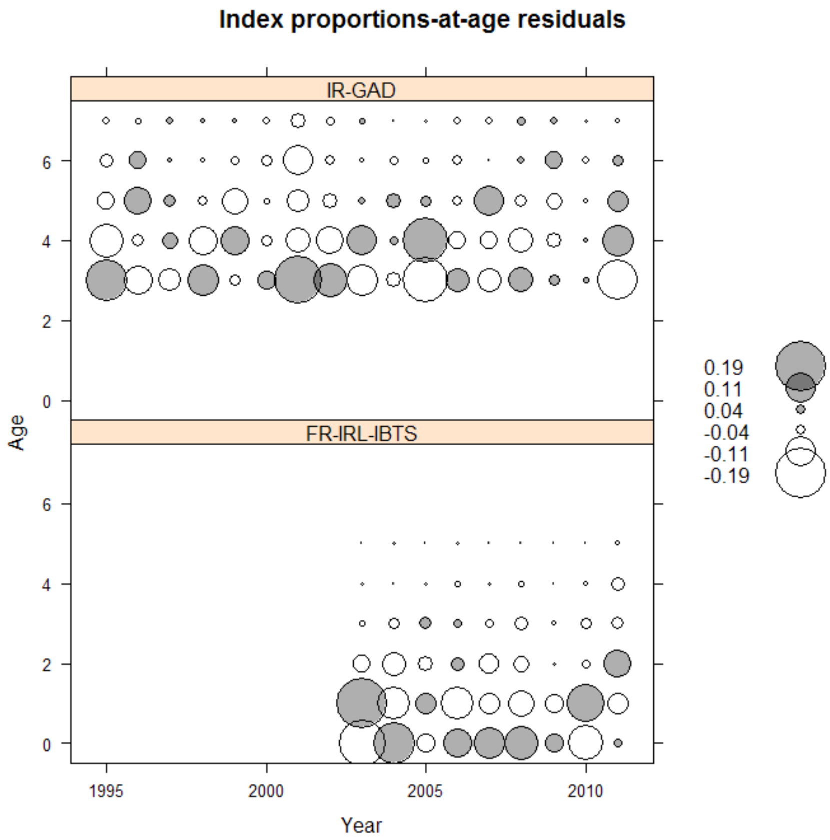


Figure 7.4.13. Index proportions-at-age residuals (observed – predicted).

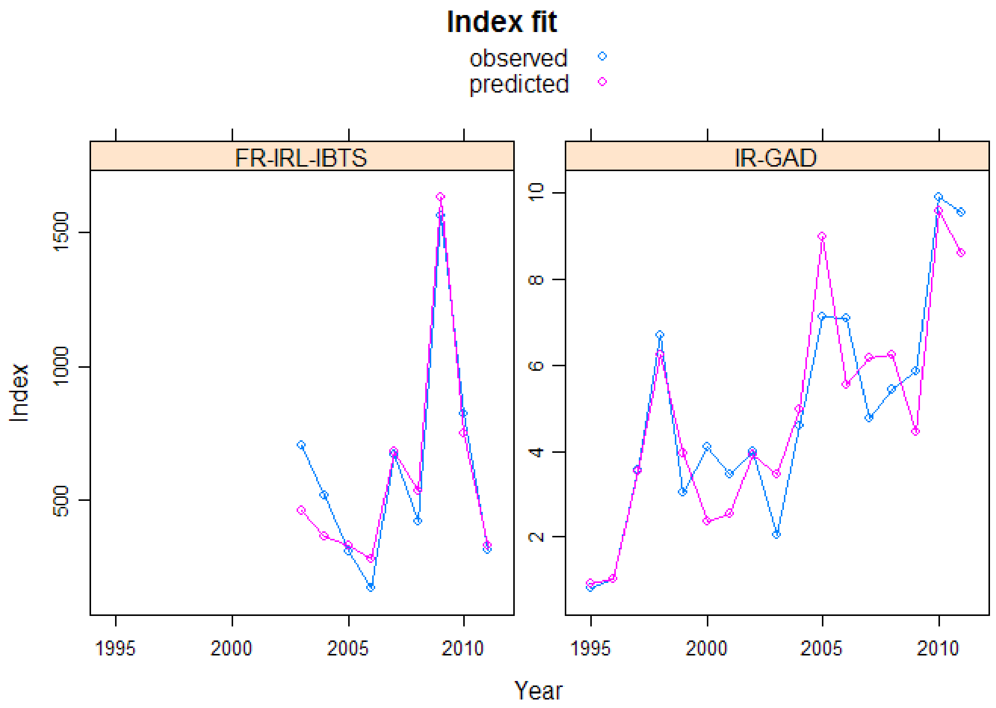


Figure 7.4.14. Observed and predicted index cpue.

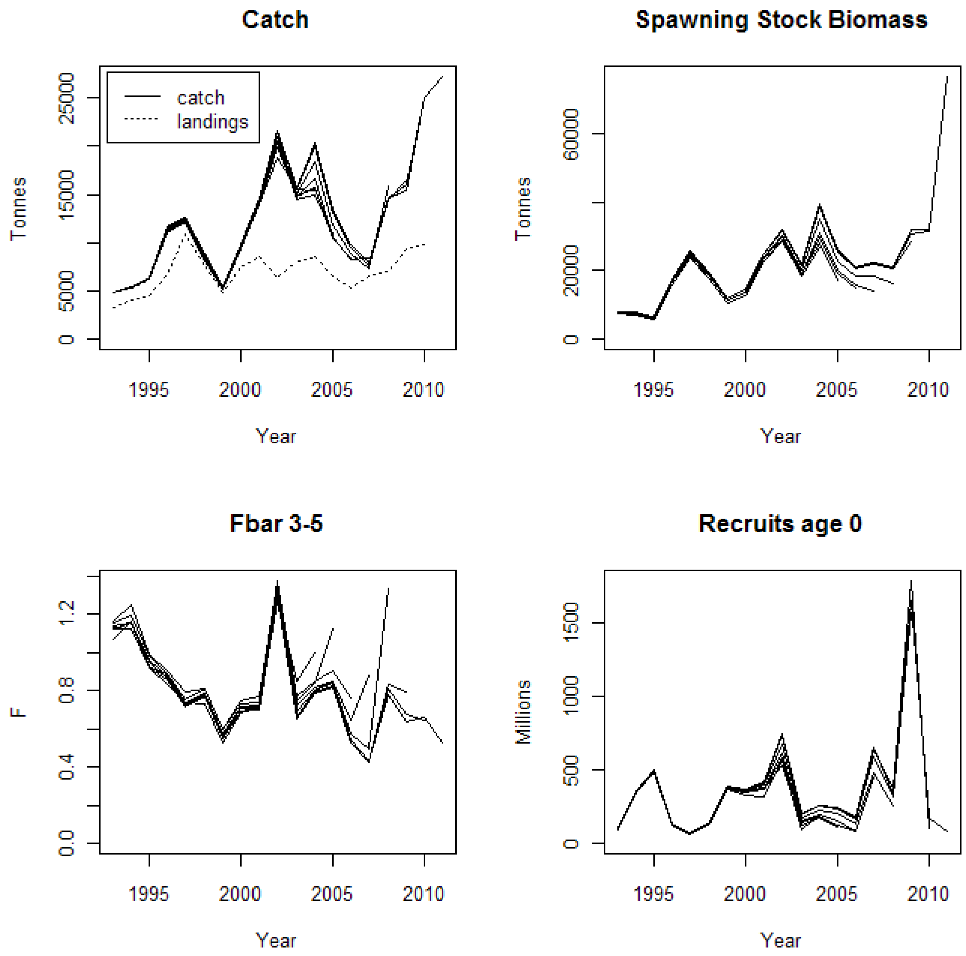


Figure 7.4.15. Retrospective analysis of the final ASAP run. Note that the survey index only started in 2003.

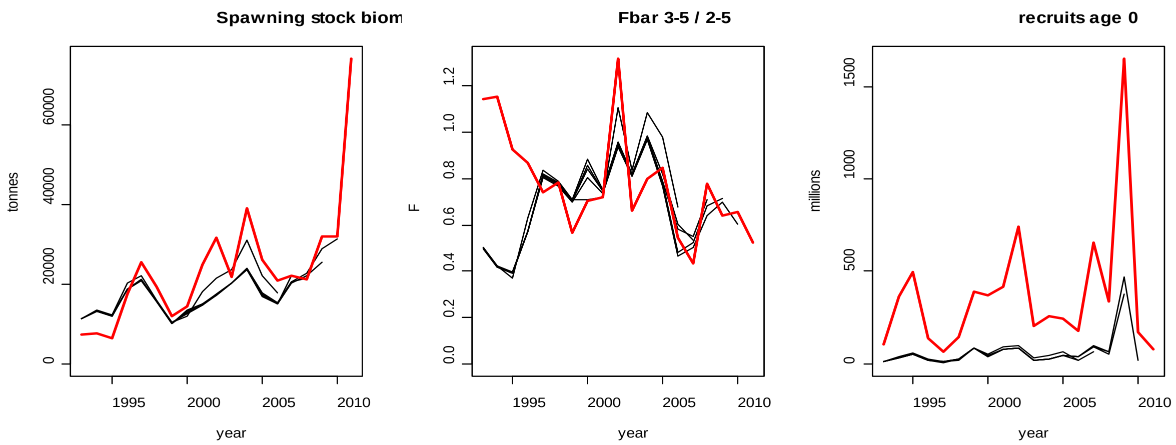


Figure 7.4.16. Comparison of the 2012 ASAP assessment (red) with historic XSA assessments (black).

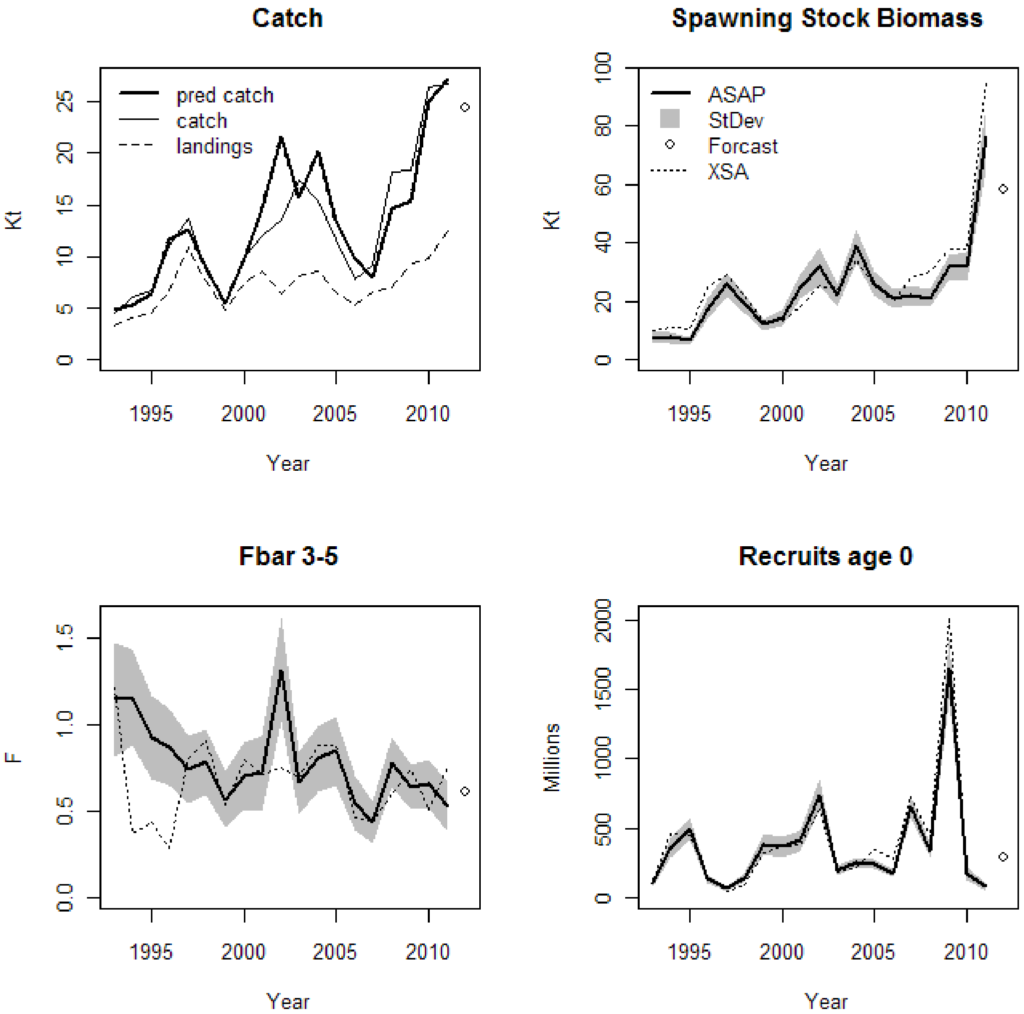


Figure 7.4.17. Stock summary plot. The thick black line represents the ASAP assessment standard deviations from ASAP are shaded grey. The forcast / assumed values for 2012 are given by open circles. The thick black line in the catch plot represents the predicted catch from ASAP. The dotted line in the SSSB, FBAR and recruitment plots represents the XSA assessment.

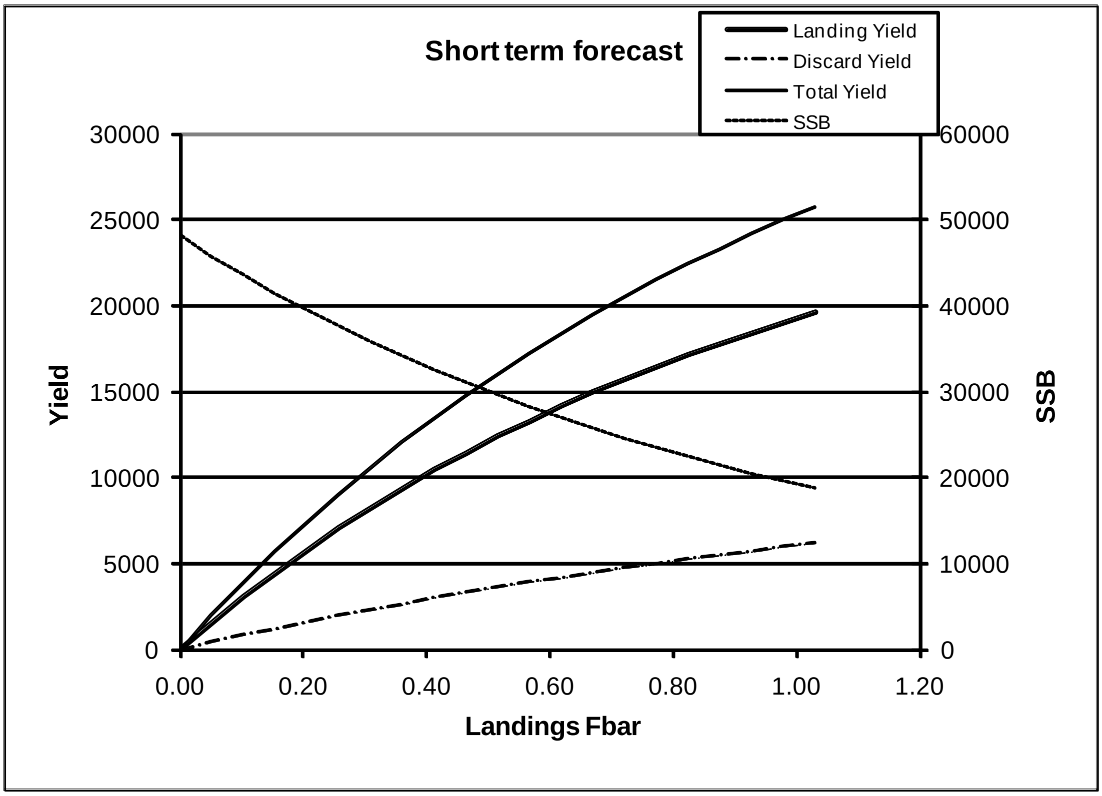


Figure 7.4.18. Short-term forecast (yield in 2012 and SSB in 2013).

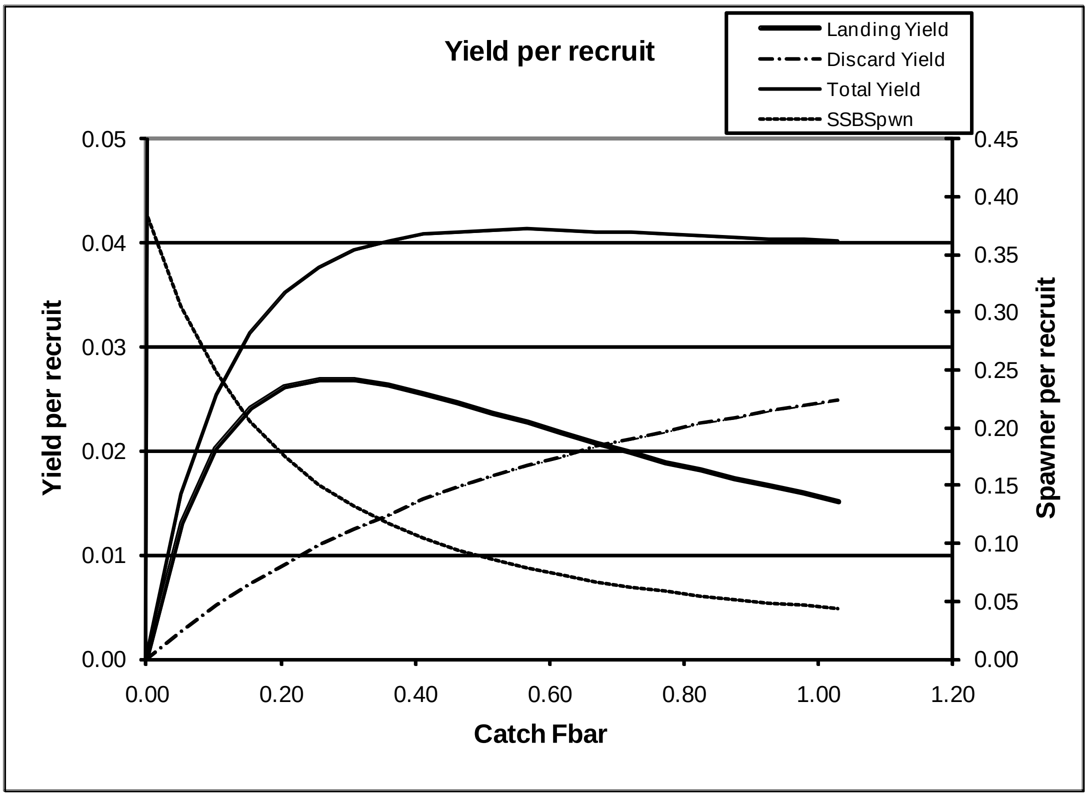


Figure 7.4.19. Yield-per-recruit analysis. F_{MAX} of the landings is 0.28 and $F_{0.1}$ of the landings is 0.18.

7.5 *Nephrops* in Division VIIb (Aran Grounds, FU17)

Type of assessment in 2012

UWTV based assessment using WK*NEPH* 2009 protocol as described in the Stock Annex. This year long-term reference points have been examined for this stock. Further description on the background is presented in Section 7.5.2.

ICES advice applicable to 2011

"Following the ICES MSY framework implies harvest ratio of 10.5%, resulting in landings of 950 t."

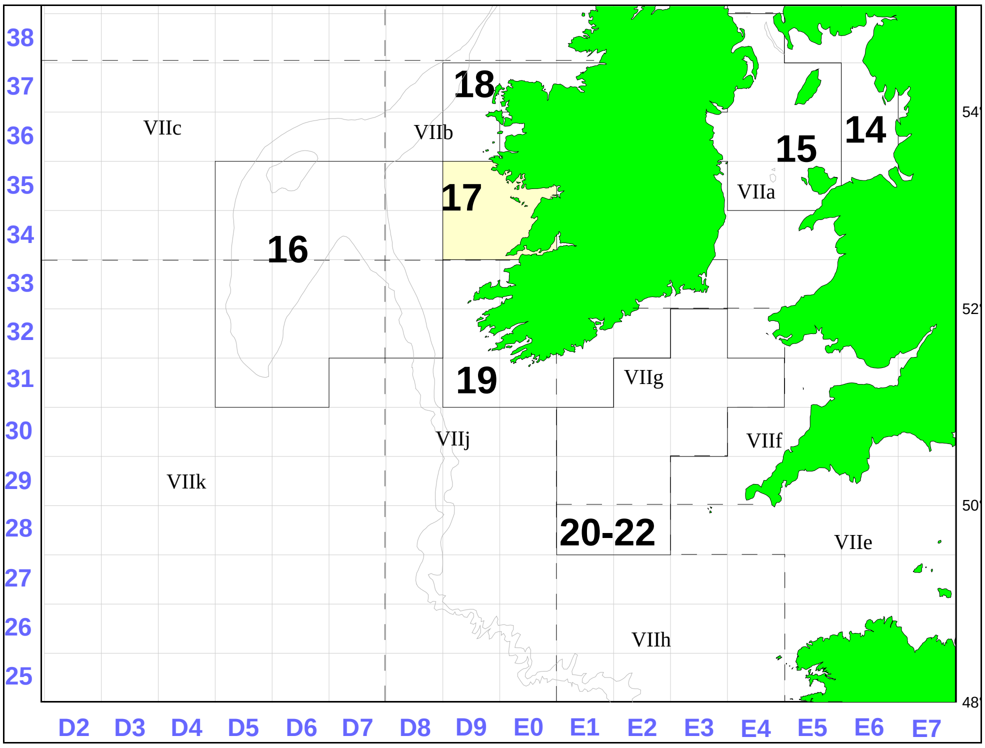
ICES advice applicable to 2012

"ICES advises on the basis of the MSY approach that landings in 2012 should be no more than 1100 t."

7.5.1 General

Stock description and management units

The Aran Grounds *Nephrops* stock (FU17) covers ICES rectangles 34–35 D9–E0 within VIIb. This stock is included as part of the TAC Area VII *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).



The TAC is set for Subarea VII which does not correspond to the stock area (FU 17 is shaded light yellow). There is no evidence that the individual functional units belong to the same stock. The 2012 TAC is 21 759 t, the same as the 2011 TAC. No FU17 specific restrictions in TAC apply thus, up to 100% of the Area VII TAC could, in theory be taken within FU17.

Management applicable to 2011 and 2012

TAC in 2011

'Species: Norway lobster *Nephrops norvegicus*		Zone: VII (NEP/07.)
Spain	1 306 (1)	
France	5 291 (1)	
Ireland	8 025 (1)	
United Kingdom	7 137 (1)	
EU	21 759 (1)	
TAC	21 759 (1)	Analytical TAC

(1) Of which no more than the following quotas may be taken in VII (Porcupine Bank – Unit 16) (NEP/*07U16):

Spain	377
France	241
Ireland	454
United Kingdom	188
EU	1 260';

Council Regulation (EU) No 683/2011 of 17 June 2011 amending Regulation (EU) No 57/2011 as regards fishing opportunities for certain fish stocks.

TAC in 2012

Species: Norway lobster *Nephrops norvegicus*		Zone: VII (NEP/07.)
Spain	1 306 (1)	
France	5 291 (1)	
Ireland	8 025 (1)	
United Kingdom	7 137 (1)	
Union	21 759 (1)	
TAC	21 759 (1)	Analytical TAC Article 11 of this Regulation applies.

(1) Special condition: of which no more than the following quotas may be taken in VII (Porcupine Bank – Unit 16) (NEP/*07U16):

Spain	380
France	238
Ireland	457
United Kingdom	185
Union	1 260

COUNCIL REGULATION (EU) No 43/2012 of 17 January 2012 fixing for 2012 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.

The MLS implemented by EC is set at 25 mm CL i.e. 8.5 cm total length and this regulation is applied by the Irish and UK fleets whereas a more restrictive regulation adopted by the French Producers' Organisations (35 mm CL i.e. 11.5 cm total length) is applied by the French trawlers.

Ecosystem aspects

This section is detailed in Stock Annex.

Fishery description

Since 1996 the Republic of Ireland fleet had over 99% of the landings from this FU. A description of the fleet is given in the Stock Annex. 36 Irish trawlers reported landings from this FU in 2011. This is about a 67% increase compared with the number of vessels reporting in 2009. In addition, 19 of these vessels reported landings in excess of 10 t. The majority of these vessels are based in the port of Ros-a-Mhíl. Recently vessels from the ports of Clogherhead and Dunmore-East also fish the Aran grounds in peak times of the early summer and also the winter months Vessel lengths range from 13 to 38 m and engine power ranges from 120–870 kW (See Stock Annex). The majority of vessels are in the 20–25 m length range and make fishing trips between 3-7 days in duration. 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 (Figure A.2.5).

Fishery in 2011

The 2011 landings decreased by 40% from those made in 2010 and amounted to 600 t. The decrease is mainly to effort reductions in the area. 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.

7.5.2 Data

Sampling of landings and discards resumed in 2008 after a break of two years (2006–2007) in the sampling programme. This break was due to non-cooperation with sampling by the fishing industry. Sampling levels in 2011 were good and are detailed in Section 2 (Table 2.1). Historical data availability and quality is reported in the Stock Annex (Section B).

Landings

The reported landings time-series is shown in Figure 7.5.1 and Table 7.5.1. The reported Irish landings from FU17 have fluctuated around 800 t in the recent years. There are concerns about the accuracy of reported landings statistics for *Nephrops* by Irish vessels due to restrictive quotas and various misreporting practices. The introduction of sales notes and increased control and enforcement since 2007 should improve the accuracy of reported landings data.

Commercial cpue

Effort data for this FU is available from 1995 for the Irish otter trawl *Nephrops* directed fleet. In 2011 this fleet accounted for ~95% of the landings compared with an average of 70% over the time period. These data have not been standardized to take into account vessel or efficiency changes during the time period. Effort shows a declining trend since late 1990s and the 2011 effort is the lowest observed in the time-series (Table 7.5.2.). Landings per unit of effort (lpues) increased in the mid-2000s and has remained at a high level since then. Lpue in 2011 was above average at 52 kg/hr (Figure 7.5.2).

Discarding

Before 2001 there was no discard sampling and it was reported that *Nephrops* discarding in this fishery was relatively low. Since 2001 discard rates have been estimated using unsorted catch and discards sampling (as described in the Stock Annex). Discard rates range between 14–30% of total catch by weight and 20–40% of total catch by number (Table 7.5.3). 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 (10% is assumed). No estimates of discards were available in 2006 and 2007 due to the non-cooperation of the fishing industry with sampling programmes.

Discarding by the *Nephrops* trawl fleet is around 47% of the total catch by weight (Table 7.5.4). The main discards are small whole *Nephrops*. The main fish species discarded are dogfish, haddock, whiting and megrim (Anon, 2011).

Biological sampling

The Irish sampling programme resumed in 2008 and since then coverage and intensity has been very good. The mean size of whole *Nephrops* (>35 mm) in Irish landings has remained stable between 1995 and 2000 for both sexes (Figure 7.5.3 and Table 7.5.5.). The mean size of *Nephrops* in the catch has remained relatively stable since 2001.

The sex ratio in the landings has fluctuated with a slightly male biased in most years (Figure 7.5.4). The proportion of males was higher in 2009 due an increased proportion of the landings taken in autumn. Conversely in 2011 the majority of the landings were made in Q2 when the catches are dominated by female *Nephrops* (see Fishery in 2009 WGCSE Report 2010).

There is no change to other biological parameters as described in the Stock Annex.

Abundance indices from UWTV surveys

WK*NEPH* 2009 concluded that this survey could be used as an absolute index of abundance for this stock provided the bias (see text table below) was taken into account (ICES, 2009). These bias sources are not easily estimated and are largely based on expert opinion. In the Aran Grounds the largest source of perceived bias is the "edge effect". The bias correction factor is in line with other stocks with similar density e.g. FU11 = 1.33 and FU12 = 1.32 (ICES, 2009).

FU	Area	Edge effect	detection rate	species identification	Occupancy	Cumulative bias
17	Aran	1.35	0.9	1.05	1	1.3

The blanked krigged contour plot and posted point density data are shown in Figure 7.5.5. The krigged contours correspond very well to the observed data. In general the densities are higher towards the western side of the ground and there is a notable trend towards lower densities to the east. Densities and abundance have fluctuated considerably in the time-series (e.g. 0.6–1.4 burrows/m^2). The mean density in 2011 is approx 30% decrease on 2010 and is below the average of the time-series.

The summary statistics from this geostatistical analysis are given in Table 7.5.6 and plotted in Figure 7.5.6. The statistical analysis follows these steps documented in WD 05: 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 2011 estimate of 638 million burrows are below average but the estimates have fluctuated widely since the survey commenced. The estimation variance of the survey as calculated by EVA is very low (CVs in the order <5%).

Raised abundance estimates are presented for the first time for the smaller Slyne Head and Galway Bay grounds (Table 7.5.7; Figure 7.5.6.). The spatial extent of these grounds has been estimated (See Lordan *et al.*, WD05). The abundance estimates are the product of the mean density and ground area. The sample variances, standard errors, t-values and 95% CI were calculated for each ground. The size and contribution to landings of these grounds is small relative to the Aran grounds on average 10%. This has not been taken into account in the overall abundance estimate or catch options.

7.5.3 Assessment

Summary of Review Group comments on the 2011 assessment

The assessment was carried out in accordance with the description in the stock annex. The assessment approach used by WGCSE 2010 was said to be consistent with that set out in the stock annex and WK*NEPH* (2009). The stock annex was very clear and contained good information on ecosystem consideration.

Discard estimates are included in the assessment since 2001 with the exception of 2006–2007 when there was no sampling of landings and discards.

Technical comments

1) The RG appreciates the WG's efforts to address last year's RG recommendation to explore the analyses leading to an apparent very low F_{MSY} harvest ratio for males. However, the WG was not able to conclude on an alternative SCA analysis for this stock. The RG supports the WGs recommendation to explore this at the next benchmark process.

2) Table 7.5.5; why does the product of the mean density and the domain area or area surveyed not give the total abundance? For geostats, is the mean density the simple mean over tows? Unless these things are explained, people may deduce that there are errors in the table.

Conclusions

The RG agrees that the UWTV survey and associated F_{MSY} values represent an appropriate means of providing quantitative management advice.

The RG agrees that $F_{35\%spr}$ is consistent with the approach adopted by WGCSE for choosing F_{MSY} proxies for *Nephrops*.

The RG report contained some technical comments and attempts have been made to address these in 2012.

The assessment approach used by WGCSE 2012 is consistent with that used last year and set out in the Stock Annex and WK*NEPH* (ICES, 2009). Since the most recent three years of sampling data were available, three year averages of mean weights in the landings and proportions retained in the fishery have been used. This is in line with the procedure used for other stocks.

As discussed last year and noted by the RG the reference points derived from the SCA analysis for this stock will be maintained until they are revisited at the next benchmark or through an inter-benchmark process. Similarly the domain area, including the other patches in Galway Bay and Slyne, will not be modified until the next benchmark or inter-benchmark. In response to the RGs question about the product of the domain area and mean density not equalling the abundance estimate WGCSE would like to confirm that this is because the abundance estimate is derived from the geostatistical estimation process whereas the mean presented in Table 7.5.7 is a mean of all the observations.

Comparison with previous assessments

The assessment is based on the same methods and similar data as used in 2011. The stock size is estimated to have decreased and harvest ratio has also decreased slightly based on the UWTV survey.

State of the stock

UWTV abundance estimates suggest that the stock size has fluctuated widely without trend and the 2011 estimate is below the average of the series (geomean: 819 million). Table 7.5.7 summarizes recent harvest ratios for the stock along with other stock parameters. Figure 7.5.7 is the stock summary plot for FU17. Recent harvest rates have fluctuated around 8%, and landing have fluctuated around 850 t.

7.5.4 Short-term projections

Catch option table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 7.5.8. A three year average (2009–2011) of mean weight in landings and proportion of removals retained was used. WGCSE noted that the mean weight declined and the proportions of removal retained increased somewhat in 2011. This observation is confirmed with good sampling and is due to an influx of vessels which tend to "tail"[1] more of their catch in 2011. Since 2002 mean weight in the landings has varied between 18–27 g. The estimate harvest ratio has also varied a lot, 3–16% with 2008 being the highest observed.

A prediction of landings for 2013 was made for the Aran Grounds Functional Unit using the approach agreed procedure proposed at WK*NEPH* 2009 and outlined in the Stock Annex. Table 7.5.9 shows landings predictions at various harvest ratios, including those equivalent to fishing within the range of $F_{0.1}$ to F_{max}. The F_{2011} (mean F 2008–2011) for the Aran grounds is estimated below the $F_{msy\ proxy}$ proposed by ICES.

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[1] This is a labour intensive process whereby the head and thorax of the *Nephrops* are removed and only the tail is retained for landing. Vessel which tail extensively tend to land more of the smaller *Nephrops* caught.

7.5.5 MSY explorations

As discussed previously no new MSY explorations were carried out at WGCSE this year. The results of the final SCA model carried out last year are given in the text table below. The F multipliers required to achieve the potential F_{msy} proxies, the harvest rates that correspond to those multipliers and the resulting level of spawner per recruit as a percentage of the virgin level.

		F_{BAR} 20–40mm		Harvest Rate	% Virgin Spawner per Recruit	
		Female	Male		Female	Male
$F_{0.1}$	Comb	0.06	0.17	7.2%	64.3%	39.4%
$F_{0.1}$	Female	0.11	0.31	9.1%	49.7%	25.4%
$F_{0.1}$	Male	0.05	0.14	6.4%	68.8%	44.8%
F_{35}	Comb	0.12	0.34	10.5%	47.0%	23.2%
$F_{35\%}$	Female	0.55	0.19	12.8%	34.9%	15.0%
$F_{35\%}$	Male	0.07	0.21	8.4%	60.0%	34.8%
F_{MAX}	Comb	0.12	0.34	11.1%	47.0%	23.2%
F_{MAX}	Female	0.56	0.19	13.0%	34.5%	14.8%
F_{MAX}	Male	0.09	0.26	9.8%	54.1%	29.2%

This fishery is highly seasonal (see Annex), but the timing of the fishery has varied somewhat in recent years. This coupled with limited time-series of survey data and biological knowledge of the stock suggests that a risk adverse harvest rate would be appropriate.

Compared to other *Nephrops* fisheries in ICES area the absolute population density of this stock is relatively high Figure 7.5.7. This implies that sperm limitation if males are overfished is not likely to be a significant problem. The combined sex $F_{35\%\ SPR}$ would result in >20% males SPR and 47% female SPR. **The WGCSE and RGCSE 2010 concluded that a combined sex $F_{35\%}$ was a suitable $F_{msy\ proxy}$ for this stock. This corresponds to a harvest rate of 10.5%.**

7.5.6 Biological reference points

Precautionary reference points have not been defined for *Nephrops* stocks. Given the short time-series of UWTV survey data it is not possible to define an appropriate $B_{trigger}$. The combined sex $F_{35\%}$ SPR is proposed by the WG as proxy for F_{MSY}.

7.5.7 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.

7.5.8 Uncertainties and bias in assessment and forecast

The SCA and YPR analysis carried out by WGCSE 2010 was based on 2008 and 2009 sampling. The fit to the SCA model was problematic, as discussed above, so harvest proxies are likely to be uncertain. The harvest ratio for the combined sex $F_{35\%}$ appears to be conservative relative to other stocks with similar burrow densities as noted by RGCSE 2010.

There are several key uncertainties and bias sources in the method proposed (these are discussed further in WK*NEPH* 2009 (ICES, 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 (ICES, 2007, 2008, 2009). These recommendations have been retrospectively applied to historical survey estimates this year (Section 5.1) and these are now considered final. Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that was more accurate but no more precise (ICES, 2009). The survey estimates themselves are likely to be fairly precisely estimated given the homogeneous distribution of burrow density and the modelling of spatial structuring. The cumulative bias estimates for FU17 are largely based on expert opinion. The precision of these cannot yet be characterized. Ultimately there still remains a degree of subjectivity in the production of UWTV indices.

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. These parameters are quite variable (Table 7.5.8). In future years the uncertainty in these key parameters should be estimated.

Landings data are assumed to be accurate. Since 2007 the introduction of "buyers and sellers legislation" in Ireland is thought to have improved the accuracy of the reported landings.

Finally, the catch options developed do not take into account *Nephrops* abundance outside the current domain area or on the Slyne or Galway Bay Grounds. This is likely to cause a small (<10%) underestimate in the catch options for FU17 as a whole.

7.5.9 Recommendation for next benchmark

This stock was benchmarked in 2009. WK*NEPH* 2009 suggested several areas to be addressed before the next Benchmark. For this stock the inputs to the SCA analysis need further investigation given that growth and natural mortality parameters are assumed from the Irish Sea and the fit to the SCA analysis might be improved. The next benchmark should also look at integrating UWTV estimates for Galway Bay and Slyne head *Nephrops* as well as the accuracy of the ground boundary for the main Aran ground. WGCSE recommend that these issues could be addressed through and inter-benchmark process in advance of WK*NEPH* 2013.

7.5.10 Management considerations

The trends from the fishery (landings, effort lpue, mean size, etc.) appear to be relatively stable. Lpues have been relatively high in the last five years. Conversely, the UWTV abundance and mean density estimates show large fluctuations in burrow abundance and harvest rates. This suggests that the *Nephrops* population at current exploitation and recruitment rates is rather dynamic. The generally low apparent harvest rate (9% average) appears to have little impact on observed stock fluctuations. A new survey point should be available after July 2012 which will provide a more up to date prognosis of stock status. The use of the most up to date survey information should be considered for this stock.

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 could be displaced towards the Aran and other *Nephrops* grounds where effort control has not been put in place. This has not happened to date and the 2011 effort was the lowest in the time-series.

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).

7.5.11 References

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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.

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	991	9	1000
2011	0	600	0	600

Table 7.5.2. *Nephrops* in FU 17 (Aran Grounds). Irish effort and lpue for *Nephrops* directed fleet.

	Irish *Nephrops* Directed Fleet		
Year	Effort (Hrs)	Landings (tonnes)	Lpue (kg/hr)
1995	15 306	530	34.6
1996	9109	311	34.1
1997	15 763	478	30.3
1998	21 909	926	42.3
1999	19 546	743	38.0
2000	17 131	547	31.9
2001	18 700	600	32.1
2002	18 565	861	46.4
2003	19 922	732	36.8
2004	12 899	381	29.5
2005	14 900	729	45.8
2006	10 798	559	51.8
2007	13 608	815	59.9
2008	16 676	963	57.8
2009	10 620	561	52.8
2010	16 199	875	54.0
2011	8100	418	51.5

Table 7.5.3. *Nephrops* in FU17 (Aran Grounds). Landings and discard weight and numbers by year and sex.

	Female		Male		Both sexes
Year	Landings (t)	Discards (t)	Landings (t)	Discards (t)	% Discard
2001	312	109	601	138	21%
2002	423	96	729	99	14%
2003	237	89	688	98	17%
2004	267	71	259	45	18%
2005	323	106	441	86	20%
2006					
2007	No Sampling				
2008	324	160	726	98	20%
2009	90	130	534	134	30%
2010	404	125	587	73	17%
2011	323	51	277	31	12%

	Female Numbers '000s		Male Numbers '000s		Both sexes
Year	Landings	Discards	Landings	Discards	% Discard
2001	18,665	12,161	29,949	13,250	34%
2002	23,105	9,374	31,256	8,326	25%
2003	14,530	9,577	29,538	8,744	29%
2004	16,109	7,068	12,930	4,282	28%
2005	20,280	11,383	21,828	8,967	33%
2006					
2007	No Sampling				
2008	15,697	13,223	31,184	8,350	32%
2009	3,084	7,485	20,421	8,218	40%
2010	16,741	7,928	23,858	5,288	25%
2011	16,805	4,726	13,962	2,965	20%

Table 7.5.4. *Nephrops* in FU17 (Aran Grounds). Composition of discards by the *Nephrops* trawl fleet in VIIb.

Species	Discards	Landings	Catch
Hake	426.57	35.44	462.01
Lesser Spotted Dogfish	249.48		249.48
Others	654.55	103.93	758.48
Haddock	518.7	84.19	602.89
Megrim	328.32	211.96	540.28
Angler-piscatorius		19.3	19.3
Mackerel	120.94		120.94
Angler-budegassa		54.77	54.77
Black Sole		52.66	52.66
Dab	107.35		107.35
Dogfish	703.46		703.46
Grey Gurnard	260.07		260.07
Nephrops	1329.158	5316.63	6645.788
Turbot		23.64	23.64
Whiting	402.47	66.09	468.56
Witch	170.68	18.34	189.02
Sum of all species	5271.748	5986.95	11258.7
Percentage of Catch	47%	53%	

Table 7.5.5. *Nephrops* in FU17 (Aran Grounds). Mean size trends for catches and whole landings by sex.

	Catches		Catches		Whole Landings			
	<35 mm CL		>35 mm CL		<35 mm CL		>35 mm CL	
Year	Males	Females	Males	Females	Males	Females	Males	Females
1995	na	na	na	na	32.0	31.8	38.3	37.0
1996	na	na	na	na	31.1	32.1	37.8	37.4
1997	na	na	na	na	31.9	32.0	37.8	37.4
1998	na	na	na	na	31.3	31.7	38.0	37.2
1999	na	na	na	na	31.3	32.3	38.0	37.1
2000	na	na	na	na	32.0	31.4	38.4	36.3
2001	28.9	27.5	38.0	37.3	na	na	na	na
2002	30.7	29.1	38.2	37.2	na	na	na	na
2003	30.5	27.4	38.2	38.0	na	na	na	na
2004	29.3	28.3	37.3	37.5	na	na	na	na
2005	28.9	27.7	37.8	37.2	na	na	na	na
2006	No Sampling							
2007								
2008	27.4	29.7	36.8	37.8	na	na	na	na
2009	30.3	28.4	38.0	37.1	na	na	na	na
2010	30.2	29.6	38.7	37.3	na	na	na	na
2011	28.6	28.3	38.4	37.0	na	na	na	na

Table 7.5.6. *Nephrops* in FU17 (Aran Grounds). Results summary table for geostatistical analysis of UWTV survey.

Ground	Year	Number of stations	Mean Density (No./M2)	Area Surveyed (m2)	Domain Area (km2)	Burrow Count	Geostatistical Abundance Estimate (millions burrows)	CV on Burrow estimate
Aran Grounds	2002	49	0.84	8,316	943	7,036	818	4%
	2003	41	1.01	7,937	943	9,814	989	5%
	2004	64	1.43	7,561	943	10,687	1397	3%
	2005	70	1.09	8,701	936	8,774	1063	3%
	2006	67	0.64	10,934	932	6,928	616	3%
	2007	71	0.93	11,252	942	10,272	906	3%
	2008	63	0.56	13,075	906	7,617	536	3%
	2009	82	0.73	10,900	940	6,585	718	2%
	2010	91	0.85	11,441	937	8,091	827	2%
	2011	76	0.67	11,645	909	7,365	638	3%

Table 7.5.7. *Nephrops* in FU17 (Galway Bay and Slyne Head). Results summary table for analysis of UWTV survey.

Ground	Year	Number of stations	Mean Density (No./m²)	Area Surveyed (m²)	Domain Area (km²)	Burrow Count	Raised Abundance Estimate (millions burrows)	CV on Burrow estimate
Galway Bay	2002	7	1.58	1,299	74	2,017	114.98	9%
	2003	3	1.60	591	74	941	117.87	11%
	2004	9	0.73	2,312	74	1,625	52.07	19%
	2005	4	1.67	661	74	1,107	124.11	6%
	2006	3	0.98	540	74	522	74.01	16%
	2007	5	1.14	890	74	992	82.57	9%
	2008	10	0.42	1,907	74	859	33.37	23%
	2009	8	0.93	1,207	74	1,116	68.46	6%
	2010	10	1.61	1,284	74	1,757	101.39	9%
	2011	10	0.51	1,355	74	745	40.73	25%

Ground	Year	Number of stations	Mean Density (No./M²)	Area Surveyed (m²)	Domain Area (km²)	Burrow Count	Raised Abundance Estimate (millions burrows)	CV on Burrow estimate
Slyne Head	2002	5	0.85	1,216	39	1,027	33.21	10%
	2003	0	-	-	39	-	-	-
	2004	3	0.68	827	39	531	25.22	23%
	2005	3	0.55	531	39	294	21.77	6%
	2006	3	0.41	526	39	210	15.65	28%
	2007	4	0.63	838	39	547	25.54	24%
	2008	0	-	-	39	-	-	-
	2009	6	0.40	531	39	144	10.66	22%
	2010	9	0.74	1,117	39	928	32.66	20%
	2011	7	0.66	1,166	39	785	26.45	11%

***random stratified estimates are given for the Slyne Head and Galway Bay grounds.**

Table 7.5.8. *Nephrops* in FU17 (Aran Grounds). Forecast inputs (bold) and historical estimates of mean weight in landings and harvest ratio. Removals estimated in years with no sampling (shaded) using ratio of removals to landings in adjacent years.

Year	Landings in Number (millions)	Discards in Number (millions)	Removals in Number (millions)	Prop Removals Retained	Adjusted Survey (millions)	Harvest Ratio	Landings (t)	Discards (t)	Mean Weight in landings (gr)
2001	48.7	25.4	71.6	0.68			912		
2002	54.5	17.7	70.4	0.77	629	11.2%	1,152	192	21.2
2003	44.1	18.3	60.6	0.73	761	8.0%	933	183	21.2
2004	29.0	11.4	39.3	0.74	1075	3.7%	525	112	18.1
2005	42.4	19.7	60.1	0.70	818	7.4%	778	182	18.4
2006	na	na	49.5	na	474	10.4%	636	na	na
2007	na	na	57.3	na	697	8.2%	913	na	na
2008	46.9	21.6	66.3	0.71	412	16.1%	1,050	245	22.4
2009	23.5	15.7	37.6	0.62	552	6.8%	625	256	26.6
2010	41.0	13.3	53.0	0.77	636	8.3%	1,000	194	24.4
2011	30.8	7.7	37.7	0.82	491	7.7%	600	83	19.5
Avg 09-11				0.74					23.5

na= not available due to non-cooperation with sampling programmes.

Shading indicates removal estimated based on combined 2005 and 2008 numbers-at-length scaled appropriately to landings in 2006 and 2007. The commensurate harvest ratio estimate is also shaded.

Table 7.5.9. *Nephrops* in FU 17 (Aran Grounds). Catch option table for 2013.

			Implied fishery	
	Harvest rate	Survey Index (millions)	Retained number (millions)	Landings (tonnes)
MSY framework	10.50%	491	38	894,008
F2011	7.68%	491	28	653,704
F0.1 Combined	7.20%	491	26	613,034
Fmax Combined	11.10%	491	40	945,094
	0%	491	0	0 -
	2%	491	7	170,287
	4%	491	14	340,574
	6%	491	22	510,862
	8%	491	29	681,149
	10%	491	36	851,436
	12%	491	43	1,021,723

		Basis
Landings Mean Weight (Kg)	0.0235	Sampling 2009–2011
Survey Overestimate Bias	1.3	WKNEPH 2009
Survey Numbers (Millions)	638	UWTV Survey 2011
Prop. Retained by the Fishery	0.74	Sampling 2009–2011

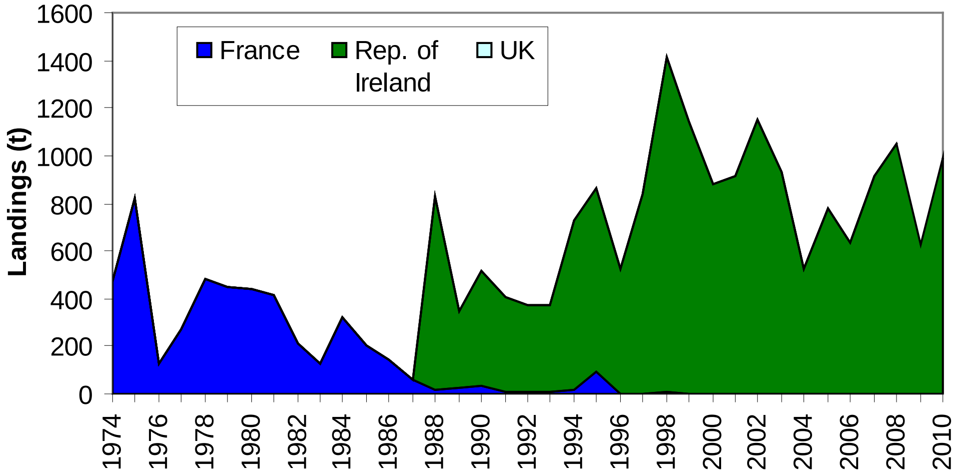


Figure 7.5.1. ***Nephrops*** **in FU17 (Aran Grounds). Landings in tonnes by country.**

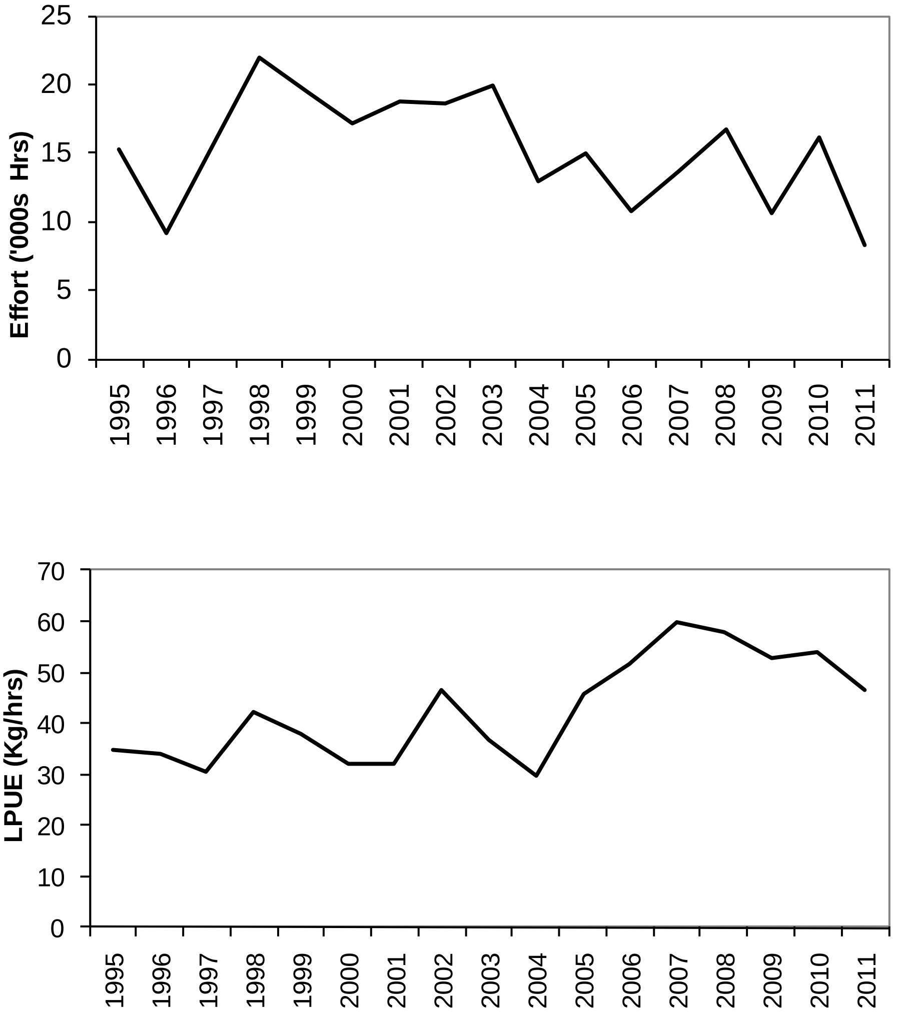


Figure 7.5.2. ***Nephrops*** **FU17 Aran Grounds. Irish effort and lpue for** ***Nephrops*** **directed fleet.**

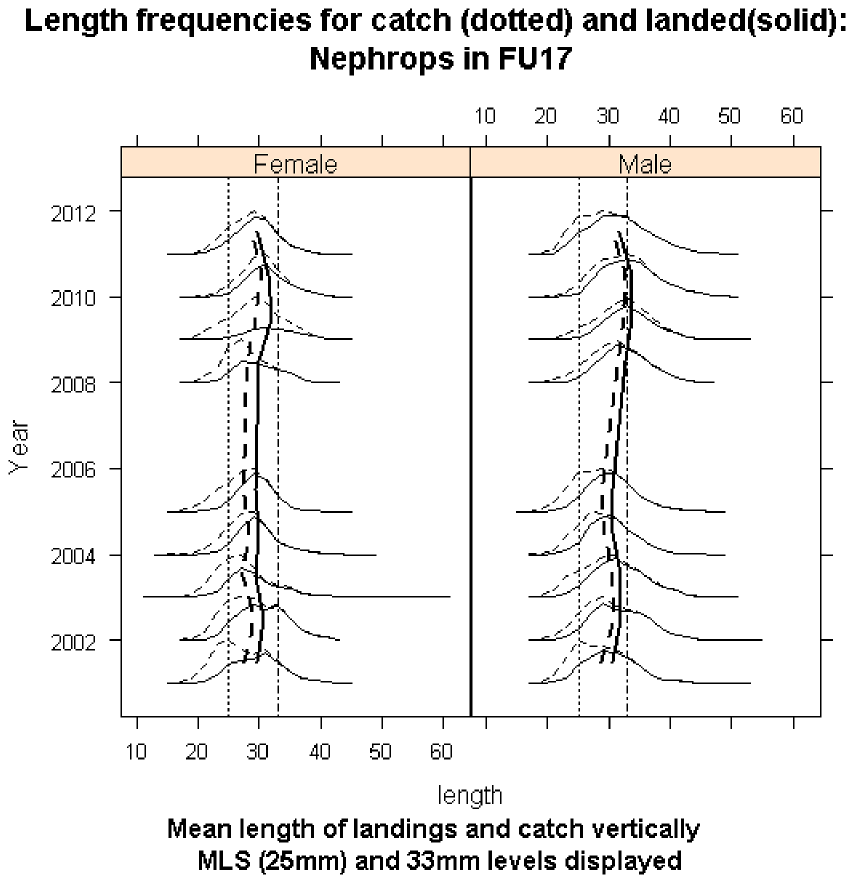


Figure 7.5.3. ***Nephrops*** **FU17 Aran Grounds. Length distributions in the catches 2001–2005, 2008–2011.**

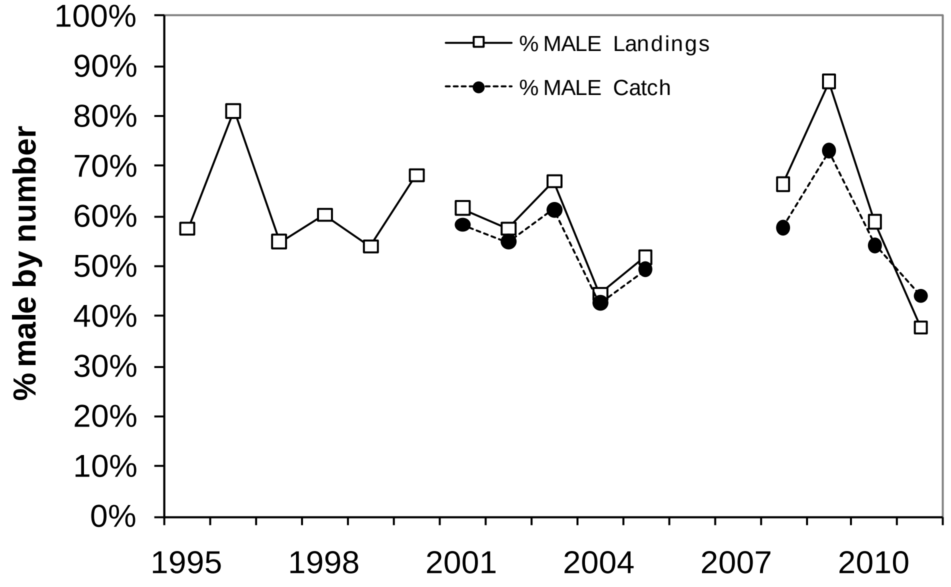


Figure 7.5.4. ***Nephrops*** **in FU17 (Aran Grounds). Sex ratio of whole landings (1995–2000), landings (2001–2011) and catch (2001–2011).**

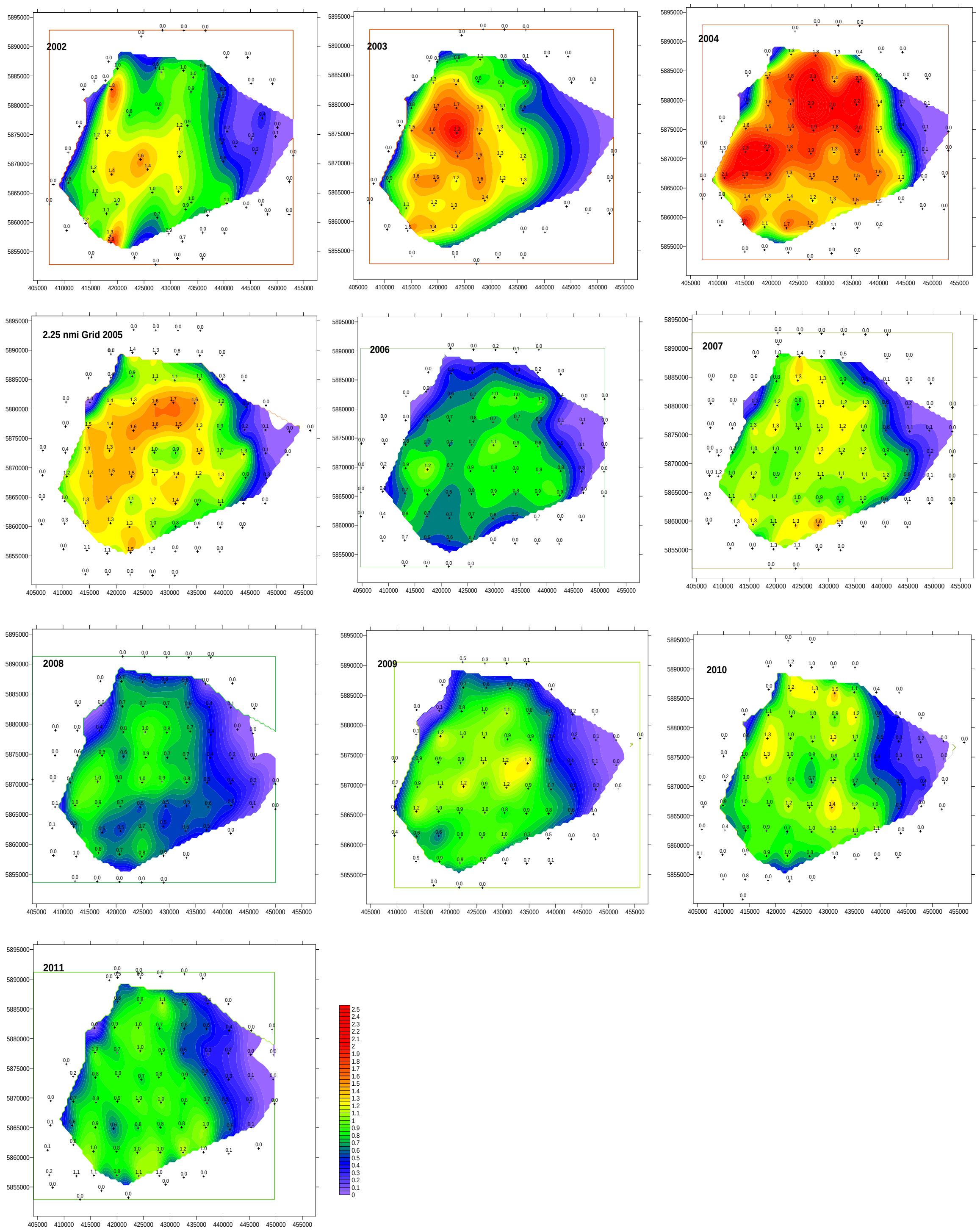


Figure 7.5.5. ***Nephrops*** **in FU17 (Aran Grounds). Contour plots of the krigged density estimates for the Aran Ground UWTV surveys from 2002–2011.**

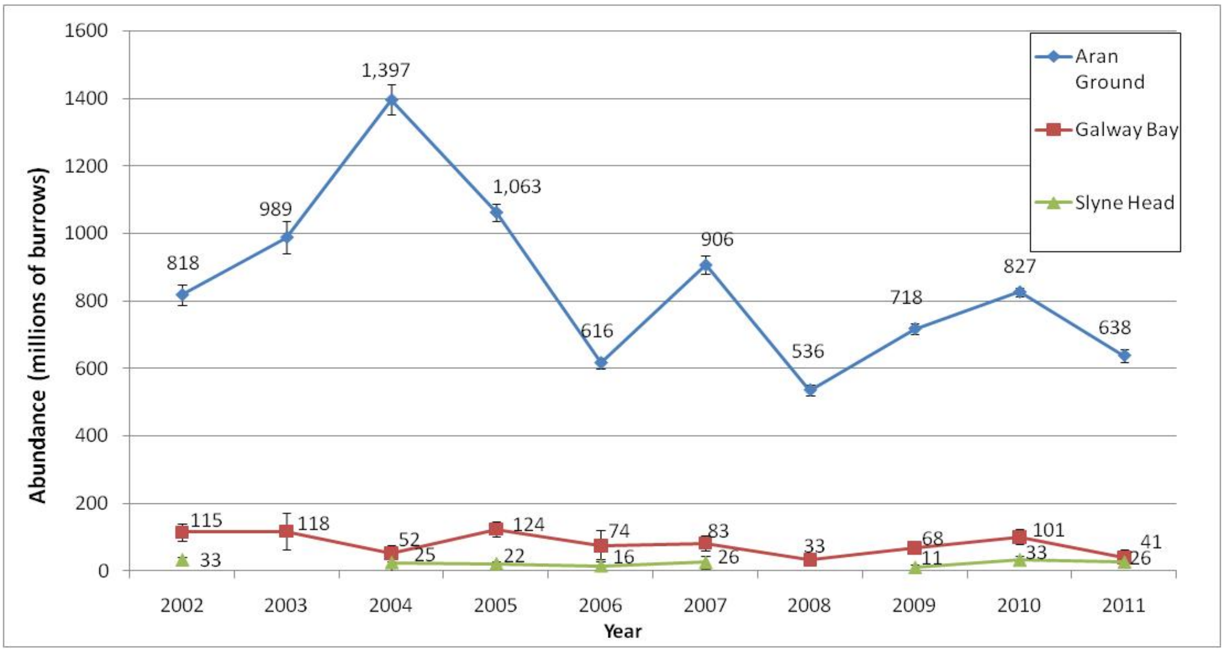
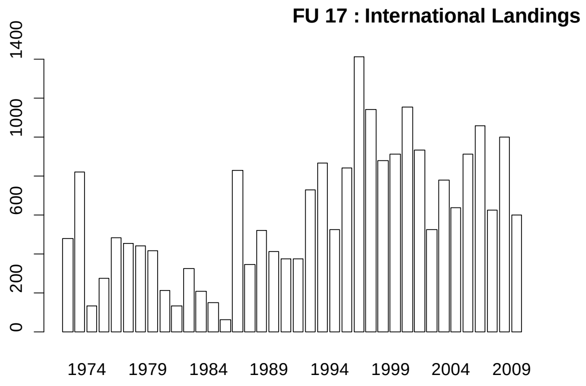
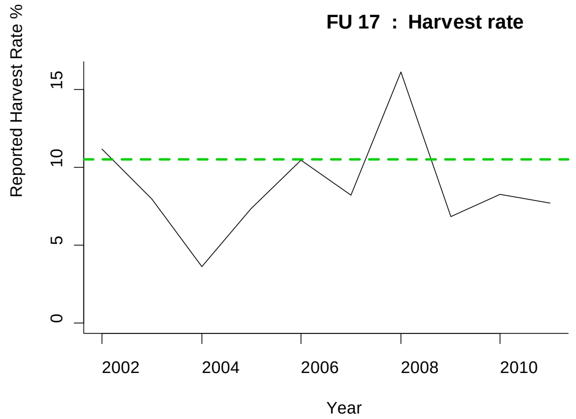


Figure 7.5.6. ***Nephrops*** **burrow estimates in FU17 Aran, Galway Bay and Slyne Head grounds 2002–2011.**





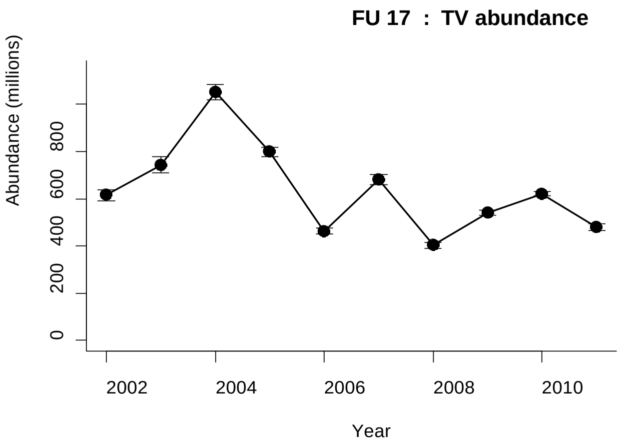


Figure 7.5.7. ***Nephrops*** **FU17 Aran Grounds. Stock Summary plots: Landings (tonnes), UWTV abundance (millions) and Harvest Ratio (% dead removed/UWTV abundance).**

7.6 *Nephrops* in Division VIIb,c,j,k (Porcupine Bank, FU16)

Type of assessment in 2012

This year the Working Group updated the fishery information, survey data and other indicators for *Nephrops* in Division VIIbcjk. The assessment is based on multiple lines of evidence from several indicators. This year there is a conflicting signal in the survey information. Information on the size distribution of the landings has been significantly improved with the provision of grade data for around 60% of the Irish landings by the fishing industry. WGCSE explored two new approaches for data limited stocks; DCAC and the '*Nephrops* data limited' approach. A benchmark is planned for 2013.

ICES advice applicable to 2011

Catches in 2011 should be reduced to the lowest possible level to allow the incoming recruitment to rebuild the stock.

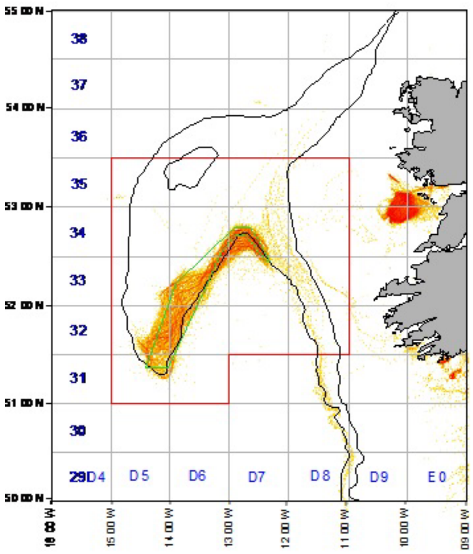
ICES advice applicable to 2012

ICES advises on the basis of the precautionary considerations that catches in 2012 should not increase to allow the stock to rebuild.

7.6.1 General

Stock description and management units

The TAC area is Subarea VII, in 2011 and 2012 an 'of which' clause was introduced specifically for the Porcupine Bank (FU16). The Functional Unit for assessment includes some parts of the following ICES Divisions VIIb, 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 from 01/05–31/07 since 2010 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 2011 and 2012

TAC in 2011

'Species: Norway lobster *Nephrops norvegicus*		Zone: VII (NEP/07.)
Spain	1 306 (1)	
France	5 291 (1)	
Ireland	8 025 (1)	
United Kingdom	7 137 (1)	
EU	21 759 (1)	
TAC	21 759 (1)	Analytical TAC

(1) Of which no more than the following quotas may be taken in VII (Porcupine Bank – Unit 16) (NEP/*07U16):

Spain	377
France	241
Ireland	454
United Kingdom	188
EU	1 260';

Council Regulation (EU) No 683/2011 of 17 June 2011 amending Regulation (EU) No 57/2011 as regards fishing opportunities for certain fish stocks.

TAC in 2012

Species: Norway lobster *Nephrops norvegicus*		Zone: VII (NEP/07.)
Spain	1 306 (1)	
France	5 291 (1)	
Ireland	8 025 (1)	
United Kingdom	7 137 (1)	
Union	21 759 (1)	
TAC	21 759 (1)	Analytical TAC Article 11 of this Regulation applies.

(1) Special condition: of which no more than the following quotas may be taken in VII (Porcupine Bank – Unit 16) (NEP/*07U16):

Spain	380
France	238
Ireland	457
United Kingdom	185
Union	1 260

Council Regulation (EU) No 43/2012 of 17 January 2012 fixing for 2012 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.

Closed area restrictions

A seasonal closed area has been in place since 2010 (shown in the map above) and the specific coordinates and conditions are: "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 July 2012: cod, megrims, anglerfish, haddock, whiting, hake, Norway lobster, plaice, pollack, saithe, skates and rays, common sole and spurdog.” (Article 11 of EC Reg 43/2012 Article 11).

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 paragraph 1, transit through the Porcupine Bank, 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. Although it is legal to land smaller prawns from this fishery, marketing restrictions imposed by producer organizations in France mean smaller *Nephrops* (< 35 mm CL or 115 mm whole length) are not retained in this fishery.

The mesh size restrictions apply to towed gears in VIIb–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 2011

Historically *Nephrops* fisheries in this area are very seasonal and rather sporadic, mainly targeting *Nephrops* when available and when weather conditions are good. Total international landings increased by ~30% in 2011 to ~1200 t (Figure 7.6.1 and Table 7.6.1). The total landings estimates presented in Table 7.6.1 include the WGCSE best estimate of “unallocated landings” for the area ~390 t. These unallocated landings include an estimate of Spanish landings derived using VMS effort in 2011 and VMS-lpue (Landings per unit of effort) in 2010 adjusted by the change in Irish lpue from 2010–2011. The “unallocated” landings also include an estimate of suspected area misreported catches for Irish vessels. This was derived in the following way: If a vessel had a daily lpue outside FU16 on trips which also fished in 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 FU. Any residual catch was assumed to be taken in FU16.

Effect of regulations

In the past TACs and quotas were applied to the whole of VII so the FU16 fishery has not been restricted. In 2011 an "of which clause" was implemented in the TAC regulation specifically for the Porcupine Bank in 2011 for the first time. Overall landings for 2011 are slightly below the "of which" limit of 1260 t. Quotas have been very restrictive for some countries[1] and vessels and this has led to various changes in fishing patterns. Vessels have tried to optimise the economic value of the catch by targeting areas and periods with relatively smaller[2] volumes of 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.

A spatio-temporal closure has been in place during May to July (a period when the majority of landings were made historically) since 2010. An analysis of VMS effort data by month illustrates that the closed area has been respected by the fleet (Figure 7.6.2). The only effort occurring inside the closed area in July 2010 and 2011 was that associated with the IFSRP surveys (see Section 7.6.2). Considerable effort has been displaced to the parts of the *Nephrops* ground not fully covered by the closure.

The closure is therefore expected to be quite effective at reducing fishing mortality within the closed area (~75% of the area on the bank where *Nephrops* are fished). For this part of the stock area fishing effort and mortality will have been reduced at a time of peak female emergence and typically high lpue and landings. The closure will also have inadvertently concentrated effort and fishing mortality on the remaining ~25% of the stock area not covered by the closure.

During the IFSRP survey in July 2011 a significant difference in average cpue (both in number and weight) was observed inside and outside the closed area. The catch rates were around 2.5 times higher inside the closed area for both gears used. A similar result was observed for the Spanish survey Figure (7.6.3). A time series of catches in number by station were available at WGCSE for the survey from 2004 to 2011. In the earlier years the cpue was roughly equivalent inside and outside the area with the spatio-temporal closure. In 2009 the majority of the recruitment was observed inside the closed area (Figure 7.3.9). In September 2010 and 2011 after the closures from May to July, the cpue was ~2.5 times higher inside the closed area (Figure 7.6.3).

7.6.2 Data

An overview of the data provided and used by the WG is provided in Table 2.1.

Length compositions of annual landings are available from Spain (1986–2009), France (1995–2007) and Ireland (1995–2005 and 2008–2011). Sampling intensity in Spain was

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[1] Ireland received a substantial quota swap from France in 2011

[2] There is a large price differential between the large and small grades. So less volume of the larger grade generates an economically viable return for fishing.

extremely low in 2008 and 2009 (two and five samples) and no sampling data has been made available since 2010. There has been no sampling in France since 2008 due to low landings.

No sampling was possible in 2006 and 2007 for Ireland due to the withdrawal of co-operation with scientific sampling programmes by the fishing industry. Sampling in Ireland resumed in 2008 but sampling levels were low initially due to problems in accessing frozen graded landings. In 2010 and 2011 landings length distributions have be reconstructed using data on the size distribution and volumes of each frozen grade landed. In 2011 the Irish industry provided grade data for approximately 60% of the total landings.

Sampling of *Nephrops* in this area is hampered by several factors:

- The remote nature of the fishery.
- Trips are long duration (normally >12 days) sometimes fishing in multiple areas.
- An increasing proportion of the landings are landed frozen and graded at sea making access to samples problematic.
- There is reluctance from fishermen and processors to allow sampling of landings due to high value of the larger *Nephrops* and the risk of damage to individuals during sampling.

Sampling intensity in the period 2006–2009 was insufficient to get precise and accurate length structure data of the catches. Despite the low sampling intensity in recent years, the trends in indicators such as length and sex ratio are consistent across all countries and in the survey (Figures 7.6.4 and 7.6.8).

Landings

Data on the mean size (carapace length, CL) of male and female *Nephrops* in the landings are available from Spain, France and Ireland (Table 7.6.2; Figure 7.6.4). The longest time-series are from Spain and, prior to 2002, these have been quite stable at between 39 and 43 mm CL for the males, and between 34 and 38 mm CL for the females. The increasing trend in the mean size in the landings after 2002 has previously been highlighted by WGCSE as an important indicator for this stock. The mean sizes in the landings of Irish trawlers shows a strong decline in 2011 reflecting the recruitment of a reasonably strong year class to the fishery.

The time-series of raised international length–frequency distributions of the sampled landings by sex are given in Figure 7.6.5. 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 shows a recruiting year class entering the landings at ~35 mm CL. This year class was also apparent in the 2010 and 2011 data. This is the first time in the time-series a very obvious year-class signal has appeared in the landings–length distributions (though there are possibly other YC appearing at a slightly large size in other years e.g. early 1990s).

It is difficult to extract other useful signals in the length–frequency distributions plot, so for males three simple indicators were calculated (Figure 7.6.6). These were a recruitment proxy (% of males <32 mm CL), and percentage of larger individuals (>50 mm CL) in the sampled landings. An exploitation proxy was also calculated using the slope of ln(CL) vs. ln(Numbers) between 41–56 mm CL i.e. the slope of downward limb on the Right-Hand-Side of the length–frequency distribution (Figure 7.6.7).

These indicators suggest that the recruitment has fluctuated in the past and for the period 2004 to 2008 it was probably very weak. The recruitment proxy 2009–2011 returned to around average (note: this conclusion is relatively insensitive to choice of length threshold). The fishery during 2003–2010 did exploit a higher proportion of larger individuals (>50 mm) than ever before in the time-series. In 2011 the proportion of the landings >50 mm returned to close to the mean observed between 1986 and 2002. The exploitation proxy also showed an increasing trend between 2002 and 2009 but has returned close to the historic average (i.e. 1986–2002 mean) in 2011.

Discards

There are few historical estimates of discards for this stock. Recent Irish sampling (2009–2012) observed very minimal discarding (mainly limited to small and damaged individuals <5% by number). Information from the industry suggests that the restrictive monthly vessel quotas introduced in 2011 has also lead to some instances of high grading of landings although there are no scientific observations of this.

Biological

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 7.6.8). Both the commercial and survey data indicate that sex ratio switched back to a more usual situation in 2010 and 2011 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). It has been suggested that 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* in recent years although this has not been confirmed through sampling. A similar switch to female dominated catches has also been observed in the Farn Deeps in recent years (ICES, 2010). The return to a more usual male dominated sex ratio is a positive sign and may well be linked to maturation of the recent good recruitment (see below).

The L_{50} or length at 50% maturity of 30 mm observed during July 2010 (Stokes and Lordan, 2011) was very similar to previous observations for Irish catches from this stock (Lordan, unpublished data) albeit slightly higher than the 28.3 mm previously reported for Spanish catches (González Herraiz and Fariña, 2005). If 'sperm limitation' was a problem in 2007 and 2008 this will have an impact on larval production and subsequent recruitment success.

There are no changes to other biological parameters for this stock and they are not relevant to the current trends based assessment.

Surveys

The longest time-series of fishery-independent source of data is from the Spanish Porcupine trawl survey 2001–2011 (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, 2009) and in previous IBTS reports. The 2011 survey experienced exceptionally poor weather conditions and some gear problems which is likely to have reduced *Nephrops* catch rates although to what extent is unknown.

Distribution of *Nephrops* catches and biomass in Porcupine surveys between 2001 and 2011 are shown in Figure 7.6.9. There was a year effect in 2008 when unusual gear parameters were observed and 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 but declined somewhat in 2011 (Figure 7.6.10).

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 (Table 7.6.2; Figure 7.6.11). 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). In 2010 the modal length of this year class increased to ~36 mm significantly faster than previous growth estimates from MIX analysis (Hillis and Geary, 1990). This mode is no longer so apparent in the 2011 length distributions.

The landings to survey biomass ratio is presented in Figure 7.6.12. This confirms the conclusion that exploitation rates increased during the mid to late 2000s. The ratio in 2010 and 2011 is similar to the levels observed in the early 2000s.

An Irish Fisheries Science Research Partnership (IFSRP) survey was developed in collaboration with the Irish fishing industry to obtain data from the closed area in 2010 and 2011. The results of the 2010 survey were presented to WGCSE 2011 and are given in Stokes and Lordan (2011). The 2011 the survey was mainly resourced through the allocation of additional quota to the vessel. A total of 25 tows of 60 min duration using a 'Baca survey trawl' were successfully carried out by MFV Sean Oisín (Reg. S22) between 6–28th of July. A further 38 tows were made using the vessels usual commercial net. The specific objectives of the survey 2011 were as follows:

1) To obtain size and sex ratio data from 25 survey and 30 commercial stations allocated randomly to three survey strata, inside and outside the closed area.
2) To further evaluate the utility of commercial grading information, versus survey data, to monitor the size and sex distribution within the fishery.
3) To compare data from a standard commercial trawl with that from a standard survey trawl currently in use in the Porcupine area. This was particularly important as the length frequency results from 2010 contrasted somewhat with the survey in the area.
4) To investigate variability in different fishery parameters such as size, sex ratio, female maturity and cpue over time and space. Where possible making comparison to historical data.

The main finding was that catch rates of 86.24 Kg/Hr for the commercial tows were significantly higher in 2011 than in 2010 (58.14 Kg/Hr). This catch rate was also significantly higher than previously observed in July for Irish commercial vessels (see Stokes and Lordan, 2011). The cpue for the "Baca survey tows" was 34.9 Kg/Hr (adjusting the baca cpue to a similar door spread to the commercial net would equate to around 65.2 Kg/Hr). The size distribution of catches made with the baca and commercial net were not significantly different indicating similar gear selectivity. As observed in 2010 strong patterns in size and sex ratio were observed spatially over the ground with larger individuals and males becoming more prevalent in catches to the southwest of the ground. Catch rates were significantly higher inside the closed area than outside using both nets as already discussed in Section 7.6.1.

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 lpue/cpue and abundance trends over the longer term. These data are presented by country in Table 7.6.3 and Figure 7.6.13. Note: Irish and French effort is in hours and Spanish effort is power adjusted and is reported in thousands of day*BHP/100. Updated information was not available for France and Spain this year. A new VMS based effort time-series has been calculated for the Porcupine Bank this year for the first time. This includes all the effort of vessels at trawling speed within the known area of the *Nephrops* grounds (Table 7.6.4). For Ireland there is a good correlation between this effort and the reported effort for vessels targeting *Nephrops* shown in Table 7.6.3. The VMS effort is around one third higher in most years. Total effort has declined by more than 50% since 2006 and Ireland was the only country to increase its effort in the area over this period.

The effort index for the Spanish fleet (all gears) operating in Porcupine shows a steady decline from the 1970s until the early 1990s. Since then Spanish effort has declined more gradually. *Nephrops* lpue data for the Spanish fleet (all gears) shows a general declining trend until 2003. In 2004 and 2005 lpue increased rapidly (possibly due to increased targeting of *Nephrops* although the reasons for this spike have never been fully explained) before declining again 2006.

Fishing effort for French *Nephrops* vessels[3] has fluctuated widely with peaks in the mid 1980s and through the late 1990s. Effort in 2008 was the lowest in the series (and the lpue in that year is probably not representative and have been removed from Figure 7.6.13). Lpue data for the French fleet in FU16 were high in the 1980s but showed a declining trend since then.

Fishing effort data for the Irish otter trawl *Nephrops* directed fleet[4]. increased by 40% in 2011 and cpue increased by a further 12% in 2011. A detailed analysis of Irish lpue data was carried out in 2011 following discussions with the industry about changing fishing patterns and the accuracy of lpue as an indicator of stock abundance (WGCSE 2011, WD 12). The main conclusion of that analysis was as follows: It remains possible that lpues in the mid 1990s were not comparable to more recent lpues. This is primarily because targeting behaviour and fleet composition has changed significantly over time. Since the mid 2000s the fishery has targeted areas with lower densities of larger *Nephrops*. The upturn in lpues observed in 2010 and 2011 occurred despite

[3] where *Nephrops* constituted 10% of the landed value.

[4] A threshold of 30% of *Nephrops* in reported landings by trip is used to identify the landing and effort of this fleet.

the closure of the majority of the fishing area during months with historically high lpues. This strongly suggests without the closure the lpue increases in 2010 and 2011 would have been higher.

Information from the fishing industry

Several meetings have been held with the main Irish vessels operating in the fishery together with their representatives in recent years. This has led to significant exchange of information between the scientists and industry involved in this fishery. The provision of grade information for around 60% of the landings in 2011 is a major development. This was directly in response to the WGCSE 2011 conclusion that the grade composition of the landings can be used to accurately reconstruct size distributions of the landings provided sampling to assess the parameters of each market sized grade carried out in parallel.

The industry has also collaborated with the development of the IFSRP described above. Although the number of observer trips in 2011 was low (only two) the situation has improved in 2012 with three trips already completed in the first half of the year.

The Irish industry considers that the stock has increased significantly and no longer requires the Functional Unit of which clause.

7.6.3 Stock assessment

The assessment is based on multiple lines of evidence from several indicators. The available data includes commercial landings compositions for males and females from the main fleets, catch rates and length distributions from the Spanish Porcupine Bank survey (2001–2011) and Irish IFSRP survey (2010–2011), along with lpue or cpue and effort data for the main fleets.

WKLIFE explorations

WKLIFE classified this stock into category 6; data limited. As stated above this stock is assessed using multiple lines of evidence from several indicators. The stock is recovering from a low level so the current management concerns are the current stock size relative to some yet undefined precautionary level and whether recent catch and/or catch limits are consistent with MSY. Following the recommendations from WKLIFE for data poor stocks some additional explorations were carried out at WGCSE 2012.

DCAC

Depletion corrected average catch, DCAC, is available in the NOAA toolbox (http://nft.nefsc.noaa.gov/DCAC.html). It is a "simple formula for estimating sustainable yields in data-poor situations" as stated in the original article on this model (MacCall, 2009). The formula is an extension of the potential yield formula, and it provides useful estimates of sustainable yield for data-poor fisheries on long-lived species. Wetzel and Punt (2011) simulation tested a number of methods used to set harvest levels for data-poor and data-limited stocks, including DCAC, and found that DCAC was fairly robust to misspecification of M and F_{MSY}/M, but NOT to misspecification of depletion ($=B_{current}/B_{virgin}$). They found that harvest levels set by DCAC were no longer conservative and led to overfishing when an overly optimistic depletion levels were assumed. So caution is needed when setting values for depletion in the application of DCAC.

WGCSE carried out a number of explorations with DCAC. The most appropriate model contained the following parameter settings: Natural mortality was assumed to be 0.15 since M in deep water *Nephrops* stocks is likely to be lower than the standard 0.2–0.3 assumed for many other *Nephrops* stocks. Given the low M the STD error was reduced to 0.3 to reduce skewness and out of bounds estimates. A conservative F_{MSY} to M ratio of 0.5 was assumed. A quite high depletion delta of 0.75 was chosen given the recent stock history. The B_{MSY}/B_0 was taken to be 0.4 in line with the recommendations. The average DCAC was 1240 t slightly higher then the current "of which limit" in the TAC regulation (Table 7.6.5. and Figure 7.6.14). This is around 40% below the average landings taken from the stock over the last 44 years during which time the stock appears to have been overfished and declining.

Data limited approach for *Nephrops*

WGCSE investigated the following approach for "data limited *Nephrops* stocks" including those in FU16. The area of the *Nephrops* ground was first estimated using the following method. Irish *Nephrops* directed VMS between 2006 and 2011 was mapped using the methods described in Gerritsen and Lordan (2011). Then a polygon covering the most intense VMS activity was manually specified and its areas estimated using an average of several different projections in ArcGIS. The total area estimated was around 7000 km^2.

The mean weight in the landings was 43 g based on the reconstructed size distributions in 2011. The discard percentage was assumed to be zero given the minor discards observed heretofore. Harvest ratios at a range of densities (0.01–0.09 m^2) and landings (700–1500 t) were then calculated (Table 7.6.6). These average density levels are very conservative and are well below the range of average densities for other stocks where UWTV surveys are routinely carried out. For example in the Fladen (FU7) the average density is ~0.2/m^2 and the average size in the landings is ~29 g.

To date there was only 1 exploratory UWTV station completed on the Porcupine Bank in 2011 and the density at that station was ~0.06/m^2. The current "of which limit" in the TAC regulation of 1,200 t may well be sustainable if burrow densities are at or above 0.06/m^2 when assuming a very conservative harvest ratio of <7% (based on the lowest $F_{0.1}$ observed in other *Nephrops* stocks). The first comprehensive UWTV survey of the Porcupine Bank is planned for June 2012, weather permitting. After that there should be a sounder basis for using this approach or other UWTV methods to develop catch options for this stock.

Category 4?

WGCSE was asked to consider if Porcupine *Nephrops* falls into category 4 (survey information only). Clearly the Spanish Porcupine trawl survey 2001–2011 (SpPGFS-WIBTS-Q4) is an important indicator for this stock and has tracked the incoming recruitment since 2009. This survey is, however, prone to year effects 2008 and 2011 and also has a very low *Nephrops* cpue relative to the commercial fishery due to timing of the survey in September. Given the other information available and the plans to benchmark this stock in 2013 it is probably not a priority to explore survey based HCR (harvest control rule) simulations for this stock this year.

Comparison with previous assessments

The assessment is based on similar indicators to those used in 2011. There was an increase in catch rates on the IFSRP survey and there was also a recovery in several of the commercial indicators such as sex ratio, size, recruitment and exploitation proxies. The sex ratio has returned to a more usual situation where males account for a larger proportion of commercial and survey catches.

This fishery-independent information from the Spanish survey (SpPGFS-WIBTS-Q4) showed a strong increase in the stock in 2010 and although 2011 catch rates declined somewhat this may be due to the poor weather conditions and gear performance problems experienced during the survey.

State of the stock

The main state of the stock indicators is shown in Figure 7.6.15. The size distribution of commercial landings and survey biomass to landings indicate that exploitation rate has declined relative to the late 2000s (Figure 7.6.12). Survey information indicates that recruitment to the fishery has been very weak between 2004 and 2008 and the stock declined to a low level. The average recruitment observed in the 2009 survey has resulted in increased abundance and biomass. Cpue on the Spanish survey declined in 2011 whereas the Irish IFSRP shows a strong increase (+48%) in cpue in 2011 relative to 2010.

Lpues showed a generally declining trend in most fleets over the time-series available and reached their lowest levels in the early 2000s. The lpue has been increasing since 2010 but is influenced by the seasonal closure introduced between May–July (a period when lpue is typically highest). . The marked decline in the proportion of males (observed in the catches in-between 2007–2009) may impair future recruitment in the short term.

7.6.4 Short-term projections

There is no possibility to forecast catches in the short term using the available stock indicators. The assessment is based on several indicators which indicate the stock has increased from a low level in 2008. Landings would be expected to increase in coming years as the recruitment first observed in 2009 grows further. Figure 7.6.16 shows the time-series of landings for this stock with a 5yr moving average smoother. Landings have increased in the past for a period of five or six years in response to previous "strong" year classes entering the fishery e.g. 1991–1996. If unconstrained with the closed area and quota we might expect catches to increase in the short term in a similar way. Recruitment may be impaired in the near future (2012–2013) if sperm limitation occurred during 2008 and 2009. However, it also seems likely that other ecosystem drivers effect recruitment success in this stock (REF?).

7.6.5 MSY explorations

WGCSE 2012 carried out some MSY explorations as described above in Section 7.6.3. The DCAC and the *Nephrops* data limited approaches required strong assumptions. WGCSE concluded that the current catch limit of 1200 t was likely to be a sustainable yield in the short term. Further information, such as a dedicated UWTV survey, would be needed to determine a MSY for this stock.

7.6.6 Biological reference points

There are no reference points defined or agree for this stock.

7.6.7 Management plans

There is no management plan for this stock.

7.6.8 Uncertainties and bias in assessment and forecast

The assessment is based on trends in several indicators. The Spanish survey (SpPGFS-WIBTS-Q4) is prone to year effects due to weather and gear and the 2011 decline in cpue may be due to these factors. Commercial lpue is only available for Ireland in 2011 but may well be an underestimate relative to the historic time-series due to the closure of much of the *Nephrops* grounds between May and July when historically the highest lpues have been observed. Despite the poor recent catch sampling the size and sex ratio indicators from the commercial fleets show a similar trend to the fishery-independent survey. All the available information suggests several years of poor recruitment, prior to 2009. Since then indicators have returned to more normal levels.

An analytical assessment and short-term forecast is not feasible at the moment.

7.6.9 Recommendation for next benchmark

This stock is scheduled for benchmark in 2013 at WK*NEPH*.

The benchmark should focus on the following issues:

- The utility of new UWTV information as a basis for analytical assessment and provision of catch options (a survey is planned for June 2012);
- The use of commercial grade information to reconstruct historical size distributions of landings;
- Possible ecosystem drivers of recruitment;
- A detailed analysis of the spatial differences in survey data across the stock area and possible impacts on stock parameters;
- Alternative assessment models, biomass, age or length structured.

7.6.10 Management considerations

The introduction of the "of which limit" with the TAC regulations in 2011 and 2012 has increased the risk of highgrading and area misreporting in this fishery. It has also resulted in an increase in effort in one country as vessels try to establish track record.

A seasonal closed area (May 1–July 31) has been in place since 2010. The closure has been respected by the fleet and has therefore afforded some protection to the majority of the stock area (~75%). For this part of the stock area fishing effort and mortality has been reduced at a time of peak female emergence and typically high lpue and landings. The closure will also have inadvertently concentrated effort and fishing mortality in ~25% of the stock area not currently covered by the closure. Survey information in 2011 indicates that abundance was 2.5 times higher inside the closed area than outside.

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 several years e.g. FU25, 26, 27 and 31. Recruitment in *Nephrops* populations in deep water may be more sporadic than for shelf stocks with strong larval retention mechanisms. This makes these stocks more vulnerable to over exploitation and potential recruitment failure as has been observed on the Porcupine Bank over the last decade. The strong recruitment observed in catches since 2009 offers an opportunity to rebuild this stock.

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 (Anon, 2011).

7.6.11 References

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Table 7.6.1. *Nephrops* Porcupine Bank (FU 16): Landings (tonnes) by country, 1965–2011.

Year	France	Rep. of Ireland	Spain	UK E& W	UK Scotland	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	333	108	29	908
2004	289	494	588	126	28	1526
2005	397	754	799	208	156	2315
2006	462	731	571	201	155	2120
2007	302	1060	496	146	183	2186
2008	26	562	234	41	138	1000
2009	4	356	294	13	159	825
2010	4	579	235	10	90	917
2011	8	643	na	23	122	1,186*

*** Indicates the WGs best estimate of landings in 2011 and includes 391 tonnes of unallocated landings.**

Table 7.6.2. ***Nephrops*** **Porcupine Bank (FU 16): Mean sizes (mm CL) of male and female** ***Nephrops*** **in Spanish, French and Irish landings and the Spanish Porcupine Groundfish survey 1981–2011.**

	Spain		Rep. of Ireland		France		Porcupine Survey	
Year	Landings		Landings		Landings		Catch	
	Males	Females	Males	Females	Males	Females	Males	Females
1981	39.9	34.5	-	-	-	-	-	-
1982	40.9	34.8	-	-	-	-	-	-
1983	40.8	34.0	-	-	-	-	-	-
1984	39.7	33.1	-	-	-	-	-	-
1985	38.7	33.5	-	-	-	-	-	-
1986	40.7	36.4	-	-	-	-	-	-
1987	39.3	35.0	-	-	-	-	-	-
1988	40.7	38.3	-	-	-	-	-	-
1989	40.5	36.8	-	-	-	-	-	-
1990	41.0	36.1	-	-	-	-	-	-
1991	39.4	34.5	-	-	-	-	-	-
1992	39.2	34.1	-	-	-	-	-	-
1993	41.6	36.1	-	-	-	-	-	-
1994	40.8	36.5	-	-	-	-	-	-
1995	41.3	36.6	40.7	36.5	43.2	38.3	-	-
1996	41.6	35.1	34.6	35.3	41.7	38.9	-	-
1997	39.7	34.8	35.9	34.5	41.9	38.4	-	-
1998	41.1	34.6	37.2	35.6	41.9	38.4	-	-
1999	41.5	35.7	36.6	33.7	43.1	39.1	-	-
2000	41.1	34.8	na	na	45.3	40.5	-	-
2001	41.1	36.3	37.8	35.4	45.4	39.4	35.5	28.4
2002	39.7	35.3	36.1	38.5	45.3	40.3	37.0	31.2
2003	41.4	37.8	44.5	36.2	46.2	38.9	39.2	31.4
2004	43.5	38.5	43.5	35.7	46.4	41.5	39.4	30.0
2005	43.4	38.1	46.9	40.6	45.9	41.0	44.6	33.3
2006	43.9	38.0	na	na	48.9	41.4	43.6	34.5
2007	43.7	41.0	na	na	48.3	43.8	45.4	37.4
2008	51.0	40.6	43.3	37.5	na	na	48.0	38.2
2009	43.0	42.7	44.1	40.1	na	na	32.2	28.3
2010	na	na	43.2	40.4	na	na	35.8	31.3
2011	na	na	39.5	38.4	na	na	39.0	33.5

Table 7.6.3. ***Nephrops*** **Porcupine Bank (FU 16): Landings and effort for the various different fleets exploiting the stock 1971–2011.**

Year	Spain			France[1]			Ireland[2]		
	Effort	LPUE	Mean Standardised LPUE	Effort	LPUE (>10%)	Mean Standardised LPUE	Effort	CPUE	Mean Standardised LPUE
	day*BHP/100 (x1000)	Kg/day*BHP/100		('000's Hrs)	(kg/hr)		('000's Hrs)	(kg/hr)	
1971	159	9							
1972	188	9							
1973	181	12							
1974	192	10							
1975	229	9							
1976	187	7							
1977	196	8							
1978	166	11							
1979	157	14							
1980	163	18							
1981	143	23							
1982	138	29							
1983	108	26		18	35	1.5			
1984	114	22		30	35	1.5			
1985	115	24		33	36	1.5			
1986	95	15		28	38	1.6			
1987	105	16		24	26	1.1			
1988	109	14		22	27	1.1			
1989	105	14		14	23	1.0			
1990	96	14		15	23	1.0			
1991	85	12		19	18	0.8			
1992	59	14		32	21	0.9			
1993	49	15		36	22	0.9			
1994	50	16		38	28	1.2			
1995	48	12		42	30	1.2	15	41	1.3
1996	43	11		41	26	1.1	8	42	1.3
1997	42	11		41	25	1.0	11	35	1.1
1998	43	10		40	22	0.9	10	42	1.3
1999	37	12		43	21	0.9	9	35	1.1
2000	30	7		23	16	0.6	2	31	1.0
2001	29	9		24	17	0.6	8	30	0.9
2002	31	9		18	22	0.8	10	38	1.2
2003	38	9		7	19	0.8	7	26	0.8
2004	32	18		9	25	1.1	16	21	0.7
2005	30	27		15	26	1.1	24	30	1.0
2006	39	15		22	21	0.9	28	25	0.8
2007	35	14		17	20	0.8	36	27	0.9
2008	24	10		4	7	0.3	20	26	0.8
2009	26	11		na	na	na	12	27	0.8
2010	23	10		na	na	na	19	29	0.9
2011	na	na		na	na	na	26	33	1.0

[1] = Vessels where <10% of landed value was *Nephrops*.

[2] = Estimated catches for vessels where 30% of the landed weight was *Nephrops*.

Table 7.6.4. ***Nephrops*** **Porcupine Bank (FU 16): Effort ('000s hrs) by Country based on VMS within the Porcupine** ***Nephrops*** **grounds at trawling speeds 2006–2011.**

Year	ESP	FRA	IRL	OTH	Total
2006	38	30	36	29	133
2007	48	20	42	27	137
2008	48	5	23	20	96
2009	31	12	15	11	69
2010	17	6	27	6	57
2011	11	8	45	4	69

Table 7.6.5. *Nephrops* Porcupine Bank (FU 16): Depletion Corrected Average Catch analysis inputs and results.

Depletion Corrected Average Catch Model Version 2.1 (Calculation Engine)					
Case Description: Porc					
Number of Years = 44					
Random Number Seed = 96940397					
Number of Iterations = 10000					
Value STD Deviation Distribution					
Sum of Catch = 89255.0000 0.0000 Normal					
Natural Mortality = 0.1500 0.3000 Lognormal					
FMSY to M = 0.5000 0.2000 Lognormal					
Depletion Delta = 0.7500 0.1000 Lognormal					
BMSY / B0 = 0.4000 0.1000 Beta					
Uncorrected Avg. Catch = 2028.522727					
Average DCAC = 1240.931930					
Median DCAC = 1258.033552					
1% - 99% CI = 704.080621 - 1658.545073					
5% - 95% CI = 859.773590 - 1558.255500					
10% - 90% CI = 950.297146 - 1503.661238					
20% - 80% CI = 1060.784405 - 1427.571775					
Minimum = 364.366381 - Maximum = 1833.298528					

Table 7.6.6. *Nephrops* in FU 16 (Porcupine Bank): Harvest ratios for a range of landings (700–1500 t) and densities (0.01–0.09 animals m^{-2}), given 0 % discard and a mean weight of 43 g in catches. Area is set to 7000 km^2 (minimum estimate). Likely densities for FU 16 are in the range 0.02–0.09 animals m^{-1} (0.06 was the density observed in a single station in 2011).

FU 16: Porcupine Bank		7000	Area (km2)	43	mean weight (g)		0%	percentage discards
					Density				
landings	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
700	23.3%	11.6%	7.8%	5.8%	4.7%	3.9%	3.3%	2.9%	2.6%
800	26.6%	13.3%	8.9%	6.6%	5.3%	4.4%	3.8%	3.3%	3.0%
900	29.9%	15.0%	10.0%	7.5%	6.0%	5.0%	4.3%	3.7%	3.3%
1000	33.2%	16.6%	11.1%	8.3%	6.6%	5.5%	4.7%	4.2%	3.7%
1100	36.5%	18.3%	12.2%	9.1%	7.3%	6.1%	5.2%	4.6%	4.1%
1200	39.9%	19.9%	13.3%	10.0%	8.0%	6.6%	5.7%	5.0%	4.4%
1300	43.2%	21.6%	14.4%	10.8%	8.6%	7.2%	6.2%	5.4%	4.8%
1400	46.5%	23.3%	15.5%	11.6%	9.3%	7.8%	6.6%	5.8%	5.2%
1500	49.8%	24.9%	16.6%	12.5%	10.0%	8.3%	7.1%	6.2%	5.5%
2145	**71.3%**	**35.6%**	**23.8%**	**17.8%**	**14.3%**	**11.9%**	**10.2%**	**8.9%**	**7.9%**
825	27.4%	13.7%	9.1%	6.9%	5.5%	4.6%	3.9%	3.4%	3.0%
4289	142.5%	71.2%	47.5%	35.6%	28.5%	23.7%	20.4%	17.8%	15.8%

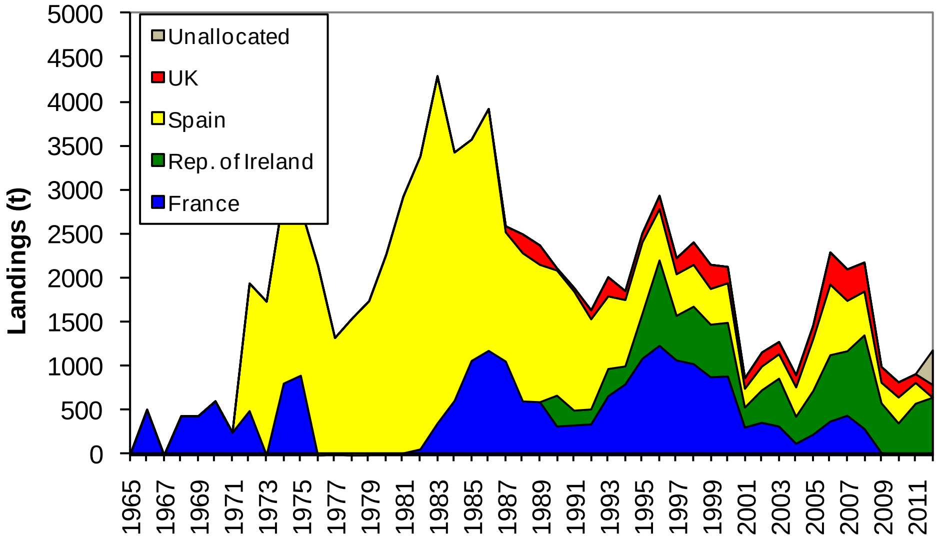


Figure 7.6.1. ***Nephrops*** **in FU16 (Porcupine Bank). WGs best estimates of landings in tonnes by country.**

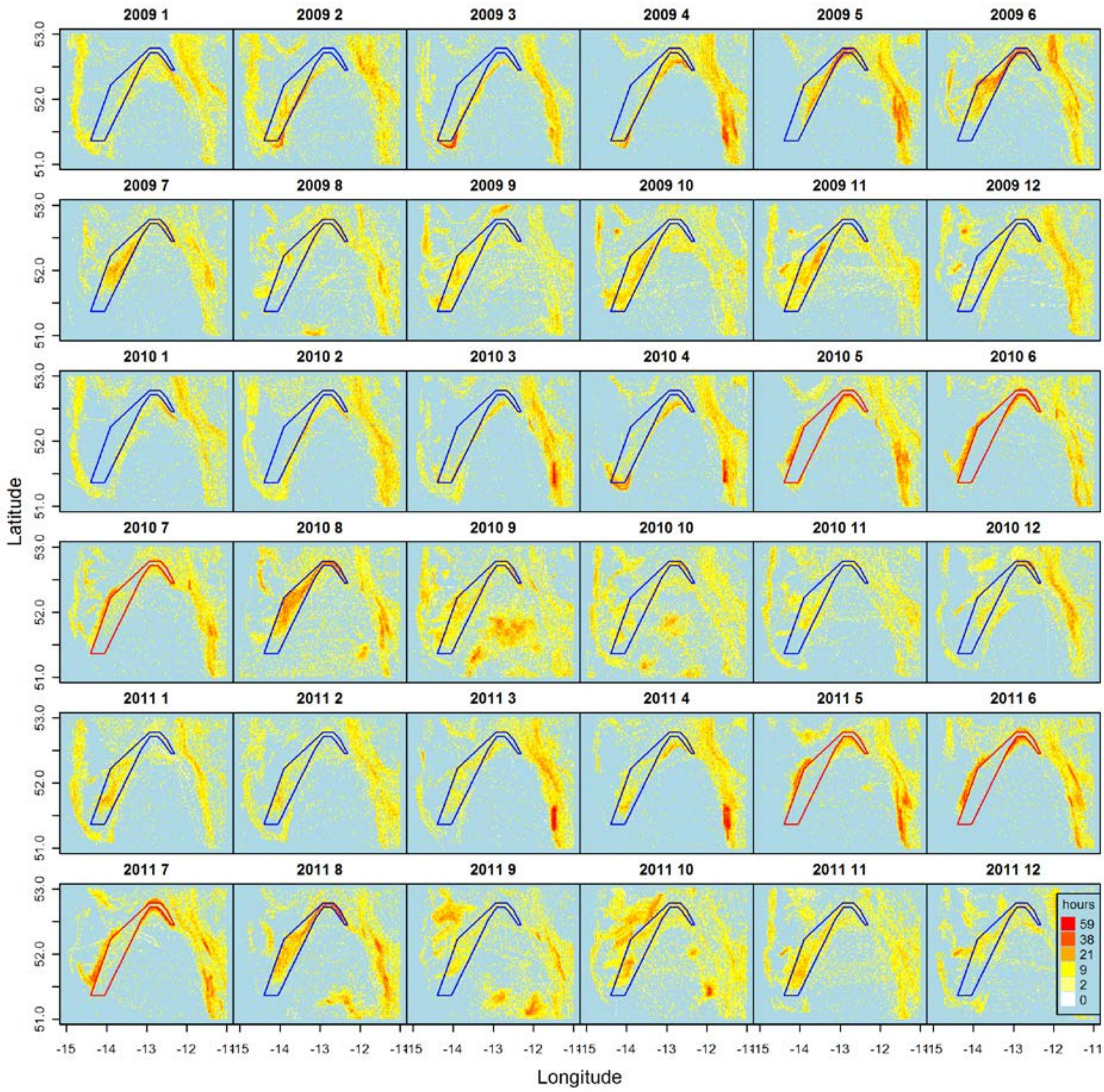


Figure 7.6.2. ***Nephrops*** **in FU16 (Porcupine Bank). Fishing activity from VMS by month for all vessels between January 2009 and August 2010. The black polygon indicates the closed area a square root effort scale has been used to enhance contrast.**

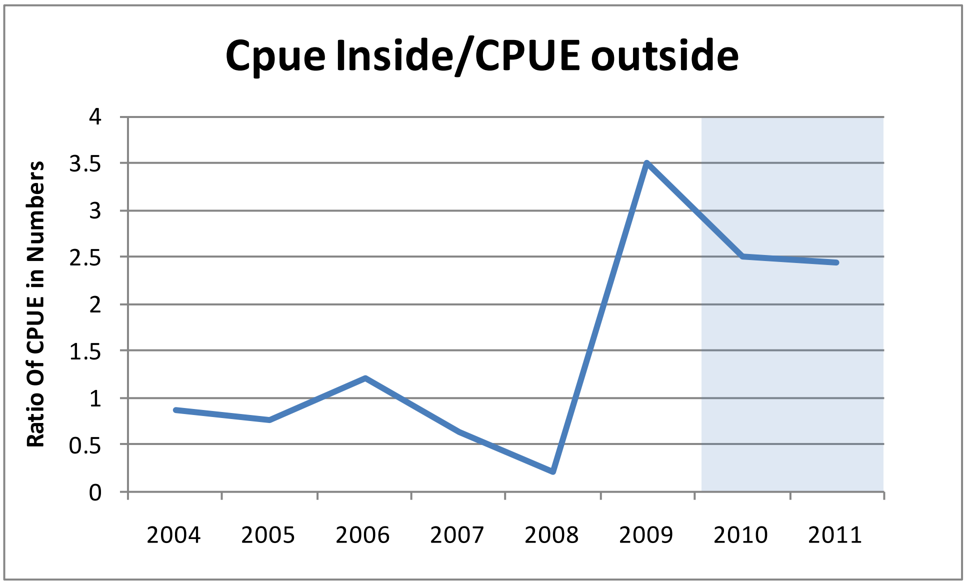


Figure 7.6.3. *Nephrops* in FU16 (Porcupine Bank). The ratio of average cpue in numbers inside and outside the closed area on the Porcupine Bank. The closed area was introduced in 2010 as indicated by the light blue shading on the plot.

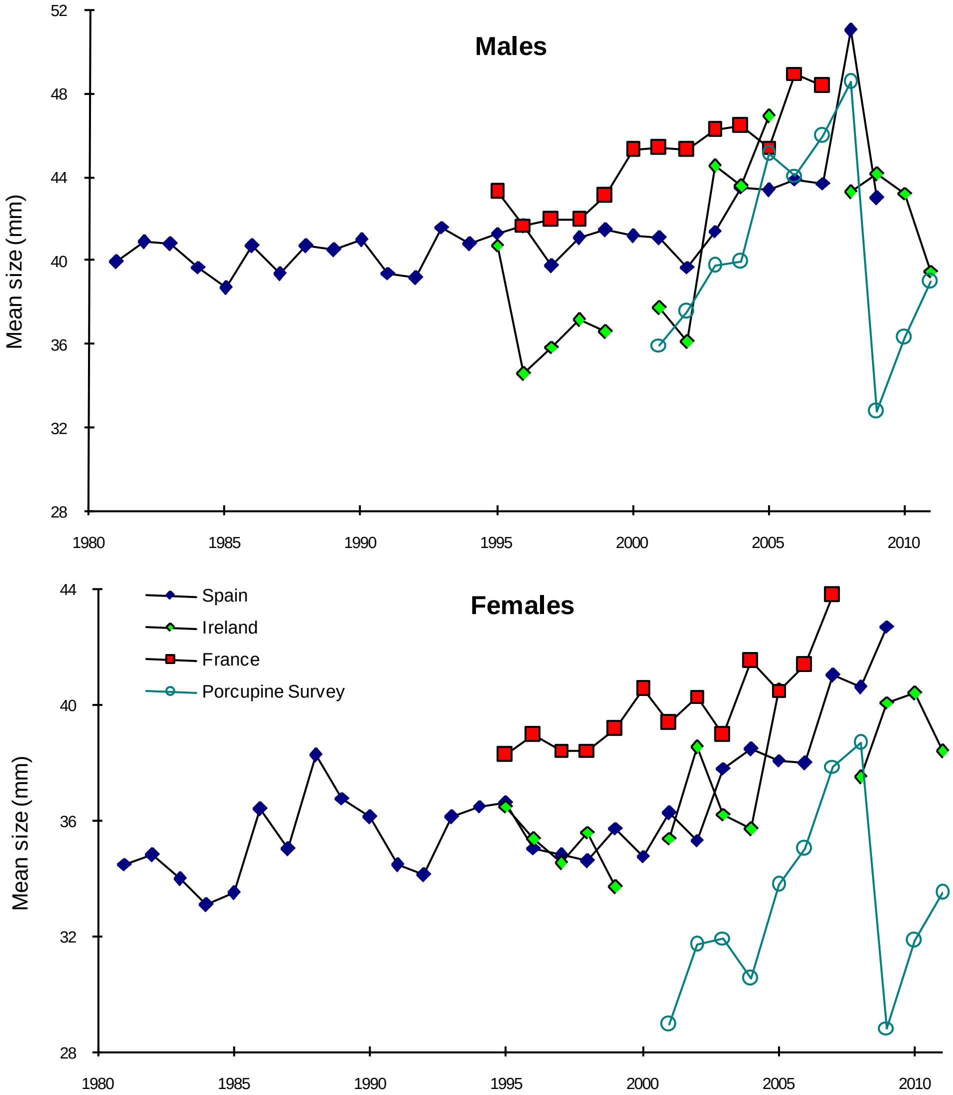


Figure 7.6.4. ***Nephrops*** **in FU16 (Porcupine Bank). Landings mean sizes by sex and country and mean size in the catch for the Porcupine survey.**

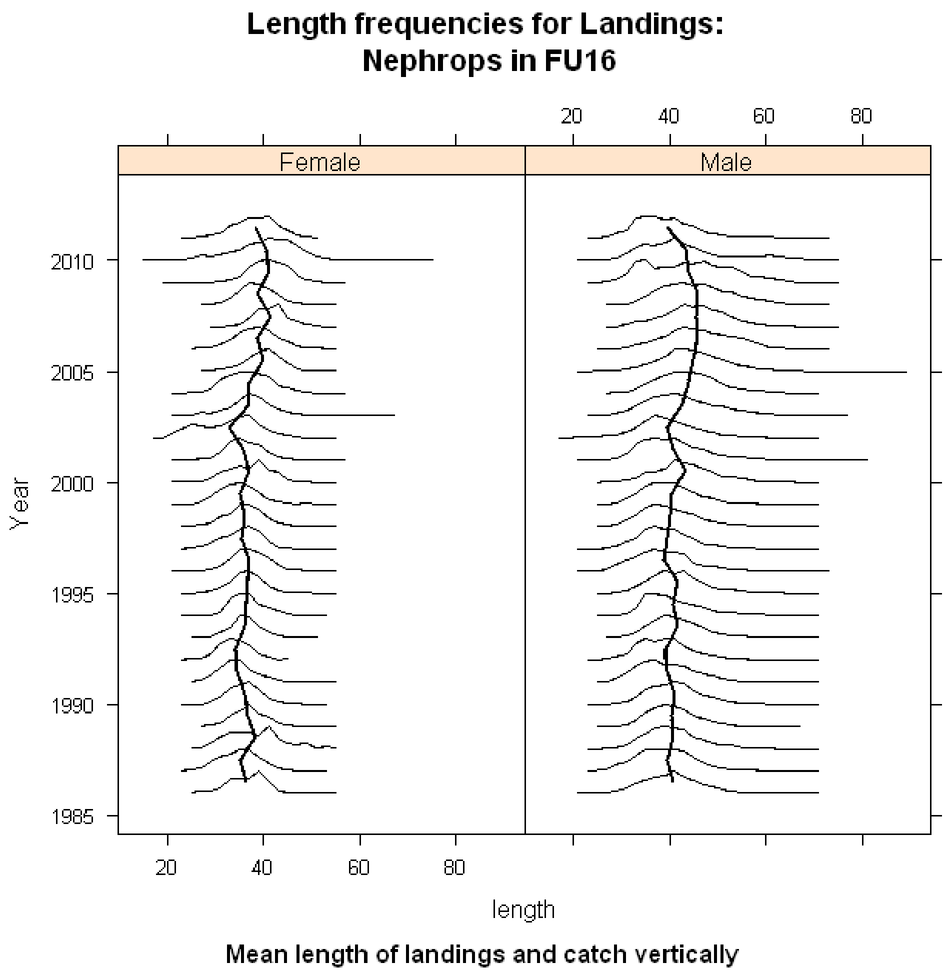


Figure 7.6.5. ***Nephrops*** **in FU16 (Porcupine Bank). Female and male landings length distributions.**

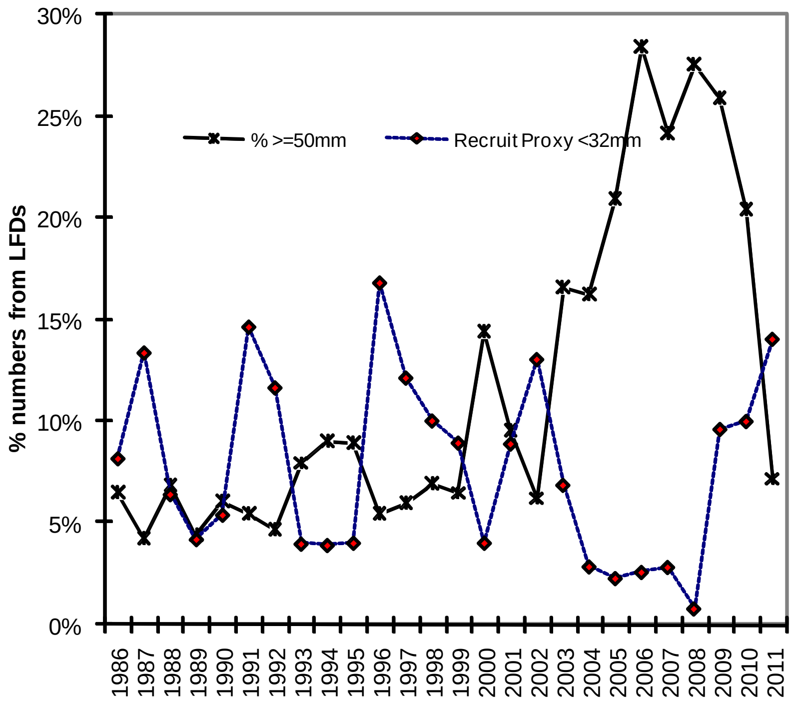


Figure 7.6.6. ***Nephrops*** **in FU16 (Porcupine Bank). Trends in the percentages of the sampled male** ***Nephrops*** **landings <32 mm carapace length (a possible recruitment proxy) and >50 mm carapace length.**

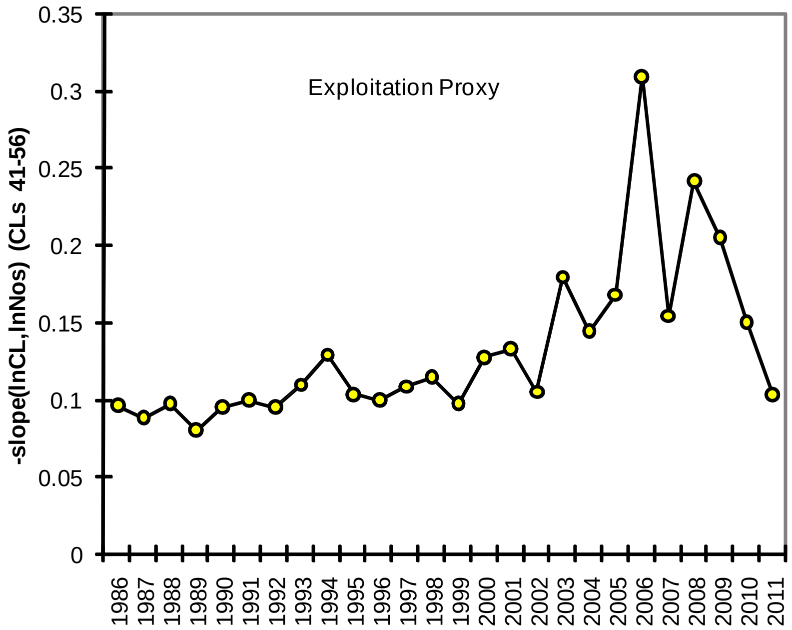


Figure 7.6.7. ***Nephrops*** **in FU16 (Porcupine Bank). Trends in an exploitation proxy for this stock. This is derived from the slope of the length frequency for male** ***Nephrops*** **between carapace lengths of 41–56 mm which are considered fully selected in the fishery.**

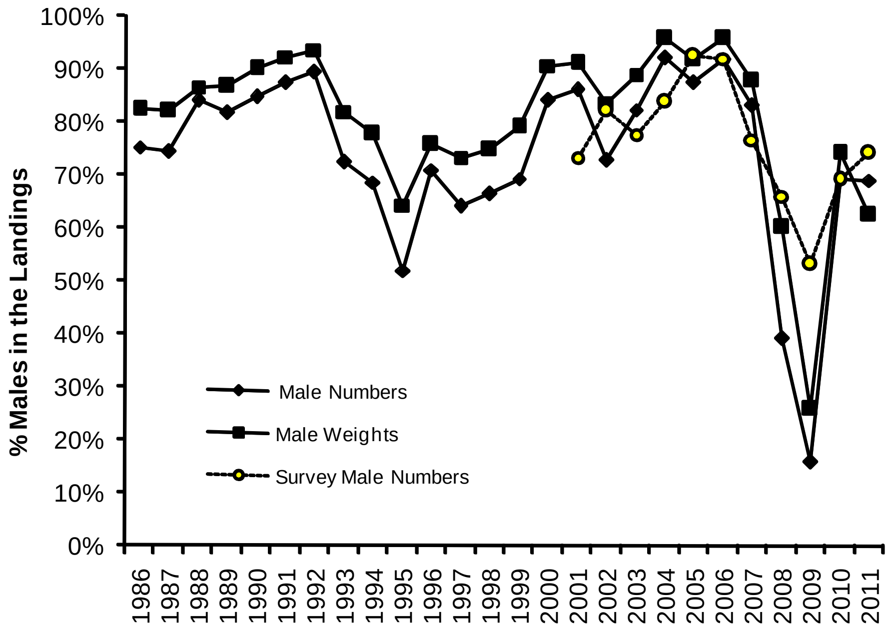


Figure 7.6.8. ***Nephrops*** **in FU16 (Porcupine Bank). Sex ratio of international landings* and survey catches. *only Irish sampling data is available since 2010.**

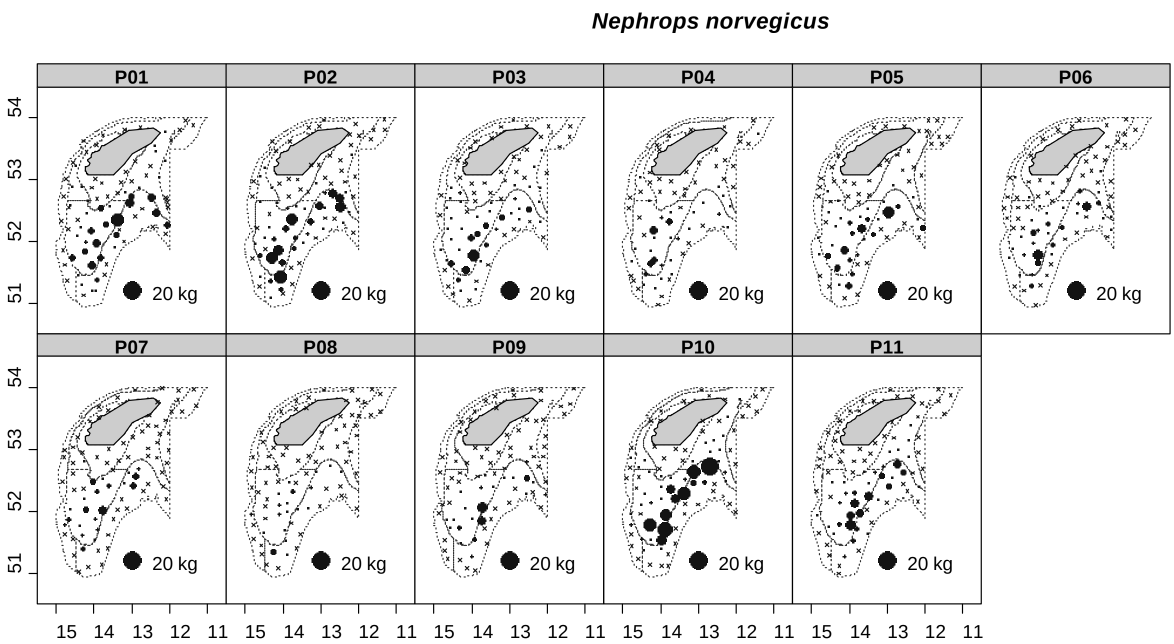


Figure 7.6.9. ***Nephrops*** **in FU16 (Porcupine Bank). Distribution of** ***Nephrops norvegicus*** **catches in Porcupine surveys between 2001 and 2011. The grey polygon is an area of untrawlable seabed.**

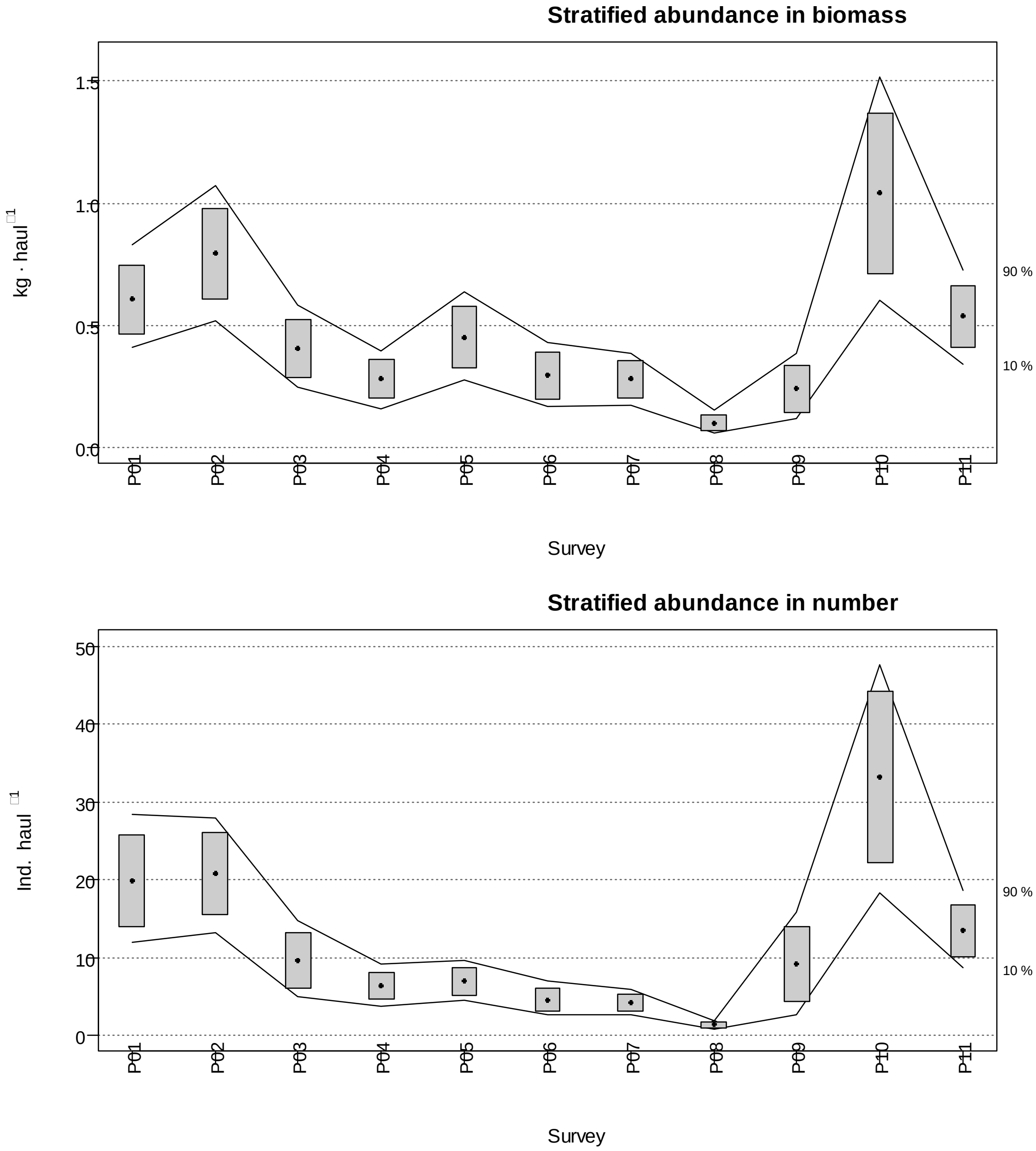


Figure 7.6.10. *Nephrops* in FU16 (Porcupine Bank). Changes in *Nephrops norvegicus* biomass and number stratified indices during Porcupine Survey time-series (2001–2011). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α=0.80, bootstrap iterations=1000).

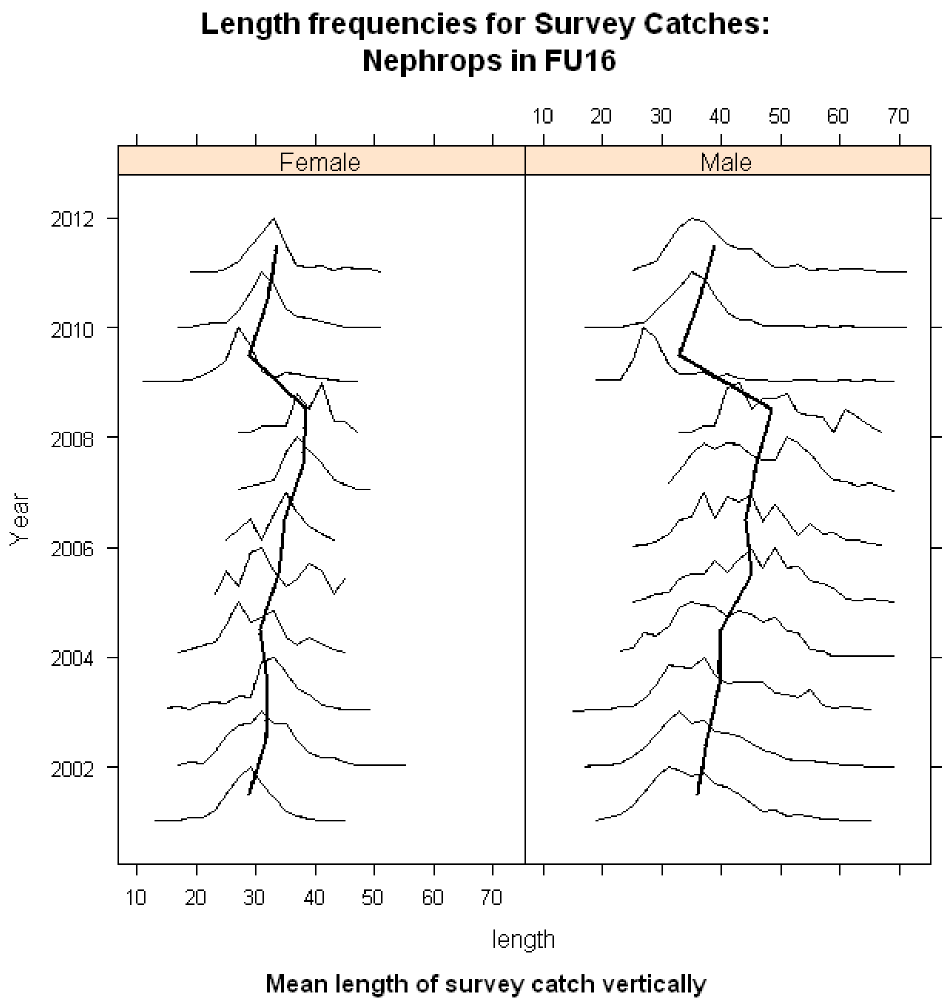


Figure 7.6.11. ***Nephrops*** **in FU16 (Porcupine Bank). Female and male Porcupine Survey length distributions.**

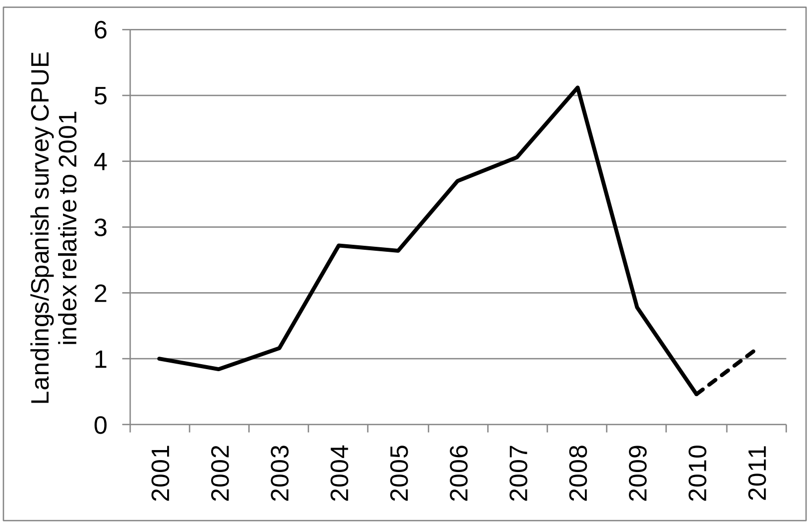
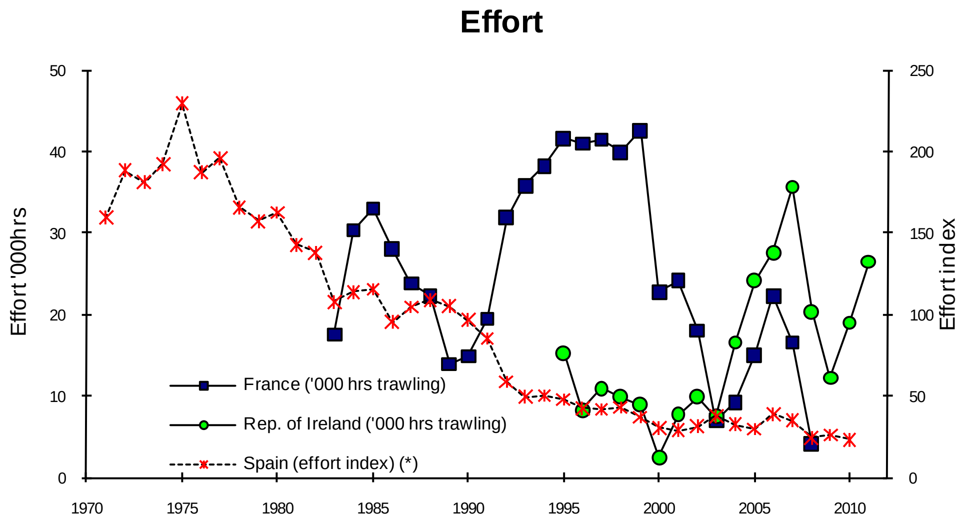
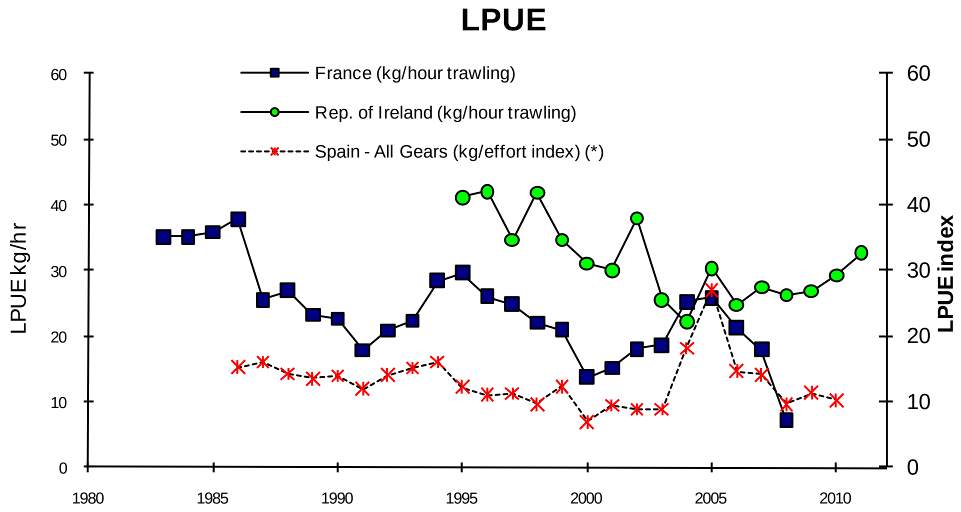


Figure 7.6.12. ***Nephrops*** **in FU16 (Porcupine Bank). Relative ratio of landings to survey biomass.**


Effort
Effort '000hrs
Effort index
France ('000 hrs trawling)
Rep. of Ireland ('000 hrs trawling)
Spain (effort index) (*)
0
10
20
30
40
50
0
50
100
150
200
250
1970
1975
1980
1985
1990
1995
2000
2005
2010


LPUE
LPUE kg/hr
LPUE index
France (kg/hour trawling)
Rep. of Ireland (kg/hour trawling)
Spain - All Gears (kg/effort index) (*)
0
10
20
30
40
50
60
1980
1985
1990
1995
2000
2005
2010

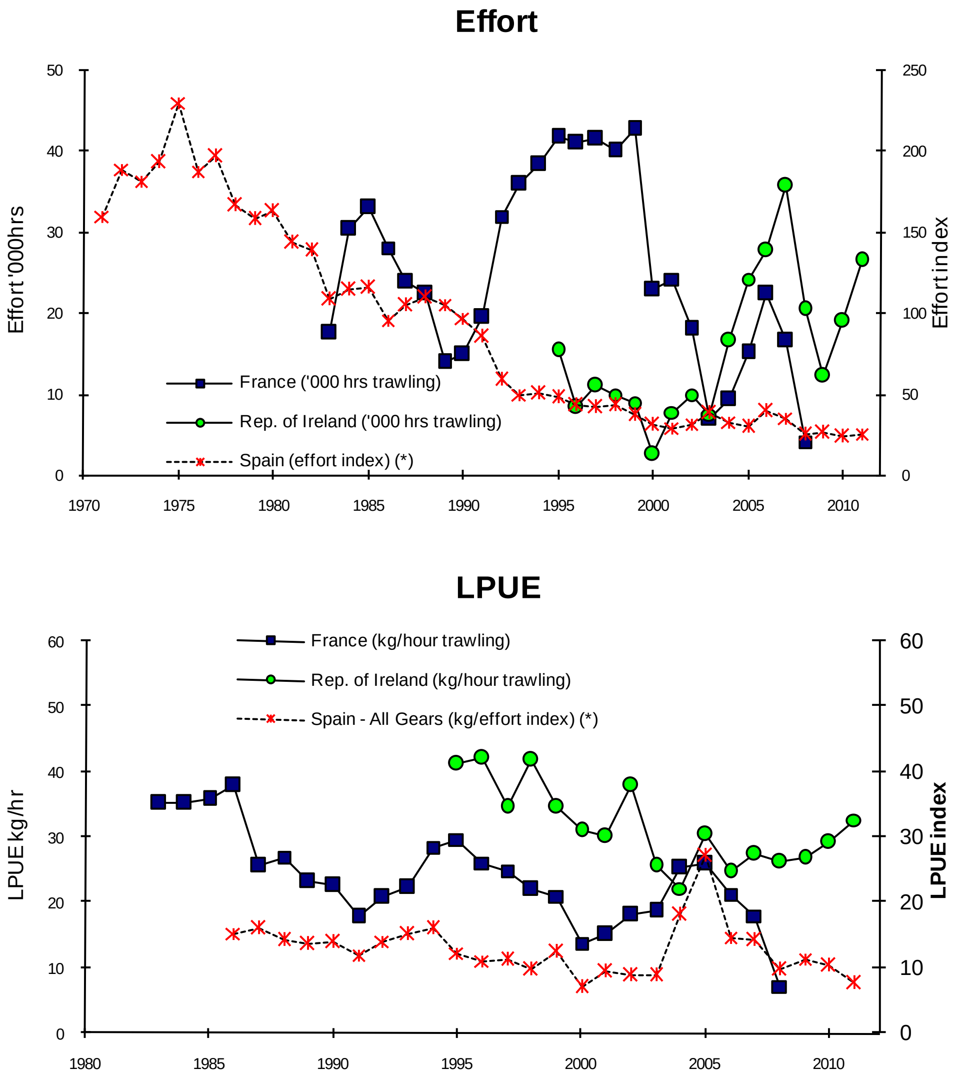


Figure 7.6.13. ***Nephrops*** **in FU16 (Porcupine Bank). Effort and lpue trends for fleets. (*) The Spanish effort index is based on a combination of hours at sea and average engine power. Irish and French effort and lpue are not standardized.**

Figure 7.6.14. ***Nephrops*** **in FU16 (Porcupine Bank). Depletion Corrected Average Catch analysis results. Histogram of 10 000 iterations of DCAC catch.**

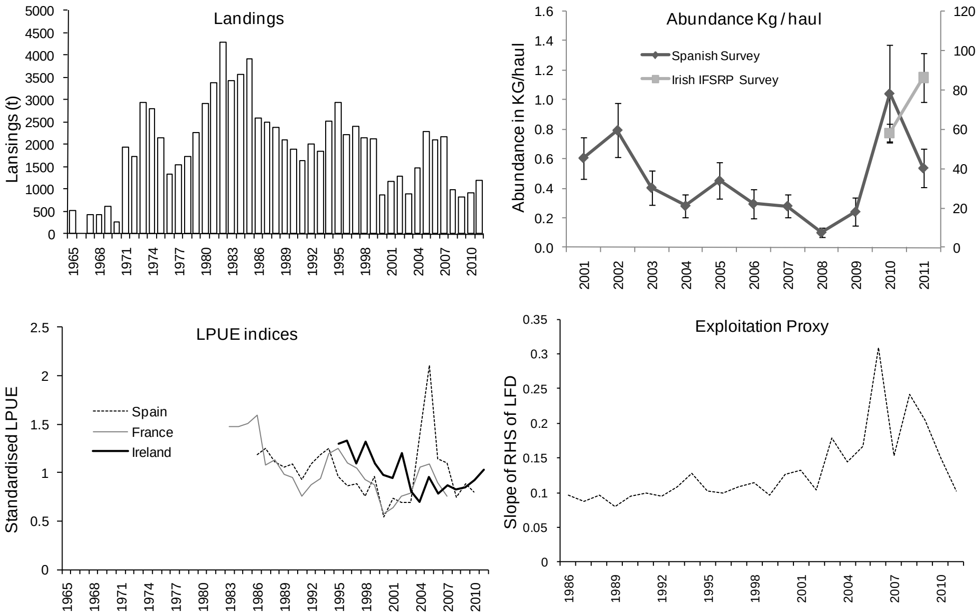


Figure 7.6.15. ***Nephrops*** **in FU16 (Porcupine Bank). Left: ICES landings over the years (top), standardized lpues by fleet (bottom). Right: Trends over the years in biomass (top, in kg/haul) and abundance (bottom, individuals/haul) from the Spanish Porcupine survey (LHS).**

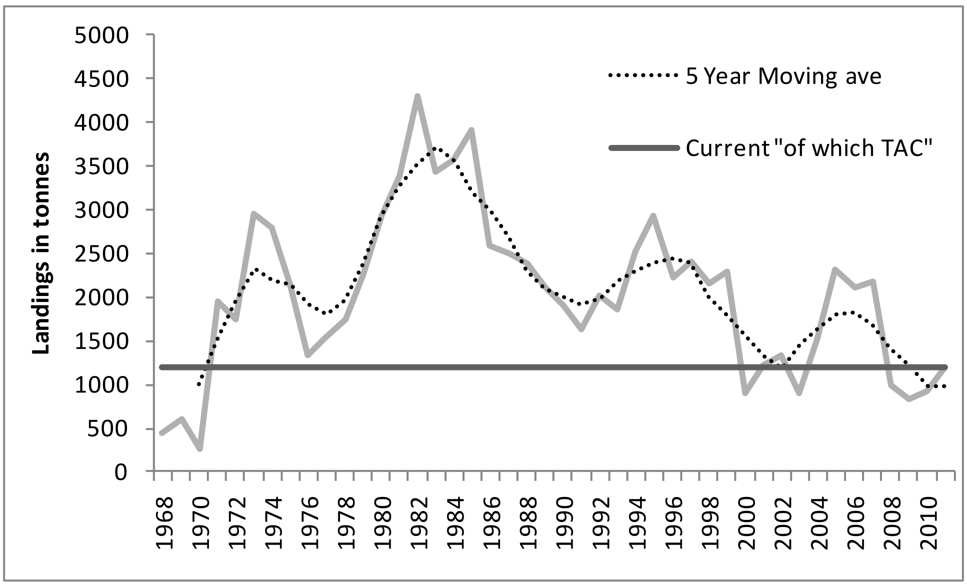


Figure 7.6.16. ***Nephrops*** **in FU16 (Porcupine Bank). Time series of landings (light grey line) with a five year moving average smoother (black broken line) and the current "of which catch" limit in the TAC regulation (dark grey line).**

7.7 *Nephrops* in the Celtic Sea (FU20-22)

ICES description	VIIfgh
Functional Units	Celtic Sea, VIIfgh (FU20–22)

Type of assessment in 2012

This year there was an update assessment by dividing the whole area into two subareas: *Nephrops* data limited method for FU20–21 and FU22 Smalls UWTV based assessment using WK*NEPH* 2009 protocol to provide catch options for that component of the stock.

There has been an upward trend in lpue in both FU20–21 and FU22 since the early 2000s until 2008–2009. There are indications of a strong recruitment from UWTV information in 2006 and fishery data in 2007 and 2008. (and the strength of more recent year classes is not known.

ICES advice in 2011 applicable to 2012

ICES advises on the basis of the MSY approach that landings from FU22 in 2012 should be no more than 2300 t. For the remaining areas FU20–21 ICES advises on the basis of precautionary considerations that landings should be reduced from the recent level of 2600 t. To protect the stock in these functional units, management should be implemented at the functional unit level.

MSY approach

Following the ICES MSY framework implies the harvest ratio for the Smalls FU22 to be less than 10.9%, resulting in landings of less than 2300 t in 2012.

PA considerations

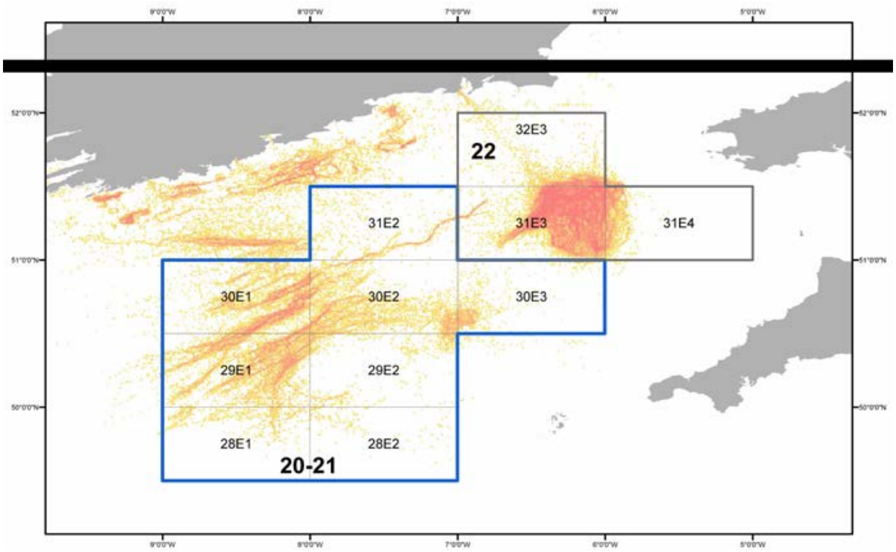
Considering the recent high lpues trend and unknown exploitation status for FU20–21, catches should be reduced from the recent level of ~2600 t.

7.7.1 General

Stock description and management units

The Celtic Sea *Nephrops* stock (FU20–22) is included in the whole ICES Area VII 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]. The TAC is set for Subarea VII which does not correspond to the stock area.

Historically FU20–22 is 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 2012 recommends that FU20–22 should be split into FU20–21 and FU22 for the purposes of assessment and advice provision.



The FU20–21 bounded by the blue polygon and FU22 bounded by the grey are shown above together with the spatial distribution of Irish *Nephrops* directed VMS effort between 2005–2009.

Management applicable in 2011 and 2012

Currently the TAC is set for Subarea VII .The 2012 TAC is 21 759 t identical to the 2011 TAC. This TAC includes many *Nephrops* stocks and this may allow unrestricted catches for stocks under excessive fishing pressure where catches should be limited.

The MLS implemented by EC is set at 25 mm CL *i.e.* 8.5 cm total length and this regulation is applied by the Irish and UK fleets whereas a more restrictive regulation adopted by the French Producers' Organisations (35 mm CL i.e. 11.5 cm total length) was applied by the French trawlers for a long period. In application of the Council Regulation (EC) N° 1459/1999, June 24th 1999, modifying the regulation (EC) N° 850/98 of the Council for the conservation of fishery resources through technical measures for the protection of juveniles, the French minimum mesh size of codend was set at 100 mm in January 2000 whereas the Irish mesh size was maintained at 80 mm.

TAC in 2011

‘**Species:** Norway lobster *Nephrops norvegicus*		**Zone:** VII (NEP/07.)
Spain	1 306 (1)	
France	5 291 (1)	
Ireland	8 025 (1)	
United Kingdom	7 137 (1)	
EU	21 759 (1)	
TAC	21 759 (1)	Analytical TAC

(1) Of which no more than the following quotas may be taken in VII (Porcupine Bank – Unit 16) (NEP/*07U16):

Spain	377
France	241
Ireland	454
United Kingdom	188
EU	1 260’;

Council Regulation (EU) No 683/2011 of 17 June 2011 amending Regulation (EU) No 57/2011 as regards fishing opportunities for certain fish stocks.

TAC in 2012

Species: Norway lobster *Nephrops norvegicus*		**Zone:** VII (NEP/07.)
Spain	1 306 (1)	
France	5 291 (1)	
Ireland	8 025 (1)	
United Kingdom	7 137 (1)	
Union	21 759 (1)	
TAC	21 759 (1)	Analytical TAC Article 11 of this Regulation applies.

(1) Special condition: of which no more than the following quotas may be taken in VII (Porcupine Bank – Unit 16) (NEP/*07U16):

Spain	380
France	238
Ireland	457
United Kingdom	185
Union	1 260

Council Regulation (EU) No 43/2012 of 17 January 2012 fixing for 2012 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.

Ecosystem aspects

This section is detailed in Stock Annex.

Fishery description

France and Ireland are the main countries involved in the FU20–22 *Nephrops* fishery. In 2011 32 French trawlers landed *Nephrops* from FU20–22 more than 1 t and representing more than 99% of the total landings (45 in 2010). Of these, 21 exceeded 10 t representing around 91% of French landings; among them, five vessels exceeded 35 t and accounted for 33% of the total.

In 2011, 59 Irish vessels reported landings from FU20–22 (65 in 2010). Of these, 43 vessels reported landings in excess of 10 t accounting for 95% of the total Irish landings.

The French minimum mesh size of codend was set at 100 mm in January 2000 whereas the Irish mesh size was maintained at 80 mm.

Landings

In 2011, total landings FU20–22 were 2854 tonnes compared to 4635 in 2010 (-38%). This is the historical lowest level of landings for the overall time-series. Landings are reported mainly by France and the Republic of Ireland (Figure 7.7.1; Table 7.7.1). French landings have gradually decreased from 80–90% of the total at the end of 1980s to around 50–60% at the beginning of 2000s. Since 2007, French landings declined to almost 25% of the total reported quantities (Table 7.7.1). In 2011, French contribution to the total landings reached the historically lowest level (620 t whereas 2165 t and 1112 t were respectively landed in 2009 and 2010). There has been a slight decrease in Irish landings (2185 t in 2011 against 3110 t in 2010: -30%). The overall fishing profile remains typically seasonal (Table 7.7.2) with the majority of landings coming from the 2nd and 3rd quarters.

Uptake of quotas

There is no specific TAC for the FU20–22 *Nephrops;* thus, the question should be examined for the whole Subarea VII. For the two main fleets operating in the Celtic Sea, the total harvested quantities on VII remained below the allowed quotas. In 2011, 5291 t were allocated to France whereas actual French landings dropped to 650 t (1130 t in 2010) mostly i.e. 95% coming from the Celtic Sea. In 2011, 8025 t were allocated to the Republic of Ireland and the uptake of quota was of 98% (7839 t) (28% of the national landings coming from the Celtic Sea).

Discards

The increasing practice of tailing *Nephrops* by the French trawlers has a significant influence on LFDs mainly on females (Figure 7.7.2) and may affect the total discard rate induced by this fleet. Hence, the method for discard derivation applied since 2006 on LFD French dataset for years with no sampling onboard (see WGSSDS 2006–2008) is not currently used for the assessment. The Irish discard rate seems to have decreased for the last four years after some higher values in the second half of 2000s mainly linked to the high recruitment to the fishery in 2007.

7.7.2 Data

Landings

Landings information by country (France and Ireland) is given in the Stock Annex. Data from years with complete common dataset on landings and discards are presented for both countries in Figure 7.7.3. The Table 7.7.3 provides information on mean size of landings by year and country.

Length–frequency distributions (LFD) differ significantly between the two countries. The two ogives of selectivity through meshes are different because of different meshes. The fisheries also concentrate on different parts of the Celtic Sea with different underlying mean sizes and densities of individual *Nephrops*. The mean size in the French landings has increased since the beginning of 2000s (coincidently with mesh regulations), whereas it remained almost stable in the Irish landings.

The decline in mean sizes observed in 2007 and 2008 may be due to a strong year class in earlier years. Relatively high densities of individuals (potentially due to increased recruitment) were also apparent in the 2006 Irish UWTV survey in FU22 (Figure 7.7.4).

Since 2009, the WGCSE has pointed out a significantly increasing proportion of tailed individuals present in French landings whereas this proportion was already high for Irish trawlers. For 2005–2011, tailed *Nephrops* were comprised between 11 to 20% of the French landings when it was less than 5% before. This is linked to increasing fuel prices with higher proportions of tailed individuals retained to compensate this loss according to the French industry.

By the end of 2007, tailed *Nephrops* could not be sampled at auction and, as the sampling onboard remains difficult to apply routinely due to long trip duration by the French trawlers, the problem was partially tackled by apportioning tailed individuals to the smallest category of landings at auction. Since the end of 2007, new biometric relationships established during the EVHOE survey have been used (Stock Annex): this allows to fit CL vs. 2nd abdominal segment of tail by sex.

As illustrated in Figure 7.7.2, accounting for tailed *Nephrops* has a significant impact on the LF distributions. Two approaches were examined by WGCSE 2012 to reconstruct the landings LFDs. One method extrapolates tails to CL, the other approach assumes that the tails have the same LFD as the smallest market category (as used in previous years). The total numbers of *Nephrops* landed by sex were calculated for both sexes (Table 7.7.4). The first method results in +15% increase in the numbers landed (+13% for males, +33% for females). It is obviously important to account for the tailed component of the landings properly in sampling plans. As indicated in the Table 7.7.3, the mean size of French landings for recent years decreases by 2.5–5.5 mm CL when tails are taken into account. It should be noted that the mean CL remains larger than the Irish one.

Discards

In 2002 a new catch self-sampling programme was put in place by Ireland. 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 onboard 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. The quality of the sampling has not yet been qualitatively assessed in terms of precision and accuracy.

French data sampled in 2009 (14 trips, 199 hauls during three quarters) cannot yet be integrated in the assessment. In 2010, the French DCF plan (12 validated trips, 108 hauls in four quarters) provided yearly estimates for discards. As for landings, the Irish discard sampling began in 2002. Thus, there is rather common dataset on discards between French and Irish fleets. Available information on complete yearly sets (1997-FR, 2008-IRL to 2011-IRL) is given by Tables 7.7.5, 7.7.6 and Figure 7.7.3.

Discard rates differ between the main fleets, but it is not clear whether this is related to gear/market factors or whether it is due the spatial heterogeneity of the *Nephrops* being exploited (i.e. differing population length distributions). It is not yet possible to estimate if the inter-fleet variability of the discard rate is larger than the inter-annual one.

Changes in discard rate is a consequence of the strength of recruitments, increase in the MLS (which tends to increase the discards) and the gear selectivity. Other practices as stated above (tailing individuals) may affect discard rate. The relative contribution of each of these four factors remains unknown.

Back-calculation

The possibilities of back-calculation for discards have been considered by WGCSE. For a long period, a "proportional derivation" of discards was processed on the FU20–22 *Nephrops* by WK*NEPH*, but was considered as unreliable because it induces lack of contrast in inter-annual variations of recruitment (see reports of WGSSDS 2005–2008; WGCSE 2009). An alternative probabilistic approach developed during the IBP *Nephrops* 2012 for the FU23–24 (Bay of Biscay) stock was also investigated in the past to the FU20–22 (Stock Annex). The increasing proportion of tails probably results of changes in discard practices. Thus, the back-calculation approach used in the past is now considered inappropriate and has been stopped until this stock is benchmarked.

Surveys

Abundance indices from UWTV surveys (FU22)

WK*NEPH* 2009 concluded that UWTV surveys could be used as an absolute index of abundance for *Nephrops* stocks provided the various biases (see text table below) were taken into account (ICES, 2009). This direct use of the survey is in lieu of alternative assessment approaches. These bias sources are not easily estimated and are largely based on expert opinion. In the FU22 Smalls grounds the largest source of perceived bias is the “edge effect”. The bias correction factor is in line with other stocks with similar density e.g. FU11 = 1.33 and FU12 = 1.32 (ICES, 2009).

FU	Area	Edge effect	detection rate	species identification	Occupancy	Cumulative bias
22	Smalls	1.35	0.9	1.05	1	1.3

The blanked krigged contour plot and posted point density data are shown in Figure 7.7.4. 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 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 2011 is approximately +10% on 2010 and just above the average of the time-series (1632 million burrows).

The summary statistics from this geostatistical analysis (Figures 7.7.4, 7.7.5) show that the estimates have remained fairly stable since the survey commenced except in the first year which was the highest level (1954 millions burrows).The estimation variance of the survey as calculated by EVA is very low (CVs in the order <6%). Additional details of the survey are presented in WD06.

Groundfish survey data (FU20–22)

In FU20–22, the French groundfish survey EVHOE while not focusing on *Nephrops* does provide some indication of the LFDs and the strength of recruitment (see Stock Annex). The Irish groundfish survey has been carried out since 2003 and also gives some information on the length compositions and mean size in the catches of *Nephrops* in FU20–21 and FU22. The discontinued UK bottom trawl survey also occurred on the same area between 1984 and 2004 (see WGSSDS 2006), however, only two sampling stations were surveyed within FU20–22 area.

Commercial lpue

Thresholds of 10% and 30% of total trip landings composed from *Nephrops* are applied to the French and Irish otter fleets to identify *Nephrops* directed fishing activity.

Effort data is available from 1983 to 2008 for the French *Nephrops* fleet (Table 7.7.7; Figure 7.7.6). Since 2009, the new registration system of official French statistics has changed the way fishing effort is computed. As a consequence, there is no reference to the number of hours for use of a fishing gear and that hampers unbiased estimates while vessels alternate fishing gears and targeted species during the same trip. To circumvent this problem, new allocation method was tested to characterize a *Nephrops* trawler based on thresholds of *Nephrops* landings weight with no reference to the other species composing the landings by trip. Estimators based on a simple threshold of 500 kg landed *Nephrops*/trip gave satisfactory results compared to the previous estimators (based on threshold of 10% of landings: Table 7.7.7). The coefficients of correlation for fishing effort and for lpue between previous and current estimators over the years 1999–2008 are respectively equal to 0.96 and 0.98. Thus, estimates of French fishing effort and lpue (in terms of hours) since 2009 (Table 7.7.7; Figure 7.7.6) have been calculated by this way.

As for last year's WG, the WGCSE 2012 investigated the disaggregated lpue series for FU20–21 and FU22 separately in order to evaluate trends between the areas. The French trawlers are essentially operating in FU20–21 and are showing similar patterns as the Irish trawlers in FU20–22 for a long-time. The highest lpues for both countries were observed in 2008 and 2009 with a reduction evident in 2010. In 2011 Irish Lpue indices remain relatively stable whereas French series declined. Recent lpues for Irish trawlers in FU22 have also been high relative to the remainder of the series and there are indications that the lpue increases occur in FU22 before FU20–21.

French effort has fluctuated with a decreasing trend since 2004 to the lowest observed in 2011. The decrease of the French fishing effort was caused by the reduction of the number of vessels due to decommissioning schemes. Lpue for French trawlers increased between 2007 and 2008 (+22%: 22.6 kg/h against 18.5 kg/h), remained stable in 2009 (22.7 kg/h). In 2010, lpue decreased (16.9 kg/h), then the declining trend was also observed in 2011 (12.4 kg/h).

Effort data, aggregated and spatially separated (FU20–21 and FU22), are available from 1995 for the Irish otter trawl *Nephrops* directed fleet. These data have not been standardised to take into account vessel or efficiency changes during the time period.

Irish effort has increased over the series with a maximum level in 2007 and 2008. A slight reduction occurred in 2009 although the overall fishing effort remained stable in 2010, increasing steeply in FU22 (+36%) and dropping in FU20–21 (-36%). In 2011, Irish fishing effort decreased on both areas (-17% in FU20–21; -25% in FU22). The lpue reached a maximum value in 2008 (60.5 kg/h) in the Smalls ground, decreased by -10% in 2009 (54.3 kg/h) and remained stable in 2010 (54.8 kg/h); in 2011, the Smalls' lpue declined by -9% (49.7 kg/h). Outside Smalls the lpue was maximised in 2008 and 2009, but decreased by -21% in 2010 (34.4 kg/h against 43.6 kg/h) and remained stable in 2011 (34.8 kg/h). (Table 7.7.7; Figure 7.7.6).

Other relevant data

French fishing industry underlined that the increase of lpue series since the end of 1990s may be caused by the change of the global fishing efficiency of the fleet because some old vessels were replaced by more recent ones. Fishing power analysis including spatial distribution will be undertaken on a set of French *Nephrops* trawlers remaining in the fishery for a long period (e.g. 1999–2011; 35 vessels) combining information involving in other substantial species targeted in the Celtic Sea (cod). Furthermore, the problem of the actual size composition of tailed individuals in landings was also debated with Producers' Organisations. The possibility of European regulation such as a *numerus clausus* licence system was also debated. The self-sampling onboard on discarded fraction of catches initially planned for the 2nd quarter 2011 with the aim of providing additional information to the DCF sampling dataset was provisionally delayed.

7.7.3 Historical stock development

Previously ICES has considered this stock to be stable or increasing based on long term indicators (LPUE, mean size) and recent UWTV survey data. There have been indications of strong recruitment in recent years (e.g. 2006) as underlined by the Irish UWTV survey in 2006 and by commercial lpue for Irish in 2007 and for French trawlers in 2008 and 2009. Recent harvest rates for the Smalls component suggest the stock is exploited below F_{MSY}.

Comparison with previous assessments

FU22

This year landings have been revised for FU22 to include UK landings (these data were not available by rectangle at short notice last year). This has changes the harvest rates relative to F_{MSY} retrospectively in the catch prediction input table for 2003–2010 compared to last year (Table 7.7.8.). This year WGCSE decided to use a series average (2003–2011) for mean weight to account for the variability in the mean weights linked to recent recruitments. For proportion removals retained recent three year average was used (as previous).

FU20–21

The assessment in 2011 was based on global indicators for the FU20–21 component of the stock e.g. lpue, mean size. Although there is no possibility for catch-at-age analysis regarding absolute levels of abundance of *Nephrops* in FU20–22, there is usually significant information on the relative stock state.

The French trawlers lpue series both have indicated a rise in stock abundance since the early 2000s suggesting that fishing activity has not been detrimental to the stock, although there has been a slight decline in lpue since 2009. Until 2005, the mean length in the landings had also increased except for 2001 when the smaller size composition suggests a stronger recruitment entry in the fishery. Nevertheless, in 2006 and 2007, mean length in landings for both fleets decreased. This point combined to the former UK survey on this area (suggesting a slight trend of decrease on mean sizes for some sampling reference stations: see WGSSDS 2006) could be induced either by stronger recruitment abundance than previously or by over-fishing.

7.7.4 MSY explorations (FU22)

No new MSY explorations were carried out at WGCSE this year for FU22 Smalls. The results of the final SCA model carried out last year are given in the text table below. The F multipliers required to achieve the potential F_{MSY} proxies, the harvest rates that correspond to those multipliers and the resulting level of spawner per recruit as a percentage of the virgin level.

		F_{BAR} 20–40 mm		Harvest Rates	SPR	
		Female	Male		Female	Male
$F_{0.1}$	Combined	0.08	0.15	7.5%	57.2%	37.9%
	Female	0.13	0.26	10.9%	45.2%	25.5%
	Male	0.06	0.13	6.5%	61.5%	42.8%
$F_{35\%SPR}$	Combined	0.13	0.26	10.9%	45.2%	25.5%
	Female	0.22	0.43	15.3%	34.1%	15.9%
	Male	0.09	0.18	8.4%	53.5%	33.9%
F_{MAX}	Combined	0.15	0.31	12.3%	41.2%	21.8%
	Female	0.28	0.56	17.7%	29.5%	12.6%
	Male	0.13	0.26	10.9%	45.2%	25.5%

WGCSE 2011 concluded that the default proxy of combined sex $F_{35\%Spr}$ is appropriate as an $F_{MSY\ proxy}$. This corresponds to a harvest rate of 10.9%, this is in line with several other stocks in the remit of this WG. Fishing at the combined sex $F_{35\%Spr}$ is predicted to keep the SPR for both sexes >25% and should deliver long-term yield with a low probability of recruitment over-fishing. No $B_{trigger}$ can be proposed given the shortness of the UWTV series although other indicators suggest that the stock is currently at a high level relative to the past.

7.7.5 Short-term projections (FU22)

Catch options at various harvests rates are provided for the Smalls (FU22) component using the methods agreed at WK*NEPH* 2009 and applied for all other stocks with UWTV estimates in VI and VII. Catch option table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 7.7.8. A three year average (2009–2011) in proportion of removals retained was used as is standard. A longer term time horizon on the mean weight in the landings was chosen to take into account variability related to recent recruitment. . The estimated harvest ratio varied a lot, 5–24% with 2007 being the highest observed.

7.7.6 The short-term management option table giving catch options for 2013 and various harvest rates is given in Table 7.7.9. Fishing at F_{MSY} in 2013 implies landings of 2600 t. *Nephrops* data limited method (FU20–21)

Table 7.7.10 gives the recent landings from all statistical rectangles within FU20–22. Recent landings for rectangles outside the Smalls i.e. FU 20 and 21 have fluctuated considerably between 1.3 and 3.1 kt. The average landings over the period 1999–2011 were ~2.26 kt.

WGCSE investigated the approach for "data limited *Nephrops* stocks" (see WGNSSK: FU5 *Nephrops* in Botney Gut/Silver Pit) including those in FU20–21. The area of the *Nephrops* ground was first estimated using the following method. Irish *Nephrops* directed VMS between 2006 and 2011 was mapped using the methods described in Gerritsen and Lordan (2011). The various polygons covering the most intense VMS activity were then manually identified and their areas estimated using a GIS programme (Map Viewer). The polygons are shown in Figure 7.7.7. *Nephrops* are known to occur on channels of muddy sediment over a very wide area in the Celtic Sea. The total area delineated was estimated was around 3710 km^2.

WGCSE also investigate the sensitivity of this area estimate to the addition of polygons covering less intense VMS activity. This expanded the area to over 5100 km^2 (Figure 7.7.7). Undoubtedly the area estimates could be significantly improved in the future with the integration of French VMS (although this fleet is multi-purpose and alternates targeting *Nephrops* and gadoids), fisheries observer data and other habitat data (e.g. sediment maps, depth, multibeam information, etc). In the interim the WGCSE decided to use 3710 km^2 as a relatively conservative area estimate.

Aside from the area, mean weight in the landings and percentage of dead discards in numbers are needed to derive Harvest Ratios for given levels of density and landings. The fishery in FU20–21 has historically been dominated by French vessels. In recent years a higher proportions of the landings are made by Irish vessels. The mean weight in the landings and discard rates in numbers for French vessels is significantly higher than Irish vessels (see mean sizes in Table 7.7.3). To derive a recent mean weight in the landings the following approach was used.

The mean weight (averaged estimate sex combined on years 2002–2011 since the start of the Irish DCF sampling plan) and discard proportions (data from 2010 when the best discard estimates were available for France) were weighed by the relative landings of each country for 2010. Table 7.7.11 shows the mean weights of each country and the weighted estimates. WGCSE considered that mean weight and discard assumptions calculated in this way can be considered to be the most realistic value given the current share of landings by both countries Table 7.7.12 provides the combined results for harvest rates for a range of landings (1000–3000 t) and across a range of densities =(0.15–0.55 individuals/m^2). The previous estimate of *Nephrops* density for patches within FU20–21 provided by the Irish UWTV survey in 2006 was 0.42/m^2. WGCSE considers that it is probably that densities now may well be slightly lower given the UWTV index for FU22 was ~30% higher in 2006 than subsequent years.

7.7.7 Biological reference points

There are no biological reference points for FU20–22 *Nephrops* stock.

Given the short time-series of FU22 UWTV survey data it is not possible to define an appropriate $B_{trigger}$. The combined sex $F_{35\%}$ SPR is proposed by the WG as proxy for F_{MSY}.

7.7.8 Management plans

No specific management plan exists for this stock.

7.7.9 Uncertainties and bias in assessment and forecast

FU22: 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). 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 2–6%) 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 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 2003–2011 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.

There is a gap of 16 months between the survey and the start of the year for which the assessment is used to set management levels. It is assumed that the stock is in equilibrium during this period (i.e. recruitment and growth balance mortality) although this is rarely the case. The effect of this assumption on realised harvest rates has not been investigated, but remains a key uncertainty.

The quality of landings data is thought to be good and sampling and discard estimates have improved over the time-series.

FU20–21: Sampling of landing and discards for FU20–21 remains problematic due to the high proportions of the catch being discarded or landed as tails. Some discard data are available from France (1985, 1991, 1997 and 2010) and Ireland (since 2002). The discards observations are insufficient to provide a full time-series dataset. The "*Nephrops* data limited approach" offers some potential to improve the assessment and advice basis for this stock. The approach requires good estimates of mean weight in the landings and proportions of removals retained as well as further information on mean burrow density. WGCSE recommend that UWTV and sampling coverage be improved in this area.

Exploitation pattern and spatial variability

The French and Irish time-series remain different and were provided by applying different exploitation pattern on different areas.

As pointed out by the Table 7.7.9, 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): at the end of 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 are mainly fishing in the "Smalls" ground (current production of 31E3 equal to 2/3 of the total Irish landings).

Heterogeneity of LFDs for landings and discards

The problem of high variability of French landing samples between trips still remains (higher coefficients of variation at auction because of higher heterogeneity of the fished area and of long duration of trips i.e. 12–15 days and, therefore, less availability of samples at auction). Hence, high CV of numbers at sizes (20–30%) are usual. In any case, commercial samples can be extended by including the commercial part sampled onboard during the DCF plan.

The sampling of tailed individuals in French landings provides valuable information, but underlines the necessity to re-calculate the actual size-composition of discarded individuals under the revised LFDs for landings, before the next benchmark.

While the selectivity parameters are not significantly improved for *Nephrops* trawlers, it appears appropriate to continue the Irish discard plan and to conduct a French one on a yearly basis. For French trawlers, the self-sampling onboard initiated recently should provide additional information. It should be interesting to examine the part of decrease of the French discard rate since the early 2000s due to the selectivity improvement from that related to some weak recruiting classes (however, size-composition of landings for 2006 and 2007 may suggest a positive signal for recruitment and 2010s dataset of French sampling onboard provided a high discard rate of 54% [65% in 1997] (Stock Annex). Moreover, if the individual growth of this species is faster during the latter period of the compiled time-series, there would be decline of the discarded amounts with no possibility to investigate the actual recruitment level.

7.7.10 Recommendation for next Benchmark

FU20–21

This stock has not been benchmarked. The *Nephrops* data limited approach offers some potential to improve the assessment and advice basis for this stock. This should be revisited by WGCSE as further sampling and UWTV observations become available. WGCSE not the Ireland is planning to extend UWTV coverage in FU20–21 in 2013.

FU22

This stock has not been formally benchmarked by ICES although the approach used has. WGCSE recommends that this stock be inter benchmarked in 2013 in advance of WK*NEPH*. As part of that process the historical time-series of landings by rectangle should be disaggregated. Historical sampling and groundfish survey data should also be disaggregated as far as possible back in time and investigated for useful trends and signals.

Management considerations

Management for *Nephrops* stocks in the area VII should be conducted at an appropriate geographic scale (e.g. Functional Unit).

The *Nephrops* fisheries target different areas, and *Nephrops* catches and landings show very different size structures. These fisheries also have differences in non-*Nephrops* bycatch composition. Cod, whiting, and to a lesser extent haddock are the main bycatch species (e.g. Davie and Lordan, 2011).

Discarding of small *Nephrops* is substantial. The discard rate seems to have notably fluctuated between fleets or years. This shows that trawls currently used to target *Nephrops* are not technically adapted to select marketable *Nephrops*. The calculation of the discard rate may be impacted by the upwards trend of tailed individuals in landings. Discarding of other fish species is also a problem in *Nephrops* fishery (e.g. Anon, 2011).

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 a minor degree, Irish fleet also started to be impacted by European decommissioning plans in 2008 and 2009, but there was no new effect in 2010 or 2011.

Effort of Irish vessels is more directed towards the Smalls ground which has high densities of small *Nephrops*. Currently, French effort is directed towards other grounds such as the Labbadie where the substrate is more heterogeneous and the mean size of *Nephrops* is significantly larger. There have been some changes in the spatial strategies over time. The recent lpues compared between French and Irish fleets in FU20–21 are showing very similar patterns, as are the Irish lpues in the two areas FU20–21 and FU22. All lpue values over the whole time-series have not been corrected to take into account changing fishing power of fishing practices.

7.7.11 References

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Table 7.7.1. *Nephrops* FU 20–22 (Celtic Sea). Total and by country nominal landings (t) in Division VIIfgh as used by WG.

	France			Rep. of Ireland			UK			Other Countries[1]	Total reported	Unallocated	Total
Year	total	FU20–21	FU22	total	FU20–21	FU22	total	FU20–21	FU22				
1983	3667	na	na		na	na	65	na	na				
1984	3653	na	na		na	na	36	na	na				
1985	3599	na	na		na	na	3	na	na				
1986	2638	na	na		na	na		na	na				
1987	3080	na	na	329	na	na		na	na				
1988	2926	na	na	239	na	na	1	na	na				
1989	3221	na	na	784	na	na	13	na	na				
1990	3762	na	na	528	na	na	14	na	na				
1991	2651	na	na	644	na	na	13	na	na				
1992	3415	na	na	750	na	na	84	na	na				
1993	3815	na	na	770	na	na	47	na	na	0	4632	-274	4358
1994	3658	na	na	1415	na	na	42	na	na	2	5117	-274	4843
1995	3803	na	na	1575	na	na	100	na	na	2	5480	-282	5198
1996	3363	na	na	1377	na	na	77	na	na	2	4819	-217	4602
1997	2589	na	na	1552	na	na	59	na	na	4	4204	-213	3991
1998	2241	na	na	1619	na	na	48	na	na	1	3909	-90	3819
1999	2078	1051	1027	824	83	741	38	18	20	0	2940	-78	2862
2000	2848	1661	1186	1793	107	1687	45	10	34	1	4687	-44	4643
2001	2626	1750	876	2123	69	2054	19	14	5	1	4769	-33	4736
2002	3154	2559	595	1496	104	1392	15	11	3	8	4673	-50	4623
2003	3595	2796	799	1389	148	1241	19	9	10	na	5003	0	5003
2004	2605	2140	465	1629	299	1330	36	4	33	na	4270	0	4270
2005	2502	2008	494	2387	455	1931	6	6	0	na	4895	0	4895
2006	2368	2066	302	1848	450	1398	59	7	52	na	4275	0	4275
2007	2033	1816	218	3214	600	2614	52	3	48	6	5305	0	5305
2008	2348	2036	312	3411	937	2474	335	7	328	na	6094	0	6094
2009	2165	1930	235	2844	1202	1642	381	13	368	na	5390	0	5390
2010	1112	975	136	3110	756	2353	413	62	351	na	4635	0	4635
2011	620	566	54	2185	637	1548	49	34	15	na	2854	0	2854

[1]Other countries include Belgium.

Table 7.7.2. *Nephrops* FU 20–22 (Celtic Sea). Nominal landings (t) by quarter in Division VIIfgh as used by WG.

	French trawlers					Irish trawlers				
year	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4	Total
1987	759	941	972	409	3080					329
1988	547	1065	683	631	2926					239
1989	411	1493	838	480	3221					784
1990	482	1765	1229	287	3762					528
1991	500	1245	518	388	2652					644
1992	681	992	1064	678	3415					750
1993	972	1598	742	504	3815					770
1994	541	1303	1052	762	3658					1415
1995	693	1631	876	604	3803	193	1137	109	136	1575
1996	674	1437	728	523	3363	268	714	330	66	1377
1997	460	1028	683	417	2589	249	971	196	136	1552
1998	642	881	456	262	2241	351	952	264	52	1619
1999	479	447	606	546	2078	214	184	105	321	824
2000	598	1261	743	246	2848	420	1154	149	71	1793
2001	422	879	667	658	2626	456	843	317	508	2123
2002	479	1211	823	641	3154	167	557	408	363	1496
2003	533	1401	1187	474	3595	203	519	479	190	1389
2004	496	981	677	452	2605	234	686	341	367	1629
2005	628	909	537	428	2502	491	1390	233	272	2387
2006	486	1024	563	295	2368	354	965	232	297	1848
2007	294	966	423	350	2033	416	1331	415	1051	3214
2008	450	794	681	424	2348	493	1589	600	728	3411
2009	543	886	493	244	2165	933	1186	529	197	2844
2010	298	379	312	122	1112	1122	1335	343	309	3110
2011	200	261	76	83	620	615	1019	126	425	2185

Table 7.7.3. ***Nephrops*** **in VIIfgh. Mean sizes (carapace length, CL in mm) of French and Irish landings. For the period 1999–2011, French values are calculated (1) including the samples involving in tailed individuals (italic fonts) and (2) using the previous method (no sampling of tails; the total tailed proportion was apportioned in the smallest category of entire** ***Nephrops*** **at auction).**

	French sampling			Irish sampling		
Year	Males	Females	Total	Males	Females	Total
1987	38.8	35.1	38.1			
1988	35.7	34.7	35.6			
1989	38.9	36.0	38.5			
1990	39.7	35.4	39.0			
1991	38.2	34.1	37.5			
1992	37.6	34.9	37.3			
1993	40.0	36.6	39.6			
1994	39.7	37.1	39.3			
1995	39.9	36.1	39.4			
1996	39.5	36.8	39.2			
1997	39.9	37.4	39.8			
1998	39.9	36.4	39.5			
1999	*39.0*	*35.3*	*38.3*			
	40.1	36.9	39.6			
2000	*41.0*	*37.8*	*40.2*			
	42.0	39.2	41.4			
2001	*37.9*	*37.1*	*37.7*			
	38.8	39.1	38.9			
2002	*39.6*	*36.8*	*39.3*	33.0	31.1	32.2
	40.9	39.7	40.8			
2003	*40.5*	*36.3*	*40.1*	31.1	29.1	30.2
	41.5	39.8	41.4			
2004	*40.1*	*36.3*	*39.6*	33.5	32.3	32.9
	41.6	39.8	41.5			
2005	*41.1*	*37.9*	*40.6*	30.9	30.8	30.9
	43.1	40.3	42.8			
2006	*40.0*	*37.3*	*39.2*	29.7	28.6	29.2
	41.6	39.5	41.1			
2007	*38.9*	*36.9*	*38.5*	29.3	27.3	28.5
	40.7	38.7	40.4			
2008	*37.6*	*34.7*	*37.2*	32.0	29.7	31.1
	40.1	39.6	40.1			
2009	*39.0*	*34.5*	*38.5*	31.8	28.8	30.8
	41.0	40.1	41.0			
2010	*40.2*	*34.2*	*39.3*	31.6	29.5	30.7
	42.2	39.9	42.1			
2011	*39.7*	*33.6*	*39.0*	32.9	30.6	32.1
	42.6	37.8	42.5			

Table 7.7.4. ***Nephrops*** **of the Celtic Sea (VIIfgh, FU20–22). French landings (in number, 10^3 individuals) by sex for years 1999–2011. The numbers are calculated (1) column** ***No tails*****: using the previous (before 2008) sampling method (no sampling of tails; the total tailed proportion was apportioned in the smallest category of entire** ***Nephrops*** **at auction); (2) column** ***Tails*****: tails are sampled at auction.**

	males		females		total	
Year	No tails	Tails	No tails	Tails	No tails	Tails
1999	35294	38307	6081	7373	41375	45680
2000	38092	41223	10721	12004	48813	53226
2001	44602	50854	10896	10428	55498	61282
2002	52852	59130	4931	5694	57783	64824
2003	59166	64733	3793	4955	62959	69688
2004	40484	46212	4081	4793	44565	51005
2005	33656	39815	3835	4722	37491	44537
2006	31803	36207	10512	12960	42315	49168
2007	32616	37225	6186	8114	38803	45340
2008	43145	50923	3203	7442	46348	58365
2009	38521	43017	1112	4993	39633	48010
2010	17773	19305	647	3265	18420	22571
2011	9494	11093	276	1391	9770	12483
total	477500	538045	66274	88133	543774	626179
Δ	+13%		+33%		+15%	

Table 7.7.5. ***Nephrops*** **in FU20–22. French program of discard sampling onboard (years 1997 and 2010). Length distribution of landings (L) and discards (D) by sex (10^3). The reported size is the carapace length (CL, in mm). Conversion of CL to TS (total size) is done by multiplication by 3.3 (shaded area: data used for the** ***Nephrops*** **data limited method).**

CL	1997						2010					
	males		females		Total		males		females		Total	
	L	D	L	D	L	D	L	D	L	D	L	D
14								7		17		24
15												
16				1		1						
17								3				3
18				1		1						
19		1				1				1		1
20		1		12		13				5		5
21				10		10				4		4
22		187		294		481		1				1
23		630		1150		1780		11		1		12
24		874		1172		2046		23		31		54
25		1428		2490		3918		28		25		54
26		1439		1889		3328		98		91		189
27	15	4695		7332	15	12027		113		163		275
28	28	4399		6888	28	11287		115		185		300
29	45	3521		5089	45	8610		274		291		565
30	218	6863	19	9305	236	16167	24	424		434	24	857
31	521	3140	21	4821	542	7960	23	499	13	535	36	1034
32	1155	4842	65	6535	1220	11377	54	507	15	1516	69	2023
33	1984	3885	160	5140	2144	9025	89	601	46	2133	136	2735
34	2035	1360	152	1384	2186	2744	119	465	231	2477	350	2943
35	3251	1385	357	1254	3608	2639	277	566	313	2127	590	2693
36	3409	570	418	950	3827	1520	499	501	463	1574	962	2075
37	3799	410	464	333	4262	743	575	491	533	1107	1109	1598
38	4138	205	666	189	4804	394	745	361	420	518	1165	879
39	3395	72	224	85	3619	157	1112	505	321	367	1432	871
40	4713	120	205	64	4918	184	1319	617	238	222	1557	840
41	2861	33	202	41	3062	74	1354	321	169	190	1524	511
42	3367	43	47	34	3414	77	1439	288	122	115	1561	403
43	2678	25	47		2725	25	1494	477	141	230	1635	707
44	1787	8	63		1849	8	1508	277	65	187	1573	464
45	2236	7	52	2	2288	9	1301	406	61	318	1362	724
46	1428	1			1428	1	1287	522	41	208	1328	731
47	1021				1021		1159	423	21	377	1180	800
48	954	2	16		970	2	1187	364	20	173	1208	538
49	603				603		860	277	3	89	863	366
50	733	1			733	1	677	341	3	18	680	358
51	353				353		551	239	8	82	559	320
52	372				372		476	140	8	51	483	190
53	286	3			286	3	401	184	9	105	409	288
54	198				198		248	77		8	248	85
55	110				110		199	80	1	27	200	107
56	54				54		109	38			109	38
57	81				81		80	1			80	1
58	36				36		54				54	
59	8				8		43	1			43	1
60	23				23		14				14	
61	8				8		8				9	
62	3				3		3				3	
63							2	2			2	2
64												
65							2				2	
66												
67							2				2	
68							1				1	
68							1				1	
70												
71												
72							1				1	
73							1				1	
74							1				1	
75												
	47904	**40149**	**3176**	**56463**	**51080**	**96612**	**19304**	**10667**	**3265**	**16003**	**22569**	**26670**
%D		*46*		*95*		*65*		*36*		*83*		*54*

Table 7.7.6. *Nephrops* in FU20–22. Irish program of discard sampling onboard (years 2008–2011). Length distribution of landings (L) and discards (D) by sex (10^3). The reported size is the carapace length (CL, in mm). Conversion of CL to TS (total size) is done by multiplication by 3.3 (2011 data involve only in FU22) (shaded area: data used for the *Nephrops* data limited method).

CL	2008						2009						2010						2011					
	males		females		Total		males		females		Total		males		females		Total		males		females		Total	
	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
15				35		35		35				35												
16		35		35		70															4		4	
17				181		181		42		136		178									8		8	
18		83		237		320		77		223		300									13		13	
19		166		578		744		239		405		644									31	34	31	34
20		370		1002		1372		247	127	1019	127	1266				12		12	4		89	134	93	134
21		988	28	866	28	1854	111	679	56	594	167	1273		29				29	5		106	250	111	250
22	98	1127	198	1721	296	2848	220	1182	346	1836	566	3018				21		21			200	390	200	390
23	195	1431	1063	2893	1258	4324	756	1610	887	2078	1643	3688		54		48		102	13		187	671	200	671
24	1491	2022	2130	4253	3621	6275	2015	2235	2192	2845	4207	5080		41		41		82	13	11	194	826	207	837
25	3058	2931	3923	6630	6981	9561	4121	2814	3284	2782	7405	5596	21	164	148	451	169	615	48	73	234	1061	282	1134
26	5878	2971	6519	6076	12397	9047	5814	2316	5711	2561	11525	4877	280	666	284	718	564	1384	62	139	243	1078	305	1217
27	4798	3416	4981	5184	9779	8600	6595	2292	5735	2155	12331	4447	633	834	893	1172	1526	2006	186	367	269	1367	455	1734
28	8319	3258	6419	3333	14738	6591	6508	1644	5236	1347	11744	2991	1147	1097	1417	1207	2564	2304	173	628	270	1454	443	2082
29	8292	2362	5209	2138	13502	4500	7532	1311	5087	1024	12619	2335	2512	1614	3835	2297	6346	3911	171	745	231	1201	402	1947
30	9274	1926	5314	1654	14588	3580	6985	1076	3879	574	10865	1650	4972	1601	6075	2182	11047	3783	209	922	269	1766	478	2688
31	7186	1431	5495	1221	12680	2652	5539	751	3091	399	8630	1150	7992	2143	7196	2026	15188	4169	274	1277	236	1862	510	3139
32	7137	914	5299	712	12436	1626	5748	580	2486	169	8234	749	7087	1401	7658	2035	14745	3436	248	1361	178	1999	426	3360
33	7181	585	3636	320	10817	905	4680	388	2051	73	6731	461	8438	1236	7500	1864	15938	3100	337	1978	164	1985	501	3963
34	7008	332	3005	285	10013	617	4353	220	1341	16	5694	236	8153	666	7246	1557	15399	2223	396	2282	108	1559	504	3841
35	6570	55	2624		9194	55	3721	68	926		4647	68	6784	631	5570	1489	12355	2120	424	3113	104	1398	528	4511
36	5201	27	1524		6725	27	3236		797		4032		5954	428	4921	1018	10875	1446	398	3253	38	971	436	4224
37	3430		906		4337		2864		533		3397		4960	424	3643	611	8603	1035	329	3602	10	617	339	4220
38	2993		556		3548		2785		321		3106		4623	264	2710	407	7333	671	297	3449	5	490	302	3939
39	1928		366		2294		2334		235		2569		3181	152	1680	178	4861	330	241	3202		284	241	3486
40	1526		187		1713		1411		216		1627		3315	76	1189	76	4504	152	236	2772		234	236	3006
41	1459		148		1606		1667		163		1831		2873	38	904	25	3778	63	123	2479		143	123	2623
42	1114		78		1192		827		37		864		2595	12	520	12	3115	24	50	1985		45	50	2030
43	650		76		726		766		32		797		1871		208		2079		18	1460		53	18	1513
44	431		40		470		503		14		517		1219		156		1375		14	1222		9	14	1231
45	297				297		226		15		240		820		109		929		5	1156		15	5	1171
46	123				123		270		23		293		1213		139		1352		14	817		15	14	832
47	40				40		137				137		702		98		800			628		9		638
48	81				81		169				169		569		96		665			473				473
49	207				207		40				40		482		48		530			304		5		309
50	165				165		51				51		255				255			281		5		286
51	61				61		29				29		137		15		152			155				155
52	41				41		57		11		68		164				164			123				123
53							43				43		146				146			68				68
54							171				171		35				35			68				68
55							86				86		64		15		79			23				23
56							171				171		109				109			19				19
57							57				57									39				39
58							86				86									5				5
59							57				57		17				17							
60							86				86		53				53							
61							71				71									5				5
62							43				43													
63							29				29													
64							57				57													
65							14				14													
66																								
67																								
68							14				14													
68							14				14													
70							14				14													
71																								
72																								
73																								
74													17				17							
75																								
	96232	**26430**	**59724**	**39354**	**155956**	**65784**	**83082**	**19796**	**44833**	**20236**	**127915**	**40032**	**83395**	**13571**	**64271**	**19447**	**147667**	**33018**	**4288**	**40482**	**3191**	**21933**	**7479**	**62415**
%D		*22*		*40*		*30*		*19*		*31*		*24*		*14*		*23*		*18*		*10*		*13*		*11*

Table 7.7.7. Division VIIfgh. *Nephrops* effort and lpue data by country. *French data*: they are provided for otter trawlers getting at least 10% of their landings by targeting this species (period 1983–2008). Since 2009, these data have not been available, but they were calculated *vs.* estimators based on threshold of 500 kg landed *Nephrops* by trip (fishing effort was expressed as number of trips and lpue as kg/trip; see report). *Irish data*: they are linked to otter trawl vessels where >30% of monthly landings in live weight were *Nephrops*. Effort and lpue for the Irish fleet are also presented separated (FU22: Smalls ground; FU20–21: other sectors). The spatially separated values involve in yearly threshold of 30% and that explains the slight differences on fishing effort between aggregated and separated values.

	Effort (Effective hours fishing)				LPUE (kg/h)			
	France	Rep. of Ireland			France	Rep. of Ireland		
Year		total	FU22	FU20–21		total	FU22	FU20–21
1983	231440				14.2			
1984	204600				15.8			
1985	202830				16.0			
1986	162510				14.9			
1987	189580				15.2			
1988	170840				16.4			
1989	179060				16.8			
1990	229470				15.6			
1991	224710				11.3			
1992	276450				11.7			
1993	268410				13.2			
1994	258490				13.5			
1995	239240	27329	25028	2301	14.6	48.1	48.6	42.2
1996	220120	21006	18688	2319	14.2	44.8	46.6	30.4
1997	187180	23635	21824	1811	12.6	47.0	48.2	31.8
1998	155340	27494	24840	2654	13.0	51.5	53.6	32.4
1999	150770	16001	13899	2102	10.9	41.5	44.3	22.7
2000	194150	28577	26035	2542	13.8	48.3	50.6	24.4
2001	170320	35952	34166	1786	14.6	54.3	56.0	23.6
2002	165670	29066	27336	1730	18.7	46.2	47.0	33.9
2003	191600	31302	28334	2968	18.2	33.6	34.4	26.2
2004	152700	33975	28317	5658	15.8	33.1	34.4	26.5
2005	146880	53910	43502	10408	16.0	41.2	43.1	33.5
2006	136650	49043	35557	13486	16.3	35.2	38.6	26.2
2007	101980	64535	48111	16425	18.5	49.2	55.4	31.0
2008	99789	62093	41208	20885	22.6	55.1	60.5	44.4
2009	92116	57018	29096	27922	22.7	49.1	54.3	43.7
2010	66685	57713	39873	17840	16.9	48.5	54.8	34.5
2011	51994	44707	29893	14814	12.4	45.0	49.7	35.4

Table 7.7.8. *Nephrops* in the Smalls FU22. Short-term catch option prediction inputs (Bold) and recent estimates of mean weight in landings and harvest ratio (shaded cells indicates inputs to catch option calculations).

Year	Landings in Number (millions) scaled	Discards in Number (millions) scaled	Removals in Number (millions) 25% discard survival	Prop Removals Retained	Adjusted Survey (millions)	Harvest Ratio	FU 22 Landings (t)	FU 22 Discards (t)	Mean Weight in landings (gr)
2003	90.15	51.07	128.5	0.70	Na		1,931	504	21.4
2004	68.95	8.21	75.1	0.92	Na		1,759	73	25.5
2005	111.40	88.19	177.5	0.63	Na		2,355	628	21.1
2006	94.24	53.02	134.0	0.70	1503	8.9%	1,699	575	18.0
2007	163.41	148.63	274.9	0.59	1136	24.2%	2,856	1,500	17.5
2008	128.43	58.93	172.6	0.74	1114	15.5%	3,032	744	23.6
2009	92.75	31.08	116.1	0.80	1093	10.6%	2,245	589	24.2
2010	123.17	26.93	143.4	0.86	1141	12.6%	2,697	417	21.9
2011	61.55	6.65	66.5	0.93	1256	5.3%	1,617	144	26.3
			Avg 09–11	0.86			Avg 03–11		22.17

Table 7.7.9. *Nephrops* in the Smalls FU22. Short-term forecast management option table giving catch options for 2013.

			Implied fishery	
	Harvest rate	Adjusted Survey (millions)	Retained number (millions)	Landings (tonnes)
MSY framework	10.9%	1,256	117	2,830
F2011	5.2%	1,256	57	1,369
F0.1 Combined	7.5%	1,256	81	1,943
Fmax Combined	12.3%	1,256	133	3,200
	0%	1,256	0	0
	2%	1,256	22	522
	4%	1,256	43	1,043
	6%	1,256	65	1,565
	8%	1,256	86	2,087
	10%	1,256	108	2,608
	12%	1,256	130	3,130
				Basis
Landings Mean Weight (Kg)		0.0241		Sampling 2009–2011
Survey Overestimate Bias		1.30		WGCSE 2011
Survey Numbers (Millions)		1632		UWTV Survey 2011
Prop. Retained by the Fishery		0.86		Sampling 2009–2011

Table 7.7.10. ***Nephrops*** **in the Celtic Sea (FU20–22). Production by rectangle (t) for French and Irish trawlers. The total by rectangle and the % involve in years 1999–2011.**

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	%
	French trawlers														
28E1	77	75	127	207	246	172	190	212	374	365	243	160	60	2509	8.3%
28E2	142	350	330	286	363	258	297	213	189	239	227	176	131	3202	10.7%
29E1	103	182	300	536	654	355	276	258	395	349	502	125	37	4073	13.6%
29E2	127	289	205	204	247	250	368	420	241	215	201	138	111	3016	10.0%
30E1	119	169	203	438	375	198	178	105	105	140	121	34	32	2217	7.4%
30E2	288	423	431	741	807	788	575	772	439	660	572	299	150	6944	23.1%
31E3	863	1015	770	488	680	404	427	253	193	261	209	125	54	5742	19.1%
other FU20–21	195	172	154	146	105	120	123	86	72	68	64	42	46	1393	4.6%
other FU22	165	171	106	107	119	61	67	49	25	51	26	11	0	958	3.2%
FU20-21	1051	1661	1750	2559	2796	2140	2008	2066	1816	2036	1930	975	566	23354	77.7%
FU22	1027	1186	876	595	799	465	494	302	218	312	235	136	54	6700	22.3%
% FU22	49%	42%	33%	19%	22%	18%	20%	13%	11%	13%	11%	12%	9%	22%	
all FR	2078	2848	2626	3154	3595	2605	2502	2368	2033	2348	2165	1112	620	30054	
	Irish trawlers														
28E1	0	0	0	0	6	4	10	2	10	18	64	109	36	257	0.9%
28E2	0	3	1	1	2	23	15	6	2	6	72	17	109	257	0.9%
29E1	15	22	0	9	34	38	105	91	194	374	476	271	204	1832	6.5%
29E2	1	2	0	0	1	11	19	24	31	23	67	55	70	304	1.1%
30E1	5	10	10	37	62	104	133	141	154	292	297	123	101	1469	5.2%
30E2	4	5	3	2	5	36	52	99	69	147	151	111	81	763	2.7%

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	%
30E3	15	11	0	5	2	27	55	39	40	15	16	17	6	248	0.9%
31E2	44	55	54	50	37	56	68	49	101	61	59	55	30	718	2.5%
31E3	616	1424	1679	1124	941	1101	1571	1168	2392	2257	1549	2221	1428	19471	68.9%
31E4	27	25	146	134	115	17	129	85	96	61	40	110	76	1062	3.8%
32E3	97	238	229	134	185	211	231	145	126	156	53	22	44	1873	6.6%
FU20–21	83	107	69	104	148	299	455	450	600	937	1202	756	637	5847	20.7%
FU22	741	1687	2054	1392	1241	1330	1931	1398	2614	2474	1642	2353	1548	22407	79.3%
% FU22	90%	94%	97%	93%	89%	82%	81%	76%	81%	73%	58%	76%	71%	79%	
all IRL	824	1793	2123	1496	1389	1629	2387	1848	3214	3411	2844	3110	2185	28254	
	Total[1]														
FU20–21	1152	1778	1833	2674	2953	2443	2469	2523	2419	2980	3145	1793	1237	29399	
FU22	1788	2907	2935	1990	2050	1828	2425	1752	2880	3114	2245	2840	1617	30371	
Total	2940	4686	4768	4665	5003	4270	4895	4275	5299	6094	5390	4635	2854	59774	
% FU22	61%	62%	62%	43%	41%	43%	50%	41%	54%	51%	42%	61%	57%	51%	

[1] Total includes UK landings

Table 7.7.11. *Nephrops* in FU20–21 (Labadie). Estimates for mean individual weight in landings (g) sex combined and dead discard rate used for derivation of the "*Nephrops* data limited method".

	IRL	FR	Combined estimate
Mean Weight in the Landings (g) (years 2002–2011)	21.2	45.0	34.6
Dead Discards rate (in number) (year 2010)	12%	41%	28%
Landings 2010 (weight, in t)	756	975	

Table 7.7.12. *Nephrops* in FU20–21 (Labadie, Celtic Sea): Harvest ratios for a range of landings (1000–3000 t) and densities (0.15–0.55 animals/m²), given 28% removals rate and a mean weight of 34 g in landings. Area is set to 3710 m² (conservative minimum option). Previous estimate of *Nephrops* density (0.42/m²) is provided by the Irish UWTV survey in 2006.

FU 20-21: Labadie — 3 710 Area (km²) — 34.4 mean weight (g) — 28% percentage discards

		Density								
	landings (t)	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.55
	1000	6.7%	5.0%	4.0%	3.4%	2.9%	2.5%	2.2%	2.0%	1.8%
	1250	8.4%	6.3%	5.0%	4.2%	3.6%	3.1%	2.8%	2.5%	2.3%
	1500	10.1%	7.5%	6.0%	5.0%	4.3%	3.8%	3.4%	3.0%	2.7%
	1750	11.7%	8.8%	7.0%	5.9%	5.0%	4.4%	3.9%	3.5%	3.2%
	2000	13.4%	10.1%	8.0%	6.7%	5.7%	5.0%	4.5%	4.0%	3.7%
	2250	15.1%	11.3%	9.0%	7.5%	6.5%	5.7%	5.0%	4.5%	4.1%
	2500	16.8%	12.6%	10.1%	8.4%	7.2%	6.3%	5.6%	5.0%	4.6%
	2750	18.4%	13.8%	11.1%	9.2%	7.9%	6.9%	6.1%	5.5%	5.0%
	3000	20.1%	15.1%	12.1%	10.1%	8.6%	7.5%	6.7%	6.0%	5.5%
average	2261	15.2%	11.4%	9.1%	7.6%	6.5%	5.7%	5.1%	4.5%	4.1%
maximum	3145	21.1%	15.8%	12.6%	10.5%	9.0%	7.9%	7.0%	6.3%	5.7%
Minimum	1152	7.7%	5.8%	4.6%	3.9%	3.3%	2.9%	2.6%	2.3%	2.1%

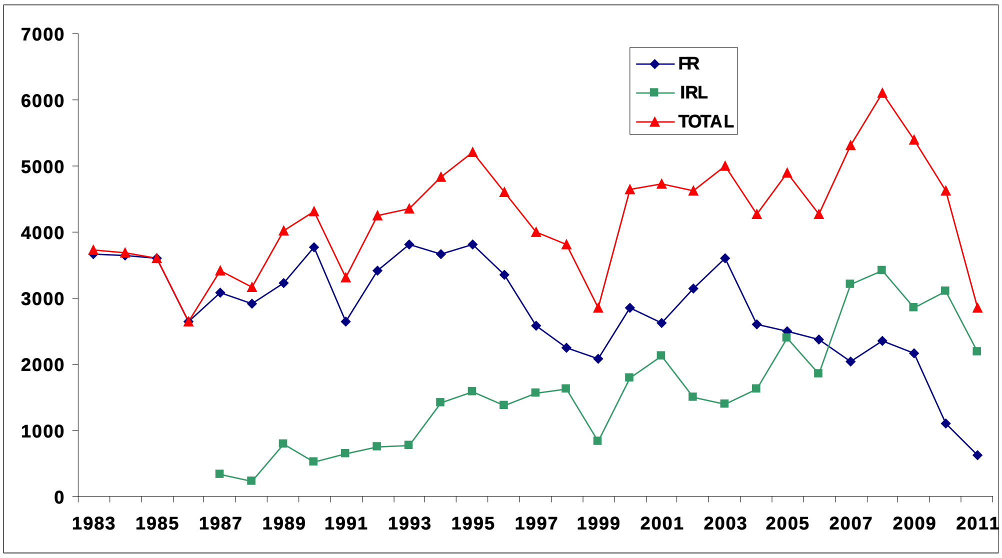


Figure 7.7.1. *Nephrops* in VIIfgh. Evolution of nominal landings (t).

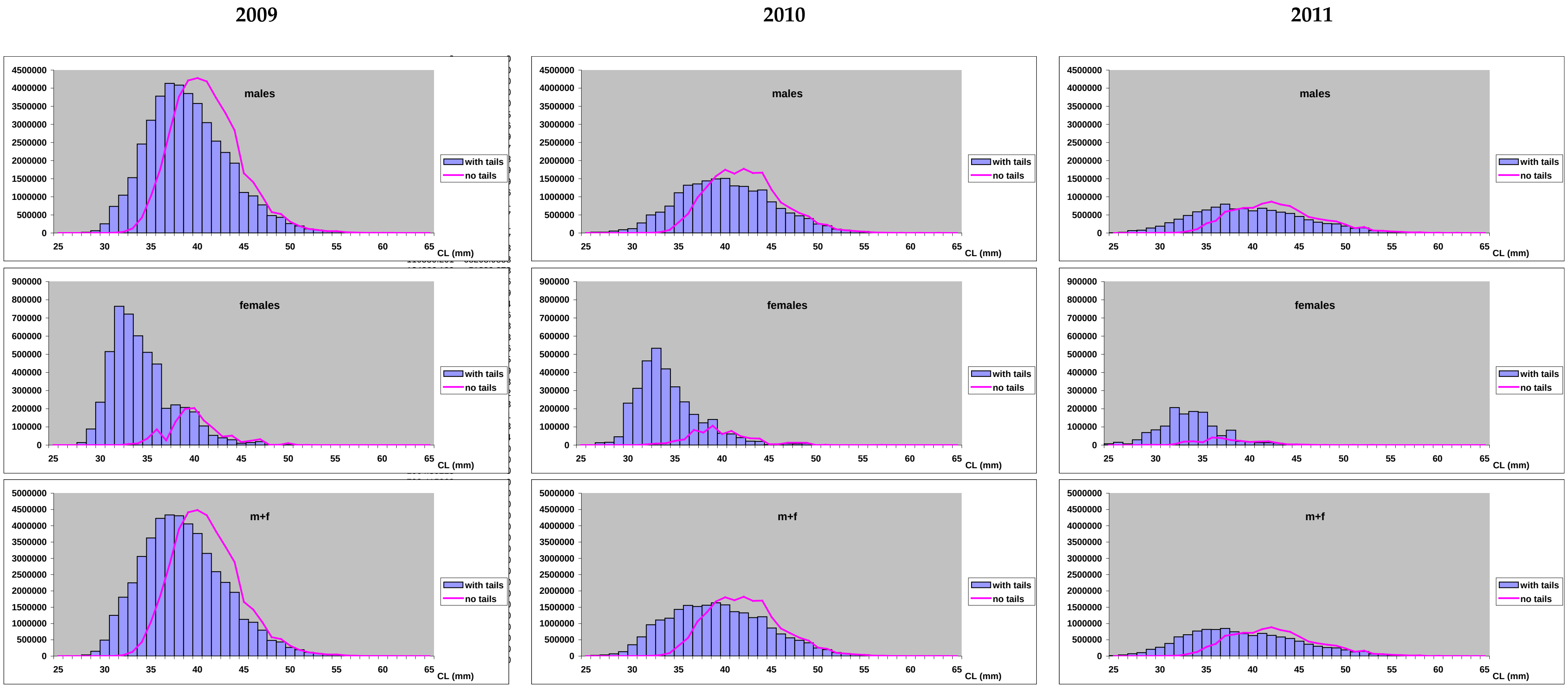


Figure 7.7.2. *Nephrops* of the Celtic Sea (VIIfgh, FU20–22). French landings by sex for years 2009–2011. Length distributions (1) including the data on tails and (2) using the previous method (no sampling of tails; the total tailed proportion was apportioned in the smallest category of entire *Nephrops* at auction).

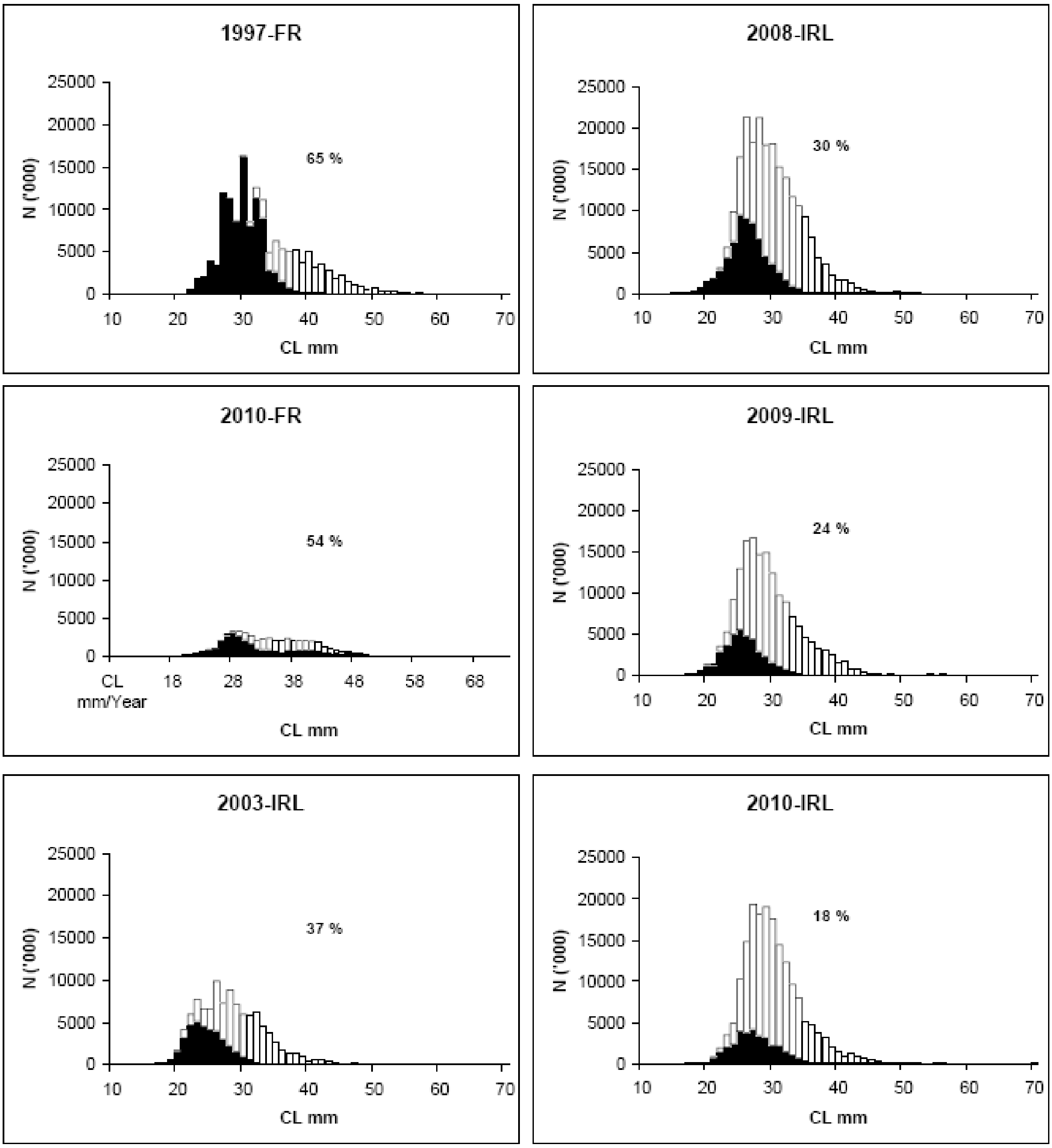


Figure 7.7.3. Nephrops in FU 20-22 Celtic Sea (VIIfgh).
Years with complete set of discard samples:
French data (1997 and 2010), Irish data (2003, 2008-2010).
Landings in white, discards in black.

Results summary table for geostatistical analysis of UWTV survey (FU 22, Smalls)

Ground	Year	Number of stations	Mean Density (no./m2)	Domain Area (km2)	Geostatistical Abundance (millions of burrows)	CV on Burrow estimate
	2006	100	0,63	2962	1954	2%
	2007	107	0,48	2955	1477	6%
	2008	76	0,47	2698	1448	6%
	2009	67	0,47	2824	1421	5%
	2010	90	0,49	2861	1483	4%
Smalls (FU22)	2011	107	0,53	2881	1632	3%

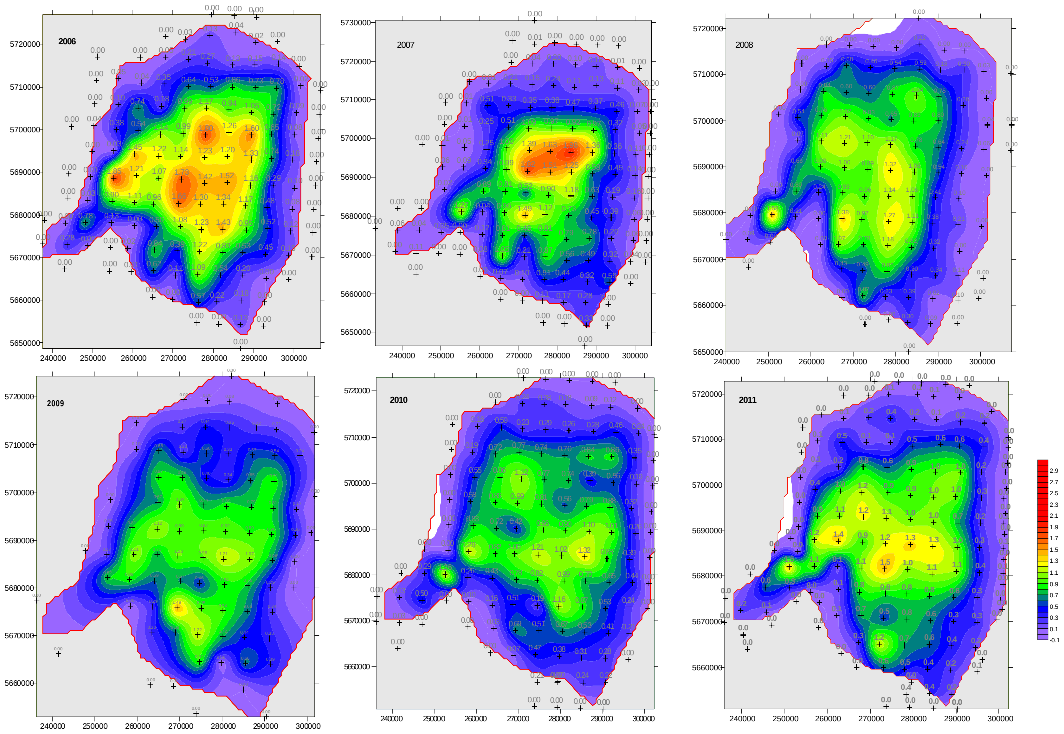


Figure 7.7.4. ***Nephrops*** **in the Celtic Sea (FU 20–22).Summary of geostatistics results 2006–2011 of the Irish UWTV survey carried out on the Smalls ground (FU22) and contour plots of burrow densities.**

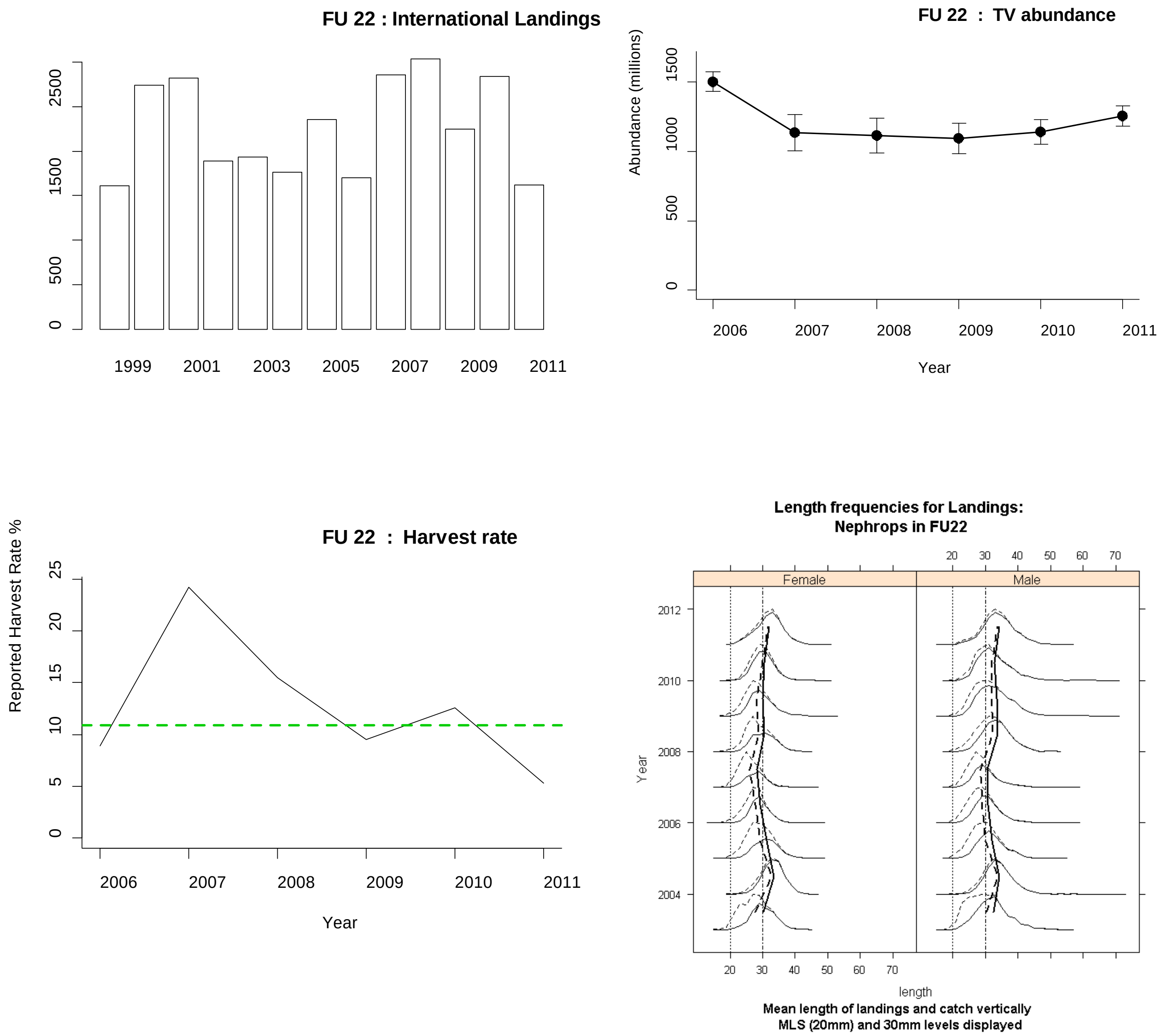
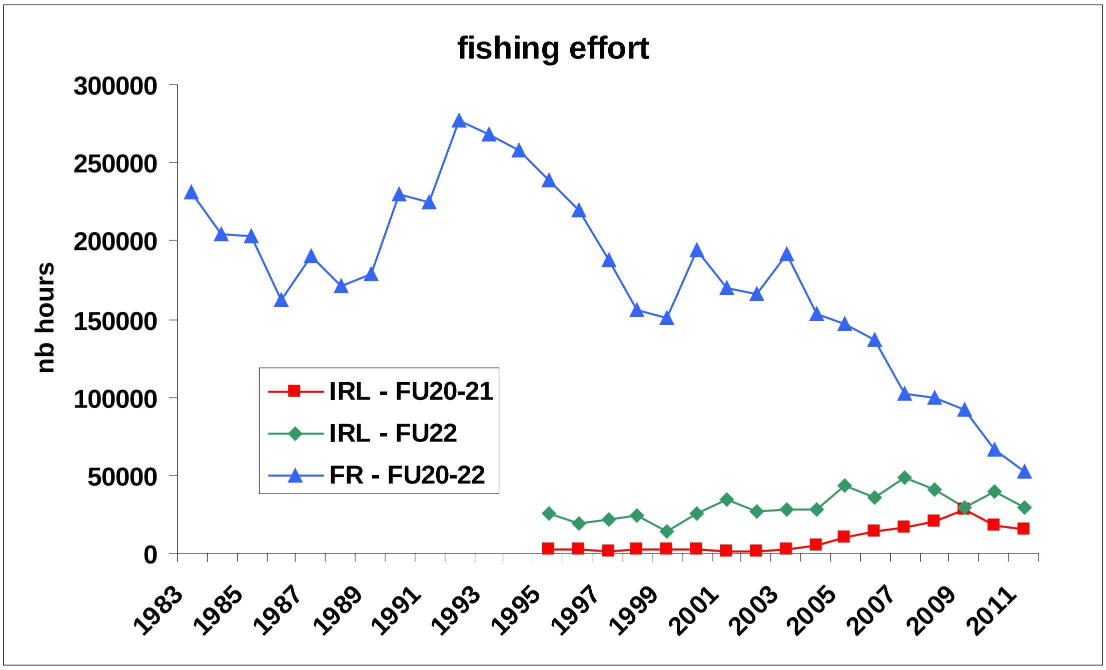


Figure 7.7.5. ***Nephrops*** **FU22 Smalls. Stock Summary plots: Landings (tonnes), UWTV abundance (millions), Harvest Ratio (% dead removed/UWTV abundance) and LFDs for landings by sex.**



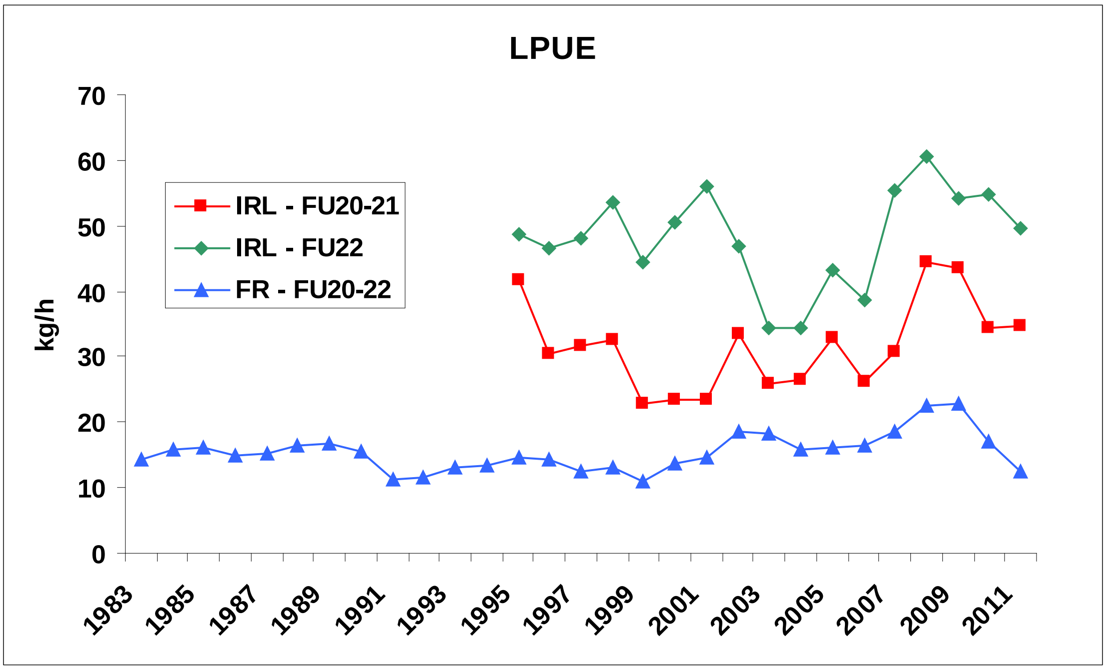


Figure 7.7.6. ***Nephrops*** **in VIIfgh (Celtic Sea, FU20–22). Fishing effort and lpue series for French and Irish trawlers (tuning fleet: threshold=10% for French, 30% for Irish of** ***Nephrops*** **weight in total landings). (French indices reported from the whole stock FU20–22; French trawling activities involve by almost 90% in the FU20-21 component of the stock since 1999).**

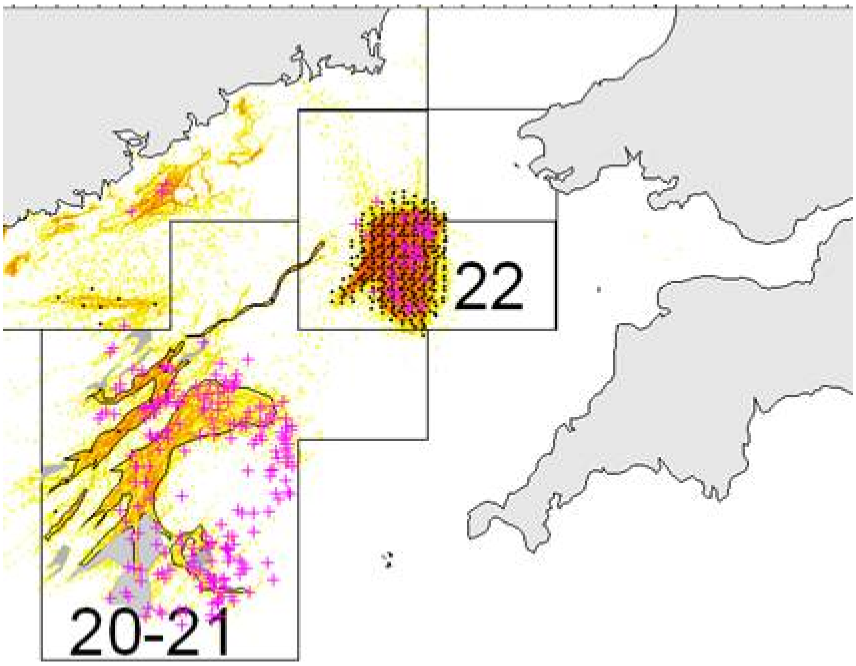


Figure 7.7.7. Nephrops in the Celtic Sea (FU20–22). Map of cumulative Irish VMS fishing effort directed at *Nephrops* is shown as a heat map underlay. Positions of UWTV survey observation of densities in 2006 are shown as black dots. The polygons for the minimum area estimated area (3710 km²) drawn as black lines. The expanded area >5100 km² would also include the polygons shown in grey. The positions for hauls catching *Nephrops* as reported by observers onboard for French trawlers (years 2005–2010: pink crosses).

7.8 *Nephrops* in Divisions VIIjg (South and SW Ireland, FU19)

Type of assessment in 2012

UWTV based assessment using WK*NEPH* 2009 protocol as described in the Stock Annex. Further description on the background is presented in Section 7.8.2.

ICES advice applicable to 2011

MSY approach

Considering the stable lpue trend and unknown exploitation status, catches should be reduced from the recent level.

PA considerations

ICES considers that the current fishery does not appear to be detrimental to the stock and recommends that *Nephrops* fisheries should not be allowed to increase relative to recent landings. This corresponds to landings of no more than 800 tonnes.

Policy paper

In light of the EU policy paper on fisheries management (17 May 2010, COM(2010) 241) this stock is classified under category 6 because the state of the stock is unknown but advice for an appropriate catch level is available. Indicators have been stable in recent years. ICES notes that the TAC and the stock assessment areas do not match.

ICES advice applicable to 2012

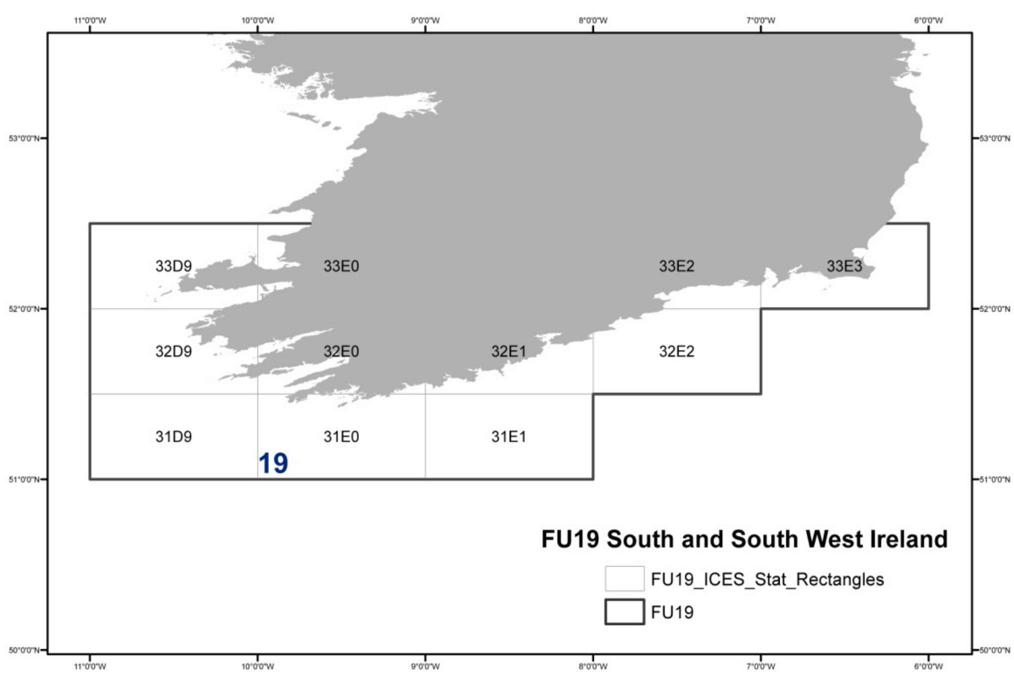
ICES advises on the basis of the precautionary considerations that catches in 2012 should be reduced.

To protect the stock in this functional unit, 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 Figure 7.8.1. Of these the 'Galley ground 4' and around Cork channels appear to be the most important (see Figure 7.8.7). The TAC is set for Subarea VII which does not correspond to the stock area. There is no evidence that the individual functional units belong to the same stock. The 2012 TAC is 21 759 t and remains unchanged compared with the 2011 TAC. No FU19 specific restrictions in TAC apply.



A map of the spatial distribution of FU19 is given in the FU 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.

Fishery description

Fleet segmentation data shows that the *Nephrops* métiers in this area also have important catches of megrim and monkfish. There are also some catches of hake in the offshore parts of FU19 which is an important nursery area for juvenile hake. The Irish fleet fishing *Nephrops* in FU19 was described in detail in the 2001 WG Report (ICES, 2001a). The minimum mesh size in use is 80 mm. French trawlers harvesting *Nephrops* on this area fish also in the Celtic Sea (FU20–22) 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). However, the increasing proportion of tailed individuals in French landings (as for FU20–22) may shift LF distributions for *Nephrops* landings to smaller sizes compared with previous years. Vessels <18 metre total length operate out of many local ports and fish the inshore *Nephrops* patches in periods of good emergence and weather. Vessels >18 m tend to fish the offshore *Nephrops* patches.

Fishery in 2011

The number of Irish vessels reporting landings in this area has increased from 28 in 2000 to 85 in 2011. Of these, only eleven reported landings in excess of 10 t and these eleven vessels accounted for 43% of the total landings. The number of French vessels reporting landings in FU19 has decreased from 35 vessels in 2005 to eleven vessels in 2011 and two of these vessels reported landings in excess of 5 tonnes.

7.8.2 Data

The sampling level for the species is given in Table 2.1.

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 (Figure 7.8.2). 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 2011 landings decreased by approximately 16% for the Irish fleet and were below the series average. 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 23 t in 2011. Landings from the UK are minor.

A time-series of landings by all FUs in ICES Subarea VII together with the overall TAC is shown in Table 7.8.11. (Note that national quotas for Ireland and the UK are restrictive in most of the recent years).

Disaggregated effort and lpue data are available for the Irish *Nephrops* directed fleet in FU19 from 1995–2011 for all vessels and vessels >18 metres total length. (Table 7.8.2; Figure 7.8.3). The lpue and effort-series is based on the same criteria for FU15, 16 and 17 (30% landings threshold) and will be contingent on the accuracy of landings data reported in logbooks. The long term trend in lpues for all vessels and vessels >18 m are stable over the dataseries. For vessels >18 m recent effort (since early 2000s) has fluctuated with an decreasing trend and lpue with an increasing trend (32 kg/hr in 2011). This can be explained by fleet mobility where vessels target *Nephrops* in this area in periods of good emergence.

Discarding

In 2002 a new catch self-sampling programme was put in place in Ireland. 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 onboard discard selection ogives 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 (Stock Annex.) The quality of the sampling has not yet been qualitatively assessed in terms of precision and accuracy.

Discarding of other species by the *Nephrops* trawl fleet is around 47% of the total catch by weight. The main discards are small whole *Nephrops*. The main fish species discarded are dogfish, haddock, whiting and megrim (Anon, 2011).

Biological sampling

Length–frequency data of the landings were collected on a regular basis 2002 to 2011 (Table 7.8.4). Spatial and temporal coverage is problematic with landings from FU19 coming from several discrete grounds (Figure 7.8.6). Discard samples are difficult to obtain due to the spatial coverage of the grounds.

The mean size in the catches of males varies from 30 to 35 mm CL, and for females between 27 and 33 mm CL (Table 7.8.3; Figure 7.8.4). There is a slight decrease in mean size for both sexes in 2011.

There is no change to other biological parameters as described in the Stock Annex.

Abundance indices from UWTV surveys

Previously, ICES have recommended that UWTV surveys could provide useful fishery independent data on the status of poorly assessed *Nephrops* stocks.

In 2006 as part of the UWTV survey in the Celtic Sea 6 indicator stations in FU19 (Galley Ground 4) were completed (stock annex Figure B.3.1). In 2011, 35 stations on the discrete patches within FU19 were completed and it was not possible to survey Galley ground 4 due to weather and time constraints (WD09). The 2006–2011 UWTV stations in FU19 were randomly picked from within polygons defined using integrated VMS data to determine the extent of the *Nephrops* patches (using methods described in Gerritsen and Lordan, 2011). Only around 40% of the total landings are made by vessels with VMS so the area estimates are likely to be underestimates of the total spatial extent of *Nephrops* in this area. The discrete grounds have been named as: Bantry Bay, Galley Ground 1–4, Cork Channels and Helvick 1–3 and are shown in Figure 7.8.7.

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). The estimation of the areas within FU19 was calculated based on polygons using ArcGIS10 (Table 7.8.5). In terms of area the Galley Grounds (1–4) account for 60% of the total grounds in FU19 and Galley Ground 4 is the largest of these representing 39% of the total area (Table 7.8.6).

A number of factors are suspected to contribute bias to UWTV surveys. In order to use the survey abundance estimate as absolute it is necessary to correct for these potential biases. The bias estimates are based on simulation models, preliminary experimentation and expert opinion. Previously a bias correction factor has not been estimated for FU19 but WD 09 offers a basis to estimate this as follows: The burrow systems are estimated to be of moderate size ~40 cm for most of the area. A field of view (FOV) of ~75 cm on the UWTV survey has been confirmed for most stations using sledge mounted lasers. There may be some random noise in the FOV due to sinking and jumping in poor weather, but this is normally not a major problem in FU19. The FOV is smaller than that used for Scottish stocks (FOV ~1 m) resulting an edge effect bias correction factor of around 1.25 based on the findings of Campbell *et al.* (2009). Burrow system detection rates are thought to be relatively high (0.9). Visibility is generally good; most systems have multiple entrances and are fairly evenly spaced making detection easier. There are some other burrowing macrobenthic species present in FU19 and misidentification is assumed to be in the order of 1.15. Fishing activity in FU19 is intensive and unoccupied burrows are likely to be filled in quickly due to a combination of fishing and hydrodynamic sediment disturbance. As for most other areas the assumption is that all the burrows counted are occupied by a single *Nephrops.*

The cumulative biases associated with the estimates of *Nephrops* abundance for FU19 are:

FU	Area	Edge effect	detection rate	species identification	Occupancy	Cumulative bias
19	South and SW Coast	1.25	0.9	1.15	1	1.3

In general the 2011 mean density for Galley Grounds 1–3 are similar ~ 0.73 (no./m²) whereas the 2006 mean density for Galley ground 4 is 0.27 (no./ m²). The mean density for the Helvick patches varies from 0.06 to 0.78 (no./m²). The 2011 mean density observed in Cork channels and Bantry Bay is similar at 0.45 and 0.43 (no./m²) respectively (Figure 7.8.6).

Raised abundance estimates (for the discrete grounds are presented in Table 7.8.7. The abundance estimation is the product of the mean density and ground area. The sample variances, standard errors, t-values and 95% CI were calculated for each ground. Two raising options were explored by WGCSE 2012 to calculate the total abundance given that Galley 4 was not surveyed in 2011. Option one was to raise the average density for all patches surveyed in 2011 to the total area estimated for FU19. This resulted in an abundance estimate of 850 million individuals. A more conservative alternative was to assume that the densities on Galley 4 were at the same density as observed in 2006. This has a total abundance estimate of 724 million. The WGCSE deemed it more appropriate to include the 2006 mean density estimate for Galley ground 4 for the FU19 2011 abundance estimate (724 million burrows).

Information from Irish Groundfish survey

Length–frequency data of the *Nephrops* catches on the Irish Groundfish survey (2003–2011) are available (Table 7.8.8; Figure 7.8.5). These data were investigated at this WG for trends in indicators such as mean size and were compared with commercial data. 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. There are some difference with the commercial data due to differences in catchability and selectivity between the commercial fishery and survey not to mention the spatial coverage differences.

7.8.3 Assessment

The WGCSE 2012 carried out an UWTV based assessment for the first time for this stock. The methods used were very much in line with WK*NEPH* (2009) and the approach taken for other stocks in VI and VII by WGCSE.

7.8.4 MSY explorations

MSY explorations were carried out for FU19 by the WG. In response to the recommendations of WKFRAME (2010), the Bell/Dobby combined sex–length cohort analysis (SCA) model (WK*NEPH*, 2009) was used to determine Harvest Rates associated with fishing at various potential F_{MSY} proxies i.e. $F_{35\%SPR}$, $F_{0.1}$ and F_{max}. This approach was previously applied to all other *Nephrops* stocks with UWTV and catch sampling data. Length distributions for male and female landings and discards were available for Irish sampling from FU19 from 2002 to 2011.

The length–frequency distributions reference period 2009–2011 were used as input to the SCA model. The length distributions in the reference period were relatively stable. Other SCA inputs such as growth parameters and discard survival were all taken from the stock annex.

Parameter	Males	Immature Females	Mature females
L□	68	68	49
K	0.17	0.17	0.1
Natural Mortality	0.3	0.3	0.2
Discard Survival	25%	25%	25%
A	0.000322	0.000684	0.000684
B	3.207	2.963	2.963

The L_{50} for female maturity was estimated at 26 mm and was based on Irish sampling in FU19. Figure 7.8.8 shows the estimated YPR and SPR curves. The SCA model fit to both landings and discards of both sexes is fairly good. The YPR plot indicates a more domed YPR for females than males. The results of the model in the table below show the F multipliers required to achieve the potential F_{MSY} proxies; the harvest rates that correspond to those multipliers and the resulting level of spawner-per-recruit as a percentage of the virgin level. The estimated harvest rates are very close to those estimated for several other stocks in VI and VII.

		Fmult	Fbar 20–40mm		Harvest Rate %	% Virgin Spawner per Recruit		
			Male	Female		Male	Female	Comb
$F_{0.1}$	Male	0.2	0.13	0.04	6.5	42.57	72.19	53.38
$F_{0.1}$	Female	0.55	0.36	0.11	14.2	18.97	49.02	29.94
$F_{0.1}$	Comb	0.24	0.16	0.05	7.5	37.60	68.41	48.85
F_{max}	Male	0.36	0.24	0.07	10.4	27.48	59.20	39.06
F_{max}	Female	1.04	0.68	0.21	21.9	10.54	34.63	19.33
F_{max}	Comb	0.47	0.31	0.10	12.7	21.85	52.80	33.15
$F_{35\%SpR}$	Male	0.27	0.18	0.06	8.3	34.51	65.83	45.94
$F_{35\%SpR}$	Female	1.03	0.68	0.21	21.8	10.63	34.83	19.46
$F_{35\%SpR}$	Comb	0.44	0.29	0.09	12.1	23.16	54.40	34.56

WGCSE took into account the following considerations based on the check list presented in Section 2.2:

- Compared to other *Nephrops* fisheries in the ICES area the population density of FU19 appears to be moderate ~0.5/m². In 2011 Galley ground 4 was not surveyed and the 2006 mean density for this ground has been used.
- There is one year of UWTV survey data available (2011) for this FU.
- The biological parameters are assumed in line with other Celtic Sea Stock but probably vary significantly between areas with different density levels. Natural mortality estimates are assumed in line with other stocks.
- Fishery operates throughout the year but there has been some variability of the seasonality depending on *Nephrops* emergence.
- The time-series of mean size in the landings/catches is very short and quite noisy. The mean size in survey catches is also short but covers only a few of the patches regularly and the survey only operates in quarter 4.
- Area estimates are likely to be conservative estimates of the stock distribution. Around 50% of the landings are made by vessels <18 metres which do not currently have VMS.
- Mean weights have been variable over the available time-series but this is likely to be a result of the variability in sampling of the discrete patches.

- Sampling and discard estimates have been improving over the time-series.

Given the above considerations the WG concluded default proxy of combined sex $F_{0.1}$ is appropriate as an F_{msy} proxy. This corresponds to an interim harvest rate of 7.5%, which is in line with several other stocks in the remit of this WG. Fishing at the combined sex $F_{0.1}$ is predicted to keep the SPR for both sexes >53% and should deliver long-term yield with a low probability of recruitment overfishing. No $B_{trigger}$ can be proposed given the shortness of the UWTV series. Given that the stock in recent years has been at a relatively moderate level (as evidenced in the lpue series) it is likely to be above $B_{trigger}$.

7.8.5 Short-term projections

Projections are carried out for FU19 component using the method agreed at WK*NEPH* 2009 and applied for all other stocks with UWTV estimates in VI and VII by WGCSE.

Catch option for 2013 at various harvest rations were calculated using the approach agreed at the Benchmark Workshop (WK*NEPH*, 2009). Catch options are calculated by applying a bias correction factor (1.3) to the UWTV survey estimate, using three year mean weight in the landings, three year mean proportions of the catch retained and harvest ratios at different reference points from a SCA analysis to calculate landings options.

The inputs to the catch option table are given in Table 7.8.9. Table 7.8.10 shows landings predicted at a range of harvest ratios including those equivalent to fishing at F_{MSY} proxies for the fishery as well as $F_{current} = F_{2011}$. Only the Harvest Rates associated with the combined sex F_{MSY} proxies are identified in the table as they are considered more appropriate to this stock. As for other *Nephrops* stocks the F_{MSY} proxy harvest rate values are considered preliminary and may be modified following further data exploration and analysis.

7.8.6 Biological reference points

There are no biological reference points for FU19 *Nephrops* stock. Given the short time-series of UWTV survey data it is not possible to define an appropriate $B_{trigger}$. The combined sex $F_{0.1}$ is proposed by the WG as proxy for F_{msy}.

7.8.7 Management plans

No specific management plan exists for this stock.

7.8.8 Uncertainties and bias in 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). 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). Different densities are apparent on the various different grounds within this FU. For the 2011 survey the number of observations on each individual patch is relatively low making the relative standard error (RSE) estimates not that relevant. Aggregrating all areas together gives a mean burrow density of 0.5 with a RSE of around 13% which is below the 20% threshold recommended by SGNEPS 2012 (Report in draft). 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 2009–2011 are used although there is some variability of these over time.

There is a lag between the survey and the start of the year for which the assessment is used to set management levels. It is assumed that the stock is in equilibrium during this period (i.e. recruitment and growth balance mortality) although this is rarely the case. The effect of this assumption on realized harvest rates has not been investigated, but remains a key uncertainty.

The quality of landings data is thought to be good and sampling and discard estimates have improved over the time-series.

7.8.9 Recommendations for next benchmark

This stock has not been formally benchmarked by ICES. This UWTV approach is something that could be considered formally through an inter-benchmark process in advance of planned WK*NEPH* 2013. For this stock the inputs to the SCA analysis could warrant further investigation. The growth and natural mortality parameters used here were assumed in line with the Celtic Sea. The utility of the IRGS and other survey information is also something that could be developed further. The spatial extent of the *Nephrops* grounds is also something that requires further investigation as the current area estimates are likely to be under estimates of the total extent of *Nephrops* in this area.

7.8.10 Management considerations

The trends from the fishery (landings, effort lpue, mean size, etc.) appear to be relatively stable. Lpues have been moderate in the last three years. The UWTV abundance and mean density estimates differences in burrow density between the discrete patches. The low harvest rate (7.0%)) indicates that *Nephrops* are lightly exploited in the area relative to other stocks. A new survey point should be available in 2012 which will provide a more up to date prognosis of stock status. The use of the most up to date survey information should be considered for this stock.

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).

7.8.11 FU18

For FU18 landings information from 1993 was available to the WG only (Table7.8.1). The Republic of Ireland has taken 100% of the landings for the last seven years. The highest reported landings were in 1994 with 124 t; landings in recent years have been minor (13 t in 2011). This FU will be monitored to see if any fishery develops.

7.8.12 References

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Table 7.8.1. ***Nephrops*** **in FU18 and FU19 (NW, SW and SE Ireland). Landings in tonnes by country and Functional Unit.**

Year	FU 18			FU 19			
	Rep. of Ireland	UK	Total	France	Rep. of Ireland	UK	Total
1989		0		245	652	2	899
1990		0		181	569	4	754
1991		0		212	860	5	1077
1992		0		233	640	15	888
1993	9	1	10	229	672	4	905
1994	124	2	126	216	153	21	390
1995	24	0	24	175	507	12	695
1996	46	1	46	145	736	7	888
1997	13	0	13	93	656	7	756
1998	77	1	78	92	733	2	827
1999	15	0	16	77	499	3	579
2000	9	0	9	144	541	11	696
2001	2	0	2	111	702	2	815
2002	14	0	14	188	1130	0	1318
2003	16	0	16	165	1075	0	1239
2004	22	0	22	76	997	1	1074
2005	15	0	15	62	648	2	711
2006	14	0	14	65	675	1	741
2007	3	0	3	63	894	0	957
2008	1	0	1	46	805	15	866
2009	14	0	14	55	764	15	833
2010	7	0	7	14	694	13	722
2011	13	0	13	23	585	1	608

Table 7.8.2. *Nephrops* in FU19 (SW and SE Ireland). Irish *Nephrops* directed effort (in hours) and lpue, 1993–2011.

Year	Irish Fleet - *Nephrops* trawlers (>30% landings weight)					
	All Vessels			Vessels >18 m		
	Effort hrs	Landings Tonnes	LPUE Kg/hr	Effort hrs >18 m	Landings Tonnes	LPUE >18 m Kg/hr
1995	9126	206	22.5	3.75	121	32.2
1996	9295	220	23.7	2.55	86	33.7
1997	9604	248	25.8	2.39	101	42.1
1998	15775	386	24.5	4.95	188	38.1
1999	13345	206	15.4	1.85	47	25.3
2000	9329	178	19.1	3.11	86	27.7
2001	9701	309	31.8	3.62	130	35.9
2002	25565	764	29.9	12.93	434	33.5
2003	28887	621	21.5	14.47	363	25.1
2004	26554	529	19.9	13.69	311	22.7
2005	23848	455	19.1	9.38	218	23.3
2006	24272	460	19.0	7.74	187	24.2
2007	30361	665	21.9	10.18	263	25.9
2008	25101	573	22.8	9.53	315	33.1
2009	22797	527	23.1	8.40	243	28.9
2010	23650	467	19.7	3.76	114	30.2
2011	18723	315	16.8	5.18	167	32.3

Table 7.8.3. *Nephrops* in FU19 (SW and SE Ireland). Mean time-series for catches and landings, 1995–2011.

Year	Catches		Landings			
			<35mm CL		>35mm CL	
	Males	Females	Males	Females	Males	Females
1995	na	na	na	na	na	na
1996	34.5	31.3	31.1	29.7	38.7	38.8
1997	34.6	32.9	31.2	30.9	39.8	38.4
1998	na	na	na	na	na	na
1999	38.5	35.4	31.8	31.2	41.3	39.1
2000	na	na	na	na	na	na
2001	na	na	na	na	na	na
2002	30.4	28.8	29.7	28.8	39.9	40.5
2003	33.1	29.4	31.1	30.0	38.4	38.0
2004	32.8	28.8	32.0	30.2	39.8	37.7
2005	31.3	27.5	29.1	26.9	38.4	37.0
2006	34.4	31.7	31.4	30.4	38.9	37.7
2007	35.6	33.2	32.4	31.7	39.1	38.2
2008	36.2	33.1	32.5	31.6	38.9	38.1
2009	33.9	29.2	31.2	29.8	39.3	37.4
2010	32.7	29.2	29.4	28.2	39.4	37.3
2011	30.4	28.5	28.9	27.5	38.9	36.9

na = not available.

Table 7.8.4. *Nephrops* in FU19 (SW and SE Ireland). Sampling levels.

Number of Samples				Total numbers of *Nephrops* measured			
Year	Graded Landings	Catch	Discards	Year	Graded Landings	Catch	Discards
2002		3	2	2002		2,235	1,081
2003	2	12	15	2003	763	3,173	7,234
2004	1	5	4	2004	152	1,278	1,169
2005		6	2	2005		3,221	1,670
2006		8		2006		4,716	
2007	2	13		2007	561	22,170	
2008		18		2008		12,311	
2009		16		2009		7,601	
2010	1	18		2010	331	7,662	
2011		15		2011		7,684	

Table 7.8.5. *Nephrops* in FU19 (SW and SE Ireland). Area estimates of *Nephrops* grounds based on integrated VMS data using ArcGIS10.

FU	Ground	Eckert VI (world) (km²)	Irish National Grid (km²)	Cylindrical Equal Area (km²)	Average(km²)
19	Helvick 1	38.52	38.58	38.58	38.56
19	Helvick 2	31.44	31.48	31.49	31.47
19	Helvick 3	12.65	12.67	12.67	12.66
19	Helvick 1-3	82.61	82.72	82.74	82.69
19	Bantry Bay	90.92	91.08	90.72	90.91
19	Galley Grounds 1	61.81	61.91	61.91	61.88
19	Galley Grounds 2	77.88	77.99	77.99	77.95
19	Galley Grounds 3	202.56	202.85	202.85	202.75
19	Galley Grounds 4	651.79	652.61	652.61	652.33
19	Galley Grounds 1-4	994.04	995.35	995.35	994.91
19	Cork Channels	484.28	484.93	485.02	484.75

Table 7.8.6. *Nephrops* in FU19 (SW and SE Ireland). Percentage area contribution of the various *Nephrops* grounds.

% Area composition of *Nephrops* grounds in FU19		
Ground	Area km²	%
Bantry	90.91	5%
Cork Channels	484.75	29%
Galley Grounds 1	61.88	4%
Galley Grounds 2	77.95	5%
Galley Grounds 3	202.75	12%
Galley Grounds 4	652.33	39%
Helvick 1	38.56	2%
Helvick 2	31.47	2%
Helvick 3	12.66	1%
Total	1653.26	

Table 7.8.7. ***Nephrops*** **in FU19 (SW and SE Ireland). Results summary table for statistical analysis of UWTV survey.**

Year	Ground	Area Surveyed (m²)	Area Estimates (km²)	Burrow count	Mean Density (no./m²)	95%CI	CViid (Relative SE)	Domain Area (Km²)	Raised abundance estimate (million burrows)
2006	Bantry	-	90.91	-	-	-	-	-	
	Cork Channels	-	484.75	-	-	-	-	-	
	Galley Grounds 1	-	61.88	-	-	-	-	-	
	Galley Grounds 2	-	77.95	-	-	-	-	-	
	Galley Grounds 3	-	202.75	-	-	-	-	-	
	Galley Grounds 4	927.53	652.33	293	0.27	0.25	0.36	652.33	175.23
	Helvick 1	-	38.56	-	-	-	-	-	
	Helvick 2	-	31.47	-	-	-	-	-	
	Helvick 3	-	12.66	-	-	-	-	-	
2011	Bantry	740.51	90.91	334	0.43	0.37	0.31	90.91	38.83
	Cork Channels	1,645.84	484.75	768	0.45	0.26	0.26	484.75	218.64
	Galley Grounds 1	386.74	61.88	248	0.67	1.33	0.46	61.88	41.74
	Galley Grounds 2	447.43	77.95	352	0.76	1.40	0.42	77.95	59.62
	Galley Grounds 3	615.26	202.75	472	0.75	0.46	0.19	202.75	152.63
	Galley Grounds 4		652.33					652.33	na
	Helvick 1	436.96	38.56	341	0.78	0.05	0.01	38.56	30.13
	Helvick 2	314.97	31.47	84	0.22	0.89	0.96	31.47	6.78
	Helvick 3	242.76	12.66	18	0.06	0.82	1.00	12.66	0.82
*2011	FU19	4830.46	1,653.26	2616	0.51	0.14	0.13	1653.26	850.13
**2011	FU19								724.42

*2011 Abundance estimate does not include 2006 Galley ground 4

**2011 Abundance estimate includes 2006 Galley Ground 4 estimate

Table 7.8.8. ***Nephrops*** **in FU19 (SW and SE Ireland). Mean weights and mean size from IGFS survey (2003–2011) sampling in FU19.**

Year	Mean Size in catch (CL mm)	Mean Size >25mm (CL mm)	Mean Weight in catch (g)	Mean Weight >25mm (g)	Number of samples	Numbers in samples
2003	31.41	33.16	20.37	24.25	11	1121
2004	25.88	28.17	10.94	14.37	3	562
2005	28.82	30.54	15.46	18.62	5	515
2006	30.28	32.22	18.11	22.09	4	237
2007	32.30	32.30	22.27	22.27	4	91
2008	29.82	30.72	17.25	18.97	15	845
2009	32.31	33.00	22.29	23.85	9	285
2010	28.85	30.27	15.51	18.10	13	1379
2011	29.76	30.71	17.14	18.96	21	4020
Average(03–11)	29.94	31.23	17.70	20.16	9	1006

Table 7.8.9. ***Nephrops*** **in FU19 (SW and SE Ireland).). Forecast inputs (bold) and historical estimates of mean weight in landings and harvest ratio.**

Year	Landings in Number (millions)	Discards in Number (millions)	Removals in Number (millions)	Prop Removals Retained	Adjusted Survey (millions)	Harvest Ratio	Landings (t)	Discards (t)	Mean Weight in landings (gr)
2006	25.1	2.5	27.3	0.92			741	41	29.5
2007	29.9	1.5	31.3	0.96			957	27	32.0
2008	26.6	1.4	27.8	0.96			866	23	32.6
2009	30.1	6.9	36.3	0.83			833	87	27.7
2010	27.3	9.0	35.4	0.77			722	106	26.4
2011	27.4	12.6	38.8	0.71	**557**	7.0%	608	137	22.2
Avg 09–11				**0.77**					**25.42**

Table 7.8.10. ***Nephrops*** **FU19 (SW and SE Ireland). Catch option table for 2013.**

			Implied fishery	
	Harvest rate	Survey Index (millions)	Retained number (millions)	Landings (tonnes)
MSY framework	7.5%	557	32	817,767
F_{2011}	7.0%	557	30	758,519
$F_{0.1\ Combined}$	7.5%	557	32	817,767
$F_{35\%SpR}$	12.1%	557	52	1,319,331
$F_{max\ Combined}$	12.7%	557	54	1,384,752
	0%	557	0	0
	2%	557	9	218,071
	4%	557	17	436,142
	6%	557	26	654,214
	8%	557	34	872,285
	10%	557	43	1,090,356
	12%	557	51	1,308,427
				Basis
Landings Mean Weight (Kg)		25.42		Sampling 2009–2011
Survey Overestimate Bias		1.30		WKNEPH 2009
Survey Numbers (Millions)*		724		UWTV Survey 2011
Prop. Retained by the Fishery		0.77		Sampling 2009–2011

Table 7.8.11. *Nephrops* in VII summary table of landings by Function Unit and outside FU for TAC Area VII.

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	Fus 20+21+22 - All Celtic Sea FUs combined	Other statistical rectangles Outside FUs	Total Landings ICES Subarea VII	TAC for VII
1978	961	7296	1744	481				249	10 730	
1979	900	8948	2,69	452				237	12 807	
1980	730	4578	2925	442				205	8880	
1981	829	7249	3381	414				382	12 255	
1982	869	9315	4289	210				234	14 917	
1983	763	9448	3426	131			3667	174	17 609	
1984	602	7760	3571	324			3653	187	16 097	
1985	498	6901	3919	207			3599	194	15 317	
1986	671	9978	2591	147			2638	113	16 138	
1987	449	9753	2499	62			3409	107	16 279	24 700
1988	462	8586	2375	828			3165	140	15 557	24 700
1989	401	8128	2115	344		899	4005	134	16 026	26 000
1990	563	8300	1895	519		754	4290	102	16 423	26 000
1991	747	9554	1640	410		1077	3295	169	16 892	26 000
1992	427	7541	2015	372		888	4165	409	15 816	20 000
1993	515	8102	1857	372	10	905	4648	455	16 863	20 000
1994	447	7606	2512	729	126	390	5143	570	17 523	20 000
1995	584	7796	2936	866	26	695	5,505	397	18 805	23 000
1996	475	7247	2230	525	46	888	4828	623	16 862	23 000
1997	566	9971	2409	841	15	756	4240	340	19 138	23 000
1998	388	9128	2155	1410	78	827	3925	514	18 426	23 000
1999	624	10 786	2289	1140	16	579	2943	322	18 699	23 000
2000	567	8370	911	880	9	696	4689	243	16 365	21 000
2001	532	7441	1222	913	2	815	4771	368	16 064	18 900
2002	577	6793	1327	1154	14	1318	4673	243	16 099	17 790
2003	376	7052	907	933	16	1239	5002	186	15 712	17 790
2004	472	7266	1525	525	22	1074	4268	161	15 314	17 450
2005	570	6529	2312	778	15	711	4946	180	16 042	19 544
2006	628	7535	2120	637	14	741	4264	270	16 210	21 498
2007	959	8424	2186	1096	3	957	5300	206	19 130	25 153
2008	726	10 482	1000	1057	1	841	6001	322	20 430	25 153
2009	693	9166	825	625	10	833	5359	107	17 619	24 650
2010	583	8929	917	1000	7	722	4622	359	16 602	22 432
2011	561	10159	1187	600	13	608	2854	109	16091	21,759
Average	611	8241	2191	631	24	846	4322	270	16 171	

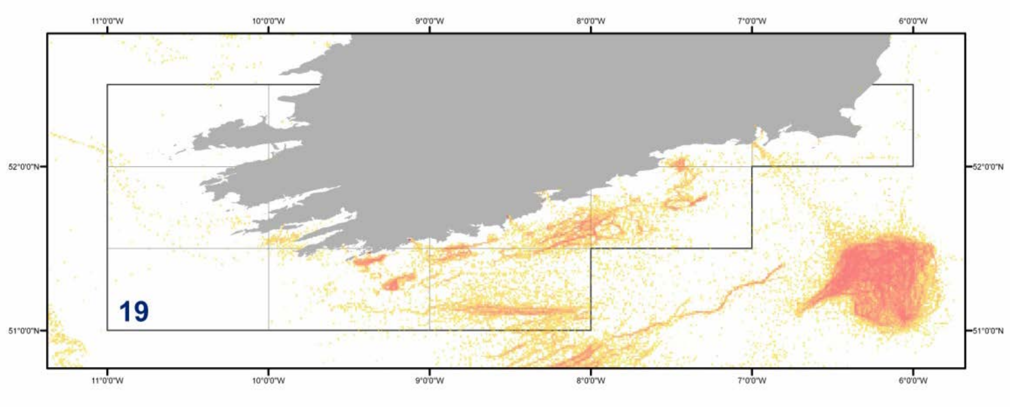

Figure 7.8.1. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). The spatial distribution of the fishery of the Irish Fishery from VMS data (2005–2008).**

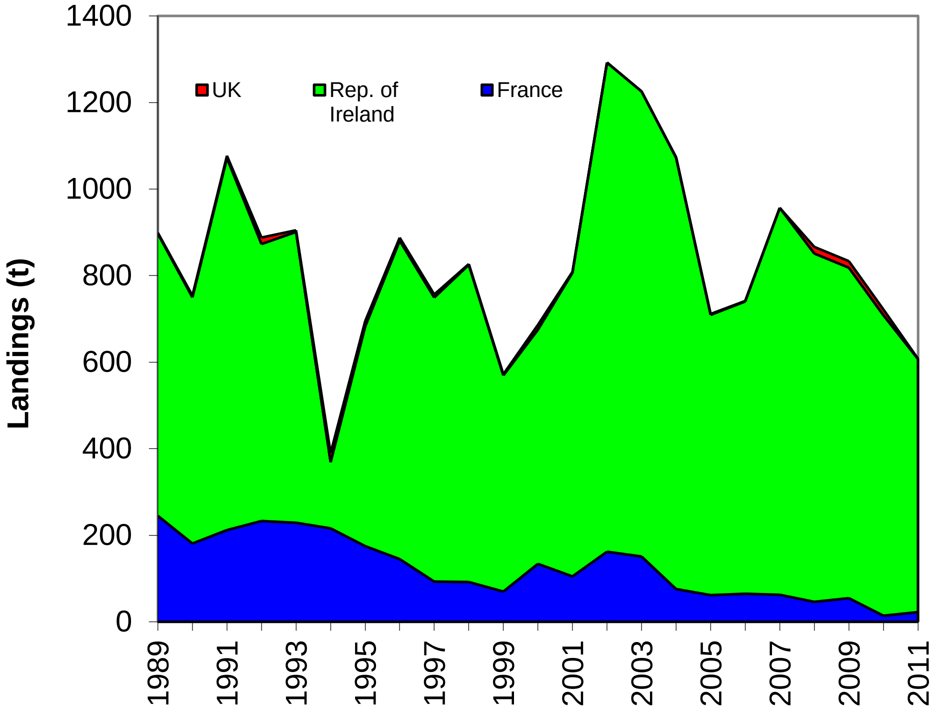

Figure 7.8.2. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Landings in tonnes by country.**

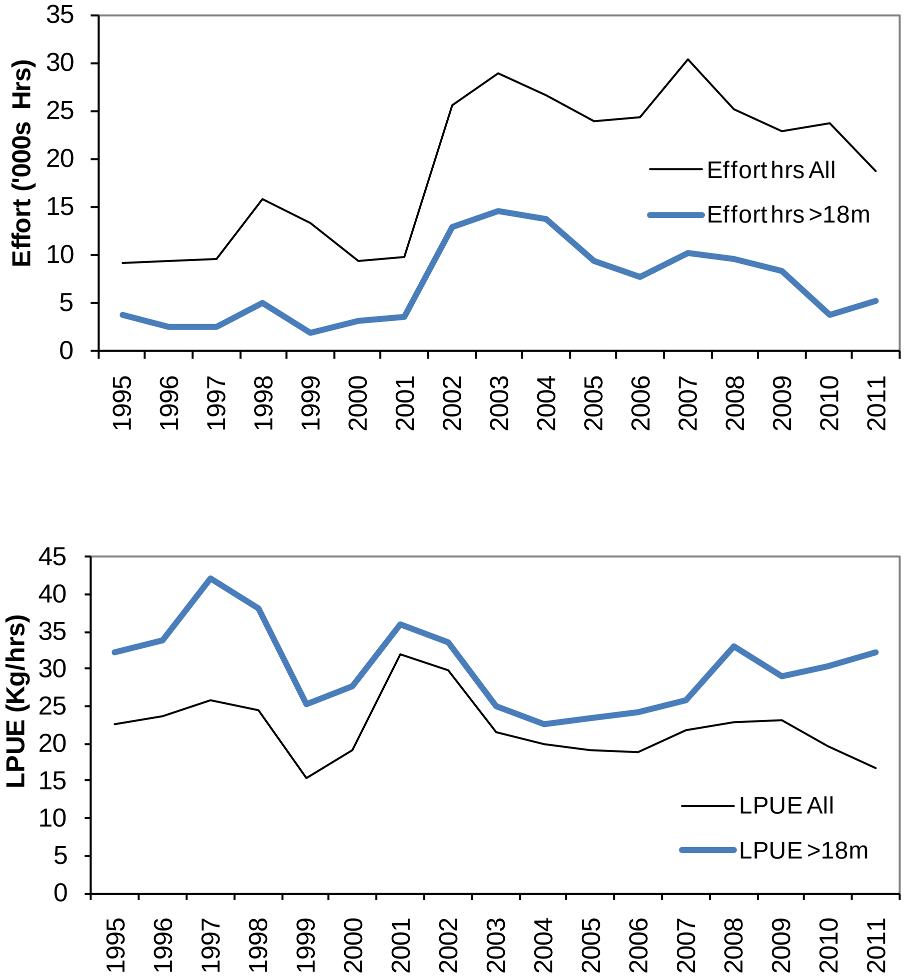

Figure 7.8.3. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Trawl effort for Irish OTB vessels where >30% of landed weight was** ***Nephrops*****.**

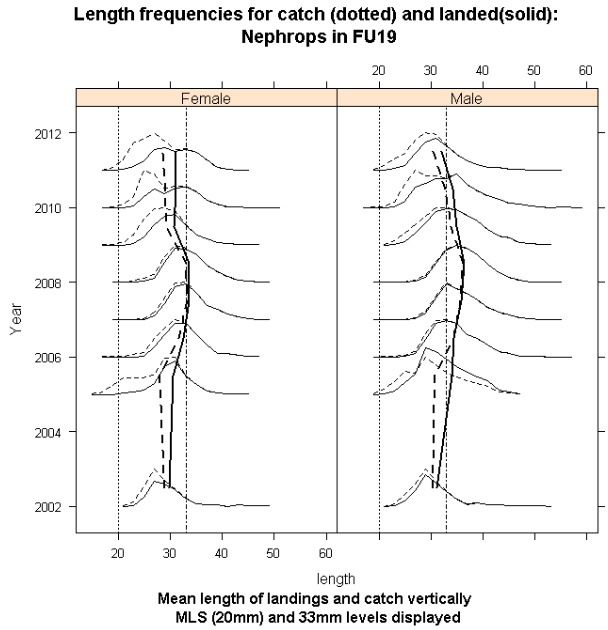

Figure 7.8.4. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean size trends for catches and whole landings by sex 2002–2011.**

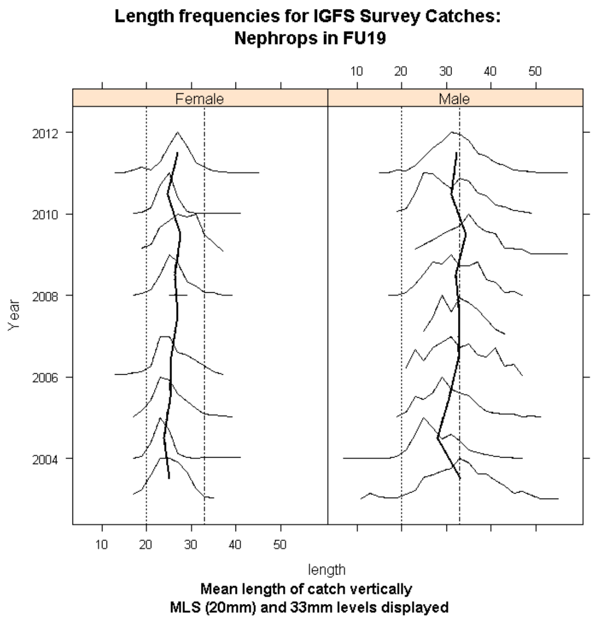

Figure 7.8.5. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean size trends for catches by sex from Irish Groundfish Survey 2003–2011.**

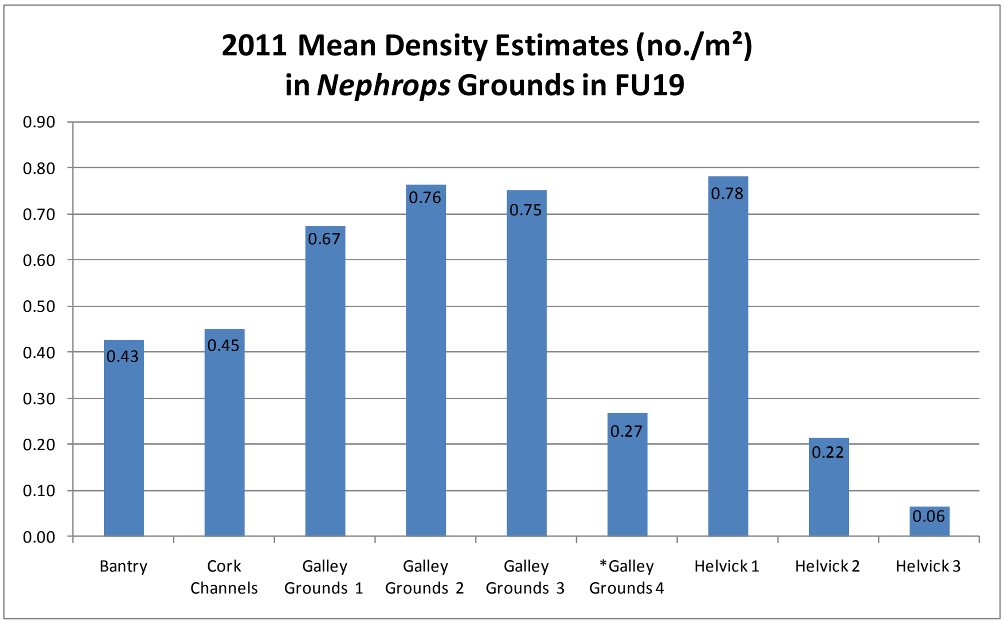

Figure 7.8.6. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). 2011 Mean density estimates for the various** ***Nephrops*** **grounds in FU19. * Galley ground 4 estimate is from 2006 TV survey.**

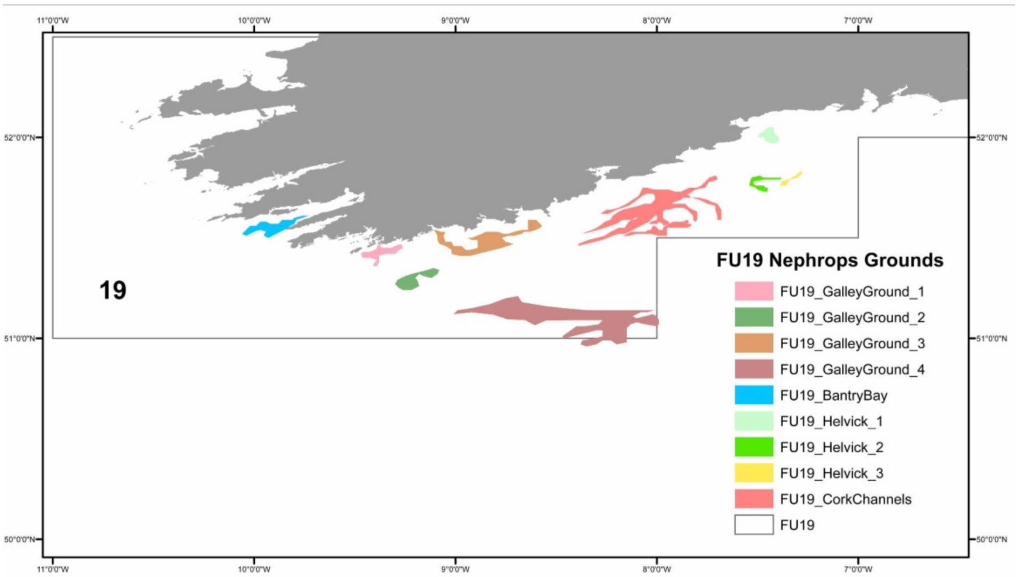

Figure 7.8.7. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Discrete** ***Nephrops*** **grounds in FU19.**

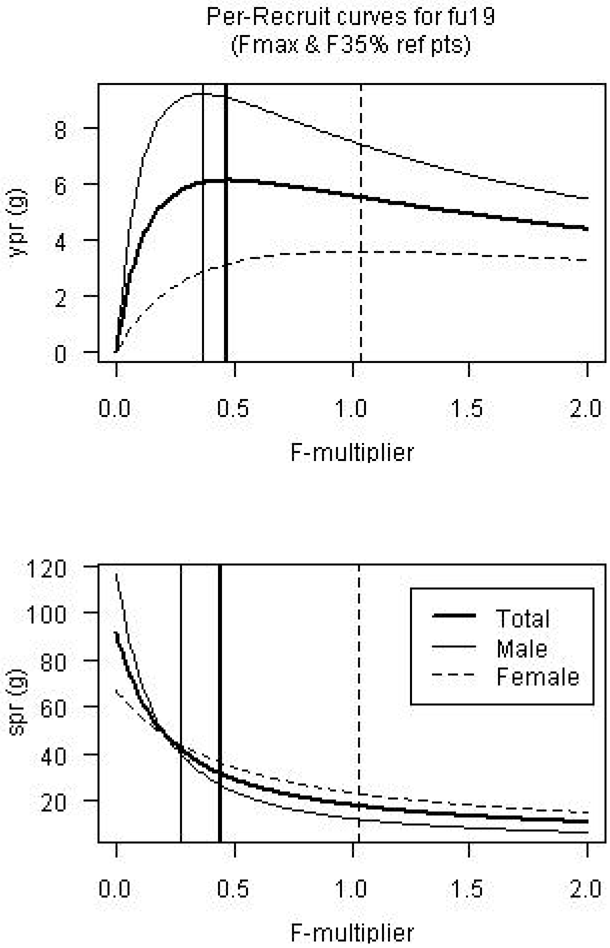

Figure 7.8.8. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Separable Cohort Analysis model fit. Solid lines are for males, dashed lines are females. The top panel gives the yield-per-recruit against fishing mortality, the thick solid line gives the combined value and vertical lines represent F_{max} for the three curves. The bottom panel gives the spawner per recruit against fishing mortality.**

7.9 Plaice in West of Ireland Division VII b, c

Type of assessment in 2012

No assessment was performed.

7.9.1 General

Stock Identity

Plaice in VIIb are mainly caught by Irish vessels on sandy grounds in coastal areas. Plaice catches in VIIc are negligible. There are two distinct areas in which plaice are caught by Irish vessels in VIIb: an area to the west of the Aran Islands and an area in the north of VIIb which extends into VIa (the Stags and Broadhaven Ground). During 1995–2000 a large proportion of the VIIbc 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 VIa. 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 nominal landings are given in Table 7.9.1.

7.9.3 Historical stock development

No analytical assessment was performed but following recommendations from WGLIFE a Depletion-Corrected Average Catch (DCAC; MacCall, 2009) analysis was performed. Because the value of the depletion delta parameter is unknown, a range of values were used (10%, 50% and 90%; delta is the difference in biomass in the first year and biomass in the last year as a proportion of the virgin biomass (unfished vulnerable abundance). Also, because average catch is analysed, the year-range chosen can have a large influence on the results. Two year ranges were tested: 1950–present (the time period after WWII when the stock was heavily exploited) and 1995–present (the time period when the landings showed a declining trend). All other settings are based on default values and recommendations from MacCall (2009). Table 7.9.2 shows the input and output values. The year-range has a major influence on the estimated depletion-corrected average catch.

The most conservative estimate of DCAC (27.9 tonnes) is around the same level as recent landings. But landings have been much higher for many years over the full time-series since 1908 (Table 7.9.1).

7.9.4 Reference

MacCall, AD. 2009. Depletion-corrected average catch: a simple formula fro estimating sustainable yields in data-poor situations. ICES J Mar Sci 66:10 p. 2267–2271.

Table 7.9.1. Landings of plaice in VIIbc 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	1961	0	182	0	30	0	212		
1909	0	0	0	49	0	49	1962	0	239	0	42	0	281		
1910	0	0	0	36	0	36	1963	0	471	2	67	0	540		
1911	0	0	2	54	0	56	1964	0	427	2	66	0	495		
1912	0	0	1	40	0	41	1965	0	417	2	99	0	518		
1913	0	0	0	54	0	54	1966	0	0	1	127	0	128		
1914	0	0	0	85	0	85	1967	0	182	2	112	0	296		
1915	0	0	1	23	0	24	1968	0	403	0	89	0	492		
1916	0	0	0	22	0	22	1969	0	281	2	99	0	382		
1917	0	0	0	36	0	36	1970	0	124	0	110	0	234		
1918	0	0	0	29	0	29	1971	0	0	1	89	0	90		
1919	0	0	1	32	0	33	1972	0	110	0	124	0	234		
1920	0	0	25	15	0	40	1973	0	60	1	124	0	185		
1921	0	0	9	34	0	43	1974	0	45	1	106	0	152		
1922	0	0	1	37	0	38	1975	0	10	0	153	0	163		
1923	0	0	1	30	0	31	1976	0	9	0	133	0	142		
1924	0	0	4	166	0	170	1977	0	4	0	135	0	139		
1925	0	0	5	28	0	33	1978	0	16	0	122	0	138		
1926	0	13	10	42	0	65	1979	0	6	0	117	2	125		
1927	0	126	14	45	0	185	1980	0	12	0	142	65	219		
1928	0	40	7	35	0	82	1981	0	9	4	135	58	206		
1929	0	262	25	31	0	318	1982	0	8	4	122	22	156		
1930	0	96	6	44	0	146	1983	0	37	0	108	7	152		
1931	0	238	8	58	0	304	1984	0	2	6	110	0	118		
1932	0	411	19	76	0	506	1985	0	10	7	150	0	167		
1933	0	595	29	29	0	653	1986	0	11	5	114	0	130		
1934	0	406	31	33	0	470	1987	0	13	1	153	0	167		
1935	0	249	18	33	0	300	1988	0	9	2	157	0	168		
1936	0	265	47	37	0	349	1989	0	1	14	159	0	174		
1937	0	242	59	25	0	326	1990	0	11	92	130	0	233		
1938	0	359	25	20	0	404	1991	0	9	3	179	0	191		
1939	0	0	0	24	0	24	1992	0	3	9	180	0	192		
1940	0	0	0	47	0	47	1993	0	2	3	191	0	196		
1941	0	0	0	43	0	43	1994	0	1	5	200	0	206		
1942	0	0	0	41	0	41	1995	0	5	2	239	0	246		
1943	0	0	0	29	0	29	1996	0	1	2	248	0	251	-11	240
1944	0	0	0	42	0	42	1997	0	3	0	206	0	209	4	213
1945	0	0	0	30	0	30	1998	0	0	1	160	0	161	22	183
1946	0	0	5	32	0	37	1999	0	0	2	157	0	159	13	172
1947	5	0	9	36	0	50	2000	0	31	0	99	0	130	-22	108
1948	0	0	8	47	0	55	2001	0	8	0	70	0	78	9	87
1949	0	0	20	63	0	83	2002	0	17	2	51	0	70	1	71
1950	0	289	16	42	0	347	2003	0	7	0	56	2	65	7	72
1951	0	100	12	31	0	143	2004	0	14	0	39	1	54	1	55
1952	0	120	18	46	0	184	2005	0	12	0	25	0	37	1	38
1953	0	340	8	48	0	396	2006	0	11	0	20	1	32	-2	30
1954	0	273	5	72	0	350	2007	0	12	0	23	0	35	-1	34
1955	0	111	3	96	0	210	2008	0	9	0	21	1	31	4	35
1956	0	174	1	64	0	239	2009	0	7	0	45	0	52	1	53

Year	BEL	FRA	UK	IRL	OTH	TOT	Year	BEL	FRA	UK	IRL	OTH	TOT	Unalloc	WG est
1957	0	80	1	60	0	141	2010	0	6	0	27	0	33	0	33
1958	0	204	0	71	0	275	2011	0	2	0	16	0	18	-2	16
1959	0	392	5	54	0	451									
1960	0	197	3	46	0	246									

Table 7.9.2. Settings and results from DCAC.

Year range	sumCatch (landings)	CV	Nyears	M	StDev	Fmsy/M	StDev[1]	Bmsy/B0	StDev[2]	Delta	StDev[2]	Avg Catch	Avg DCAC
1950–2011	12264	0.2	62	0.12	0.5	0.8	0.2	0.25	0.1	0.1	0.1	197.8	181.4
1950–2011	12264	0.2	62	0.12	0.5	0.8	0.2	0.25	0.1	0.5	0.1	197.8	136.3
1950–2011	12264	0.2	62	0.12	0.5	0.8	0.2	0.25	0.1	0.9	0.1	197.8	111.5
1995–2011	1661	0.2	17	0.12	0.5	0.8	0.2	0.25	0.1	0.1	0.1	97.7	76.8
1995–2011	1661	0.2	17	0.12	0.5	0.8	0.2	0.25	0.1	0.5	0.1	97.7	40
1995–2011	1661	0.2	17	0.12	0.5	0.8	0.2	0.25	0.1	0.9	0.1	97.7	27.9

[1] **Assuming lognormal distribution.**

[2] **Assuming bounded (1-0) beta distribution.**

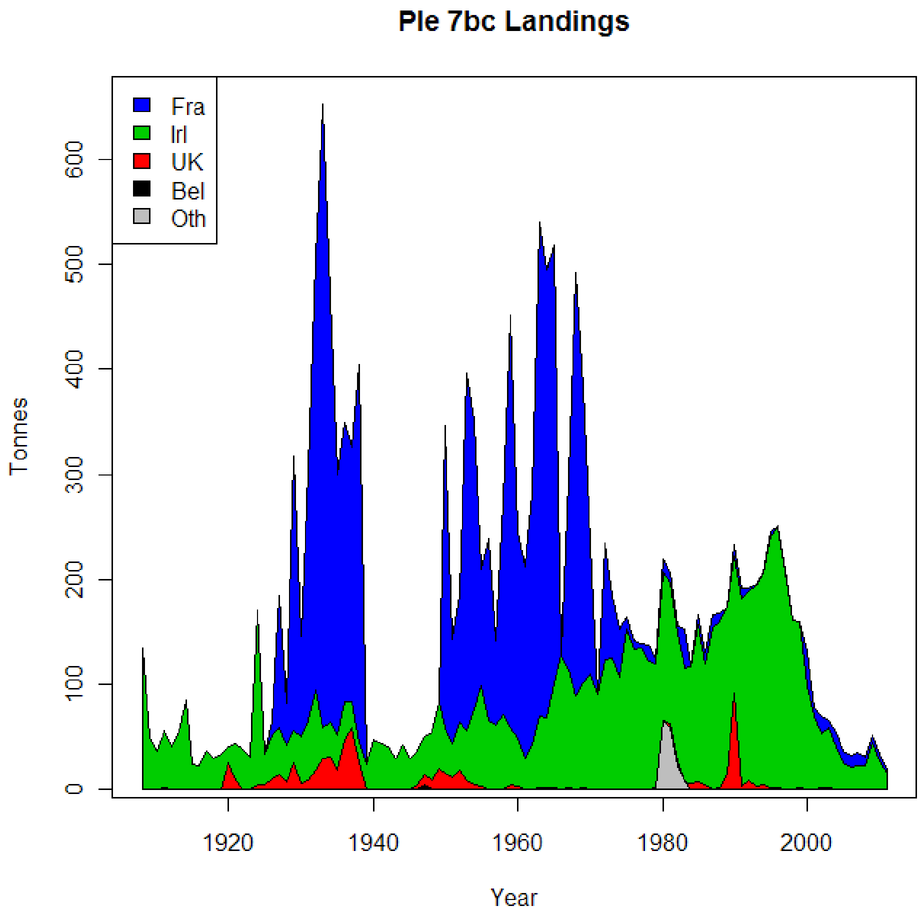

Figure 7.9.1. Landings of plaice in VIIbc as officially reported to ICES.

7.10 Plaice in Divisions VIIf,g (Celtic Sea)

Type of assessment in 2011

Update of the analytic assessment used to derive relative trends (due to the short time-series of discard data) fitted by the ICES WKFLAT (2011) benchmark meeting to a revised assessment data structure which includes estimates of discards-at-age. The model was fitted at WGCSE 2011.

ICES advice applicable to 2012

No reliable forecast can be presented for this stock because the assessment is only indicative of trends and the absolute level of stock size is uncertain.

The stock is considered to be below any possible reference points, while the exploitation rate is deemed too high to improve this and thus above possible reference points. Therefore, catches of plaice should be reduced and measures to reduce discards should be introduced.

ICES advice applicable to 2011

*Following the transition scheme towards the ICES MSY framework implies fishing mortality to be reduced to ((0.8*0.44)+(0.2*0.19*0.25)) = 0.38, resulting in landings of less than 500 t in 2011. This is expected to lead to an SSB of 1500 t in 2012.*

7.10.1 General

Stock description and management units

A TAC is allocated to ICES areas VIIf&g which corresponds to the stock area.

Management applicable to 2011 and 2012

TACs and quotas set for 2011 (source Council Regulation (EU) No 57/2011).

Species: Plaice *Pleuronectes platessa,* Zone: VIIf and VIIg (PLE/7FG.)

Belgium	56
France	101
Ireland	200
United Kingdom	53
Total EU	410
Total TAC	410

TACs and quotas set for 2012 (source Council Regulation (EU) No 43/2012)

Species: Plaice *Pleuronectes platessa,* Zone: VIIf and VIIg (PLE/7FG.)

Belgium	46
France	83
Ireland	197
United Kingdom	43
Total EU	369
Total TAC	369

Fishery in 2011

The main fishery is concentrated on the Trevose Head ground off the north Cornwall coast and around Land's End. Although plaice are taken throughout the year, heaviest landings are in March, after the peak of spawning, with a second peak in September. The fisheries taking plaice in the Celtic Sea mainly involve vessels from Belgium, France, England and Wales. In 2010 France reported 31% of the landings, Belgium 43%, the UK 12% and Ireland 14%. In 2011 France reported 23% of the landings, Belgium 50%, the UK 11% and Ireland 16%. The WG estimated total international landings for 2011 were 421 t, just above the TAC of 410 t.

Discards are a significant component of the catch and have been raised for the international fishery for the second time in this year's assessment of the stock status; the time series is available from 2004–2011. The data for the years 2004–2010 was revised this year following the submission of revised data from the UK. In recent years the proportion that discards contribute to the total catch has been increasing and since 2006 they have exceeded the landings.

7.10.2 Data

Landings

National landings data and estimates of total landings 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 was raised and collated to the total international level for first time, a process that will be 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). 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 total international discard numbers-at-age estimates. 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 combined, raised, 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 the previously lower levels; until 2011 when at 1107 t they again were more than double the landings. Data from 2011 national discard sampling programmes are summarized in Figures 7.10.3a and b.

Biological information

Following minor revisions to discard data for previous years, the international age compositions and landings and discard weights-at-age have been amended.

Quarterly age compositions for 2011 were available for Belgium, Ireland and UK(E+W), representing approximately 50% of the total landings. Methods for the derivation of international catch numbers-at-age are fully described in the Stock Annex.

International landings and discard numbers-at-age in years for which both are available (2004–2011) are compared in Figure 7.10.4; in recent years discards considerably exceeds landing numbers at the majority of ages.

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. Raw data back to 1995 was obtained by WKFLAT (2011) and used to update the catch weights and stock weights files (Table 7.10.6).

Discard weight-at-age

Discard weight-at-age raw data was available for Belgium and UK(E+W). UK weight-at-age data was derived from data collated for each year from 2002. Belgian weight-at-age data was derived using estimates of total catch biomass and total numbers-at-age from 2004 onwards. The two 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 two countries for each year and age (Table 7.10.8).

Stock weight-at-age

For the years from 2004 for which discard estimates are available, 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. For the years prior to 2004, a revised set of stock weights-at-age data based on the international landings only was produced. These new values were based on the 'observed' weight data, but were SOP corrected (Table 7.10.9).

Landings and discard numbers- and weights-at-age in the landings, discards and stock as used for the assessment are given 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 1. This affected one discard age and age 1 for the landings. Sensitivity to the value used will be explored as the model is developed.

Natural mortality and maturity

The estimates of natural mortality (0.12 yr all years and all ages, from tagging studies) is based on the value estimated for Irish Sea plaice. The maturity ogive is based on UK(E&W) VIIfg survey data for March 1993 and March 1994 (Pawson and Harley, 1997) was produced in 1997 and is 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 VIIf and the Irish Celtic Explorer IBTS survey (IGFS-WIBTS-Q4) are presented in Table 7.10.10. The UK(E&W) data indicate relatively strong 1994 and 1999 year classes. There is an indication stronger recent year classes entering the fishery but survey data at this age tend to be noisy. IGFS suggests that 2008, 2009 and 2010 are all strong year classes, BTS suggests that the 2008 and 2009 are strong but not 2010.

The Celtic Explorer IBTS survey series started in 2003 and is not yet included in the assessment. 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 (Figure 7.10.5). The survey was not fitted within the assessment model, but will be monitored for inclusion as the time-series progresses.

Figure 7.10.6 presents the log UK (BTS-Q3) 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 recent years.

Commercial lpue

Commercial tuning indices of abundance from the UK(E&W) beam trawl and otter trawl data are presented in Table 7.10.11. Figure 7.10.7 presents the log commercial lpue 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 illustrates the historical consistency of year-class estimates from the commercial data throughout the time-series for the beam trawls with more noise resulting from two major year effects in the otter trawl data.

Effort and lpue data were available for the UK(E+W) beam trawl, UK(E&W) otter trawl, Irish otter trawl, beam trawl and seine fleets, Belgian beam trawl and the UK September beam trawl survey (Tables 7.10.2, 7.10.3, 7.10.4 and Figures 7.10.1, 7.10.2). Commercial lpue data show 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 relatively small and short-term increases for beam trawlers fishing in VIIf and for otter trawlers and Irish seine vessels in VIIg east. Overall the lpue rates remain at low values compared to historic catch rates.

UK(E&W) beam trawl effort levels have declined in both VIIf and VIIg from the high levels observed in 1999–2001, since 2008 they have remained stable. UK(E&W) otter trawl effort levels for VIIf and VIIg have shown a general decline since 1990, increased in VIIf after 2000 and have been relatively stable since 2003.

Irish otter trawl effort has steadily increased since 1999, while beam trawl show a less pronounced increase over the time-series prior to 2008, with a decrease in 2008 and 2009; the Irish seine fleet shows only a weak downward since 2003.

Other relevant data

Other than the rectangle closures, there were no early closures of the fishery for plaice in 2011. There is relatively little information on the level of landings misreporting on this stock, although it is not considered to be a problem. Reports from industry suggest that the main issues affecting the fishery in VIIf&g are displacement of effort due to the rectangle closures and the restrictions on the use of 80 mm mesh west of 7°W.

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.

Comparative model runs

For each of the three models (TI_PTVS, TI_TVS and TV_PTVS), Figures 7.10.8–7.10.10a present the estimated time-series of SSB, recruitment, fishing mortality, total discard and landings weight and the proportion of discards by weight.

The text table below compares the log likelihood, the significance, number of observations and the Akaike Information Criteria (AICs) of the fit.

Selection	Discards	– log.likelihood	AIC	N_param	N_obs
TI	PTVS	217.16	616.32	91	520
TI	TVS	217.51	609.04	87	520
TV	PTVS	212.43	614.86	95	520

Consistent with the WKFLAT and WGCSE 2011 runs and, as would be expected from the similar log likelihood values, the models all have very similar fits in terms of the residual patterns in the fits to the data. All of the model fits indicate mostly negative residuals at oldest survey ages in the earliest part of the time-series and positive residuals in the most recent years. There is no information that allows selection between them.

None of the models fit the large increase in the discard data in 2007 well; producing a very strong year effect in the discard residuals in that year and negative year effects in the adjacent years. This strong increase in discards was observed for a number of fleets and is therefore considered to be a real effect; modelling a smooth transitions in the discard selection does not match the observed discard pattern in 2007 but does seem applicable to the other years which have treasonable fits.

All of the models follow the strong increase in discards in 2011 (3x the landings), resulting in a substantial increase in fishing mortality in the final year. Fishing mortality will be considerably over estimated, if the increase results from discard sampling noise. There are no indications for the data of a strong year classes that could have resulted in strongly increased discarding at the oldest ages no increase in fleet effort. Consequently there is considerable uncertainty associated with the increased mortality rate.

The fit to the landings-at-age data is reasonable apart from the first age, which is poor for all models.

Comparison of the management and stock metrics from the three model fits show very similar time-series trends and absolute values in the estimates from the three models (Figure 7.10.11), estimates from the TI models in which historic selection patterns for the landings are time invariant lie within the confidence intervals of the preferred TV_PTVS model. In all model fits SSB has increased to the level at the start of the assessment time-series. Total fishing mortality was estimated to be gradually decreasing by the 2010 model fit; in the current fit fishing mortality is estimated to be increasing strongly as a result of the high level of estimated discards on 2011. Figure 7.10.12 compares the model estimates from the 2011 and 2012 model fits, spawning biomass, recruitment, landings and discards are relatively stable between model fits with some variation in the historic hindcast. Fishing mortality estimates in the most recent years have been revised strongly upwards in the most recent years and are heavily dependent on the most recent discard estimates.

Final assessment

The settings and data for the model fits are set out in the table below:

Assessment year		2012
Assessment model		AP
Catch data		Including discards 1990–2011
Tuning fleets	UK(E&W)-BTSurvey	1990–2011 ages 1–5
	UK commercial beam trawl	1990–2011 ages 4–8
	UK commercial otter trawl	1990–2011 ages 4–8
	Ire GFS Q3/4	Series omitted
Selectivity model		Linear Time Varying Spline at age (TV)
Discard fraction		Polynomial Time Varying Spline at age (PTVS)
Landings num-at-age, range:		1–9+
Discards num-at-age, year range, age range		2004–2011, 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 in (a); the estimated relative selection pattern (b), the log residuals for the discard-at-age data (c), the log survey (d) and commercial fleet catchability residuals (e and f) and the log residuals for the landings and discards-at-age data (f).

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.

On the relative scale SSB is estimated to have increased to the level of the start of the assessment time-series. Total fishing mortality which was last year estimated to be gradually decreasing is estimated using the 2011 data to have increased strongly as a result of the substantial increase in the number of discards. 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 VIIfg (~74% by weight). There are indications from the assessment model that the most recent recruitment is strong, possibly the strongest in the short time-series, however there is no indication of this within the survey data which indicates a high but not very abundant year class.

7.10.4 Short-term projections

No short-term projections are presented for this stock. Catches are dominated by discards which will increase if the incoming recruitment is as substantial as indicated by surveys and the assessment fit.

7.10.5 Maximum sustainable yield evaluation

On the basis of the revision of the assessment data structures and model no MSY reference points are recommended for this stock they will be developed when the assessment model is developed further.

7.10.6 Precautionary approach reference points

On the basis of the revision of the assessment data structures and 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 the landed catch for recent years are considered to be sufficient to support current assessment approaches, and associated CVs of some national catch-at-age datasets are available in the Stock Annex. The sampling levels for those countries supplying information are given in table Section 2.1.2.

Discards

Estimates of discarding are now included in this assessment. The composition of the fleets and therefore the gear types employed in the fishery show fluctuations over time, so it is likely that the discard rates observed in the fishery now are not applicable to periods earlier in the time-series and this is incorporated within the assessment model estimation. From 2003 onwards, discard sampling for Ireland, Belgium, France and UK(E&W) has been improved under the Data Collection Regulation; however only discard data from the UK and Belgium was available in a suitable form for the raising of the data to the international level. These countries only contributed just over half the catch, therefore discard estimates are expected to be quite uncertain.

Consistency

Historically the plaice in VIIfg assessment suffered from a retrospective pattern in estimated SSB, fishing mortality and recruitment, which was considered to result from the lack of discard information in the assessment. Figure 7.10.12 compares the model estimates from the 2011 and 2012 model fits, spawning biomass, recruitment, landings and discards are relatively stable between model fits with some variation in the historic hindcast. Fishing mortality estimates in the most recent years have been revised strongly upwards in the most recent years and are heavily dependent on the most recent discard estimates which exhibited a strong increase in 2011 in the otter and beam trawl data at the older ages. Figure 7.10.13 presents a comparison between the new assessment model estimates and the longer time-series from the previous XSA based assessment (without discards). Including discards raises the level of recruitment and fishing mortality as the 3–6 age range covers discarded ages. Spawning biomass levels in the recent years are comparable with those of the XSA assessment but historically there is a surprising difference with the AP model estimating considerably lower biomass than the previous assessment based on the landings data only; clearly this will need further investigation.

Misreporting

Misreporting has been considered a potential problem for this stock in earlier years. However, misreporting of catches across ICES divisions is thought to be minor.

7.10.9 Management considerations

Based on the historic assessment (Figure 7.10.13) the SSB of this stock is estimated to have been low since ~2000. The new assessment fit does not have the length of time-series from which to provide a historic comparison but the decrease in biomass through the time-series for which data is available is supported by the reduction in the catch rates from the survey and the commercial fleets. SSB has recently increased following a gradual reduction in total fishing mortality in recent years. Fishing mortality is estimated to be increasing by the most recent assessment and is likely to be well above the levels that would lead to high levels of biomass and yield. This is corroborated by the catch rates by commercial vessels and the survey which are all low compared to historic rates.

The high level of discarding in this fishery was taken to be indicative that there is a mismatch between the mesh size employed in the fishery and the size of the fish being landed on the market. Increases in the mesh size of the gear should result in lower fishing mortality levels, fewer discards and ultimately, in increased yield from the fishery. The results of studies presented to the 2004 WG (ICES, 2004) indicate that this would also benefit the sole VIIf,g stock without decreasing sole landings in the long term. More recently discarding is occurring at increasing older ages suggesting other market incentives are impacting on fishers' behaviour.

Regulations and their effects

Technical measures in force for this stock are minimum mesh sizes, minimum landing size, and restricted areas for certain classes of vessels. Technical regulations regarding allowable mesh sizes for specific target species, and associated minimum landing sizes, came into force on 1 January 2000 (Section 2.1). The minimum landing size for plaice in Divisions VIIf,g is currently 27 cm.

Since 2005, ICES rectangles 30E4, 31E4, and 32E3 have been closed during the first quarter with the intention of reducing fishing mortality on cod. There is evidence that this closure has redistributed effort to other areas. Many vessels (particularly beam trawlers from the UK and Belgium) fished close to the borders of the closed rectangles during the closure, and fished intensively inside the rectangles when they were reopened. Information from the UK shows that plaice can be caught in areas outside of the closed area with the same catch rates. Fishing mortality has decreased since 2005, and the closure may have been one of the contributing factors.

Table 7.10.1. Plaice in Divisions VIIf&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**					
Belgium	194	187	216	188	210					
UK (Engl. & Wales)	61	63	55	54	45					
France	104	62	N/A	136	98					
Ireland	58	63	63	63	67					
Total reported	417	375	N/A	442	420					
Discards	1288	583	608	670	1107					
Unallocated	-7	62	N/A	-9	1					
Landings used by WG	410	437	463	433	421					
Catch as used by WG	1698	1020	1071	1103	1528					

Table 7.10.2. Plaice in Divisions VIIf&g : lpue for UK(E&W) fleets.

	LANDINGS PER UNIT EFFORT (LPUE)						LANDINGS/EFFORT DATA				ADDITIONAL EFFORT DATA			
	RECT. GROUP		RECT. GROUP		RECT. GROUP		RECT GROUP VIIf (grp1)				VIIg (East)		VIIg (West)	
	VIIf (grp 1)		VIIg EAST (grp 2)		VIIg WEST (grp 3)		otter trawl catch		Beam trawl catch		Otter	Beam	Otter	Beam
	TRAWL	BEAM	TRAWL	BEAM	TRAWL	BEAM		000s		000s	000s	000s	000s	000s
YEAR		TRAWL		TRAWL		TRAWL	tonnes	hr fished	tonnes	hr fished	hr fished	hr fished	hr fished	hr fished
1972	7.70		4.97		1.15		361.82	45.72			6.01		0.74	
1973	7.54		2.75		34.92		353.95	45.28			3.59		0.05	
1974	4.99		1.22		0.00		198.12	38.94			2.03		0.00	
1975	4.88		4.07		0.75		173.01	33.53			10.35		0.04	
1976	4.54		2.70		2.13		112.09	25.61			5.21		0.04	
1977	4.06		1.76		0.00		102.81	27.16			5.36		0.04	
1978	4.19	3.06	2.24	0.00	0.00	0.00	117.74	27.08	7.58	2.50	6.73	0.00	0.00	0.00
1979	5.31	3.62	3.34	2.19	0.00	0.00	125.81	23.84	6.30	1.96	4.54	0.13	0.00	0.00
1980	5.91	4.27	4.03	7.15	2.46	0.00	162.29	26.43	17.65	4.31	2.67	0.10	0.60	0.00
1981	5.36	3.50	3.20	3.13	1.05	5.23	126.27	24.10	23.72	6.24	7.78	0.78	4.78	0.10
1982	4.82	5.10	1.14	6.73	0.06	5.57	92.65	19.20	55.42	9.95	7.50	1.86	2.56	0.58
1983	6.05	3.92	2.66	5.24	0.00	4.88	108.76	17.61	47.72	12.35	5.33	6.82	0.00	0.80
1984	6.15	6.41	4.90	7.49	0.00	4.14	160.64	23.16	99.01	13.55	4.35	4.31	0.00	2.06
1985	6.98	6.38	5.09	8.05	2.61	7.10	188.06	25.24	146.73	18.69	5.72	5.14	0.57	1.41
1986	6.62	5.22	4.28	10.62	1.44	11.31	142.84	21.18	90.44	20.72	7.72	4.31	0.82	0.68
1987	6.60	4.32	6.46	10.79	0.86	10.66	199.03	24.43	145.37	38.76	9.87	4.83	0.83	0.92
1988	10.04	8.53	7.32	9.95	1.97	14.42	205.56	20.09	204.58	25.62	9.96	2.18	0.43	0.88
1989	7.40	5.63	6.36	9.67	4.35	16.42	130.67	17.61	96.05	20.26	8.13	3.72	0.25	0.26
1990	4.16	3.93	2.43	6.80	2.70	5.34	97.82	22.56	157.15	30.77	10.55	4.89	0.45	4.32
1991	2.87	3.58	2.22	2.83	1.17	2.94	56.52	18.57	193.27	40.81	6.25	12.39	0.91	2.52
1992	2.78	2.26	2.32	2.54	1.68	2.08	44.82	16.00	91.34	35.78	5.22	16.61	8.42	2.59
1993	2.72	2.84	1.43	2.28	1.77	1.41	38.14	13.79	107.43	39.64	4.43	18.44	0.94	2.73
1994	2.71	2.47	2.18	3.07	0.83	4.14	23.36	9.48	84.97	37.03	3.03	9.48	0.24	1.94
1995	2.93	2.66	2.23	3.34	3.35	2.22	26.38	8.46	96.28	37.59	2.61	11.60	0.46	2.16
1996	2.63	2.05	1.91	1.84	0.38	0.77	23.60	8.67	81.18	39.78	4.60	8.70	1.68	3.91
1997	2.41	1.90	1.89	2.33	1.30	0.48	20.47	8.14	83.68	43.00	5.18	12.67	1.90	2.56
1998	1.59	1.54	1.24	0.93	0.33	0.69	10.94	7.13	85.06	47.84	5.09	10.45	1.55	2.81
1999	2.59	1.63	1.99	0.67	0.35	0.68	11.99	5.69	85.44	50.87	1.97	26.00	3.86	5.47
2000	2.29	1.00	3.10	0.68	0.19	0.60	10.98	4.05	53.46	51.19	2.56	17.53	2.34	3.36
2001	2.25	1.07	2.53	0.87	0.32	0.68	9.78	4.42	53.31	49.32	2.71	19.95	2.68	1.55
2002	1.31	1.14	3.70	1.49	0.54	0.27	6.81	6.10	37.93	37.53	1.54	6.19	2.49	0.93
2003	1.67	1.17	0.82	1.25	0.29	0.09	15.83	9.94	47.73	40.71	0.55	11.87	1.73	2.40
2004	1.28	1.16	0.93	0.51	0.18	0.22	12.44	9.42	40.06	32.37	3.03	14.25	2.03	2.42
2005	0.81	0.75	0.13	0.51	0.01	0.07	9.5	12.09	22.25	27.73	0.30	9.57	2.35	1.67
2006	1.53	0.88	0.47	0.91	0.05	0.03	19.78	12.97	13.99	18.57	0.31	10.48	3.47	1.16
2007	1.07	1.95	1.45	0.85	0.1	0.56	11.85	10.66	18.10	15.37	0.41	6.79	3.49	0.19
2008	1.27	2.95	1.69	0.8	0.01	0.1	13.21	10.13	18.80	13.83	1.58	3.84	3.65	0.08
2009	1.02	1.39	0.81	1.07	0.09	0.09	8.23	8.97	24.31	12.31	3.43	3.54	4.38	0.71
2010	1.03	1.86	0.98	1.1	0.02	0.07	7.65	7.67	19.63	14.44	1.19	4.47	7.43	1.62
2011	0.79	1.9	0.43	1.05	0.01	0.005	6.20	7.32	18.79	13.79	0.10	2.92	5.38	1.80

Table 7.10.3. Plaice in Divisions VIIfg: lpue and effort for Belgian fleets in VIIf,g.

		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

Table 7.10.4. Plaice in Divisions VIIfg: lpue and effort for Irish otter trawl, beam and seine fleets in VIIg.

	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	44.77	120.43	0.37	11.12	11.06	1.01

	IR-TBB-7G		
Year	Landings (t)	Effort (000 hr)	lpue (kg/h)
1995	37.92	20.78	1.83
1996	53.02	26.76	1.98
1997	94.59	28.25	3.35
1998	122.13	35.25	3.46
1999	25.80	40.87	0.63
2000	12.62	37.03	0.34
2001	4.80	39.71	0.12
2002	7.08	31.62	0.22
2003	9.37	49.26	0.19
2004	6.17	54.86	0.11
2005	9.49	49.65	0.19
2006	14.46	60.48	0.24
2007	21.18	55.86	0.38
2008	14.18	37.22	0.38
2009	6.96	37.96	0.18
2010	6.56	40.22	0.16
2011	6.88	36.07	0.19

Table 7.10.5. Plaice in Divisions VIIf&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
1	8	15	2	3	1
2	130	270	127	135	135
3	513	341	626	223	326
4	340	443	345	430	208
5	104	145	273	191	248
6	76	47	68	152	130
7	46	29	20	44	69
8	26	11	10	8	28
+gp	13	15	12	8	17
TOTALNUM	1257	1315	1485	1187	1161

Table 7.10.6. Plaice in Divisions VIIf&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	0.185	0.151	0.178	0.276	0.135	0
2	0.205	0.258	0.203	0.238	0.255	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	0.412	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	0.595	0.62	0.654	0.633	0.67	0.677
7	0.693	0.595	0.749	0.784	0.695	0.714	0.749	0.739	0.763	0.787
8	0.76	0.666	0.839	0.882	0.802	0.808	0.844	0.857	0.851	0.889
+gp	0.8762	0.8435	1.0653	1.1812	1.1824	1.0948	1.1579	1.2661	1.0036	1.1033
SOPCOFAC	1.0052	1.0262	1.0225	1.0135	1.0042	1.0125	0.9995	1.0000	1.0047	0.9997

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	0.327	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	0.481	0.563	0.5	0.455	0.485	0.512
6	0.53	0.484	0.514	0.483	0.567	0.658	0.598	0.598	0.603	0.553
7	0.612	0.554	0.608	0.56	0.661	0.75	0.643	0.801	0.714	0.523
8	0.694	0.633	0.706	0.646	0.761	0.839	0.728	0.728	0.752	0.947
+gp	0.8632	0.8887	0.9932	0.9097	1.0465	1.0399	0.9886	0.9585	1.0655	1.0667
SOPCOFAC	1.0034	1.0024	1.0006	1.0009	1.0113	1.0022	0.9997	1.0001	1.0004	0.9998

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	0.26	0.305	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	0.398	0.343	0.353	0.33	0.356	0.339
5	0.466	0.463	0.44	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	0.69	0.839	0.875	0.695	0.859	0.681	0.75	0.714	0.638
+gp	1.1007	1.1886	1.1906	1.2018	1.0905	1.1262	1.0389	0.9919	1.0163	0.8369
SOPCOFAC	1.0002	1.0009	1	1.0007	1.0007	1.0004	0.9994	1.0007	1.0011	1.0008

AGE\YEAR	2007	2008	2009	2010	2011
1	0.278	0.26	0.279	0.233	0.228
2	0.271	0.273	0.267	0.292	0.242
3	0.277	0.298	0.275	0.331	0.283
4	0.303	0.329	0.329	0.328	0.335
5	0.389	0.386	0.376	0.376	0.378
6	0.457	0.433	0.469	0.458	0.465
7	0.537	0.511	0.499	0.598	0.600
8	0.547	0.719	0.605	0.469	0.690
+gp	0.9862	0.9042	0.7197	1.043	1.181
SOPCOFAC	1.0005	1.0001	0.9993	1.0002	1.0000

Table 7.10.7. Plaice in Divisions VIIf&g: Discard numbers-at-age.

Discard numbers at age				Numbers*10**-3							
AGE\YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	0	0	0	455	572	542	1829	73	671	385	960
2	0	0	0	360	1211	2584	3331	3595	985	2719	2656
3	0	0	0	641	441	750	3408	632	2041	1017	1429
4	0	0	0	171	118	74	814	393	761	550	1019
5	0	0	0	68	41	47	81	69	399	345	501
6	0	0	0	3	12	12	32	4	44	54	45
7	0	0	0	4	4	1	11	1	4	8	99
8	0	0	0	1	22	1	9	1	5	0	56
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	0	0	0	1703	2421	4011	9515	4768	4910	5078	6765
TONSLAND	0	0	0	274	321	453	1288	583	608	670	1107
SOPCOF %	0	0	0	100	100	100	100	100	100	100	100

Table 7.10.8. Plaice in Divisions VIIf&g: Discard weights-at-age.

Discardss weights at age (kg)											
AGE\YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	0	0	0	0.123	0.095	0.064	0.088	0.092	0.088	0.085	0.118
2	0	0	0	0.152	0.127	0.107	0.126	0.11	0.127	0.125	0.148
3	0	0	0	0.177	0.154	0.154	0.159	0.154	0.127	0.143	0.173
4	0	0	0	0.194	0.188	0.176	0.163	0.172	0.127	0.149	0.168
5	0	0	0	0.212	0.202	0.201	0.204	0.211	0.143	0.163	0.225
6	0	0	0	0.337	0.344	0.242	0.249	0.282	0.194	0.189	0.304
7	0	0	0	0.23	0.403	0.395	0.368	0.365	0.2	0.445	0.339
8	0	0	0	0.455	0.419	0.349	0.425	0.283	0.257	0.523	0.389
+gp	0	0	0	0	0	0	0	0	0	0	0

Table 7.10.9. Plaice in Divisions VIIf&g: Stock weights-at-age.

Stock weights at age (kg)

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

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

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

YEAR	2007	2008	2009	2010	2011
1	0.278	0.260	0.279	0.233	0.228
2	0.271	0.273	0.267	0.292	0.242
3	0.277	0.298	0.275	0.331	0.283
4	0.303	0.329	0.329	0.328	0.335
5	0.389	0.386	0.376	0.376	0.378
6	0.457	0.433	0.469	0.458	0.465
7	0.537	0.511	0.499	0.598	0.600
8	0.547	0.719	0.605	0.469	0.690
+gp	0.986	0.904	0.720	1.043	1.181

Table 7.10.10. Plaice in Divisions VIIf&g: Survey abundance indices (figures used in the assessment shown in bold).

IRGFS

2003 2011

1 1 0.79 0.92

1 7

832	0	45	84	37	8	3	1
980	2	6	31	51	20	13	1
845	39	63	83	19	9	3	3
1046	3	105	80	22	18	11	12
1168	2	51	166	68	22	9	8
1139	7	113	106	72	19	8	5
1018	213	199	548	247	100	21	16
1381	233	871	304	479	197	84	23
1392	250	1150	701	195	210	84	107

E+W BT Survey

1990 2011

1 1 0.75 0.85

1 6

69.86	12	161	215	64	15	6	0	0	2	0	1
123.41	2	841	33	65	21	12	3	0	1	0	0
125.08	3	487	307	13	5	15	2	5	0	0	2
127.67	4	120	107	44	2	5	1	1	0	0	0
120.82	144	127	40	20	11	1	0	0	0	0	0
114.9	1.18	275.26	103.33	19.17	3.4	7.86	1.77	0	0	1.95	0
118.6	9.6	265.28	341.68	36.5	1.17	3.11	0.95	0	0	0	0
114.9	8	258.92	117.34	39.68	4.88	2.03	1.92	0.98	0	0	0
114.9	5.73	272.51	145.01	53.99	10.25	2.3	1.11	0	0	0	1.05
118.6	192.35	180.96	94.43	34.42	23.33	8.3	0	0	2.01	0	0
118.6	100.48	402.77	74.92	37.06	7.78	6.52	0	1.05	0	0	0
118.6	42.17	250.76	185.17	18.75	10.37	5.02	4.02	1.96	0	0	0
118.6	1.11	162.16	207.68	95.41	7.03	7.27	2.41	4.17	1	0	0
118.6	72.02	116.66	95.45	72.29	25.89	3.22	2.05	1	1.05	2.17	0
114.9	188.27	296.99	38.39	31.11	15.42	2.52	1.11	1.11	2.85	0	2.23
118.6	3.08	228.29	89.2	24.74	9.55	12.96	2.98	0.95	0	0	0.99
118.6	95.51	101.72	120.93	40.51	11.34	2.12	10.71	0	2.94	0.93	0
118.6	41.3	178.36	109.4	56.05	17.92	1.98	2.98	0.99	1.98	0.99	0
118.6	7.43	166.85	257.39	56.51	18.62	5.72	0.98	2.95	0	0	1
118.6	221.89	191.89	66.36	93.19	25.44	12.92	4.85	1.89	0	0.99	0
118.6	169.87	393.45	105	31.32	47.37	7.93	5.09	1.04	0	0.99	2.1
118.6	10	433	353	63	24	27	18	3	3	1	0

Table 7.10.11. Plaice in Divisions VIIf&g: Commercial tuning data available to the working group (figures used in the assessment shown in bold).

UK (E+W) BEAM TRAWL VIIF.

1990 2011

1 1 0 1

4 8

30.8	**159.5**	**46.3**	**26.6**	**11.0**	**9.2**
40.8	**141.5**	**87.1**	**29.0**	**15.1**	**14.1**
35.8	**32.0**	**46.7**	**27.4**	**7.5**	**2.3**
39.6	**25.0**	**15.5**	**24.6**	**15.1**	**7.3**
37.0	**49.1**	**9.2**	**9.1**	**7.6**	**9.8**
37.6	**39.5**	**29.7**	**9.9**	**5.8**	**6.4**
39.8	**13.6**	**13.6**	**12.8**	**3.8**	**4.4**
43.0	**23.7**	**8.4**	**6.7**	**4.5**	**0.7**
47.8	**63.1**	**17.5**	**3.6**	**4.3**	**2.7**
50.8	**52.5**	**25.8**	**7.7**	**2.4**	**1.9**
51.2	**26.9**	**17.8**	**12.7**	**4.9**	**1.8**
49.3	**27.5**	**17.7**	**10.1**	**5.9**	**2.4**
37.5	**16.8**	**7.8**	**7.4**	**3.5**	**1.8**
40.7	**33.8**	**9.9**	**4.9**	**3.4**	**2.4**
32.4	**25.8**	**17.5**	**3.4**	**2.5**	**2.0**
27.7	**12.7**	**7.5**	**5.0**	**1.9**	**1.1**
18.6	**4.5**	**4.4**	**3.0**	**1.6**	**0.4**
15.4	**12.0**	**3.2**	**2.0**	**1.4**	**0.6**
13.8	**18.1**	**5.2**	**1.9**	**1.4**	**0.9**
12.2	**15.2**	**10.6**	**3.0**	**1.0**	**0.6**
14.1	**18.6**	**7.2**	**5.9**	**1.7**	**0.1**
18.8	**7.3**	**8.7**	**3.1**	**2.6**	**0.8**

UK(E+W) OTTER TRAWL VIIF

1989 2011

1 1 0 1

4 8

17.6	62.0	23.1	7.4	5.1	0.4
22.6	129.1	34.2	13.3	4.1	4.4
18.6	78.8	36.9	16.5	4.4	5.0
16.0	12.5	18.5	8.5	1.4	0.4
13.8	8.8	3.9	6.3	4.1	2.7
9.5	15.1	2.7	3.1	1.4	1.7
8.5	14.5	5.5	1.6	0.8	0.7
8.7	4.3	3.4	2.5	1.0	1.1
8.1	5.5	1.2	0.7	0.4	0.1
7.1	8.6	2.0	0.5	0.7	0.2
5.7	7.9	3.8	0.9	0.2	0.1
4.1	6.5	2.5	1.3	0.4	0.1
4.4	4.0	2.4	1.3	0.6	0.2
6.1	3.0	1.5	1.1	0.4	0.2
9.9	9.3	2.1	1.3	0.9	0.6
9.4	10.4	5.8	0.9	0.5	0.3
12.1	5.5	2.8	1.5	0.5	0.3
13.0	6.8	6.4	4.5	2.3	0.6
10.6	7.4	2.2	1.4	1.0	0.5
10.1	8.2	2.4	1.6	1.1	0.6
9.0	7.3	2.3	0.9	0.5	0.3
7.6	4.4	2.9	0.7	0.3	0.2
7.7	1.1	1.5	0.7	0.5	0.3

Table 7.10.12. Plaice in Divisions VIIf&g: AP Model Diagnostics.

Sun May 27 15:50:58 2012	
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?	TRUE
negative log.likelihood	212.4321
AIC	614.8642
Nparameters	95
Nobservations	520
Final parameter values	
Ftrend 1	0.786745
Ftrend 2	0.721754
Ftrend 3	0.758098
Ftrend 4	0.725965
Ftrend 5	0.806718
Ftrend 6	0.778147
Ftrend 7	0.821911
Ftrend 8	0.727583
Ftrend 9	0.674771
Ftrend 10	0.843583
Ftrend 11	0.772043
Ftrend 12	0.784844
Ftrend 13	0.663379
Ftrend 14	0.631855
Ftrend 15	0.781269
Ftrend 16	0.598898
Ftrend 17	0.717343
Ftrend 18	0.81996
Ftrend 19	1.20749
sel.C 1	-2.11236
sel.C 2	1.615651
sel.C 3	31.24612
sel.C 4	-10.6372
sel.C 5	-0.04276
sel.C 6	-0.97352
sel.C 7	5.077658
sel.C 8	-2.75169

Table 7.10.12. Plaice in Divisions VIIf&g: AP Model Diagnostics.

logrecruitment 1	13.37972
logrecruitment 2	12.59398
logrecruitment 3	12.41501
logrecruitment 4	12.54571
logrecruitment 5	11.96504
logrecruitment 6	11.09387
logrecruitment 7	9.270412
logrecruitment 8	8.553365
logrecruitment 9	9.010416
logrecruitment 10	9.364609
logrecruitment 11	9.146474
logrecruitment 12	8.949407
logrecruitment 13	8.639735
logrecruitment 14	8.478526
logrecruitment 15	9.042842
logrecruitment 16	8.831751
logrecruitment 17	8.552969
logrecruitment 18	8.100985
logrecruitment 19	8.689667
logrecruitment 20	9.238186
logrecruitment 21	8.942668
logrecruitment 22	9.258423
logrecruitment 23	8.511405
logrecruitment 24	8.889767
logrecruitment 25	9.282941
logrecruitment 26	9.44021
Catchability1	-5.98045
Catchability2	-5.92864
Catchability3	-3.44801
sel.U 1	-0.6906
sel.U 2	-0.53428
sel.U 3	0.309431
sel.U 4	0.404232
sel.U 5	-0.65403
sel.U 6	-0.78524
sel.U 7	-0.37863
sel.U 8	-0.04658
sel.U 9	-4.67971
sel.U 10	-4.38754
sel.U 11	-5.9567
sel.U 12	-5.39001

Table 7.10.12. Plaice in Divisions VIIf&g: AP Model Diagnostics.

b1	3.71689
b2	-0.6905
b3	-2.33621
b4	-3.11821
b5	0.102747
b6	-0.03937
b7	0.614449
b8	-0.0371
b9	0.005085
b10	0.014721
b11	-0.03076
b12	0.032317
sds.land1	-2.08402
sds.land2	-1.50864
sds.land3	2.478249
sds.disc1	-0.84796
sds.disc2	0.471159
sds.disc3	0.762088
sds.tun1	-2.0457
sds.tun2	0.711809
sds.tun3	1.072453
sds.tun4	-1.03188
sds.tun5	-0.10124
sds.tun6	0.040478
sds.tun7	-0.72467
sds.tun8	1.165039
sds.tun9	0.038749

Table 7.10.13. Plaice in Divisions VIIf&g: Fishing Mortalities.

Total Fishing mortality at age

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average(08-10)
1	0.119	0.105	0.106	0.098	0.106	0.098	0.1	0.085	0.076	0.091	0.081	0.078	0.064	0.059	0.07	0.051	0.059	0.066	0.092	0.072
2	0.642	0.578	0.597	0.565	0.619	0.582	0.604	0.529	0.474	0.58	0.522	0.513	0.423	0.393	0.47	0.349	0.407	0.451	0.638	0.499
3	0.67	0.643	0.699	0.69	0.778	0.758	0.81	0.728	0.669	0.84	0.776	0.783	0.662	0.635	0.781	0.599	0.72	0.821	1.207	0.916
4	0.511	0.597	0.702	0.708	0.798	0.775	0.823	0.732	0.675	0.846	0.78	0.785	0.663	0.637	0.781	0.599	0.721	0.82	1.207	0.916
5	0.338	0.529	0.69	0.712	0.801	0.777	0.825	0.729	0.675	0.846	0.782	0.785	0.665	0.638	0.781	0.599	0.722	0.82	1.207	0.916
6	0.514	0.605	0.71	0.715	0.8	0.776	0.825	0.728	0.675	0.847	0.778	0.785	0.665	0.639	0.781	0.599	0.723	0.82	1.207	0.917
7	0.791	0.715	0.751	0.723	0.794	0.764	0.809	0.708	0.653	0.815	0.738	0.742	0.622	0.591	0.71	0.535	0.631	0.697	0.996	0.775
8	0.786	0.715	0.752	0.724	0.794	0.764	0.81	0.708	0.653	0.815	0.737	0.742	0.622	0.587	0.71	0.535	0.633	0.697	0.996	0.775
+gp	0.786	0.715	0.752	0.724	0.794	0.764	0.81	0.708	0.653	0.815	0.737	0.742	0.622	0.587	0.71	0.535	0.633	0.697	0.996	0.775
FBAR 3- 6	0.508	0.594	0.700	0.706	0.794	0.772	0.821	0.729	0.674	0.845	0.779	0.785	0.664	0.637	0.781	0.599	0.722	0.820	1.207	

Discard Fishing mortality at age

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average(08-10)
1	0.114	0.101	0.102	0.094	0.102	0.095	0.097	0.083	0.074	0.089	0.079	0.077	0.063	0.058	0.069	0.050	0.058	0.065	0.091	0.058
2	0.518	0.465	0.480	0.455	0.501	0.474	0.496	0.439	0.398	0.493	0.450	0.449	0.375	0.353	0.428	0.322	0.380	0.426	0.608	0.376
3	0.183	0.190	0.223	0.238	0.290	0.305	0.352	0.341	0.337	0.453	0.448	0.481	0.432	0.437	0.565	0.453	0.568	0.671	1.019	0.564
4	0.021	0.030	0.045	0.056	0.079	0.094	0.123	0.132	0.146	0.218	0.236	0.275	0.266	0.289	0.396	0.335	0.439	0.538	0.844	0.437
5	0.005	0.009	0.015	0.020	0.027	0.037	0.049	0.056	0.065	0.103	0.117	0.147	0.153	0.178	0.257	0.232	0.324	0.418	0.688	0.325
6	0.013	0.018	0.019	0.021	0.024	0.029	0.034	0.034	0.035	0.054	0.065	0.075	0.079	0.095	0.143	0.144	0.213	0.300	0.541	0.219
7	0.362	0.229	0.166	0.103	0.080	0.059	0.049	0.033	0.033	0.041	0.034	0.023	0.025	0.039	0.059	0.054	0.093	0.142	0.303	0.096
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
+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
FBAR 3- 6	0.056	0.062	0.075	0.084	0.105	0.117	0.139	0.141	0.146	0.207	0.216	0.245	0.232	0.250	0.340	0.291	0.386	0.482	0.773	

Landings Fishing mortality at age

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average(08-10)
1	0.005	0.004	0.004	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
2	0.124	0.113	0.117	0.110	0.118	0.108	0.108	0.090	0.076	0.087	0.072	0.065	0.048	0.040	0.042	0.027	0.027	0.025	0.030	0.026
3	0.487	0.453	0.476	0.452	0.488	0.453	0.458	0.387	0.332	0.387	0.328	0.302	0.230	0.198	0.216	0.146	0.152	0.150	0.188	0.149
4	0.490	0.567	0.657	0.652	0.719	0.681	0.700	0.600	0.529	0.628	0.544	0.510	0.397	0.348	0.385	0.264	0.282	0.282	0.363	0.276
5	0.333	0.520	0.675	0.692	0.774	0.740	0.776	0.673	0.610	0.743	0.665	0.638	0.512	0.460	0.524	0.367	0.398	0.402	0.519	0.389
6	0.501	0.587	0.691	0.694	0.776	0.747	0.791	0.694	0.640	0.793	0.713	0.710	0.586	0.544	0.638	0.455	0.510	0.520	0.666	0.495
7	0.429	0.486	0.585	0.620	0.714	0.705	0.760	0.675	0.620	0.774	0.704	0.719	0.597	0.552	0.651	0.482	0.538	0.555	0.693	0.525
8	0.786	0.715	0.752	0.724	0.794	0.764	0.810	0.708	0.653	0.815	0.737	0.742	0.622	0.587	0.710	0.535	0.633	0.697	0.996	0.622
+gp	0.786	0.715	0.752	0.724	0.794	0.764	0.810	0.708	0.653	0.815	0.737	0.742	0.622	0.587	0.710	0.535	0.633	0.697	0.996	0.622
FBAR 3- 6	0.453	0.532	0.625	0.623	0.689	0.655	0.681	0.588	0.528	0.638	0.563	0.540	0.432	0.388	0.441	0.308	0.336	0.338	0.434	

Table 7.10.14. Plaice in Divisions VIIf&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	2006	2007	2008	2009	2010	2011
1	5184	8188	11668	9381	7703	5652	4810	8458	6848	5182	3298	5941	10282	7652	10493	4971	7257	10753	12584
2	6155	4081	6537	9305	7540	6142	4546	3862	6887	5631	4196	2698	4872	8556	6399	8680	4189	6067	8930
3	3553	2873	2031	3190	4692	3601	3044	2203	2019	3801	2797	2209	1432	2832	5120	3546	5428	2473	3426
4	837	1612	1340	895	1420	1912	1497	1202	944	917	1455	1142	895	655	1331	2080	1729	2343	965
5	499	446	787	589	391	567	781	583	512	426	349	591	462	409	307	540	1014	746	915
6	511	316	233	350	256	156	231	304	249	231	162	142	239	211	192	125	263	437	291
7	436	271	153	102	152	102	64	90	130	113	88	66	57	109	99	78	61	113	171
8	156	175	118	64	44	61	42	25	39	60	44	37	28	27	54	43	40	29	50
+gp	114	133	263	196	158	111	131	66	62	52	49	34	37	36	27	38	27	17	29
TOTAL	19438	20089	25125	26068	24353	20302	17145	18793	19691	18415	14441	14864	20309	22493	26029	22109	22017	24988	29372

Table 7.10.15. Plaice in Divisions VIIf&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	1204.35	2014.54	2803.28	3592	5195	7218	508.37	833.48	1157.03	164.89	414.17	732.46	0.431	0.501	0.582	0.453	0.056
1994	1254.24	1922.61	2562.53	5920	8173	11369	528.22	834.55	1077.58	149.65	327.99	587.82	0.504	0.577	0.649	0.532	0.062
1995	1316.27	1821.30	2295.38	8494	11688	15730	600.35	829.47	1042.05	231.19	453.63	826.79	0.598	0.684	0.764	0.625	0.075
1996	1535.59	1913.27	2253.89	7079	9341	12487	682.68	863.34	1046.96	322.48	560.22	890.00	0.614	0.702	0.809	0.623	0.084
1997	1858.25	2193.53	2532.98	5791	7680	10136	897.28	1087.52	1278.80	341.01	561.92	848.54	0.693	0.784	0.874	0.689	0.105
1998	1799.58	2058.67	2317.08	4414	5635	7362	851.75	990.29	1124.78	288.15	450.70	646.93	0.684	0.762	0.844	0.655	0.117
1999	1523.41	1703.78	1896.18	3797	4793	6062	727.81	833.17	956.86	261.15	382.22	538.10	0.735	0.822	0.935	0.681	0.139
2000	1324.57	1491.16	1659.69	6834	8458	10389	571.16	653.29	736.81	218.86	327.37	469.74	0.654	0.731	0.811	0.588	0.141
2001	1508.29	1692.31	1880.45	5526	6833	8398	530.89	614.66	699.93	271.91	402.79	551.71	0.602	0.671	0.748	0.528	0.146
2002	1461.51	1627.30	1809.09	4245	5182	6212	603.33	688.96	787.82	367.95	494.04	636.73	0.758	0.847	0.974	0.638	0.207
2003	1379.20	1534.14	1691.84	2828	3283	3847	510.07	586.03	662.78	285.94	374.99	471.80	0.699	0.784	0.880	0.563	0.216
2004	1070.47	1187.29	1285.02	5132	5943	6780	381.60	440.47	500.18	292.94	362.67	447.40	0.704	0.784	0.868	0.540	0.245
2005	1089.96	1188.93	1276.98	8999	10318	11706	305.35	344.27	385.24	275.44	345.18	419.39	0.597	0.668	0.751	0.432	0.232
2006	1382.10	1503.95	1627.96	6715	7667	8819	319.01	358.56	405.25	378.81	455.23	552.48	0.574	0.645	0.734	0.388	0.250
2007	1647.66	1812.20	1978.21	9039	10443	12147	410.21	471.37	533.88	580.58	693.39	821.29	0.703	0.785	0.864	0.441	0.340
2008	1901.08	2072.14	2263.57	4138	4947	5973	340.10	383.92	433.85	459.78	549.59	652.02	0.533	0.599	0.667	0.308	0.291
2009	1924.53	2108.89	2311.68	5641	7226	9246	403.56	454.07	512.27	479.41	562.48	678.59	0.654	0.728	0.837	0.336	0.386
2010	1849.01	2097.20	2329.08	7488	10746	14971	369.52	421.21	471.13	517.28	624.21	756.18	0.735	0.823	0.917	0.338	0.482
2011	1674.02	1957.82	2289.57	7535	12514	21215	360.79	417.21	475.92	958.64	1203.86	1511.20	0.984	1.202	1.477	0.434	0.773
Mean	1693.06	1866.56	2051.64	6225	7597	9348	590.41	673.72	762.78	361.33	462.58	589.41	0.601	0.676	0.762	0.520	0.198

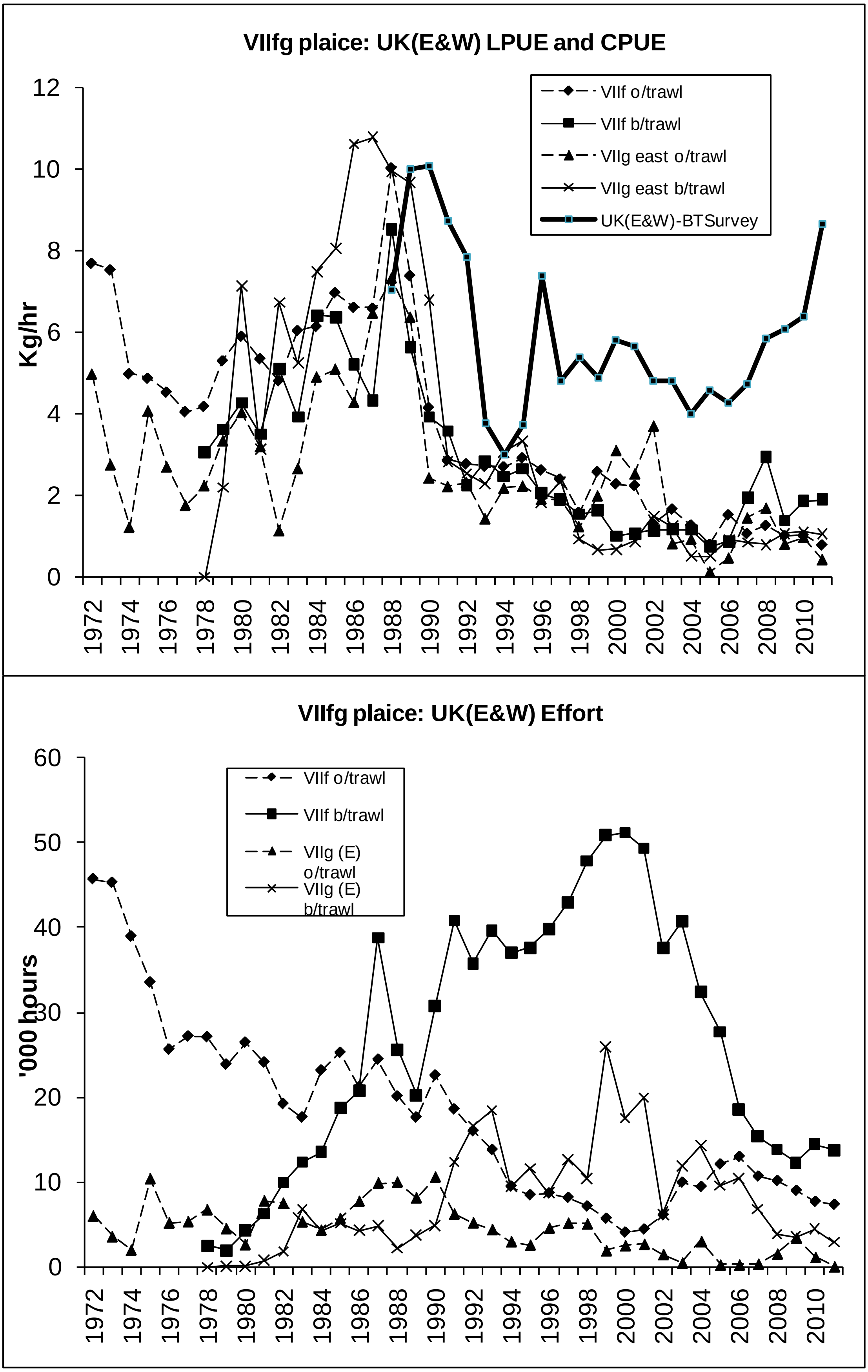

Figure 7.10.1. Plaice in Division VIIf&g: UK(E&W) lpue and effort by fleet.

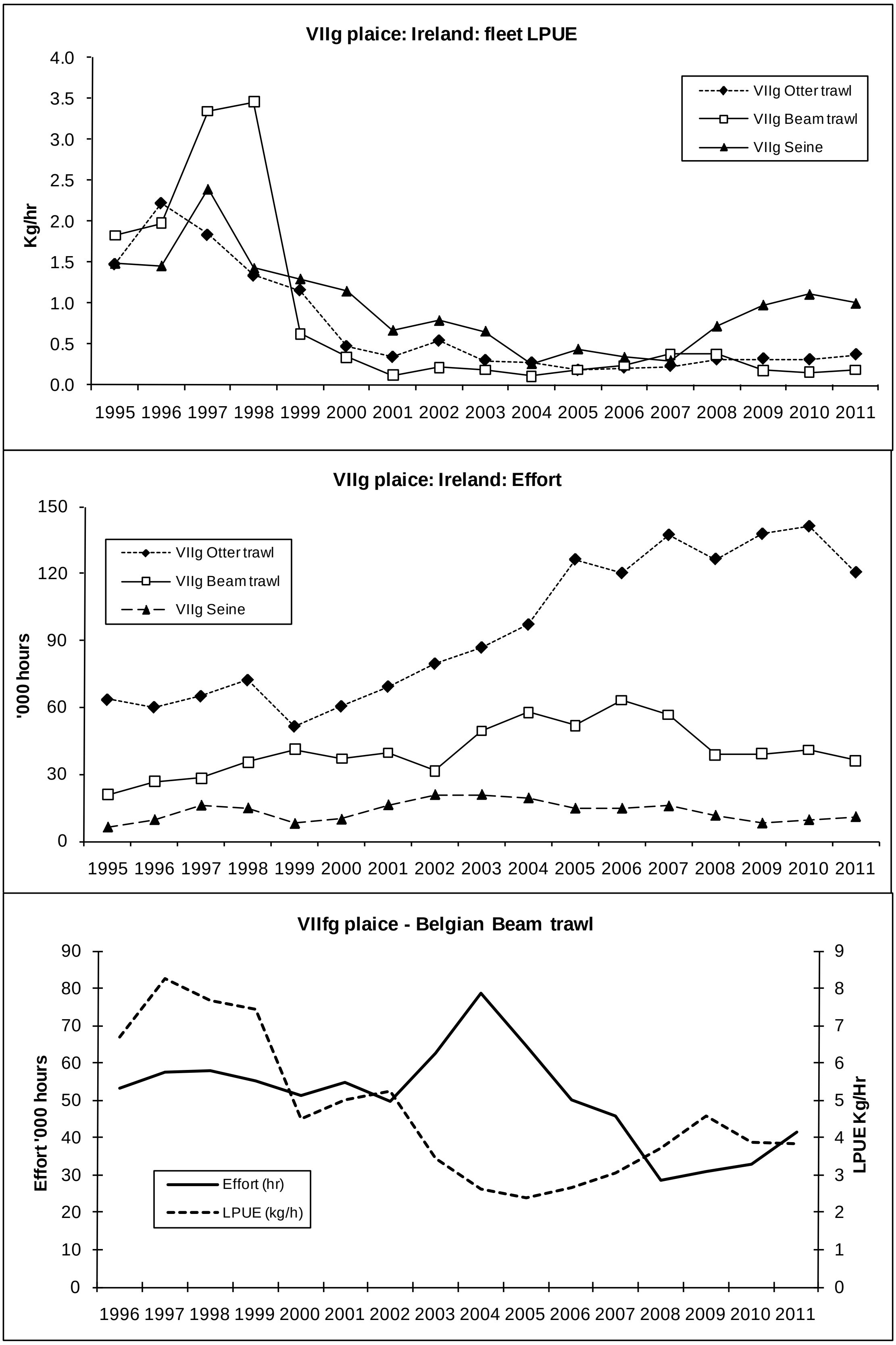

Figure 7.10.2. Plaice in Division VIIf&g: Ireland and Belgium: lpue and effort by fleet.

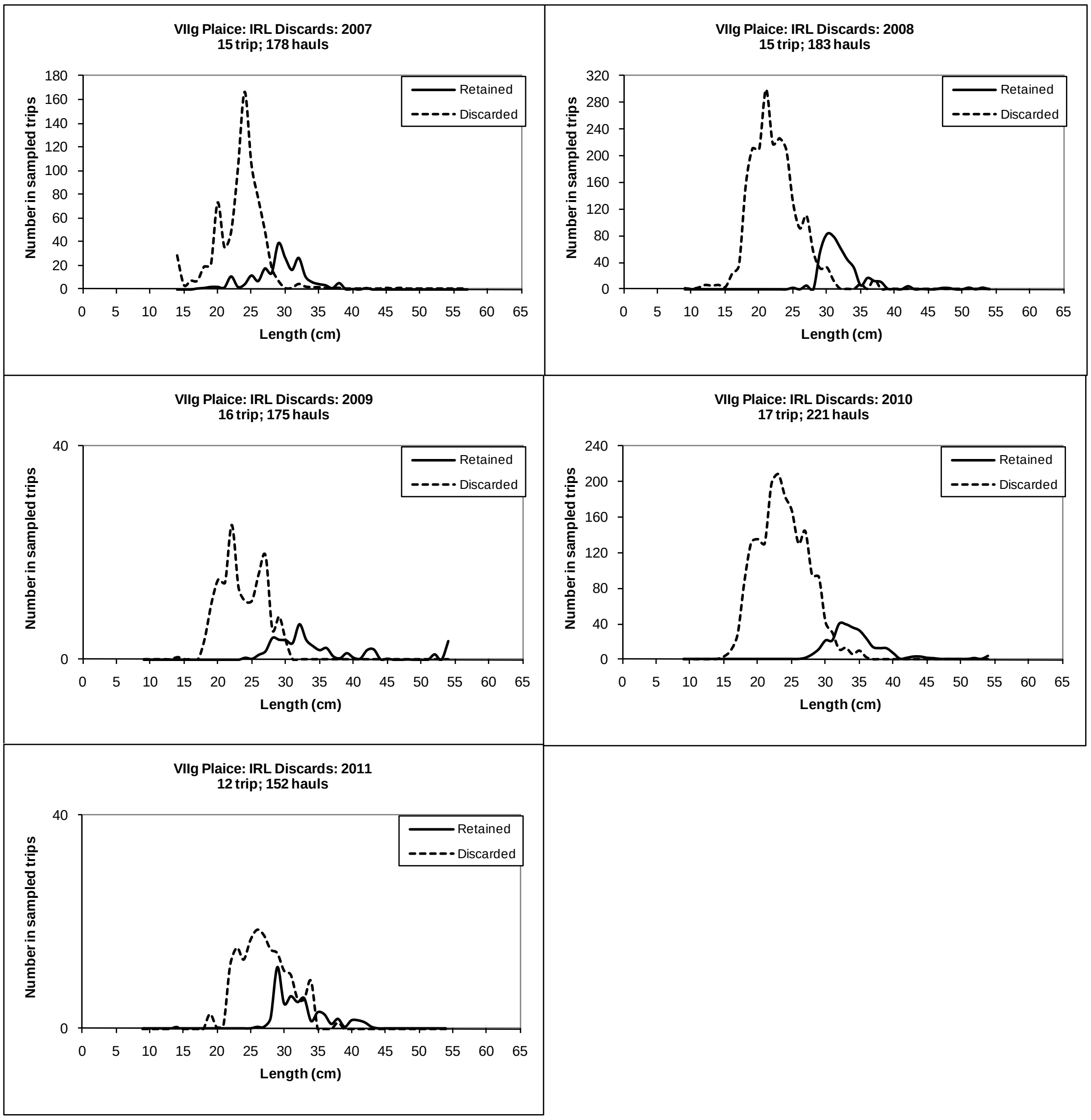

Figure 7.10.3a. Plaice in Division VIIf&g: Ireland otter trawl discard sampling results in 2007–2009: raised to sampled trips.

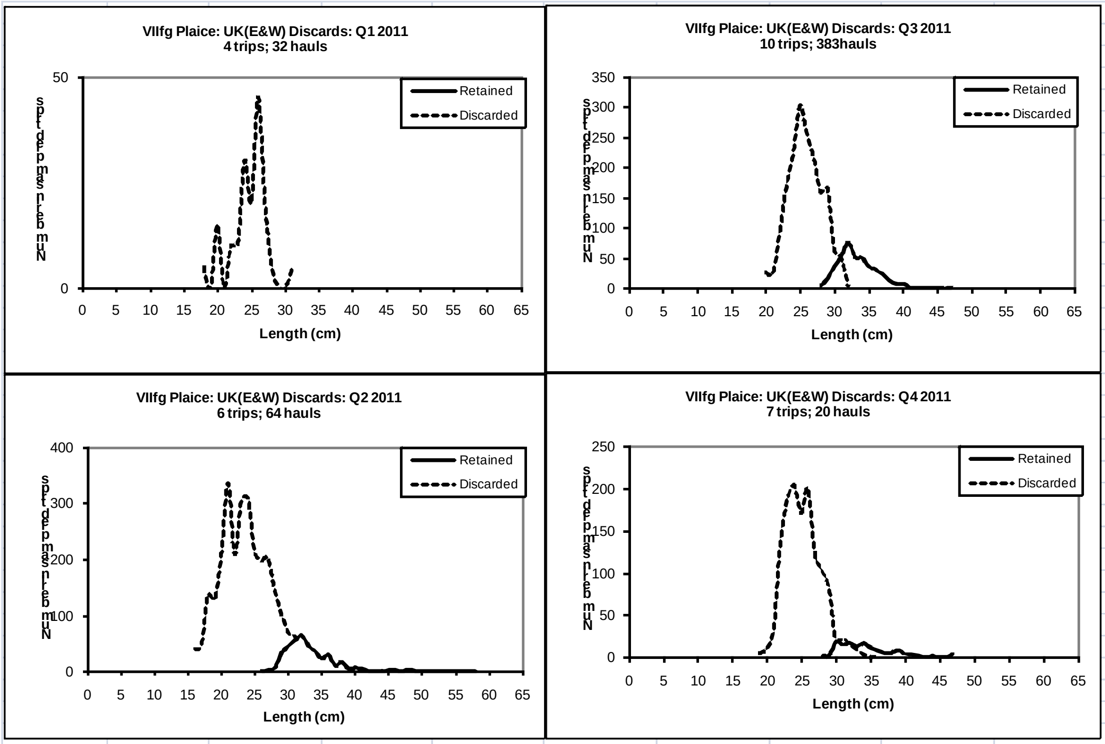

Figure 7.10.3b. Plaice in Division VIIf&g: UK(E&W) Discard sampling results in 2011: raised to sampled trips. All gears bar beam.

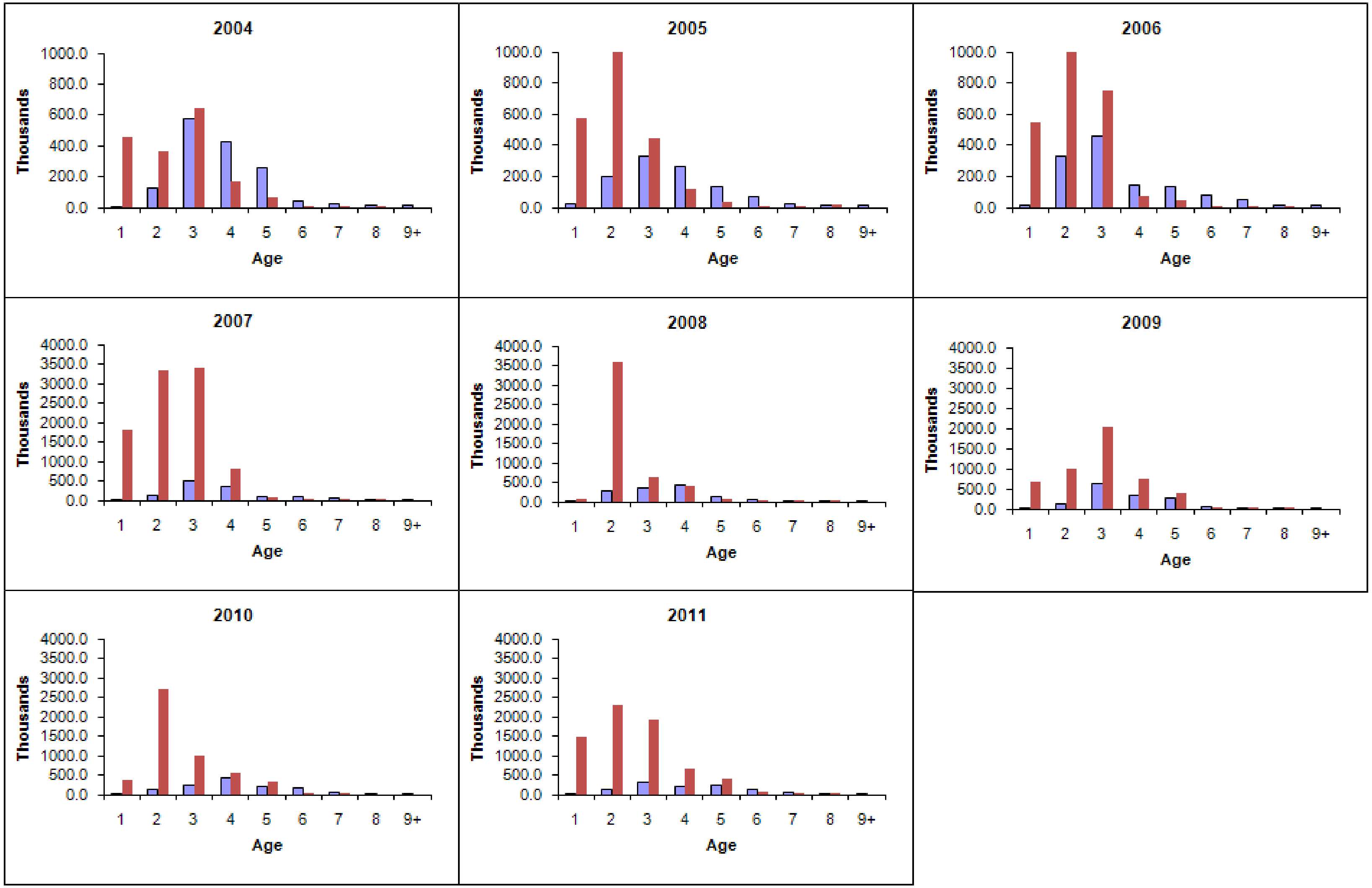

Figure 7.10.4. Plaice in Division VIIf&g: Age composition of International landings and discards from 2001 to 2011.

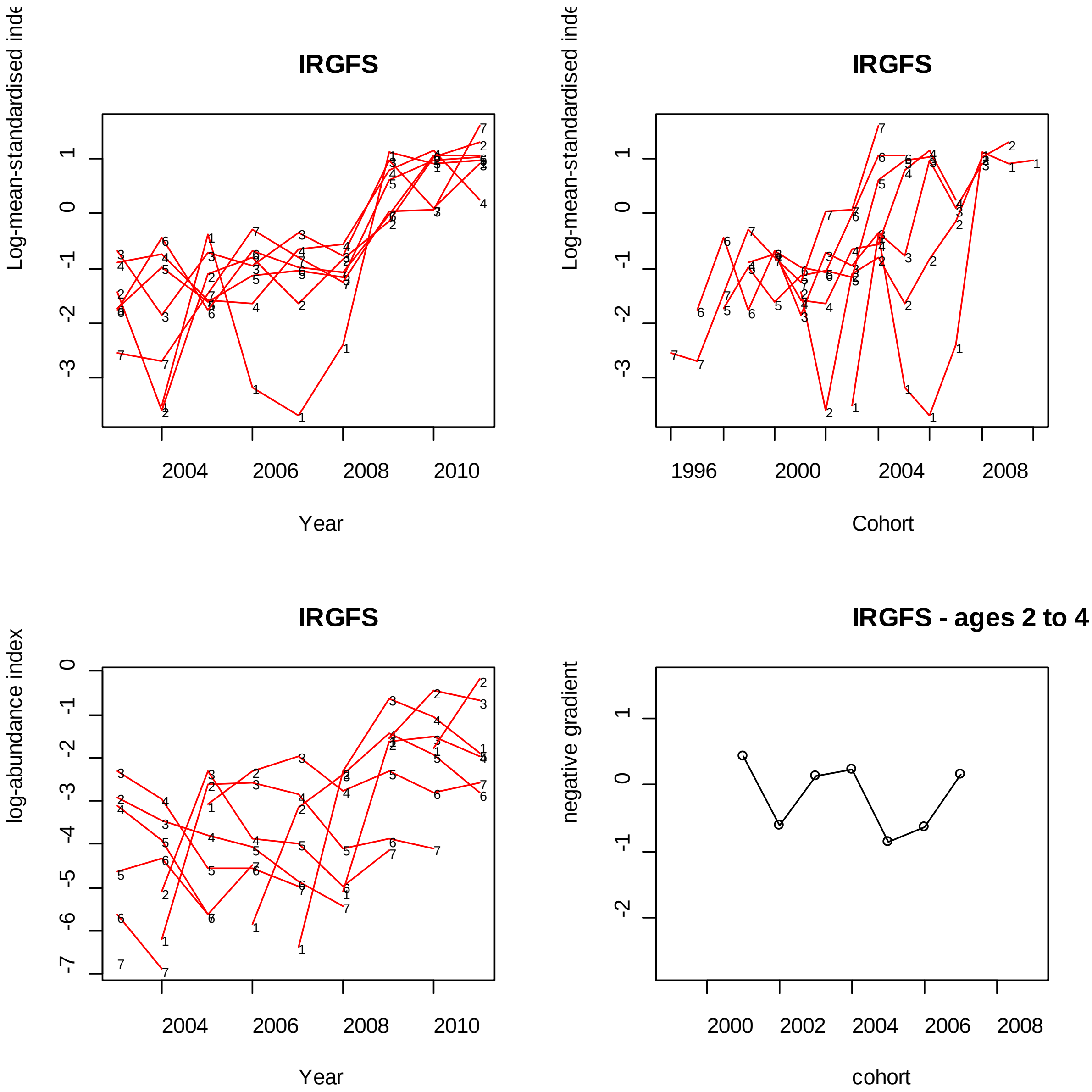

Figure 7.10.5. Plaice in Division VIIf&g: Irish ground fish survey log cpue at age; by year and year class (top row) , with log catch curves and the negative slope of the catch curves; ~Z (bottom row).

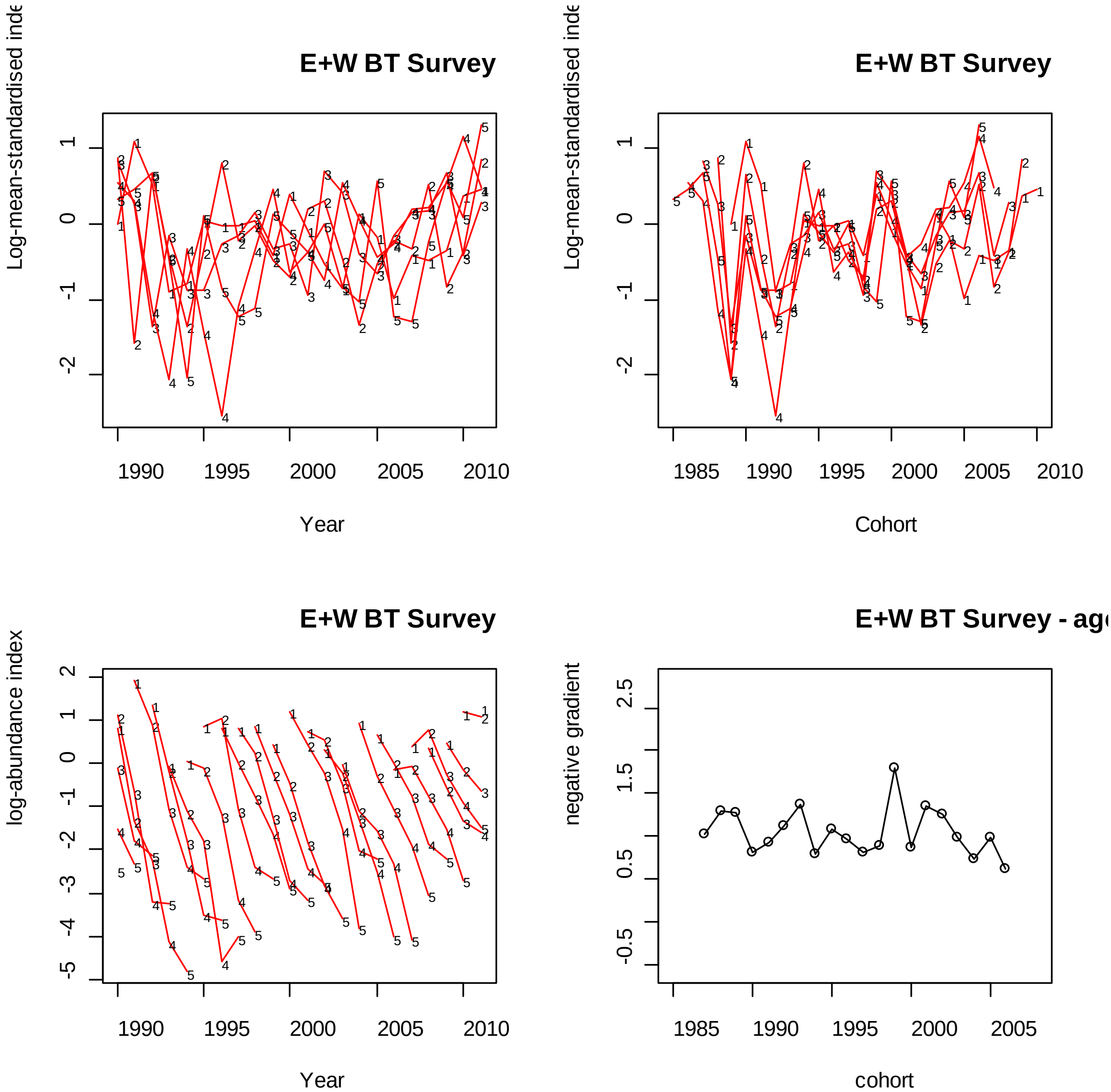

Figure 7.10.6. Plaice in Division VIIf&g: UK (BTS-Q3) Beam trawl survey log cpue by year, year class, log catch curves and the negative slope of the catch curves (~Z).

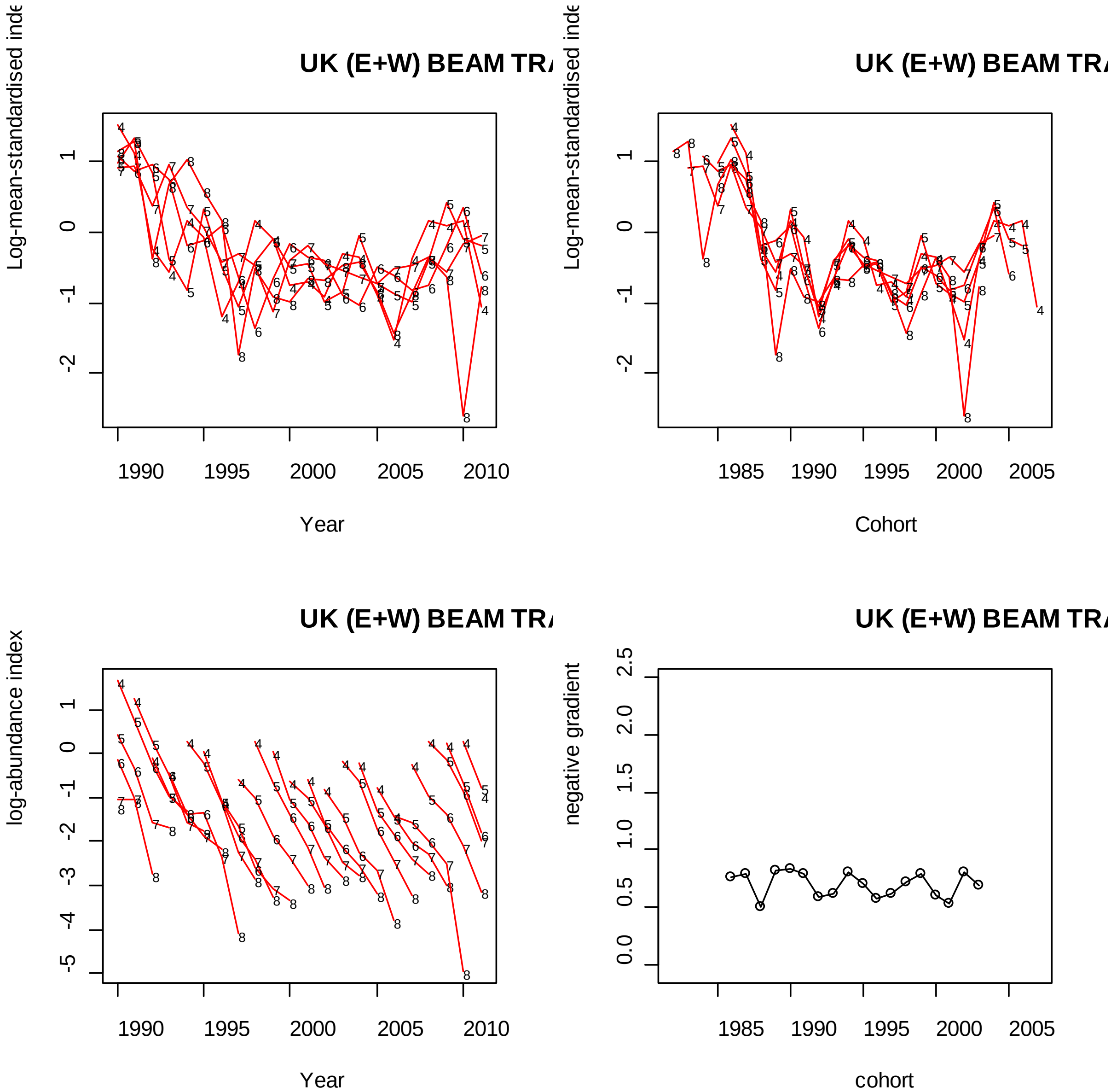

Figure 7.10.7a. Plaice in Division VIIf&g: UK EW Beam trawl fleet log cpue by year, year class, log catch curves and the negative slope of the catch curves (~Z).

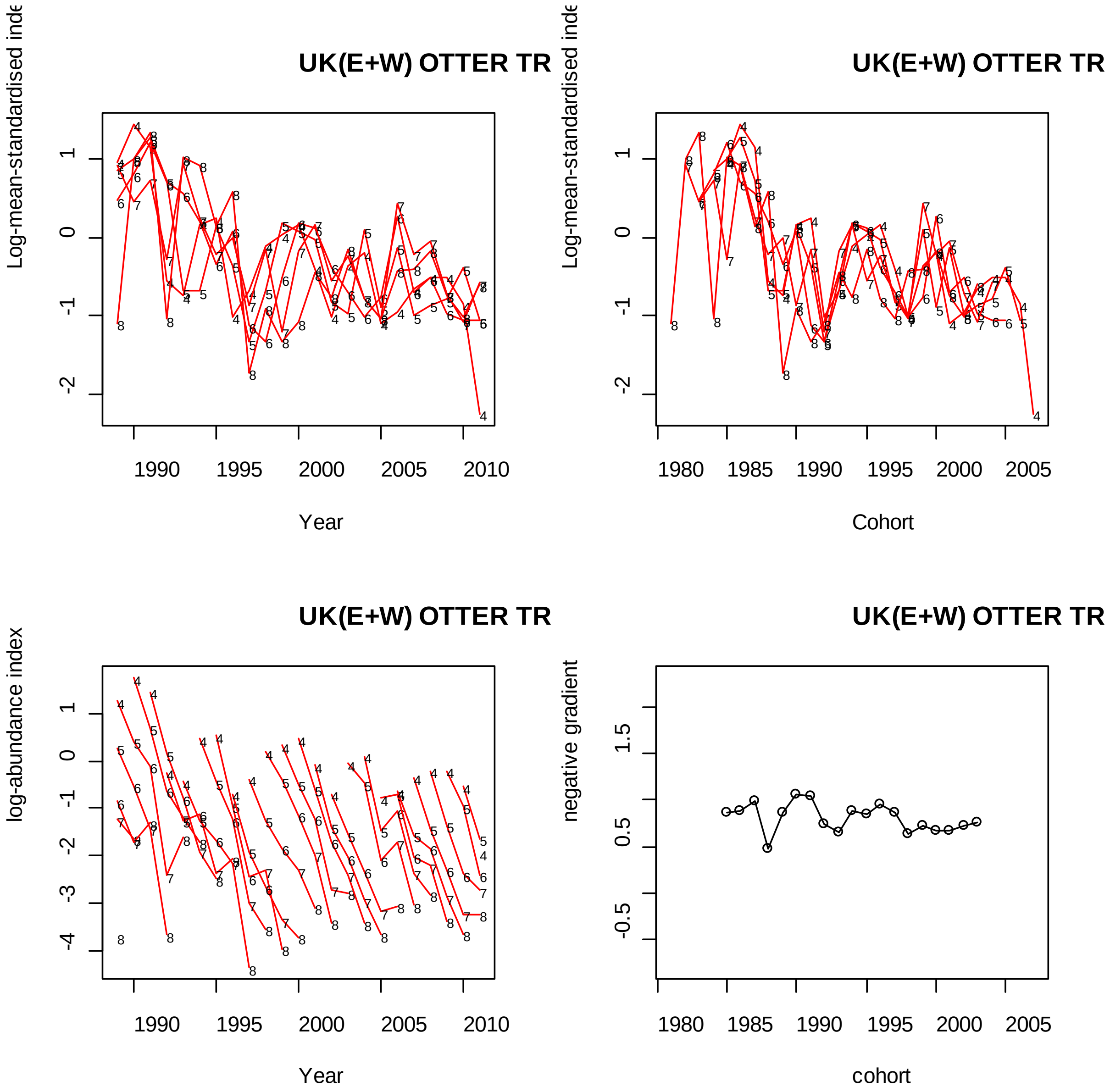

Figure 7.10.7b. Plaice in Division VIIf&g: UK EW Otter trawl fleet log cpue by year, year class, log catch curves and the negative slope of the catch curves (~Z).

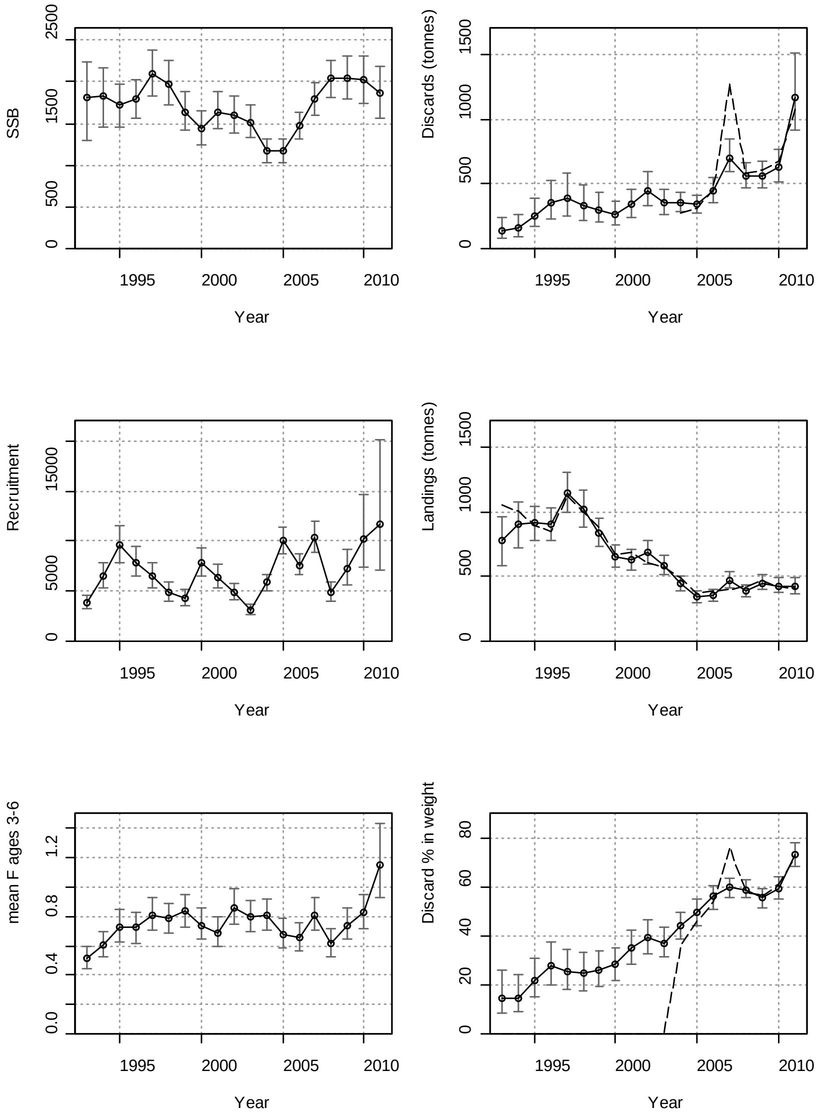

Figure 7.10.8. Plaice in Division VIIf&g: The estimated time-series of spawning–stock biomass, recruitment, average fishing mortality at ages 3–6, total discard weight, total landings weight and the discard percentage in weight with standard error bars derived from bootstrapping the hessian matrix, for the fit of the TI_PTVS model for the data to 2011.

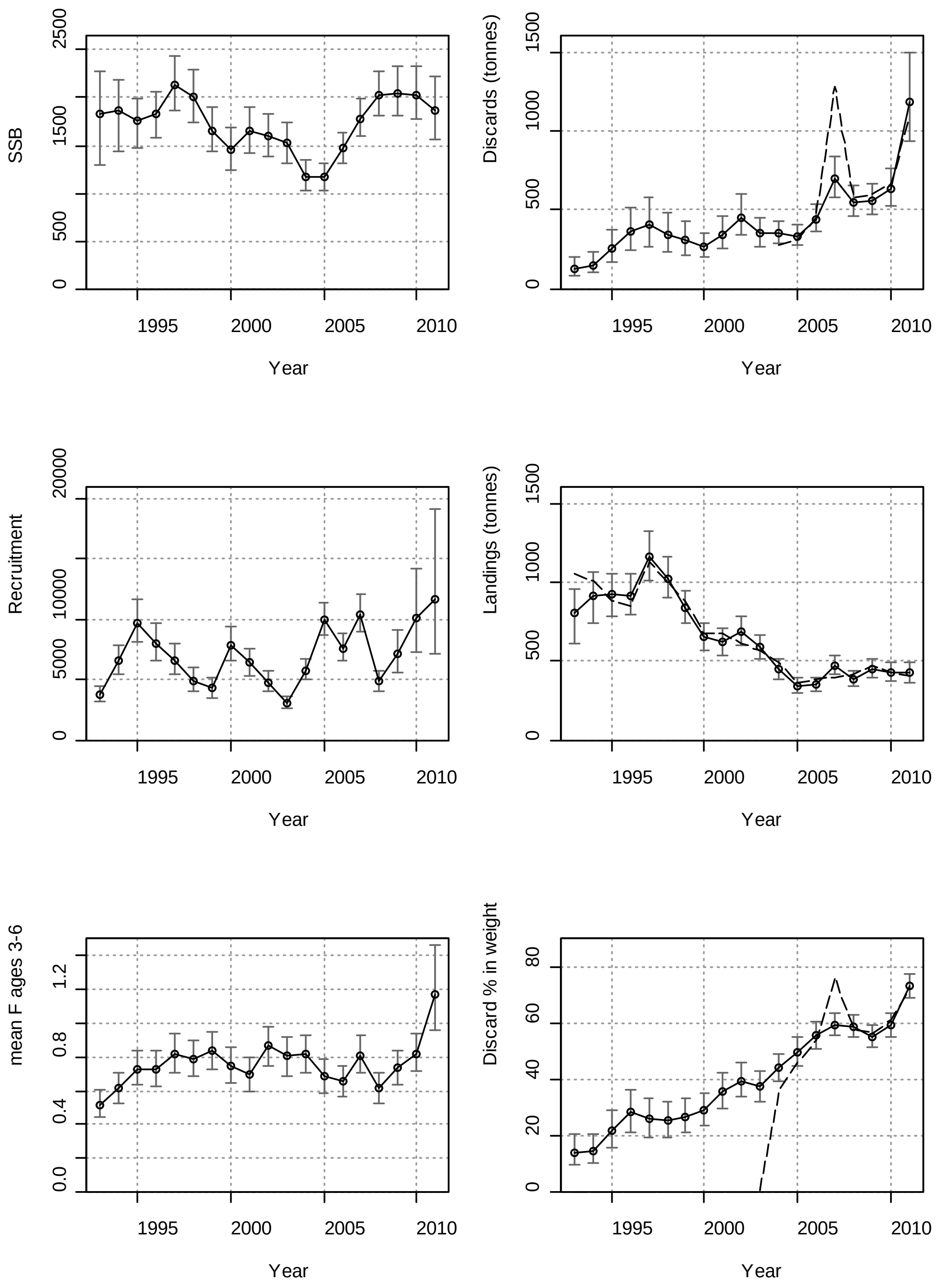

Figure 7.10.9. Plaice in Division VIIf&g: The estimated time-series of spawning–stock biomass, recruitment, average fishing mortality at ages 3–6, total discard weight, total landings weight and the discard percentage in weight with standard error bars derived from bootstrapping the hessian matrix, for the fit of the TI_TVS model for the data to 2011.

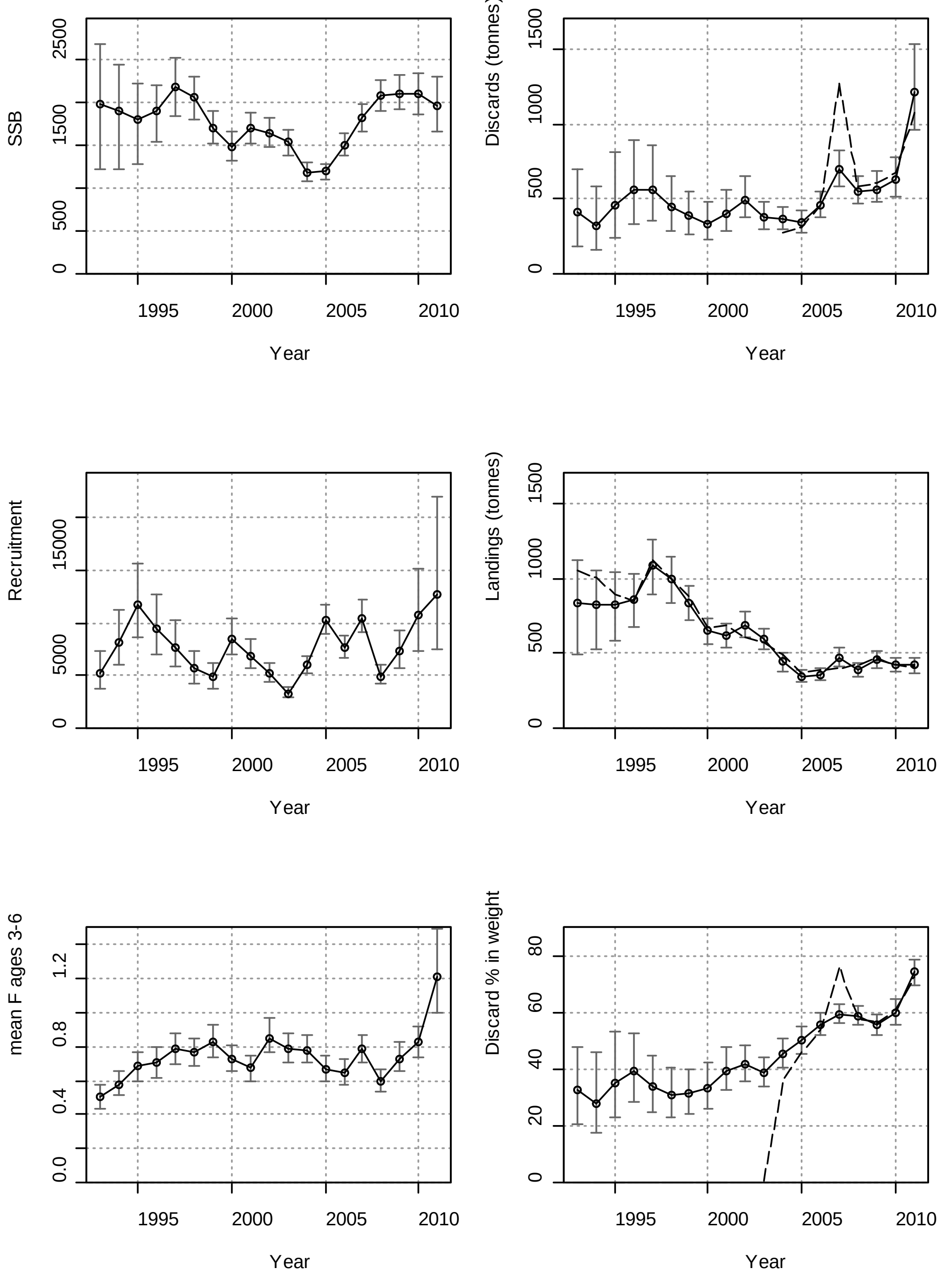

Figure 7.10.10a. Plaice in Division VIIf&g: The estimated time-series of spawning–stock biomass, recruitment, average fishing mortality at ages 3–6, total discard weight, total landings weight and the discard percentage in weight with standard error bars derived from bootstrapping the hessian matrix, for the fit of the TV_PTVS model for the data to 2011.

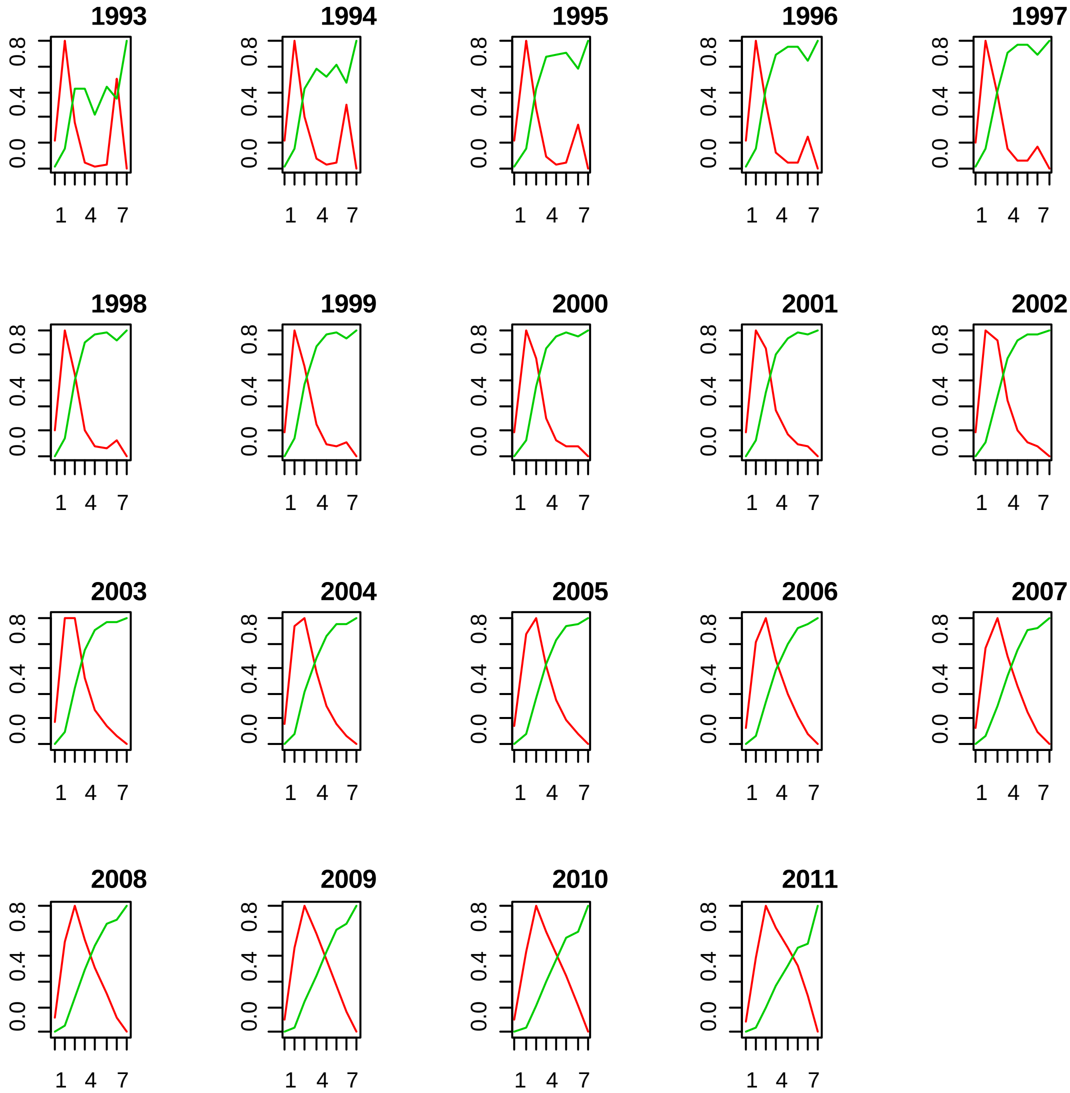

Figure 7.10.10b. Plaice in Division VIIf&g: The estimated selection pattern at-age for landings (green) and discards (red) scaled to a highest value = 1.0 for the TV_PTVS model which fits a time variant selection pattern to the landings and a polynomial time variant spline for the discard selection.

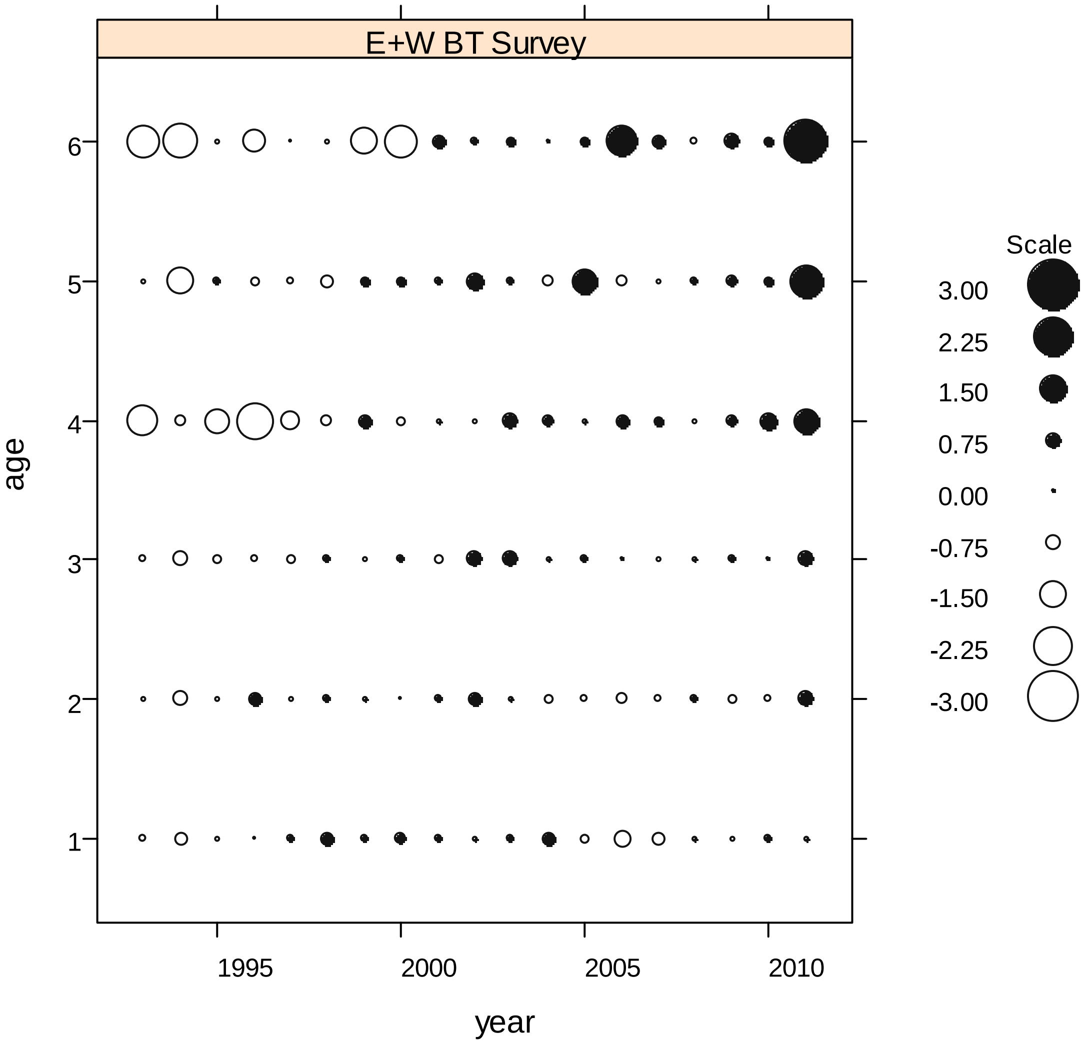

Figure 7.10.10c. Plaice in Division VIIf&g: The Log catchability residuals for the fit TV_PTVS model fit to the UKBT survey.

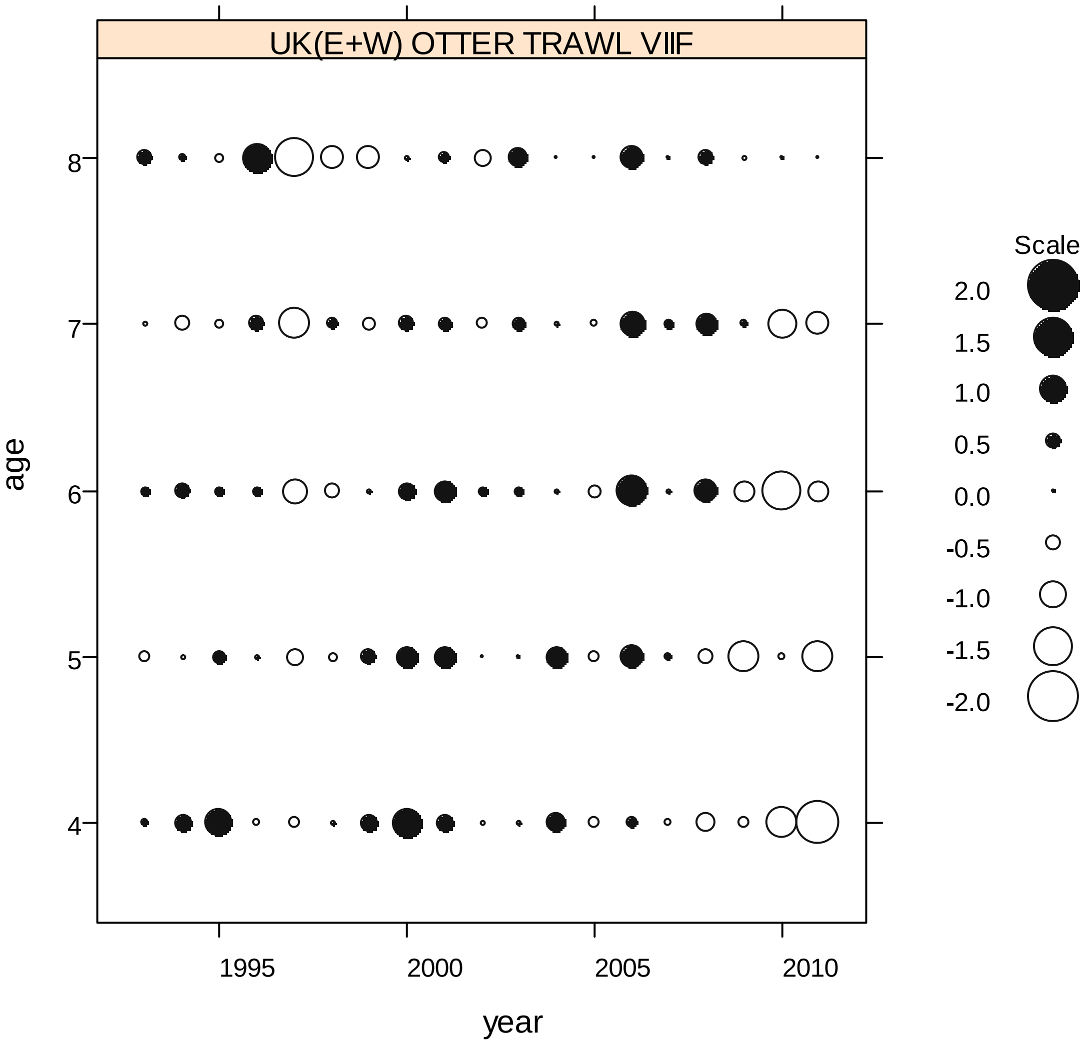

Figure 7.10.10d. Plaice in Division VIIf&g: The Log catchability residuals for the fit TV_PTVS model fit to the UK commercial otter trawl data.

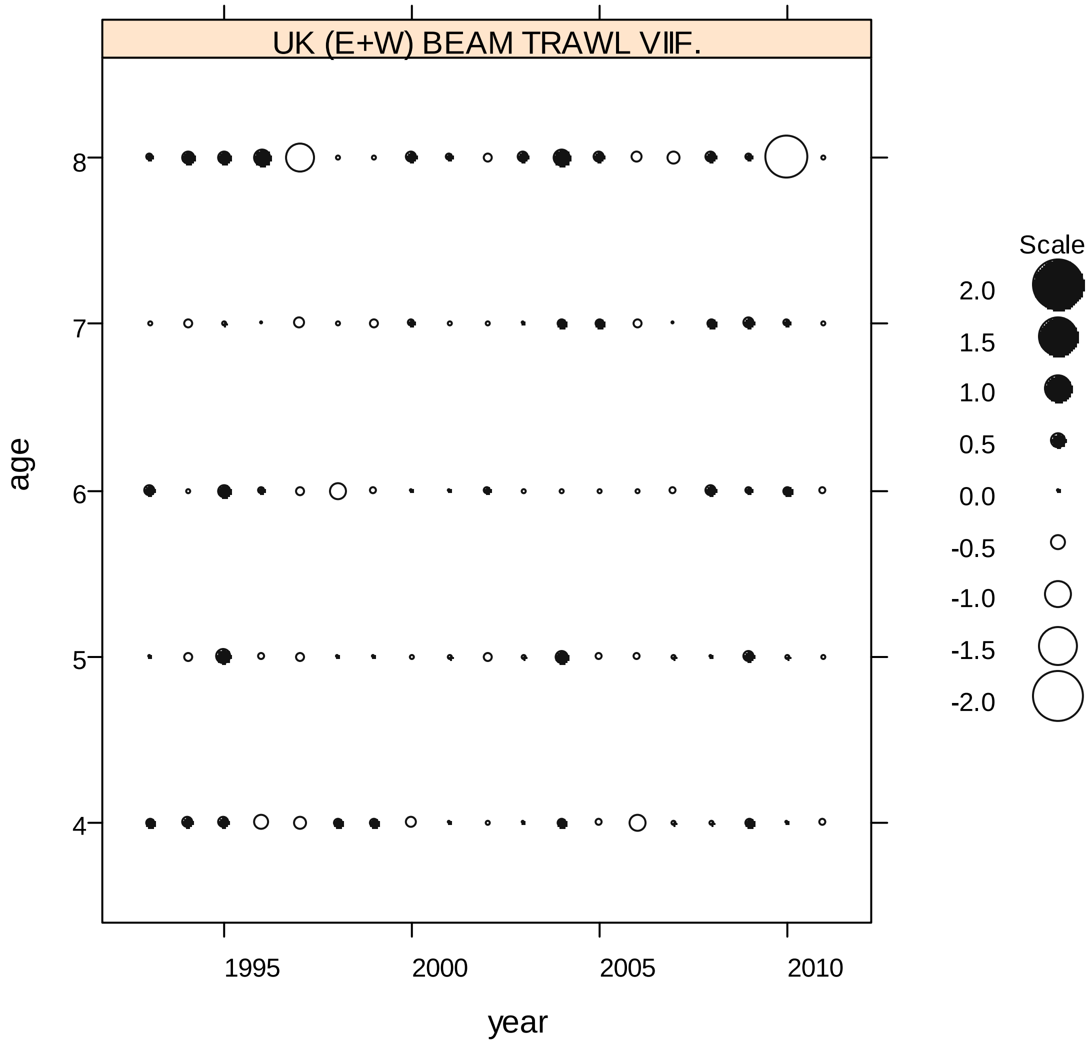

Figure 7.10.10e. Plaice in Division VIIf&g: The Log catchability residuals for the fit TV_PTVS model fit to the UK commercial beam trawl data.

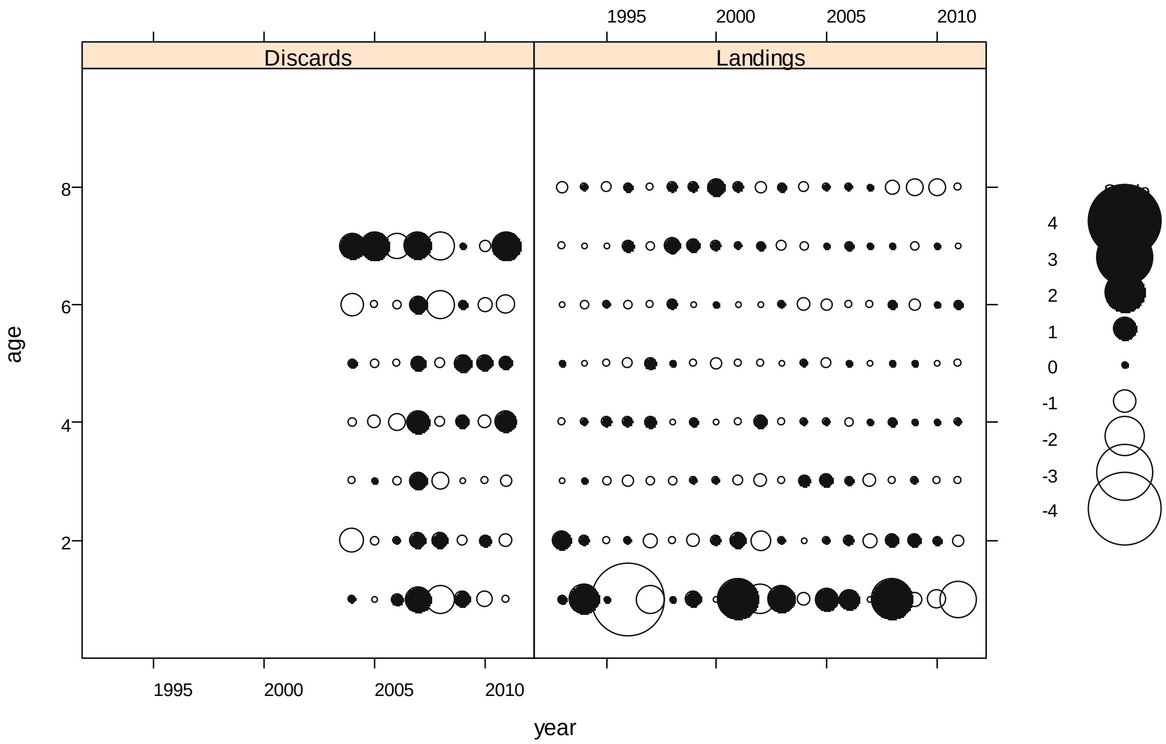

Figure 7.10.10f. Plaice in Division VIIf&g: The Log residuals for the fit TV_PTVS model fit to the discard and landings numbers-at-age data.

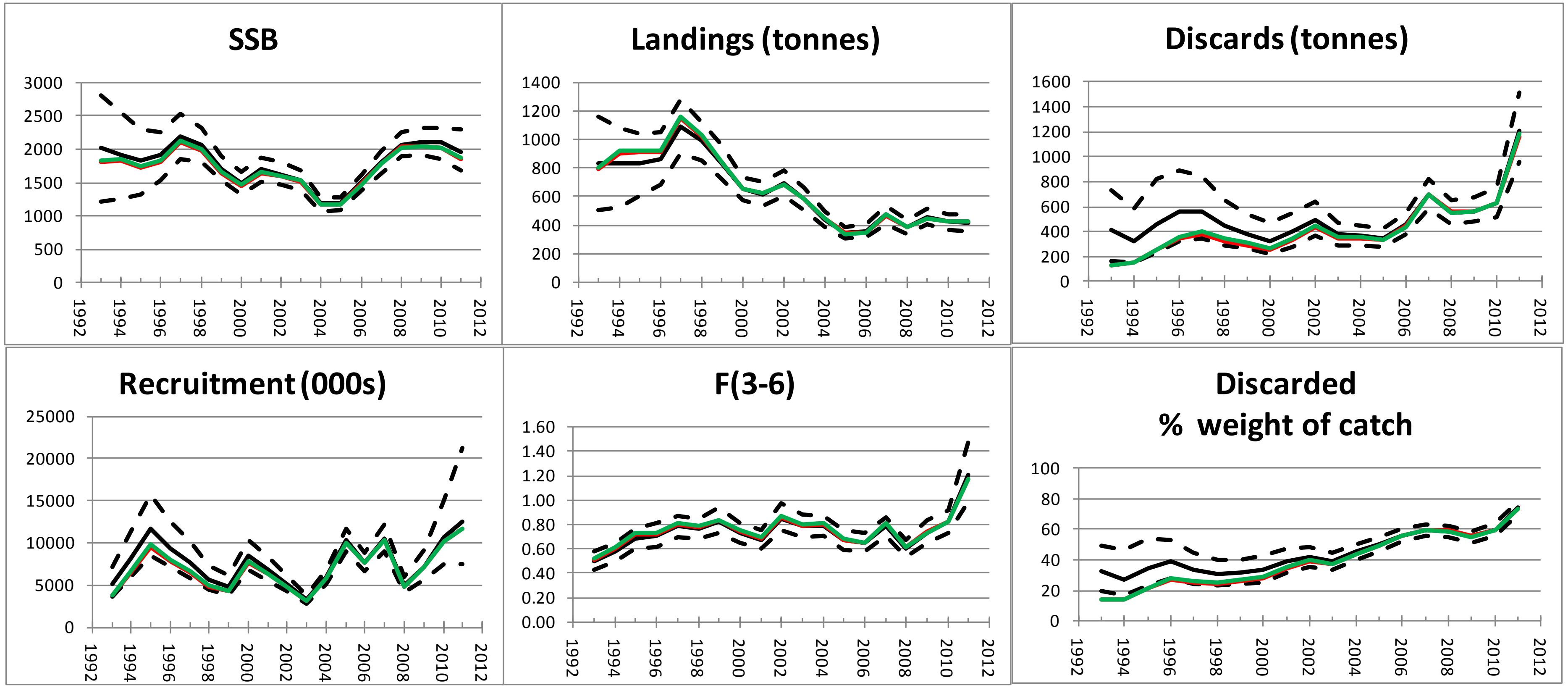

Figure 7.10.11. Plaice in Division VIIf&g: The time-series of stock and fishery trends from fits the three WKFLAT models; black lines preferred TV_PTVS model with 5 and 95% C.L. red lines TI_PTVS model, green lines TI_TVS model.

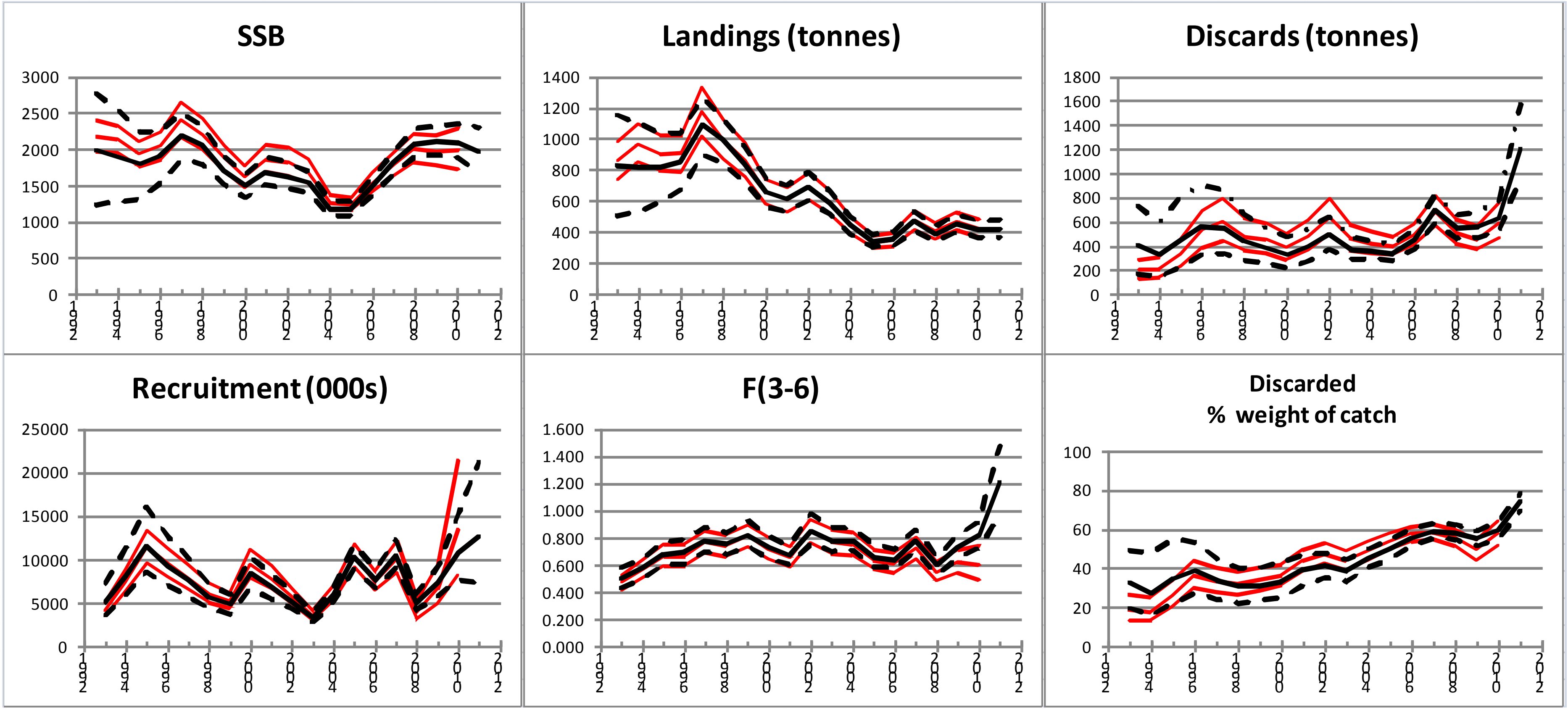

Figure 7.10.12. Plaice in Division VIIf&g: The time-series of stock and fishery trends from fits the 2010 and 2011 models; black lines preferred 2011 TV_PTVS model with 5 and 95% C.L. red lines the 2010 model.

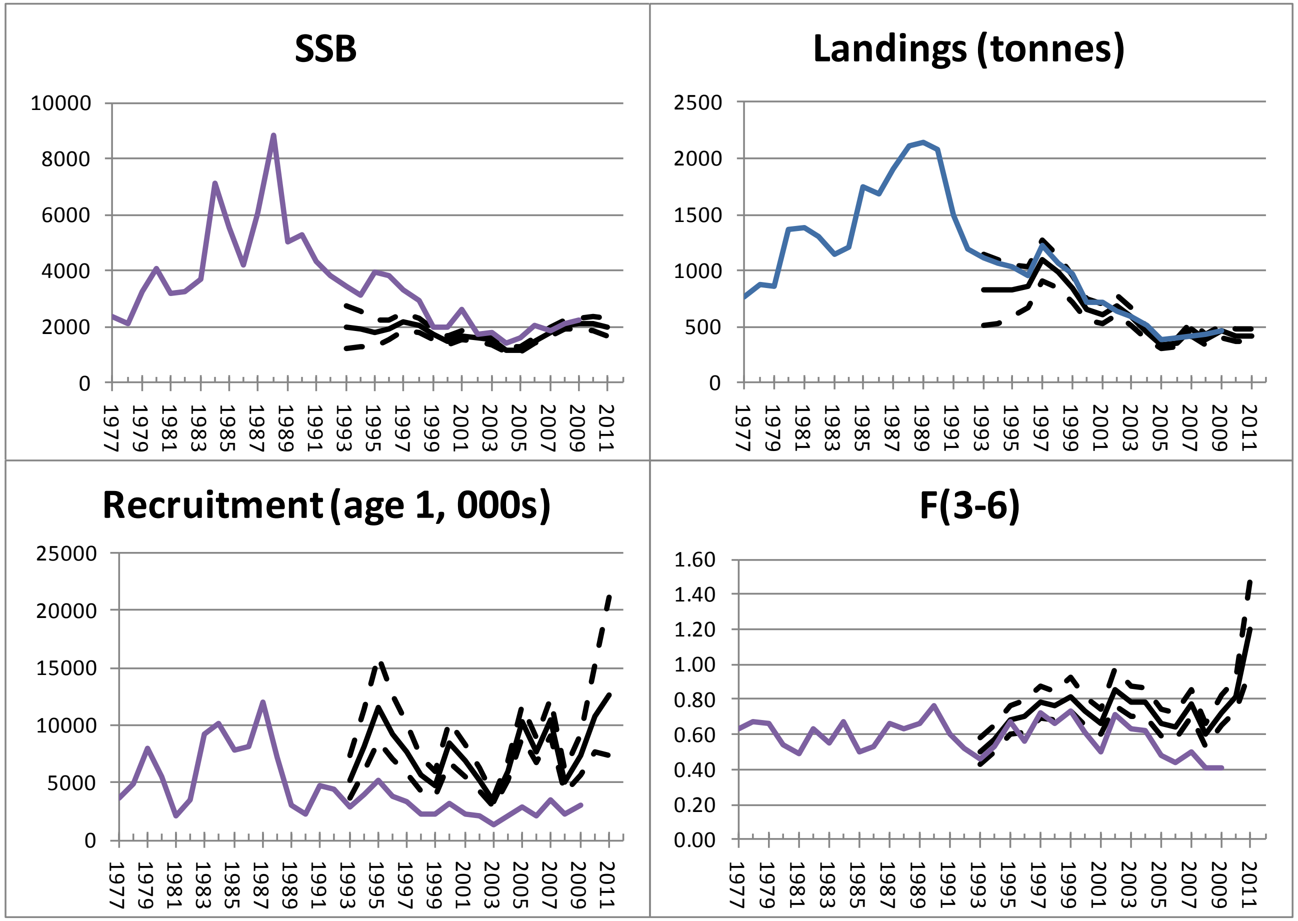

Figure 7.10.13. Plaice in Division VIIf&g: The time-series of stock and fishery trends from the preferred TV_PTVS model with 5 and 95% C.L. compared to the 2010 assessment estimates based on the landings only assessment.

7.11 Plaice in the southwest of Ireland (ICES Divisions VIIh–k)

Type of assessment in 2012

A separable VPA assessment was performed for the VIIjk component of the landings. This analysis uses catch numbers and weights were aggregated for the Irish landings for the years 1993–2011.

7.11.1 General

Stock Identity

Plaice in VIIj are mainly caught by Irish vessels on sandy grounds off counties Kerry and west Cork. Plaice 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 (these fish are mainly caught closer to the French coast in VIIh (Figure 7.11.14).

7.11.2 Data

The nominal landings are given in Table 7.11.1.

Most non-Irish landings were from VIIh which is likely to be a different stock. Because age data were only available for Irish landings (which were mainly from VIIjk) the remainder of Section 7.11 concerns Irish data only in VIIjk.

Sampling

Figure 7.11.1 shows that plaice landings in VIIjk in 2011 were mostly taken in VIIj by otter trawlers. This was reflected in the sampling.

Data quality

Figure 7.11.2 shows the length distribution of the Irish landings in VIIjk between 1993 and 2011. There are no distinct modes of strong year classes discernible. One sample was removed (420-DEM196); it contained 192 plaice at 27 cm and no other length classes. In 1994 and 1995 a considerable number of small plaice (<20 cm) appeared in the samples. The most likely explanation for this is that discard fish were mistakenly entered as landings; these were therefore excluded from the analysis. The sample numbers appeared to be sufficient.

The age data for 1995 were considered insufficient and for this year the combined age data for 1993–1996 were used.

Annual Age–Length-Keys (ALKs) were constructed (all quarters and gear types combined) and applied to the sampled length–frequency distributions. Figure 7.11.3 shows the age distribution of plaice in VIIjk between 1993 and 2011.

7.11.3 Historical stock development

Because plaice in VIIh were not sampled, it would not be appropriate to raise the data to all landings in VIIhjk. Instead, the official International landings figures for VIIjk were used to raise the age distributions (Table 7.11.2).

The estimated catch numbers-at-age are given in Table 7.11.3, catch weights-at-age are given in Table 7.11.4. There appears to be relatively little contrast (particularly weak or strong year classes) in the catch numbers. This is also illustrated by Figure

7.11.4, which shows the standardised catch proportions-at-age. Figure 7.11.5 shows the log catch numbers-at-age. The rate of decline in catch numbers through the cohorts appears to be reasonably stable. This can be further investigated by calculating the slope of the log-catch numbers (Z). Figure 7.11.6 shows the catch curves; plaice under the age of 4 are not fully selected and from age 7 onwards the data get quite noisy, therefore the slope of the log-catch numbers was estimated over ages 4 to 7 (Figure 7.11.7). The pseudo-cohort Z generally varied between 0.6 and 1.2. The estimate for Z appears to be quite variable.

Yield-per-recruit

The yield-per-recruit was estimated using a method by Thompson and Bell (1934). This method requires the selectivity to be estimated. This was done by estimating the slope of the log catch numbers for ages that are fully selected and using this slope (Z) to predict the population numbers for ages that are not fully selected. The Z was estimated on pseudo-cohorts which were standardised to take account of annual variations in the catch numbers. Figure 7.11.8 shows that plaice in VIIjk appear to be fully selected by the age of 4 and that after the age of 9 the data get very sparse. Figure 7.11.9 shows the slope of the mean log standardised catch numbers. The predicted catch numbers from this slope were used to estimate the 'observed' selectivity. This was then modelled by applying a linear model after a logit transformation. The estimated selection curve is also shown in Figure 7.11.9. A natural mortality of 0.12 was assumed (based on the value used by the WG for plaice in VIIfg) and the WG maturity ogive for plaice in VIIfg was used to estimate SSB. The yield was estimated for a range of F values based on the average catch weights. Figure 7.11.10 shows the YPR curve, F_{MAX} is estimated to be 0.39. $F_{0.1}$ is estimated as 0.21. Recent values of Z ranged from 0.55 to 1.2, with M=0.12 this would result in an F of between 0.43 and 1.08. This is well above F_{MAX} and $F_{0.1}$

7.11.4 Exploratory assessment

Several different exploratory assessments were carried out by means of a separable VPA in the Lowestoft suite. The initial runs explored the age range to be used in the separable and the choices of reference age, final F and S. The results of these are available on the ICES SharePoint site under data for this stock.

7.11.5 Final assessment

The results of the final separable assessment are given in Table 7.11.5. A terminal F of 0.5 on age 4 and a terminal S of 0.8 was used. The residual pattern is acceptable Figure 7.11.11. The S patterns for all but the youngest age were very stable throughout the time period and the results were largely similar for a separable of the last three years versus one over the whole time-series. At the youngest age selectivity has increased recently, or year classes are stronger than predicted by the model. More over the pattern of selectivity-at-age with a slight dome shape is consistent with the selectivities seen in other similar plaice fisheries. The F trajectory over the last few years looks fairly flat and indicates an apparent slight stepped reduction around 2005. There is some confidence in the population dynamic trends shown by this assessment, both because of the coherence of the age structure and because the results are consistent with many of the expectations of plaice stocks in general. The assessment provides an opportunity to formally quantify our understanding of the stock dynamics of plaice. While it would be desirable to have independent information on biomass trends in the form of an appropriate cpue or even lpue time-series and to perform less subjective assessment methods this should not preclude its use as the basis of advice.

The results of a traditional VPA based on the separable analysis is given in Table 7.11.6. Summary plots are shown in Figure 7.11.12. A yield-per-recruit was preformed with MFDP the results are shown in Figure 7.11.13. Current F_{BAR} 0.36 is above a poorly defined F_{MAX} value of 0.35. $F_{0.1}$ and $F_{35\%SPR}$ are at 0.13 and 0.14 respectively.

7.11.6 References

Thompson and Bell. 1934. W.F. Thompson and F.H. Bell, Biological statistics of the Pacific halibut fishery. 2. Effect of changes in intensity upon total yield and yield per unit of gear, Rep. Int. Fish. (Pacific Halibut) Comm. 8 (1934), p. 49.

Table 7.11.1. Plaice in Divisions VII h–k (Southwest Ireland). Nominal landings (t), 1987–2011, as officially reported to ICES.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995
Belgium*	250	245	403	301	252	246	344	197	235
Denmark	1	1	1	-	-	-	-	-	-
France	85	135	229	77	173	90	64	48	60
Ireland	300	369	454	338	478	477	383	271	321
Netherlands	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-
UK - Eng+Wales+N	.	.	73	88	287	264	218	258	282
UK - England & Wa	246	433	.	.	.	.	.	.	.
UK - Scotland	-	1	-	1	1	6	7	1	4
Total	882	1184	1160	805	1191	1083	1016	775	902

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004
Belgium*	304	442	335	45	4	27	69	20	67
Denmark	-	-	-	-	-	-	-	-	-
France	48	69	49	.	54	50	45	32	32
Ireland	305	344	286	299	200	160	155	127	91
Netherlands	52	-	13	1	2	-	-	-	-
Spain	-	-	-	1	5	3	2	6	6
UK - Eng+Wales+N	154	138	106	82	75	73	59	56	36
UK - England & Wa	.	.	.	.	.	.	.	.	.
UK - Scotland	1	1	1	1	1	-	-	-	-
Total	864	994	790	428	341	313	330	241	232

Country	2005	2006	2007	2008	2009	2010	2011
Belgium	32	22	7	25	1		4
Denmark							
France	20	37	30	12	44	55	57
Ireland	90	65	72	72	71	66	71
Netherlands	.						
Spain	.	1	13	1			
UK - Eng+Wales+N	28	18	20	12	32	35	44
UK - England & Wa	.						
UK - Scotland	.						
Total	170	143	142	122	148	156	176

Table 7.11.2. Official landings of plaice in divisions VIIj and VIIk only.

Year	Bel	Fra	Irl	Esp	UK	Total
1993	.	8	383	-	46	437
1994	.	6	251	-	60	317
1995	.	12	317	-	90	419
1996	.	3	295	-	38	336
1997	.	6	337	-	32	375
1998	.	8	282	-	16	306
1999	42	0	296	<0.5	15	353
2000	4	16	195	5	9	229
2001	-	16	157	3	6	182
2002	14	21	155	2	5	197
2003	4	7	125	6	9	151
2004	<0.5	5	87	6	6	104
2005	-	4	88	-	2	94
2006	-	6	63	1	1	71
2007	-	9	72	11	2	94
2008	-	5	72	1	1	79
2009	-	7	71	-	2	79
2010	-	11	66	-	1	78
2011*	-	10	66	-	2	78

*** Preliminary data.**

Table 7.11.3. Catch numbers-at-age for plaice in VIIjk.

	1	2	3	4	5	6	7	8	9	10	11	12+
1993	0	93	624	479	115	45	23	10	6	2	0	1
1994	68	104	340	260	82	45	18	8	5	2	1	0
1995	10	207	633	348	107	36	16	7	5	1	2	0
1996	1	77	314	228	127	37	23	5	3	0	0	0
1997	0	166	277	268	119	42	19	4	0	0	0	9
1998	0	46	355	164	103	38	26	10	4	3	0	0
1999	11	143	312	201	65	37	18	11	9	2	2	8
2000	2	74	161	190	64	36	7	5	3	2	0	2
2001	1	55	165	146	47	6	22	2	7	0	0	0
2002	0	54	155	172	54	42	44	12	4	2	0	1
2003	0	74	166	65	29	6	15	10	1	2	1	0
2004	7	31	121	91	27	12	2	2	4	1	1	0
2005	1	25	71	77	48	22	13	4	0	1	0	1
2006	0	17	41	53	38	12	7	1	1	0	2	0
2007	0	47	136	61	22	17	4	2	0	0	0	0
2008	1	55	106	70	21	5	2	1	0	0	0	0
2009	0	13	112	78	30	11	5	0	1	0	0	0
2010	1	47	36	51	36	15	4	1	1	1	0	0
2011	0	17	77	50	33	20	10	3	1	0	0	0

Table 7.11.4. Weight-at-age for plaice in VIIjk.

	1	2	3	4	5	6	7	8	9	10	11	12+
1993		0.196	0.256	0.306	0.417	0.582	0.751	0.939	1.151	1.532		1.983
1994	0.046	0.222	0.302	0.368	0.460	0.563	0.708	0.873	1.029	1.311	1.374	
1995	0.100	0.228	0.272	0.325	0.391	0.521	0.651	0.840	0.817	1.536	1.540	
1996	0.029	0.298	0.379	0.432	0.463	0.512	0.529	0.493	0.398	2.324		
1997	1.112	0.295	0.339	0.430	0.483	0.654	0.807	0.937				1.319
1998		0.249	0.308	0.419	0.529	0.690	0.779	0.757	0.941	1.192	2.201	
1999	0.218	0.289	0.354	0.417	0.596	0.627	0.840	0.882	1.170	1.729	2.120	1.136
2000	0.120	0.273	0.348	0.420	0.486	0.609	0.807	1.107	1.439	1.080		1.393
2001	0.215	0.243	0.325	0.405	0.537	0.644	0.800	0.550	1.115			
2002		0.211	0.296	0.328	0.415	0.498	0.567	0.701	1.014	1.098		1.533
2003		0.274	0.358	0.402	0.482	0.575	0.734	0.876	1.041	1.875	1.259	
2004	0.129	0.259	0.310	0.341	0.448	0.550	0.631	0.637	0.900	1.139	1.326	1.807
2005	0.170	0.238	0.276	0.324	0.381	0.459	0.731	0.949		1.223	1.535	1.992
2006		0.272	0.319	0.370	0.438	0.519	0.794	0.895	0.791	0.395	1.878	
2007		0.239	0.281	0.354	0.433	0.482	0.573	0.727	1.394	0.837	1.266	
2008	0.293	0.239	0.282	0.336	0.358	0.529	0.754	0.399	1.100	1.554		
2009		0.224	0.255	0.335	0.403	0.462	0.520		1.080		1.393	1.138
2010	0.217	0.257	0.310	0.342	0.369	0.462	0.563	0.739	0.735	0.718	2.512	
2011	0.286	0.257	0.282	0.321	0.355	0.407	0.626	0.625	0.507	0.841	0.963	1.133

Table 7.11.5. Separable VPA analysis diagnostics plaice in VIIjk.

1 Title : PLE7jk, WGCSE 2012, COMBSEX, PLUSGROUP

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Separable analysis

from 1993 to 2011 on ages 2 to 6

with Terminal F of .500 on age 4 and Terminal S of .800

Initial sum of squared residuals was 65.734 and

final sum of squared residuals is 9.254 after 42 iterations

Matrix of Residuals

Years,	1993/94,	1994/95,	1995/96,	1996/97,	1997/98,	1998/99,	1999/**,	2000/**,
Ages								
2/ 3,	-.637,	-.535,	.315,	-.100,	.167,	-.783,	.800,	-.081,
3/ 4,	.133,	-.100,	.354,	-.012,	.056,	.286,	-.041,	-.603,
4/ 5,	.377,	.231,	-.296,	-.105,	-.131,	.039,	-.031,	.039,
5/ 6,	-.467,	.151,	-.254,	.332,	.038,	.123,	-.572,	1.020,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.001,
WTS ,	1.000,	1.000,	1.000,	1.000,	1.000,	1.000,	1.000,	1.000,

Years,	2001/**,	2002/**,	2003/**,	2004/**,	2005/**,	2006/**,	2007/**,	2008/**,	2009/**,	2010/**,	TOT,	WTS,
2/ 3,	.272,	-.630,	.363,	.303,	.425,	-.712,	-.087,	.260,	-.112,	.771,	-.001,	.415,
3/ 4,	-.150,	-.119,	.129,	.285,	-.092,	-.312,	.051,	.017,	.423,	-.306,	-.001,	.799,
4/ 5,	.280,	.098,	-.163,	-.080,	-.265,	.397,	-.138,	-.012,	-.158,	-.083,	-.001,	1.000,
5/ 6,	-.583,	.551,	-.195,	-.586,	.345,	.317,	.284,	-.235,	-.288,	.016,	-.001,	.468,
TOT ,	.000,	.000,	-.001,	-.001,	-.001,	.000,	-.001,	-.001,	.000,	.000,	-.005,	
WTS ,	1.000,	1.000,	1.000,	1.000,	1.000,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
F-values,	.9935,	.6999,	.9577,	.7275,	.8920,	.8468,	1.0253,	1.0307,	.7986,

,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,
F-values,	1.2206,	.7558,	.6192,	.6723,	.5637,	.8181,	.5842,	.5166,	.4744,	.5000,

Selection-at-age (S)

,	2,	3,	4,	5,	6,
S-values,	.1589,	.6664,	1.0000,	.9352,	.8000,

Run title : PLE7jk, WGCSE 2012, COMBSEX, PLUSGROUP

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SEPARABLY GENERATED FISHING MORTALITIES

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE									
2,	.1579,	.1112,	.1522,	.1156,	.1418,	.1346,	.1629,	.1638,	.1269,
3,	.6621,	.4664,	.6381,	.4848,	.5944,	.5643,	.6832,	.6868,	.5322,
4,	.9935,	.6999,	.9577,	.7275,	.8920,	.8468,	1.0253,	1.0307,	.7986,
5,	.9291,	.6545,	.8956,	.6803,	.8342,	.7919,	.9588,	.9639,	.7469,
6,	.7948,	.5599,	.7661,	.5820,	.7136,	.6775,	.8202,	.8246,	.6389,

SEPARABLY GENERATED FISHING MORTALITIES

YEAR,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,
AGE										
2,	.1940,	.1201,	.0984,	.1068,	.0896,	.1300,	.0928,	.0821,	.0754,	.0795,
3,	.8133,	.5037,	.4126,	.4480,	.3757,	.5451,	.3893,	.3442,	.3161,	.3332,
4,	1.2206,	.7558,	.6192,	.6723,	.5637,	.8181,	.5842,	.5166,	.4744,	.5000,
5,	1.1414,	.7068,	.5791,	.6287,	.5272,	.7650,	.5463,	.4831,	.4437,	.4676,
6,	.9765,	.6047,	.4954,	.5379,	.4510,	.6545,	.4674,	.4132,	.3795,	.4000,

SEPARABLY GENERATED POPULATION NUMBERS

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE									
2,	1334,	1354,	1232,	842,	827,	853,	625,	607,	489,
3,	1155,	1010,	1075,	938,	665,	637,	661,	471,	457,
4,	624,	528,	562,	503,	513,	326,	321,	296,	210,
5,	240,	205,	233,	191,	216,	186,	124,	102,	94,
6,	86,	84,	94,	84,	86,	83,	75,	42,	35,

SEPARABLY GENERATED POPULATION NUMBERS

YEAR,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,
AGE										
2,	500,	439,	235,	246,	388,	462,	413,	227,	516,	260,
3,	382,	365,	345,	189,	196,	315,	360,	334,	186,	425,
4,	238,	150,	196,	203,	107,	119,	162,	216,	210,	120,
5,	84,	62,	63,	93,	92,	54,	47,	80,	114,	116,

6, 39, 24, 27, 31, 44, 48, 22, 24, 44, 65,

1 Run title : PLE7jk, WGCSE 2012, COMBSEX, PLUSGROUP

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Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE									
2,	-.0792,	-.0340,	.0452,	-.0108,	.0518,	-.0742,	.1022,	-.0231,	.0167,
3,	.0994,	-.0551,	.1566,	-.0190,	-.0024,	.1515,	-.0518,	-.2022,	-.0537,
4,	.2545,	.0678,	-.0825,	-.0465,	-.0523,	-.0752,	.0681,	-.1087,	.2026,
5,	-.1787,	.0038,	-.1280,	.1793,	.0157,	.0503,	-.2273,	.2639,	-.1927,
6,	-.0055,	.1279,	-.1415,	.0204,	.0043,	-.0095,	-.0394,	.2653,	-.3449,

Fishing mortality residuals

YEAR,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,
AGE										
2,	-.0769,	.0689,	.0408,	.0157,	-.0442,	-.0141,	.0517,	-.0183,	.0502,	.0000,
3,	-.1501,	.0591,	.0710,	.0383,	-.1051,	.0073,	-.0162,	.0999,	-.0502,	-.0792,
4,	.0336,	-.1618,	.0125,	-.0766,	.1757,	-.0840,	-.0257,	-.0431,	-.0630,	.0753,
5,	.1482,	-.0492,	-.1143,	.1029,	.0762,	-.0290,	-.0129,	-.0283,	.0268,	-.0519,
6,	.3732,	-.2131,	.0655,	.2874,	-.0695,	-.1126,	-.1578,	.1224,	.1145,	.0293,

1

Table 7.11.6. Separable VPA traditions VPA outputs from a separable VPA analysis for plaice in VIIjk.

Run title : PLE7jk, WGCSE 2012, COMBSEX, PLUSGROUP

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Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE									
2,	.0787,	.0772,	.1974,	.1048,	.1935,	.0604,	.2651,	.1407,	.1436,
3,	.7614,	.4112,	.7947,	.4658,	.5919,	.7158,	.6314,	.4846,	.4785,
4,	1.2481,	.7676,	.8751,	.6809,	.8396,	.7717,	1.0934,	.9220,	1.0012,
5,	.7505,	.6583,	.7676,	.8596,	.8498,	.8423,	.7315,	1.2277,	.5542,
6,	.7893,	.6878,	.6246,	.6024,	.7179,	.6679,	.7808,	1.0898,	.2940,
+gp,	.7893,	.6878,	.6246,	.6024,	.7179,	.6679,	.7808,	1.0898,	.2940,
0 FBAR 2- 6,	.7256,	.5204,	.6519,	.5427,	.6386,	.6116,	.7004,	.7730,	.4943,

Table 8 Fishing mortality (F) at age

YEAR,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	FBAR **-**
AGE											
2,	.1171,	.1890,	.1392,	.1225,	.0454,	.1159,	.1446,	.0638,	.1256,	.0795,	.0896,
3,	.6633,	.5628,	.4836,	.4863,	.2705,	.5524,	.3731,	.4442,	.2660,	.2539,	.3214,
4,	1.2541,	.5941,	.6317,	.5957,	.7394,	.7341,	.5585,	.4734,	.4114,	.5753,	.4867,
5,	1.2897,	.6576,	.4647,	.7316,	.6034,	.7360,	.5334,	.4548,	.4705,	.4157,	.4470,
6,	1.3497,	.3915,	.5609,	.8252,	.3815,	.5419,	.3096,	.5357,	.4940,	.4293,	.4863,
+gp,	1.3497,	.3915,	.5609,	.8252,	.3815,	.5419,	.3096,	.5357,	.4940,	.4293,	
0 FBAR 2- 6,	.9348,	.4790,	.4560,	.5523,	.4081,	.5360,	.3838,	.3944,	.3535,	.3507,	

1

Run title : PLE7jk, WGCSE 2012, COMBSEX, PLUSGROUP

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Traditional vpa Terminal populations from weighted Separable populations

Table 9 Relative F at age

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE									
2,	.1084,	.1483,	.3028,	.1932,	.3030,	.0988,	.3785,	.1821,	.2905,
3,	1.0494,	.7902,	1.2191,	.8583,	.9270,	1.1704,	.9014,	.6269,	.9680,
4,	1.7201,	1.4750,	1.3425,	1.2547,	1.3149,	1.2617,	1.5610,	1.1928,	2.0256,
5,	1.0343,	1.2649,	1.1775,	1.5839,	1.3308,	1.3771,	1.0444,	1.5883,	1.1211,
6,	1.0878,	1.3216,	.9581,	1.1100,	1.1243,	1.0921,	1.1147,	1.4099,	.5948,
+gp,	1.0878,	1.3216,	.9581,	1.1100,	1.1243,	1.0921,	1.1147,	1.4099,	.5948,
0 REFMEAN,	.7256,	.5204,	.6519,	.5427,	.6386,	.6116,	.7004,	.7730,	.4943,

Table 9 Relative F at age

YEAR,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	MEAN **-**
AGE											
2,	.1252,	.3947,	.3053,	.2219,	.1113,	.2162,	.3766,	.1618,	.3552,	.2265,	.2479,
3,	.7096,	1.1749,	1.0605,	.8806,	.6630,	1.0305,	.9721,	1.1262,	.7524,	.7240,	.8676,
4,	1.3416,	1.2402,	1.3851,	1.0786,	1.8121,	1.3694,	1.4550,	1.2005,	1.1639,	1.6403,	1.3349,

5, 1.3797, 1.3729, 1.0191, 1.3247, 1.4787, 1.3730, 1.3897, 1.1532, 1.3310, 1.1851, 1.2231,
6, 1.4439, .8174, 1.2299, 1.4942, .9349, 1.0109, .8066, 1.3583, 1.3975, 1.2241, 1.3266,
+gp, 1.4439, .8174, 1.2299, 1.4942, .9349, 1.0109, .8066, 1.3583, 1.3975, 1.2241,
0 REFMEAN, .9348, .4790, .4560, .5523, .4081, .5360, .3838, .3944, .3535, .3507,
1

Run title : PLE7jk, WGCSE 2012, COMBSEX, PLUSGROUP

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Traditional vpa Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE									
2,	1301,	1480,	1225,	819,	1002,	841,	651,	594,	438,
3,	1232,	1066,	1215,	892,	654,	732,	702,	443,	458,
4,	705,	510,	627,	487,	497,	321,	317,	331,	242,
5,	230,	179,	210,	232,	219,	190,	132,	94,	117,
6,	86,	96,	82,	86,	87,	83,	73,	56,	25,
+gp,	81,	73,	70,	75,	68,	93,	99,	29,	130,
0 TOTAL,	3635,	3405,	3430,	2591,	2526,	2260,	1973,	1547,	1409,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	2012,	GMST 93-**	AMST 93-**
AGE													
2,	515,	453,	252,	232,	399,	455,	430,	230,	502,	260,	0,	568,	666,
3,	337,	407,	333,	194,	182,	338,	360,	330,	191,	393,	213,	494,	581,
4,	252,	154,	205,	182,	106,	123,	173,	220,	188,	130,	270,	276,	321,
5,	79,	64,	75,	97,	89,	45,	52,	88,	121,	110,	65,	113,	129,
6,	60,	19,	29,	42,	41,	43,	19,	27,	49,	67,	65,	49,	56,
+gp,	88,	99,	23,	33,	37,	19,	14,	16,	23,	50,	68,		
0 TOTAL,	1330,	1196,	918,	780,	854,	1023,	1047,	910,	1074,	1010,	680,		

1

Run title : PLE7jk, WGCSE 2012, COMBSEX, PLUSGROUP

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Traditional vpa Terminal populations from weighted Separable populations

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE									
2,	338,	385,	319,	213,	260,	219,	169,	154,	114,
3,	641,	555,	632,	464,	340,	381,	365,	230,	238,
4,	606,	439,	539,	419,	427,	276,	273,	285,	208,
5,	230,	179,	210,	232,	219,	190,	132,	94,	117,
6,	86,	96,	82,	86,	87,	83,	73,	56,	25,
+gp,	81,	73,	70,	75,	68,	93,	99,	29,	130,

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

YEAR, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011,

AGE										
2,	134,	118,	66,	60,	104,	118,	112,	60,	131,	67,
3,	175,	211,	173,	101,	94,	176,	187,	172,	99,	204,
4,	216,	132,	177,	156,	91,	106,	148,	189,	161,	112,
5,	79,	64,	75,	97,	89,	45,	52,	88,	121,	110,
6,	60,	19,	29,	42,	41,	43,	19,	27,	49,	67,
+gp,	88,	99,	23,	33,	37,	19,	14,	16,	23,	50,

1

Run title : PLE7jk, WGCSE 2012, COMBSEX, PLUSGROUP

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Traditional vpa Terminal populations from weighted Separable populations

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE									
2,	255,	329,	279,	244,	296,	209,	188,	162,	106,
3,	315,	322,	331,	338,	222,	225,	249,	154,	149,
4,	216,	188,	204,	210,	214,	134,	132,	139,	98,
5,	96,	83,	82,	107,	106,	101,	78,	46,	63,
6,	50,	54,	43,	44,	57,	57,	46,	34,	16,
+gp,	74,	62,	57,	41,	65,	77,	102,	32,	111,
0 TOTALBIO,	1006,	1037,	995,	985,	959,	804,	795,	568,	543,

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,
AGE										
2,	109,	124,	65,	55,	109,	109,	103,	51,	129,	67,
3,	100,	146,	103,	54,	58,	95,	101,	84,	59,	111,
4,	83,	62,	70,	59,	39,	44,	58,	74,	64,	42,
5,	33,	31,	34,	37,	39,	19,	19,	35,	45,	39,
6,	30,	11,	16,	19,	21,	21,	10,	13,	23,	27,
+gp,	56,	90,	20,	27,	36,	13,	9,	10,	15,	32,
0 TOTALBIO,	410,	463,	308,	251,	302,	301,	300,	267,	335,	318,

Run title : PLE7jk, WGCSE 2012, COMBSEX, PLUSGROUP

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Traditional vpa Terminal populations from weighted Separable populations

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE									
2,	66,	85,	73,	63,	77,	54,	49,	42,	28,
3,	164,	167,	172,	176,	115,	117,	129,	80,	77,
4,	186,	162,	175,	181,	184,	116,	114,	120,	84,
5,	96,	83,	82,	107,	106,	101,	78,	46,	63,
6,	50,	54,	43,	44,	57,	57,	46,	34,	16,
+gp,	74,	62,	57,	41,	65,	77,	102,	32,	111,
0 TOTSPBIO,	636,	613,	601,	613,	604,	522,	518,	354,	379,

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,
AGE										
2,	28,	32,	17,	14,	28,	28,	27,	13,	34,	17,

3,	52,	76,	54,	28,	30,	49,	53,	44,	31,	58,
4,	71,	53,	60,	51,	34,	37,	50,	63,	55,	36,
5,	33,	31,	34,	37,	39,	19,	19,	35,	45,	39,
6,	30,	11,	16,	19,	21,	21,	10,	13,	23,	27,
+gp,	56,	90,	20,	27,	36,	13,	9,	10,	15,	32,
0 TOTSPBIO,	270,	293,	201,	177,	189,	169,	168,	179,	202,	210,

1

Run title : PLE7jk, WGCSE 2012, COMBSEX, PLUSGROUP

At 17/05/2012 18:10

Traditional vpa Terminal populations from weighted Separable populations

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE									
2,	255,	332,	280,	244,	295,	209,	190,	162,	107,
3,	316,	325,	331,	338,	222,	226,	250,	154,	149,
4,	216,	190,	204,	210,	213,	135,	133,	139,	98,
5,	96,	83,	82,	107,	106,	101,	79,	46,	63,
6,	50,	55,	43,	44,	57,	57,	46,	34,	16,
+gp,	74,	62,	57,	41,	65,	77,	103,	32,	111,
0 TOTALBIO,	1006,	1048,	998,	985,	958,	804,	801,	568,	543,

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,
AGE										
2,	109,	124,	66,	55,	108,	109,	103,	51,	129,	67,
3,	100,	146,	104,	54,	58,	95,	102,	84,	59,	111,
4,	83,	62,	71,	59,	39,	43,	58,	74,	64,	42,
5,	33,	31,	34,	37,	39,	19,	19,	35,	45,	39,
6,	30,	11,	16,	19,	21,	21,	10,	13,	23,	27,
+gp,	56,	90,	20,	28,	36,	13,	9,	10,	15,	32,
0 TOTALBIO,	410,	464,	311,	252,	302,	301,	302,	267,	336,	318,

1

Run title : PLE7jk, WGCSE 2012, COMBSEX, PLUSGROUP

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Traditional vpa Terminal populations from weighted Separable populations

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE									
2,	66,	86,	73,	63,	77,	54,	49,	42,	28,
3,	164,	169,	172,	176,	115,	117,	130,	80,	77,
4,	186,	163,	176,	181,	184,	116,	115,	120,	84,
5,	96,	83,	82,	107,	106,	101,	79,	46,	63,
6,	50,	55,	43,	44,	57,	57,	46,	34,	16,
+gp,	74,	62,	57,	41,	65,	77,	103,	32,	111,
0 TOTSPBIO,	636,	619,	603,	613,	603,	522,	522,	355,	379,

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR,	2002,	2003,	2004,	2005,	2006,	2007,	2008,	2009,	2010,	2011,

AGE										
2,	28,	32,	17,	14,	28,	28,	27,	13,	34,	17,
3,	52,	76,	54,	28,	30,	49,	53,	44,	31,	58,
4,	71,	53,	61,	51,	34,	37,	50,	63,	55,	36,
5,	33,	31,	34,	37,	39,	19,	19,	35,	45,	39,
6,	30,	11,	16,	19,	21,	21,	10,	13,	23,	27,
+gp,	56,	90,	20,	28,	36,	13,	9,	10,	15,	32,
0 TOTSPBIO,	270,	293,	202,	177,	189,	169,	168,	179,	203,	210,

1

Run title : PLE7jk, WGCSE 2012, COMBSEX, PLUSGROUP,

At 17/05/2012 18:10

Table 16 Summary (without SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

,	RECRUITS,	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 2–6,
,	Age 2					
1993,	1301,	1006,	636,	437,	.6872,	.7256,
1994,	1480,	1037,	613,	317,	.5172,	.5204,
1995,	1225,	995,	601,	419,	.6968,	.6519,
1996,	819,	985,	613,	336,	.5483,	.5427,
1997,	1002,	959,	604,	375,	.6213,	.6386,
1998,	841,	804,	522,	306,	.5864,	.6116,
1999,	651,	795,	518,	353,	.6809,	.7004,
2000,	594,	568,	354,	229,	.6466,	.7730,
2001,	438,	543,	379,	182,	.4805,	.4943,
2002,	515,	410,	270,	197,	.7304,	.9348,
2003,	453,	463,	293,	151,	.5153,	.4790,
2004,	252,	308,	201,	104,	.5185,	.4560,
2005,	232,	251,	177,	94,	.5324,	.5523,
2006,	399,	302,	189,	71,	.3761,	.4081,
2007,	455,	301,	169,	94,	.5572,	.5360,
2008,	430,	300,	168,	79,	.4715,	.3838,
2009,	230,	267,	179,	79,	.4423,	.3944,
2010,	502,	335,	202,	78,	.3855,	.3535,
2011,	260,	318,	210,	78,	.3719,	.3507,
Arith. Mean ,	636,	576,	363,	209,	.5456,	.5530,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Run title : PLE7jk, WGCSE 2012, COMBSEX, PLUSGROUP,

At 17/05/2012 18:10

Table 17 Summary (with SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

,	RECRUITS,	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 2–6,
,	Age 2						
1993,	1301,	1006,	636,	437,	.6871,	1.0002,	.7256,
1994,	1480,	1048,	619,	317,	.5120,	1.0102,	.5204,
1995,	1225,	998,	603,	419,	.6950,	1.0026,	.6519,
1996,	819,	985,	613,	336,	.5484,	.9998,	.5427,
1997,	1002,	958,	603,	375,	.6215,	.9996,	.6386,
1998,	841,	804,	522,	306,	.5863,	1.0001,	.6116,
1999,	651,	801,	522,	353,	.6758,	1.0076,	.7004,

2000,	594,	568,	355,	229,	.6457,	1.0015,	.7730,
2001,	438,	543,	379,	182,	.4799,	1.0012,	.4943,
2002,	515,	410,	270,	197,	.7297,	1.0010,	.9348,
2003,	453,	464,	293,	151,	.5148,	1.0010,	.4790,
2004,	252,	311,	202,	104,	.5139,	1.0089,	.4560,
2005,	232,	252,	177,	94,	.5310,	1.0026,	.5523,
2006,	399,	302,	189,	71,	.3763,	.9994,	.4081,
2007,	455,	301,	169,	94,	.5576,	.9992,	.5360,
2008,	430,	302,	168,	79,	.4696,	1.0041,	.3838,
2009,	230,	267,	179,	79,	.4425,	.9994,	.3944,
2010,	502,	336,	203,	78,	.3848,	1.0018,	.3535,
2011,	260,	318,	210,	78,	.3715,	1.0012,	.3507,

Arith. Mean ,	636,	578,	364,	209,	.5444	.5530,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

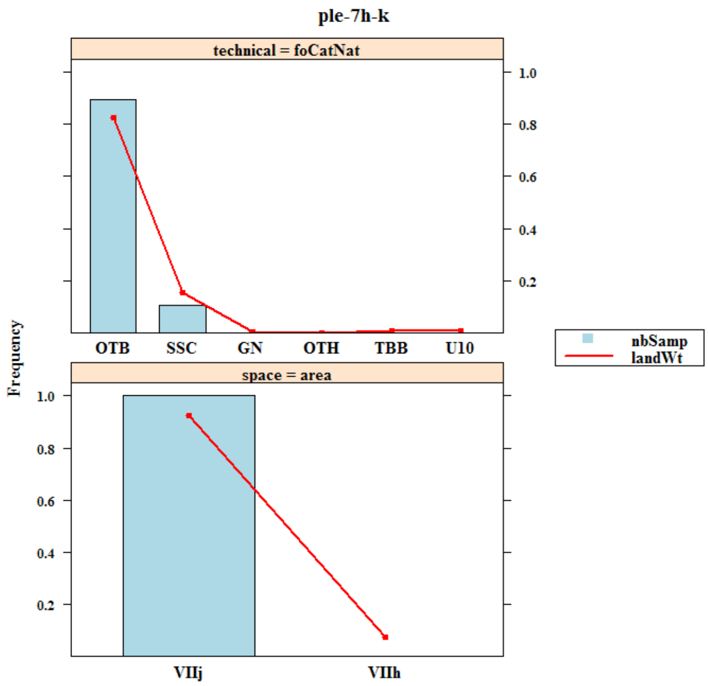


Figure 7.11.1. Irish Operational landings and sampling levels (number of samples) for plaice in VIIjk by geartype (top) and ICES division (bottom). The sampling appears to be representative of the landings.

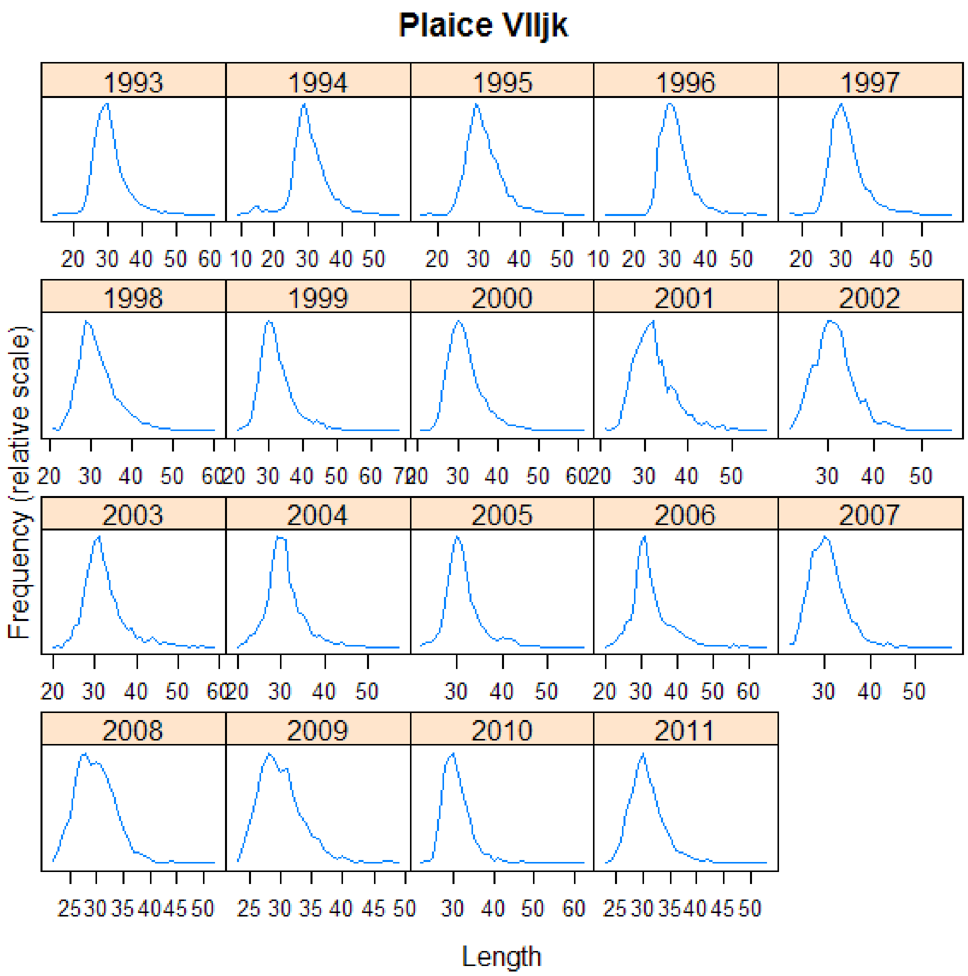


Figure 7.11.2. Length–frequency distribution of the Irish landings of plaice in VIIjk between 1993 and 2011. All gears and quarters combined.

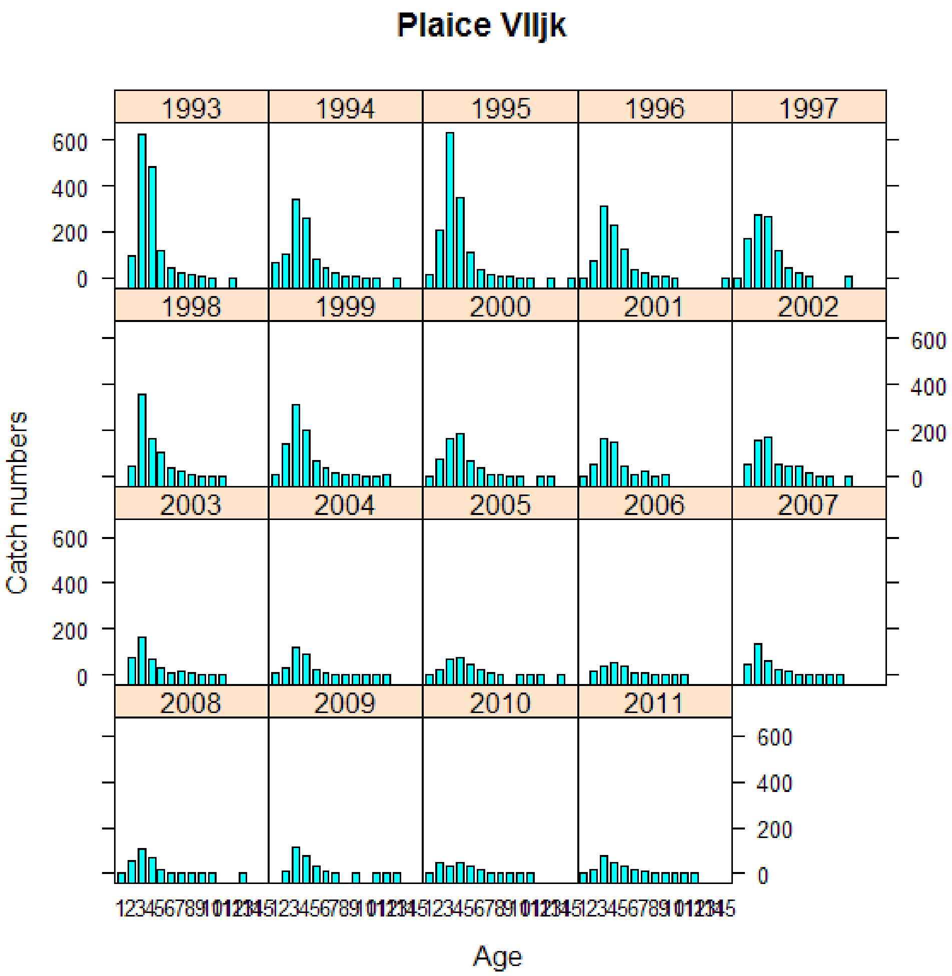


Figure 7.11.3. Age distribution of plaice in VIIjk between 1993 and 2011. All gears and quarters combined. The age data for 1995 were considered insufficient and for this year the combined age data for 1993–1996 were used.

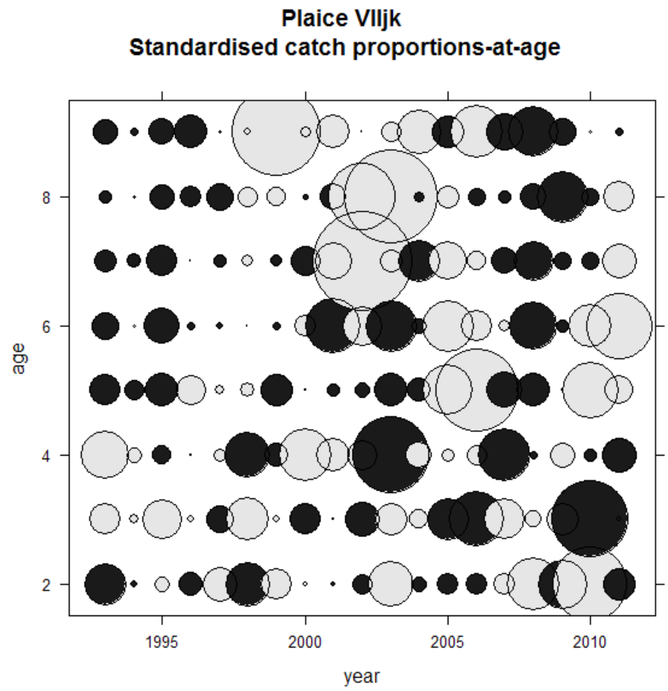


Figure 7.11.4. Standardised catch proportions-at-age for plaice in VIIjk. Grey bubbles represent higher than average catch-at-age and black bubbles represent lower than average catch-at-age.

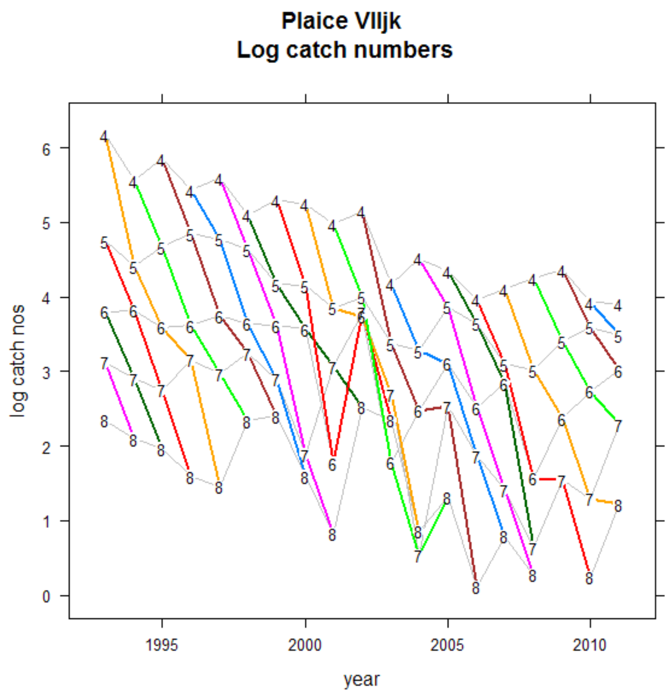


Figure 7.11.5. Log catch numbers-at-age (ages 4–8).

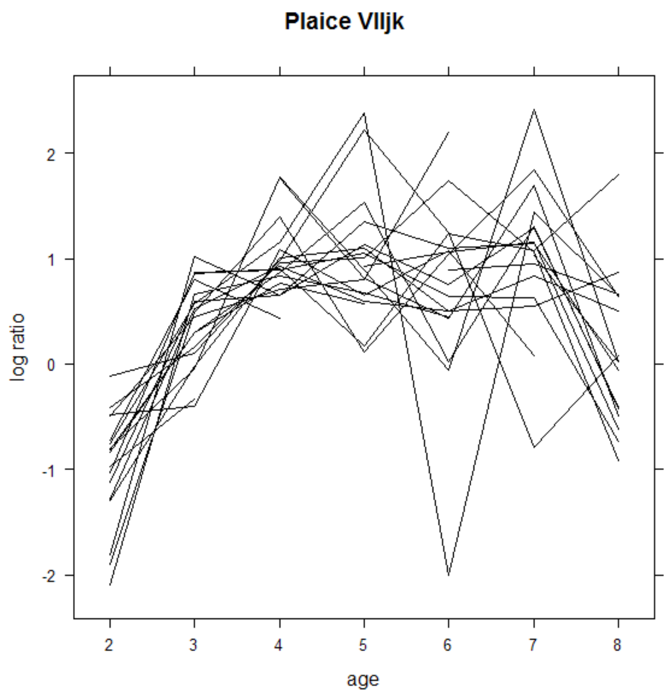


Figure 7.11.6. Catch curves of plaice in VIIhk. Plaice from the age of 4 appear to be fully selected, the data get quite noisy from the age of 7 onwards.

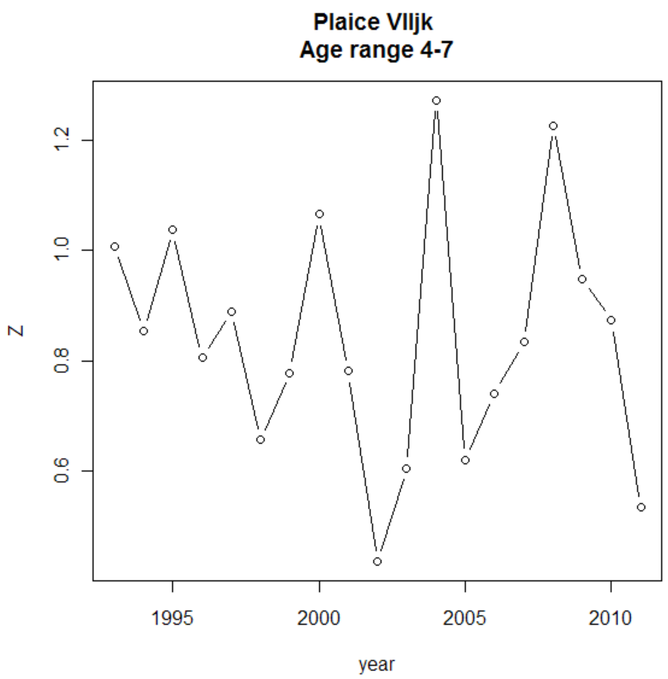


Figure 7.11.7. Z estimated over pseudo-cohorts as the slope of the log catch numbers.

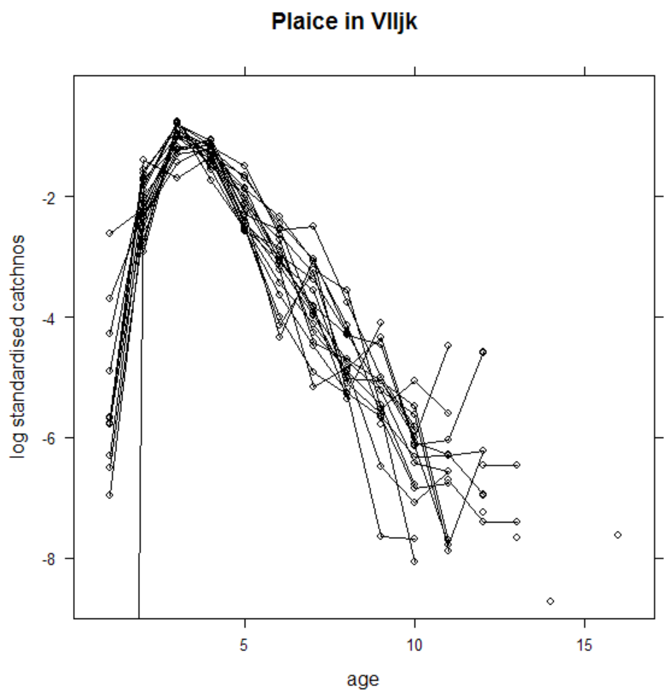


Figure 7.11.8. Log catch numbers (standardised by year). Fish appear to be fully selected from the age of 4.

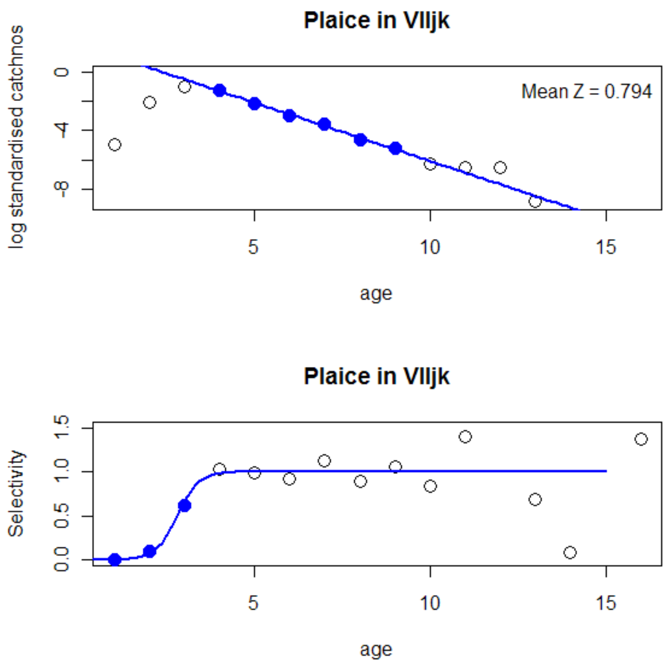


Figure 7.11.9. Selectivity was modelled by fitting a line through the mean log standardised catch numbers of ages 4 to 9 to predict the expected catch numbers for ages 1 to 3 if these were fully selected. The proportions of observed divided by expected catch number were taken as the 'observed' selectivity. This was then modelled using a logit transformation.

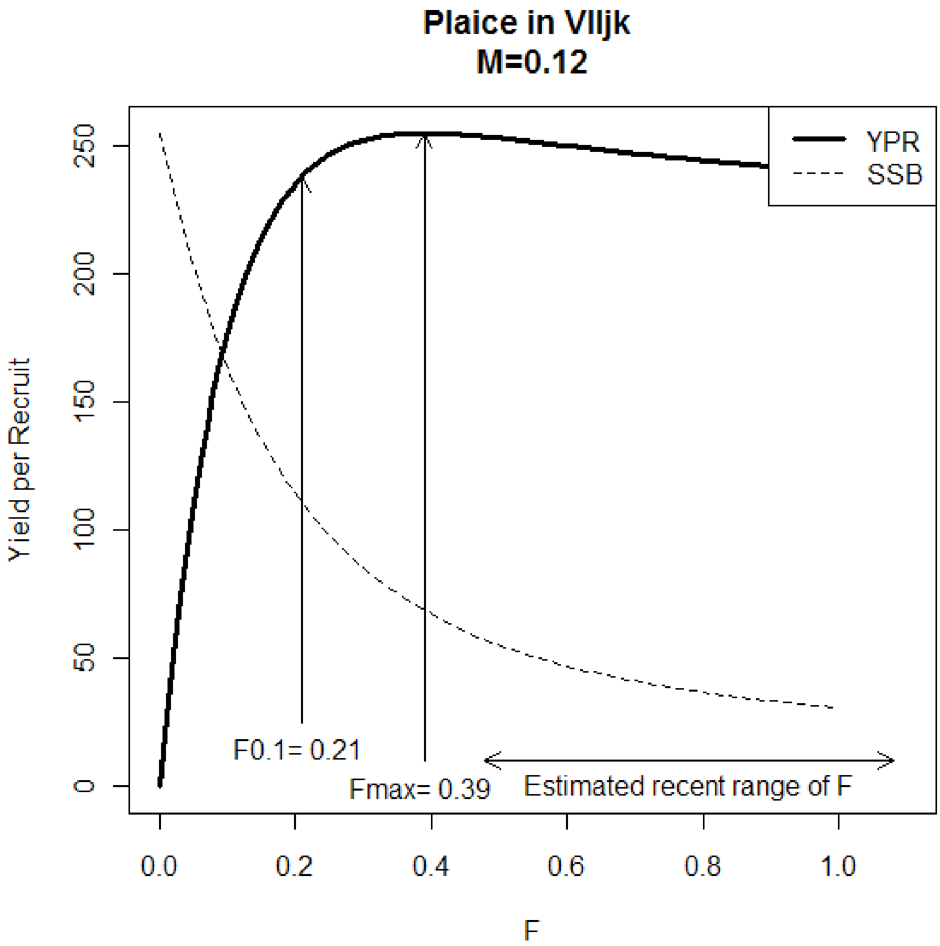


Figure 7.11.10. YPR analysis using the Thompson-Bell approach. Recent estimates of Z were between 0.6 to 1.2 which translates to an F of 0.48 to 1.08.

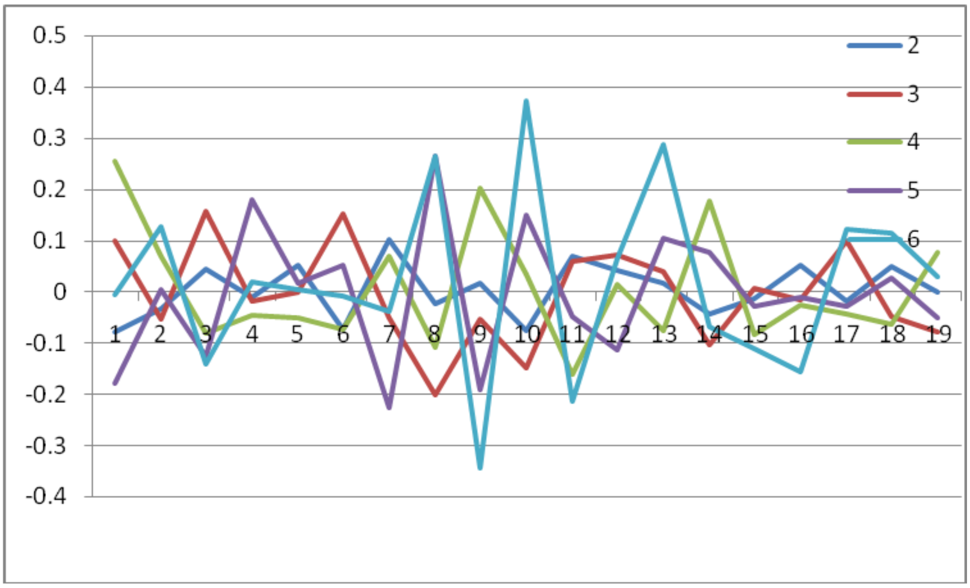


Figure 7.11.11. Fishing mortality residuals at age for a separable VPA with Terminal F of 0.5 on age 4 and Terminal S of 0.8 on age 6 and a fixed selection pattern over the entire time-series.

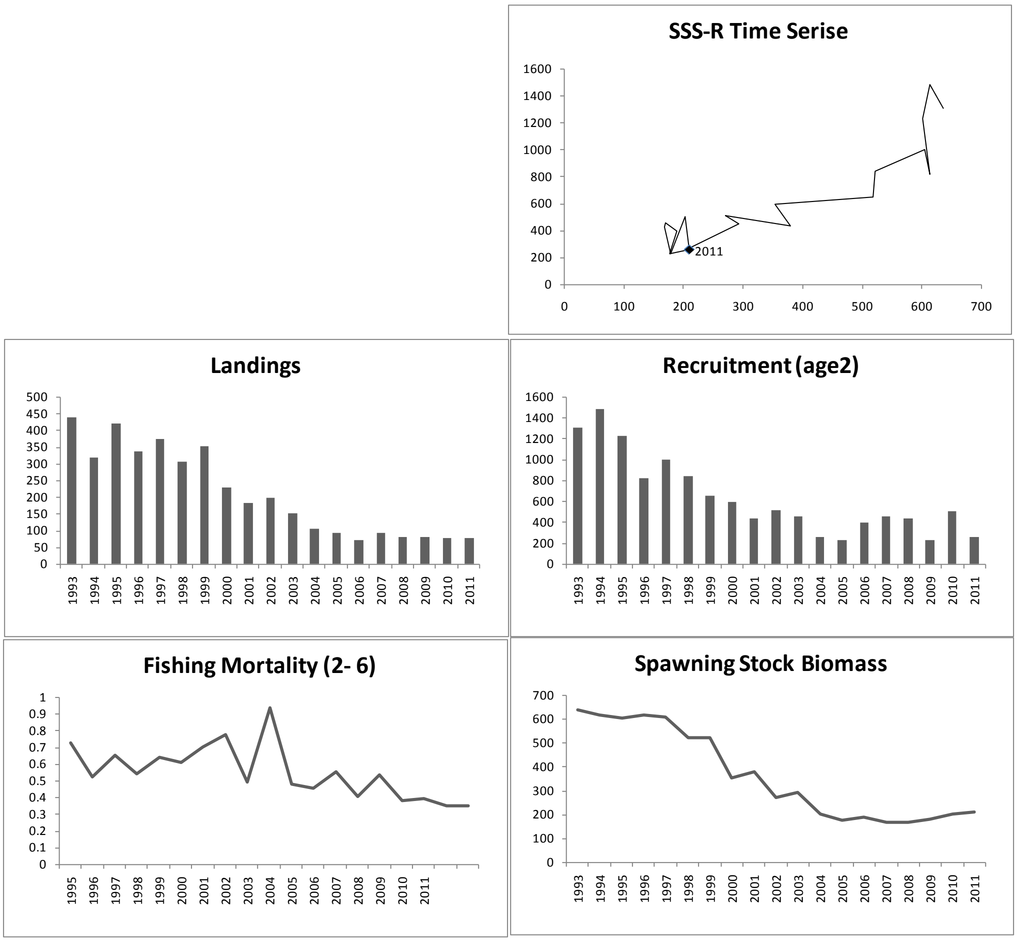
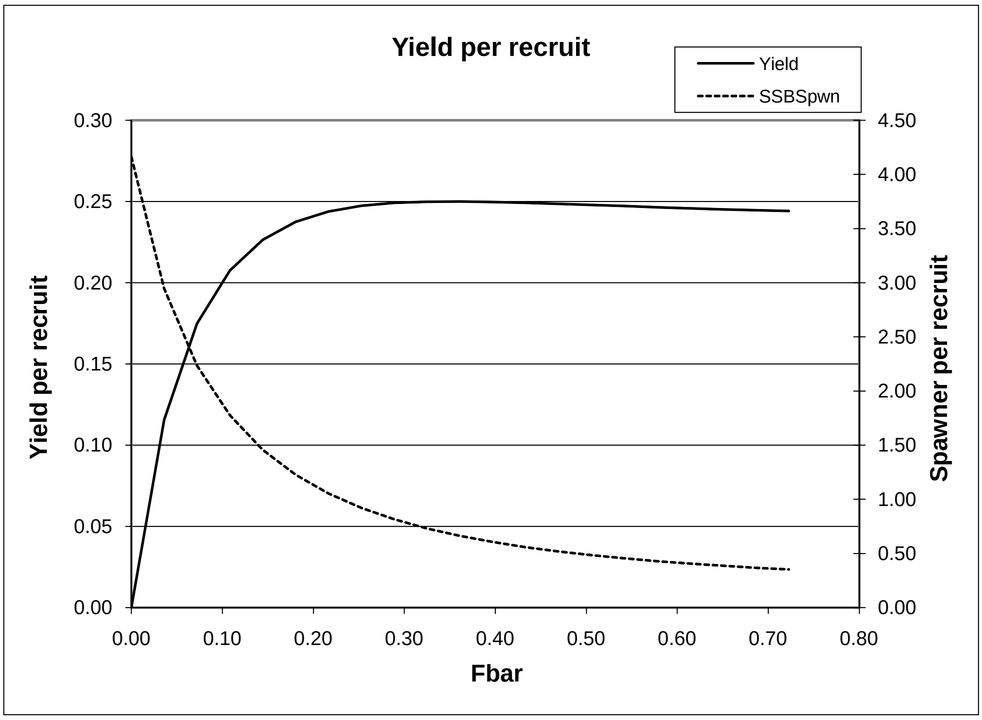


Figure 7.11.12. PleVIIjk Time-series of Landings, Recruitment, Fishing Mortality, Spawning–Stock Biomass and Stock–Recruitment for a Traditional vpa Terminal populations from weighted Separable populations.



MFYPR version 2a
Run: Ple7kj
Time and date: 06:25 18/05/2012

Reference point	F multiplier	Absolute F
Fbar(2-7)	1.0000	0.3612
FMax	0.9659	0.3489
F0.1	0.3735	0.1349
F35%SPR	0.3995	0.1443

Weights in kilograms

Figure 7.11.13. PleVIIjk Yield-Per-Recruit analysis.

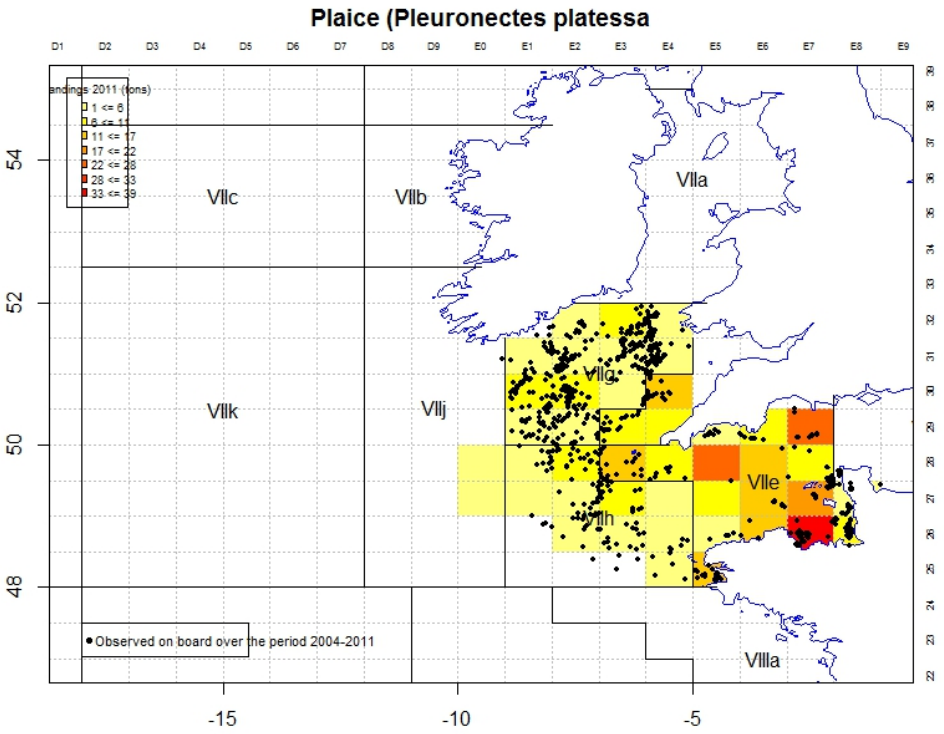


Figure 7.11.14. PleVIIhjk. The spatial distribution French landings of Plaice from VIIhjk and surrounding areas. Observed hauls where plaice were caught are also plotted.

7.12 Sole in West of Ireland Division VIIb, c

Type of assessment in 2012

No assessment was performed.

7.12.1 General

Stock Identity

Sole in VIIb are mainly caught by Irish vessels on sandy grounds in coastal areas. Sole catches in VIIc are negligible. In VIIb there are two distinct areas where sole are caught: an area to the west of the Aran Islands and an area in the north of VIIb which extends into VIa (the Stags and Broadhaven Ground). The landings and lpue of sole in VIIbc appear to have been more or less stable since the start of the logbooks time-series in 1995 (WD1, WGCSE 2009 & Figure 7.12.2.). 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 nominal landings are given in Table 7.12.1. The time-series of official landings is presented in Figure 7.12.1.

The time-series of otter trawl landings effort and lpue since 1995 are shown in Figure 7.12.2. Lpue has remained stable over the time-series.

7.12.3 Historical stock development

No analytical assessment was performed but following recommendations from WGLIFE a Depletion-Corrected Average Catch (DCAC; MacCall, 2009) analysis was performed. Because the value of the depletion delta parameter is unknown, a range of values were used (10%, 50% and 90%; delta is the difference in biomass in the first year and biomass in the last year as a proportion of the virgin biomass (unfished vulnerable abundance). Also, because average catch is analysed, the year-range chosen can have a large influence on the results. Two year ranges were tested: 1950–present (the time period after WWII when the stock was heavily exploited) and 1995–present (the time period when the landings showed a declining trend). All other settings are based on default values and recommendations from MacCall (2009). Table 7.9.2 shows the input and output values. The year-range has a major influence on the estimated depletion-corrected average catch.

The most conservative estimate of DCAC for the long time-series (35 tonnes) is similar to recent landings.

The limited information available (lpue and DCAC indicate that this stock may be harvested sustainably).

7.12.4 Reference

MacCall, AD. 2009. Depletion-corrected average catch: a simple formula fro estimating sustainable yields in data-poor situations. ICES J Mar Sci 66:10 p. 2267–2271.

Table 7.12.1. Landings of Sole in VIIbc 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	1961	0	110	1	12	0	123		
1909	0	0	0	32	0	32	1962	0	100	0	8	0	108		
1910	0	0	0	28	0	28	1963	0	172	0	19	0	191		
1911	0	0	1	22	0	23	1964	0	159	1	24	0	184		
1912	0	0	1	22	0	23	1965	0	95	5	24	0	124		
1913	0	0	1	25	0	26	1966	0	0	1	11	0	12		
1914	0	0	1	43	0	44	1967	0	78	0	11	0	89		
1915	0	0	1	12	0	13	1968	0	121	0	8	0	129		
1916	0	0	0	14	0	14	1969	0	86	1	9	0	96		
1917	0	0	0	6	0	6	1970	0	3	0	8	0	11		
1918	0	0	0	7	0	7	1971	0	0	2	5	0	7		
1919	0	0	0	6	0	6	1972	0	4	0	13	0	17		
1920	0	0	9	5	0	14	1973	0	0	0	12	0	12		
1921	0	0	10	9	0	19	1974	0	25	0	12	0	37		
1922	0	0	4	9	0	13	1975	0	7	0	19	0	26		
1923	0	0	2	10	0	12	1976	0	6	0	44	0	50		
1924	0	0	15	64	0	79	1977	0	3	0	14	0	17		
1925	0	0	11	18	0	29	1978	0	3	0	16	0	19		
1926	0	7	10	18	0	35	1979	0	6	0	13	0	19		
1927	0	47	11	19	0	77	1980	0	9	0	24	0	33		
1928	0	49	8	16	0	73	1981	0	6	0	47	0	53		
1929	0	74	11	18	0	103	1982	0	5	1	55	0	61		
1930	0	52	5	22	0	79	1983	0	9	0	40	0	49		
1931	0	82	9	29	0	120	1984	0	3	0	17	0	20		
1932	0	122	10	27	0	159	1985	0	6	0	44	0	50		
1933	0	411	10	10	0	431	1986	0	8	0	29	0	37		
1934	0	217	10	13	0	240	1987	0	2	0	39	0	41		
1935	0	40	7	11	0	58	1988	0	2	1	34	0	37		
1936	0	43	20	9	0	72	1989	0	0	0	38	0	38		
1937	0	32	25	14	0	71	1990	0	0	0	41	0	41		
1938	0	44	21	7	0	72	1991	0	5	0	46	0	51		
1939	0	0	0	13	0	13	1992	0	2	0	43	0	45		
1940	0	0	0	19	0	19	1993	0	1	0	59	0	60	0	60
1941	0	0	0	14	0	14	1994	0	1	0	60	0	61	9	70
1942	0	0	0	8	0	8	1995	0	2	0	59	0	61	-2	59
1943	0	0	0	11	0	11	1996	0	2	0	52	0	54	3	57
1944	0	0	0	16	0	16	1997	0	3	1	51	0	55	0	55
1945	0	0	0	20	0	20	1998	0	0	0	49	0	49	17	66
1946	0	0	12	10	0	22	1999	0	0	0	68	0	68	4	72
1947	15	0	6	8	0	29	2000	0	12	0	65	0	77	-9	68
1948	0	0	11	14	0	25	2001	0	7	0	53	0	60	0	60
1949	0	41	12	12	0	65	2002	0	14	0	50	0	64	-3	61
1950	0	24	9	6	0	39	2003	0	19	0	50	0	69	-5	64
1951	0	27	7	6	0	40	2004	0	18	0	49	0	67	2	69
1952	0	40	2	6	0	48	2005	0	7	0	38	0	45	-1	44
1953	0	99	2	4	0	105	2006	0	12	0	31	0	43	0	43
1954	0	116	1	7	0	124	2007	0	7	0	34	0	41	1	42
1955	0	66	1	9	0	76	2008	0	6	0	31	0	37	3	40
1956	0	161	1	6	0	168	2009	0	5	0	46	0	51	0	51

Year	BEL	FRA	UK	IRL	OTH	TOT	Year	BEL	FRA	UK	IRL	OTH	TOT	Unalloc	WG est
1957	0	94	1	4	0	99	2010	0	8	0	35	0	43	0	43
1958	0	163	2	6	0	171	2011	0	5	0	22	0	27	-5	22
1959	0	327	1	8	0	336									
1960	0	80	1	9	0	90									

Table 7.9.2. Settings and results from DCAC.

Year range	sumCatch (landings)	CV	Nyears	M	StDev	Fmsy/M	StDev[1]	Bmsy/B0	StDev[2]	Delta	StDev[2]	Avg Catch	Avg DCAC
1950–2011	4155	0.2	62	0.1	0.5	0.8	0.2	0.25	0.1	0.1	0.1	67.0	60.6
1950–2011	4155	0.2	62	0.1	0.5	0.8	0.2	0.25	0.1	0.5	0.1	67.0	40.7
1950–2011	4155	0.2	62	0.1	0.5	0.8	0.2	0.25	0.1	0.9	0.1	67.0	35
1995–2011	911	0.2	17	0.1	0.5	0.8	0.2	0.25	0.1	0.1	0.1	53.6	40.1
1995–2011	911	0.2	17	0.1	0.5	0.8	0.2	0.25	0.1	0.5	0.1	53.6	19.8
1995–2011	911	0.2	17	0.1	0.5	0.8	0.2	0.25	0.1	0.9	0.1	53.6	13.6

[1] **Assuming lognormal distribution.**

[2] **Assuming bounded (1-0) beta distribution.**

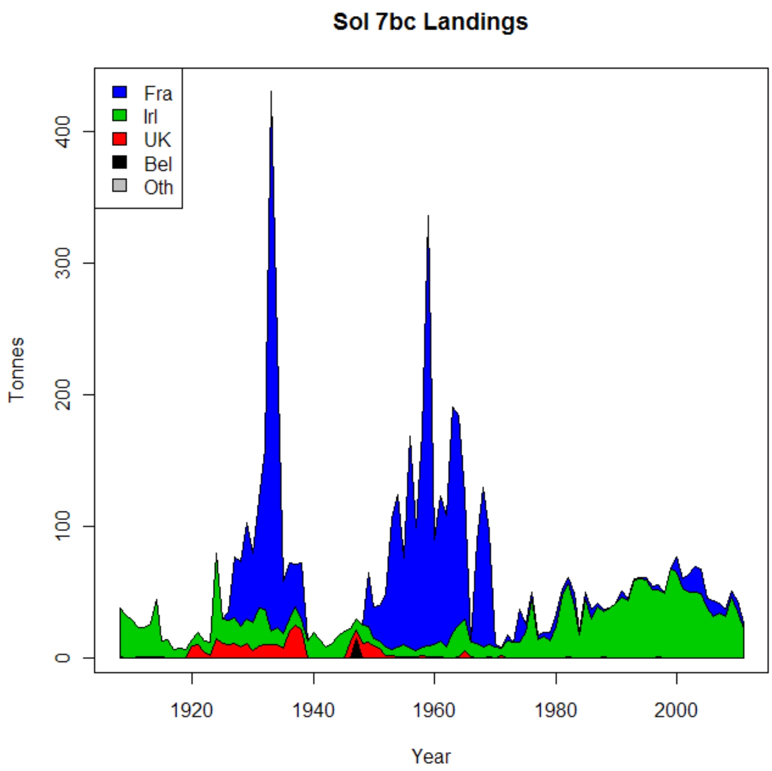


Figure 7.12.1. Landings of Sole in VIIbc as officially reported to ICES.

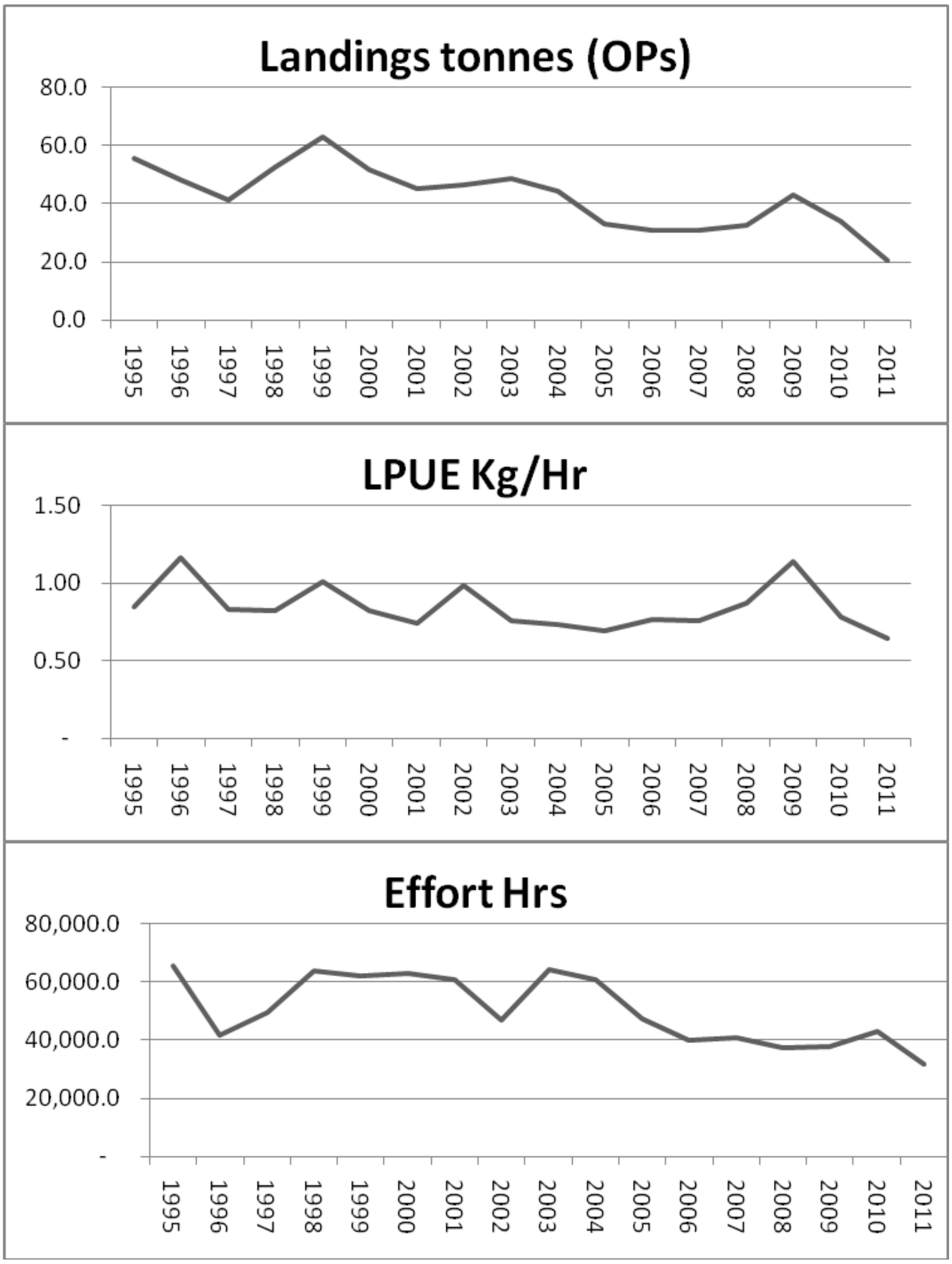


Figure 7.12.2. Sole in VIIbc Irish otter trawl landings effort and lpue since 1995.

7.13 Sole in Divisions VIIfg

Type of assessment in 2011: Update

ICES advice applicable to 2011

In the advice for 2011, the stock status was presented as follows:

Fishing mortality	**2007**	**2008**	**2009**
F_{MSY}	Below	Below	Below
F_{PA}/F_{lim}	Below	Below	Below
Spawning–Stock Biomass (SSB)	2008	2009	2010
MSY $B_{trigger}$	Above	Above	Above
B_{PA}/B_{lim}	Above	Above	Above

MSY approach

Following the ICES MSY framework implies fishing mortality to be 0.31, resulting in landings of 1400 t in 2011. This is expected to lead to an SSB of 4900 t in 2012.

PA approach

The fishing mortality in 2011 should be no more than F_{PA} corresponding to landings of less than 1700 t in 2011. This is expected to keep SSB above B_{PA} in 2012.

ICES advice applicable to 2011

In the advice for 2012, the stock status was presented as follows:

F (Fishing Mortality)				
	2008	2009	2010	
MSY (F_{MSY})	✓	✓	✓	Appropriate
Precautionary approach (F_{PA},F_{lim})	✓	✓	✓	Harvest sustainably
SSB (Spawning–Stock Biomass)				
	2009	2010	2011	
MSY ($B_{trigger}$)	✓	✓	✓	Above trigger
Precautionary approach (B_{PA},B_{lim})	✓	✓	✓	Full reproductive capacity

MSY approach

Following the ICES MSY framework implies fishing mortality to be 0.31, resulting in landings of 1060 t in 2012. This is expected to lead to an SSB of 3600 t in 2013.

PA approach

The fishing mortality in 2012 should be no more than F_{PA} corresponding to landings of less than 1230 t in 2012. This is expected to keep SSB above B_{PA} in 2013.

Technical comments made by the Review Group (RGCS)

The Working Group agree fully with the overall remarks from the Review Group that the Stock Annex is not up to date (cfr. … "*Text from 2010 Working Group*"). This year, the Stock Annex will be updated as much as possible.

The Review group asked for a better explanation of the method used for calculating the total international catch and stock weights-at-age. The total international catch weights-at-age were calculated as the weighted mean of the annual weight-at-age data supplied by Belgium, UK(E&W) and Ireland which account for 95% of the total international landings (weighted by landed numbers), and smoothed using a quadratic fit:

[e.g.: $Wt = (0.1109*Age) - (0.0004*(Age^2)) - 0.008$; $R^2 = 0.98$]

where catch weights-at-age are mid-year values (age = 1.5, 2.5, etc.).

The stock weights were calculated as the weighted mean of the 1st quarter weights-at-age data supplied by Belgium, UK(E&W) and Ireland (weighted by landed numbers) and soothed using a quadratic fit through these points.

Catch weights-at-age and stock weights-at-age have been scaled to give a SOP of 100%.

The reason that the stock annex provides the above mentioned equations by year is because they do differ from year to year. The review groups should be able to reproduce the catch and stock weights if they desire to do so.

This technique has been used for many years (at least since stock has been assessed by the Southern Shelf Demersal WG. The same technique has been used in other stocks in the WGCE (e.g. plaice VIIe).

The Review group criticised the report of no inclusion of ecosystem information in the stock annex (e.g. from available literature). This year a substantial overview on the Celtic Seas eco-region is incorporated in the stock annex from the NWW-Atlas (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. ISBN 978 1 902895 45 1).

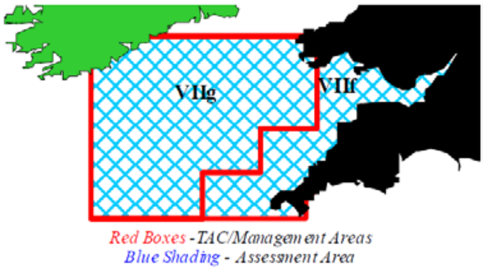
The Review group questioned the parameter setting of the q-plateau at age 7 where for a neighbouring sole stock (VIIa) the q-plateau was changed from 7 to 4 at the WKFLAT, February 2011. The Working group would like to note that in an update assessment you have to follow the stock annex. Deviation from settings (as was done for several setting at the WKFLAT in 2011 for sole VIIa) are only allowed by ICES to be done at Benchmarks. It is possible that the q-plateau parameter should be set lower then 7 for this stock.

The review group proposed a similar approach for sole VIIfg as for sole VIIa by using a combined ALK from all the countries involved in the fisheries. The Working Group fully support this proposal. The Working Group has no doubt that this approach will improve the assessment and it is the absolute top priority to be investigated at the next benchmark.

The review group thought it would be wise to update the Belgian commercial beam trawl tuning file. The Working group fully agreed with this proposal and will try accommodating this request if possible if human resources are made available (see also Section 7.13.2, penultimate paragraph). The same remark is also applicable to a possible investigation of the reason for contradicting signals from the UK(E&W) commercial beam trawl and the survey in the assessment.

7.13.1 General

Stock description and management units



A TAC is in place for ICES Divisions VIIfg. These Divisions do correspond to the stock area. The basis for the stock assessment Area VIIfg is described in detail in the Stock Annex.

Management applicable to 2010 and 2011

Management of sole in VIIfg is by TAC and technical measures. The agreed TACs in 2010 and 2011 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.

2011 TAC

Species:	Common sole *Solea solea*	**Zone:**	VIIf and VIIg (SOL/7FG.)
Belgium	775		
France	78		
Ireland	39		
United Kingdom	349		
EU	1 241		
TAC	1 241		Analytical TAC

2012 TAC

Species:	Common sole *Solea solea*	**Zone:**	VIIf and VIIg (SOL/7FG.)
Belgium	663		
France	66		
Ireland	33		
United Kingdom	298		
Union	1 060		
TAC	1 060		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 until 2012. A derogation has permitted beam trawlers to fish there in March 2005. The effects of this closure have been discussed in WGSSDS and ACFM 2007. No new information was available at the time of the update working group.

Fishery in 2011

The Working Group estimated the total international landings at 1029 t in 2011 (Table 7.13.1), which is 17% below the 2011 TAC (1241 t) and 8% higher than last year's forecast of 956 t.

Early in the time-series officially reported landings included Divisions VIIg–k for some countries and their total was higher than the WG estimate. Since 1999 official landings correspond to Divisions VIIfg, and the total is lower than the working group estimate. During the period 2002–2004 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.

7.13.2 Data

Landings

Belgian landings submitted to the Working Group for 2010 were revised upward by 2% to 630 t. The Irish landings were revised upward by 15% to 27 t. The 2010 values for the numbers-at-age were therefore also updated. Total landings now amount to 876 t (Table 7.13.1).

Annual length compositions for 2011 are given by fleet in Table 7.13.2. Length distributions of the total Belgian and UK(E&W) landings for the last twelve years are plotted in Figure 7.13.1. Belgian land a greater proportion of small fish compared to the UK(England & Wales).

Quarterly numbers- and weight-at-age data are available for the Belgian, UK(E&W) and Irish landings (approximately 95% of the total landings). Catch weights-at-age were calculated, weighted by national catch numbers-at-age, and then quadratically smoothed in year (using age = 1.5, 2.5, etc.) and SOP-corrected. For 2011, the quadratic fit used was:

$$W(t) = -0.0388 + (0.069*(AGE)) - (0.0012*(AGE)^2) \qquad R2 = 0.92$$

Further details on raising procedures are given in the Stock Annex.

Stock weights-at-age were the first quarter catch weights of the Belgian, the UK and the Irish beam trawl fleets and smoothed by fitting a quadratic fit:

$$W(t) = 0.0786 + (0.0369*(AGE)) - (0.0006*(AGE)^2) \qquad R2 = 0.98$$

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 twelve years are plotted in Figure 7.13.2. The standardised catch proportion-at-age is presented in Figure 7.13.3.

Only UK(E&W) has uploaded the 2011 data into InterCatch and therefore no comparison has been made between aggregated data outside InterCatch and InterCatch aggregated data. Last year the comparison was made with only minor differences of 1%. The reason for no InterCatch upload by other countries is mainly because financial and human resources are not sufficiently available to deal with the increasing demand of data calls and workload. Prioritisation has been made by countries and unfortunately data submission into Interatch for sole VIIfg was not high enough on the priority list to be carried out in 2012.

Sampling levels for those countries providing age compositions are given in Table 2.1.

Discards

The available discard data indicate that discarding of sole is usually minor. In 2007, 2008, 2009, 2010 and 2011, discarding of sole in the UK fleet was estimated at about 3%, 1%, 6%, 9% and 9% respectively in numbers. Discard rates of sole in the Belgian beam trawl fleet were available to the working group for 2004–2005 and 2008–2011 accounting for about 2%–5% of the total sole catches in weight. The length distributions of retained and discarded catches of sole from the Belgium beam trawl fleet in Area VIIf and VIIg separately for 2011 are presented in Figures 7.13.4a. The UK length distributions for 2011 from samples of UK gear except beam trawls are given in Figure 7.13.4b. The Irish length distributions from the otter trawl fleet for 2011 are shown in Figure 7.13.4c. It should be noted that the Irish otter trawl landings only amount to less than 2% of the total international landings.

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 7.13.6 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 from most of the ages. The internal consistency plot indicates also a reasonable fit for most of the age range (Figure 7.13.6).

Commercial lpue

Available estimates of effort and lpue are presented in Tables 7.13.7–7.13.8 and Figure 7.13.7.

Belgian beam trawl (BE-CTB) effort was at highest levels in 2003–2005. During these years effort shifted from the Eastern English Channel (VIId) to the Celtic Sea because of days at sea limitations in the former area. In 2006, these restrictions had been lifted and effort decreased back to similar levels compared to the early 2000s. The sharp effort reduction in 2008 may be a combined result of the unrestricted effort regime in VIId and the high fuel prices. Since the series low in 2008, effort has increased slightly. Lpue peaked in 2002. After a sharp decline to its record low in 2004, lpue has been increasing gradually to almost the highest level of the time-series in 2002.

The effort from the UK(E&W) beam trawl fleet (UK(E&W)-CBT) has declined sharply since the early 2000s to a record low in 2009. The 2011 value being slightly higher than the 2009 value. Lpue in the 1990s and 2000s was stable, 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 and 2011.

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 and BEL-CBT), show high consistencies for the entire age range (Figure 7.13.8–7.13.9).

Other relevant data

Reports from UK industry suggest that the main issues affecting the fishery in VIIfg 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 7.13.9). It should be noted that the year range of the Belgian commercial beam trawl tuning fleet only covers 1971 up to 2003 (see also Section 7.13.9 recommendation for next Benchmark). Table 7.13.9 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

Adding the 2011 data to the time-series, together with the Belgian and Irish landings revisions for 2010 did not cause any additional anomalies compared to previous years. The "single fleet runs", "separable VPA", etc. are not presented in this report, but are available in the 'Exploratory runs folder'. This folder also contains a comparison plot of SSB, R and F of last year's final assessment and of the same assessment but with the Belgian and Irish landings revisions. The trends were very similar for both assessments.

The catchability residuals for the final XSA are shown in Figure 7.13.10 and the XSA tuning diagnostics are given in Table 7.13.10. The UK beam trawl fleet (UK-CBT) show a decreasing trend with predominantly positive residuals since 2007. The UK beam trawl survey (UK(E&W)-BTS-Q3) show a similar trend over the same time-series with predominantly negative residuals, indicating a conflicting signal between these two fleets (see also Section 7.13.9. recommendation for next Benchmark). 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. A comparison of estimates of fishing morality and SSB for the single tuning fleets and the final XSA indicate a lower F for the commercial fleet and a higher F for the survey. The SSB estimates from the commercial fleet are higher than the final XSA, but the survey gives almost identical values for the last four years. The Working group was not able to explain the reason for these discrepancies and proposed that this will be investigated further in the future. It should however be noted that this has been mentioned by previously Working Groups and Review Groups, but due to restrictions of financial and human resources, this has not been addressed yet.

In this year's assessment the estimates for the recruiting year class 2010 were estimated solely by the UK beam trawl survey UK(E&W)-BTS-Q3) (Figure 7.13.11). The survivor estimates of the two prominent fleets (the UK(E&W)-BTS-Q3 survey and the UK(E&W)-CBT commercial fleet) which have at least 96% of the weighting for all the ages, differ remarkably from each other for ages 3 to 6. However, it should be noted that the UK beam trawl survey is rather consistent in the predicted year class strengths at different ages (see detailed diagnostics in ICES files), where the UK commercial beam trawl fleet has a higher variability in estimates of year-class strength at different ages. The working group was not able to clarify that particular issue. The different estimates from the two fleets do only generate a small retrospective bias and therefore probably balance off each other in the assessment. The working group also assumed that the Trevose closure, a change in special distribution of the UK beam trawl fleet and the ending of the Belgian tuning-series in 2003, may have an influence on the divergence in survivor estimates from both dominant tuning.

F shrinkage gets low weights for all ages (<4%). The weighting of the survey decreases for the older ages as the commercial UK(E&W)-CBT fleet is given more weight (Figure 7.13.11).

Final update assessment

The final settings used in this year's assessment (and since 2006) are as detailed below:

	2012 assessment		
Fleets	Years	Ages	α–β
BEL-CBT commercial	1971–2003	2–9	0–1
UK-CBT commercial	1991–2011	2–9	0–1
UK(E&W)-BTS-Q3 survey	1988–2011	1–9	0.75–0.85
-First data year	1971		
-Last data year	2011		
-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)			

Retrospective patterns for the final run are shown in Figure 7.13.12. There is a tendency in the last three years to underestimated fishing mortality and overestimated SSB.

The final XSA output is given in Table 7.13.11 (fishing mortalities) and Table 7.13.12 (stock numbers). A summary of the XSA results is given in Table 7.13.13 and trends in yield, fishing mortality, recruitment and spawning stock biomass are shown in Figure 7.13.13.

Comparison with previous assessment

With the addition of the 2011 data, estimates of fishing mortality and SSB for the most recent years were revised slightly. For example, last year fishing mortality and SSB in 2010 were estimated to be 0.26 and 3870 t. In this year's assessment, the 2010 estimates have been revised upwards by 14% (fishing mortality) and downwards by 4% (SSB). The estimated recruitment by XSA in 2010 (year class 2009) was revised upward by 5% in this year's assessment.

State of the stock

Trends in landings, SSB, F(4–8) and recruitment are presented Table 7.13.13 and Figure 7.13.13.

During the eighties fishing mortality increased for this stock. In the following decades fishing mortality fluctuated around this higher level. However fishing mortality has decreased since the late 1990s and is estimated to be below F_{MSY} (0.31) since 2005. Fishing mortality in 2011 is estimated to be 0.24.

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 and the 2007 year class to be the second highest for this stock. The 2009 year class is by far the lowest in the time-series. The incoming recruitment (year class 2010) is estimated to be above average.

SSB has declined almost continuously from the highest value of 8000 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 and above average recruitment in 2009 and 2011 is predicted to keep SSB well above $B_{PA}/B_{trigger}$.

7.13.4 Short term projections

The 2009 year class in 2010 was estimated by far to be the lowest in the time-series at around 1.2 million fish at age 1 and 5% higher than estimated last year. The XSA survivor estimate for this year class was used for further prediction.

The 2010 year class in 2011 was estimated by XSA to be above average with 7.0 million one year olds. The estimates solely coming from the UK(E&W)-BTS-Q3 survey. The XSA survivor estimates for this year class were used for further prediction

The long-term GM_{71-09} recruitment (5.0 million) was assumed for the 2011 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 2012	XSA		Source
2009	3	926		XSA
2010	2	6310		XSA
2011	1	-	5031	GM 1971–2009
2012 & 2013	recruits	-	5031	GM 1971–2009

Population numbers at the start of 2012, estimated for ages 2 and older, were taken from the XSA output.

Fishing mortality was set as the mean over the last three years. Weights-at-age in the catch and in the stock are averages for the years 2009–2011. Input to the short-term predictions and the sensitivity analysis are shown in Table 7.13.14. Results are presented in Table 7.13.15 (management options) and Table 7.13.16 (detailed output).

Assuming *status quo* F, implies a catch in 2012 of around 1010 t (the agreed TAC is 1060 t) and a catch of 970 t in 2013. Assuming *status quo* F will result in a SSB of 4050 t in 2013 and 4170 t in 2014.

Assuming *status quo* F, the proportional contributions of recent year classes to the predicted landings and SSB are given in Table 7.13.17. The assumed GM recruitment accounts for about 5% of the landings in 2013 and about 11% of the 2014 SSB.

Results of a sensitivity analysis are presented in Figure 7.13.14 (probability profiles). The approximate 90% confidence intervals of the expected *status quo* yield in 2013 are 650 t and 1200 t. There is less than 5% probability that at current fishing mortality SSB will fall below the B_{pa} $B_{trigger}$ of 2200 t in 2014.

There are no known specific environmental drivers known for this stock.

7.13.5 MSY explorations

Yield-per-recruit results, long-term yield and SSB, conditional on the present exploitation pattern and assuming *status quo* F in 2011, are given in Table 7.13.18 and Figure 7.13.15. F_{MAX} is estimated to be 0.37. It should be noted that F_{MAX} is poorly defined. Long-term yield and SSB (using GM recruitment and F_{sq}) are estimated to be 970 t and 4100 t respectively.

Investigations for possible F_{MSY} candidates for this stock were done in 2010 WGCSE. 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.

7.13.6 Biological reference points

The Working Group's current approach to reference points is outlined in Section 1.4.4. Current biological reference points are given in the text table below:

Reference points	ACFM 98 onwards
F_{MSY}	0.31 (stochastic simulations using Ricker,WG2010)
F_{lim}	0.52 (based on F_{loss}, WG1998)
F_{PA}	0.37 (F_{lim} x 0.72)
B_{lim}	Not defined
B_{PA}	2200 t (based on B_{loss} (1991), WG1998)
$B_{trigger}$	B_{PA}

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 VIIfg 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 suggest that the results of the analysis carried out in 2006 can probably still be used. The results of the F_{MSY} analysis, carried out during the 2010 Working group also confirm that a fishing mortality of 0.31 could be a candidate for a long-term management objective for sole in VIIfg, although other species caught in the fishery should also be considered.

7.13.8 Uncertainties and bias in assessment and forecast

Sampling

The major fleets fishing for VIIfg sole are sampled (approximately 95% of the total landings). Sampling is considered to be at a reasonable level (Table 2.1). However the assessment is likely to improve if a combined ALK is used to obtain the age composition (see Section 7.13.9).

Discards

Discard estimates, which are low (Figure 7.13.4a–c) 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 been revised downward in previous assessments and therefore estimates of very strong year classes may cause bias in the forecast. This year's assessment estimates the incoming recruitment (year class 2010) slightly above average in the time-series and therefore there is no major concern regarding an overly optimistic forecast.

Consistency

The assessment provided by the WG is highly consistent with last year's assessment with similar trends in fishing mortality, SSB and recruitment. There is only a slight retrospective pattern in the last few years, indicating that there is no major concern about the uncertainty in the assessment and the forecast.

Misreporting

Area misreporting is known to have been considerable over the period 2002–2004. 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 (method explained in the report of WGSSDS 2007). Since 2007 the area misreporting that could be estimated was negligible.

7.13.9 Recommendation for next Benchmark

Year	Candidate Stock	Supporting Justification	Suggested time	Indicate expertise necessary at benchmark meeting
2012	VIIf,g sole	The use of a combined ALK from Belgium, UK(E&W) and Ireland instead of the use of separate ALK's by county at the moment. A need to update the Belgian commercial tuning-series. The Belgian beam trawl tuning-series is only used up to 2003, mainly because the estimation of the corresponding lpue series could not be calculated correctly. At the 2009 WKFLAT a possible way of calculating Belgian beam trawl lpue for Division VIId was proposed, using a more realistic horsepower correction method. The proposed method could be investigated, not only for the Belgian beam trawl lpue but also for the UK beam trawl lpue in Division VIIfg, which are the two commercial fleets used in this assessment. Investigate the reason for the conflicting signals in the assessment diagnostics between the commercial UK(E&W)-CBT fleet and the UK(E&W)-BTS-Q3 survey (possible differences in spatial distributions, etc.). Investigate if commercial tuning fleets should still be used in future assessments of sole in VIIfg. Investigate the spatial distribution of the major Celtic sea fleets and possible impacts of the Trevose closure. Investigate if the Irish ground fish survey (IGFS-IBTS_Q4) can be incorporated in the assessment.	2014	Expertise on commercial lpue dataseries correction

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 8000 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 and above average recruitment in 2009 and 2011 is predicted to keep SSB well 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.

Table 7.13.1 - Celtic Sea Sole (ICES Divisions VIIfg). 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 [1]	766	-	50	30	168	-	-	1013	16	1029	1241

1 Preliminar
* including VIIg-k

Table 7.13.2 - Sole in VIIfg. Annual length distributions by fleet

Length (cm)	UK (England & Wales) Beam trawl	Belgium All gears	Ireland* All gears
17			
18			
19			
20			
21	134	106	
22	0	4435	
23	1502	40453	105
24	13246	310756	1275
25	23325	406887	2297
26	34005	372710	4963
27	33529	356260	4966
28	41439	293961	7799
29	47391	229841	8175
30	47379	220277	7942
31	35618	141396	6354
32	27885	118372	5745
33	22174	97577	6020
34	20522	73227	5435
35	16339	66038	4583
36	10825	52445	4058
37	12337	47972	3736
38	7722	39932	2785
39	10498	31032	2026
40	7989	34501	1402
41	6895	19735	997
42	5139	17489	818
43	4260	16470	499
44	3145	8514	232
45	1901	8096	296
46	1252	3995	151
47	441	3067	170
48	366	2644	211
49	109	716	26
50	178	423	
51	43	423	
52		212	
53			
54			
55			
56			
57			
58			
59			
60			
Total	437588	3019963	83066

* Distributions from sample only

Table 7.13.3 - Sole in VIIfg. Catch numbers at age (in thousands)

Run title : CELTIC SEA SOLE - 2012WG
At 7/05/2012 15:14

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1971
AGE	
1	0
2	386
3	270
4	1341
5	625
6	433
7	537
8	763
9	376
+gp	1220
0 TOTALNUM	5951
TONSLAND	1861
SOPCOF %	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	541	364	155	119	312	314	318	328	657	602
3	902	1882	438	287	834	438	741	560	972	675
4	314	748	863	336	560	349	339	747	876	792
5	670	305	411	638	611	271	154	208	584	399
6	329	352	209	304	559	244	159	154	180	377
7	213	119	239	110	261	404	99	197	62	150
8	232	110	97	102	131	120	198	124	96	120
9	314	116	109	67	197	28	71	153	100	94
+gp	730	644	541	372	463	365	174	169	352	380
0 TOTALNUM	4245	4640	3062	2335	3928	2533	2253	2640	3879	3589
TONSLAND	1278	1391	1105	919	1350	961	780	954	1314	1212
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	342	647	672	196	494	318	526	479	277	1458
3	831	1078	846	1473	1296	957	464	1164	994	690
4	309	729	606	766	1173	797	879	601	1176	658
5	467	284	542	565	526	577	441	621	399	496
6	280	349	184	296	358	273	387	237	452	151
7	207	225	277	100	193	205	127	188	138	156
8	92	192	106	140	87	100	78	82	115	55
9	111	52	47	73	103	61	67	24	50	46
+gp	326	320	274	240	328	179	268	102	129	162
0 TOTALNUM	2965	3876	3554	3849	4558	3467	3237	3498	3730	3872
TONSLAND	1128	1373	1266	1328	1600	1222	1146	992	1189	1107
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	433	354	295	129	177	245	197	608	1721	704
3	1700	863	790	1156	1035	890	932	1718	1480	1918
4	644	1104	739	1098	904	599	724	834	683	860
5	409	332	864	420	424	400	297	282	241	436
6	253	186	283	483	229	252	171	143	60	242
7	61	161	149	133	192	127	108	80	56	65
8	59	63	65	112	57	126	51	31	43	39
9	28	83	42	65	43	45	52	23	19	26
+gp	89	99	146	109	106	106	87	44	51	81
0 TOTALNUM	3676	3245	3373	3705	3167	2790	2619	3763	4354	4371
TONSLAND	981	928	1009	1157	995	927	875	1012	1091	1168
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	29	119	425	271	685	335	211	612	273	93
3	1465	697	1721	855	1330	865	447	468	1278	758
4	2202	1134	792	837	715	743	552	430	722	1079
5	660	1860	794	473	576	474	558	349	337	297
6	249	402	721	398	163	325	274	295	250	204
7	95	223	114	348	148	157	196	175	159	145
8	54	80	60	48	178	145	75	104	115	99
9	36	26	34	41	44	184	108	44	64	49
+gp	51	75	49	43	51	70	171	194	114	149
0 TOTALNUM	4841	4616	4710	3314	3890	3298	2592	2671	3312	2873
TONSLAND	1345	1392	1249	1044	946	945	800	805	876	1029
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 7.13.4 - Sole in VIIfg. Catch weights at age (kg)

Run title : CELTIC SEA SOLE - 2012WG
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Table 2 Catch weights at age (kg)

	YEAR	1971
	AGE	
	1	0.039
	2	0.106
	3	0.167
	4	0.222
	5	0.272
	6	0.315
	7	0.352
	8	0.383
	9	0.408
	+gp	0.4397
0	SOPCOFAC	0.9999

Table 2 Catch weights at age (kg)

	YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	AGE										
1		0.106	0.081	0.063	0.046	0.114	0.098	0.068	0.023	0.048	0.078
2		0.147	0.143	0.137	0.132	0.167	0.169	0.154	0.132	0.144	0.154
3		0.186	0.202	0.205	0.212	0.218	0.235	0.234	0.232	0.234	0.225
4		0.226	0.258	0.270	0.286	0.268	0.297	0.309	0.321	0.316	0.292
5		0.264	0.311	0.329	0.355	0.316	0.355	0.378	0.401	0.392	0.355
6		0.302	0.361	0.385	0.417	0.363	0.409	0.441	0.471	0.461	0.414
7		0.340	0.408	0.436	0.473	0.409	0.460	0.499	0.531	0.523	0.469
8		0.376	0.452	0.483	0.523	0.453	0.506	0.551	0.581	0.579	0.519
9		0.413	0.493	0.525	0.567	0.496	0.548	0.598	0.622	0.627	0.565
	+gp	0.5384	0.6021	0.6239	0.6715	0.6649	0.6681	0.7196	0.6636	0.7202	0.665
0	SOPCOFAC	1.001	1.001	1.000	1.000	0.999	1.000	0.998	1.001	0.999	1.000

Table 2 Catch weights at age (kg)

	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	AGE										
	1	0.061	0.085	0.019	0.089	0.046	0.048	0.074	0.013	0.049	0.054
	2	0.156	0.173	0.131	0.17	0.144	0.146	0.157	0.109	0.134	0.15
	3	0.243	0.255	0.235	0.246	0.236	0.236	0.235	0.198	0.214	0.239
	4	0.324	0.33	0.33	0.317	0.321	0.32	0.309	0.28	0.291	0.32
	5	0.397	0.398	0.416	0.383	0.4	0.396	0.378	0.355	0.363	0.393
	6	0.462	0.459	0.494	0.444	0.471	0.466	0.442	0.424	0.43	0.459
	7	0.521	0.514	0.562	0.5	0.536	0.528	0.502	0.487	0.494	0.516
	8	0.572	0.561	0.622	0.552	0.594	0.584	0.557	0.543	0.553	0.566
	9	0.617	0.602	0.673	0.598	0.645	0.632	0.608	0.592	0.609	0.608
	+gp	0.7043	0.6786	0.7716	0.7026	0.7479	0.7404	0.7385	0.6909	0.7474	0.674
0	SOPCOFAC	0.9994	1.0004	0.9985	1.0016	1.0004	1.001	0.9993	0.9993	0.9993	0.9998

Table 2 Catch weights at age (kg)

	YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	AGE										
	1	0.073	0.057	0.081	0.068	0.027	0.074	0.079	0.015	0.078	0.066
	2	0.147	0.134	0.151	0.147	0.124	0.156	0.163	0.122	0.166	0.148
	3	0.216	0.207	0.216	0.22	0.214	0.234	0.244	0.222	0.248	0.225
	4	0.281	0.275	0.276	0.288	0.296	0.307	0.32	0.315	0.322	0.296
	5	0.342	0.338	0.331	0.351	0.372	0.376	0.393	0.4	0.39	0.363
	6	0.398	0.396	0.38	0.409	0.439	0.44	0.462	0.478	0.451	0.425
	7	0.451	0.45	0.425	0.462	0.5	0.5	0.528	0.549	0.506	0.482
	8	0.499	0.5	0.465	0.51	0.552	0.555	0.589	0.613	0.553	0.533
	9	0.543	0.545	0.5	0.553	0.598	0.605	0.647	0.67	0.594	0.579
	+gp	0.6402	0.6445	0.5626	0.6429	0.6773	0.7071	0.7809	0.7655	0.6649	0.6773
0	SOPCOFAC	0.9995	0.9994	0.9996	0.9982	1.0008	0.9997	0.9994	1.0005	1	0.9954

Table 2 Catch weights at age (kg)

	YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	AGE										
	1	0.054	0.123	0.066	0.068	0.085	0.075	0.098	0.132	0.092	0.14
	2	0.13	0.171	0.13	0.145	0.139	0.139	0.155	0.178	0.146	0.204
	3	0.202	0.218	0.194	0.219	0.192	0.2	0.209	0.225	0.199	0.266
	4	0.271	0.266	0.256	0.288	0.245	0.258	0.26	0.271	0.25	0.325
	5	0.336	0.313	0.317	0.354	0.297	0.313	0.31	0.317	0.3	0.382
	6	0.399	0.361	0.377	0.415	0.349	0.365	0.356	0.362	0.349	0.437
	7	0.457	0.408	0.435	0.473	0.4	0.414	0.401	0.408	0.396	0.489
	8	0.513	0.454	0.493	0.528	0.451	0.46	0.443	0.453	0.441	0.539
	9	0.564	0.501	0.549	0.578	0.501	0.503	0.482	0.498	0.486	0.586
	+gp	0.7045	0.6379	0.7217	0.6918	0.6177	0.6087	0.5448	0.6024	0.5939	0.6856
0	SOPCOFAC	1.0001	1.0019	1.0003	1.0004	0.9992	0.9999	1.0035	0.9994	1.0005	1

Table 7.13.5 - Sole in VIIfg. Stock weights at age (kg)

Run title : CELTIC SEA SOLE - 2012WG
At 7/05/2012 15:15

Table 3 Stock weights at age (kg)

YEAR	1971
AGE	
1	0.09
2	0.076
3	0.136
4	0.19
5	0.239
6	0.406
7	0.472
8	0.389
9	0.346
+gp	0.5826

Table 3 Stock weights at age (kg)

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
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	0.113	0.113	0.145	0.113	0.113	0.113	0.113
3	0.157	0.142	0.159	0.141	0.16	0.174	0.167	0.163	0.157	0.159
4	0.222	0.203	0.221	0.215	0.21	0.236	0.257	0.255	0.238	0.232
5	0.298	0.263	0.305	0.295	0.269	0.366	0.36	0.392	0.354	0.306
6	0.351	0.334	0.45	0.353	0.354	0.392	0.413	0.437	0.394	0.385
7	0.352	0.322	0.448	0.593	0.432	0.454	0.521	0.485	0.622	0.462
8	0.593	0.4	0.464	0.423	0.462	0.505	0.508	0.595	0.556	0.551
9	0.417	0.539	0.624	0.465	0.425	0.907	0.56	0.657	0.704	0.737
+gp	0.6005	0.5822	0.6707	0.7112	0.728	0.7006	0.7826	0.6963	0.7714	0.6627

Table 3 Stock weights at age (kg)

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
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	0.118	0.113	0.113	0.113	0.113	0.113	0.113	0.113
3	0.164	0.175	0.173	0.175	0.18	0.153	0.158	0.152	0.164	0.179
4	0.255	0.262	0.274	0.268	0.273	0.242	0.233	0.227	0.247	0.23
5	0.356	0.37	0.429	0.472	0.398	0.361	0.363	0.308	0.369	0.356
6	0.487	0.488	0.517	0.433	0.462	0.473	0.466	0.465	0.476	0.536
7	0.543	0.633	0.641	0.462	0.546	0.468	0.687	0.546	0.523	0.376
8	0.61	0.606	0.613	0.48	0.636	0.587	0.687	0.526	0.753	0.859
9	0.766	0.464	0.836	0.944	0.89	0.82	0.676	0.542	0.847	0.735
+gp	0.8561	0.823	0.9784	0.7983	0.8435	0.8378	0.818	0.7522	0.9732	0.6789

Table 3 Stock weights at age (kg)

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
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	0.148	0.113	0.113	0.104	0.113	0.113	0.11	0.062	0.113
3	0.184	0.196	0.135	0.143	0.186	0.178	0.195	0.204	0.169	0.187
4	0.265	0.267	0.227	0.233	0.284	0.276	0.282	0.317	0.306	0.312
5	0.388	0.392	0.329	0.335	0.387	0.386	0.371	0.433	0.434	0.434
6	0.498	0.47	0.43	0.441	0.486	0.495	0.454	0.541	0.534	0.538
7	0.751	0.492	0.521	0.54	0.573	0.598	0.529	0.635	0.603	0.619
8	0.754	0.576	0.599	0.629	0.647	0.689	0.593	0.712	0.648	0.68
9	0.475	0.636	0.661	0.705	0.708	0.766	0.644	0.772	0.677	0.725
+gp	0.8963	0.7272	0.7572	0.8447	0.808	0.8923	0.7318	0.8525	0.707	0.7835

Table 3 Stock weights at age (kg)

YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
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	0.158	0.116	0.149	0.143	0.117	0.151	0.147	0.142	0.175
3	0.189	0.205	0.176	0.213	0.188	0.177	0.2	0.21	0.21	0.215
4	0.289	0.258	0.248	0.275	0.235	0.236	0.249	0.271	0.274	0.257
5	0.403	0.317	0.329	0.337	0.284	0.294	0.298	0.33	0.333	0.3
6	0.512	0.381	0.415	0.399	0.334	0.35	0.349	0.386	0.388	0.344
7	0.609	0.449	0.502	0.459	0.386	0.406	0.4	0.439	0.438	0.389
8	0.691	0.521	0.587	0.52	0.441	0.46	0.453	0.491	0.484	0.436
9	0.757	0.594	0.667	0.579	0.496	0.513	0.506	0.54	0.526	0.483
+gp	0.873	0.8113	0.869	0.7401	0.6414	0.6622	0.6027	0.6414	0.6088	0.6022

Table 7.13.6 - Sole in VIIfg. Indices of abundance (No/100km) for UK(E&W)-BTS-Q3) survey

	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	50	9	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	55	750	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	88	357	108	43	14	11	6	3	3	12
2008	5	1039	104	13	15	6	8	3	3	4
2009	1	509	318	24	6	8	3	2	2	2
2010	16	85	471	122	17	2	6	7	3	1
2011	18	503	52	138	69	7	2	6	3	0
Geomean	15	364	284	57	18	8	5	3	2	2
Mean	29	499	346	75	22	10	6	3	2	2

Table 7.13.7 - Sole in VIIfg. Indices of effort.

	England & Wales		Belgium		Ireland		
Year	Otter trawl	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	7.32	13.79		39.58	120.14	14.62	35.33

[1]Division VIIf 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 VIIg only - Fishing hours (x10^3)
[4]Fishing hours (x10^3)

Table 7.13.8 - Sole in VIIfg. 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 sein[5]	Beam trawl[5]
Year	Division VIIfg	Division VIIf	Division VIIg[3]	Division VIIf	Division VIIfg	Division VIIfg	Division VIIg	Division VIIg	Division VIIg
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	1.50	0.31	6.72		16.14	0.19	0.02	0.20

[1]Kg/hr corrected for GRT.

[2]Kg/hr corrected for fishing power using P = 0.000204 BHP^1.23

[3]Division VIIg (East).

[4]Kg/100km

[5]Kg/hour

Table 7.13.9 - Sole in VIIfg. Tuning series

Indices in bold are used in the assessment

BE-CBT **Belgium Beam trawl (Effort = Corrected formula)**

	1971	2003												
	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
51.98		193	661	377	241	143	74	55	23	16	18	7	3	2
52.11		166	771	608	188	100	84	33	25	21	8	6	10	7
55.03		493	1286	622	189	66	36	11	14	5	3	1	3	0
56.05		1509	1174	435	124	20	16	14	6	2	9	3	1	1
52.06		621	1445	710	307	174	38	16	11	11	6	17	1	1
43.24		0	1292	1704	570	163	56	27	15	1	1	1	4	0.6
42.81		16	538	929	1273	315	160	50	19	12	2	7	1	3

UK(E&W)-CBT **UK(E+W) VIIf Beam trawl**

	1991	2011													
	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		1.9	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		0.2	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		0.4	31	204	107	52	50	28	13	6	10	4	2	1	0
51.19		0.1	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		0.1	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		0.9	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		0.4	7	57	125	41	34	22	19	12	12	4	7	16	1

Table 7.13.9 - Sole in VIIfg. Tuning series - continued

Indices in bold are used in the assessment

UK(E&W)-BTS-Q3 **UK(E+W) VIIf Corystes (automated indices since 1995)**

	1988	**2011**									
	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**

IR - GFS : Irish Groundfish Survey (IBTS 4th Qtr) - VIIb Sole number at age (Interim indices for new Celtic Explorer series)

	2003	2011									
	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

UK (E+W) TRAWL 107F. (Processed as unsexed - from 2001WG)

1991		2011									
1		1	0	1							
1		10									
18.57		0	1.7	6.4	13	11.2	3.5	3.3	1.1	0.8	0.8
16.00		0	8.4	29.4	10.4	6.9	5.9	1.5	1.8	0.8	0.9
13.79		0.1	0.8	3.7	10.2	3.8	2	1.4	0.3	0.6	0.2
9.48		0	1.7	4.3	2.5	4.9	1.7	1.5	1.1	0.6	0.7
8.46		0	2.3	12	5.3	2.5	4.5	0.9	1.2	0.7	0.2
8.67		0.1	2.8	4.3	4.9	2.4	1.4	1.4	0.3	0.5	0.2
8.14		0	2	8	6.8	4.1	2.1	0.7	1.2	0.4	0.3
7.13		0	2	4	2.7	2.1	1.3	0.4	0.3	0.5	0.1
5.69		0.1	8.5	12.4	3.5	1.5	1.2	0.8	0.4	0.1	0.3
4.05		0	0.9	1.8	1.6	0.7	0.2	0.2	0.2	0.1	0
4.42		0	1.5	10.1	2.3	1.7	0.6	0.3	0.2	0.2	0.1
6.10		0	0.5	4.8	8.2	1.8	1	0.3	0.2	0.2	0.1
9.94		0.1	1.6	2.8	3.3	6.7	1	0.7	0.3	0.1	0.1
9.42		0	1	4.8	2.9	3.3	4.9	0.9	0.6	0.4	0.2
12.09		0	2.6	4.9	6.1	2.3	2.6	4.9	0.7	0.7	0.2
12.97		0	0.4	7.1	7.7	9.5	3	3.9	6.9	1.3	0.9
10.66		0	0.5	2.6	3.5	3.2	3.2	1.2	1.5	2.6	0.3
10.13		0	0.4	3.5	**5**	3.8	2.9	2.7	0.9	1.6	2.2
9.00		0	0	0	0	0	0	0	0	0	0
7.60		0	0.2	5.3	3.7	2.3	2.1	1.1	0.8	0.9	0.2
7.3		0	0.7	5.7	8.6	3.2	3.2	2.4	1.3	1.2	0.9

Table 7.13.10 - Sole VIIfg - XSA diagnostics

Lowestoft VPA Version 3.1

7/05/2012 15:14

Extended Survivors Analysis

CELTIC SEA SOLE - 2012WG

CPUE data from file s7fgtun.txt

Catch data for 41 years. 1971 to 2011. Ages 1 to 10.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BE-CBT	1971	2011	2	9	0	1
UK(E&W)-CBT	1991	2011	2	9	0	1
UK(E&W)-BTS-Q3	1988	2011	1	9	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 47 iterations

1

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	0	0	0	0	0	0	0	0	0	0
2	0.008	0.021	0.099	0.054	0.166	0.121	0.065	0.074	0.051	0.091
3	0.311	0.244	0.404	0.265	0.36	0.29	0.21	0.18	0.194	0.175
4	0.345	0.374	0.426	0.312	0.328	0.312	0.271	0.285	0.411	0.222
5	0.544	0.485	0.432	0.431	0.326	0.335	0.362	0.246	0.337	0.262
6	0.371	0.667	0.311	0.356	0.23	0.275	0.294	0.294	0.249	0.312
7	0.366	0.589	0.353	0.216	0.193	0.322	0.237	0.276	0.227	0.2
8	0.542	0.531	0.272	0.219	0.147	0.262	0.224	0.17	0.262	0.193
9	0.632	0.483	0.399	0.27	0.285	0.199	0.284	0.177	0.135	0.152

1

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
2002	6.78E+03	3.77E+03	5.76E+03	7.94E+03	1.65E+03	8.44E+02	3.26E+02	1.36E+02	8.08E+01
2003	5.22E+03	6.14E+03	3.39E+03	3.82E+03	5.09E+03	8.68E+02	5.27E+02	2.04E+02	7.13E+01
2004	5.96E+03	4.72E+03	5.44E+03	2.40E+03	2.38E+03	2.84E+03	4.03E+02	2.65E+02	1.09E+02
2005	5.20E+03	5.39E+03	3.87E+03	3.29E+03	1.42E+03	1.40E+03	1.88E+03	2.56E+02	1.82E+02
2006	3.42E+03	4.71E+03	4.62E+03	2.69E+03	2.18E+03	8.35E+02	8.86E+02	1.37E+03	1.86E+02
2007	3.89E+03	3.10E+03	3.61E+03	2.92E+03	1.75E+03	1.42E+03	6.00E+02	6.61E+02	1.07E+03
2008	1.00E+04	3.52E+03	2.48E+03	2.44E+03	1.93E+03	1.13E+03	9.77E+02	3.94E+02	4.60E+02
2009	6.38E+03	9.08E+03	2.98E+03	1.82E+03	1.68E+03	1.22E+03	7.64E+02	6.98E+02	2.85E+02
2010	1.24E+03	5.78E+03	7.63E+03	2.25E+03	1.24E+03	1.19E+03	8.22E+02	5.25E+02	5.32E+02
2011	6.97E+03	1.12E+03	4.97E+03	5.69E+03	1.35E+03	8.00E+02	8.41E+02	5.93E+02	3.65E+02

Estimated population abundance at 1st Jan 2012

0.00E+00	6.31E+03	9.26E+02	3.77E+03	4.12E+03	9.41E+02	5.30E+02	6.23E+02	4.42E+02

Taper weighted geometric mean of the VPA populations:

4.90E+03	4.41E+03	3.70E+03	2.47E+03	1.47E+03	8.97E+02	5.58E+02	3.57E+02	2.30E+02

Standard error of the weighted Log(VPA populations) :

0.4112	0.408	0.3548	0.375	0.4095	0.4801	0.5927	0.7718	0.9452

Table 7.13.10 - Sole VIIfg - XSA diagnostics - continued

Log catchability residuals.

Fleet : BE-CBT

Age	1971
1	No data for this fleet at this age
2	0.23
3	-0.48
4	0.26
5	0.32
6	0.13
7	0.5
8	0.32
9	0.02

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	No data for this fleet at this age									
2	0.13	0.54	0.11	-0.15	0.55	0.21	0.38	0.41	1.18	0.55
3	0.18	0.38	-0.1	-0.34	0.4	0.15	0.08	0.08	0.05	0.22
4	-0.16	0.13	-0.05	-0.31	-0.01	-0.02	0.07	0.41	0.27	-0.09
5	0.14	0.2	0.14	0	0.26	-0.08	-0.46	0.13	0.21	-0.13
6	0.3	-0.09	0.51	0.27	-0.18	0.08	-0.21	0.05	-0.04	0.21
7	-0.01	-0.3	0.12	0.38	0.15	0.19	-0.38	0.63	-0.87	0.17
8	0.21	-0.42	-0.01	-0.45	0.57	-0.01	-0.17	0.3	-0.16	-0.14
9	-0.1	-0.18	0.15	-0.1	0.07	-0.27	-0.23	0.02	-0.01	0.08

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	No data for this fleet at this age									
2	0.22	0.45	0.17	-1.66	-0.09	0.42	0.05	-0.31	0.09	1.61
3	0.12	-0.02	-0.19	-0.06	0.01	-0.16	-0.54	-0.48	0.18	0.42
4	-0.15	-0.25	-0.34	-0.12	-0.09	0	-0.19	-0.15	0.13	0.08
5	0.05	-0.24	0.02	0.12	-0.04	0	-0.05	-0.1	-0.04	0
6	0.21	-0.18	-0.1	0.07	0.11	0.38	-0.03	0.09	0.22	-0.35
7	0.41	0.14	0.22	-0.06	0.06	0.69	0.02	0.18	0.19	-0.46
8	0.36	0.51	-0.08	0.19	-0.27	-0.13	0.57	0.17	0.24	-0.42
9	0.42	-0.22	-0.29	-0.06	-0.08	0.15	0.03	-0.31	-0.17	-0.42

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	No data for this fleet at this age									
2	0.79	0.42	-0.16	-1.11	-0.77	-0.44	-0.91	0.03	0.26	0.09
3	0.42	0.29	-0.2	0.1	0.25	0.07	0	0.2	-0.03	-0.71
4	0.31	-0.03	0.23	0.42	0.19	-0.08	0.45	0.1	-0.55	-0.17
5	0.24	-0.18	0.19	0.05	0.04	0.02	-0.07	0.05	-0.92	-0.31
6	0.02	-0.33	0.36	-0.03	0.04	0.21	-0.09	-0.47	-1.6	0.07
7	-0.85	0.23	-0.07	0.1	-0.32	0.22	0.66	-0.45	-1.28	-0.4
8	-0.97	0.44	-0.74	-0.02	-0.27	-0.26	0.16	-0.65	-0.83	-0.75
9	-0.49	0.29	-0.02	-0.3	-0.32	0.07	-0.43	-0.1	-0.62	-0.4

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	No data for this fleet at this age									
2	99.99	-3.27	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	0.04	-0.32	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	-0.2	-0.06	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	0.39	0.05	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6	-0.2	0.57	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
7	-0.23	0.45	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
8	0	0.21	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
9	-0.03	0.27	99.99	99.99	99.99	99.99	99.99	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	-6.3729	-5.1059	-4.8873	-4.9181	-4.9839	-5.0731	-5.0731	-5.0731
S.E(Log q)	0.8639	0.2857	0.2322	0.2422	0.3734	0.4508	0.4212	0.262

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	0.97	0.068	6.43	0.15	32	0.85	-6.37
3	1.07	-0.422	4.91	0.57	33	0.31	-5.11
4	1.07	-0.609	4.68	0.71	33	0.25	-4.89
5	0.85	1.918	5.28	0.84	33	0.2	-4.92
6	0.76	2.377	5.4	0.76	33	0.27	-4.98
7	0.81	1.756	5.29	0.74	33	0.36	-5.07
8	0.89	1.321	5.22	0.83	33	0.37	-5.15
9	0.92	2.145	5.2	0.96	33	0.21	-5.18
1							

Table 7.13.10 - Sole VIIfg - XSA diagnostics - continued

Fleet : UK(E&W)-CBT

Age		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	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	0.36
	3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.03
	4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.5
	5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.52
	6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.37
	7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.37
	8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.4
	9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.51

Age		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	1	No data for this fleet at this age									
	2	0.1	-1.17	0.24	0.1	0.4	-0.66	-0.81	-0.11	-0.15	-0.13
	3	0.29	-0.17	-0.26	-0.12	0.17	-0.36	-0.16	0.21	-0.2	-0.54
	4	0.09	-0.02	-0.5	-0.38	0.26	0.04	-0.17	-0.18	-0.12	-0.68
	5	0.04	-0.09	-0.23	-0.25	-0.02	0.02	0.19	-0.1	-0.27	-0.43
	6	0.13	-0.25	-0.39	0.16	-0.04	0.21	0.12	0.14	-0.4	-0.35
	7	-0.04	0.08	-0.17	-0.14	0.03	0.09	-0.15	0.08	0.07	-0.34
	8	-0.21	-0.34	-0.06	0.45	-0.05	0.29	0.02	0.29	0.26	0.07
	9	0.23	0.34	0.4	0.73	0.29	0.22	0.14	-0.17	0.57	0.35

Age		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	1	No data for this fleet at this age									
	2	-0.49	-0.56	0.03	0.38	0.45	1.15	0.69	0.52	-1.64	1.31
	3	-0.19	-0.16	-0.44	-0.16	0.2	0.5	0.93	0.5	0.01	-0.07
	4	-0.17	-0.26	-0.54	-0.09	0.23	0.27	0.65	0.74	0.32	0.01
	5	-0.25	-0.07	-0.29	-0.34	0.22	0.34	0.21	0.49	0.27	0.04
	6	-0.2	0.02	-0.25	-0.46	-0.23	0.39	0.27	0.51	0.04	0.21
	7	-0.08	-0.07	0.04	-0.19	-0.13	0.31	0.41	0.1	0.07	-0.35
	8	0.43	-0.07	0.19	-0.23	-0.02	0.43	0.27	0.21	-0.04	-0.15
	9	0.74	-0.13	0.55	0.06	0.37	0.54	0.66	0.23	-0.17	-0.15

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	-8.9209	-6.8882	-6.2947	-5.982	-5.7919	-5.7711	-5.7711	-5.7711
S.E(Log q)	0.717	0.3498	0.3782	0.2716	0.2877	0.2031	0.2632	0.4236

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	2.05	-1.676	9.43	0.12	21	1.41	-8.92
3	1.53	-1.769	6.15	0.37	21	0.51	-6.89
4	1.17	-0.699	6.04	0.48	21	0.45	-6.29
5	0.99	0.068	5.99	0.75	21	0.28	-5.98
6	0.98	0.15	5.81	0.78	21	0.29	-5.79
7	0.97	0.418	5.78	0.91	21	0.2	-5.77
8	1.03	-0.413	5.67	0.89	21	0.25	-5.67
9	1.02	-0.187	5.48	0.88	21	0.3	-5.47
1							

Fleet : UK(E&W)-BTS-Q3

Age		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	1	99.99	99.99	99.99	99.99	99.99	99.99	-1.39	-0.19	-0.48	-0.23
	2	99.99	99.99	99.99	99.99	99.99	99.99	0.02	0.29	0.4	0.16
	3	99.99	99.99	99.99	99.99	99.99	99.99	0.29	1.05	0.1	0.47
	4	99.99	99.99	99.99	99.99	99.99	99.99	-0.15	0.54	-0.09	0.16
	5	99.99	99.99	99.99	99.99	99.99	99.99	-0.14	0.41	-0.06	0.68
	6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.54	0.23	0.33
	7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.5	0.57	99.99
	8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.65	99.99	0.99
	9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	1.71	99.99	0.84

Age		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	1	0.2	-0.68	0.36	-0.66	-0.67	0.09	0.53	0.81	0.48	0.23
	2	0.12	0.31	0.34	0.1	0.1	-0.26	0.24	-0.33	0.49	0.31
	3	0.55	-0.07	0.78	0.15	0.47	-0.62	0.12	-0.51	-0.71	0.38
	4	0.78	-0.19	0.36	-0.15	0.67	0.18	0.12	0.1	0.23	-0.07
	5	1.01	-1.03	-0.22	0.1	0.14	1.01	0.7	0.61	-0.18	-0.11
	6	0.69	-1.11	0.65	0.64	-0.23	0.54	0.52	0.34	99.99	0.27
	7	-0.71	-0.35	99.99	-0.66	0.11	0.73	0.69	1.25	0.28	0.23
	8	-0.15	-0.16	99.99	-0.25	-0.12	1.2	0.35	0.63	0.22	99.99
	9	0.38	-0.23	1.72	0.29	1.49	99.99	1.59	99.99	1.31	1.52

Age		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	1	0.3	0.04	0.56	-0.09	0.1	0.24	0.36	0.1	-0.05	0
	2	-0.06	0.26	0.25	-0.44	-0.32	-0.56	-0.77	-0.6	0.23	-0.3
	3	0.39	-0.15	0.13	-0.63	-0.52	-0.25	-1.16	-0.71	-0.04	0.5
	4	0.48	-0.16	-0.31	-0.68	-0.47	-0.57	-0.3	-0.81	-0.01	0.33
	5	0.28	0.49	0.31	-0.36	-0.73	-0.02	-0.72	-0.32	-1.55	-0.31
	6	-0.02	0.44	0.54	-0.88	99.99	-0.62	-0.13	-1.01	-0.47	-1.27
	7	-0.17	-0.07	0.33	0.09	-1.31	-0.42	-0.68	-0.69	0.29	0
	8	1.25	0.83	0.4	-0.75	0.01	-0.27	-0.07	-0.69	-0.04	-0.51
	9	99.99	99.99	99.99	0.33	99.99	0.45	0.33	-0.19	-0.85	99.99

Table 7.13.10 - Sole VIIfg - XSA diagnostics - continued

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

Age	1	2	3	4	5	6	7	8	9
Mean Log q	-7.1553	-7.2227	-8.4745	-9.0861	-9.3072	-9.1677	-9.3217	-9.3217	-9.3217
S.E(Log q)	0.4936	0.3563	0.5482	0.4131	0.6235	0.6454	0.6093	0.62	1.0963

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	0.73	1.81	7.53	0.67	24	0.34	-7.16
2	0.85	1.152	7.4	0.72	24	0.3	-7.22
3	0.75	1.085	8.42	0.47	24	0.41	-8.47
4	1.1	-0.418	9.21	0.44	24	0.46	-9.09
5	1.25	-0.673	9.82	0.25	24	0.79	-9.31
6	1.55	-1.221	10.52	0.21	21	0.99	-9.17
7	1.77	-2.125	11.78	0.29	21	0.99	-9.32
8	1.69	-2.384	11.59	0.4	20	0.9	-9.15
9	2.63	-3.192	14.34	0.23	15	1.65	-8.61
1							

Terminal year survivor and F summaries :

Age 1 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
UK(E&W)-CBT	1	0	0	0	0	0	0
UK(E&W)-BTS-Q3	6310	0.504	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
6310	0.5	0	1	0	0

1

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2009

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
UK(E&W)-CBT	3449	0.734	0	0	1	0.134	0.025
UK(E&W)-BTS-Q3	750	0.295	0.118	0.4	2	0.831	0.111
F shrinkage mean	884	1.5				0.035	0.095

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
926	0.27	0.31	4	1.135	0.091

Table 7.13.10 - Sole VIIfg - XSA diagnostics - continued

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2008

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
UK(E&W)-CBT	2634	0.322	0.61	1.9	2	0.395	0.242
UK(E&W)-BTS-Q3	4883	0.261	0.101	0.39	3	0.583	0.138
F shrinkage mean	2569	1.5				0.022	0.247

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3773	0.2	0.22	6	1.117	0.175

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2007

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
UK(E&W)-CBT	4367	0.249	0.107	0.43	3	0.452	0.211
UK(E&W)-BTS-Q3	3979	0.223	0.244	1.09	4	0.531	0.229
F shrinkage mean	2699	1.5				0.017	0.322

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4122	0.17	0.13	8	0.758	0.222

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2006

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
UK(E&W)-CBT	1179	0.198	0.125	0.63	4	0.589	0.215
UK(E&W)-BTS-Q3	679	0.215	0.193	0.89	5	0.394	0.348
F shrinkage mean	744	1.5				0.016	0.322

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
941	0.15	0.13	10	0.909	0.262

1

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 2005

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
UK(E&W)-CBT	803	0.169	0.146	0.87	5	0.664	0.217
UK(E&W)-BTS-Q3	223	0.212	0.216	1.02	6	0.321	0.626
F shrinkage mean	629	1.5				0.015	0.269

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
530	0.13	0.21	12	1.58	0.312

Table 7.13.10 - Sole VIIfg - XSA diagnostics - continued

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
UK(E&W)-CBT	689	0.151	0.17	1.13	6	0.709	0.182
UK(E&W)-BTS-Q3	486	0.211	0.062	0.29	7	0.279	0.25
F shrinkage mean	482	1.5				0.012	0.251

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
623	0.12	0.1	14	0.823	0.2

1

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2003

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
UK(E&W)-CBT	500	0.142	0.096	0.68	7	0.744	0.172
UK(E&W)-BTS-Q3	305	0.219	0.172	0.78	8	0.245	0.269
F shrinkage mean	396	1.5				0.011	0.213

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
442	0.12	0.1	16	0.799	0.193

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2002

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
UK(E&W)-CBT	304	0.139	0.064	0.46	8	0.774	0.143
UK(E&W)-BTS-Q3	229	0.218	0.122	0.56	8	0.214	0.185
F shrinkage mean	173	1.5				0.013	0.238

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
284	0.12	0.06	17	0.52	0.152

Table 7.13.11 - Sole in VIIfg. Fishing mortality

Run title : CELTIC SEA SOLE - 2012WG
At 7/05/2012 15:15

	1971
1	0.0000
2	0.0825
3	0.1455
4	0.3790
5	0.3885
6	0.3032
7	0.3997
8	0.3339
9	0.2473
+gp	0.2473
FBAR 4-8	0.3609

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.000
2	0.0676	0.1041	0.0546	0.0414	0.1300	0.0728	0.0830	0.0719	0.2433	0.147
3	0.2511	0.3132	0.1577	0.1220	0.3971	0.2426	0.2194	0.1845	0.2798	0.375
4	0.2248	0.3033	0.2063	0.1565	0.3282	0.2555	0.2676	0.3194	0.4313	0.344
5	0.2936	0.3155	0.2423	0.2073	0.4161	0.2329	0.1531	0.2333	0.3932	0.317
6	0.3232	0.2208	0.3298	0.2538	0.2524	0.2585	0.1864	0.2020	0.2894	0.421
7	0.2139	0.1655	0.2051	0.2578	0.3203	0.2604	0.1419	0.3293	0.1049	0.370
8	0.2674	0.1463	0.1769	0.1136	0.4894	0.2130	0.1757	0.2370	0.2358	0.270
9	0.1988	0.1856	0.1894	0.1598	0.2967	0.1615	0.1687	0.1792	0.2722	0.339
+gp	0.1988	0.1856	0.1894	0.1598	0.2967	0.1615	0.1687	0.1792	0.2722	0.339
FBAR 4-8	0.2646	0.2303	0.2321	0.1978	0.3613	0.2441	0.1849	0.2642	0.2909	0.344

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0853	0.1669	0.1221	0.0496	0.1069	0.1244	0.1125	0.1323	0.0905	0.2191
3	0.2754	0.3714	0.3045	0.3776	0.4644	0.2766	0.2403	0.3444	0.3921	0.3021
4	0.2616	0.3673	0.3277	0.4403	0.5172	0.5136	0.3907	0.4923	0.6143	0.4327
5	0.3109	0.3620	0.4536	0.5101	0.5445	0.4592	0.5285	0.4672	0.6287	0.5033
6	0.3410	0.3583	0.3745	0.4252	0.6274	0.5364	0.5657	0.5338	0.6520	0.4558
7	0.3823	0.4477	0.4748	0.3186	0.4811	0.8037	0.4540	0.5249	0.6050	0.4318
8	0.3614	0.6487	0.3481	0.4147	0.4475	0.4366	0.7316	0.5277	0.6286	0.4559
9	0.3809	0.3174	0.2837	0.3812	0.5411	0.5752	0.5199	0.4568	0.6317	0.4891
+gp	0.3809	0.3174	0.2837	0.3812	0.5411	0.5752	0.5199	0.4568	0.6317	0.4891
FBAR 4-8	0.3314	0.4368	0.3958	0.4218	0.5236	0.5499	0.5341	0.5092	0.6257	0.4559

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.1276	0.0968	0.0806	0.0449	0.0639	0.0728	0.0427	0.1191	0.1412	0.1099
3	0.3792	0.3563	0.2887	0.4514	0.5232	0.4572	0.3818	0.5449	0.4157	0.2068
4	0.4522	0.4019	0.5193	0.7217	0.6794	0.5792	0.7365	0.6158	0.3832	0.4020
5	0.4651	0.3942	0.5584	0.5580	0.6005	0.6457	0.5620	0.6322	0.3172	0.3996
6	0.4601	0.3533	0.6072	0.6199	0.5984	0.7779	0.5598	0.5131	0.2323	0.5348
7	0.2981	0.5291	0.4702	0.5690	0.4737	0.6973	0.8152	0.4909	0.3427	0.3757
8	0.2558	0.5049	0.3727	0.6905	0.4510	0.5788	0.5932	0.5101	0.4724	0.3778
9	0.3930	0.6037	0.6615	0.6916	0.5483	0.6876	0.4424	0.5169	0.5992	0.5168
+gp	0.3930	0.6037	0.6615	0.6916	0.5483	0.6876	0.4424	0.5169	0.5992	0.5168
FBAR 4-8	0.3863	0.4367	0.5056	0.6318	0.5606	0.6558	0.6533	0.5524	0.3496	0.4180

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	FBAR 09-11
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0081	0.0206	0.0994	0.0543	0.1660	0.1208	0.0651	0.0735	0.0510	0.0912	0.0719
3	0.3109	0.2438	0.4043	0.2646	0.3602	0.2904	0.2098	0.1802	0.1936	0.1749	0.1829
4	0.3447	0.3739	0.4257	0.3118	0.3284	0.3115	0.2714	0.2853	0.4106	0.2223	0.3061
5	0.5442	0.4848	0.4322	0.4312	0.3260	0.3352	0.3615	0.2457	0.3368	0.2624	0.2817
6	0.3712	0.6671	0.3110	0.3559	0.2298	0.2749	0.2936	0.2937	0.2491	0.3119	0.2849
7	0.3664	0.5885	0.3528	0.2164	0.1932	0.3217	0.2369	0.2756	0.2273	0.2001	0.2343
8	0.5423	0.5308	0.2722	0.2192	0.1468	0.2624	0.2235	0.1705	0.2619	0.1931	0.2085
9	0.6316	0.4831	0.3988	0.2695	0.2854	0.1993	0.2836	0.1772	0.1351	0.1520	0.1548
+gp	0.6316	0.4831	0.3988	0.2695	0.2854	0.1993	0.2836	0.1772	0.1351	0.1520	
FBAR 4-8	0.4338	0.5290	0.3588	0.3069	0.2449	0.3011	0.2774	0.2541	0.2971	0.2380	

Table 4.3.12 - Sole in VIIfg. Stock numbers at age (start of year, in thousand)

Run title : CELTIC SEA SOLE - 2012WG
At 7/05/2012 15:15

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	9610	4277	3389	3405	2974	5194	4637	5494	3535	5132	4859
2	5123	8699	3870	3066	3081	2691	4700	4196	4971	3198	4644
3	2096	4270	7357	3156	2627	2675	2138	3954	3494	4186	2269
4	4466	1640	3006	4867	2439	2104	1627	1518	2873	2629	2863
5	2040	2768	1185	2008	3583	1887	1371	1140	1051	1889	1545
6	1738	1252	1868	782	1426	2635	1126	983	885	753	1153
7	1712	1163	820	1355	509	1001	1852	787	738	655	510
8	2823	1040	850	629	999	356	658	1292	618	480	533
9	1801	1831	720	664	477	807	197	481	980	441	343
+gp	5830	4247	3989	3289	2643	1890	2569	1176	1081	1549	1384
TOTAL	37237	31187	27053	23221	20757	21239	20875	21020	20226	20912	20104

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	4890	6794	4708	5660	3159	5742	4491	3720	8610	4200
2	4397	4424	6148	4260	5121	2858	5195	4064	3366	7791
3	3629	3653	3388	4923	3668	4164	2284	4200	3222	2782
4	1411	2493	2280	2261	3054	2086	2857	1625	2694	1969
5	1837	983	1563	1486	1317	1647	1129	1749	899	1319
6	1019	1218	619	898	808	691	942	602	992	434
7	685	655	770	385	531	390	366	484	320	468
8	319	423	379	434	253	297	158	210	259	158
9	368	201	200	242	259	147	174	69	112	125
+gp	1078	1233	1163	793	821	428	692	291	288	438
TOTAL	19633	22079	21217	21342	18991	18450	18288	17015	20761	19684

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	4457	4429	3412	3320	4055	5480	6294	15180	7857	4170
2	3800	4033	4007	3087	3004	3670	4958	5695	13735	7109
3	5663	3027	3312	3345	2671	2550	3087	4299	4574	10791
4	1861	3507	1918	2245	1927	1432	1460	1907	2256	2731
5	1156	1071	2123	1032	987	884	726	633	932	1391
6	721	657	654	1099	535	490	419	375	304	614
7	249	412	418	322	535	266	204	217	203	218
8	275	167	220	236	165	301	120	82	120	130
9	91	193	91	137	107	95	153	60	44	68
+gp	287	228	315	228	263	223	255	114	118	210
TOTAL	18559	17723	16470	15053	14249	15390	17676	28560	30145	27434

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	GMST 71-09	AMST 71-09
1	6783	5216	5961	5202	3422	3889	10033	6384	1239	6973	0*	5031	5385
2	3773	6137	4720	5394	4707	3096	3519	9078	5776	1121	6310	4539	4856
3	5763	3387	5440	3867	4623	3608	2483	2983	7632	4967	926	3603	3836
4	7940	3821	2401	3285	2685	2918	2441	1821	2254	5690	3773	2420	2598
5	1653	5090	2379	1420	2176	1750	1933	1684	1239	1353	4122	1482	1626
6	844	868	2836	1397	835	1421	1132	1219	1192	800	941	893	1006
7	326	527	403	1880	886	600	977	764	822	841	530	547	655
8	136	204	265	256	1370	661	394	698	525	593	623	349	486
9	81	71	109	182	186	1071	460	285	532	365	442	223	362
+gp	114	205	156	191	215	406	726	1253	947	1109	1146		
TOTAL	27413	25527	24670	23075	21106	19419	24098	26168	22158	23812	18814		

* Replaced with GM (71-09) (=5031)

Table 7.13.13 - Sole in VIIfg. Summary

Run title : CELTIC SEA SOLE - 2012WG
At 7/05/2012 15:15

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 8
1971	9614	9517	8049	1861	0.2312	0.3609
1972	4277	8006	6347	1278	0.2014	0.2646
1973	3389	6647	5312	1391	0.2619	0.2303
1974	3405	6714	5692	1105	0.1941	0.2321
1975	2974	5896	5041	919	0.1823	0.1978
1976	5194	5397	4370	1350	0.3089	0.3613
1977	4637	5950	4686	961	0.2051	0.2441
1978	5494	5091	3771	780	0.2068	0.1849
1979	3535	5103	3893	954	0.2451	0.2642
1980	5132	5251	4028	1314	0.3262	0.2909
1981	4859	4604	3428	1212	0.3536	0.3442
1982	4890	4814	3563	1128	0.3166	0.3314
1983	6794	5142	3663	1373	0.3748	0.4368
1984	4708	5381	3923	1266	0.3227	0.3958
1985	5660	4797	3313	1328	0.4009	0.4218
1986	3159	4629	3373	1600	0.4744	0.5236
1987	5742	3739	2522	1222	0.4846	0.5499
1988	4491	3910	2714	1146	0.4222	0.5341
1989	3720	3251	2115	992	0.4689	0.5092
1990	8610	3890	2411	1189	0.4931	0.6257
1991	4200	3612	2139	1107	0.5174	0.4559
1992	4457	3868	2456	981	0.3994	0.3863
1993	4429	3841	2482	928	0.3738	0.4367
1994	3412	3270	2261	1009	0.4462	0.5056
1995	3320	3091	2160	1157	0.5357	0.6318
1996	4055	3065	2085	995	0.4773	0.5606
1997	5480	2979	1825	927	0.5078	0.6558
1998	6294	3064	1630	875	0.5369	0.6533
1999	15180	4290	1825	1012	0.5546	0.5524
2000	7857	3903	1947	1091	0.5603	0.3496
2001	4170	5420	3130	1168	0.3732	0.4180
2002	6783	5972	4107	1345	0.3275	0.4338
2003	5216	5615	3779	1392	0.3683	0.5290
2004	5961	5163	3541	1249	0.3527	0.3588
2005	5202	5278	3548	1044	0.2943	0.3069
2006	3422	4555	3102	946	0.3050	0.2449
2007	3889	4417	3312	945	0.2854	0.3011
2008	10033	4749	3032	800	0.2639	0.2774
2009	6384	5691	3554	805	0.2265	0.2541
2010	1239	5497	3717	876	0.2357	0.2971
2011	6973	5465	3898	1029	0.2640	0.2380
2012	5031[1]	5760[2]	4212[2]			0.2631[3]
Arith. Mean	5323	4891	3457	1123	0.3581	0.3939
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

[1] Geometric mean 1971-2009

[2] From forecast

[3] Mean $F_{(2009\text{-}2011)}$

Table 7.13.14 - Sole in VIIfg
Input for catch forecast and Fmsy analysis

Input: F mean 09-11 not rescaled to F2011
Catch and stock weights are mean 09-11
Recruits age 1 in 2012,13 and 14 GM (71-09)

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	5031	0.40	WS1	0.090	0.00
N2	6310	0.50	WS2	0.146	0.12
N3	926	0.31	WS3	0.206	0.01
N4	3773	0.22	WS4	0.264	0.03
N5	4122	0.17	WS5	0.319	0.06
N6	941	0.15	WS6	0.373	0.07
N7	530	0.21	WS7	0.424	0.07
N8	623	0.12	WS8	0.474	0.06
N9	442	0.12	WS9	0.522	0.06
N10	1146	0.12	WS10	0.614	0.03
H.cons selectivity			Weight in the HC catch		
sH1	0.0000	0.00	WH1	0.107	0.24
sH2	0.0719	0.28	WH2	0.159	0.18
sH3	0.1829	0.05	WH3	0.211	0.16
sH4	0.3061	0.31	WH4	0.260	0.15
sH5	0.2817	0.17	WH5	0.309	0.14
sH6	0.2849	0.11	WH6	0.355	0.13
sH7	0.2343	0.16	WH7	0.401	0.13
sH8	0.2085	0.23	WH8	0.445	0.12
sH9	0.1548	0.14	WH9	0.488	0.11
sH10	0.1548	0.14	WH10	0.580	0.09
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		
HF12	1	0.1	K12	1	0.1
HF13	1	0.1	K13	1	0.1
HF14	1	0.1	K14	1	0.1
Recruitment in 2013 and 2014					
R13	5031	0.4			
R14	5031	0.4			

Table 7.13.15 Sole in VIIfg - Management option table

MFDP version 1a
Run: Sol7FG_fin
Sole in VIId
Time and date: 10:10 10/05/2012
Fbar age range: 4-8

2012 Biomass	SSB	FMult	FBar	Landings
5760	4212	1.0000	0.2631	1010

2013 Biomass	SSB	FMult	FBar	Landings	2014 Biomass	SSB
5769	4053	0.0000	0.0000	0	6832	5136
.	4053	0.1000	0.0263	108	6718	5029
.	4053	0.2000	0.0526	213	6607	4924
.	4053	0.3000	0.0789	315	6498	4821
.	4053	0.4000	0.1052	416	6392	4721
.	4053	0.5000	0.1315	514	6288	4623
.	4053	0.6000	0.1579	610	6187	4528
.	4053	0.7000	0.1842	704	6088	4434
.	4053	0.8000	0.2105	796	5991	4343
.	4053	0.9000	0.2368	886	5896	4254
.	4053	1.0000	0.2631	973	5803	4167
.	4053	1.1000	0.2894	1059	5713	4082
.	4053	1.2000	0.3157	1143	5624	3999
.	4053	1.3000	0.3420	1225	5538	3918
.	4053	1.4000	0.3683	1306	5453	3839
.	4053	1.5000	0.3946	1384	5370	3762
.	4053	1.6000	0.4209	1461	5289	3686
.	4053	1.7000	0.4472	1536	5210	3612
.	4053	1.8000	0.4736	1610	5133	3540
.	4053	1.9000	0.4999	1682	5057	3470
.	4053	2.0000	0.5262	1752	4983	3401

Input units are thousands and kg - output in tonnes

Fmult corresponding to Fpa = 1.41						
.	4053	1.41	0.371	1314	5445	3831
Fmult corresponding to Fmsy = 1.18						
.	4053	1.18	0.3104	1127	5642	4016

Bpa = 2 200 t

Table 7.13.16 - Sole in VIIfg. Detailed results

MFDP version 1a
Run: Sol7FG_fin
Time and date: 10:10 10/05/2012
Fbar age range: 4-8

Year:	**2012**	F multiplier:	1	Fbar:	0.263				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
1	0.000	0	0	5031	453	0	0	0	0
2	0.072	417	73	6310	976	883	137	883	137
3	0.183	148	34	926	196	417	88	417	88
4	0.306	949	268	3773	1009	3320	888	3320	888
5	0.282	965	321	4122	1323	4040	1297	4040	1297
6	0.285	223	85	941	351	941	351	941	351
7	0.234	106	45	530	224	530	224	530	224
8	0.209	112	53	623	293	623	293	623	293
9	0.155	60	32	442	228	442	228	442	228
10	0.155	157	98	1146	708	1146	708	1146	708
Total		3135	1010	23844	5760	12342	4212	12342	4212

Year:	**2013**	F multiplier:	1	Fbar:	0.263				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
1	0.000	0	0	5031	453	0	0	0	0
2	0.072	301	53	4552	704	637	99	637	99
3	0.183	846	195	5313	1125	2391	506	2391	506
4	0.306	176	50	698	187	614	164	614	164
5	0.282	589	196	2514	807	2464	791	2464	791
6	0.285	666	255	2814	1049	2814	1049	2814	1049
7	0.234	128	55	640	270	640	270	640	270
8	0.209	68	33	379	178	379	178	379	178
9	0.155	63	33	458	236	458	236	458	236
10	0.155	168	105	1231	760	1231	760	1231	760
Total		3003	973	23631	5769	11628	4053	11628	4053

Year:	**2014**	F multiplier:	1	Fbar:	0.263				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
1	0.000	0	0	5031	453	0	0	0	0
2	0.072	301	53	4552	704	637	99	637	99
3	0.183	611	140	3833	811	1725	365	1725	365
4	0.306	1007	284	4004	1070	3524	942	3524	942
5	0.282	109	36	465	149	456	146	456	146
6	0.285	406	155	1716	640	1716	640	1716	640
7	0.234	381	164	1915	808	1915	808	1915	808
8	0.209	82	39	458	216	458	216	458	216
9	0.155	38	20	279	144	279	144	279	144
10	0.155	179	112	1309	808	1309	808	1309	808
Total		3114	1005	23563	5803	12019	4167	12019	4167

Input units are thousands and kg - output in tonnes

Table 7.13.17 **Sole VIIf,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	2008	2009	2010	2011	2012
Stock No. (thousands) of 1 year-olds	6384	1239	6973	5031	5031
Source	XSA	XSA	XSA	GM71-09	GM71-09
Status Quo F:					
% in 2012 landings	26.6	3.4	7.2	0.0	-
% in 2013 landings	20.1	5.1	20.0	5.4	0.0
% in 2012 SSB	21.1	2.1	3.3	0.0	-
% in 2013 SSB	19.5	4.0	12.5	2.4	0.0
% in 2014 SSB	15.4	3.5	22.6	8.8	2.4

GM : geometric mean recruitment

Sole VIIf,g : Year-class % contribution to

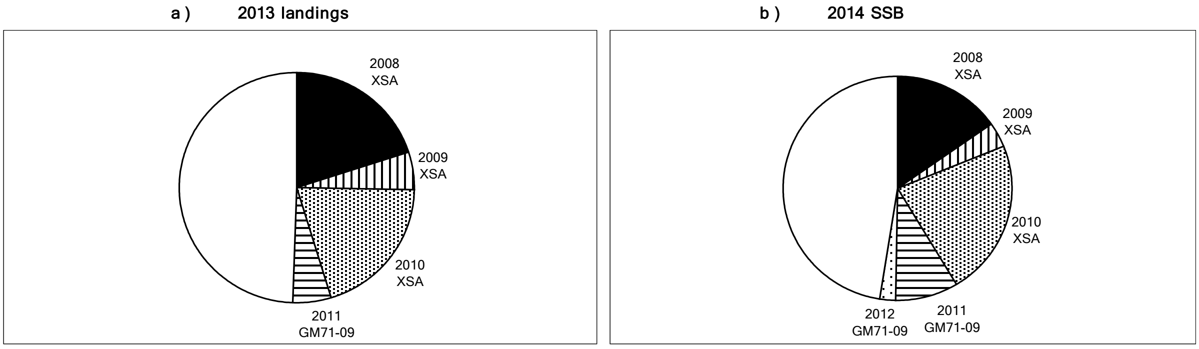


Table 7.13.18 - Sole in VIIfg Yield per recruit summary table

MFYPR version 2a
Run: Sol7FG_yield_fin
Time and date: 10:17 10/05/2012
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	10.5083	4.3777	8.1776	4.0439	8.1776	4.0439
0.1000	0.0263	0.1434	0.0619	9.0762	3.5525	6.7516	3.2202	6.7516	3.2202
0.2000	0.0526	0.2493	0.1034	8.0179	2.9530	5.6994	2.6223	5.6994	2.6223
0.3000	0.0789	0.3302	0.1319	7.2108	2.5041	4.8983	2.1748	4.8983	2.1748
0.4000	0.1052	0.3935	0.1518	6.5796	2.1596	4.2730	1.8318	4.2730	1.8318
0.5000	0.1315	0.4440	0.1658	6.0757	1.8901	3.7748	1.5637	3.7748	1.5637
0.6000	0.1579	0.4851	0.1756	5.6664	1.6757	3.3710	1.3506	3.3710	1.3506
0.7000	0.1842	0.5191	0.1826	5.3288	1.5026	3.0390	1.1789	3.0390	1.1789
0.8000	0.2105	0.5474	0.1875	5.0469	1.3612	2.7625	1.0387	2.7625	1.0387
0.9000	0.2368	0.5714	0.1908	4.8086	1.2444	2.5296	0.9232	2.5296	0.9232
1.0000	0.2631	0.5919	0.1931	4.6052	1.1468	2.3315	0.8269	2.3315	0.8269
1.1000	0.2894	0.6096	0.1945	4.4300	1.0647	2.1614	0.7460	2.1614	0.7460
1.2000	0.3157	0.6250	0.1954	4.2777	0.9950	2.0141	0.6775	2.0141	0.6775
1.3000	0.3420	0.6385	0.1958	4.1443	0.9353	1.8857	0.6190	1.8857	0.6190
1.4000	0.3683	0.6504	0.1959	4.0266	0.8838	1.7729	0.5686	1.7729	0.5686
1.5000	0.3946	0.6610	0.1958	3.9221	0.8391	1.6733	0.5251	1.6733	0.5251
1.6000	0.4209	0.6705	0.1955	3.8288	0.8001	1.5847	0.4872	1.5847	0.4872
1.7000	0.4472	0.6790	0.1951	3.7450	0.7658	1.5055	0.4540	1.5055	0.4540
1.8000	0.4736	0.6868	0.1946	3.6692	0.7354	1.4343	0.4247	1.4343	0.4247
1.9000	0.4999	0.6938	0.1940	3.6005	0.7085	1.3701	0.3988	1.3701	0.3988
2.0000	0.5262	0.7002	0.1934	3.5378	0.6844	1.3118	0.3758	1.3118	0.3758

Reference point	F multiplier	Absolute F
Fbar(4-8)	1.0000	0.2631
FMax	1.3909	0.3659
F0.1	0.6246	0.1643
F35%SPR	0.5672	0.1492

Figure 7.13.1 - Sole in VIIfg. Dotted lines give the length distributions of UK (England and Wales) landings; solid lines of Belgian landings

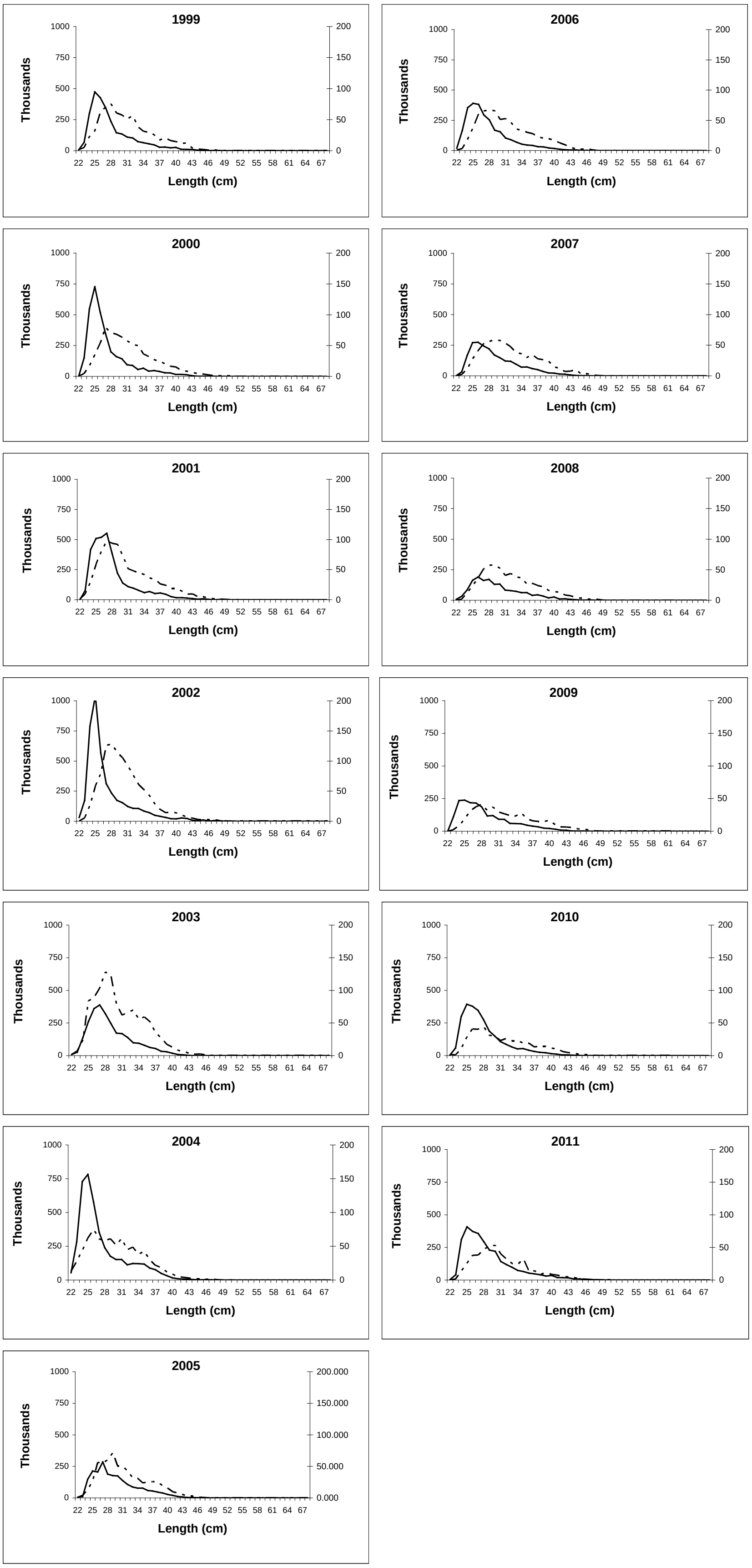


Figure 7.13.2 - Sole in VIIfg. Age composition of landings

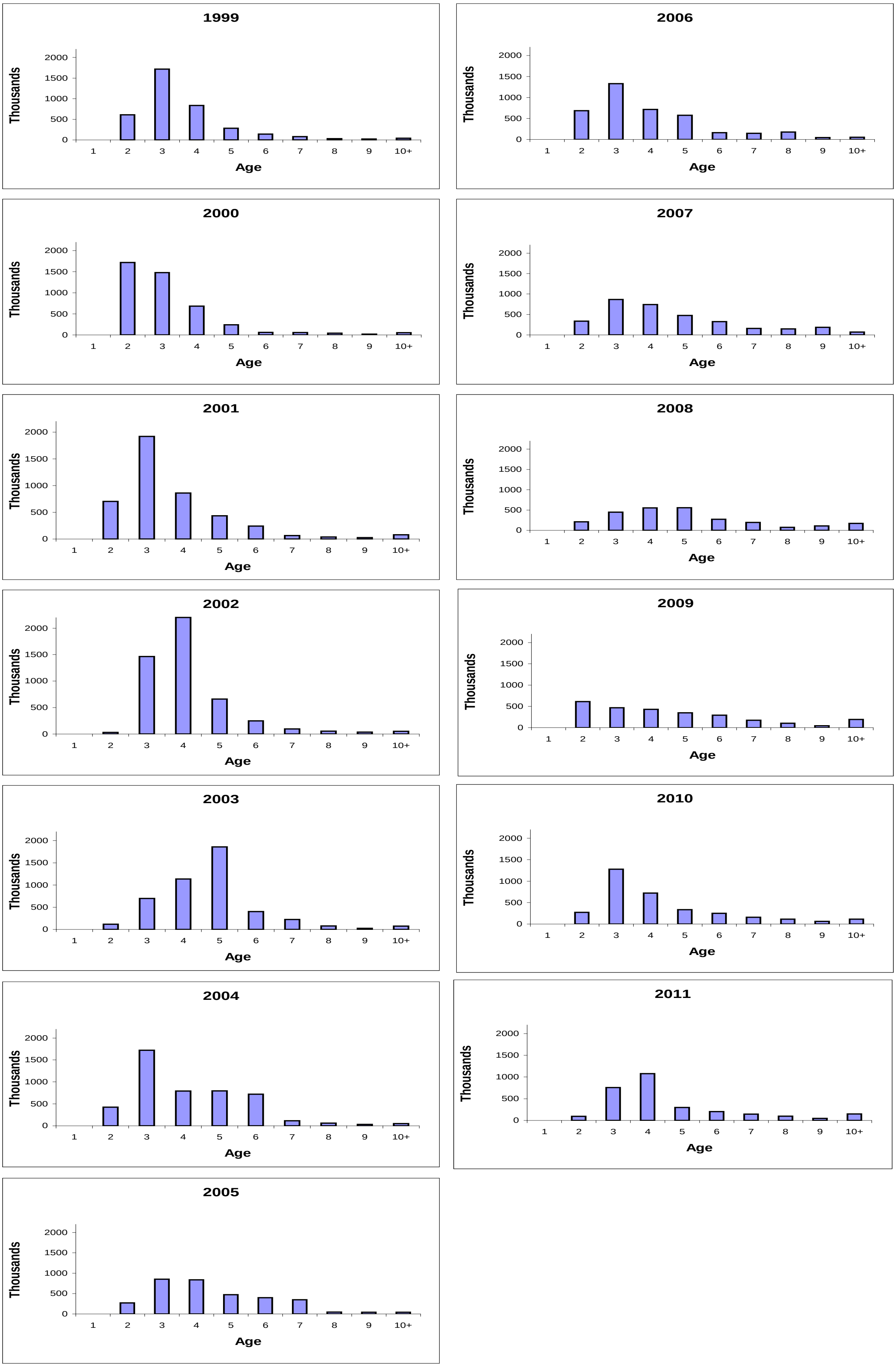


Figure 7.13.3 - Sole VIIfg - Standardized catch proportion

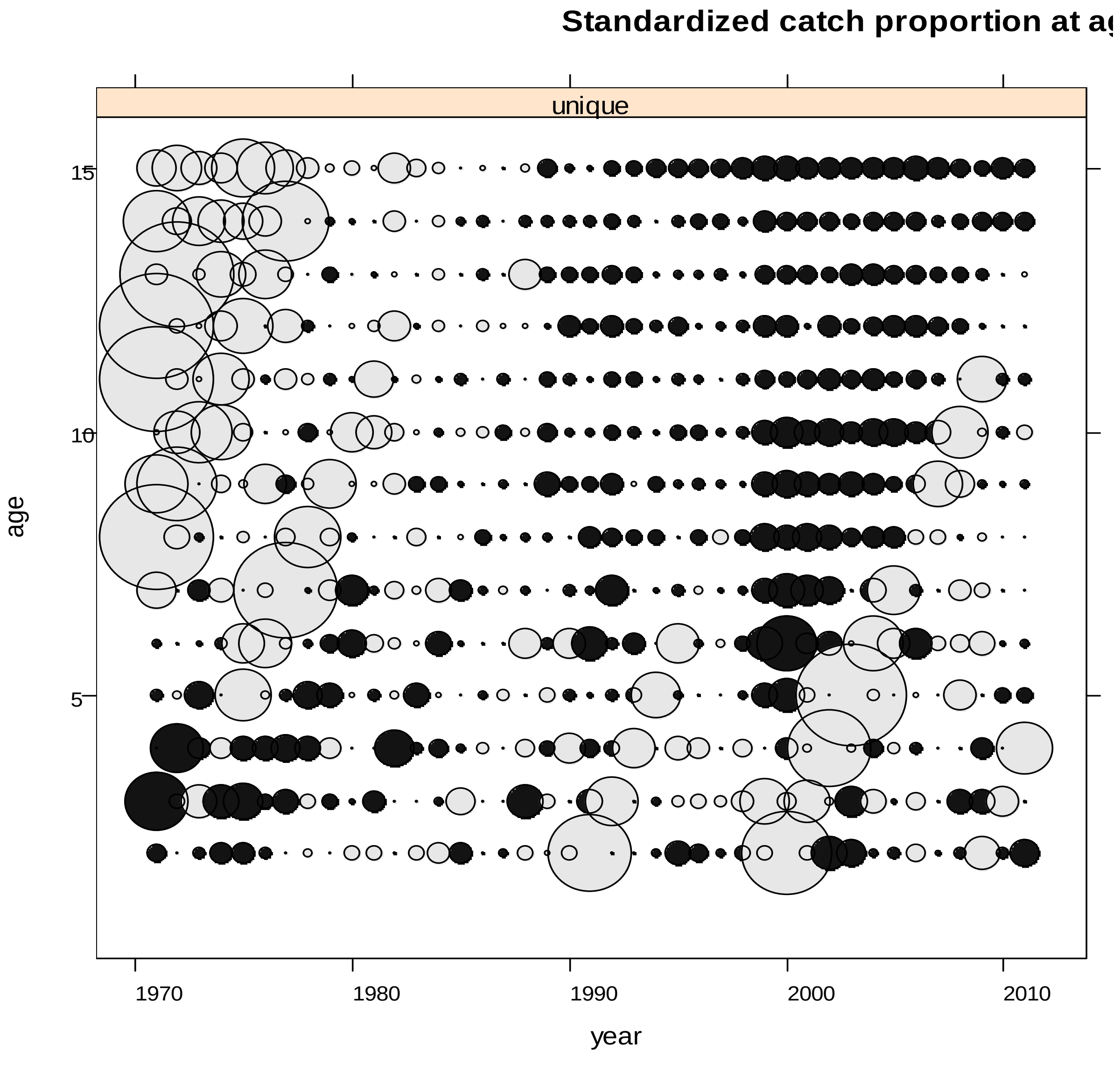
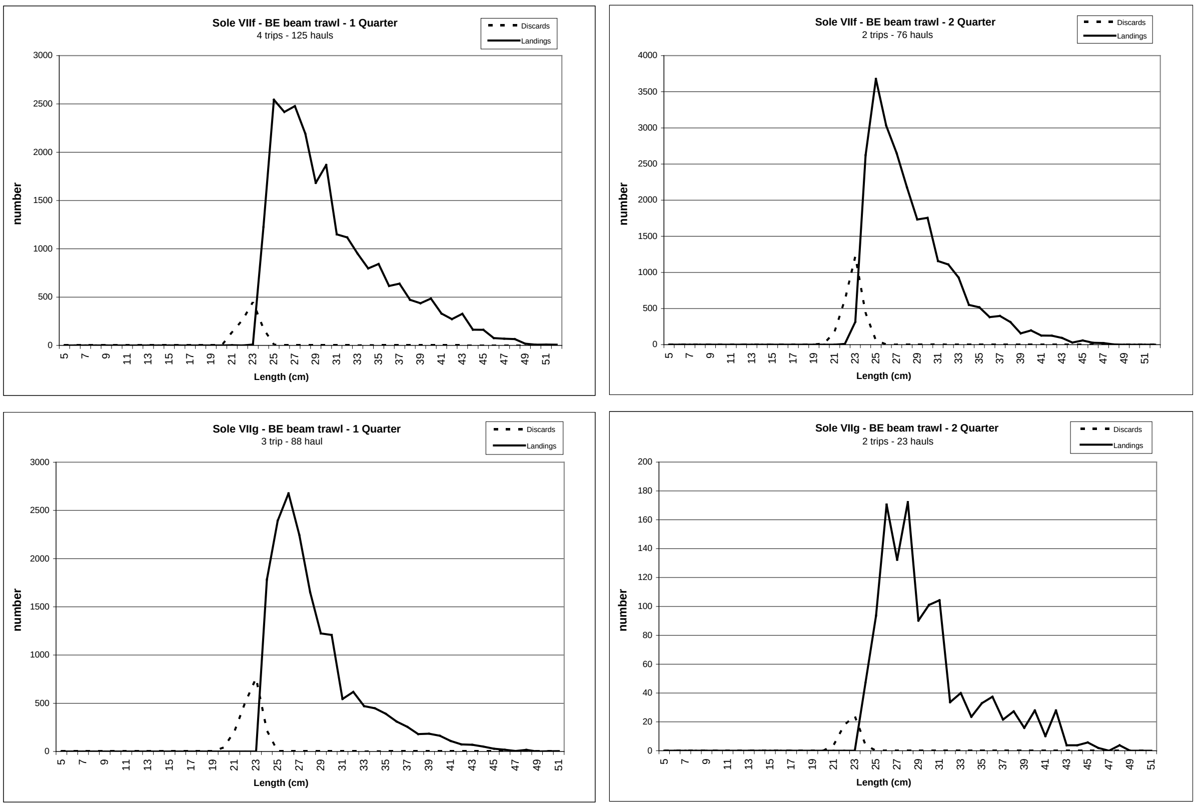


Figure 7.13.4a - Sole VIIfg - BE Length distributions of discarded and retained fish from discard sampling studies

VIIf



VIIg

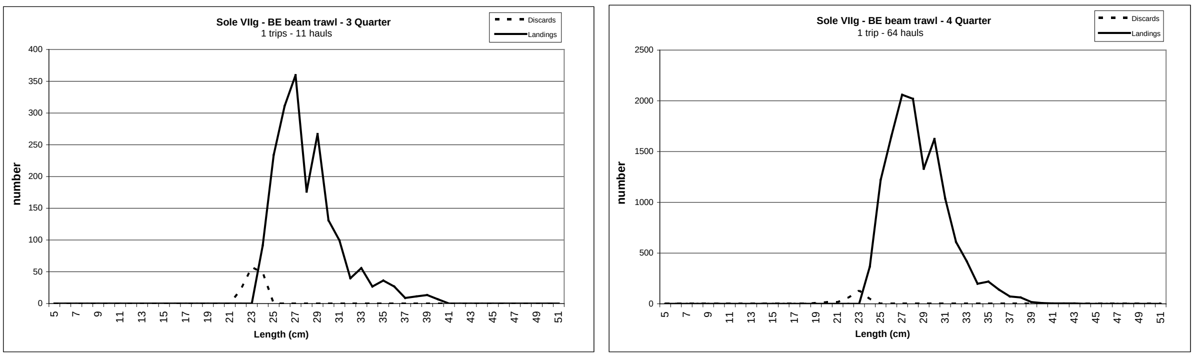


Figure 7.13.4b - Sole VIIfg - UK (E+W) Length distributions of discarded and retained fish from discard sampling studies

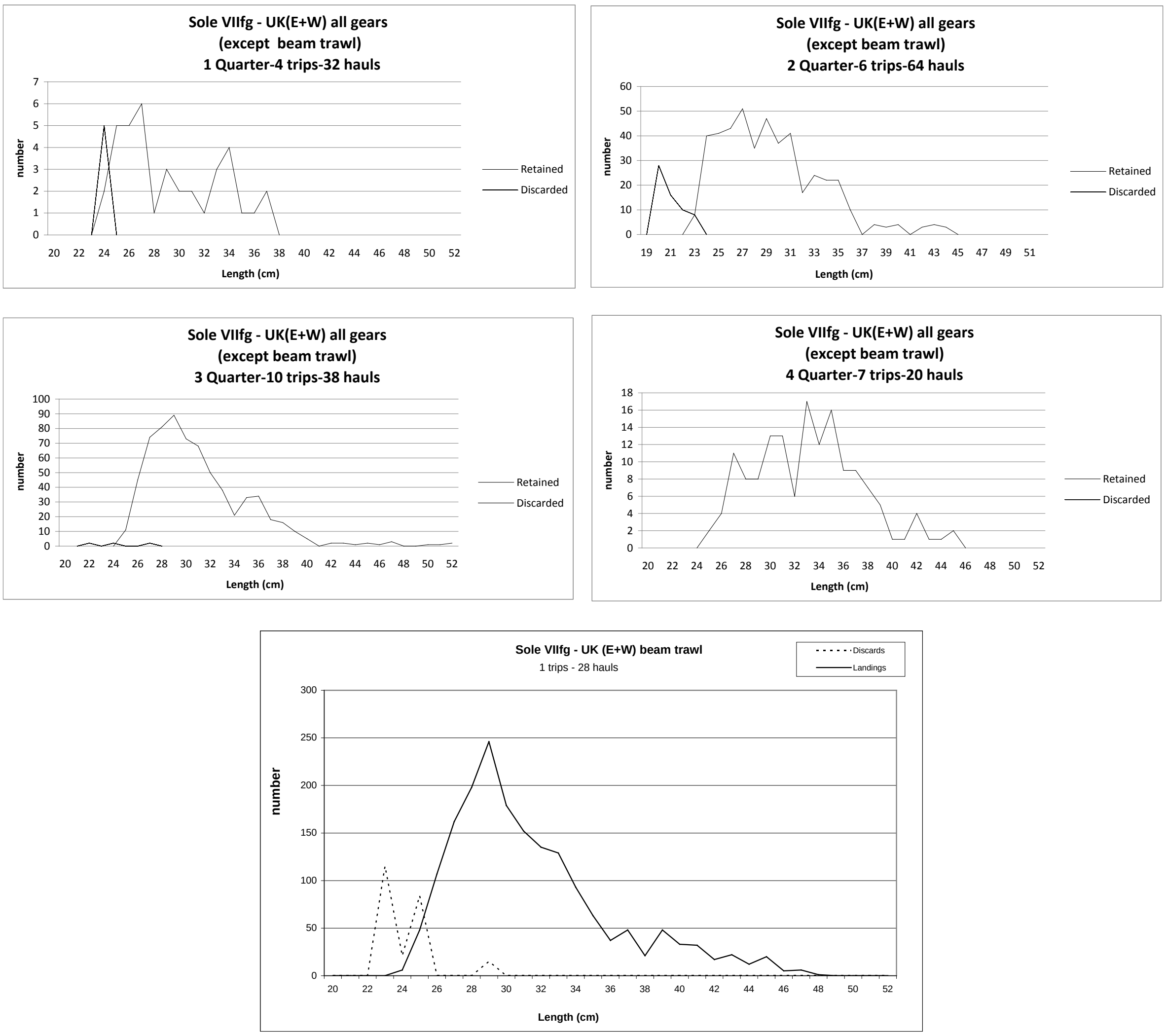


Figure 7.13.4c - Sole VIIfg - IRL Length distributions of discarded and retained fish from discard sampling studies

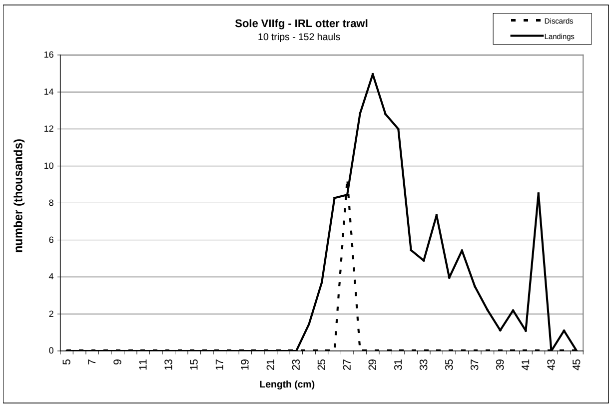
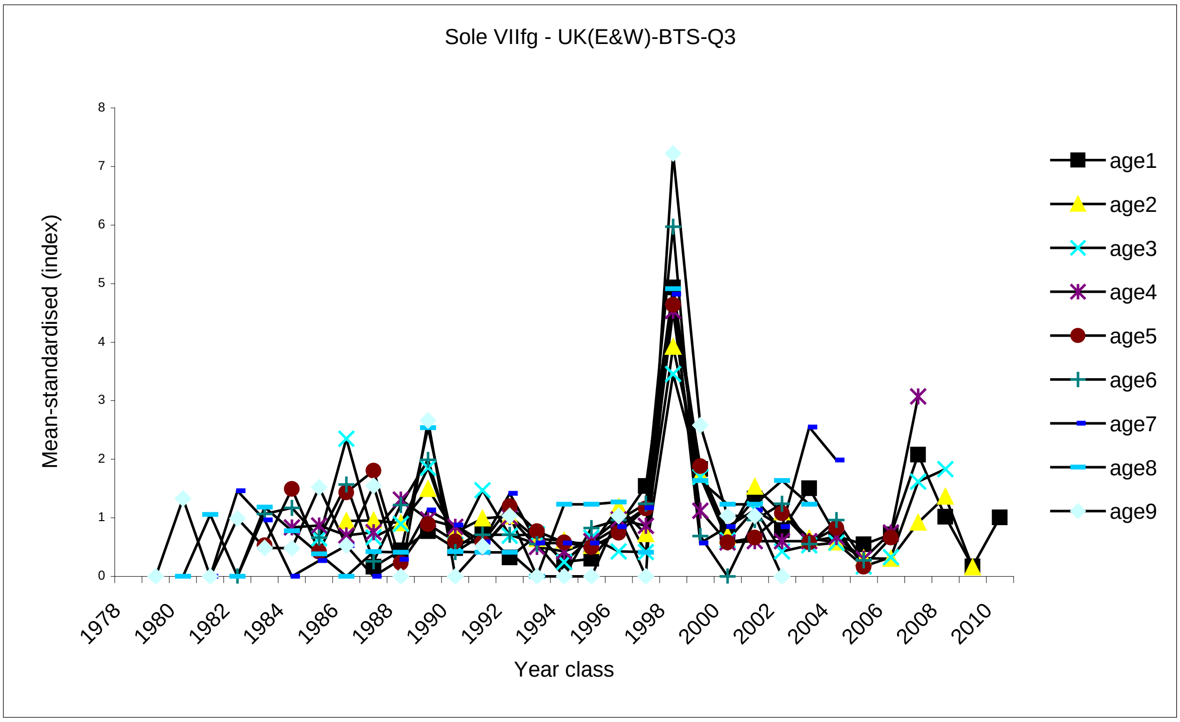


Figure 7.13.5 - Sole VIIfg - Mean-standardised index of UK(E&W) VIIfg Corystes survey



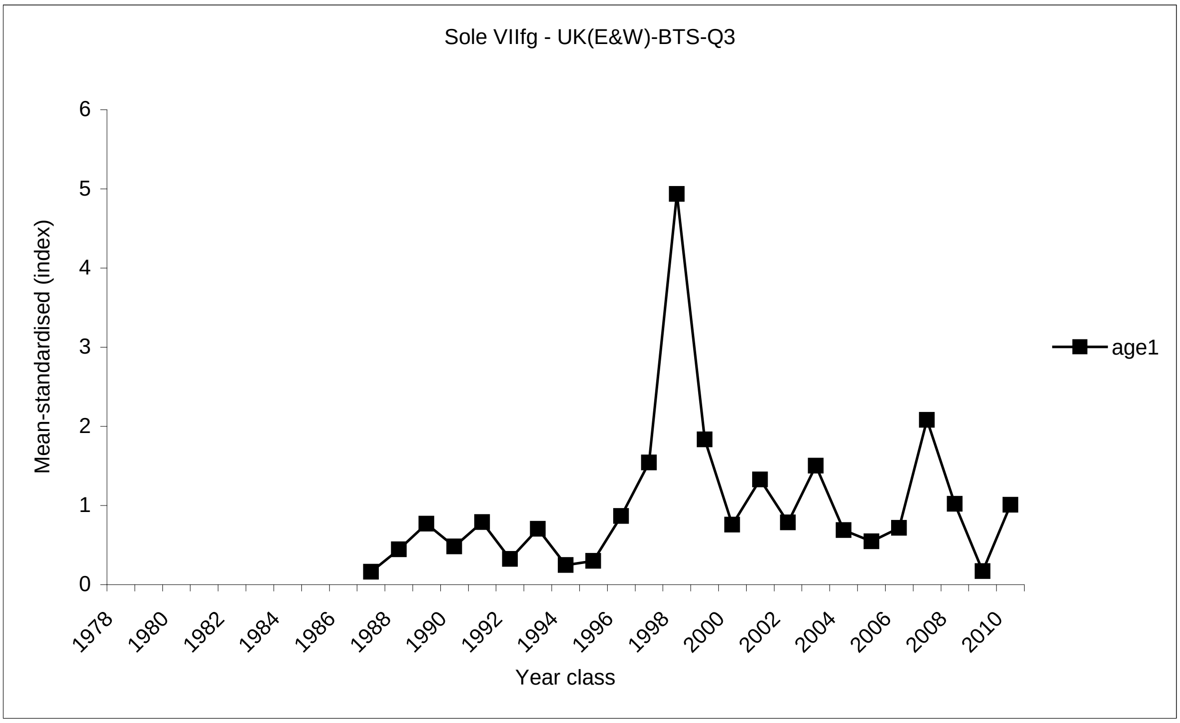


Figure 7.13.6 - Sole in VIIfg - Consistency plot UK(E&W)-BTS-Q3 survey

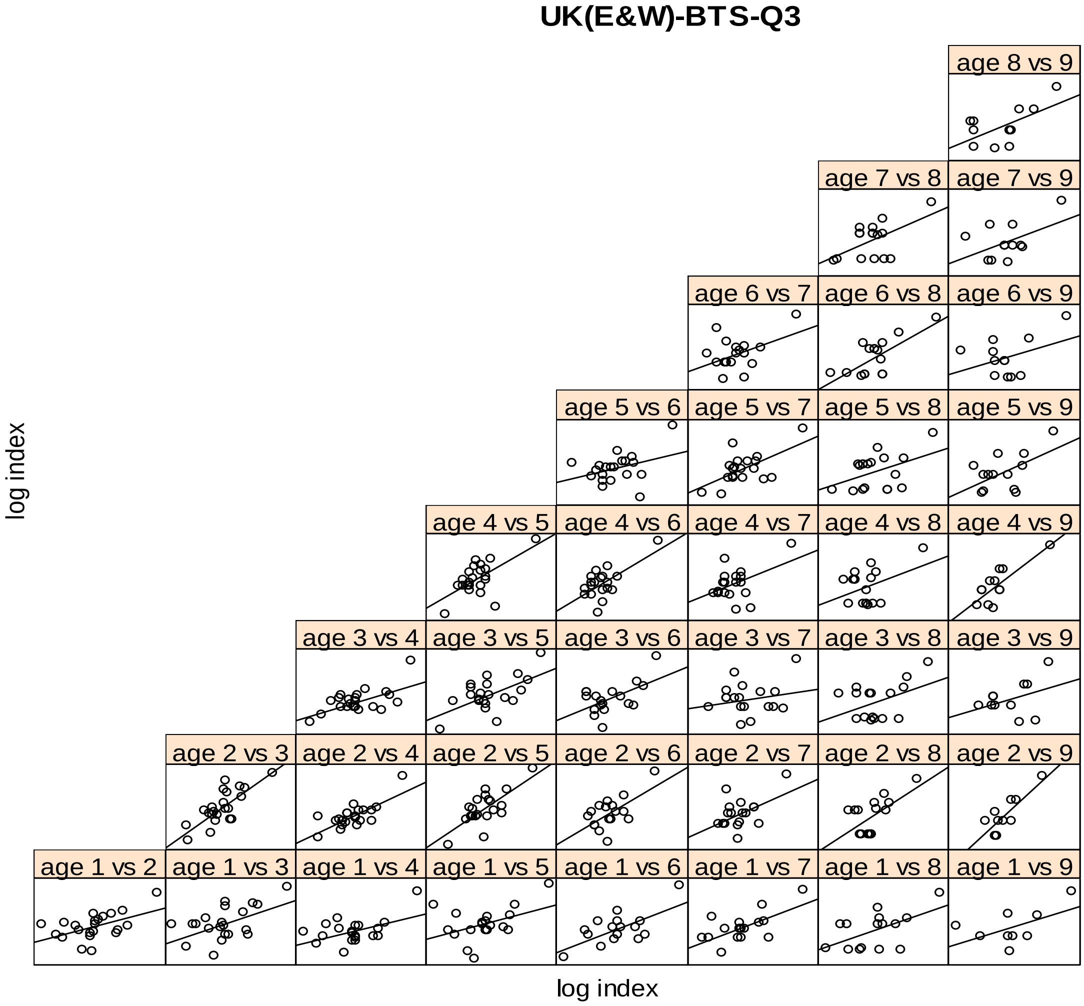
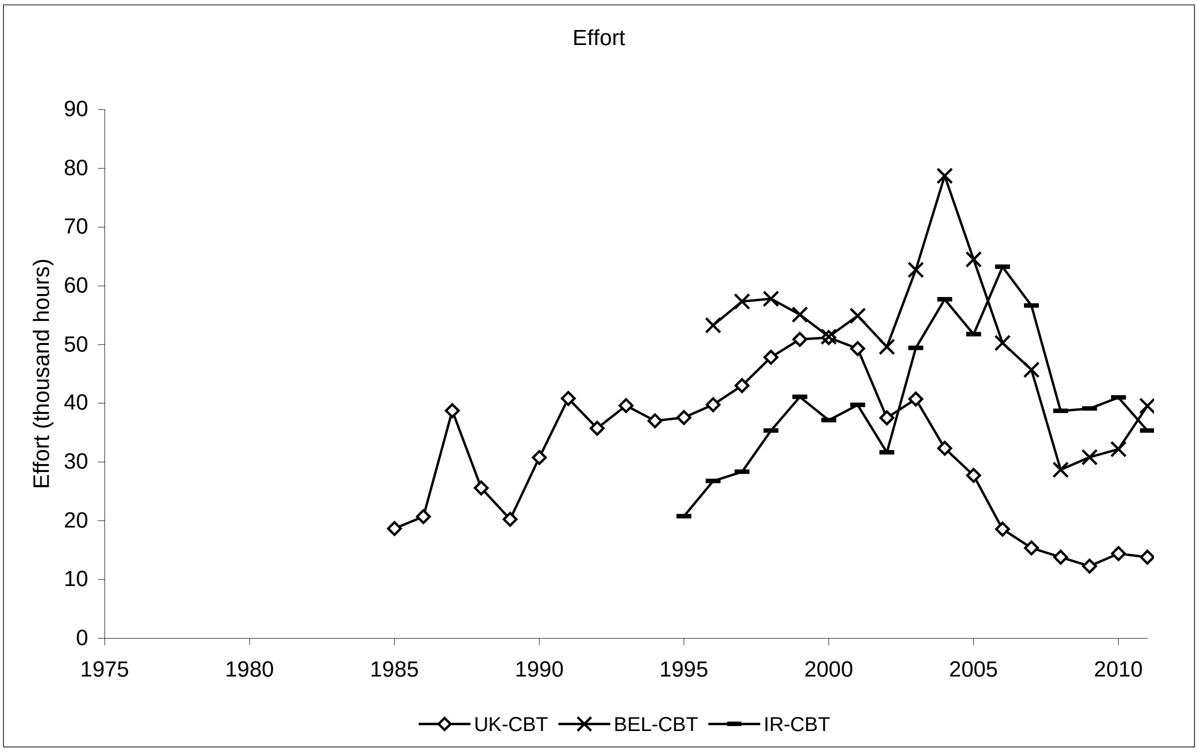


Figure 7.13.7 - Sole in VIIfg. Effort (in thousand hours, GRT corrected in case of E&W beam trawl fleet) and LPUE (in kg/hour; or in kg/100km in case of UK(BTS-3Q) survey) for three beam trawl fleets and one survey.



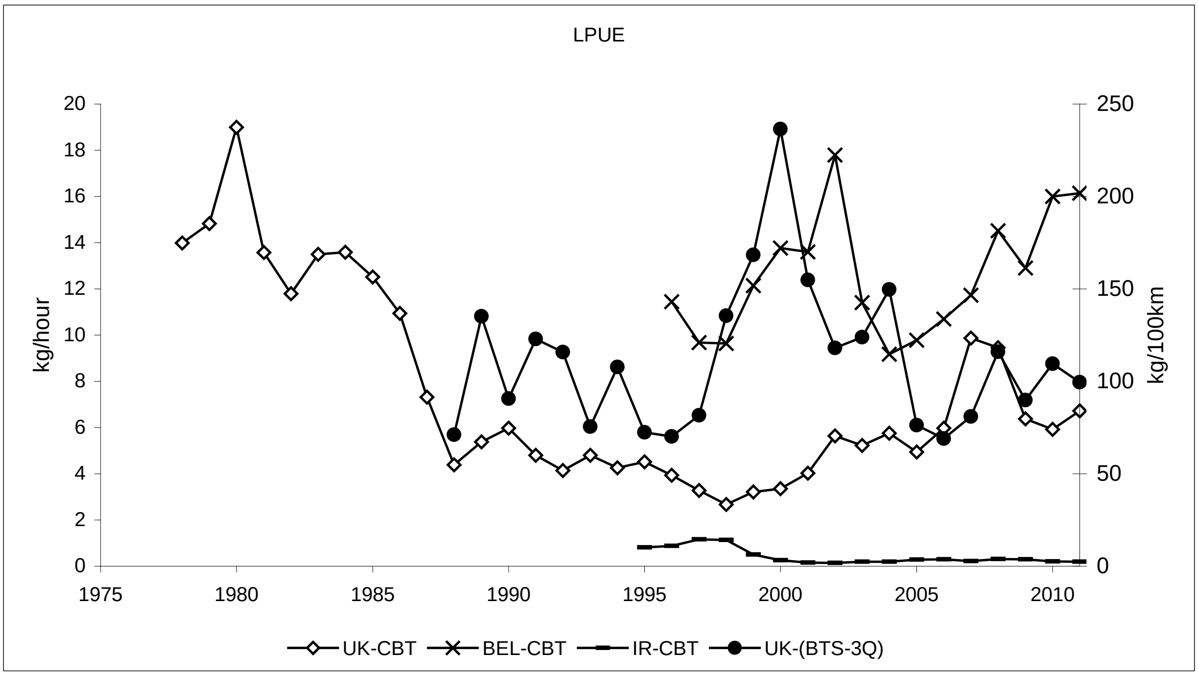


Figure 7.13.8 - Sole in VIIfg - Consistency plot Uk(E&W) beam trawl

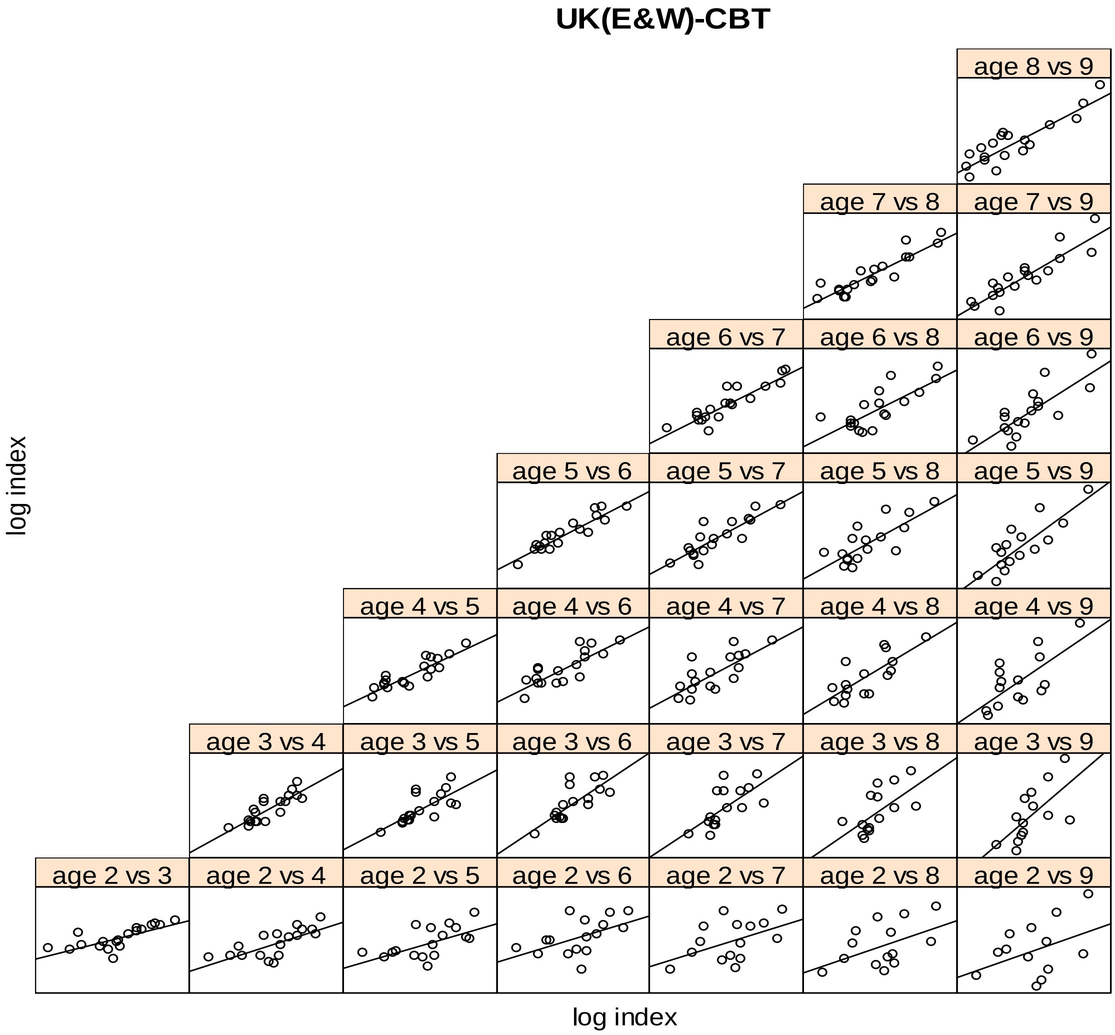


Figure 7.13.9 - Sole in VIIfg - Consistency plot Belgian beam trawl

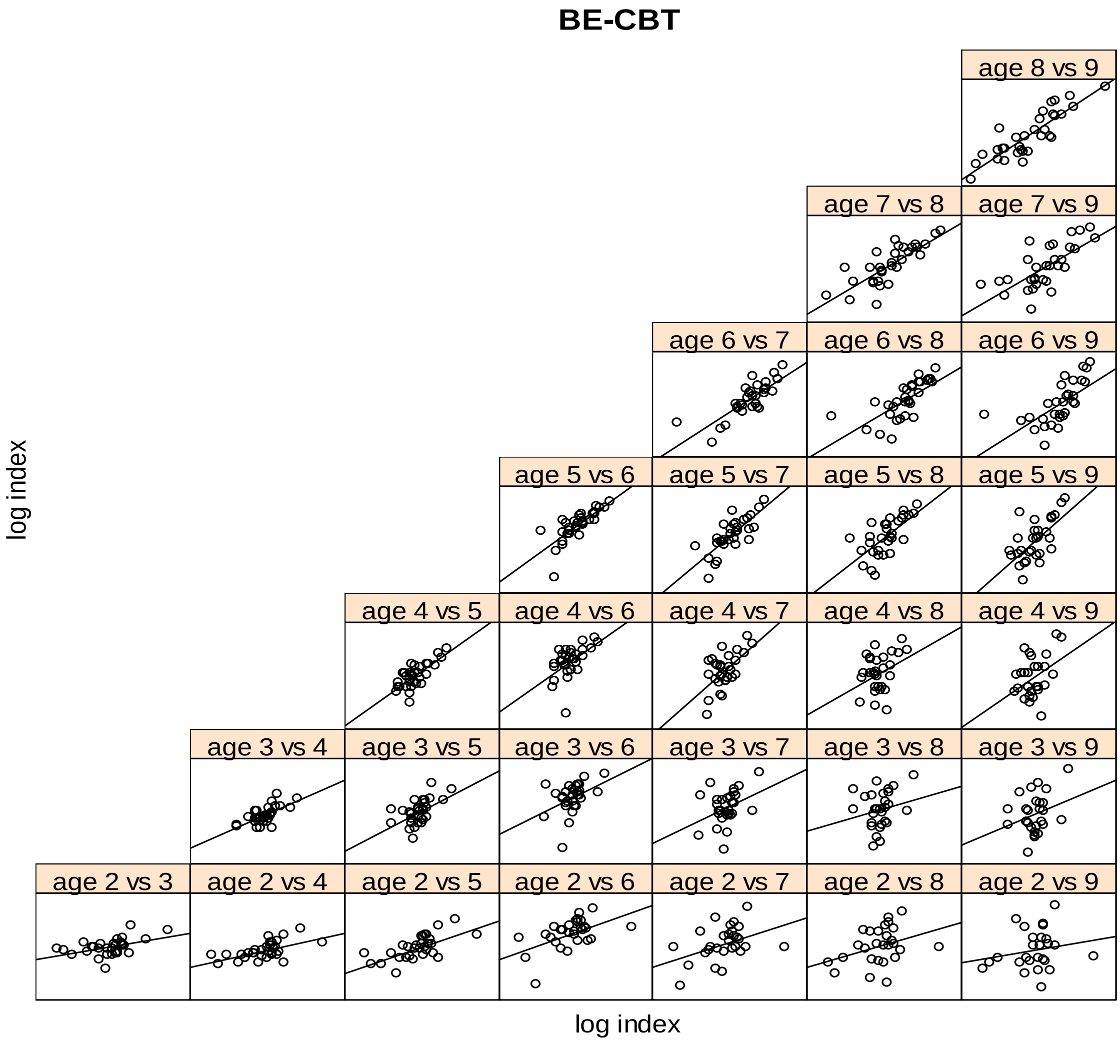
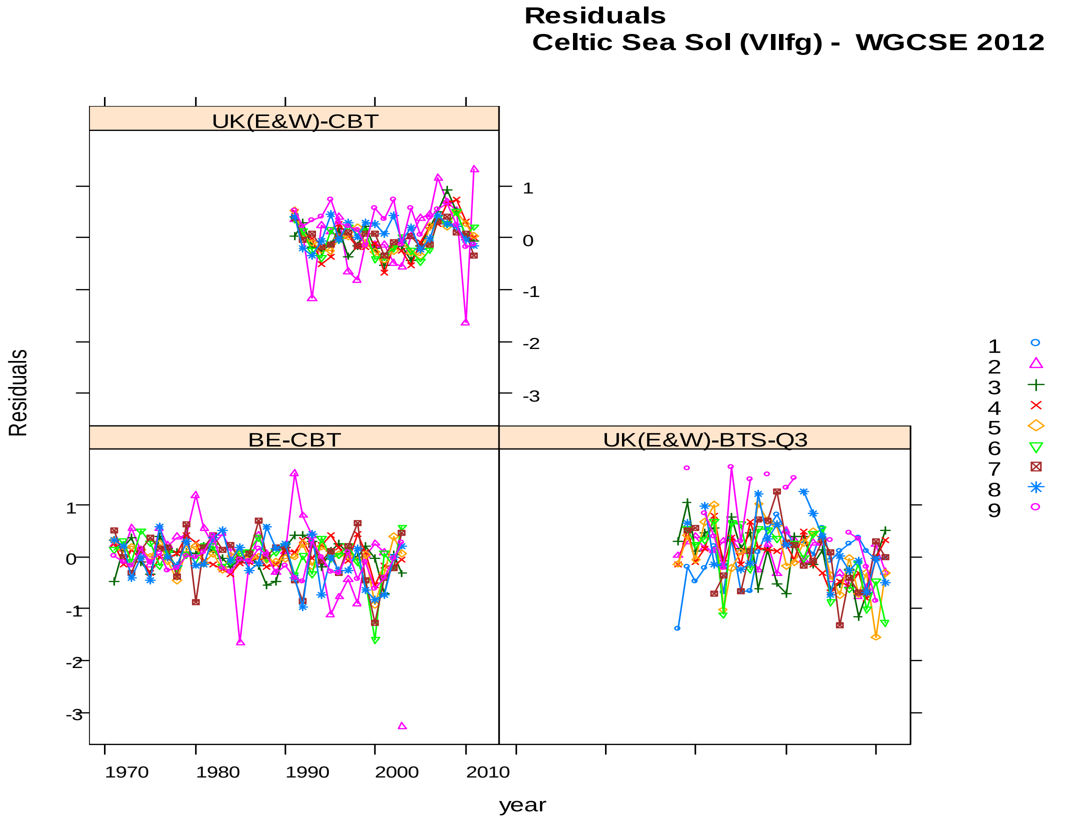


Figure 7.13.10 - Sole in VIIfg. Catchability residuals for final XSA run



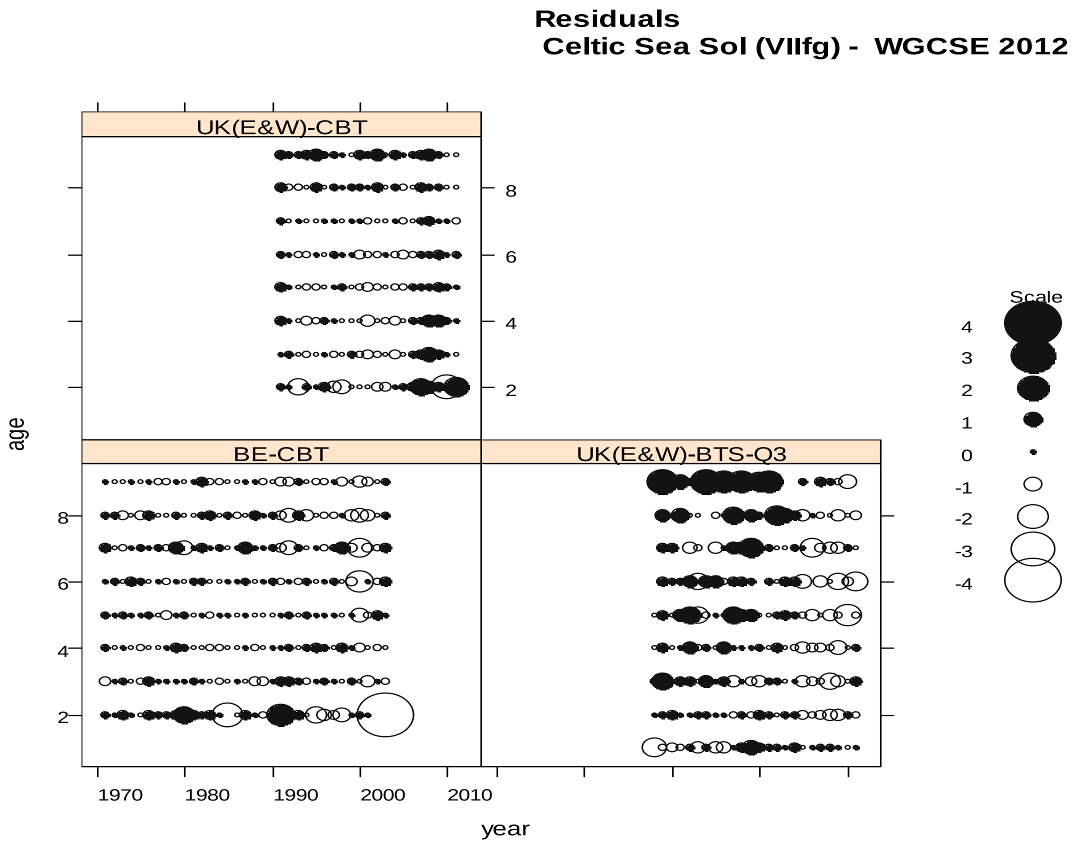


Figure 7.13.11 - Sole in VIIfg. Estimates of survivors from different fleets and shrinkage, as well as their different weighting in the final XSA-run

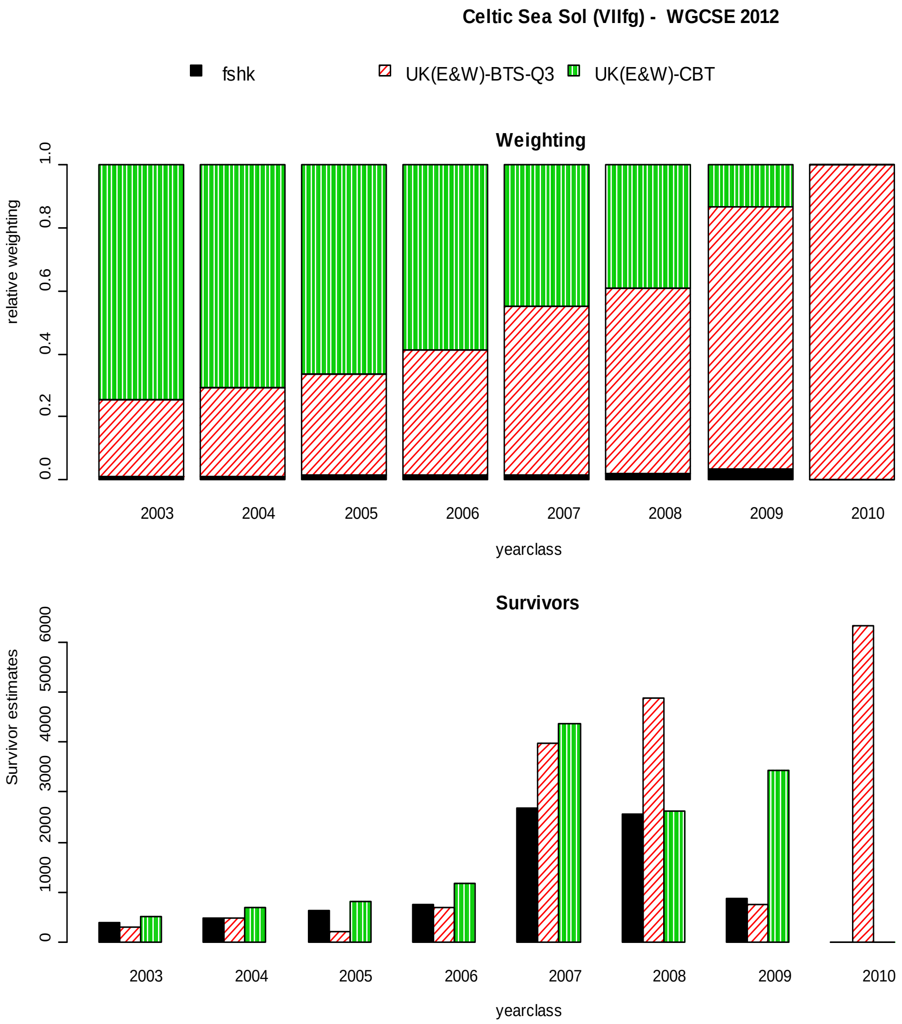


Figure 7.13.12 - Sole VIIf,g retrospective XSA analysys (shinkage SE=1.5)

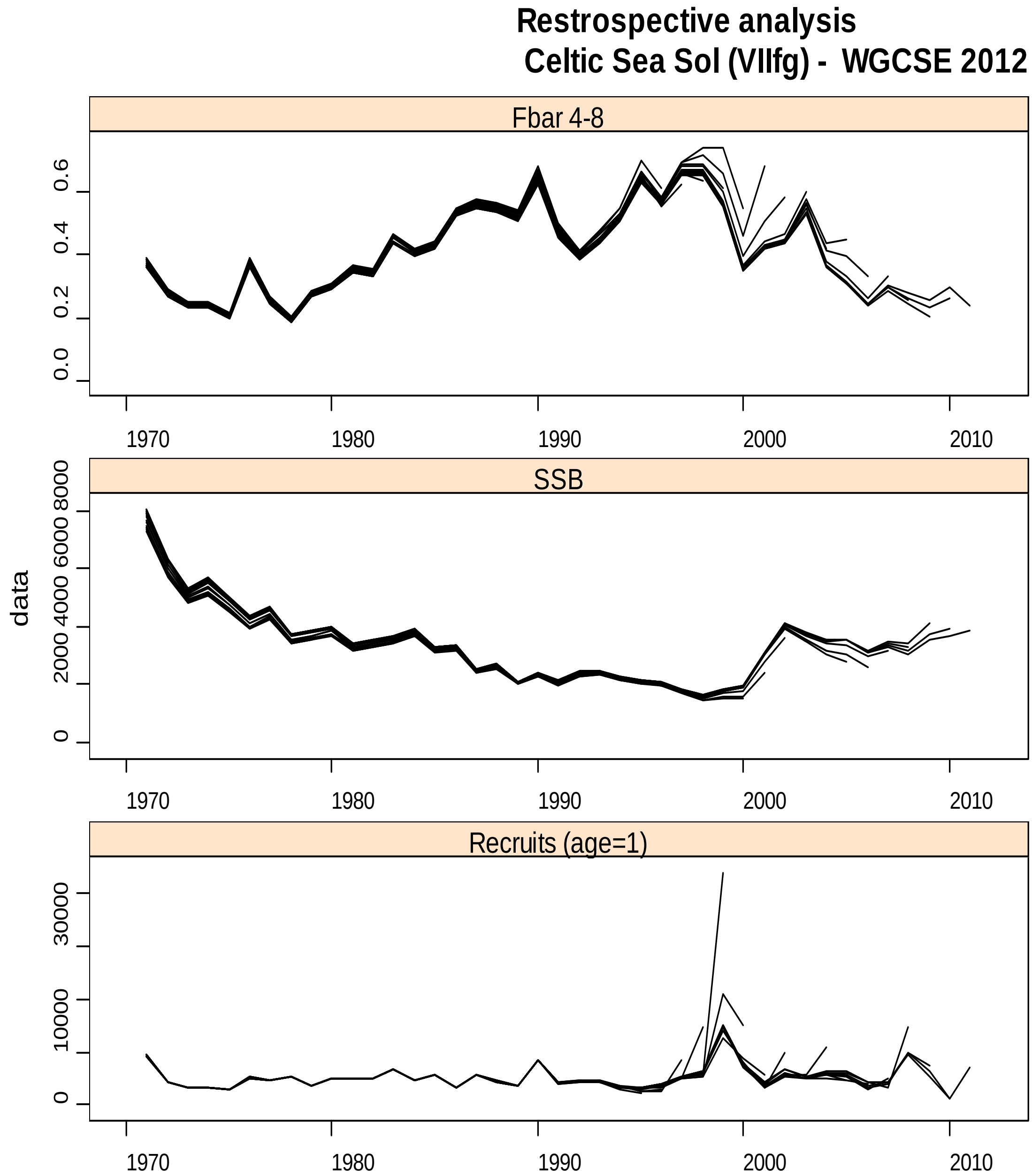
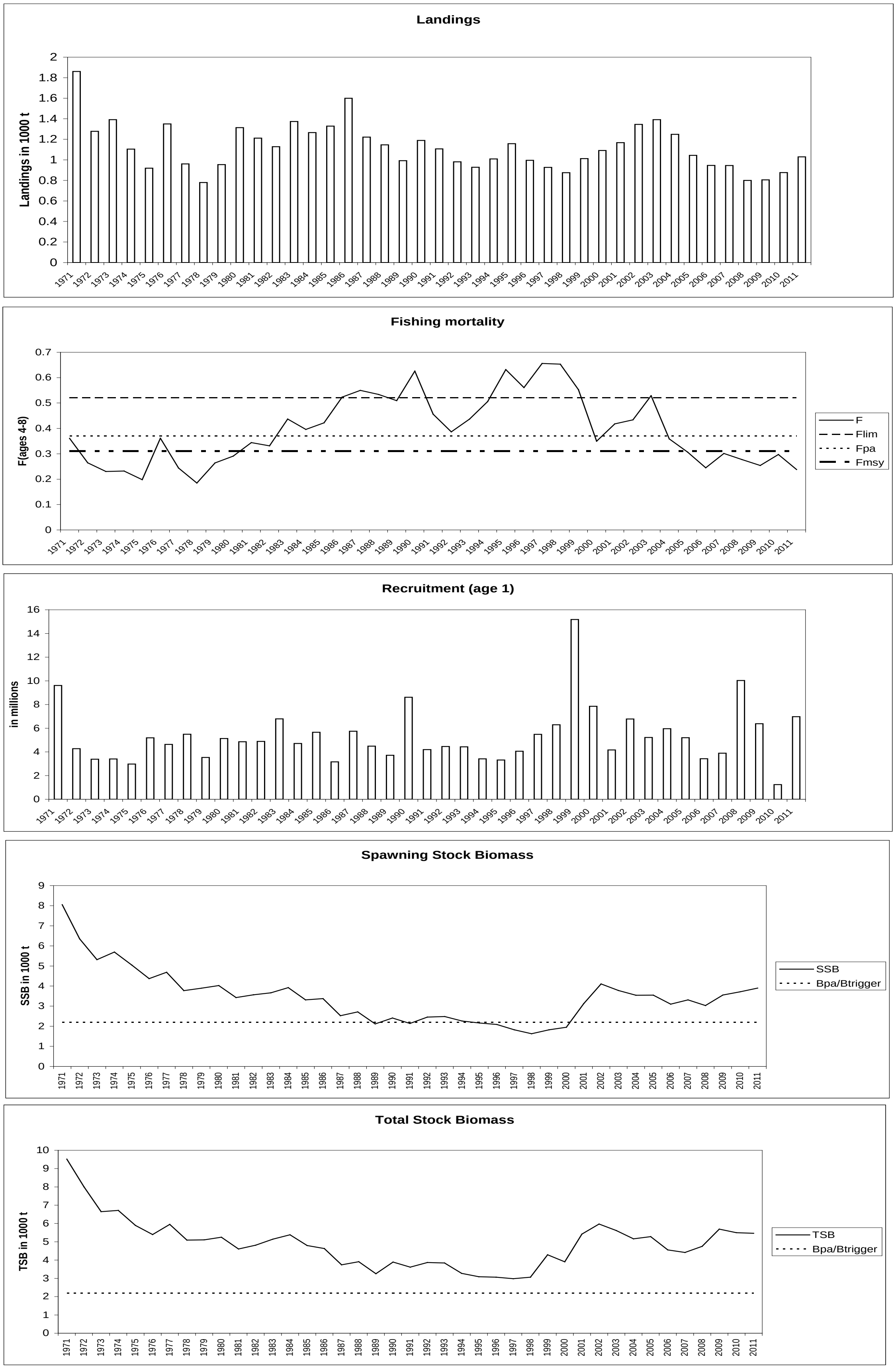


Figure 7.13.13 Sole in VIIfg. Summary plots



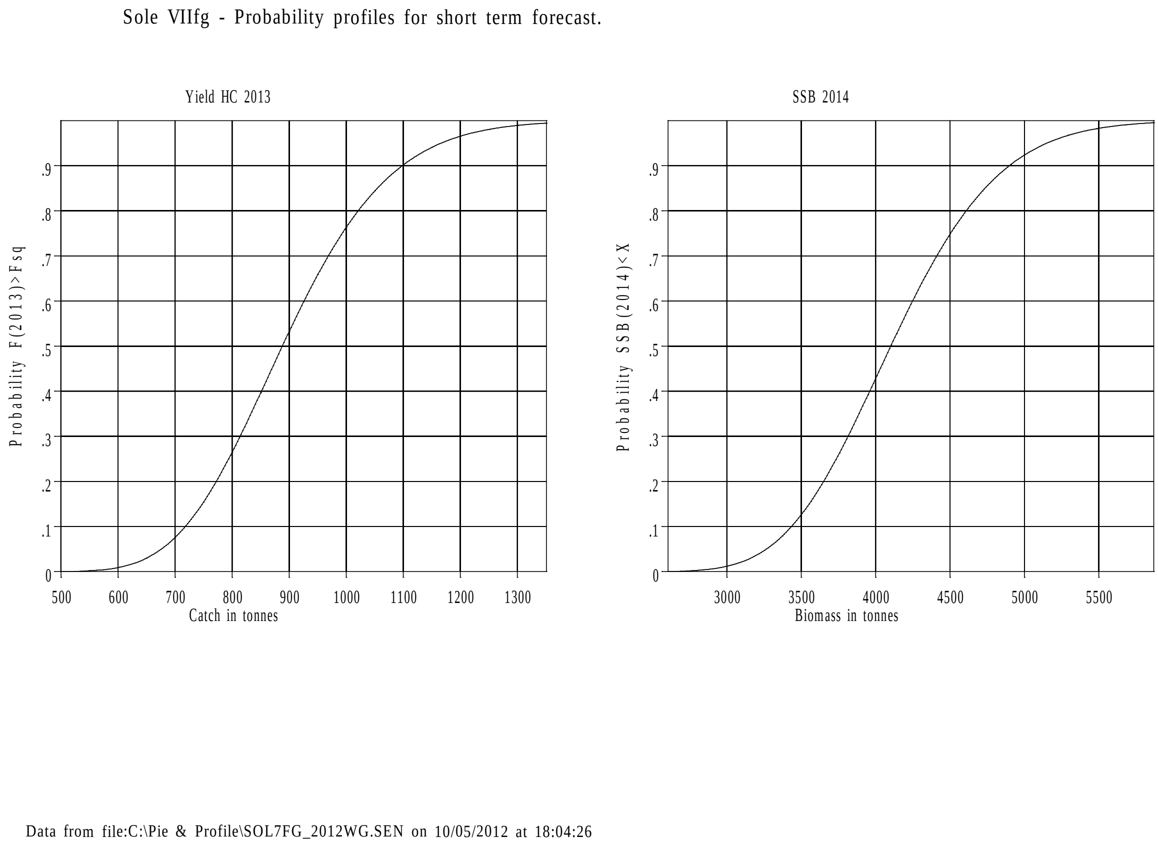
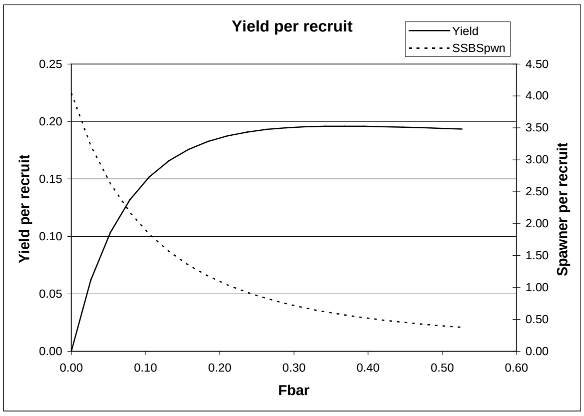
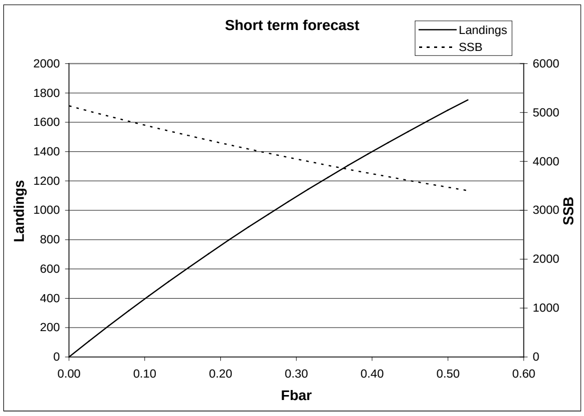


Figure 7.13.14. Sole VIIfg. Probability profiles for short-term forecast.

Figure 7.13.15 - Sole in VIIfg Yield per recruit and short term forecast plots





MFYPR version 2a
Run: Sol7FG_yield_fin
Time and date: 10:17 10/05/2012

Reference point	F multiplier	Absolute F
Fbar(4-8)	1.0000	0.2631
FMax	1.3909	0.3659
F0.1	0.6246	0.1643
F35%SPR	0.5672	0.1492

MFDP version 1a
Run: Sol7FG_fin
Sole in VIId
Time and date: 10:10 10/05/2012
Fbar age range: 4-8

Input units are thousands and kg - output in tonnes

Figure 7.13.16 - Sole in VIIfg. Three year average exploitation pattern, standardised to Fbar (4-8)

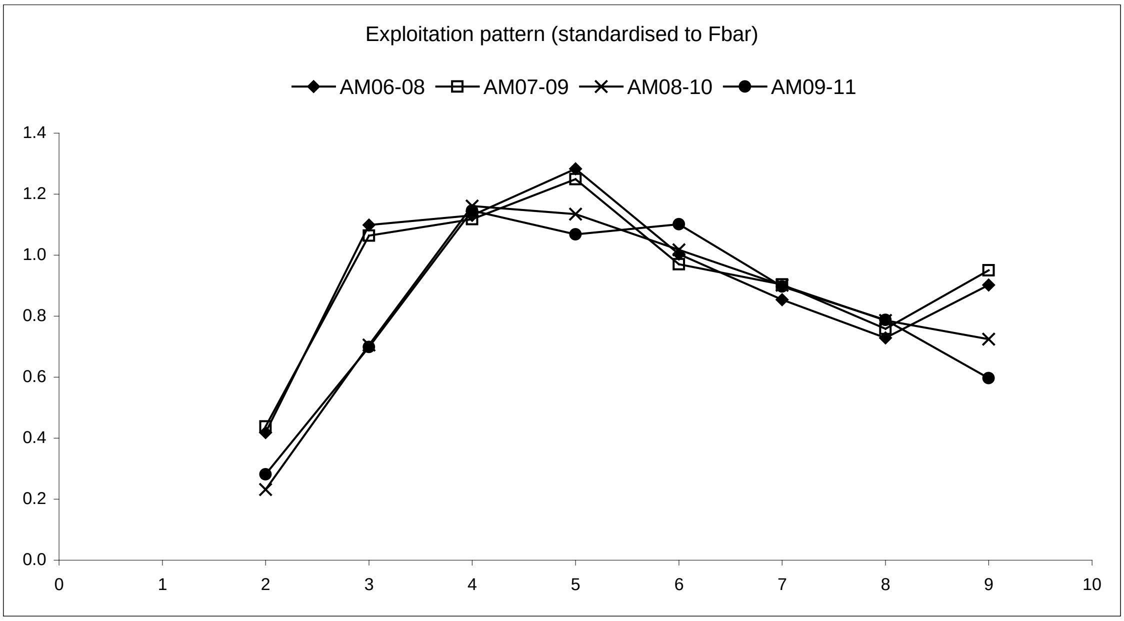
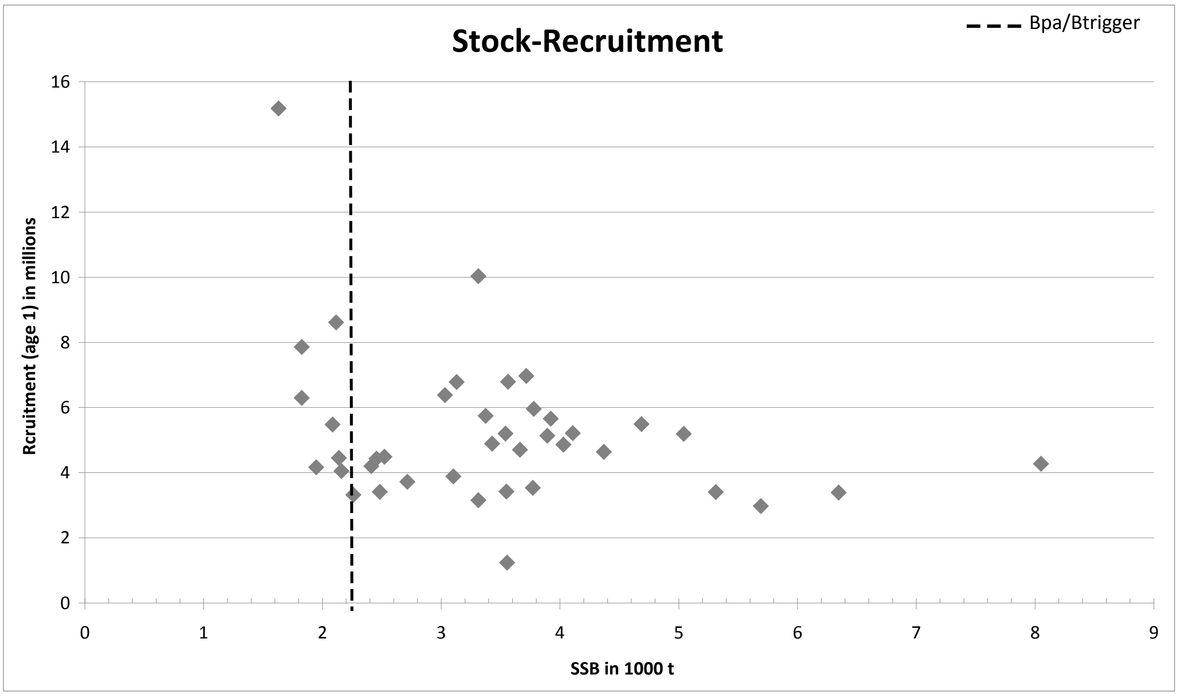


Figure 7.13.17 - Sole VIIfg - Stock/recruiment plot



7.14 Sole in the Southwest of Ireland (ICES Divisions VIIh–k)

Type of assessment in 2012

No assessment was performed, however catch numbers and weights were aggregated for the Irish landings for the years 1993–2011 and these were used to perform a yield-per-recruit analysis.

7.14.1 General

Stock Identity

Sole in VIIj are mainly caught by Irish vessels on sandy grounds off counties Kerry and west Cork. Sole 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 (these fish are caught off the French coast).

7.14.2 Data

The nominal landings are given in Table 7.14.1.

Most non-Irish landings were from VIIh which is likely to be a different stock. Because age data were only available for Irish landings (which were mainly from VIIjk) therefore the remainder of Section 7.14 concerns Irish data only in VIIgjk.

Sampling

Figure 7.14.1 shows that sole landings in VIIjk were mostly taken by Otter trawlers in VIIj. This is reflected in the sampling.

Data quality

Figure 7.14.2 shows the length distribution of the Irish landings in VIIjk between 1993 and 2011. In some years distinct modes of strong year classes are discernible but cohorts cannot easily be tracked. The sample numbers appear to be adequate.

Annual Age–Length Keys (ALKs) were constructed (all quarters and gear types combined) and applied to the sampled length frequency distributions. Figure 7.14.3 shows the age distribution of sole in VIIjk between 1993 and 2010.

7.14.3 Historical stock development

Because sole in VIIh were not sampled, it would not be appropriate to raise the data to all landings in VIIhjk. Instead, the official International landings figures for VIIjk were used to raise the age distributions (Table 7.14.2).

The estimated catch numbers-at-age are given in Table 7.14.3, catch weights-at-age are given in Table 7.14.4. It is possible to track some strong and weak year classes in the catch numbers-at-age matrix. This is also illustrated by Figure 7.14.4, which shows the standardised catch proportions-at-age. Figure 7.14.5 shows the log catch numbers-at-age. The rate of decline in catch numbers through the cohorts appears to be reasonably stable. This can be further investigated by calculating the slope of the log-catch numbers (Z). Figure 7.14.6 shows the catch curve, sole under the age of 4 are not fully selected and from age 10 onwards the data get quite noisy, therefore the slope of the log-catch numbers was estimated over ages 4 to 9 (Figure 7.14.7). Z estimates varied mostly between 0.2 and 0.7.

Yield-per-recruit

The yield-per-recruit was estimated using a method by Thompson and Bell (1934). This method requires the selectivity to be estimated. This was done by estimating the slope of the log catch numbers for ages that are fully selected and using this slope (Z) to predict the population numbers for ages that are not fully selected. The Z was estimated on pseudo-cohorts which were standardised to take account of annual variations in the catch numbers. Figure 7.14.8 shows that sole in VIIjk appear to be fully selected by the age of 5 and that after the age of 10 the data get very sparse. Figure 7.14.9 shows the slope of the mean standardised log catch numbers. The predicted catch numbers from this slope were used to estimate the 'observed' selectivity. This was then modelled by applying a linear model after a logit transformation. The estimated selection curve is also shown in Figure 7.14.9. A natural mortality of 0.1 was assumed (based on the value used by the WG for sole in VIIfg) and the WG maturity ogive for sole in VIIfg was used to estimate SSB. The yield was estimated for a range of F values based on the average catch weights. Figure 7.14.10 shows the YPR curve, F_{MAX} is estimated to be 0.34. $F_{0.1}$ is estimated to be 0.16. Recent values of Z ranged between 0.15 and 0.45, with M=0.1 this would result in an F of 0.05 to 0.35. This suggests that this stock may be within safe biological limits.

7.14.4 References

Thompson and Bell. 1934. W.F. Thompson and F.H. Bell, Biological statistics of the Pacific halibut fishery. 2. Effect of changes in intensity upon total yield and yield per unit of gear, Rep. Int. Fish. (Pacific Halibut) Comm. 8 (1934), p. 49.

Table 7.14.1. Sole in Divisions VII h–k (Southwest Ireland). Nominal landings (t), 1973–2011, as officially reported to ICES.

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Belgium	406	369	210	638	519	290	384	522	576	471
Denmark	-	-	-	-	-	-	-	-	-	-
France	390	143	207	19	103	23	29	27	107	104
Ireland	108	116	97	152	126	73	109	162	195	172
Netherlands	4	15	2	33	140	60	-	-		
Spain	190	153	152	131	26	1	8	2		
UK - Eng+Wales+N.	.	.	.	.	.	.	.	.	.	.
UK - England & Wal	6	5	24	11	12	11	18	42	83	108
UK - Scotland	-	-	-	-	-	-	-	-	-	-
Total	1104	801	692	984	926	458	548	755	961	855

Country	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Belgium	411	474	318	442	271	254	252	353	358	312
Denmark	-	-	-	-	-	-	-	-	-	-
France	176	120	25	38	44	53	84	66	55	43
Ireland	176	156	201	188	168	182	206	266	306	255
Netherlands	51	194	280	3		-	-	-	-	-
Spain	38					-	-	-	-	-
UK - Eng+Wales+N.	.	.	.	.	.	.	177	144	234	215
UK - England & Wal	129	151	200	261	193	166	.	.	.	.
UK - Scotland	-	-	-	-	-	-	-	-	-	2
Total	981	1095	1024	932	676	655	719	829	953	827

Country	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Belgium	317	338	433	375	368	346	101	8	13	154
Denmark	-	-	-	-	-	-	-	-	-	-
France	44	42	47	50	58	74	.	79	103	108
Ireland	237	184	243	183	203	221	207	111	125	130
Netherlands	-	-	-	70	-	7	1	10	-	-
Spain	-	-	-	-	-	-	-	-	-	1
UK - Eng+Wales+N.	209	172	192	148	113	111	97	95	111	124
UK - England & Wal	.	.	.	.	.	.	.	.	.	.
UK - Scotland	5	2	-	-	-	-	-	-	-	-
Total	812	738	915	826	742	759	406	303	352	517

Country	2003	2004	2005	2006	2007	2008	2009	2010	2011
Belgium	170	157	90	36	31	10	11	20	10
Denmark	-	-							
France	133	103	93	92	78	57	79	87	90
Ireland	105	111	98	63	78	72	60	71	63
Netherlands	-	-		1					
Spain	-	-	2						
UK - Eng+Wales+N.	78	79	112	87	91	80	58	51	54
UK - England & Wal	.	.							
UK - Scotland	-	-							
Total	486	450	395	279	278	219	208	229	217

Table 7.14.2. Official landings of sole in VIIjk.

Year	Belgium	France	Ireland	Spain	UK	Total
1993	-	1	237	.	8	246
1994	-	0	176	.	2	178
1995	-	3	232	.	6	241
1996	-	2	163	.	1	166
1997	-	2	187	.	2	191
1998	-	9	208	.	2	219
1999	96	0	199	.	1	296
2000	8	6	103	.	0	117
2001	7	13	114	.	0	134
2002	69	23	121	.	0	213
2003	48	20	82	.	0	150
2004	2	7	78	.	0	87
2005	-	7	70	<0.5	0	77
2006	-	11	49	-	1	61
2007	-	9	74	.	0	83
2008	-	8	69	-	0	77
2009	0	9	60	-	0	69
2010	0	14	68	-	0	82
2011*	0	23	62	-	0	85

*** Preliminary data.**

Table 7.14.3. Catch numbers-at-age for sole in VIIjk.

	2	3	4	5	6	7	8	9	10	11	12	2	14+
1993	33	218	224	77	56	57	32	21	12	11	5	5	14
1994	23	117	130	69	41	22	19	11	12	13	11	4	27
1995	0	279	81	174	117	51	15	15	4	22	8	8	6
1996	12	46	116	80	53	54	31	8	5	6	10	3	33
1997	39	161	84	110	43	41	38	16	1	0	4	3	17
1998	23	137	113	59	93	40	43	34	9	5	3	5	32
1999	51	179	218	187	67	77	30	28	19	2	11	1	19
2000	39	96	83	42	29	16	21	11	17	8	3	0	5
2001	65	115	53	49	38	22	22	14	9	4	2	5	8
2002	13	139	183	66	38	39	15	8	24	8	21	5	31
2003	2	54	93	128	76	45	18	4	5	9	14	0	9
2004	7	18	92	48	36	19	14	6	8	1	7	1	20
2005	10	34	47	65	17	38	21	9	4	4	0	4	14
2006	13	29	30	28	38	18	16	11	6	4	1	1	11
2007	1	44	36	30	44	42	21	16	10	4	4	1	8
2008	0	1	25	90	43	21	20	25	11	8	5	3	3
2009	0	0	14	37	74	30	16	16	15	6	6	5	1
2010	0	4	42	43	47	41	12	8	8	8	5	6	3
2011	0	1	19	50	35	25	25	10	6	6	6	5	3

Table 7.14.4. Weight-at-age for sole in VIIjk.

	2	3	4	5	6	7	8	9	10	11	12	13	14+
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	0.706
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	0.737
1995		0.194	0.322	0.362	0.338	0.370	0.493	0.452	0.722	0.579	0.401	0.297	0.593
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	0.698
1997	0.133	0.200	0.281	0.334	0.409	0.526	0.618	0.592	0.679		0.691	0.848	0.922
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	0.806
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	0.764
2000	0.180	0.210	0.255	0.396	0.416	0.472	0.503	0.489	0.506	0.452	0.555		0.636
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	0.726
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	0.897
2003	0.168	0.191	0.296	0.323	0.329	0.378	0.371	0.575	0.499	0.548	0.477		0.595
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	0.728
2005	0.131	0.168	0.198	0.249	0.383	0.313	0.340	0.446	0.525	0.468		0.489	0.613
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	0.718
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	0.522
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	0.626
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	0.587
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	0.519
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	0.618

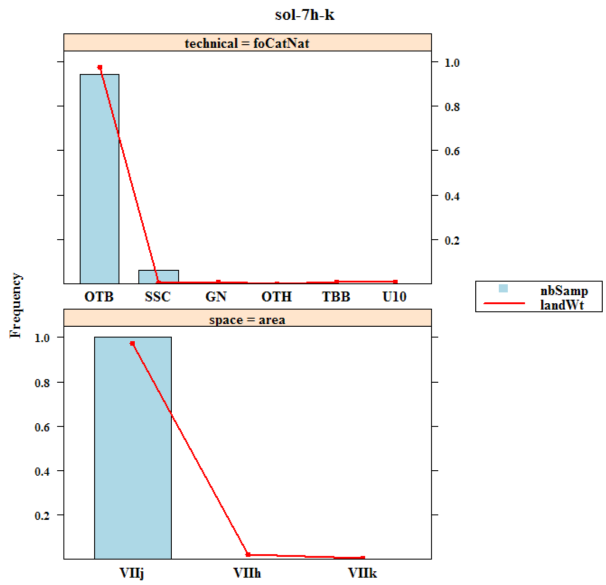


Figure 7.14.1. Irish Operational landings and sampling levels (number of samples) for sole in VIIjk by quarter (top), geartype (middle) and ICES division (bottom). The sampling appears to be representative of the landings.

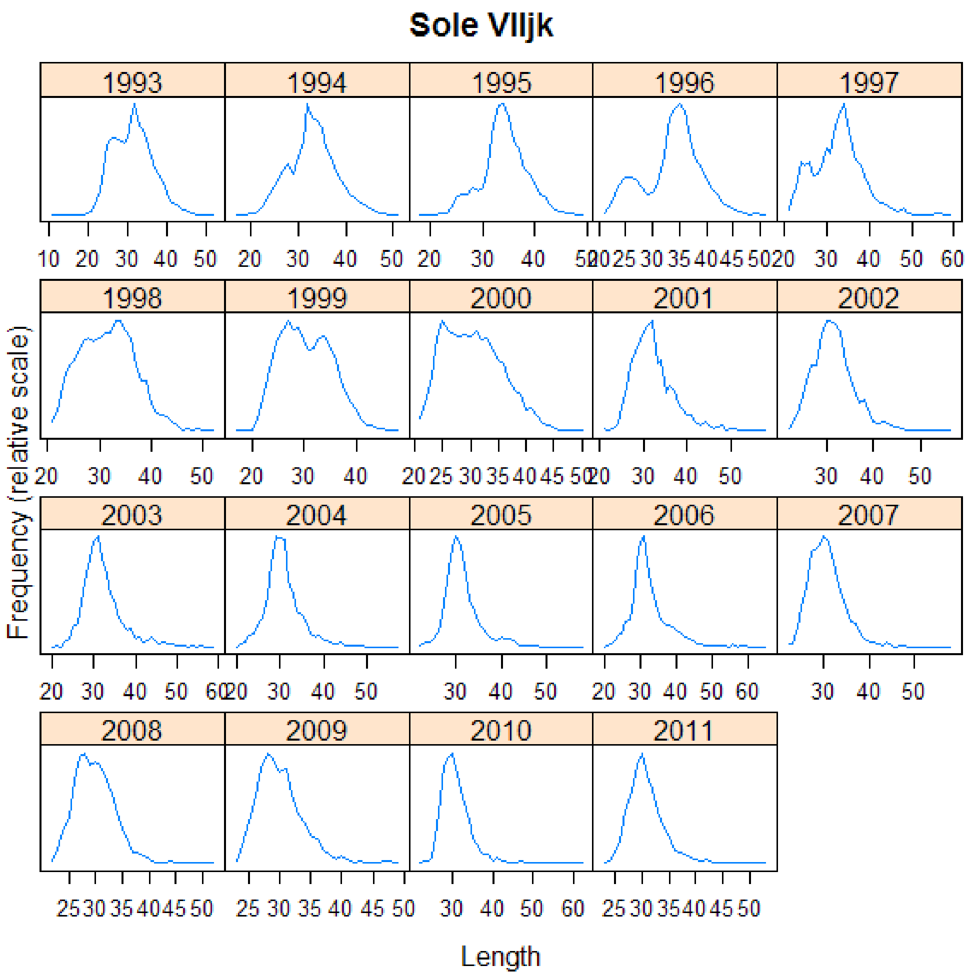


Figure 7.14.2. Length–frequency distribution of the Irish landings of sole in VIIjk between 1993 and 2011. All gears and quarters combined.

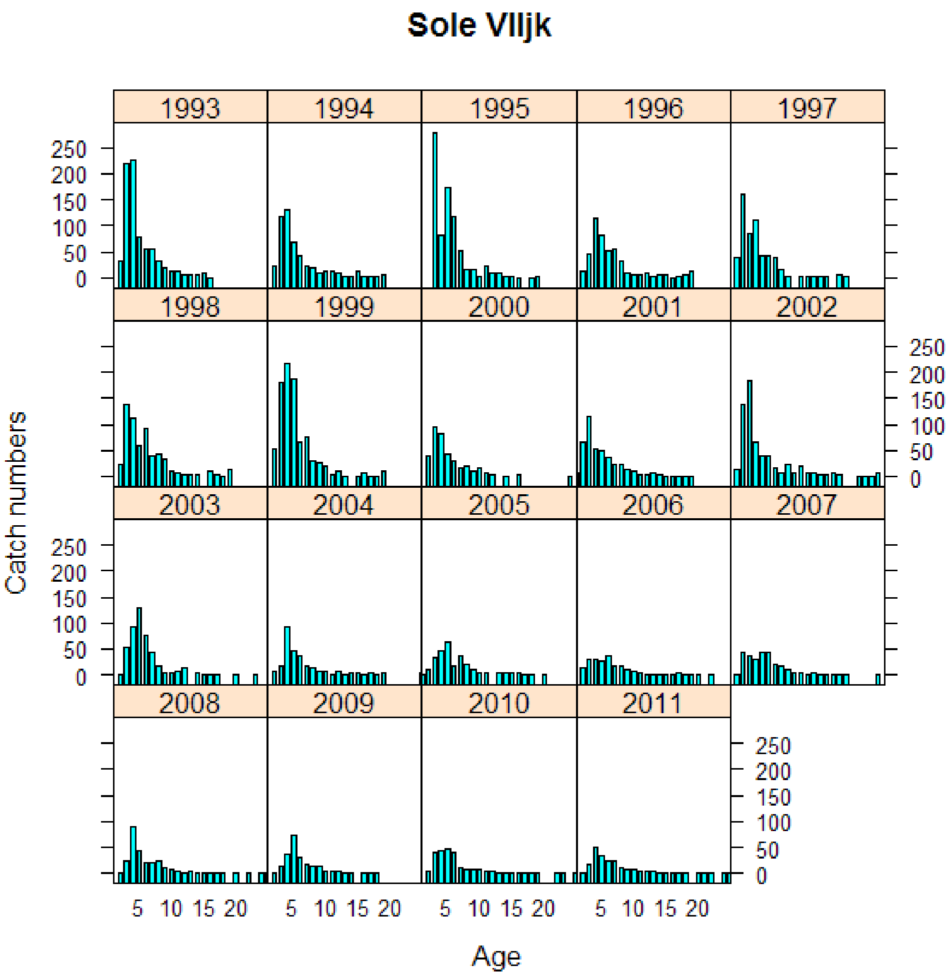


Figure 7.14.3. Age distribution of sole in VIIjk between 1993 and 2011. All gears and quarters combined.

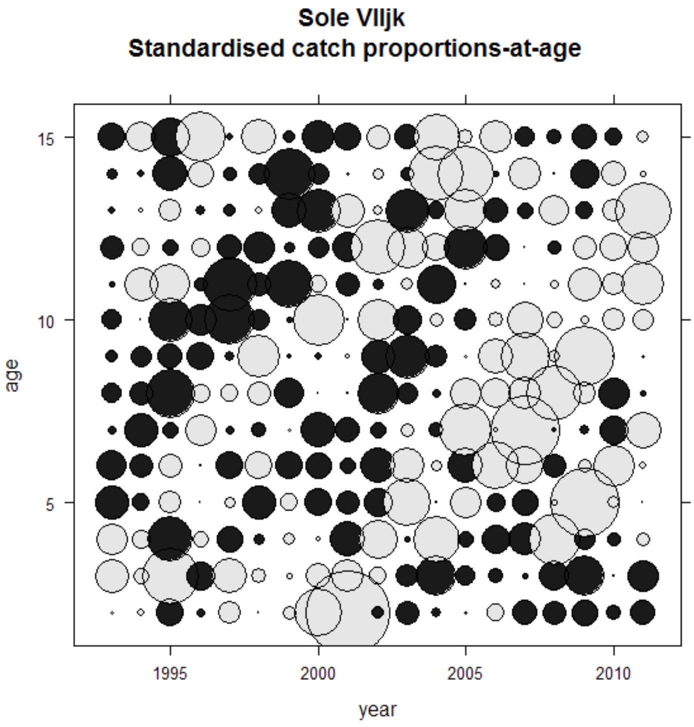


Figure 7.14.4. Standardised catch proportions-at-age for sole in VIIjk. Grey bubbles represent higher-than-average catch-at-age and black bubbles represent lower-than-average catch-at-age.

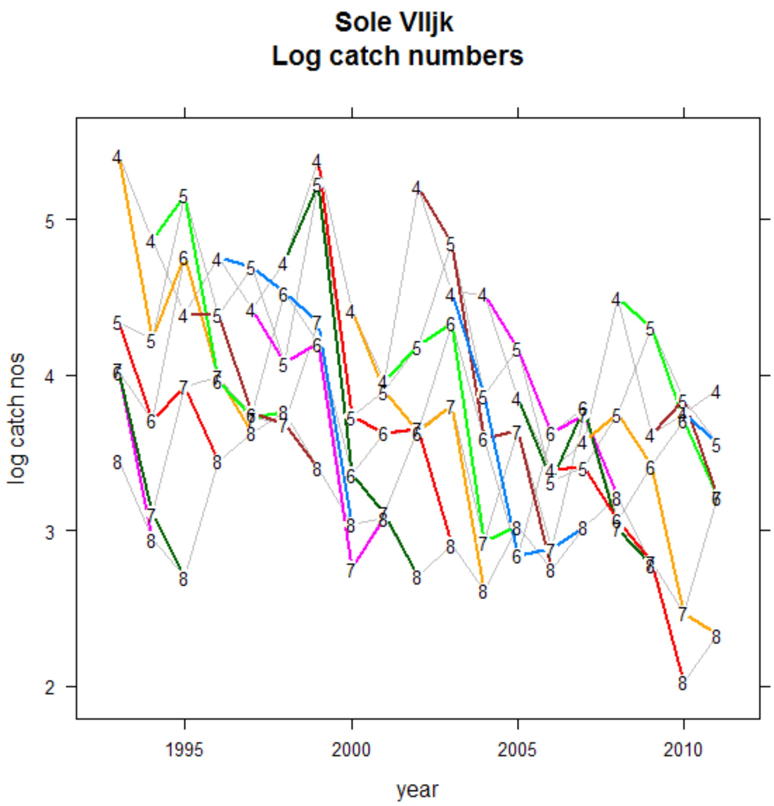


Figure 7.14.5. Log catch numbers-at-age (ages 4–8).

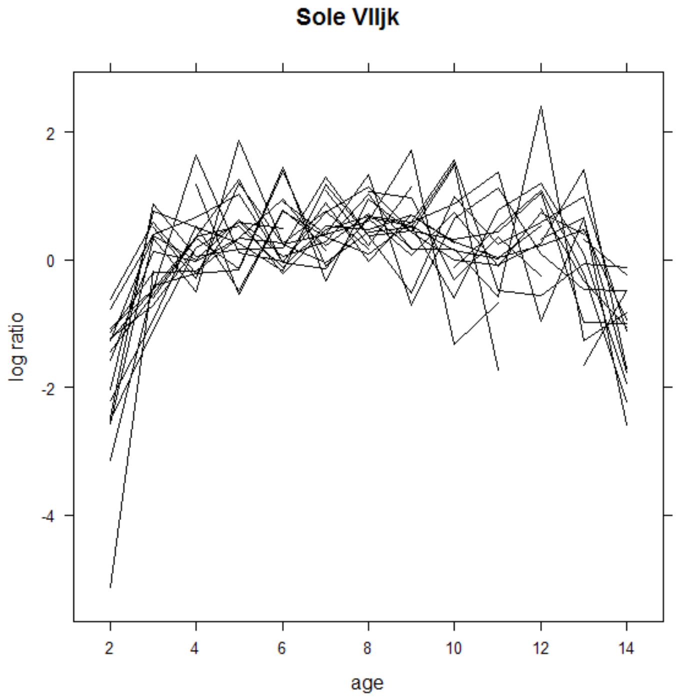


Figure 7.14.6. Catch curve of plaice in VIIbc. Sole from the age of 4 appear to be fully selected, the data get quite noisy from the age of 10 onwards.

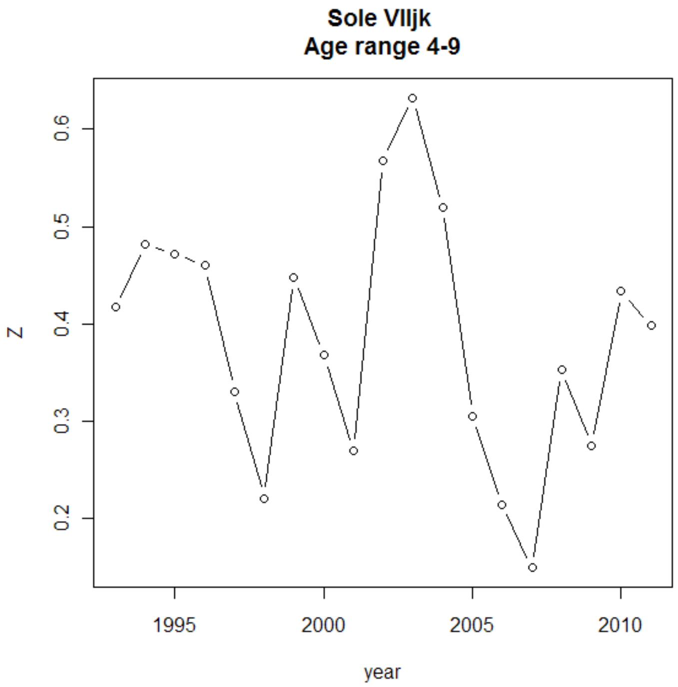


Figure 7.14.7. Z estimated over pseudo-cohorts as the slope of the log catch numbers.

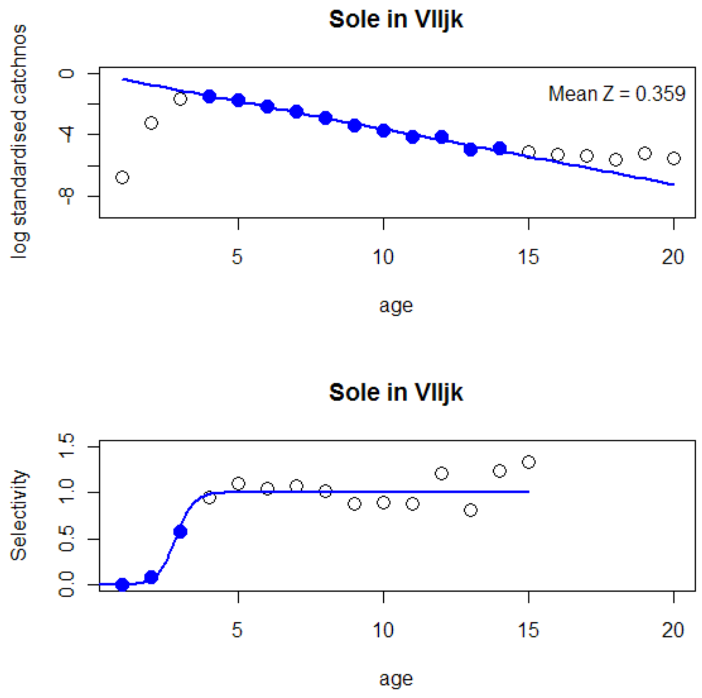


Figure 7.14.8. Selectivity was modelled by fitting a line through the mean log standardised catch numbers of ages 4 to 14 to predict the expected catch numbers for ages 1 to 3 if these were fully selected. The proportions of observed divided by expected catch number were taken as the 'observed' selectivity. This was then modelled using a logit transformation.

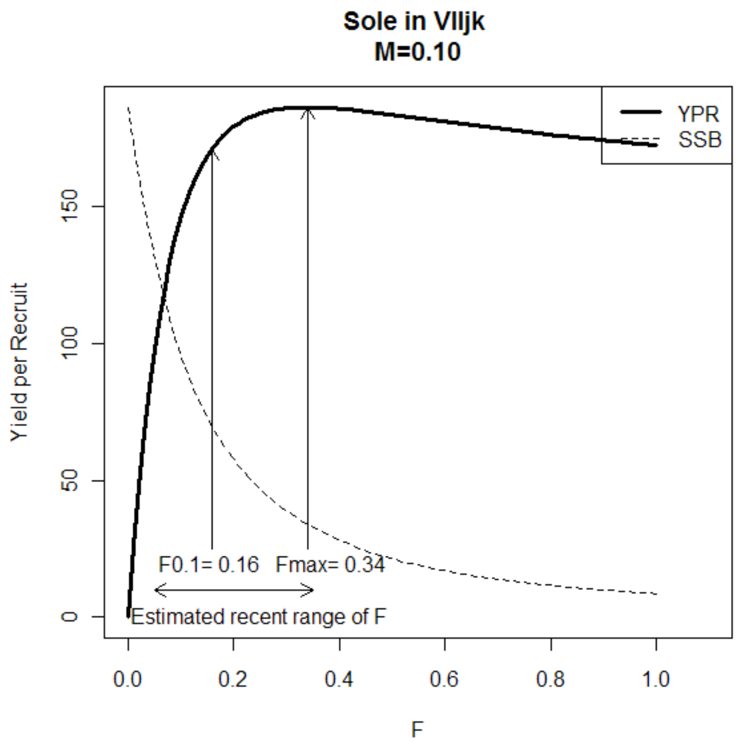


Figure 7.14.9. YPR analysis using the Thompson–Bell approach. Recent estimates of Z were between 0.15 to 0.45 which translates to an F of 0.05 to 0.35.

7.15 Whiting in Division VIIe-k

Type of assessment in 2011

This year WGCSE propose a full analytical assessment (XSA) tuned with two surveys and forecast (MFDP) for this stock. Previously the assessment has been used as indicative of trends but not considered suitable for forecast. In fact the stock assessments in recent years have been extremely consistent in terms of trends and levels. The issue in the recent past has been the accuracy of forecasts from the assessment due to retrospective reductions in recruit estimates. This is no longer a major concern and WGCSE concluded that the assessment and forecast were a suitable basis for management advice.

ICES advice applicable to 2011

MSY approach

The SSB estimates show an increase since 2007. The underlying data do not support the provision of estimates of F_{MSY}*. However it is likely that recent F is above* F_{MSY} *at the current selection pattern. Therefore, effort in fisheries that catch whiting should not be allowed to increase.*

Management by TAC is inappropriate for this stock because landings – but not catches – are controlled. Recruitment in 2008 appears to be above average and catches and SSB may increase in 2011 if effort remains constant. Technical measures to minimise discards should be considered with urgency. ICES advises that the a square mesh panel of at least 120 mm should be introduced for the Nephrops fleet and a minimum mesh size of at least 100 mm with a square mesh panel of at least 110 mm for all other fleets.

PA considerations

The current estimates of fishing mortality and SSB are uncertain, but SSB shows an increasing trend since 2007. ICES considers that fishing effort should not be allowed to increase in fisheries that catch whiting in 2011.

Policy paper

In light of the EU policy paper on fisheries management (17 May 2010, COM(2010) 241) this stock is classified under category 8 (State of the stock is not known precisely but SSB is increasing). SSB estimates in the last two years are 70% higher than the SSB in the previous three years. This category would result in a TAC increase of 15% (16 568 t). However Annex IV.1 may apply because it is likely that the stock is overfished with regards to F_{MSY}.

ICES advice applicable to 2012

Precautionary considerations

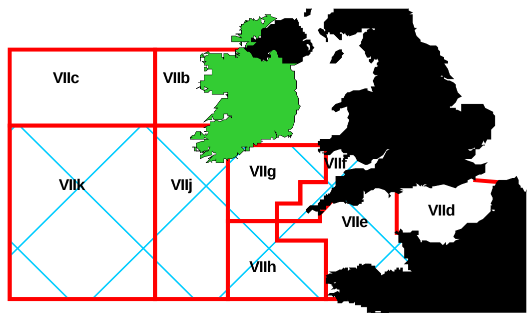
The SSB estimates show an increase since 2007 and the exploitation status is unknown. Therefore, catches should not be allowed to increase.

Management by TAC is inappropriate for this stock because landings, but not catches, are controlled. Recruitment in 2008 and 2009 appears to be above average. Catches and SSB may increase *in 2011 if effort remains constant. Technical measures to minimise discards should be considered with urgency.*

7.15.1 General

Stock description and management units

The TAC for whiting is set for Divisions VIIb–h and VIIk. However VIIj has been omitted from the area for the last three years. This assessment area does not correspond to the TAC area. Whiting in VIIb,c are not assessed and 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 2012 TAC for whiting VIIb–h and k has been increased from 16 658 t 2011 to 19 053 t (2012). This TAC has not been considered restrictive, with officially reported VIIe–k landings totalling 8555 t in 2011,. The assessment is based on landings only, as reported in logbooks, and does not include discards. The introduction of buyers and sellers legislation in 2007 should improve landings statistics, but has not been analysed as yet.

TAC in 2011

Species: Whiting *Merlangius merlangus*		**Zone:** VIIb, VIIc, VIId, VIIe, VIIf, VIIg, VIIh, VIIj and VIIk (WHG/7X7A-C)
Belgium	158	
France	9 726	
Ireland	4 865	
The Netherlands	79	
United Kingdom	1 740	
EU	16 568	
TAC	16 568	Analytical TAC Article 13 of this Regulation applies.

TAC in 2012

Species: Whiting *Merlangius merlangus*		Zone: VIIb, VIIc, VIId, VIIe, VIIf, VIIg, VIIh, VIIj and VIIk (WHG/7X7A-C)
Belgium	186	
France	11 431	
Ireland	5 298	
The Netherlands	93	
United Kingdom	2 045	
Union	19 053	
TAC	19 053	Analytical TAC Article 11 of this Regulation applies.

Fishery in 2011

ICES officially reported landings for Divisions VIIe–k and landings as used by the Working Group are given in Table 7.15.1. ICES Official landings increased by ~23 t, as a result of minimal revisions from all countries ranging between 1–7 tonnes. . The 2011 reported landings are 523 t higher than those used by WGCSE in 2012.

The VIIe–k whiting stock is primarily targeted by otter trawlers and to a lesser extent Scottish seines and beam trawls. Otter trawlers utilize two mesh size ranges of 70–89 mm and 100–119 mm. Effort of trawlers utilizing these two mesh size ranges has remained relatively stable within the Celtic Sea as a whole, however effort of the larger mesh range has declined within VIIf and VIIg over recent years. The vessels utilizing these mesh ranges have different species selectivity patterns. Several main species groups are targeted by otter trawlers catching whiting, as part of a targeted mixed gadoid fishery and as bycatch within the *Nephrops* and hake, anglerfish, and megrim fisheries. Beam trawlers operate to the eastern side of the assessment area, VIIe–h where small quantities of whiting are taken as a bycatch species in flatfish, anglerfish, and ray target fisheries. The spatial distributions of landings by Irish and UK fleets in 2011 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. No French spatial data were available for 2011. The majority of UK landings are from otter trawlers in VIIe, and focused within 29E5 and 29E6.

7.15.2 Data

An overview of the data provided and used by the WG is provided in Table 2.1.

Landings

National landings and numbers-at-age data were aggregated for the Area VIIe–k following methodology described in the Stock Annex. The landings data were allocated to quarters using the mean proportion by quarter over the period 2006–2008, which appeared to be reasonably stable. Secondly, the sample length distributions within each quarter were assumed to be representative of the landings of each métier. National sampling levels for the landings are presented in Table 2.1.

The length compositions from various fleets for 2011 are displayed in Table 7.15.2 and Figure 7.15.2. The landings length distributions of the Irish otter trawl, UK and French fleets, which account for the majority of the landings, are similar, averaging around 37 cm, similar to last year. Scottish seine fleets land a wider distribution reaching sizes over 50 cm. The peak length ranges from 37 cm to 44 cm, with a slight tendency for seiners in VIIj to land smaller fish than in VIIg.

The international catch numbers-at-age are given in Table 7.15.3 and Figure 7.15.3. It is possible to track strong year classes in the landings-at-age matrices. The age distribution has remained similar over time, with the exception of periods where strong year classes pass through older ages. Older ages and the plus group were slightly higher in the 2011 landings than in the preceding year, but as with 2010, appreciably higher than 2008–2009. Age group 0 was included in the assessment data to allow inclusion of 0-group indices in the XSA, although landings at this age were not recorded in most years. Very small landings of 0-group whiting were not included in the catch-at-age data-file to avoid spurious F-shrinkage effects at this age. Mean weights-at-age in the catch and stock (Tables 7.15.4 and 7.15.5) were derived as per the methodology described in the Stock Annex. The stock weights are shown in Figure 7.15.4 At WGCSE 2011 an error was identified whereby age 7 mean weights have historically been used in the calculation of SSB rather than a weighted average mean weight for 7+. The impact of this on the SSB calculation is negligible (max difference of 47 t). This together with the procedure for smoothing stock weights should be amended at the next benchmark. There is some variability of stock weights particularly at older ages. Mean weight-at-age appears to decline during periods of high SSB e.g. between 1994–1997. There is some indication of a decreasing trend in weights for ages 6 and 7 over the whole time period.

Discards

Discard data are available from the Irish fishery since 1994 (ICES: SGDBI, 2002), from French sampling in 1991, 1997, and 2005–2011, and for the UK (E&W) fisheries from 2001–2011. These data are not used in the assessment as the data available does not cover the full time-series of landings-at-age-data, and historically sampled fleets may not be representative of the main fleets involved in the fishery. Furthermore, there is a need to examine and agree the best raising practice for the various fleets. Discard rates are substantial (>50% by fleet/quarter) and variable. It is not clear if current sampling intensity will obtain precise enough annual estimates to support an assessment method where catch numbers are assumed to be exact as in XSA.

A summary of the 2011 discard sampling and discarding rates is presented in Table 7.15.6. Discard rates between years, quarters and fleets can be very variable, but France has reported a significant reduction in discard rate for recent years. Discarding is presented here raised to the landings, unlike previous years where sampling ratios only were presented for France and the UK. Discarded whiting length distributions from 2011 Irish and French otter trawlers, and all UK gears were made available to the WG (Figure 7.15.5). The available data indicate that discarding occurs above the 27 cm MLS with fish being discarded up to 50 cm in some fleets. The discard L_{50}'s for most countries/fleets is around 26 cm cm, down from about 30 cm in 2010 but up from previous years.

Age compositions for Irish discard data were provided for otter trawlers in VIIg and VIIj for 2004–2011 indicating discarding from age 0 up to age 8 in some years. Substantial discarding of ages 1 and 2 occurs for most years (Figure 7.15.6). Discard numbers-at-age have not yet been calculated for other fleets.

Biological

Mean stock weights- and numbers-at-age data were calculated following the methodology described in the Stock Annex.

Natural mortality was assumed to be 0.2 over all age groups and years.

Available data on maturity-at-age are described in the Stock Annex. Since 2006 the knife-edge maturity ogive has been replaced with indices calculated based on data from the UK WCGFS but a fixed vector is still used. Recent maturity sampling by Ireland and the UK on dedicated surveys confirms the use of this ogive but is in-sufficient to provide annual data.

Age	0	1	2	3	4	5+
Maturity	0	0.39	0.90	0.99	0.99	1.00

The proportions of F and M before spawning were both set to zero to reflect the SSB calculation date of January 1st.

Surveys

A time-series of available standardized survey abundance indices for ages 0–3 are displayed in Table 7.15.8. Further details of these surveys are given in WGSSDS 2008 Table 1.3.3 and described in the Stock Annex. Figure 7.15.9 shows standardized and log standardized abundance indices by age (0–3) for the three surveys used in the assessment by year class. In total four fishery-independent survey indices including 2011 data were available to the WG. The strong 1999 year class is evident in all surveys. The complete time-series and ages available from these surveys are given in the tuning fleet information available to the Working Group (Table 7.15.8). Prior to WGCSE 2012 an error was discovered in the 2010 IR-GFS-7G-SweptArea data. This was corrected but given the weight it receives in the assessment it had a significant impact on last year's assessment. A comparison between last year's assessment, the assessment updated to include the corrected tuning fleet and this year's final assessment is given in Figure 7.15.7.

The internal consistency of the commercial and survey tuning fleets was examined using pairwise scatterplots of log numbers-at-age, bearing in mind that the correlations may be impacted by changes in fishing mortality. Plots for the two tuning fleets and three surveys included in the assessment are provided in Figure 7.15.8a–b. Year effects were examined with mean log standardized plots of indices by age and year (Figure 7.15.9a). Cohort tracking was examined with mean log standardized plots of indices by age and cohort (Figure 7.15.9b).

The EVHOE-WIBTS-Q4 survey log indices scatterplots display a reasonably positive correlation between adjacent ages. The mean log standardized indices by year display a year effect in 2006 and by cohort demonstrates good tracking of stronger year classes. The UK-WCGFS Q1 is now terminated, but shows reasonably good consistency between years in the log-index scatterplots and reasonably consistent cohort tracking with minor evidence of year effects. There is some suggestion of a trend over time (Figure 7.15.8). Log-indices for the Irish VIIg swept-area survey reveal some positive correlation for younger ages. The mean log standardized index by year demonstrated some slight year effect in 2003 which was the first year of the new series.

Commercial lpue

Estimates of commercial lpue, from 1995 to 2011, were available for the Irish otter trawl, Scottish seine, and beam trawl fleets operating in Divisions VIIg and VIIj (Table 7.15.9 and Figure 7.15.11). Provisional French fleet data for 2011was also provided. The effort-series is raw effort in hours uncorrected for changes in vessel power or changes in species targeting (i.e. métier compositions). Increased Irish VIIg otter trawl landings and lpue occurred 2005–2007, returning to prior levels in 2008. This increase coincides with the 1999 year class passing through the fishery. Effort for this fleet has steadily increased since 1999 with landings and lpue tracking each other and rising since 2008. The more recent elevated effort has been associated with fleet displacement due to restrictive management in other areas, particularly VIa and VIIa. The VIIj otter trawl fleet landings, effort, and lpue show similar levels since 2005, although marginal increases to those of 2008–2009 are observed. In the earlier part of the time-series lpue for the IR-7G-SSC and IR-7J-SSC showed declining tends. Since 2006/2007 lpue has increased. Landings by these two fleets however are low. Effort and lpue data for the Irish beam trawls (TBB) operating in VIIg and VIIj are also included in Table 7.15.9 but is not plotted as landings, effort and lpue are minimal.

Estimates of commercial lpue, up to 2008 were available for French gadoid trawlers and French *Nephrops* trawlers operating in Divisions VIIf,g (Table 7.15.9 and Figure 7.15.10). Fishing effort in the FR-GADOID fleet has been declining since 1989, while the effort in the FR-*NEPHROPS* has declined since 1992. The FR-GADOID fleet's lpue increased to high levels in 1994 and 1995 but declined since. Sharp increases in lpue for the French gadoid fleet occurred in both 1998 and 2005, since which lpue has declined. Lpue for the FR-*NEPHROPS* fleet peaked in the mid-to-late 1990s, having declined since to levels similar to the early 1980s. Landings, effort and lpue for both these fleets currently demonstrate the lowest levels within the time-series. Limited lpue data from France are available for Divisions VIIj–k, but they are not considered representative. The commercial tuning fleets available to the assessment are given in Table 7.15.8.

Abundance indices-at-age were available for three commercial fleets, the French gadoid, and *Nephrops* fleets, and the Irish otter trawl fleet. As with the surveys, the internal consistency of the French fleets (Figure 7.15.7a), any year effects (Figure 7.15.8a) and cohort tracking (Figure 7.15.8b) were examined. The French commercial *Nephrops* index demonstrates very good internal consistency. The French gadoid fleet shows good consistency, although consistency at age 3 is slightly poorer. The IR-OT-7g&j previously used in the assessment was not considered as a consequence of poor cohort tracking and *a priori* concerns about changes in targeting practice and fishing power following recent fleet changes since 2002.

Other relevant data

Meetings held with representatives of the fishing industry raised no specific concerns or comments.

7.15.3 Historical stock development

An XSA assessment was carried out for this stock applying the same settings as last year's update assessment, with the addition of 2011 data and the correction of the 2010 index for the IR-IGFS Swept area. The settings previously used and applied this year are detailed within the Stock Annex.

Data screening

The general methodology is outlined in Section 2. Preliminary investigations were carried out using FLR under R version 2.4.1. The packages FLCore 1.4–3, FLAssess 1.4.1, FLXSA 1.4–2 and FLEDA 1.4–2 were used.

Final update assessment

The final assessment was carried out using the Lowestoft VPA suite. The assessment uses the same settings as last year (detailed below), with the exception of the French commercial tuning fleets which were not updated since 2009due to data non-availability. The tuning data available, and the subset used in the assessment, are given in Table 7.15.8.

		2011	2012
Catch date range:	Years	1982–2010	1982–2011
	Ages	0–7+	0–7+
Fbar Age Range:		2–5	2–5
Assessment Method:		XSA	XSA
Commercial Tuning Fleets:			
FR-Gadoid Late	Yrs	1993–2008	1993–2008
	Ages	3–6	3–6
FR-Nephrops	Yrs	1993–2008	1993–2008
	Ages	3–6	3–6
Survey Tuning-series:			
FR-EVHOE	Yrs	1997–2010	1997–2011
	Ages	0–4	0–4
UK-WCGFS	Yrs	1987–2001	1987–2001
	Ages	1–6	1–6
IR-IGFS Swept-area	Yrs	1999–2010	1999–2011
	Ages	0–6	0–6
Time taper:		No	No
Q plateau age:		5	5
F shrinkage S.E:		1.0	1.0
	Num yrs	5	5
	Num ages	3	3
Fleet S.E:		0.5	0.5

The full XSA diagnostics are given in Table 7.15.10. The assessment is now dominated by the survivor estimates given by the two surveys (only the 2005 cohort has some commercial tuning data contributing to the estimates). The surveys are very consistent in their estimates of the 2011, 2010 and 2006 cohorts. There is some divergence in the estimates for the 2009, 2008 and 2007 cohorts but on the whole the estimates are reasonably consistent given that whiting are prone to year effects in survey catches. Where there is divergence the final estimates are fairly evenly weighted, Figure 7.15.12 shows the scaled weights received by each fleet in the assessment.

The log-catchability residuals from the XSA fit are plotted for each tuning-series in Figure 7.15.13. The residual patterns for the two surveys do not show any trends. Some year effects are apparent 1998, 2003, 2004 and 2006 for EVHOE and 2007 for IR-GFS-7G-SweptArea. In the past the commercial fleets showed waves in the residual patterns thought to be associated with changing targeting practices by the commercial fleet. This will have little impact on the current assessment. The main discrepancy between the surveys in the estimation of the 2007 year class is also apparent in the residuals.

The retrospective pattern is shown in Figure 7.15.14. There is no apparent retrospective bias in F or SSB and the estimates and trends are very consistent from year to year. In the past the main rational for not accepting this assessment as a Category 1 (i.e. full assessment and forecast) was the problem forecasting landings and SSB in the short term due to retrospective bias on the estimates of recruitment. This recruitment bias is a consequence of the non-inclusion of discards in the assessment and was particularly severe when stronger year classes entered the fishery.

Estimates of fishing mortality and stock numbers from the final XSA are given in Tables 7.15.11 and 7.15.12. Fishing mortality at ages 4 and 5 are very consistent, F-at-ages 2 and 3 are lower but follow a similar pattern to the older ages. There is a slight decline in the relative F at age 2 which is in the F_{BAR} range. This is something that should be fixed at the next benchmark but it is not significant enough to be a major concern now. These are summarized in Table 7.15.13 and Figure 7.15.14. The assessment this year reveals a slight decrease in fishing mortality. Recruitment of 2011 is below the time-series average.

Comparison with previous assessments

This assessment settings used are in accordance with the stock annex and have remained unchanged since 2007. Since 2009 updated French commercial tuning fleets have not available. There was a major correction to the 2010 index for the IR-IGFS Swept area. Minor revisions to landings and landings numbers-at-age have been included for 2010. Figure 7.15.7 shows a comparison between last year's assessment and an update of the 2011 assessment with corrected 2010 tuning data and this year's final XSA assessment. The new assessment is very consistent with the 2011 update. The 2012 assessment gives a 15% reduction in F_{2010} and 7% increase in SSB 2010 compared with the update 2011 assessment.

State of the stock

Trends in landings, F(2–5), SSB, and recruitment are presented in Table 7.15.13 and Figure 7.15.15. SSB displays peak biomass in the mid-1990s following a series of good recruitment in preceding years.

SSB then shows a declining trend up to 2007. Since then SSB has increased rapidly and is now close to the highest levels observed. The 2011 estimate of 64 kt is well above B_{pa} (21 000 t). Fishing mortality (F_{bar}) has declined since 2007 and is now at the lowest level ever observed for this stock. There has been two above average recruitments (2008 and 2009) entering the fishery and SSB.

There is no apparent relationship between SSB and recruitment (Figure 7.15.16) nor is there evidence of reduced recruitment at the levels of SSB seen over the time-series.

7.15.4 Short-term projections

As previously discussed there were problems forecasting out of this assessment in the past due to strong retrospective revision in recruitment. This is not a problem in the current assessment. The update assessment and retrospective pattern are very consistent therefore. WGCSE preformed short-term projections this year.

The short-term projection settings were as described in the stock annex with the following exceptions. The GM period was 1982–2009 (-2 years instead of -1). The XSA estimate of the 2011 year class (18 m) was used in the forecast instead of GM (71 m). Both surveys have a very low index for the 2011 year class and although the historical performance of the terminal recruit estimation in this assessment is poor it is likely that the 2011 year class is weak (this has little impact on the 2013 landings prediction, see Table 7.15.14).

The input values for the catch forecast (using the MFDP software) are given in Table 7.15.15. The F-at-age values used were calculated as the mean of the XSA values from 2009–2011, unscaled. Catch and stock weights-at-age were also the mean of the period 2009–2011. Stock numbers-at-age in 2011 for ages 0 and older were obtained from the XSA. SSB values are calculated for 1 January.

Table 7.15.14 gives the management option table from the *status quo* catch prediction, and short-term results are shown in Figure 7.15.17. Assuming *status quo* F ($F_{sq} = 0.35$) implies landings of 19 kt in 2012 and 17 kt in 2013. The TAC for 2012 is likely to be very restrictive (the total TAC is 19 kt and recent landings from VIId are in the order of 6 kt).

The detailed output for the *status quo* F forecast by age group is given in Table 7.15.16, and the estimated contributions of recent year classes to the predicted catches and SSBs are given in Table 7.15.17. The assumptions of $GM_{1982\text{-}2009}$ recruitment for 2012 and 2013 and the XSA estimate of recruitment in 2011 are predicted to contribute <3% to the landings in 2013 and 40% to SSB in 2014.

7.15.5 Biological reference points

Precautionary approach to reference points

The Working Groups current approach to reference points is outlined in Section 2. A summary of reference point proposals to date and their technical basis is given in the Stock Annex. The reference points were not re-examined in this update assessment, those currently adopted and their basis are as follows:

F_{LIM}	No Proposal
F_{PA}	No Proposal
B_{LIM}	15 000 t (B_{LIM} = B_{LOSS} 1983, ACFM1998)
B_{PA}	21 000 t (B_{PA} = B_{LOSS} 1983 x 1.4)

MSY reference points

WGCSE carried out some MSY evaluations using the srmsymc program. This program uses fishing mortality-at-age (average of the most recent three year), catch and stock weights (three year averages), maturity and natural mortality-at-age together with their CVs in a stochastic framework to estimate proxies for the fishing mortality biomass and landings at maximum sustainable yield.

The lack of a stock–recruit relationship is something that was previously mentioned for this stock. Less than 50% of the S–R realisations for the various models (Beverton and Holt, Ricker and Hockey Stick) fitted the data in 'srmsymc' and the results of srmsymc were deemed uninformative by WGCSE 2012. The results are available on the ICES SharePoint in the data folder for this stock.

Yield–per–recruit analysis

Results for deterministic yield and SSB per recruit (using program MFYPR), conditional on the recent exploitation pattern, are given Figure 7.15.17. F_{max} is not well determined due to the very flat-topped nature of the Y/R curve. $F_{0.1}$ was better determined but was considered to be too low as an interim MSY proxy for a fairly productive stock such as Celtic Sea whiting. WGCSE concluded that $F_{35\%SPR}$ was a more appropriate F_{MSY} candidate in the short term. This reference point has been used for many other moderately productive gadoid stocks worldwide. This is obviously something that will need to be revisited if selection in the fishery improves or if an assessment including discards is performed in the future.

7.15.6 Management plans

No management plan has been agreed or proposed.

7.15.7 Uncertainties and bias in assessment and forecast

Sampling

The sampling levels for those countries supplying data for 2011 are given in Table 2.1. Sampling levels of the landed catch for recent years are considered to be sufficient to support current assessment approaches. Sampling levels were not available by fishery/métier and the WG was therefore unable to evaluate whether or not current sampling levels are sufficient to support fishery/métier disaggregated assessment approaches.

Ageing

The strong recent cohorts passing through the fishery indicates that age estimation is consistent throughout the age range used in the assessment, although some underestimation does occur at older ages.

Discards

Discarding is a major feature of most fisheries catching whiting in the Celtic Sea. The non-inclusion of discard data in the assessment is a major source of uncertainty and may explain a large proportion of the retrospective bias problems and changing catchabilities in commercial fleets observed throughout the assessment period. The sampling of discards has improved since the implementation of the DCF sampling programmes, although a time-series of raised discard estimates together with metrics on their precision and accuracy are not available for all the main fleets in the fishery.

Surveys

The surveys for whiting are prone to year effects and there are some indications of a 2011 year effect in the EVHOE index. This will have some impact on recent survivor estimates since it receives roughly 30–40% of the scaled weights. Having said that the estimates are reasonably consistent with the IR-IGFS Swept-area index for most year classes.

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

The 2012 assessment was accepted by WGCSE as a basis to provided management advice and a short-term forecast. Nevertheless several short-comings still exist with the current assessment and a benchmark assessment of whiting is necessary in the near future (preferably 2014). This would only be possible if significant progress can be made with the estimation of discards for the main fleets involved in the fishery.

The loss of the commercial tuning information may be consistent with recent ICES trends to remove commercial information from assessments. However in this stock there is little reason to believe that misreporting may have been an issue. Moreover the available survey information is only useful at younger ages and prone to year effects likely due to spatial distribution differences. Re-establishment of some form of tuning information at the older ages should be implemented at the next benchmark meeting to stabilize the assessment.

A better methodology of deriving stock weights is necessary in order to avoid the problem of declining weight-at-age at age 8 and 9 which is required to estimate the weight of the currently moderate +gp.

Problem: The primary uncertainty of this assessment is underestimation of mortality. Currently the assessment is based on landings only. Discarding is a major feature of most fisheries catching whiting in this stock area. Mortality may therefore be grossly underestimated in younger ages. This could explain some of the retrospective bias problems and changing catchabilities in commercial fleets observed throughout the assessment period.

Solution: The available discard data has improved in the most recent years since the implementation of the DCR sampling programmes. Raw data are available for the main fleets, operating within VIIe–k. Work is now required to raise and compile a complete time-series of discard data. Assessment model and settings then need to be reviewed to ensure optimum performance.

Year of last benchmark: No benchmark assessment of this species has been carried out.

Expertise required: Expertise in discard raising and uncertainty methods, in addition to expertise in assessment methods permitting inclusion of discard data.

A further matter for consideration is the improvement of commercial tuning fleets by selection of vessel subsets with consistent spatial and temporal effort and catch composition over the majority of the time-series, moving towards the métier based approach. This would require a detailed analysis of vessel behaviour.

Currently, there are two IBTS surveys (French and Irish) covering the Celtic Sea provided to the working group. Although these surveys normally catch large quantities of whiting they seem prone to year effects as has been observed for this species in other areas (e.g. Irish Sea, North Sea). Survivor estimates are generally fairly consistent for the surveys when used independently. A detailed evaluation of the survey data and the potential for integration of the indices would be beneficial before the next benchmark.

7.15.9 Management considerations

Catches and SSB in VIIe–k whiting fluctuate considerably depending on year-class strength. The 2008 and 2009 year classes are above average, and 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 the 2010 and 2011 year classes are likely to be quite weak.

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 that the NWWRAC have recently supported the introduction of square mesh panels in all trawl fisheries operating in ICES Divisions VIIfg. These measures have already been introduced by the main fleets operating in this area. It is important that these 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. Highgrading 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. Irish otter trawl effort in VIIg,j has been stable over the last four years, but risen recently somewhat. During this period there has been a fleet modernisation and several decommissioning schemes in

Ireland both within the national whitefish fleet and beam trawl fleet. The most recent round of decommissioning occurred in 2008 and 2009 removed 40 vessels which had operated within the Celtic Sea in 2007–2008. The decommissioned vessels accounted for 15–16% of whiting landings from the stock area in 2007 and 2008. The majority of these vessels primarily landed *Nephrops* or a combination of Hake, monkfish and megrim. Only eight vessels primarily landed whitefish (cod, haddock and whiting). A French decommissioning scheme was implemented in 2008 and 2009. A reduction in the French fleet operating in VIIe–k was expected as a result and appears to be occurring.

Table 7.15.1. Whiting in Divisions VIIe–k. Nominal Landings (t) as reported to ICES, and total landings as used by the Working Group.

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Belgium	130	158	160	107	112	159	295	317	304	111	145	228	205	268	449
Denmark															
France	7,572	4,024	7,819	7,763	9,773	10,947	19,771	19,348	10,006	9,620	11,285	13,535	13,400	9,936	11,370
Germany										14					
Ireland	1,511	1,227	2,241	1,309	1,518	2,036	1,651	1,764	1,403	1,875	3,630	5,053	6,077	6,115	6,893
Netherlands		398		124										8	
Spain													4	31	24
UK (E/W/NI)	1,192	986	751	910	1,098	1,632	1,326	1,829	2,023	1,393	1,776	1,624	1,803	1,724	1,742
UK(Scotland)						1	33	32	20	41	16	23	23	34	42
United Kingdom															
Channel Islands			2	2	2								1	1	
Total	10,405	6,793	10,973	10,215	12,503	14,775	23,076	23,290	13,756	13,054	16,852	20,463	21,513	18,116	20,520
Unallocated	1,376	3,192	-135	-263	149	353	-6,535	-9,184	-248	-690	-532	-429	1,165	144	12
Total as used by Working Group	11,781	9,985	10,838	9,952	12,652	15,128	16,541	14,106	13,508	12,364	16,320	20,034	22,678	18,260	20,532

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011[a]
Belgium	479	448	194	171	149	149	129	180	218	128	127	87	101	99
Denmark														
France	11,711	16,418[b]	9,077	7,203	7,435	7,435	5,897	4,811	5,784	4,649	3,543	2,739	3,397	3,390
Germany														
Ireland	5,226	5,807	4,795	5,008	5,332	5,332	4,093	4,215	5,709	4,521	4,764	2,704	4,187	4,205
Netherlands	1			5	4	4	9	18	60	40	64	24	76	170
Spain	53	21	11	9	12	12	-	76	56	70	21	1	6	
UK (E/W/NI)	1,706	1,344	1,249	943	843	843	758	586	471	402	569	764	757	
UK(Scotland)	68	3	2	11	12	12	5	7	-	6	4	63	35	
United Kingdom														689
Channel Islands	3	2	3	3	1	1	4	0	0	0	1	-	4	1
Total	19,247	24,043	15,331	13,353	13,788	13,788	10,895	9,893	12,298	9,816	9,093	6,382	8,563	8,555
Unallocated	-2	-4,128	-466	-583	-642	-3,205	-942	2,137	-2,765	-869	-3,356	-674	-139	523
Total as used by Working Group	19,245	19,915	14,865	12,770	13,146	10,583	9,954	12,030	9,533	8,948	5,737	5,708	8,424	9,077

[a]: Preliminary.

[b]: Preliminary, Reported as VIIb–k.

Table 7.15.2. Whiting in Divisions VIIe–k. Raised length distributions for 2011 by country and fleet (Numbers in '000s).

Length	France	UK (E+W)		Ireland					
(cm)		Beam trawl	All gears (exc beam)	Scottish Seine	Otter trawl	Beam trawl	Gillnet	Otter trawl	Scottish seine
	VII e-k	VIIe-k	VIIe-k	VIIg	VIIg	VIIg	VIIg	VIIj	VIIj
19		0.0	0.8						
20		0.0	2.1						
21		0.0	4.1						
22	0.6	0.0	4.6						
23	0.3	0.0	4.7						
24	1.0	0.0	4.7						
25	0.4	0.1	25.3						
26	0.4	0.0	42.5		10.1				
27	18.1	0.3	56.3		46.2				
28	36.7	1.3	76.1	1.3	66.2		0.3		0.8
29	92.1	1.6	108.0	3.4	54.9		0.9	0.3	1.6
30	166.8	2.4	129.4	32.4	106.6	0.1	1.1	0.6	7.8
31	276.8	3.1	174.0	33.5	139.1	0.1	0.8	2.0	8.5
32	315.5	3.7	149.8	97.5	177.3	0.2	1.1	3.5	21.8
33	384.5	4.0	158.3	99.5	221.0	0.3	1.1	3.6	24.0
34	467.6	4.3	129.4	127.6	198.1	0.9	1.2	6.2	29.2
35	410.5	17.8	95.6	144.6	314.1	1.9	1.1	6.9	30.9
36	515.5	4.3	83.3	165.1	344.7	2.9	1.0	9.8	31.9
37	434.8	3.9	65.8	166.7	327.1	2.7	1.0	18.0	30.8
38	433.0	4.8	49.5	164.8	337.2	3.8	1.3	16.1	32.1
39	432.1	3.7	40.5	157.2	251.7	3.3	1.2	15.5	30.3
40	457.8	4.2	39.4	128.8	229.5	2.2	0.8	31.1	26.1
41	346.5	3.3	25.8	133.1	250.0	1.7	0.8	34.6	28.8
42	259.5	2.9	14.8	150.8	205.0	1.8	2.4	51.1	31.4
43	295.0	2.5	23.1	121.4	198.8	1.2	0.4	17.6	26.9
44	204.8	2.6	20.2	97.6	166.5	1.1	0.8	21.4	21.5
45	158.9	2.3	17.3	110.3	140.3	0.7	0.4	20.7	21.8
46	212.7	2.2	14.3	103.1	114.4	0.7	0.6	34.1	24.6
47	153.2	1.2	24.9	63.7	82.9	0.3	0.6	14.3	15.6
48	87.5	1.8	5.3	55.5	67.1	0.2	0.5	12.6	15.7
49	80.8	0.9	7.3	63.5	75.3	0.2	0.3	13.7	14.9
50	57.2	1.3	9.6	54.2	43.2	0.1	0.4	20.5	14.1
51	38.6	0.5	8.7	51.8	36.0	0.1	0.3	10.1	12.8

Length	France	UK (E+W)	Ireland						
(cm)		Beam trawl	All gears (exc beam)	Scottish Seine	Otter trawl	Beam trawl	Gillnet	Otter trawl	Scottish seine
	VII e-k	VIIe-k	VIIe-k	VIIg	VIIg	VIIg	VIIg	VIIj	VIIj
52	43.3	0.4	14.6	34.0	28.4	0.1	0.4	9.5	10.4
53	39.4	0.3	2.5	25.8	14.6	0.1	0.5	6.2	8.0
54	13.7	0.2	8.0	28.0	12.4	0.1	0.4	2.0	8.7
55	27.9	0.5	2.4	21.2	8.5	0.0	0.4	2.0	5.6
56	13.6	0.1	1.2	12.7	11.6		0.4	1.5	4.2
57	10.4	0.1	1.5	19.3	2.2		0.3	0.6	5.3
58	2.8	0.1	1.2	12.8	9.0		0.1	1.8	3.4
59	5.4	0.1	2.6	3.5			0.1	0.6	1.4
60	5.0	0.0	1.1	6.2	3.5		0.1	0.3	0.8
61	0.1	0.0	0.2	1.7			0.1		0.3
62	0.0	0.0	0.3	2.5	3.0				0.4
63	0.1	0.1	0.0	1.9	1.2				0.2
64	0.2	0.0	0.3		2.5				0.2
65	0.0			1.9	1.2				0.3
66	0.4			0.4				0.3	0.3
67				0.4					
68					1.2				
69					0				
Total N.	6501.4	82.9	1651.2	2500.0	4303.1	26.8	23.1	389.1	553.5
Total (t)	3692.6	41.7	616.4	1247.7	2186.2	14.6	14.3	289.7	364.2

Table 7.15.3. Whiting in Divisions VIIe–k. Landings numbers-at-age ('000), examples of strong year classes are highlighted.

Age	0	1	2	3	4	5	6	7+
1982	0	2624	12523	9862	4564	880	41	23
1983	0	5867	9981	9059	3393	1319	195	10
1984	0	2854	18645	4697	1815	618	128	28
1985	0	3698	15538	8005	1380	289	96	33
1986	0	3769	15157	6465	2091	553	60	45
1987	0	5977	19376	8825	2467	587	112	60
1988	0	2315	26780	11400	1962	409	70	21
1989	0	602	17057	24243	3459	339	63	25
1990	0	3270	9249	19509	8654	749	62	21
1991	0	8339	11997	5578	11742	2700	143	3
1992	0	4964	20513	9198	1420	1275	435	39
1993	0	2304	22277	17939	2829	526	382	172
1994	0	1272	14110	25384	6165	1019	135	177
1995	0	540	15062	21854	14142	2242	310	92
1996	0	1345	7473	17783	12850	5486	775	114
1997	0	609	4451	11734	21209	7322	2787	720
1998	0	1182	6680	10938	12758	13240	2865	882
1999	0	4163	10223	12444	8406	8733	6479	1188
2000	0	3575	9357	10328	5468	2351	1993	1845
2001	0	336	11648	11076	5135	2061	745	275
2002	0	1067	5962	19658	5732	1064	274	63
2003	0	462	3599	8264	11530	1675	264	20
2004	0	1209	4141	5963	6755	5978	496	69
2005	0	768	6169	8141	5008	4551	3456	147
2006	0	1366	6342	7631	3672	1767	1148	581
2007	0	988	5598	8479	4984	1535	412	226
2008	0	1269	3710	5948	2923	700	173	31
2009	0	341	4194	5693	2768	695	165	36
2010	0	530	3258	8335	4247	1273	217	117
2011	0	941	4532	5849	4947	1495	423	94

Table 7.15.4. Whiting in Divisions VIIe–k. Landings weights-at-age (kg).

Age	0	1	2	3	4	5	6	7+
1982	0.000	0.245	0.279	0.395	0.557	0.646	1.193	1.593
1983	0.000	0.273	0.328	0.441	0.545	0.678	0.731	1.652
1984	0.000	0.227	0.286	0.457	0.656	0.807	1.060	1.514
1985	0.000	0.233	0.335	0.433	0.631	1.008	1.157	0.980
1986	0.000	0.198	0.277	0.493	0.585	0.781	1.469	1.680
1987	0.000	0.222	0.284	0.398	0.658	0.877	0.897	0.990
1988	0.000	0.224	0.303	0.416	0.628	0.977	1.322	1.374
1989	0.000	0.201	0.281	0.376	0.593	0.980	1.444	1.877
1990	0.000	0.226	0.260	0.328	0.452	0.722	1.083	1.721
1991	0.000	0.220	0.291	0.355	0.395	0.534	0.834	1.695
1992	0.000	0.208	0.289	0.388	0.472	0.623	0.739	1.084
1993	0.086	0.205	0.286	0.379	0.589	0.831	0.963	1.360
1994	0.000	0.249	0.300	0.404	0.637	0.915	0.982	1.222
1995	0.090	0.202	0.275	0.382	0.527	0.844	1.124	1.197
1996	0.000	0.229	0.266	0.346	0.460	0.598	0.616	1.058
1997	0.000	0.196	0.277	0.329	0.406	0.536	0.714	1.005
1998	0.000	0.188	0.270	0.333	0.396	0.452	0.567	0.896
1999	0.000	0.222	0.298	0.352	0.426	0.441	0.497	0.633
2000	0.101	0.250	0.326	0.419	0.510	0.573	0.585	0.597
2001	0.000	0.265	0.286	0.393	0.521	0.624	0.761	0.820
2002	0.082	0.217	0.293	0.363	0.519	0.682	0.810	1.022
2003	0.000	0.211	0.281	0.369	0.447	0.603	0.831	1.149
2004	0.086	0.218	0.303	0.376	0.433	0.492	0.523	0.754
2005	0.101	0.246	0.318	0.396	0.506	0.509	0.487	0.595
2006	0.112	0.232	0.299	0.414	0.545	0.585	0.586	0.707
2007	0.000	0.206	0.290	0.389	0.492	0.603	0.564	0.673
2008	0.116	0.235	0.291	0.378	0.512	0.617	0.754	1.124
2009	0.000	0.245	0.322	0.405	0.504	0.592	0.669	0.902
2010	0.000	0.267	0.348	0.441	0.560	0.638	0.777	0.726
2011	0	0.267	0.305	0.457	0.601	0.784	0.935	1.223

Table 7.15.5. Whiting in Divisions VIIe–k. Stock weights-at-age (kg).

Age	0	1	2	3	4	5	6	7	8	9	10
1982	0	0.157	0.270	0.345	0.474	0.607	0.843	1.403	1.255	0.688	0.688
1983	0	0.167	0.276	0.363	0.498	0.632	0.826	1.313	1.256	0.732	0.732
1984	0	0.192	0.282	0.371	0.521	0.709	0.847	1.188	1.270	0.723	0.723
1985	0	0.179	0.272	0.389	0.534	0.738	1.030	1.187	1.382	1.046	0.957
1986	0	0.183	0.259	0.370	0.543	0.756	1.020	1.223	1.513	1.145	0.98
1987	0	0.171	0.253	0.367	0.533	0.752	1.059	1.261	1.474	1.585	0.864
1988	0	0.186	0.252	0.342	0.531	0.784	1.050	1.322	1.685	1.465	0.768
1989	0	0.173	0.249	0.331	0.477	0.760	1.114	1.439	1.643	1.853	0.599
1990	0	0.166	0.247	0.317	0.427	0.651	1.007	1.524	1.461	1.465	0.842
1991	0	0.151	0.248	0.317	0.396	0.553	0.815	1.310	1.154	1.032	0.929
1992	0	0.174	0.253	0.327	0.421	0.551	0.736	1.133	1.105	0.866	1.216
1993	0	0.166	0.251	0.340	0.470	0.637	0.779	1.034	1.337	0.954	1.126
1994	0	0.175	0.254	0.340	0.487	0.715	0.906	1.077	1.258	1.405	1.158
1995	0	0.108	0.259	0.346	0.476	0.711	0.861	0.994	1.047	1.341	1.044
1996	0	0.135	0.256	0.328	0.430	0.626	0.820	0.942	0.990	1.107	1.035
1997	0	0.110	0.245	0.307	0.396	0.525	0.645	0.830	1.123	0.912	0.912
1998	0	0.148	0.238	0.293	0.378	0.453	0.585	0.747	1.043	0.968	0.968
1999	0	0.112	0.245	0.324	0.419	0.491	0.518	0.677	0.779	0.725	0.725
2000	0	0.144	0.253	0.357	0.465	0.556	0.611	0.711	0.685	0.895	0.895
2001	0	0.182	0.259	0.370	0.490	0.612	0.676	0.802	0.649	0.995	0.995
2002	0	0.193	0.248	0.361	0.480	0.627	0.795	1.009	0.850	1.062	1.062
2003	0	0.187	0.244	0.332	0.439	0.560	0.693	0.886	1.202	0.875	1.127
2004	0	0.167	0.253	0.333	0.449	0.541	0.652	0.892	1.380	1.38	1.38
2005	0	0.163	0.256	0.346	0.484	0.535	0.582	0.765	1.431	1.431	1.431
2006	0	0.177	0.280	0.390	0.553	0.624	0.647	0.832	0.990	0.799	0.799
2007	0	0.204	0.285	0.403	0.566	0.666	0.727	0.951	0.811	0.633	0.633
2008	0	0.227	0.298	0.397	0.549	0.659	0.714	0.920	0.527	0.467	0.467
2009	0	0.220	0.286	0.380	0.525	0.631	0.723	0.981	0.540	0.54	0.54
2010	0	0.286	0.307	0.417	0.537	0.637	0.748	0.706	0.941	0.883	0.883
2011	0	0.246	0.268	0.441	0.598	0.780	1.059	1.066	1.579	1.579	1.579

Table 7.15.6. Whiting in Divisions VIIe–k. Summary of discard data in 2011 provided to the Working Group.

Country	Year	Fleet	Landings Tonnes	Discards Tonnes	Proportion %
France	2011	MISC	336	794	
France	2011	OT_CRU	9	1	
France	2011	OT_DEF	3337	2802	
		Total	**3683**	**3597**	**49%**
UK*	2011	Beam Trawl	31	11	
UK*	2011	Dredge	0	0	
UK*	2011	Others	627	363	
		Total	**658**	**374**	**36%**
Ireland	2011	Otter Trawls	2496	1704	
		Seiners	1614	71	
Ireland	2011	Beam Traw	15	-	
		Total	**4125**	**1775**	**30%**

Table 7.15.7. Whiting in Divisions VIIe–k. Standardized survey abundance indices of age groups 0–3.

Survey	UK-WCGFS			UK-BCCSBTS-S		FR-EVHOE				IR-GFS-7g&j				IR-GFS-7g-Swept-area			
Units	No. per min			No. per km towed		No. per 30 min haul				No. per 30 min haul				No. per 10 kmsq			
Year	1-gp	2-gp	3-gp	0-gp	1-gp	0-gp	1-gp	2-gp	3-gp	0-gp	1-gp	2-gp	3-gp	0-gp	1-gp	2-gp	3-gp
1987	0.36	1.61	0.16														
1988	0.24	0.23	0.06	0.1	0.9												
1989	0.25	0.73	0.49	0.9	1.1												
1990	0.02	0.06	0.25	5.2	0.5												
1991	0.21	0.01	0.01	4.4	1.4												
1992	1.31	0.53	0.11	6.7	1.3												
1993	4.88	0.92	0.27	10.0	1.7												
1994	8.99	1.33	0.92	2.7	1.5												
1995	0.59	5.52	1.43	2.3	1.5												
1996	0.52	1.51	1.39	4.6	1.5												
1997	0.73	0.56	0.18	10.7	0.5	31	24	9	8.5								
1998	1.19	0.77	0.53	5.3	0.5	48	15	7.9	1.2								
1999	0.84	0.50	0.15	15.1	1.0	261	62	18	5.1					24175	7307	1881	633
2000	14.91	0.93	0.29	1.2	3.1	31	77	23	2.9					6077	15 835	3116	190
2001	2.49	1.35	0.24	1.7	0.5	23	35	49	8					4650	2836	13871	1849
2002	3.35	1.80	3.04	5.3	0.3	39	15	11	10					2468	3664	1719	1252
2003	3.20	2.51	2.48	3.9	0.1	47	58	27	20	127	88	38	11	6061	2219	1027	413
2004	2.00	1.80	0.99	10.3	0.1	28	108	31	14	295	95	48	10	9778	3444	655	321
2005	Survey discontinued			6.4	0.0	44	16	5	2	83	106	29	10	1146	3177	1573	422
2006				4.3	0.3	15	10	3	1	373	161	50	10	15260	5883	2175	707
2007				7.7	0.7	178	46	4	1	332	218	47	7	9951	8081	2718	455
2008				25.1	0.7	365	45	10	3	402	140	44	11	16344	5554	2238	475
2009				6.7	0.6	30	68	31	6	346	289	65	17	11053	10 819	2154	589
2010				2.0	0.3	27	36	24	11	85	112	12	6	2105	10 592	5924	1016

Table 7.15.8. Whiting in Divisions VIIe–k. Available commercial and survey tuning-series, ages and years used in the assessment are highlighted in bold.

Whiting in the Celtic Sea VIIe-k Tuning data WGCSE 2010 (Sarah Davie 05/05/2011)

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FR-GADOID-Early: French Gadoid trawlers (FU5) - Effort, No. of whiting/age/1000 hours fished, Year, Live weight (t)

1983	1992									
1	1	0	1							
1	11									
1000	18325	41531	38575	15377	6184	886	51	0	0	0
	0	#1983	5742t							
1000	13779	97659	25223	9993	3362	688	82	46	22	0
	0	#1984	4598t							
1000	14948	75447	37539	6687	1506	540	189	9	0	0
	0	#1985	4514t							
1000	13417	66679	29328	9073	2310	266	183	20	3	2
	0	#1986	5049t							
1000	25446	79928	33683	10141	2358	518	161	30	36	0
	0	#1987	6859t							
1000	6738	71192	30313	5029	1040	184	45	4	2	0
	0	#1988	7921t							
1000	1539	41365	58078	7808	843	161	30	12	0	0
	0	#1989	8974t							
1000	10547	29023	60936	24967	2297	148	49	18	2	0
	0	#1990	7897t							
1000	31392	41485	18143	40085	8616	352	15	0	0	0
	0	#1991	7525t							
1000	15843	65677	28694	4589	4435	1226	132	0	0	0
	0	#1992	6460t							

FR-GADOID-late: French Gadoid trawlers (FU5) - Effort, No. of whiting/age/1000 hours fished, Year, Live weight (t)

1993	2008									
1	1	0	1							
1	11									
1000	4736	57675	**35630**	**5286**	**825**	**883**	469	40	20	6
	0	#1993	7815t							
1000	448	26922	**65786**	**18395**	**2948**	**289**	454	125	80	0
	0	#1994	9236t							
1000	86	10737	**43840**	**34895**	**7662**	**1360**	248	0	28	32
	0	#1995	9186t							
1000	8	2509	**34872**	**31293**	**13650**	**1708**	328	32	31	29
	0	#1996	6028t							

1000	0	3641	**17743**	**45915**	**14168**	**4338**	721	63	12	0
	0	#1997	7218t							
1000	3827	17367	**32394**	**25399**	**30762**	**21832**	3285	631	186	0
	0	#1998	7674t							
1000	3457	15689	**29265**	**22945**	**27790**	**19723**	2967	570	168	0
	0	#1999	9102t							
1000	4987	23934	**29232**	**15124**	**6851**	**7110**	5976	1306	132	10
	0	#2000	6053t							
1000	213	23745	**25724**	**9253**	**3440**	**1465**	593	539	114	57
	0	#2001	4624t							
1000	405	9574	**48049**	**13052**	**2399**	**816**	136	59	27	25
	0	#2002	4799t							
1000	13	2004	**15027**	**33581**	**3776**	**542**	94	48	67	13
	3	#2003	2975t							
1000	238	4747	**10190**	**18892**	**20570**	**1688**	269	17	0	0
	0	#2004	2589t							
1000	278	11772	**23815**	**15806**	**17601**	**15832**	418	54	0	0
	0	#2005	3659t							
1000	295	16943	**35200**	**15517**	**7869**	**5396**	2180	142	6	0
	0	#2006	2795t							
1000	369	13147	**23994**	**12964**	**2496**	**461**	400	460	53	0
	0	#2007	1898t							
1000	257	8841	**14651**	**10665**	**2942**	**586**	50	65	0	0
	0	#2008	1133t							

FR-NEPHROPS-Early: French Nephrops trawlers (FU8) - Effort, No. whiting/age/1000 hours fished, Year, Live weight (t)

1987 1992

1 1 0 1

1 11

1000	917	3681	2247	761	176	23	18	2	6	0
	0	#1987	588t							
1000	632	7960	3610	918	165	39	11	0	0	0
	0	#1988	844t							
1000	131	4874	6866	1294	128	31	5	1	0	0
	0	#1989	891t							
1000	321	1139	3596	2297	279	27	8	5	0	0
	0	#1990	671t							
1000	1048	2312	982	1745	498	33	6	0	0	0
	0	#1991	527t							
1000	1542	6078	3348	478	571	171	14	0	0	0
	0	#1992	1153t							

FR-NEPHROPS-Late: French Nephrops trawlers (FU8) - Effort, No. whiting/age/1000 hours fished, Year, Live weight (t)

1993 2008

1 1 0 1

1	11									
1000	766	6928	**5695**	**1001**	**163**	**86**	74	1	2	0
	0	#1993	1356t							
1000	184	6145	**8313**	**1840**	**214**	**17**	16	5	2	0
	0	#1994	1565t							
1000	29	2217	**7580**	**4802**	**697**	**91**	20	0	3	3
	0	#1995	1446t							
1000	2	979	**5599**	**4992**	**2359**	**305**	55	4	1	7
	0	#1996	1230t							
1000	0	737	**3511**	**10406**	**4124**	**1231**	275	23	1	0
	0	#1997	1393t							
1000	58	1042	**2567**	**4299**	**5925**	**1236**	239	46	2	0
	0	#1998	881t							
1000	1253	4408	**4764**	**3762**	**3867**	**3563**	575	136	8	0
	0	#1999	1190t							
1000	277	2381	**3085**	**2213**	**923**	**836**	959	232	23	0
	0	#2000	869t							
1000	104	2948	**3131**	**1531**	**557**	**213**	106	95	36	8
	0	#2001	548t							
1000	27	747	**4007**	**1455**	**462**	**170**	69	13	14	7
	0	#2002	550t							
1000	5	311	**1708**	**3944**	**574**	**95**	27	7	1	0
	2	#2003	543t							
1000	47	748	**1090**	**2045**	**2726**	**233**	49	6	0	0
	0	#2004	435t							
1000	104	1285	**1926**	**1133**	**1266**	**1283**	54	2	0	0
	0	#2005	378t							
1000	46	802	**1299**	**591**	**299**	**187**	101	12	0	0
	0	#2006	174t							
1000	138	981	**1159**	**604**	**137**	**26**	19	16	5	0
	0	#2007	96t							
1000	41	506	**565**	**408**	**96**	**19**	7	2	0	0
	0	#2008	54t							

FR-EVHOE: Thalassa Survey - No. whiting at age/30 min, Year

1997	2011									
1	1	0.75	1							
0	8									
1	**30.82**	**23.85**	**8.93**	**8.47**	10.38	1.93	0.24	0.00	0.00	#1997
1	**48.10**	**15.15**	**7.88**	**1.23**	1.67	0.55	0.18	0.02	0.00	#1998
1	**260.66**	**62.15**	**17.64**	**5.09**	1.92	1.67	1.18	0.15	0.13	#1999
1	**30.62**	**76.50**	**23.18**	**2.85**	1.17	0.33	0.18	0.50	0.06	#2000
1	**22.77**	**35.46**	**48.80**	**8.12**	0.79	0.14	0.11	0.02	0.04	#2001
1	**38.50**	**15.33**	**11.00**	**9.58**	0.82	0.00	0.00	0.00	0.00	#2002

```
1       46.62   58.30   27.11   19.94   14.74   0.05    0.01    0.00    0.00    #2003

1       28.23   108.11  31.11   14.36   6.98    3.98    0.00    0.00    0.00    #2004

1       44.14   15.85   5.19    1.89    1.15    0.63    0.16    0.00    0.00    #2005

1       14.60   9.53    3.45    1.18    0.30    0.03    0.00    0.01    0.00    #2006

1       178.39  46.30   4.34    0.68    0.36    0.07    0.00    0.00    0.01    #2007
1       364.99  44.55   10.17   3.27    1.43    0.14    0.00    0.00    0.03    #2008
1       29.93   68.10   30.54   6.47    1.34    0.02    0.01    0.00    0.00    #2009
1       26.91   36.04   24.03   10.89   2.95    0.71    0.01    0.00    0.00    #2010
1       12.56   56.97   100.08  55.40   11.87   2.95    0.01    0.00    0.00    #2011
UK-WCGFS:UK (E+W) PHHT Groundfish Survey in VIIf&g - Effort mins towed, no.s at-age,
Year, Vessel (final survey in 2004)

1987    2004
1       1       0.15    0.25
1       7
```

360	129	580	57	8	6	4	1	#1987	Cirolana
540	129	125	31	3	3	0	0	#1988	Cirolana
540	137	393	267	21	4	2	0	#1989	Cirolana
540	11	31	137	55	9	1	0	#1990	Cirolana
482	99	6	3	11	9	1	0	#1991	Cirolana
840	1097	441	94	28	22	6	1	#1992	Cirolana
840	4101	772	229	29	4	8	3	#1993	Cirolana
535	4809	713	490	70	17	1	3	#1994	Cirolana
1320	777.4	7282.9	1891.2	595	82.2	18.6	11.3	#1995	Cirolana
1475	773	2225	2050	391	148	11	2	#1996	Corystes
1519	1113	852	280	646	226	60	5	#1997	Cirolana
900	1071.5	691.5	477	343.3	104.8	13.3	12.5	#1998	Cirolana
900	760.2	453.9	139.4	52.1	47.8	90.2	30.5	#1999	Cirolana
1038	15471.8	962.8	296.4	118.9	47.2	51	50.6	#2000	Cirolana
880	2195.3	1186.5	206.8	35.4	2	7.6	1	#2001	Cirolana
762	2551.5	1368.9	2313.6	155.9	75.7	1.2	4.4	#2002	Cirolana
863	2765.7	2169.9	2138.8	1665.8	157.9	0	0	#2003	Cirolana
860	1716.8	1548.2	852.1	203.6	184.3	2	0	#2004	Cefas Endeavour

UK BT SURVEY : (Sept) - Prime stations only (VIIf) Effort (km towed), numbers-at-age per Km towed

1988 2011

1 1 0.75 0.85

0 1

74.12	6	66	#1988	Tows 15 minute duration - raised here to 30 minutes
91.91	80	104	#1989	Tows 15 minute duration - raised here to 30 minutes
69.86	363	37	#1990	
123.41	540	175	#1991	
125.08	839	164	#1992	
127.67	1279	213	#1993	
120.82	330	182	#1994	
104.14	240	154	#1995	
122.11	557	188	#1996	
115.63	1238	56	#1997	
104.7	553	49	#1998	
117.11	1770	116	#1999	
105.99	128	333	#2000	
118.22	204	56	#2001	
113.03	602	36	#2002	
111.92	442	6	#2003	
101.92	1053	6	#2004	
119.11	760	5	#2005	
120.56	520	31	#2006	
118.59	910	81	#2007	
119.33	2994	81	#2008	
123.22	826	72	#2009	
116.92	232	35	#2010	
118.22	256	18	#2011	

IR-GFS-7G Swept-area : Swept-area Method - Effort in kmsq

1999 2010

1 1 0.75 0.92

0 8

10.0	**24175**	**7307**	**1881**	**633**	**292**	**110**	**85**	40	0	#1999
10.0	**6077**	**15835**	**3116**	**190**	**35**	**27**	**8**	0	0	#2000
10.0	**4650**	**2836**	**13871**	**1849**	**222**	**18**	**22**	6	0	#2001
10.0	**2468**	**3664**	**1719**	**1252**	**127**	**3**	**9**	0	0	#2002
10.0	**6061**	**2219**	**1027**	**413**	**0**	**10**	**0**	0	0	#2003 *age 4 replaced with zero,was 22
10.0	**9778**	**3444**	**655**	**321**	**147**	**123**	**1**	0	0	#2004
10.0	**1146**	**3177**	**1573**	**422**	**169**	**104**	**163**	0	0	#2005 *revised 2009
10.0	**15260**	**5883**	**2175**	**707**	**68**	**0**	**28**	0	0	#2006 *revised 2009

10.0	**9951**	**8081**	**2718**	**455**	**83**	**23**	**4**	0	3	#2007*revised 2009
10.0	**16344**	**5554**	**2238**	**475**	**65**	**2**	**0**	0	0	#2008
10.0	**11053**	**10819**	**2154**	**589**	**110**	**25**	**0**	3	0	#2009
10.0	**2817**	**30977**	**784**	**172**	**11**	**2**	**0**	0	0	#2010 *revised 2012
10.0	2357	8164	7044	2090	412	28	20	0	0	#2011

IR-7G&J-OT : Irish Otter Trawl Fleet (Areas VIIg&j) - Effort in hours, no.s @ age, Year, Live weight (t), LPUE (kg/h)

1995	2011									
1	1	0	1							
1	4									
157085	679	2281	1889	1333	#				#1995	
130257	164	1549	1889	905	#				#1996	
148276	170	756	1488	1247	#				#1997	
161909	180	933	980	736	#				#1998	
92195	388	960	962	449	#				#1999	
125229	619	1042	808	500	228	103	65	2000	1506.6t	12.03
137086	91	2224	1538	1046	412	125	48	2001	2227.9t	16.25
168134	291	1140	2615	613	86	13	6	2002	1761.4t	10.48
198059	147	878	1640	1195	155	8	0	2003	1544.6t	7.80
188948	132	628	1763	1002	428	42	2	2004	2243.9t	11.88
198315	385	2630	3154	1377	1341	751	33	2005	3730.4t	18.81
185083	201	2243	2511	1282	473	332	171	2006	3008.2t	16.25
217009	252	1797	3564	2503	655	153	92	2007	3597.2t	16.58
192317	194	1225	1182	726	180	54	7	2008	1269.3t	6.60
209568	218	1155	1755	699	287	77	17	2009	1576.6t	7.52
225900	140	1374	2356	1472	414	97	12	2010	2631.5t	11.65
182782	0	470	1928	1585	510	136	20	2011	2507.2t	

13.72IR-ISCSGFS : Irish Sea Celtic Sea GFS (VIIg) - Whiting #/30 min towed (Prime stations only)

1997	2002						
1	1	0.8	0.9				
0	5						
1	21	38	70	223	113	23	#1997
1	1605	1430	300	79	135	16	#1998
1	6389	507	120	38	17	6.3	#1999
1	6062	687	104	4.2	0.2	0.1	#2000
1	1661	1549	838	8.8	0.4	0.5	#2001
1	312	298	102	77	9.1	0.2	#2002

IR-WCGFS : Irish Autumn WCGFS (VIIj) - Effort min. towed, #@ age, Yr

1993	2002		
1	1	0.75	0.79

0	6							
323	372	912	1529	1722	352	0	0	#1993
673	11235	123	304	344	25	0	0	#1994
651	15564	1736	229	285	29	0	0	#1995
671	406	618	189	42	59	0	0	#1996
1232	478	171	345	59	22	21	12	#1997
1310	2384	758	159	34	65	7	2	#1998
1281	23133	3013	175	45	12	2	2	#1999
1190	203	2445	664	44	6	0	0	#2000
595	218	1253	1709	169	12	2	0	#2001
606	3239	4489	1538	438	61	5	1	#2002

IR-GFS-7G : Irish Groundfish Survey in VIIg (IBTS 4th Qtr) - Whiting no. @ age (Interim indices: New Celtic Explorer series)

2003	2011							
1	1	0.79	0.92					
0	6							
832	6598	2571	1189	466	23	11	0	#2003
980	12662	4470	853	417	191	159	2	#2004
845	4078	4776	1745	483	178	107	182	#2005
1046	22967	8854	3273	1064	102	0	43	#2006
1168	16479	13382	4501	754	138	38	13	#2007
1139	23296	7916	3190	677	93	3	0	#2008
1018	14872	14558	2898	793	148	34	0	#2009
1381	3390	17059	9541	1636	247	29	15	#2010
1392	4189	14509	12519	3714	732	50	36	#2011

IR-GFS-7J : Irish Groundfish Survey in VIIj (IBTS 4th Qtr) - Whiting no. @ age (Interim indices: New Celtic Explorer series)

2003	2011							
1	1	0.79	0.92					
0	6							
780	227	2121	883	146	67	3	0	#2003
720	3864	1230	1675	155	27	6	4	#2004
881	455	1001	234	121	17	4	9	#2005
901	727	1141	403	31	15	3	3	#2006
874	5221	582	144	35	8	4	0	#2007
873	2468	1631	625	239	42	3	7	#2008
747	4501	3513	908	193	47	10	0	#2009
1021	2275	7315	1173	538	50	23	0	#2010
1052	18217	765	1341	155	21	9	2	#2011

IR-GFS-7G&J : Irish Groundfish Survey in VIIg&j (IBTS 4th Qtr) - Whiting no. @ age (Interim indices: New Celtic Explorer series)

2003	2011		
1	1	0.79	0.92

0	6							
1612	6836	4714	2064	582	96	12	0	#2003
1700	16710	5405	2733	570	170	115	10	#2004
1726	4761	6085	1655	573	142	75	101	#2005
1947	24194	10418	3250	637	100	3	25	#2006
2042	22609	14869	3182	508	82	39	10	#2007
2012	26990	9362	2957	734	135	6	8	#2008
1765	20379	17026	3845	989	196	41	0	#2009
2402	6783	25405	10268	2134	303	52	19	#2010
2444	22971	14390	14842	3328	641	52	35	#2011

Table 7.15.9. Whiting in Divisions VIIe–k. Landings (t), lpue of French and Irish fleets, and Effort ('000 h) of French, Irish and UK fleets.

	FR-Gadoid			FR-*Nephrops*			IR-OTB-7G			IR-OTB-7J				
	VII fg French			VII fg French			Irish otter trawlers			Irish otter trawlers			UK (E&W) in VIIe-k	
	gadoid trawlers			*Nephrops* trawlers			VIIg			VIIj			Beam	Otter
Year	Landings	Effort[4]	Lpue[3]	Landings	Effort[4]	Lpue[3]	Landings	Effort[4]	Lpue[3]	Landings	Effort[4]	Lpue[3]	Effort[4]	Effort[4]
1983	5,742	109	53	470	207	2							135	82
1984	4,598	84	55	340	173	2							131	87
1985	4,514	89	51	651	185	4							152	90
1986	5,049	116	44	374	146	3							136	85
1987	6,859	137	50	588	177	3							177	84
1988	7,921	200	40	844	156	5							195	89
1989	8,974	231	39	891	159	6							198	84
1990	7,897	188	42	671	196	3							208	99
1991	7,525	167	45	527	187	3							203	77
1992	6,460	173	37	1,153	234	5							196	86
1993	7,815	201	39	1,356	223	6							208	62
1994	9,236	171	54	1,565	223	7							220	54
1995	9,186	171	54	1,446	202	7	829	64	13	1,305	94	14	243	52
1996	6,028	152	40	1,230	179	7	906	60	15	803	70	11	261	61
1997	7,218	195	37	1,393	149	9	1,066	65	16	783	83	9	265	67
1998	9,102	172	53	881	125	7	813	72	11	545	90	6	255	62
1999	9,102	191	48	1,190	130	9	946	52	18	247	41	6	251	98
2000	6,053	157	38	869	161	5	990	61	16	517	65	8	259	104

2001	4,624	174	27	548	137	4	1,286	69	19	942	68	14	273	85
2002	4,841	165	29	550	142	4	1,004	78	13	758	90	8	249	83
2003	2,975	125	24	543	161	3	1,051	87	12	494	111	4	282	72
2004	2,589	107	24	435	127	3	1,932	97	20	312	92	3	274	76
2005	3,787	93	41	378	114	3	3,445	124	28	285	74	4	270	76
2006	2,795	75	37	175	107	2	2,757	119	23	251	66	4	252	83
2007	1,898	80	24	96	75	1	3,324	137	24	273	80	3	240	88
2008	1,133	62	18	54	70	1	1,037	126	8	233	67	4	217	71
2009	Not available			Not available			1,283	137	9	294	73	4	191	74
2010	Not available			Not available			2,208	141	16	424	85	5	196	78
2011*	628			26			24	1	0	1	2,214	120	18	293

	IR-SSC-7J			IR-SSC-7G			IR-TBB-7J			IR-TBB-7G		
	Irish Scottish Seiners			Irish Scottish Seiners			Irish Beam Trawls			Irish Beam Trawls		
Year	Landings	Effort[4]	Lpue[3]	Landings	Effort[4]	Lpue[3]	Landings	Effort[4]	Lpue[3]	Landings	Effort[4]	Lpue[3]
1995	1,008	5	192	1,123	6	175	0	0	1	63	21	3
1996	1,100	8	135	1,534	10	158	5	1	3	33	27	1
1997	806	11	75	2,654	16	165	3	2	2	44	28	2
1998	467	7	71	2,502	15	167	5	5	1	46	35	1
1999	77	1	55	1,378	8	172	8	7	1	47	41	1
2000	187	3	54	1,187	10	120	8	7	1	64	37	2
2001	236	4	53	1,005	16	62	6	3	2	79	40	2
2002	409	9	46	1,971	21	94	6	3	2	60	32	2
2003	371	9	41	1,560	21	75	13	9	1	55	49	1
2004	314	9	34	1,038	19	54	1	2	1	33	55	1
2005	253	6	41	1,004	15	68	1	2	1	24	50	0

2006	192	5	36	912	15	62	1	2	0	19	60	0
2007	205	4	58	825	16	52	0	2	0	25	56	0
2008	225	3	79	741	12	64	0	1	0	4	37	0
2009	347	3	104	734	8	90	0	3	0	2	38	0
2010	533	4	122	1,035	10	107	0	1	0	4	40	0
2011*	368	5	80	1,212	11	110	0	1	0.5	14	35	0.4

[1] = Lpue calculated as landings in kg/h fishing, power corrected.

[2] = Effort in hours fishing, power corrected.

[3] = Lpue calculated as landings in kg/h fishing.

[4] = Effort in 000 hours fishing.

*** Provisional.**

Table 7.15.10. Whiting in Divisions VIIe–k. XSA Diagnostics.

Lowestoft VPA Version 3.1						
10/05/2012 18:21						
Extended Survivors Analysis						
"Whiting in the Celtic Sea (VIIe-k)	WGCSE 2011	COMBSEX (Updated by DS 09/05/20				
CPUE data from file whg7ektutrimed.txt						
Catch data for 30 years. 1982 to 2011. Ages 0 to 7.						
Fleet	First	Last	First	Last	Alpha	Beta
	year	year	age	age		
"FR-GADOID-late: Fre	1993	2011	3	6	0	1
"FR-NEPHROPS-Late: F	1993	2011	3	6	0	1

"FR-EVHOE: Thalassa	1997	2011	0	4	0.75	1
"UK-WCGFS: UK (E+W)	1987	2011	1	6	0.15	0.25
IR-GFS-7G-SweptArea:	1999	2011	0	6	0.75	0.92
Time series weights :						
Tapered time weighting not applied						
Catchability analysis :						
Catchability independent of stock 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 = 1.000
Minimum standard error for population
estimates derived from each fleet = .500
Prior weighting not applied
Tuning converged after 30 iterations
1

Regression weights										
	1	1	1	1	1	1	1	1	1	1
Fishing mortalities										
Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	0	0	0	0	0	0	0	0	0	0
1	0.038	0.016	0.039	0.026	0.049	0.033	0.024	0.004	0.007	0.024
2	0.168	0.173	0.199	0.284	0.307	0.291	0.167	0.103	0.045	0.081
3	0.441	0.371	0.481	0.754	0.686	0.885	0.576	0.415	0.306	0.106
4	0.977	0.506	0.595	1.005	0.967	1.546	0.914	0.585	0.632	0.301
5	1.05	0.895	0.54	1.104	1.373	1.789	1.003	0.569	0.59	0.477
6	0.655	0.828	0.741	0.705	0.971	1.827	1.159	0.688	0.346	0.396
1										
XSA population numbers (Thousands)										

AGE							
YEAR	0	1	2	3	4	5	6
2002	3.84E+04	3.18E+04	4.26E+04	6.09E+04	1.02E+04	1.81E+03	6.30E+02
2003	4.27E+04	3.15E+04	2.50E+04	2.95E+04	3.21E+04	3.13E+03	5.18E+02
2004	4.06E+04	3.50E+04	2.53E+04	1.73E+04	1.67E+04	1.58E+04	1.05E+03
2005	3.84E+04	3.32E+04	2.76E+04	1.70E+04	8.73E+03	7.52E+03	7.55E+03
2006	4.12E+04	3.15E+04	2.65E+04	1.70E+04	6.55E+03	2.62E+03	2.04E+03
2007	7.22E+04	3.37E+04	2.45E+04	1.60E+04	7.00E+03	2.04E+03	5.43E+02
2008	1.23E+05	5.91E+04	2.67E+04	1.50E+04	5.39E+03	1.22E+03	2.79E+02
2009	9.65E+04	1.00E+05	4.72E+04	1.85E+04	6.91E+03	1.77E+03	3.67E+02
2010	5.26E+04	7.90E+04	8.19E+04	3.49E+04	1.00E+04	3.15E+03	8.21E+02
2011	1.77E+04	4.31E+04	6.42E+04	6.41E+04	2.10E+04	4.35E+03	1.43E+03
Estimated population abundance at 1st Jan 2012							
	0.00E+00	1.45E+04	3.44E+04	4.85E+04	4.72E+04	1.27E+04	2.21E+03
Taper weighted geometric mean of the VPA populations:							
	6.71E+04	5.62E+04	4.38E+04	2.45E+04	9.08E+03	2.55E+03	6.12E+02

Standard error of the weighted Log(VPA populations) :									
	0.5514	0.5064	0.5172	0.6448	0.8604	1.1031	1.4055		
1									
Log catchability residuals.									
Fleet : "FR-GADOID-late: Fre									
Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	No data for this fleet at this age									
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	99.99	0.25	0.1	-0.34	-1.01	-1.09	0.17	0.32	0.53	0.2
4	99.99	-0.31	0.13	-0.2	-0.47	-0.66	-0.6	0.28	0.22	0.07
5	99.99	-0.32	-0.03	0.1	-0.43	-0.63	-0.44	0.32	0.1	-0.1
6	99.99	-0.07	0.01	0.18	-0.4	-0.63	0.68	0.1	0.15	-0.27
Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011

0	No data for this fleet at this age								
1	No data for this fleet at this age								
2	No data for this fleet at this age								
3	-0.19	-0.65	-0.46	0.53	0.89	0.65	0.09	99.99	99.99	99.99
4	0.04	-0.36	-0.24	0.4	0.65	0.62	0.45	99.99	99.99	99.99
5	-0.07	-0.23	-0.3	0.52	0.87	0.13	0.51	99.99	99.99	99.99
6	-0.26	-0.4	0	0.25	0.59	-0.23	0.43	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	3	4	5	6
Mean Log q	-6.6563	-6.1665	-5.9952	-5.9952
S.E(Log q)	0.5777	0.4213	0.4062	0.3678

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	2.63	-3.1	0.68	0.21	16	1.21	-6.66
4	1.79	-4.793	3.51	0.72	16	0.48	-6.17
5	1.16	-1.441	5.6	0.85	16	0.46	-6
6	0.95	0.675	6.05	0.93	16	0.36	-5.99
1							

Fleet : "FR-
NEPHROPS-Late: F

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	No data for this fleet at this age									
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	99.99	0.72	0.33	0.2	-0.54	-0.41	-0.06	0.81	0.58	0.4

4	99.99	0.23	0.04	0.02	-0.1	0.07	-0.16	0.68	0.51	0.48
5	99.99	0.23	-0.47	-0.12	-0.01	0.31	0.09	0.53	0.27	0.25
6	99.99	-0.22	-0.64	-0.34	0.06	0.29	-0.01	0.57	0.19	-0.02
Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	No data for this fleet at this age									
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	-0.37	-0.53	-0.39	0.31	-0.11	-0.08	-0.87	99.99	99.99	99.99
4	0.06	-0.29	-0.26	-0.03	-0.41	-0.23	-0.61	99.99	99.99	99.99
5	0.46	0.07	-0.15	0.07	-0.22	-0.6	-0.74	99.99	99.99	99.99
6	0.35	0.04	0.2	-0.09	-0.6	-0.92	-0.82	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	3	4	5	6						

Mean Log q	-8.9566	-8.377	-8.1736	-8.1736			
S.E(Log q)	0.4971	0.3457	0.3658	0.4527			
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	1.04	-0.169	8.9	0.57	16	0.53	-8.96
4	1	-0.01	8.38	0.83	16	0.36	-8.38
5	0.89	1.396	8.2	0.92	16	0.32	-8.17
6	0.82	2.864	8.11	0.95	16	0.29	-8.3
1							

Fleet : "FR-EVHOE: Thalassa

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	99.99	99.99	99.99	99.99	99.99	-0.42	-0.12	0.85	-0.54	-0.34
1	99.99	99.99	99.99	99.99	99.99	-0.43	-0.84	0.47	-0.08	-0.13
2	99.99	99.99	99.99	99.99	99.99	-0.68	-0.67	0.32	0.44	0.3
3	99.99	99.99	99.99	99.99	99.99	-0.42	-1.59	0.18	-0.18	0.62
4	99.99	99.99	99.99	99.99	99.99	-0.14	-1.28	0.04	-0.13	-0.04
5	No data for this fleet at this age									
6	No data for this fleet at this age									

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	0.2	0.28	-0.17	0.33	-0.84	1.1	1.28	-0.98	-0.48	-0.15
1	-0.44	0.89	1.42	-0.46	-0.9	0.6	-0.01	-0.13	-0.52	0.56
2	-0.47	0.97	1.12	-0.68	-1.03	-0.74	-0.08	0.39	-0.45	1.25
3	-0.33	1.07	1.37	-0.4	-0.93	-1.25	0.11	0.45	0.24	1.08
4	-0.51	0.82	0.8	0	-1.08	-0.47	0.62	0.02	0.49	0.85
5	No data for this fleet at this age									
6	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	0	1	2	3	4
Mean Log q	-6.9262	-6.9885	-7.4725	-7.8669	-7.8879
S.E(Log q)	0.6736	0.6605	0.7421	0.8594	0.6539

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
0	0.68	1.393	8.19	0.6	15	0.44	-6.93
1	1.41	-0.681	5.42	0.17	15	0.95	-6.99
2	0.8	0.522	8.09	0.34	15	0.61	-7.47

3	0.81	0.495	8.31	0.34	15	0.71	-7.87			
4	0.93	0.292	8	0.57	15	0.63	-7.89			
1										
Fleet : "UK-WCGFS: UK (E+W)										
Age	1987	1988	1989	1990	1991					
0	No data for this fleet at this age									
1	-1.22	-1.4	-0.18	-3.2	-1.56					
2	1.34	-1.28	0.05	-1.28	-3.28					
3	0.56	-0.86	0.4	-0.21	-2.38					
4	0.06	-1.11	0.2	0.08	-1.37					
5	1.14	0.16	0.63	0.73	-0.44					
6	1.75	99.99	1.12	0.62	0.25					
Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	No data for this fleet at this age									
1	-0.14	1.29	1.62	-0.52	-0.1	0.31	0.83	0.35	2.49	1.44
2	-0.21	-0.16	0.29	1.41	0.7	0.26	0.65	0.31	0.81	0.39

3	-0.12	0.04	0.55	0.98	0.57	-0.86	0.79	-0.24	0.57	0.2
4	0.64	-0.09	0.44	0.73	0.07	-0.02	0.51	-0.5	0.56	-0.21
5	0.4	-0.31	0.67	0.53	-0.07	0.08	-0.75	-0.76	0.29	-2.3
6	0.12	0.6	0.13	0.88	-0.58	-0.1	-1.34	0.04	0.41	-0.2
Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	No data for this fleet at this age									
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
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
Mean log catchability and standard error of ages with catchability										
independent of year class strength and constant w.r.t. time										

Age	1	2	3	4	5	6
Mean Log q	-11.353	-11.3964	-11.5838	-11.683	-11.4969	-11.4969
S.E(Log q)	1.4614	1.1904	0.8602	0.6083	0.8426	0.7999

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	0.6	0.86	11.29	0.26	15	0.88	-11.35
2	0.55	1.312	11.2	0.4	15	0.64	-11.4
3	0.59	2.204	11.07	0.69	15	0.45	-11.58
4	0.91	0.548	11.48	0.75	15	0.57	-11.68
5	1.38	-1.662	12.81	0.6	15	1.09	-11.5
6	1.44	-2.759	13.2	0.76	14	0.88	-11.23
1							

Fleet : IR-GFS-7G-SweptArea:

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.45	-0.18	0.05
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.18	0.19	-0.8
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.12	0.24	0.85
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.12	-0.87	1.17
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.53	-1.26	1.06
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.39	0.1	0.36
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.18	-1.16	1.07

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	-0.57	0.22	0.75	-1.34	1.18	0.19	0.16	0	-1.05	0.15
1	-0.02	-0.53	-0.18	-0.22	0.47	0.71	-0.24	-0.12	0.1	0.46
2	-0.52	-0.5	-0.93	-0.07	0.31	0.6	0.21	-0.45	-0.03	0.41
3	-0.33	-0.78	-0.4	0.12	0.58	0.36	0.21	0.08	-0.1	-0.15
4	0	99.99	-0.66	0.46	-0.19	0.42	-0.09	-0.08	-0.08	-0.11
5	-1.18	-0.65	-0.06	0.99	99.99	1.35	-1.23	0.56	-0.33	-0.3
6	0.64	99.99	-1.99	1.1	0.87	0.96	99.99	99.99	0.12	0.41

Mean log catchability and standard error of ages with catchability

independent of year class strength and constant w.r.t. time

Age	0	1	2	3	4	5	6
Mean Log q	-4.3065	-4.2417	-4.69	-5.3186	-5.7049	-6.4828	-6.4828
S.E(Log q)	0.6798	0.4179	0.5042	0.5452	0.5945	0.7945	1.0518

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
0	0.89	0.347	5.04	0.46	13	0.63	-4.31

1	1.04	-0.146	3.96	0.52	13	0.45	-4.24
2	0.73	1.166	6.26	0.63	13	0.36	-4.69
3	1.45	-0.952	3.17	0.29	13	0.79	-5.32
4	1.37	-0.601	4.41	0.2	12	0.84	-5.7
5	0.77	1.025	6.89	0.66	12	0.61	-6.48
6	1.02	-0.053	6.24	0.5	10	1.11	-6.26
1							
Terminal year survivor and F summaries :							
Age 0 Catchability constant w.r.t. time and dependent on age							
Year class = 2011							
Fleet	Estimated	Int	Ext	Var	N	Scaled	Estimated
	Survivors	s.e	s.e	Ratio		Weights	F
"FR-GADOID-late: Fre	1	0	0	0	0	0	0
"FR-NEPHROPS-Late: F	1	0	0	0	0	0	0

"FR-EVHOE: Thalassa	12477	0.696	0	0	1	0.507	0
"UK-WCGFS: UK (E+W)	1	0	0	0	0	0	0
IR-GFS-7G-SweptArea:	16915	0.705	0	0	1	0.493	0
F shrinkage mean	0	1				0	0
Weighted prediction :							
Survivors	Int	Ext	N	Var	F		
at end of year	s.e	s.e		Ratio			
14497	0.5	0.15	2	0.307	0		
Age 1 Catchability constant w.r.t. time and dependent on age							
Year class = 2010							
Fleet	Estimated	Int	Ext	Var	N	Scaled	Estimated
	Survivors	s.e	s.e	Ratio		Weights	F

"FR-GADOID-late: Fre	1	0	0	0	0	0	0
"FR-NEPHROPS-Late: F	1	0	0	0	0	0	0
"FR-EVHOE: Thalassa	36175	0.487	0.517	1.06	2	0.375	0.023
"UK-WCGFS: UK (E+W)	1	0	0	0	0	0	0
IR-GFS-7G-SweptArea:	32998	0.408	0.713	1.75	2	0.534	0.025
F shrinkage mean	35792	1				0.091	0.024
Weighted prediction :							
Survivors	Int	Ext	N	Var	F		
at end of year	s.e	s.e		Ratio			
34408	0.3	0.31	5	1.024	0.024		
1							
Age 2 Catchability constant w.r.t. time and dependent on age							

Year class = 2009							
Fleet	Estimated	Int	Ext	Var	N	Scaled	Estimated
	Survivors	s.e	s.e	Ratio		Weights	F
"FR-GADOID-late: Fre	1	0	0	0	0	0	0
"FR-NEPHROPS-Late: F	1	0	0	0	0	0	0
"FR-EVHOE: Thalassa	41007	0.411	0.655	1.59	3	0.355	0.095
"UK-WCGFS: UK (E+W)	1	0	0	0	0	0	0
IR-GFS-7G-SweptArea:	59188	0.322	0.12	0.37	3	0.58	0.067
F shrinkage mean	20379	1				0.065	0.183
Weighted prediction :							
Survivors	Int	Ext	N	Var	F		
at end of year	s.e	s.e		Ratio			
48462	0.25	0.26	7	1.061	0.081		

Age 3 Catchability constant w.r.t. time and dependent on age							
Year class = 2008							
Fleet	Estimated	Int	Ext	Var	N	Scaled	Estimated
	Survivors	s.e	s.e	Ratio		Weights	F
"FR-GADOID-late: Fre	1	0	0	0	0	0	0
"FR-NEPHROPS-Late: F	1	0	0	0	0	0	0
"FR-EVHOE: Thalassa	71860	0.373	0.432	1.16	4	0.339	0.071
"UK-WCGFS: UK (E+W)	1	0	0	0	0	0	0
IR-GFS-7G-SweptArea:	44411	0.28	0.059	0.21	4	0.606	0.113
F shrinkage mean	6754	1				0.055	0.579
Weighted prediction :							
Survivors	Int	Ext	N	Var	F		

at end of year	s.e	s.e		Ratio			
47179	0.22	0.24	9	1.118	0.106		
1							
Age 4 Catchability constant w.r.t. time and dependent on age							
Year class = 2007							
Fleet	Estimated	Int	Ext	Var	N	Scaled	Estimated
	Survivors	s.e	s.e	Ratio		Weights	F
"FR-GADOID-late: Fre	1	0	0	0	0	0	0
"FR-NEPHROPS-Late: F	1	0	0	0	0	0	0
"FR-EVHOE: Thalassa	22523	0.333	0.202	0.61	5	0.357	0.181
"UK-WCGFS: UK (E+W)	1	0	0	0	0	0	0
IR-GFS-7G-SweptArea:	10683	0.259	0.093	0.36	5	0.574	0.35
F shrinkage mean	2874	1				0.069	0.939

Weighted prediction
:

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
12735	0.2	0.19	11	0.96	0.301

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2006

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
"FR-GADOID-late: Fre	1	0	0	0	0	0	0
"FR-NEPHROPS-Late: F	1	0	0	0	0	0	0
"FR-EVHOE: Thalassa	2642	0.339	0.261	0.77	5	0.284	0.413
"UK-WCGFS: UK (E+W)	1	0	0	0	0	0	0

IR-GFS-7G-SweptArea:	2665	0.273	0.199	0.73	6	0.578	0.41
F shrinkage mean	698	1				0.138	1.077
Weighted prediction :							
Survivors	Int	Ext	N	Var	F		
at end of year	s.e	s.e		Ratio			
2211	0.23	0.2	12	0.865	0.477		
1							
Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5							
Year class = 2005							
Fleet	Estimated	Int	Ext	Var	N	Scaled	Estimated
	Survivors	s.e	s.e	Ratio		Weights	F
"FR-GADOID-late: Fre	860	0.595	0	0	1	0.058	0.368
"FR-NEPHROPS-Late: F	331	0.512	0	0	1	0.078	0.769

"FR-EVHOE: Thalassa	667	0.356	0.221	0.62	5	0.193	0.454
"UK-WCGFS: UK (E+W)	1	0	0	0	0	0	0
IR-GFS-7G-SweptArea:	846	0.317	0.195	0.62	7	0.495	0.373
F shrinkage mean	1108	1				0.175	0.297
Weighted prediction :							
Survivors	Int	Ext	N	Var	F		
at end of year	s.e	s.e		Ratio			
788	0.25	0.13	15	0.526	0.396		

Table 7.15.11. Whiting in Divisions VIIe–k. Fishing mortality (F)-at-age. F_{bar} range is 2–5.

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE											
0	0	0	0	0	0	0	0	0	0	0	0
1	0.1058	0.1366	0.0798	0.097	0.0739	0.0626	0.0301	0.0249	0.0836	0.1096	0.0419
2	0.6227	0.731	0.8392	0.8031	0.7132	0.6564	0.4359	0.3214	0.6399	0.4958	0.4279
3	1.0481	1.441	0.9652	1.1689	0.9845	1.3471	1.0988	0.9266	0.7542	1.0796	0.9187
4	1.2366	1.5064	1.5569	0.8753	1.2304	1.5203	1.4824	1.3525	1.0945	1.7585	0.9271
5	1.3855	1.9852	1.5187	1.3025	1.1554	1.7757	1.2859	1.2667	1.4198	1.4165	1.0136
6	1.2386	1.6666	1.3642	1.1289	1.1368	0.7725	1.2529	0.6783	0.8426	1.3145	0.9532
+gp	1.2386	1.6666	1.3642	1.1289	1.1368	0.7725	1.2529	0.6783	0.8426	1.3145	0.9532
0 FBAR 2–5	1.0732	1.4159	1.22	1.0375	1.0209	1.3249	1.0757	0.9668	0.9771	1.1876	0.8218
	1.2234	1.6442	1.346933	1.115567	1.123433	1.5477	1.289033	1.181933	1.0895	1.4182	0.953133
	1.139955	1.16124	1.104044	1.075245	1.100434	1.168164	1.19832	1.222521	1.115034	1.194173	1.159812

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0.0215	0.0089	0.0068	0.0291	0.0141	0.0285	0.089	0.0364	0.0071	0.0378
2	0.2671	0.1778	0.1385	0.1228	0.1271	0.2114	0.3643	0.2953	0.1596	0.1681
3	0.8451	0.5552	0.4591	0.241	0.2886	0.5223	0.7669	0.7818	0.6864	0.4412
4	0.8341	0.8153	0.7034	0.542	0.5059	0.5875	1.0324	0.9646	1.2723	0.9771
5	1.1741	0.8512	0.8202	0.6608	0.6946	0.6972	1.1039	0.9613	1.3763	1.0503
6	1.0283	1.2063	0.6908	0.7691	0.8698	0.6526	0.9228	0.8254	0.981	0.6552
+gp	1.0283	1.2063	0.6908	0.7691	0.8698	0.6526	0.9228	0.8254	0.981	0.6552
0 FBAR 2–5	0.7801	0.5999	0.5303	0.3917	0.4041	0.5046	0.8169	0.7507	0.8736	0.6592
1	0.9511	0.740567	0.6609	0.481267	0.496367	0.602333	0.967733	0.902567	1.111667	0.822867
	1.219203	1.234484	1.246276	1.228661	1.228326	1.193685	1.184641	1.2023	1.272512	1.248281

YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	FBAR
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0.0164	0.0389	0.0259	0.0492	0.0329	0.024	0.0038	0.0074	0.0244	0.0119
2	0.1729	0.1993	0.2842	0.3072	0.2907	0.1667	0.1033	0.0449	0.0812	0.0765
3	0.3709	0.4812	0.7539	0.6863	0.8848	0.576	0.4153	0.3064	0.1063	0.276
4	0.5063	0.5946	1.0052	0.9675	1.5459	0.9138	0.5847	0.6324	0.3012	0.5061
5	0.8949	0.5402	1.1041	1.3729	1.7892	1.0034	0.5688	0.5905	0.4775	0.5456
6	0.8283	0.741	0.705	0.9711	1.8274	1.1589	0.688	0.3456	0.3959	0.4765
+gp	0.8283	0.741	0.705	0.9711	1.8274	1.1589	0.688	0.3456	0.3959	0.4765
0 FBAR 2–5	0.4862	0.4538	0.7869	0.8335	1.1277	0.665	0.418	0.3935	0.2416	
1	0.5907	0.538667	0.9544	1.0089	1.406633	0.831067	0.522933	0.509767	0.295	
	1.214932	1.187013	1.212861	1.210438	1.247347	1.249724	1.251037	1.295468	1.221026	

Table 7.15.12. Whiting in Divisions VIIe–k. Stock number-at-age ('000).

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	62046	50257	53997	71465	133034	105422	33073	55007	108374
1	28887	50799	41147	44209	58511	108919	86312	27078	45036
2	29860	21277	36282	31106	32849	44494	83767	68572	21625
3	16784	13116	8389	12835	11408	13180	18897	44351	40708
4	7108	4818	2542	2618	3265	3490	2806	5156	14375
5	1297	1690	875	439	895	781	626	522	1092
6	64	266	190	157	98	232	108	142	121
+gp	35	13	41	53	72	123	32	56	40
TOTAL	146082	142237	143463	162882	240131	276642	225620	200883	231370

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	163335	145774	193541	107379	63215	58626	56796	66012	134277	64022
1	88729	133727	119349	158458	87914	51756	47999	46501	54046	109936
2	33914	65100	104995	95630	128584	71489	41157	38747	37002	40482
3	9336	16911	34738	65806	65528	91647	51769	29669	25679	21045
4	15677	2596	5523	12209	30909	33876	58943	31767	14394	9764
5	3939	2210	841	1962	4418	12510	16108	29068	14465	4179
6	216	782	656	212	684	1588	5278	6563	11819	3941
+gp	4	69	290	273	200	230	1342	1995	2131	3594
TOTAL	315150	367169	459933	441929	381452	321722	279392	250322	293812	256963

AGE	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	38799	38393	42647	39621	34864	41910	60665	84026	80709	24142	0
1	52417	31766	31433	34916	32439	28544	34313	49668	68795	66079	19766
2	86773	42611	25042	25317	27493	25864	22134	27199	39517	56016	53622
3	24678	60505	29493	17246	16981	16928	15437	13057	18912	28559	42914
4	7885	10182	31750	16669	8724	6537	6954	4967	5308	10332	15840
5	3047	1809	3150	15562	7535	2612	2029	1184	1422	1841	4617
6	1294	630	518	1063	7332	2051	539	272	336	535	356
+gp	469	143	39	146	308	1020	287	48	72	285	371
TOTAL	215361	186038	164072	150541	135677	125466	142359	180421	215070	187789	137485

Table 7.15.13. Whiting in Divisions VIIe–k. Summary table.

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2-5
	Age 0					
1982	62046	22646	18983	11225	0.5913	1.0732
1983	50255	22820	16986	11781	0.6936	1.4159
1984	53996	23396	17509	9985	0.5703	1.22
1985	71465	23311	17574	10838	0.6167	1.0375
1986	133034	26071	18628	9952	0.5342	1.0209
1987	105426	37563	25009	12652	0.5059	1.3249
1988	33074	45762	33778	15128	0.4479	1.0757
1989	55016	39533	34797	16541	0.4754	0.9668
1990	108400	32755	27470	14106	0.5135	0.9771
1991	163413	33342	24235	13508	0.5574	1.1876
1992	145916	48252	32337	12364	0.3823	0.8218
1993	193753	61960	47082	16320	0.3466	0.7801
1994	107308	82307	62659	20034	0.3197	0.5999
1995	63292	84197	74701	22678	0.3036	0.5303
1996	58627	79353	72810	18260	0.2508	0.3917
1997	56795	67659	63036	20532	0.3257	0.4041
1998	65959	55373	50046	19245	0.3845	0.5046
1999	135002	44175	39435	19915	0.505	0.8169
2000	63991	45478	34625	14865	0.4293	0.7507
2001	38810	48257	40051	12770	0.3188	0.8736
2002	38413	45336	40270	13146	0.3264	0.6592
2003	42749	38007	33569	10583	0.3153	0.4862
2004	40570	34851	30513	9953	0.3262	0.4538
2005	38429	31236	27127	12030	0.4435	0.7869
2006	41180	27030	22789	9533	0.4183	0.8335
2007	72182	26286	21287	8947	0.4203	1.1277
2008	122602	31345	22276	5737	0.2575	0.665
2009	96491	53013	35447	6386	0.1802	0.418
2010	52601	70579	54084	8442	0.1561	0.3935
2011	17706	73218	64640	9077	0.1404	0.2416
Arith.						
Mean	77617	45170	36792	13218	0.4019	0.7946
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 7.15.14. Whiting in Divisions VIIe–k. Management options table.

MFDP version 1a						
Run: WHG_7ek						
WHG7ekMFDP Index file 14/05/2012						
Time and date: 12:43 15/05/2012						
Fbar age range: 2-5						
2012						
Biomass	SSB	FMult	FBar	Landings		
71748	67942	1.0000	0.3511	19127		
2013					2014	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
69053	59047	0.0000	0.0000	0	84009	73076
.	59047	0.1000	0.0351	2091	81674	70746
.	59047	0.2000	0.0702	4087	79447	68525
.	59047	0.3000	0.1053	5994	77324	66406
.	59047	0.4000	0.1404	7816	75299	64386
.	59047	0.5000	0.1755	9557	73367	62459
.	59047	0.6000	0.2106	11221	71524	60621
.	59047	0.7000	0.2457	12811	69766	58868
.	59047	0.8000	0.2808	14331	68089	57195
.	59047	0.9000	0.3159	15785	66488	55598
.	59047	1.0000	0.3511	17175	64959	54074
.	59047	1.1000	0.3862	18504	63501	52620
.	59047	1.2000	0.4213	19775	62108	51232
.	59047	1.3000	0.4564	20992	60778	49906
.	59047	1.4000	0.4915	22156	59508	48640
.	59047	1.5000	0.5266	23270	58295	47431
.	59047	1.6000	0.5617	24337	57136	46276
.	59047	1.7000	0.5968	25358	56029	45173
.	59047	1.8000	0.6319	26336	54971	44119
.	59047	1.9000	0.6670	27273	53959	43111
.	59047	2.0000	0.7021	28171	52993	42148

Input units are thousands and kg - output in tonnes.

Table 7.15.15. Whiting in Divisions VIIe–k. Input values for the catch forecast.

MFDP version 1a								
Run: WHG_7ek								
Time and date: 12:43 15/05/2012								
Fbar age range: 2-5								
2012								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	71030	0.2	0	0	0	0	0	0
1	14497	0.2	0.39	0	0	0.264667	0.0119	0.259667
2	34408	0.2	0.9	0	0	0.291	0.0765	0.325
3	48462	0.2	0.99	0	0	0.416667	0.276	0.434333
4	47179	0.2	0.99	0	0	0.554667	0.5061	0.555
5	12735	0.2	1	0	0	0.69	0.5456	0.671333
6	2211	0.2	1	0	0	0.855333	0.4765	0.793667
7	962	0.2	1	0	0	0.892667	0.4765	0.950333
2013								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	71030	0.2	0	0	0	0	0	0
1	.	0.2	0.39	0	0	0.264667	0.0119	0.259667
2	.	0.2	0.9	0	0	0.291	0.0765	0.325
3	.	0.2	0.99	0	0	0.416667	0.276	0.434333
4	.	0.2	0.99	0	0	0.554667	0.5061	0.555
5	.	0.2	1	0	0	0.69	0.5456	0.671333
6	.	0.2	1	0	0	0.855333	0.4765	0.793667
7	.	0.2	1	0	0	0.892667	0.4765	0.950333
2014								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	71030	0.2	0	0	0	0	0	0
1	.	0.2	0.39	0	0	0.264667	0.0119	0.259667
2	.	0.2	0.9	0	0	0.291	0.0765	0.325
3	.	0.2	0.99	0	0	0.416667	0.276	0.434333
4	.	0.2	0.99	0	0	0.554667	0.5061	0.555
5	.	0.2	1	0	0	0.69	0.5456	0.671333
6	.	0.2	1	0	0	0.855333	0.4765	0.793667
7	.	0.2	1	0	0	0.892667	0.4765	0.950333

Input units are thousands and kg - output in tonnes.

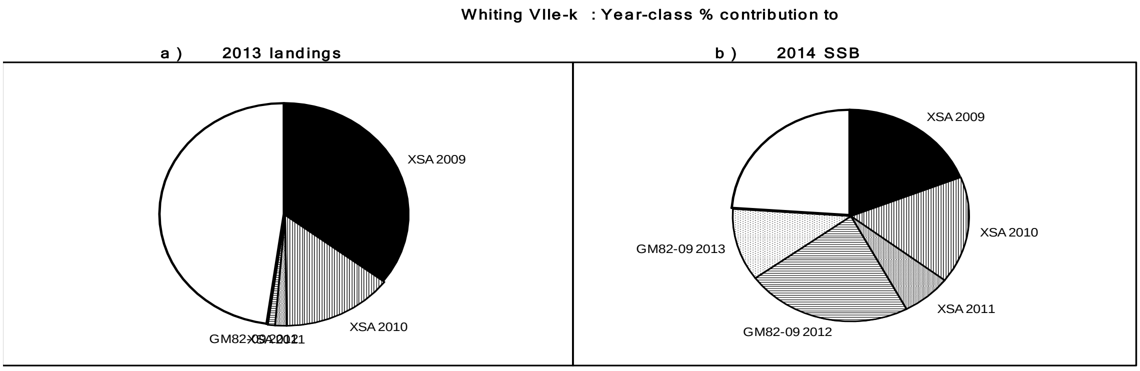
Table 7.15.16. Whiting in Divisions VIIe–k. The detailed output for the *status quo* F forecast by age group.

MFDP version 1a									
Run: WHG_7ek									
Time and date: 12:43 15/05/2012									
Fbar age range: 2-5									
Year:	2012	F multiplier:	1	Fbar:	0.3511				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	71030	0	0	0	0	0
1	0.0119	155	40	14497	3837	5654	1496	5654	1496
2	0.0765	2300	747	34408	10013	30967	9011	30967	9011
3	0.276	10642	4622	48462	20193	47977	19991	47977	19991
4	0.5061	17125	9505	47179	26169	46707	25907	46707	25907
5	0.5456	4898	3288	12735	8787	12735	8787	12735	8787
6	0.4765	766	608	2211	1891	2211	1891	2211	1891
7	0.4765	333	317	962	859	962	859	962	859
Total		36219	19127	231484	71748	147214	67942	147214	67942
Year:	2013	F multiplier:	1	Fbar:	0.3511				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	71030	0	0	0	0	0
1	0.0119	624	162	58154	15392	22680	6003	22680	6003
2	0.0765	784	255	11729	3413	10556	3072	10556	3072
3	0.276	5731	2489	26096	10873	25835	10765	25835	10765
4	0.5061	10929	6065	30108	16700	29807	16533	29807	16533
5	0.5456	8955	6012	23286	16067	23286	16067	23286	16067
6	0.4765	2092	1661	6042	5168	6042	5168	6042	5168
7	0.4765	559	531	1613	1440	1613	1440	1613	1440
Total		29673	17175	228058	69053	119819	59047	119819	59047
Year:	2014	F multiplier	1	Fbar:	0.3511				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	71030	0	0	0	0	0
1	0.0119	624	162	58154	15392	22680	6003	22680	6003
2	0.0765	3145	1022	47050	13691	42345	12322	42345	12322
3	0.276	1953	848	8895	3706	8807	3669	8807	3669
4	0.5061	5885	3266	16213	8993	16050	8903	16050	8903
5	0.5456	5715	3837	14860	10253	14860	10253	14860	10253
6	0.4765	3826	3036	11048	9450	11048	9450	11048	9450
7	0.4765	1348	1281	3892	3474	3892	3474	3892	3474
Total		22495	13452	231142	64959	119682	54074	119682	54074

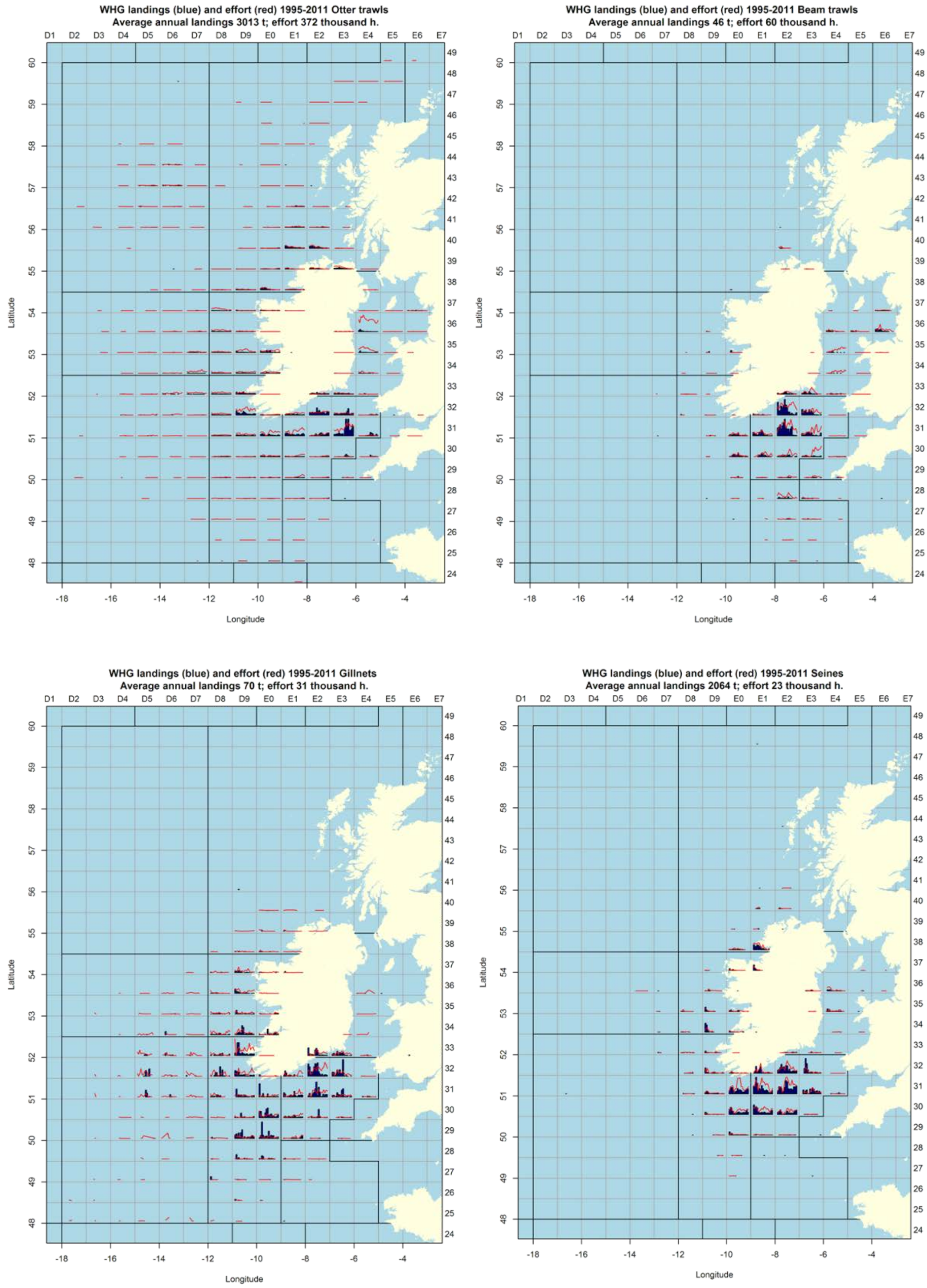
Table 7.15.17. Whiting in Divisions VIIe–k. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

Year-class			2009	2010	2011	2012	2013
Stock No. (thousands) of 0 year-olds			96491	52601	17706	71030	71030
Source			XSA	XSA	XSA	GM82-09	GM82-09
Status Quo F:							
% in	2012	landings	24.2	3.9	0.2	0.0	-
% in	2013		35.3	14.5	1.5	0.9	0.0
% in	2012	SSB	29.4	13.3	2.2	0.0	-
% in	2013	SSB	28.0	18.2	5.2	10.2	0.0
% in	2014	SSB	19.0	16.5	6.8	22.8	11.1

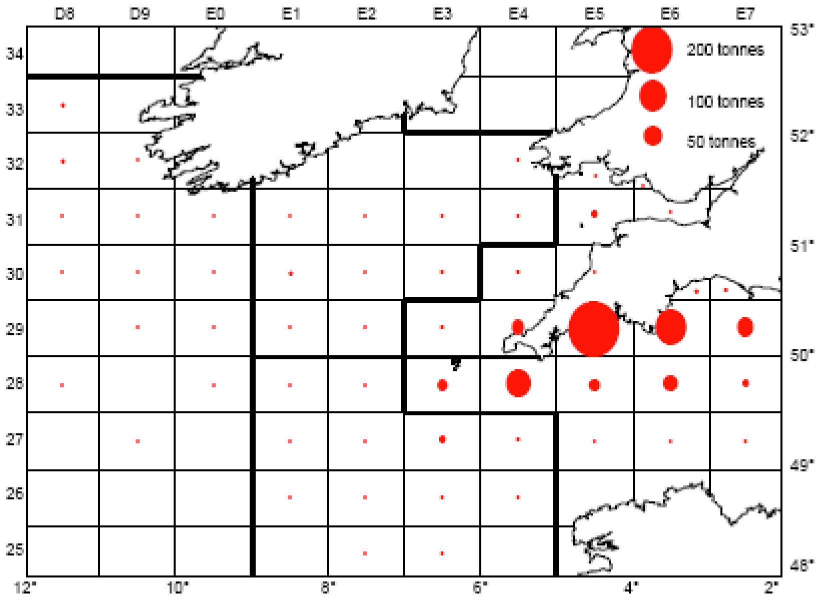
GM : geometric mean recruitment



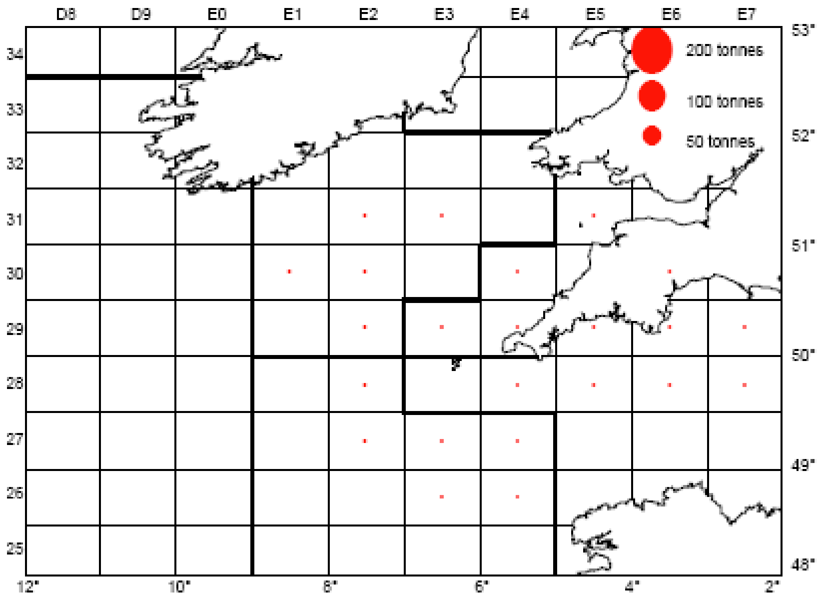
Irish landings for the main gear types by quarter in 2011.



UK (E&W) whiting landings for all gears 2011.



Total UK (E+W) Landings 688.70 tonnes.



Total UK Landings by Samples Vessels 2.82 tonnes.

Figure 7.15.1. Whiting in VIIe–k (Celtic Sea). The spatial and temporal distribution of UK landings data in 2011 available to the WG.

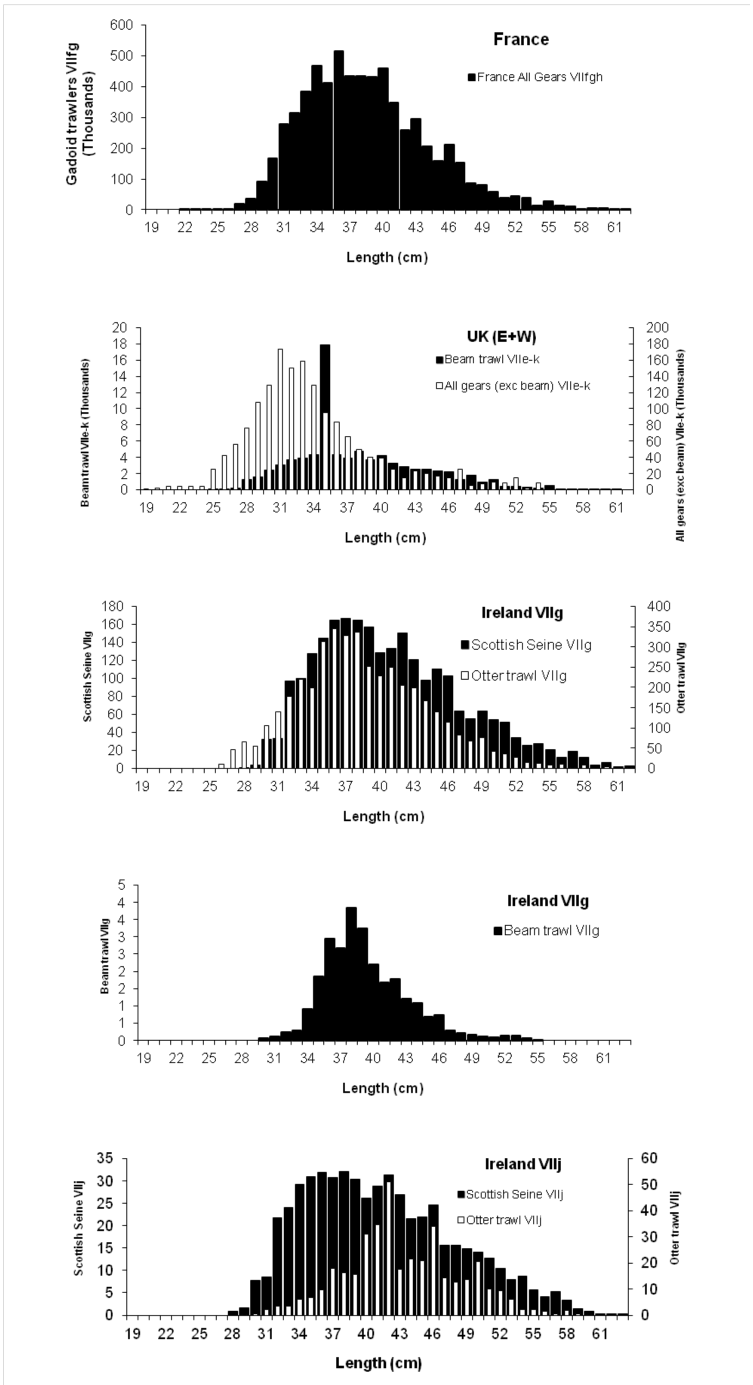
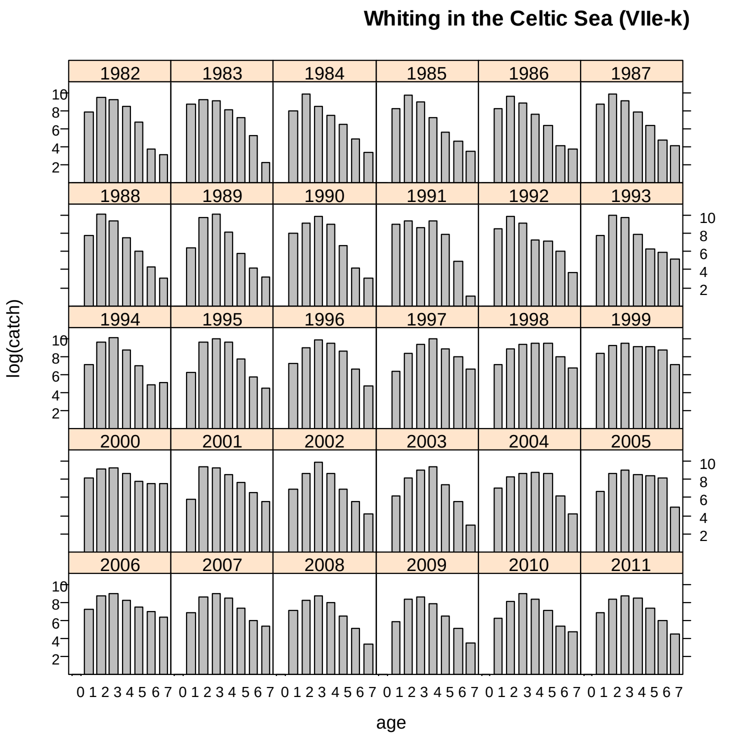
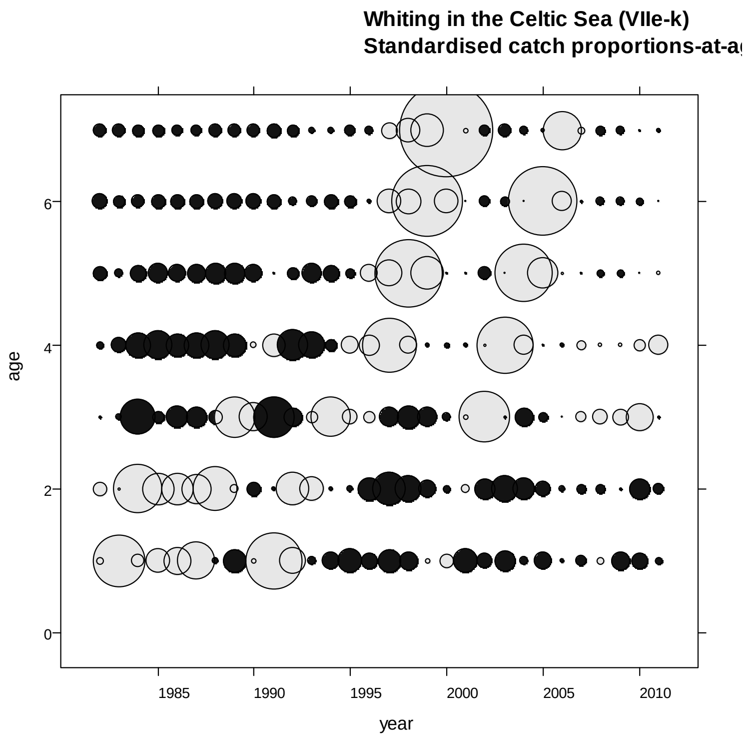


Figure 7.15.2. Whiting in VIIe–k (Celtic Sea). 2011 length compositions (raised numbers) of French, UK and Irish fleets.

(a)



(b)



7.15.3. Whiting in VIIe–k (Celtic Sea). Annual landings age composition (a) and standardized catch proportions-at-age (b).

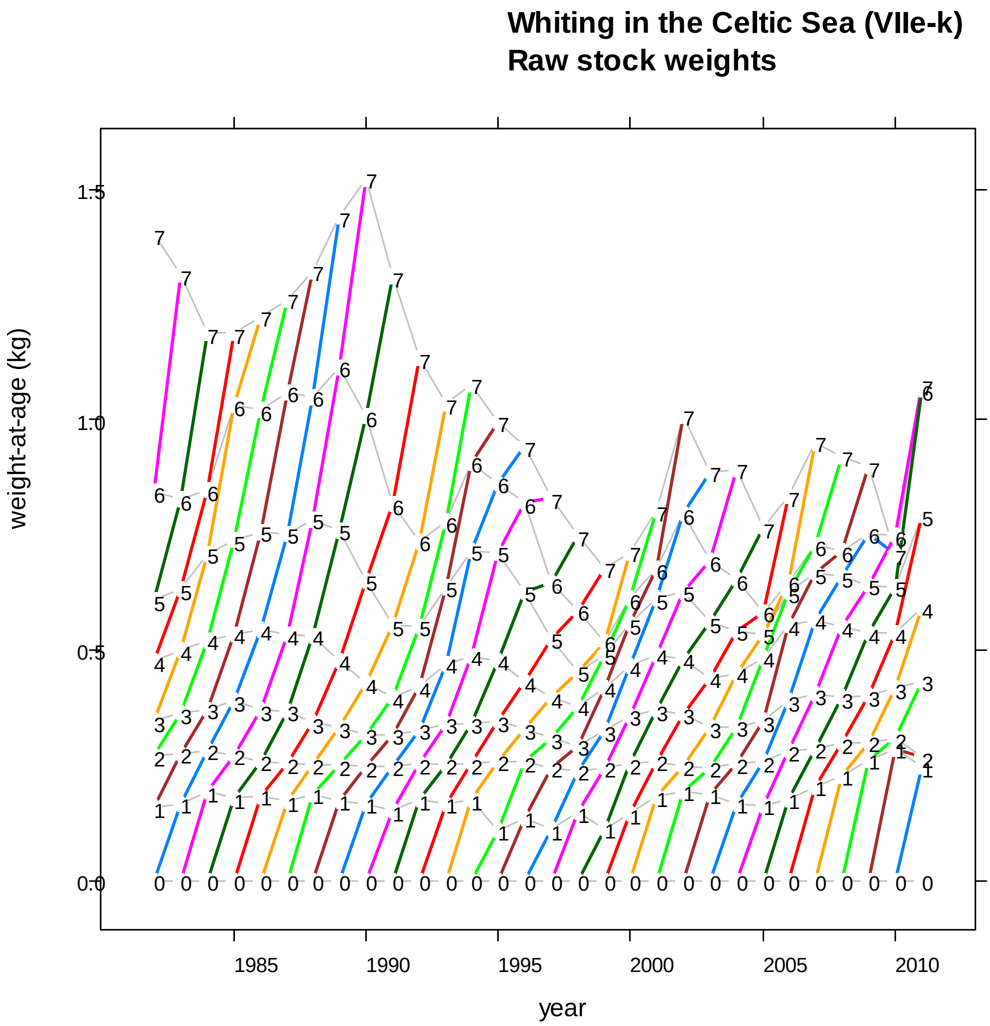


Figure 7.15.4. Whiting in VIIe–k (Celtic Sea). Stock weights-at-age.

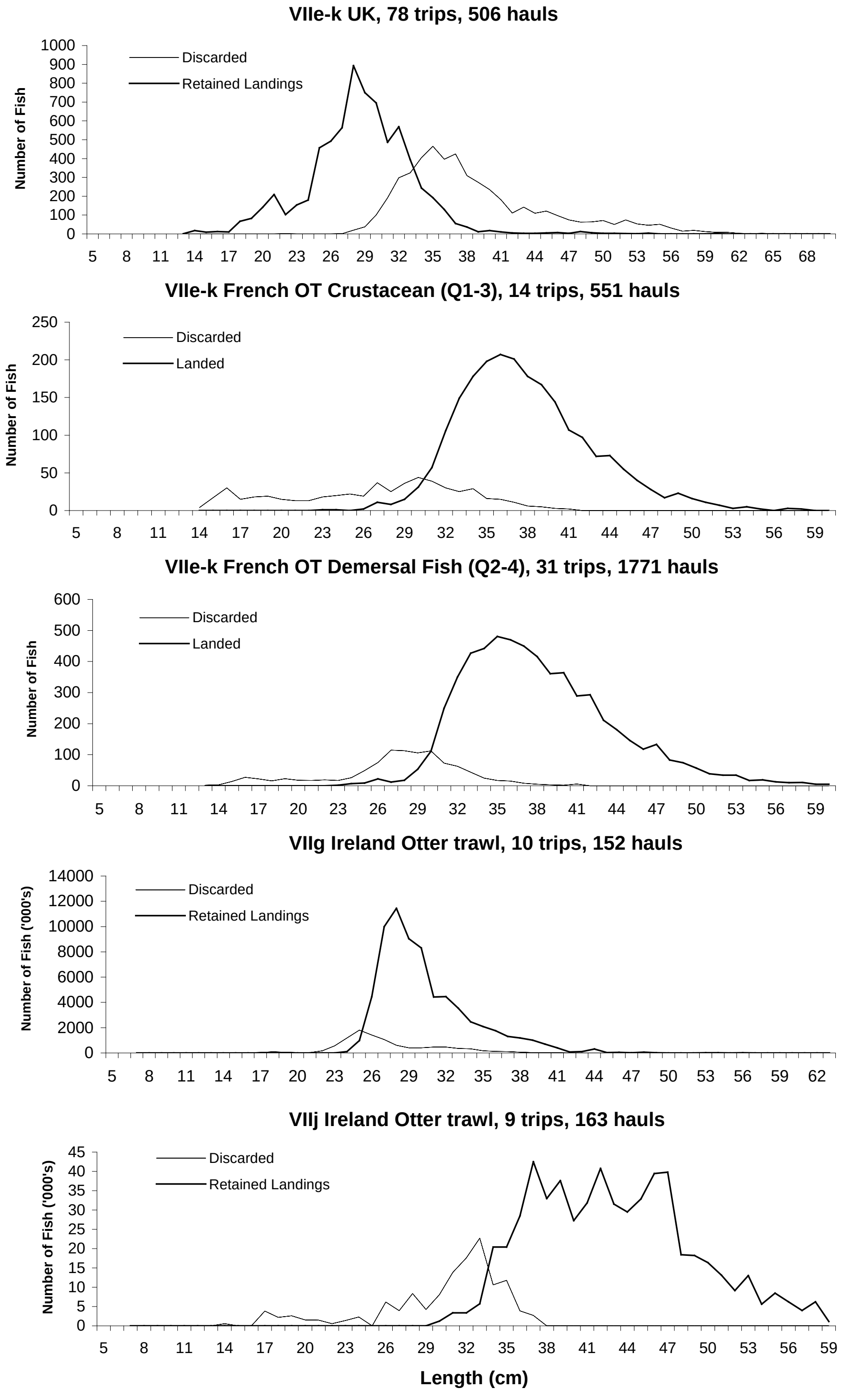


Figure 7.15.5. Whiting in VIIe–k (Celtic Sea). 2011 Annual length compositions of Irish, UK and French discards. Numbers are raised to the sampled catch for the UK and are raised by trip to the fleet for Ireland and are unraised sampled lengths for France.

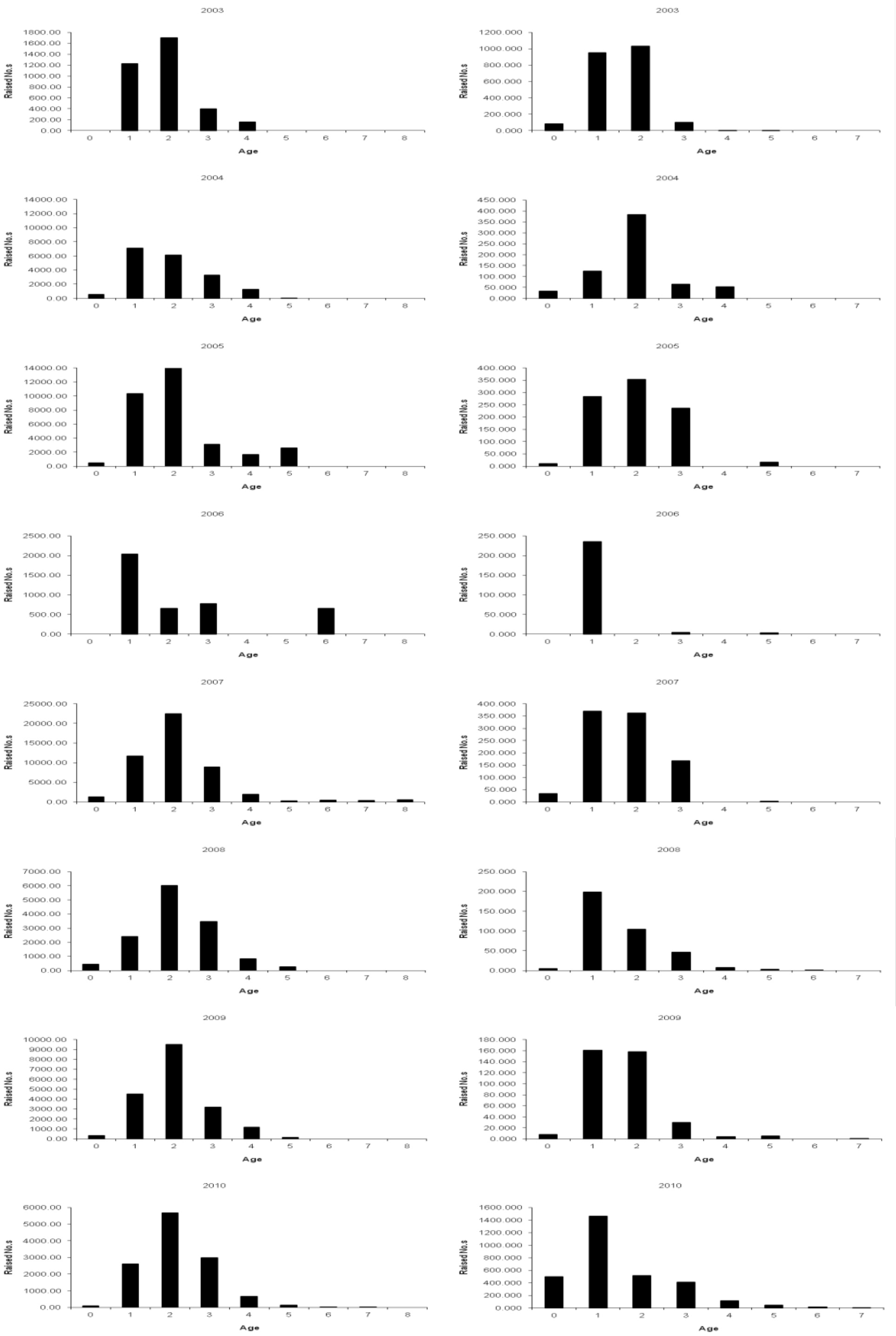


Figure 7.15.6. Whiting in VIIe–k (Celtic Sea). Age Composition of Discards from Irish otter board trawlers 2004–2011 in VIIg (left) and VIIj (right).

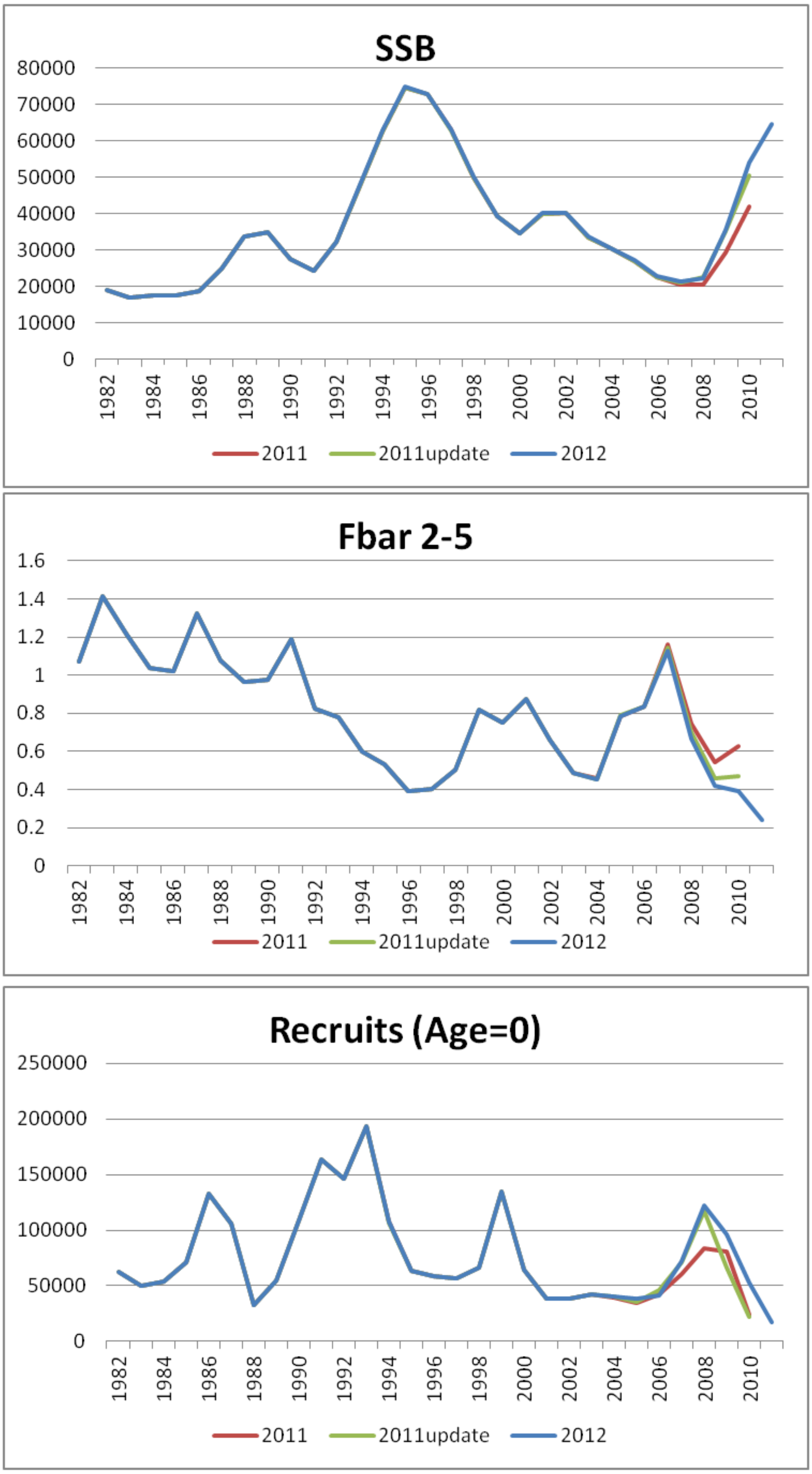
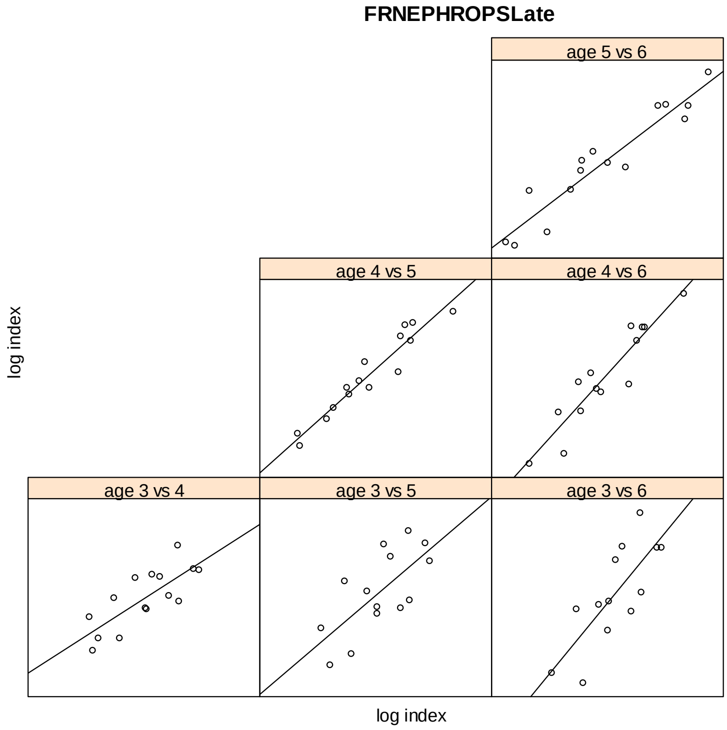
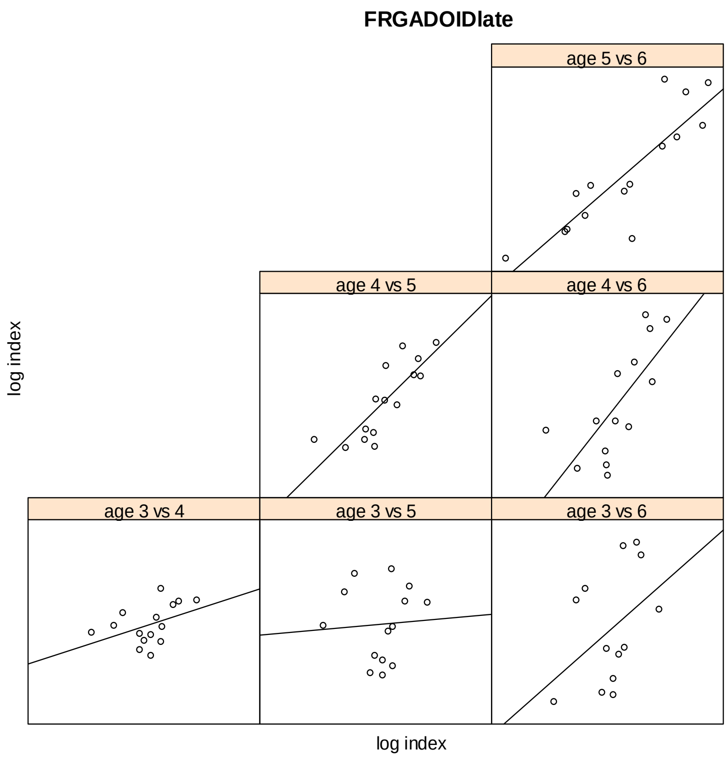


Figure 7.15.7. Whiting in VIIe–k (Celtic Sea). Camparative runs between the WGCSE 2012 assessment, the original 2011 assessment and also a repeat 2011 assessment with the updated survey tuning fleet, corrected for an error in 2010 IR-IGFS Swept-Area cpue data only.

(A)


FRNEPHROPSLate
age 5 vs 6
age 4 vs 5
age 4 vs 6
age 3 vs 4
age 3 vs 5
age 3 vs 6
log index
log index


FRGADOIDlate
age 5 vs 6
age 4 vs 5
age 4 vs 6
age 3 vs 4
age 3 vs 5
age 3 vs 6
log index
log index

(B)

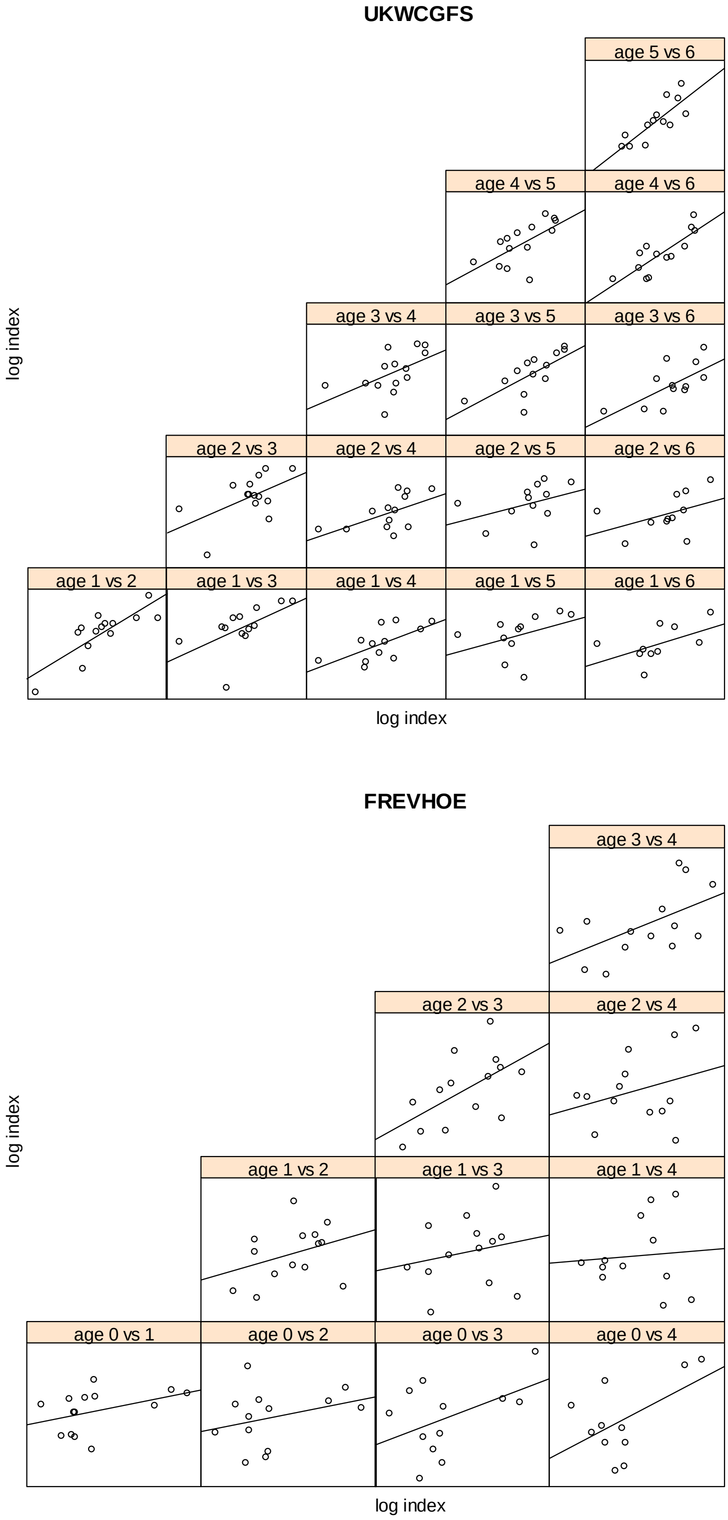


Figure 7.15.8. Whiting in VIIe–k (Celtic Sea). Pairwise scatterplots for the log numbers-at-age for the main tuning fleets to examine internal constancy of the indices (a) commercial fleets and (b) surveys.

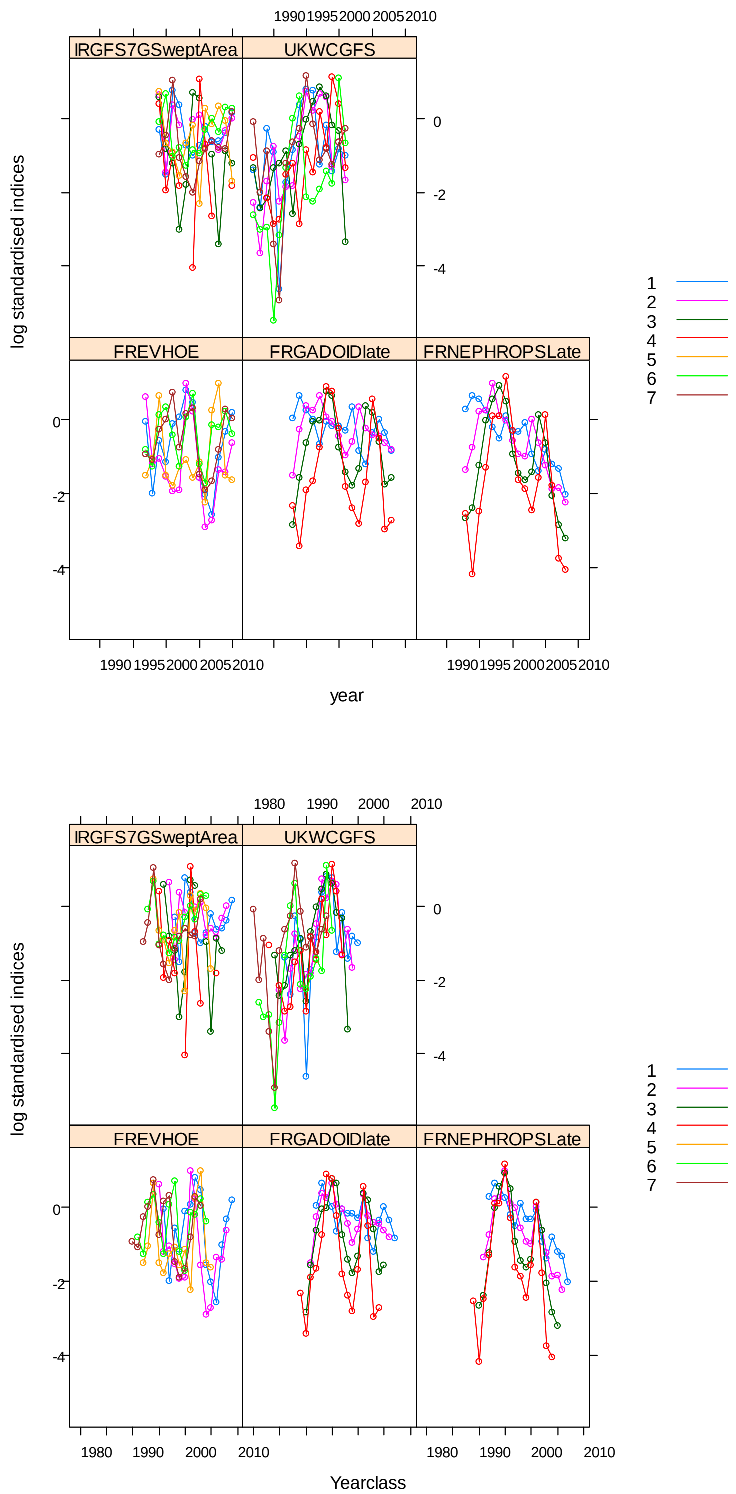


Figure 7.15.9. Whiting in VIIe–k (Celtic Sea). Mean log standardized plots of indices by (a) age and year, and (b) age and cohort.

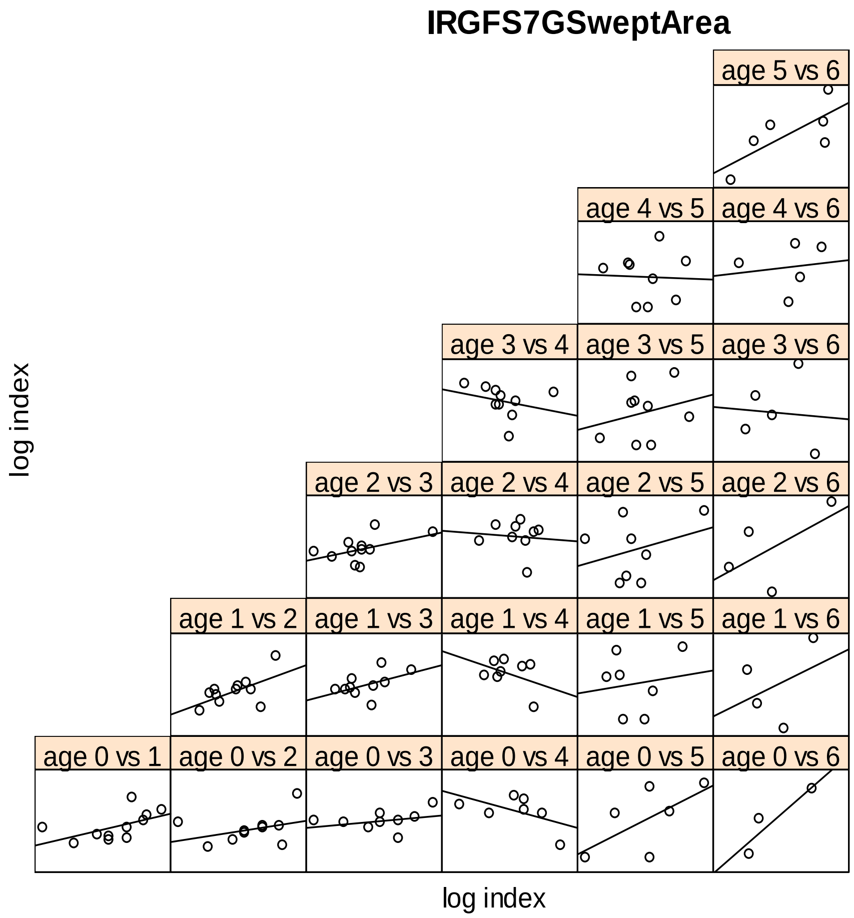


Figure 7.15.10. Whiting in VIIe–k (Celtic Sea). (a) standardized and (b) log standardized plots of survey indices used within the assessment for younger ages (0–2) by cohort.

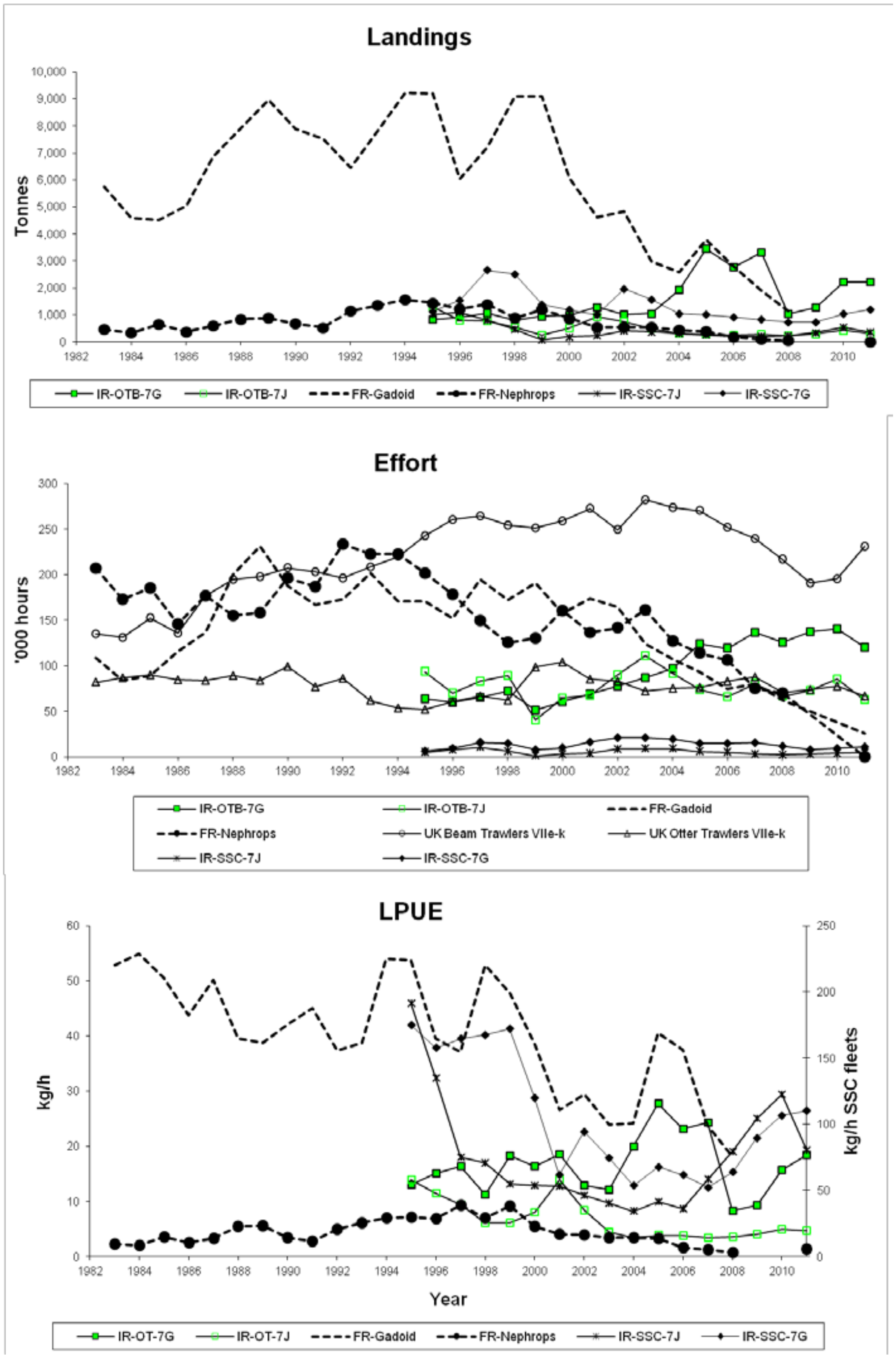


Figure 7.15.11. Whiting in VIIe–k (Celtic Sea). Landings, Effort and Landings per Unit of Effort (lpue) for some fleets landing whiting. For the UK fleets Effort is GRT corrected.

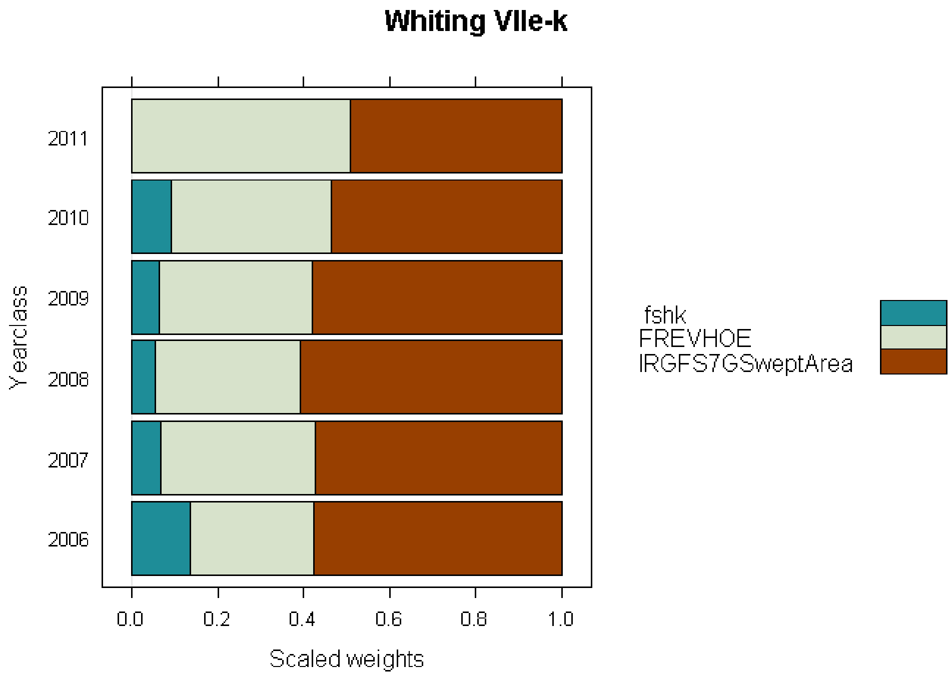


Figure 7.15.12. Whiting in VIIe–k (Celtic Sea). The survivor estimate weightings given by all fleets.

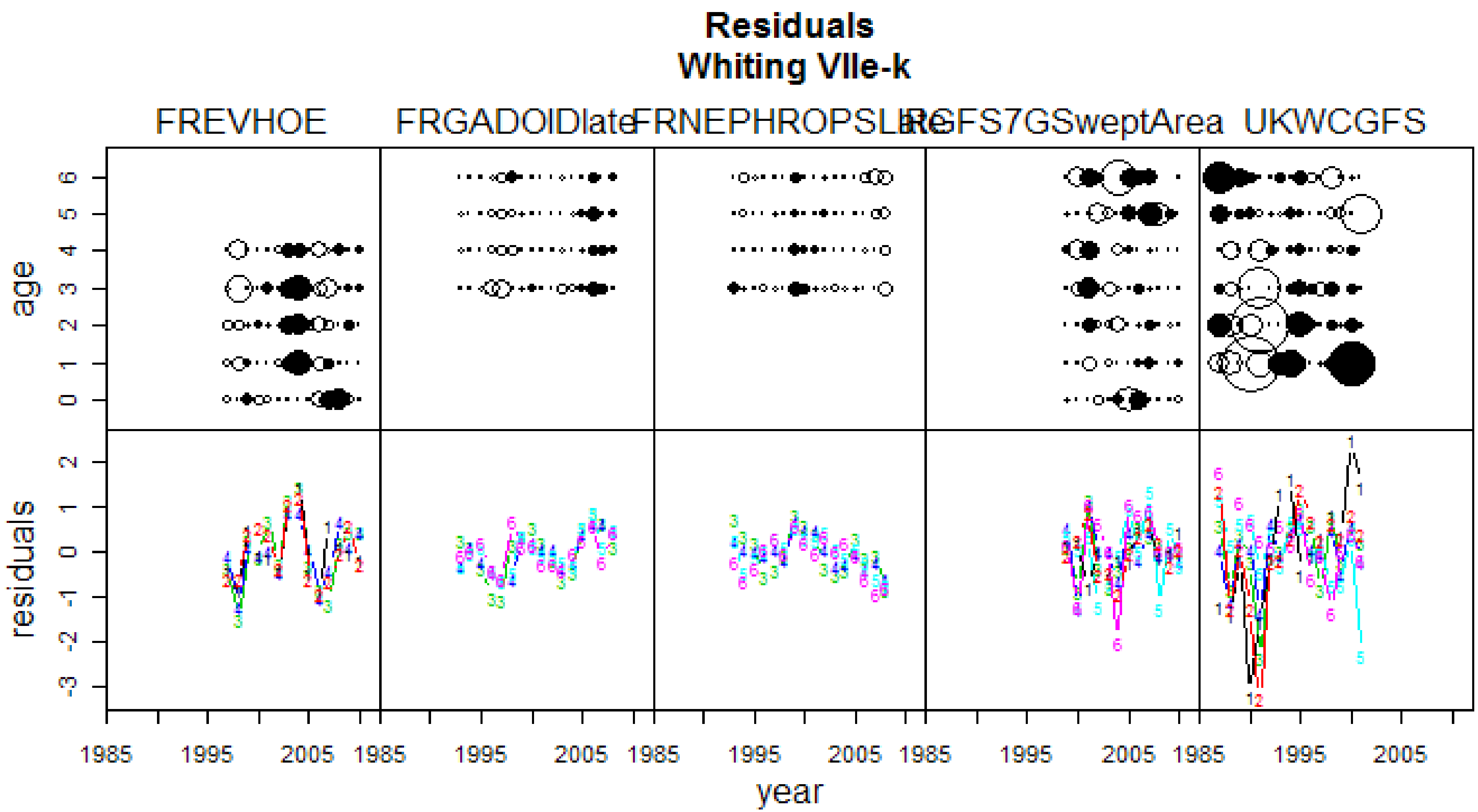


Figure 7.15.13. Whiting in VIIe–k (Celtic Sea). Log fleet catchability residuals bubble plots (above) and line plots (below).

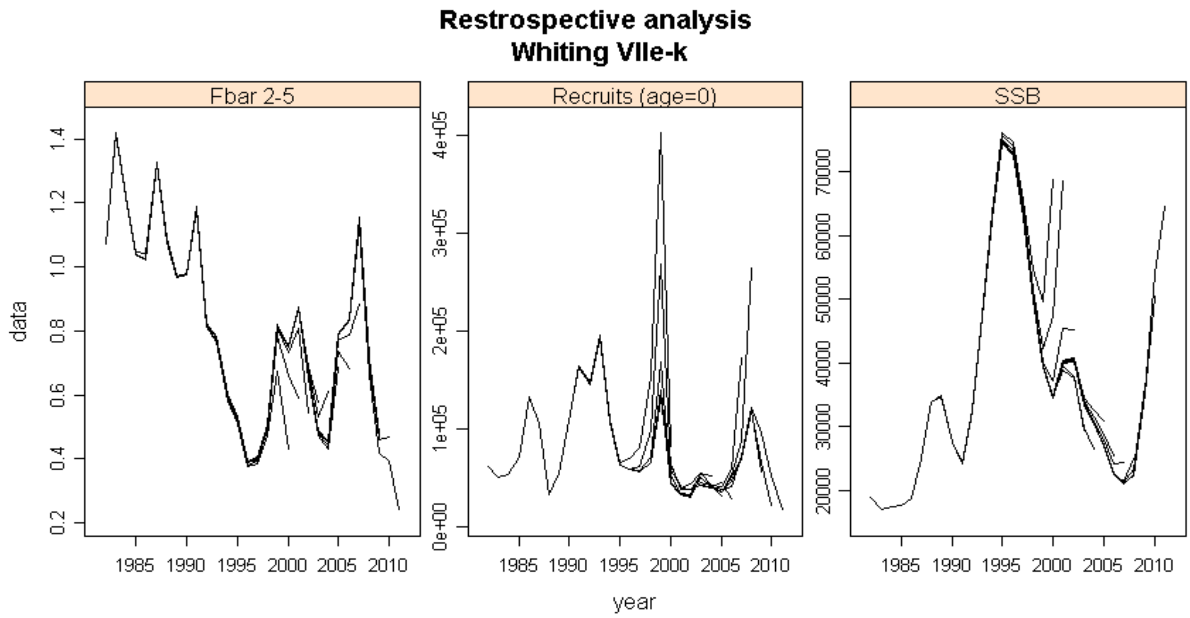


Figure 7.15.14. Whiting in VIIe–k (Celtic Sea). Retrospective analysis.

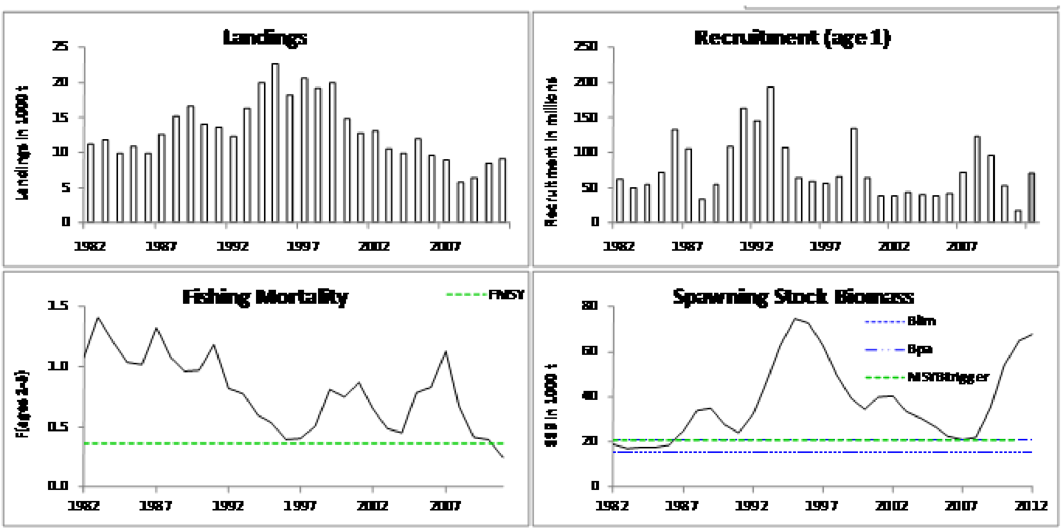


Figure 7.15.15. Whiting in VIIe–k (Celtic Sea). Stock summary.

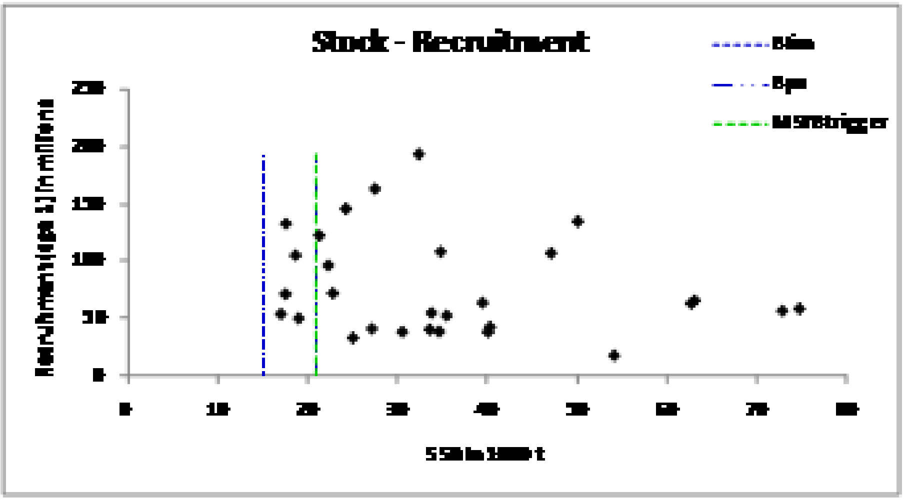
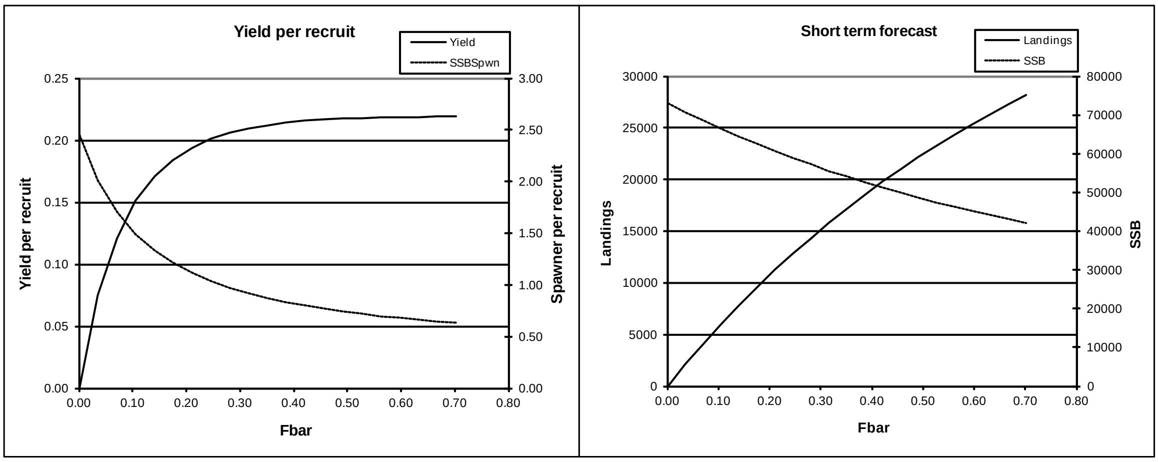


Figure 7.15.16. Whiting in VIIe–k (Celtic Sea). Stock–recruitment relationship.



MFYPR version 2a
Run: WHG_7ek
Time and date: 13:11 15/05/2012

Reference point	F multiplier	Absolute F
Fbar(2-5)	1.0000	0.3511
FMax	2.0169	0.7080
F0.1	0.5445	0.1912
F35%SPR	1.0294	0.3614

Weights in kilograms

MFDP version 1a
Run: WHG_7ek
WHG7ekMFDP Index file 14/05/2012
Time and date: 12:43 15/05/2012
Fbar age range: 2-5

Input units are thousands and kg - output in tonnes

Figure 7.15.17. Whiting in VIIe–k (Celtic Sea). Short-term predictions from the forecast.

7.16 Whiting in Divisions VIIb, c

Type of assessment

No assessment.

The nominal landings are given in Table 7.16.1.

Table 7.16.1. Nominal Landings (t) of Whiting in Division VIIb,c for 1995–2011.

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011a
France	57	76	65	37*	…1*	107	114	111	92	59	102	62	32	26	32	67	46
Ireland	1,894	1,233	403	323	206	563	357	386	423	135	65	49	100	76.0	94	144	195
Netherlands	-	-	-	-	-	-	2	-	3	-	2	-	-	-	-	-	-
Spain	+	+	-	27	1	4	-	6	-	31	18	19	1	4	-	4	-
UK(E/W/NI)	24	96	75	49	10	6	5	4	5	1	11	5	1	1	2	-	5.1
UK(Scotland)	71	17	4	27	-	19	1	+	-	-	-	-	-	-	-	-	-
Total	2,046	1,422	547	463	217	699	479	507	523	226	198	135	134	107	128	215	246

*** See VIIg–k.**

[a] Provisional.

8.2 Plaice in the Western Channel (ICES Divisions VIIe)

Type of assessment in 2012

Update assessment with no changes to the assessment settings as agreed at the Bench-mark assessment meeting (WKFlat 2010) held in February 2010. The MSY reference points were revised by the Working Group due to a change in the stock and recruit plot.

ICES advice applicable to 2011

Following the ICES MSY framework implies fishing mortality to be reduced to 0.18 (6% lower than F_{MSY} because SSB is 6% below MSY $B_{trigger}$), resulting in landings of 480 t in 2011. This is expected to lead to an SSB of 2980 t 2012.

Following the transition scheme towards the ICES MSY framework implies fishing mortality to be reduced following (0.8*F(2010)+0.2F_{MSY}*SSB(2011)*MSY $B_{trigger}$) corresponding to F of 0.39 for 2011. This results in landings of 950 t in 2011. This is expected to lead to an SSB of 2530 t in 2012.

Stock status

Fishing mortality	2007	2008	2009
F_{MSY}	above	above	above
F_{PA}	above	above	below
Spawning–Stock Biomass (SSB)	2008	2009	2010
MSY $B_{trigger}$	below	below	below
B_{PA}/B_{lim}	between	between	between

ICES advice applicable to 2012

Following the ICES MSY framework implies fishing mortality to be reduced to 0.19 (at F_{MSY} as SSB in 2012 is above MSY $B_{trigger}$), resulting in landings of 840 t in 2012. This is expected to lead to an SSB of 4620 t in 2013.

Following the transition scheme towards the ICES MSY framework implies fishing mortality of 0.35 for 2012. This results in landings of 1440 t in 2012. This is expected to lead to an SSB of 4030 t in 2013.

	F (Fishing Mortality)			
	2008	2009	2010	
MSY (F_{MSY})	✗	✗	✗	Above target
Precautionary approach (F_{pa},F_{lim})	?	?	?	Undefined
	SSB (Spawning Stock Biomass)			
	2009	2010	2011	
MSY ($B_{trigger}$)	✗	✓	✓	Above trigger
Precautionary approach (B_{pa},B_{lim})	?	?	?	Undefined

Technical comments made by the Review Group (RGCS)

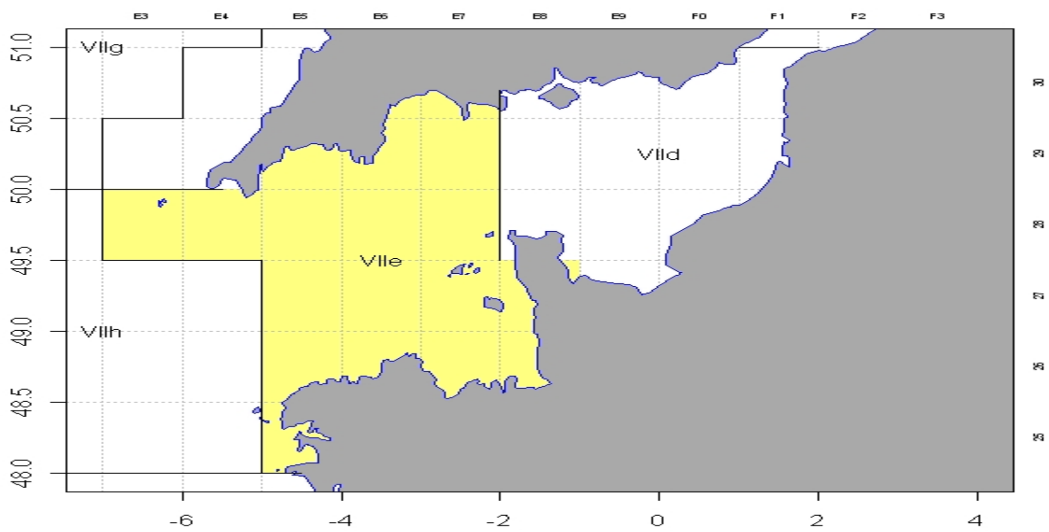
The Review Group in 2011 made no technical comments on this stock within Annex 4 'Technical minutes'.

It should be noted that the Review Group stock status comments contain an error. Within the statement *'The SSB has increased from the lowest observed (1144 t) in 2008 to 3371 t in 2011'*, the value of SSB in 2008 (1144 t) was indeed the landing within that year and the actual level of SSB in this year was 1677 t.

8.2.1 General

Stock description and management units

The management area for this stock is strictly that for ICES Area VIIe called the Western English Channel. The TAC area does not correspond to the stock area as it includes the larger component of VIId (Eastern English Channel). However, as determined by WKFlat 2010, a significant proportion of the catches of the VIIe stock are taken in the adjacent area during the time of spawning. Plaice is not the target species in VIIe, and it is generally caught as a bycatch by the sole and anglerfish directed fleets.



TAC area = VIId+e; Assessment area = VIIe.

Management applicable to 2011 and 2012

There are technical measures in operation including a minimum 80 mm mesh size and a MLS (27 cm) for this species.

The TAC and the national quotas by country for 2011

Species:	Plaice *Pleuronectes platessa*	Zone:	VIId and VIIe (PLE/7DE.)
Belgium	763		
France	2 545		
United Kingdom	1 357		
EU	4 665		
TAC	4 665		Analytical TAC

In addition, Annex IIc, restricts the number of days-at-sea to 164 for beam trawlers of mesh size equal to or greater than 80 mm, and for static nets including gillnets, trammelnets and tanglenets, with mesh size less than 220 mm, with an additional 12 days for the UK beam trawl fleet due to a reduction in capacity of the fleet.

The TAC and the national quotas by country for 2012

Species:	Plaice *Pleuronectes platessa*	Zone:	VIId and VIIe (PLE/7DE.)
Belgium	828		
France	2 761		
United Kingdom	1 473		
Union	5 062		
TAC	5 062		Analytical TAC

In addition, Annex IIc, restricts the number of days-at-sea to 164 for beam trawlers of mesh size equal to or greater than 80 mm, and for static nets including gillnets, trammelnets and tanglenets, with mesh size less than 220 mm, with an additional 12 days for the UK beam trawl fleet due to a reduction in capacity of the fleet.

The fishery in 2011

A full description of the fishery is provided in the Stock Annex, Section A2.

In the western English Channel plaice are taken mainly as a bycatch in beam trawls directed at sole and anglerfish. In 2011, the UK beam trawl fleet took around 43% of the total landing of this stock with the UK otter trawl fleet taking around 26%. The remainder of the landings are taken by the French fleets (around 20%) and the Belgian fleets (around 10%).

UK Otter trawl effort in 2011 has remained at the level observed in 2010 and these two years followed a steady decline since 2001. The UK beam trawl effort (GRT corrected) in 2011 has increased since 2010 and is now just below the series high levels observed over the period 2003–2008.

This stock is the smaller of the two stocks that make up the larger TAC area of VIId,e. The landings from this stock amounted to around 28% of the TAC in 2011 and only 25% of the TAC in 2010.

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 2011 were 1337 t with Working Group estimates of VIIe plaice landings <1% lower at 1332 t. The Working Group estimate of the 2010 landings was revised upwards due to minor revisions to the landings by UK(E&W), Belgium, the Netherlands and UK (Guernsey) and an additional 12 t from France. These combined additional landings totalled around 14 t making the revised total international landings in 2010 to be 1092 t.

Landings increased to levels of 2600 t during the latter half of the 1980s due to a series of good recruitments in 1986–1988, but subsequently dropped to levels fluctuating around 1200 t. The last few years had seen landings fall to under 1000 t, but this trend has been reversed in the past two years with increases leading to landings of over 1300 t in 2011. Unallocated landings in recent years, are generally the additional French landings derived from sales note information.

In addition to the estimated 2011 landings for VIIe, an extra 173 tonnes was added from the VIId plaice stock representing an adjustment for migration of 15% of quarter 1 between the two stocks. In addition, the 2010 migration adjustment was increased to 149 t, as a result of an increase in the Belgian VIId component. This process was agreed at the Benchmark Assessment meeting in February 2010 and the method is documented in the Stock Annex. A reciprocal correction was made to the VIId stock.

Data

Sampling levels are detailed in Section 2 (Table 2.1).

Annual length compositions of the 2011 UK(E&W) landings (three fleets) and France (two fleets) are provided (Table 8.2.3). Length distributions of UK(E&W) landings from 2002 to 2011 as used by the WG are illustrated in Figure 8.2.3.

Quarterly age compositions for landings in 2011 were available from UK(E&W) only, which accounted for almost 70% of the total reported international landings. An additional age composition representing the migration adjustment (15% of quarter 1 landings for VIId) for the combined nations of UK(E&W), Belgium, France and the Netherlands was supplied by the WGNSSK coordinator for the VIId plaice stock. The method for the derivation of the international catch numbers and the calculation of the catch and stock weights-at-age are fully described in the Stock Annex, Section B1. Catch numbers-at-age landed annually (including the migration element) are given in Table 8.2.4 and plotted for 2002 to 2011 in Figure 8.2.4. Catch and stock weights-at-age are given in Tables 8.2.5 and 8.2.6.

Catch weights are plotted as mid-year values; 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 Stock Annex). This is consistent with the procedures developed and agreed at the benchmark workshop held in February 2010.

Discards

Discards estimates, from the UK(E&W) and French discard sampling programme, are available for the period 2002–2011 (Annual Data Files on ICES network) and indicate that discarding appears to be higher in quarters 1 and 2 in this fishery, but is still low compared to other plaice stocks. In addition to these data, Belgian quarterly discard length–frequency data was available for 2010–2011 and these data showed similar discarding ratios to both the UK and France. Quarterly profiles of numbers landed and discarded-at-length in 2011 are given in Figure 8.2.2. This does not include discarding estimates for the Q1 migrants exploited in VIId. The latter estimates are thought to be minor as only mature plaice are thought to migrate.

Biological

The natural mortality and the maturity ogives used were as in previous assessments and described in the stock annex.

Surveys

There are currently two surveys that provide abundance estimates to the Working Group. The UK(E&W) commercial beam trawl survey (UK-WEC-BTS) has used the FV Carhelmar for most survey years with the exception being 2002 and 2004, when the RV Corystes was used instead. Detailed information on the survey protocols and area cover-age can be found in the Stock Annex.

Table 8.2.7 gives abundance indices as numbers caught per 100 km for age groups 1 to 9 as obtained by UK-WEC-BTS. Strong and weak year classes have been well tracked by this survey in the past (Figure 8.2.6). This survey takes place in the north of VIIe and its cpue shows a similar but slightly earlier trend to that of the commercial beam trawl fleet lpue in the same area. This difference is likely due to the inclusion of non-recruited year classes in the survey catches that do not appear in the commercial catches. The last three years have seen a large increase in this survey's cpue as a result of large catch numbers of the most recent year classes and this is a clear indication of recently improved recruitments entering the fishery.

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 (FSP-7e UK). This survey covers a substantially larger area than the UK-WEC-BTS survey and is thought to be more representative of the stock in UK waters. This dataset was first included in the 2007 assessment, and the exploratory analysis can be seen in that report (ICES, 2007; Section 3.2.5). There have been a number of vessel changes, gear changes and temporal variations in this survey-series, but the survey has performed well in tracking year classes in the past. However, a strong year effect was noticed with the 2008 data that had a significant impact on the survivor estimates and these data were excluded from the 2009 and subsequent Working Groups. These data are continued to be excluded at the 2012 Working Group for consistency, although the effect on current levels of fishing mortality and SSB is minor when included.

The FSP-7e survey shows a similar recent trend in cpue to that of the UK-WEC-BTS survey.

Commercial fleet effort and lpue

The UK cpue data shows the individual fleets that make up the composite of all otter trawl and all beam trawl fleets that are used in the commercial tuning datasets. Trends in commercial lpue and effort are given in Table 8.2.2 and Figure 8.2.1. More detailed information on the distribution of effort by area and trends in the fishery can be found in the Stock Annex. Lpue in the North of VIIe for both commercial beam and otter trawlers reached a peak in 1988–1990, fell sharply to 1995 and has since fluctuated at a low level.

Commercial beam trawl lpue in the South and West of VIIe show a general decline from 1990 to 2008 followed by a small upturn in the last few years. Commercial otter trawler lpue in the western sector shows a slow declining trend since 1997 followed by a small upturn over the last four years. In the northern and southern sectors, commercial otter trawl lpue shows much more variation throughout the time-series than that observed in the western sector but historically at much higher levels.

All three lpue time-series for beam trawl showed an increase in 2011 whilst all three time-series for otter trawl showed small decreases.

Effort (fishing power corrected, using GRT) by UK(E&W) beam trawlers shows an increasing trend between 1992 and 2003, then remaining stable at this high level until 2008 (Figure 8.2.1). In 2009 effort fell dramatically back to the levels observed in 2000, but increases in the last two years has seen effort levels restored to the high levels seen in the mid-noughties. In contrast, effort by otter trawlers continues to decline slowly from the highest values shown at the beginning of the time-series. However commercial otter trawl effort now shows a small increase in years 2009–2011but effort remains at a low level.

8.2.2 Stock assessment

Catch-at-age analysis

Section 1.3 outlines the general approach adopted at this year's Working Group meeting, and the specific approach for this stock is given in the Stock Annex. All relevant tuning and XSA outputs not included in this report are available in the 'Exploratory runs' folder. The details of the previous assessment approaches for this stock can be found in the Stock Annex.

Data screening

The age range for the analysis was 1–10+, as standard.

As this was an update assessment, full data screening, tuning data and exploratory XSA trials were not carried out. For catch data screening, a separable VPA was carried out using the standard setting as detailed in the Stock Annex. The results (Figure 8.2.5 cont.) show no anomalies in recent years, and high residuals on the youngest age as previously observed.

Tuning information available consisted of same five fleets as last year: three UK commercial series, UK otter historic, UK otter trawl, UK beam trawl; and two UK survey-series: UK-WEC-BTS, and FSP-7e (UK(E+W)). These are presented in Table 8.2.8. The figures in bold indicate the data used for the final run.

Details of the derivation of the tuning fleets are presented in the Stock Annex.

Tuning indices were examined for inconsistencies using SURBA version 3.0. Log(cpue) plots plotted by year class and by year (Figure 8.2.6). All five of the tuning indices indicate highly consistent year-class estimates, and plots of index by year do not indicate substantial year effects in the tuning data. The FSP-7e UK(E&W) data for 2008 continue to be excluded from the assessment. Inclusion of these data at the WGCSE 2009 led to the final estimates of each year class for this fleet being reduced significantly from the previous year's estimate at all ages and given that this fleet's estimates received heavy weighting in the final estimates or survivors, this data was excluded from the final assessment.

The cause of this year effect remains unclear. There were a number of changes to the survey in 2008, but these mostly affected the eastern part of the survey, whereas the greatest change in abundance was noted in the western survey and these changes continued in 2009.

Final update assessment

The settings used for the final run are shown in the table. The full assessment history is given in the Stock Annex.

		2010 XSA	2011 XSA	2012 XSA
Catch at age data		1980–2009, 1–10+ add catch from 7d	1980–2010, 1–10+ add catch from 7d	1980–2011, 1–10+ add catch from 7d
Fleets	UK-WECBTS – Survey	1986–2009, 1–8	1986–2010, 1–8	1986–2011, 1–8
	UK WECOT – Commercial	1988–2009, 3–9	1988–2010, 3–9	1988–2011, 3–9
	UK WECOT– Commercial historic	1980–1987, 2–9	1980–1987, 2–9	1980–1987, 2–9
	UK WECBT – Commercial	1989–2009, 3–9	1989–2010, 3–9	1989–2011, 3–9
	FSP-7e (UK E+W)	2003–2009, 2–8 (exc. 2008)	2003–2010, 2–8 (exc. 2008)	2003–2011, 2–8 (exc. 2008)
Taper		No	No	No
Taper range		-	-	-
Ages catch dep. Stock size		None	None	None
q plateau		7	7	7
F shrinkage se		2.5	2.5	2.5
year range		5	5	5
age range		4	4	4
Fleet SE threshold		0.5	0.5	0.5
Prior weighting		-	-	-
Plus group		10	10	10
F Bar Range		F(3–6)	F(3–6)	F(3–6)

The diagnostics for the final XSA run are shown in Table 8.2.9 and the catchability residuals are plotted in Figure 8.2.5. Some weak trends/patterns can be seen in the commercial beam trawl and otter trawl fleet (UK-WECB; UK-WECOT) residuals. The UK beam trawl survey (UK-WEC-BTS) shows a distinct change in the last few years with a trend in larger positive residuals being seen. This may well be explained by the shift in commercial effort away from the survey area in Lyme Bay to areas further south. In addition, a year effect can be seen in the survey results for 2004 and this probably associated with a change in vessel that year.

Estimates for the youngest age are almost entirely determined by the UK-WEC-BTS survey and this fleet gets more weight than the other fleets up to age 5. The FSP-7e UK survey provides >25% of the weight for most of the age at age 2 and older. The commercial fleets provide around 50% of the weight of ages 5 and older. The contribution of F-shrinkage is minor for all ages. Fishing mortalities and population numbers estimated from the final run are given in Tables 8.2.10 and 8.2.11, and summarized in Table 8.2.12. The 2008–2009 above average year-classes have led to a further increase in SSB in 2011. Last year, the 2009 year class was estimated to be the highest in the time-series and this has been confirmed by the addition of 2011 data into the assessment and is now estimated to be large by both the UK-WEC-BTS and the UK-FSP surveys. However, the 2010 year class is estimated to be larger than the 2009 year class, but this estimate is solely based on the UK-WEC-BTS survey.

A retrospective analysis (Figure 8.2.7) was run without the short FSP-7e UK(E&W) tuning-series due to the shortness of the time-series. This indicates a strong downward revision of the 2001 year-class strength, going from the third strongest year class in history to a value much closer to long-term GM. Last year the estimate of the 2009 year class was the highest in the time-series (1980–2010) but given that this was based entirely on the UK-WEC-BTS survey, this estimate was replaced by the GM value in the forecast. However, this year class is estimated to be even stronger in this assessment after the inclusion of an additional year of data. This assessment shows no retrospective bias in either SSB or F estimation.

Comparison with previous assessments

Fishing mortality is estimated to have remained relatively stable in 2011 at 0.43 and SSB is estimated to have increased to 3271 t. Last year, fishing mortality and SSB in 2010 were estimated to be 0.45 and 2629 t; this year's estimates for 2010 are 0.55 and 2271 t, an upward revision of 22% in F and a downward revision of 14% in SSB.

State of the stock

A summary of the final assessment is given in Table 8.2.12 and Figure 8.2.8. Spawning–stock biomass (SSB) was stable during the period 1981–1987, peaked above 5000 t during 1988–1990 following good recruitments in the mid-1980s, and then decreased to around 2400 t in 1995–1996. Since then SSB increased following the good 1996 year class but subsequently declined steadily to the lowest level in the time-series of around 1600 t in 2008. Above average recruitments in the 2009 year class and the reduction in fishing mortality has led to an increase in the SSB estimate for 2011 to around 3300 t.

Fishing mortality showed a gradually increasing trend up until the mid 1990s, then a slight decline followed by a sharp increase up to 2008. This assessment shows a large reduction in F in 2009 followed by a small increase in 2010 and a larger fall in 2011. Recent changes in F have been evidenced by corresponding changes in the effort observed for the UK beam trawl fleet and the F for sole, the target species for this fishery. However the large fall in F in 2011 is not reciprocated by a commensurate effort increase in this fleet. This mismatch may well be a feature of changes in the spatial distribution of this fleets effort as detailed for the VIIe sole stock at WKFlat 2012.

Two periods of below average recruitments in the period 1989–1994 and from 1998–2006 contributed to the decrease in yield and SSB seen in 2008. This assessment now estimates that three year-classes have been above the long-term GM80-09 (5988) since 2000.

8.2.3 Short-term projections

At this year's Working Group the short-term forecast was run as per the procedure as detailed in the stock annex.

Estimating year-class abundance

The 2010 year class is estimated to be highest value in the time-series at around 23.3 million with 92% of the weight coming from the UK-WEC-BTS. However, given that other year classes have been significantly revised at this age in following assessments, the Working Group considered this estimate to be highly uncertain and replaced it with the GM recruitment (GM80-09). At last year's Working Group, a similar decision was taken with the high estimate on the 2009 year class and this estimate was confirmed as being of that magnitude with the addition of a further year's data.

Working Group estimates of year-class strength used for prediction can be summarised as follows:

Recruitment at age 1:

Year class	Thousands	Basis	Surveys	Commercial	Shrinkage
2008	8148	XSA	66%	33%	1%
2009	20 328	XSA	98%	0%	2%
2010	5998	GM (80-09)	-	-	-
2011	5998	GM (80-09)	-	-	-
2012	5998	GM (80-09)	-	-	-

The input values for the catch forecast (using the MFDP software) are given in Table 8.2.13. The F-at-age values used were calculated as the mean of the XSA values from 2009–2011 unscaled. Catch and stock weights-at-age were also the mean of the period 2009–2011. Stock numbers-at-age in 2012 for ages 3 and older were obtained from the XSA, with the values for age 2 being set at 5311, the GM(80-09) less a reduction for natural mortality (0.12). Recruitment for 2012 onwards are taken to be 5998, the GM (80-09).

Table 8.2.14 gives the management option table from the *status quo* catch prediction, and short-term results are shown in Figure 8.2.9.

Assuming *status quo* F (F_{sq} = 0.48) implies landings of 2997 t in 2012 and 2910 t in 2013. (The TAC for 2012 is 5062 t. for VIId,e combined). SSB is predicted to rise from 5070 t in 2012 to 5805 t in 2013 before falling again to 5390 t in 2014. Uncertainties in these results are discussed in Section 8.2.7.

The detailed output for the *status quo* F forecast by age group is given in Table 8.2.15, and the estimated contributions of recent year classes to the predicted catches and

SSBs are given in Table 8.2.16. The assumptions of GM1980-09 recruitment are predicted to contribute 22% to the landings in 2013 and 33% to SSB in 2014.

The stock and recruitment scatterplot is given in Figure 8.2.10.

8.2.4 F_{MSY} evaluation

A full F_{MSY} evaluation was carried out at WGCSE in 2010 and the suggested level of F_{MSY} for this stock was F's within the range of 0.14 and 0.31 with the provisional proxy of 0.19 being agreed by analogy with the plaice in the Celtic Sea. Given that the assessment for the latter stock has been rejected by WKFlat 2011 and that this stock suffers from greater levels of discarding than the Western Channel stock, the provision of a more appropriate F_{MSY} was examined.

In order to attempt to derive an F_{MSY} estimate the SRMSYMC package was once again employed and F_{MSY} was calculated based on the three common stock recruit relationships; Ricker, Beverton–Holt and smooth hockeystick. Models were fitted using 1000 MCMC re-samples. For all three stock-recruit relationships (SRR), all re-samples allowed F_{MSY} and F_{crash} values to be determined. All three models show that there is little evidence of a stock–recruitment relationship with only limited information as to the trends at extreme levels of SSB.

The smooth hockeystick model showed a marked shift of the 'break-off' point in the SRR compared to the previous analysis and the breakpoint was clearly being driven by the two most recent datapoints. The results indicate that there is currently no available information in the assessment to indicate a level of SSB where recruitment is impaired. Figure 8.2.11 illustrates the smooth hockeystick curves and the percentiles of estimates with converged F_{MSY} from the analysis carried out at this year's Working Group and that of 2010.

The yield-per-recruit estimates were highly uncertain with high CV's and therefore these estimates were rejected. The Ricker and the Beverton–Holt SRR models show very different levels of estimated F_{MSY} but both were disregarded as the suggested values of F_{MSY} were poorly estimated. Given that this stock displays no stock and recruitment relationship with the highest levels of recruitment coming from some of the lowest levels of SSB; all three SSR derived candidate values for F_{MSY} were rejected.

The Working Group agreed that the most appropriate F_{MSY} value was one based on F_{MAX} 2012 as this has been consistently determined to be around the same level in the past three years. Therefore, the suggested level of F_{MSY} for this stock is 0.24.

8.2.5 Biological reference points

	Type	Value	Technical basis
MSY Approach	MSY $B_{trigger}$	1650 t	Preliminary based on lowest SSB (in converged part of XSA) from which the stock has recovered
	F_{MSY}	0.24	F_{MAX} (2012)
Precautionary Approach	B_{lim}	Not defined.	
	B_{PA}	Not defined.	
	F_{lim}	Not defined.	
	F_{PA}	Not defined.	

Each Working Group since 2004 had considered the precautionary reference points for this stock as unreliable for the following reasons:

- The stock–recruitment relation shows no evidence of reduced recruitment at lowest observed stock levels;
- The basis for B_{PA} is MBAL from a previous assessment which was rejected by WKFlat 2010;
- F_{PA} is based on B_{PA}, and therefore this reference point is also rejected;
- B_{lim} – see B_{PA}.

Given this and the Advice Drafting Group (ADG) removing the PA reference points from the advice sheet in 2011 at the recommendation of the Celtic Sea Review Group, the Working Group agreed to their removal from this report.

The Working Group agreed that the current level of $B_{Trigger}$ (Preliminary based on lowest SSB (in converged part of XSA) from which the stock has recovered) was inappropriate and the Working Group agreed that the appropriate value for $B_{Trigger}$ would be 1650 t. This is the lowest level of SSB observed over the time series (1980–2011) and this level of SSB has been seen to produce excellent numbers of recruits in subsequent years.

Yield-per-recruit analysis

Results for the deterministic yield and SSB per recruit (using program MFYPR), conditional on the recent exploitation pattern, are given in Table 8.2.17 and Figure 8.2.9. F_{MAX} is given by a reference F of 0.24, around 50% of Fsq. Long-term yield and SSB (at Fsq and assuming GM80-09 recruitment = 5.998 million) are given as 1830 t and 3650 t respectively.

8.2.6 Management plans

There is no management plan in place for this stock.

8.2.7 Uncertainties and bias in assessment and forecast

The assessment model changes introduced by WKFlat 2010 added new uncertainties into a portion of the data (~10%). The spawning migration correction assumes that a constant 15% of quarter 1 catches in VIId to originate from VIIe, based on historical tagging information. This proportion makes no provision for changes in the relative sizes of the two populations. In addition, this correction utilises the age structure of the VIId catches, representing a mix of age structure from VIIe, VIId and portions of the Area IV populations migrating into VIId for spawning.

There is a heavy reliance on the age composition data derived from UK (E&W) sample data. Around 30% 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 VIId is added. Survivor estimates for ages 1 and 2 almost entirely come from the UK survey data and some consideration should be given to using age 2 data from the commercial tuning fleets.

UK and Belgian discard data provided this year continue to support previous WG conclusions that discard levels are low in the second half of the year, and overall that discarding for this stock is variable but low compared to other plaice stocks. As the time-series of data expands, the WG will be able to better determine how to include this data in the assessment appropriately.

The assessments ability to accurately estimate age 1 recruits depends heavily upon the Carhelmar UK beam trawl survey which is not particularly consistent at catching fish of this age. The Working Group has considered these values too uncertain for use in the short-term forecast opting instead to use GM recruitment. However the large 2010 recruits estimate was confirmed in 2011 by both the Carhelmar survey and the FSP-7e surveys at age 2. This year's 2011 recruits are now also being estimated as being the largest year class in the time-series.

It should be noted that the area of coverage of the Carhelmar survey (Lyme Bay), is no longer commercially fished on the same scale as in previous years. According to VMS data, the UK commercial beam trawl fleet effort has moved further south and this could be what is driving the higher survey residuals in the last few years in the assessment diagnostics.

8.2.8 Recommendation for next Benchmark

A benchmark assessment was carried out for this stock in February 2010 but any future benchmark assessment will need to consider the following issues.

- Both the UK-WEC_BTS and the FSP-7e UK(E&W) surveys are spatially restricted to the same area as the commercial tuning fleets and little information exists on stock dynamics on the French coast. Inclusion of the UK Q1 South West Beam Trawl Survey index (Q1SWBeam) should be considered the next time this stock has a benchmark assessment as this survey covers the entire ICES Division VIIe.
- Re-investigate the assumption of 15% migration.
- Investigate the addition of age composition information from the French and Belgian fleets. These fleets collectively account for 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.
- Inclusion of discard estimates in the assessment once an adequate time-series of data is available.

8.2.9 Management considerations

The stock unit (Division VIIe) does not correspond with the management unit (Divisions VIId and VIIe). This hampers effective management of plaice in the Western English Channel, but because components of the VIIe stock are also taken during spawning time in Area VIId, some provision must be made in management to accommodate effective management of both plaice stocks.

Plaice are taken as a 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 appear to have benefited the plaice stocks.

The assessment is now able to accurately estimate recent trends in F and historical trends are estimated with some certainty. Fishing mortality is estimated to be well above F_{MAX}.

Table 8.2.1 Plaice in VIIe. Nominal landings (t) in Division VIIe, as used by Working Group.

Year	Belgium	Denmark	Netherlands	France	UK (E &W) inc. CI's.	Others	Total reported	Unallocated[1]	Total	VIIe stock caught in VIId[4]	As used by WG
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	136	1215
1981	27	-	-	537	953	-	1517	-16	1501	245	1746
1982	81	-	-	363	1109	-	1553	135	1688	250	1938
1983	20	-	-	371	1195	-	1586	-91	1495	259	1754
1984	24	-	-	278	1144	-	1446	101	1547	266	1813
1985	39	-	-	197	1122	-	1358	83	1441	310	1751
1986	26	-	-	276	1389	-	[1] 1691	119	1810	351	2161
1987	68	-	-	435	1419	-	1922	36	1958	430	2388
1988	90	-	-	584	1654	-	2328	130	2458	536	2994
1989	89	-	-	448 [1]	1712	-	2250	108	2358	450	2808
1990	82	2	-	N/A [2]	1891	2	1979	614	2593	465	3058
1991	57	-	-	251 [1]	1326	-	1635	213	1848	402	2250
1992	25	-	-	419	1110	14	1568	56	1624	326	1950
1993	56	-	-	284	1080	24	1444	-27	1417	274	1691
1994	10	-	-	277	998	-	1285	-129	1156	315	1471
1995	13	-	-	288	857	-	1158	-127	1031	264	1295
1996	4	-	-	279	855	-	1138	-94	1044	277	1321
1997	6	-	-	329	1038	1	1374	-51	1323	331	1654
1998	22	-	-	327	892	1	1242	-111	1131	299	1430
1999	12	-	-	194 [1]	947	-	1154	117	1271	345	1616
2000	4	-	-	360	926	+	1290	-9	1281	397	1678
2001	12	-	-	303	797	-	1112	-6	1106	273	1379
2002	27	-	-	242	978	+	1247	10	1257	351	1608
2003	39	-	-	216	985	-	1240	-22	1218	260	1478
2004	46	-	-	184	912	-	1142	12	1154	248	1402
2005	48	-	-	198	887	-	1133	66	1199	171	1370
2006	52	-	-	223	966	-	1241	72	1313	153	1466
2007	84	-	-	202	679	-	965	38	1003	181	1184
2008	66	-	-	148	677	-	891	83	974	170	1144
2009	53	-	2	193	724	5	978	-55	923	142	1065
2010	51	-	2	220	838	2	1113	-21	1092	149	1241
2011	140	-	3	264	930	-	1337	-5	1332	173	1505

[1]Estimated by the Working Group

[2]Divisions VIId,e = 4,739 t.

[3]Included in Division VIId

[4]Migration correction (15% of VIId Qtr 1) added to stock.

Table 8.2.2 Division VIIe PLAICE effort and LPUE and CPUE data.
The UK (E&W) data are for vessels > 12m and are corrected for fishing power (based on GRT). All effort data are in fishing hours, LPUE data are kg/hr for commercial fleets, CPUE in kg/10 km towed for Carhelmar beam survey and Kg/hour/ Metre beam length for FSP survey .

Year	(LPUE) (kg/hr).						Effort (000 hours)		Landings (tonnes)		(CPUE) (kg/10 km)	(CPUE) (Kg h^{-1} m^{-1} beam)
	West Sector		North Sector		South Sector						Carhelmar Survey (UK-WEC-BTS)	FSP survey (FSP-7e)
	Otter	Beam	Otter	Beam	Otter	Beam	Otter	Beam	Otter	Beam		
1972	2.31	-	4.50	-	0.00	-	64.60	-	194.36	-	-	-
1973	2.25	-	3.85	-	0.00	-	69.54	-	200.45	-	-	-
1974	1.65	-	3.47	-	2.94	-	50.09	-	121.03	-	-	-
1975	1.78	-	3.53	-	2.54	-	54.69	-	132.95	-	-	-
1976	1.89	-	3.62	-	4.14	-	56.13	-	144.56	-	-	-
1977	1.37	-	3.10	-	4.96	-	55.40	-	117.72	-	-	-
1978	1.61	5.41	3.63	10.35	4.24	11.84	48.80	22.09	114.02	204.69	-	-
1979	1.84	4.16	4.58	7.37	1.64	6.58	49.92	39.38	142.52	233.81	-	-
1980	2.02	3.15	5.82	6.06	0.67	6.45	49.95	62.16	150.69	335.16	-	-
1981	2.61	4.44	10.98	8.35	7.30	8.33	46.88	65.29	257.28	471.20	-	-
1982	3.28	4.43	10.77	9.23	0.00	7.69	38.51	81.59	249.60	611.52	-	-
1983	2.57	2.76	11.03	9.64	8.10	5.71	52.59	103.07	303.04	612.16	-	-
1984	2.95	4.08	10.92	10.38	2.43	7.80	52.89	87.63	281.94	575.22	-	-
1985	2.60	3.79	8.81	9.00	0.09	6.38	57.69	92.19	255.86	540.61	15.21	-
1986	3.25	6.30	10.94	12.21	10.17	6.85	49.52	76.33	315.08	602.07	16.46	-
1987	3.56	5.37	11.02	9.69	3.63	7.45	45.11	87.05	329.97	672.81	20.59	-
1988	3.90	3.50	15.38	6.51	5.04	4.85	53.40	103.36	433.20	564.72	25.34	-
1989	2.69	6.50	10.87	14.25	1.42	6.88	54.71	109.95	315.73	900.19	14.80	-
1990	2.95	6.52	7.77	15.64	3.55	10.17	53.05	100.95	268.81	990.05	11.60	-
1991	2.80	6.16	5.08	13.24	0.41	7.47	40.79	83.57	152.93	721.46	8.72	-
1992	1.92	6.30	3.51	10.61	3.06	9.69	39.91	80.87	105.41	695.70	7.45	-
1993	1.39	6.14	3.03	11.04	5.46	7.17	39.17	83.92	81.77	655.48	6.16	-
1994	1.46	4.62	2.48	9.17	2.11	6.47	38.77	100.42	63.67	650.99	5.70	-
1995	1.61	4.60	1.99	6.29	2.36	5.40	35.45	100.80	60.20	531.06	5.13	-
1996	2.00	3.09	2.49	6.66	11.62	4.39	30.54	116.45	64.83	482.18	5.97	-
1997	2.69	3.50	3.08	7.16	1.56	5.58	33.28	108.39	99.05	561.74	9.82	-
1998	1.65	2.97	4.13	6.10	1.85	3.03	29.80	111.17	73.30	459.22	8.74	-
1999	1.39	3.49	3.60	8.55	1.11	4.59	27.52	103.56	59.67	576.76	8.42	-
2000	0.81	2.98	4.00	6.63	1.25	3.72	30.49	118.83	61.82	541.33	11.31	-
2001	0.89	2.30	3.03	5.45	3.14	3.61	31.90	143.27	48.82	527.38	10.56	-
2002	0.90	2.90	4.18	6.52	0.56	3.45	28.35	139.83	57.44	651.04	8.05	-
2003	0.96	3.26	2.10	8.18	0.50	2.89	25.06	159.95	36.88	743.07	7.96	0.47
2004	0.88	3.38	2.01	6.16	0.19	2.80	25.58	158.68	37.98	701.17	4.53	0.58
2005	0.88	2.62	2.13	8.20	3.48	2.75	21.13	157.81	29.44	691.27	7.02	0.47
2006	0.96	2.68	3.41	6.97	1.71	2.50	21.06	161.44	28.57	665.16	7.47	0.47
2007	0.68	1.71	1.95	4.55	1.31	2.13	22.35	158.01	27.27	472.27	7.94	0.29
2008	0.94	1.83	2.07	4.88	0.71	2.06	19.86	158.50	25.72	465.09	8.18	0.24
2009	1.26	2.62	2.23	7.58	1.78	3.48	21.41	122.53	32.45	521.17	12.85	0.44
2010	1.68	2.64	2.71	8.55	0.45	3.50	26.06	128.45	52.41	549.64	21.63	0.71
2011	1.88	2.53	5.24	6.75	1.28	2.93	25.16	150.32	53.91	564.04	24.74	0.76

Table 8.2.3. Plaice in VIIe. Annual length distribution by fleet (2011)

	UK (England & Wales)			France	
Length (cm)	Beam trawl	Dredge	All gears (excl. beam+dredge)	Nets	Trawl
23	99		500		
24	290		571		
25	2261		6956		3190
26	7706		14811	711	7976
27	28918		41018	544	23114
28	49173		80282	0	50498
29	116257		143755	2722	89298
30	133826		160710	1117	66275
31	174838		147804	2404	47639
32	163787		131184	4725	64196
33	131132	2954	101949	4632	48101
34	103583	0	75927	3344	35092
35	92675	0	53071	4002	17886
36	73649	1093	35273	4809	16393
37	52727	1093	20846	2930	11203
38	39644	0	16966	1517	11766
39	36905	0	8255	2309	11087
40	26354	0	8025	1484	2942
41	22853	1093	4052	2014	7049
42	18875	0	2832	1153	295
43	14071	0	1985	1858	1380
44	10995	1093	1827	716	0
45	10329	0	770	257	1915
46	6723	1093	1086	326	1768
47	4972	1093	1693	310	5088
48	5125	0	828	292	1031
49	3846	0	149	72	0
50	2999	1093	483	36	2544
51	2390		249	143	884
52	2659		176	0	2544
53	1487		40	72	0
54	909		0	72	0
55	1273		47	0	2544
56	1490		120	0	
57	377		76	203	
58	578		19	54	
59	121		18	18	
60	388		765	36	
61	113			18	
62	170			0	
63	0			18	
64	0			18	
65	52				
66	0				
67	43				
68	0				
69	8				
Total	1346571	10607	1064617	44936	533698

Table 8.2.4 Plaice in VIIe. Catch numbers-at-age.

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1980	1981
AGE		
1	19	41
2	814	723
3	800	2268
4	252	591
5	230	120
6	62	103
7	63	21
8	23	47
9	13	19
+gp	138	95
TOTALNUM	2415	4027
TONSLAND	1215	1746
SOPCOF %	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	72	3	77	3	10	74	12	10	57	41
2	310	790	970	727	1025	1258	1932	352	391	691
3	2131	893	1864	1605	2532	2303	5179	2960	3408	1352
4	1420	1702	702	1399	963	1407	1160	3014	2757	1943
5	263	593	531	157	488	657	464	843	1222	973
6	89	104	197	255	116	233	155	274	272	528
7	83	41	92	142	129	90	116	121	135	106
8	17	50	30	28	68	52	40	97	80	46
9	28	2	33	16	29	45	25	32	57	33
+gp	122	100	51	52	62	52	53	101	73	51
TOTALNUM	4534	4276	4546	4383	5421	6170	9136	7805	8451	5764
TONSLAND	1938	1754	1813	1751	2161	2388	2994	2808	3058	2250
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	90	36	84	6	15	7	7	19	46	6
2	841	844	409	421	1160	963	636	678	399	585
3	1430	1488	1707	818	774	2443	1732	2480	1331	946
4	760	650	878	986	403	486	1158	1219	2069	795
5	654	266	256	269	392	185	159	414	496	950
6	452	272	111	120	127	155	66	94	181	145
7	264	219	119	58	60	80	61	38	38	79
8	72	171	83	84	41	34	23	40	14	19
9	33	40	86	69	48	18	21	17	22	12
+gp	50	86	65	90	107	101	63	46	52	37
TOTALNUM	4646	4071	3797	2920	3127	4472	3926	5046	4648	3574
TONSLAND	1950	1691	1471	1295	1321	1654	1430	1616	1678	1379
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AGE										
1	188	23	21	22	18	3	5	5	18	11
2	1400	1004	600	831	1089	428	1015	742	854	1255
3	1251	1208	1644	1034	1448	1168	781	1359	1035	1529
4	597	622	600	858	543	723	563	295	768	749
5	428	207	349	282	388	287	252	147	205	292
6	511	172	102	146	121	196	107	76	109	78
7	116	224	75	52	60	70	83	30	41	50
8	49	54	96	50	29	30	32	21	15	27
9	13	41	44	53	22	10	15	7	19	11
+gp	42	39	38	44	45	49	28	16	25	20
TOTALNUM	4595	3594	3569	3372	3764	2962	2882	2698	3089	4022
TONSLAND	1608	1478	1402	1370	1466	1184	1144	1065	1241	1505
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 8.2.5 Plaice in VIIe. Catch weights-at-age.

Table 2 Catch weights at age (kg)

YEAR	1980	1981
AGE		
1	0.248	0.144
2	0.337	0.268
3	0.428	0.389
4	0.519	0.507
5	0.612	0.622
6	0.706	0.733
7	0.801	0.841
8	0.898	0.946
9	0.996	1.047
+gp	1.404	1.387
SOPCOFAC	0.9999	1.0007

Table 2 Catch weights at age (kg)

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0.186	0.106	0.136	0.098	0.171	0.252	0.134	0.156	0.236	0.194
2	0.273	0.221	0.238	0.214	0.257	0.288	0.215	0.217	0.267	0.245
3	0.360	0.330	0.343	0.328	0.346	0.337	0.303	0.285	0.308	0.306
4	0.447	0.432	0.447	0.437	0.438	0.403	0.399	0.360	0.359	0.377
5	0.532	0.529	0.550	0.543	0.533	0.480	0.504	0.440	0.421	0.456
6	0.619	0.617	0.654	0.644	0.632	0.572	0.618	0.528	0.493	0.545
7	0.702	0.699	0.757	0.743	0.734	0.679	0.740	0.622	0.577	0.643
8	0.786	0.775	0.861	0.837	0.840	0.799	0.870	0.723	0.670	0.750
9	0.869	0.844	0.965	0.928	0.950	0.933	1.009	0.830	0.775	0.866
+gp	1.217	1.027	1.390	1.253	1.427	1.388	1.357	1.122	1.078	1.221
SOPCOFAC	0.9999	1.0003	1.0000	0.9996	0.9993	0.9997	0.9991	1.0001	0.9996	1.0004

Table 2 Catch weights at age (kg)

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	0.242	0.212	0.201	0.213	0.173	0.188	0.179	0.107	0.117	0.167
2	0.282	0.269	0.258	0.281	0.266	0.259	0.239	0.196	0.204	0.231
3	0.335	0.332	0.322	0.353	0.360	0.334	0.294	0.282	0.290	0.305
4	0.401	0.405	0.391	0.429	0.455	0.412	0.411	0.364	0.375	0.384
5	0.481	0.484	0.464	0.507	0.551	0.494	0.526	0.444	0.459	0.468
6	0.574	0.571	0.543	0.588	0.647	0.580	0.638	0.521	0.542	0.558
7	0.680	0.667	0.628	0.674	0.743	0.669	0.747	0.596	0.624	0.654
8	0.799	0.769	0.717	0.763	0.840	0.762	0.853	0.667	0.705	0.754
9	0.933	0.880	0.812	0.855	0.938	0.860	0.958	0.735	0.784	0.861
+gp	1.317	1.202	1.117	1.055	1.170	1.110	1.274	0.950	1.029	1.272
SOPCOFAC	0.9996	1.0000	1.0002	0.9998	1.0006	0.9992	1.0004	1.0000	0.9997	1.0001

Table 2 Catch weights at age (kg)

YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AGE										
1	0.193	0.147	0.254	0.226	0.206	0.186	0.208	0.098	0.180	0.120
2	0.246	0.250	0.293	0.287	0.276	0.259	0.279	0.239	0.268	0.234
3	0.306	0.352	0.342	0.354	0.352	0.334	0.356	0.376	0.361	0.348
4	0.372	0.450	0.400	0.426	0.434	0.412	0.438	0.507	0.458	0.464
5	0.446	0.548	0.468	0.504	0.521	0.493	0.526	0.634	0.560	0.581
6	0.525	0.641	0.545	0.586	0.614	0.577	0.619	0.757	0.666	0.700
7	0.612	0.734	0.632	0.674	0.712	0.663	0.718	0.874	0.776	0.819
8	0.706	0.822	0.728	0.766	0.814	0.752	0.822	0.987	0.891	0.940
9	0.806	0.910	0.833	0.864	0.923	0.844	0.932	1.096	1.011	1.061
+gp	1.137	1.231	1.189	1.106	1.165	1.095	1.270	1.336	1.262	1.367
SOPCOFAC	0.9998	1.0003	1.0005	1.0002	1.0003	1.0001	1.0002	1.0000	1.0003	1.0004

Table 8.2.6 Plaice in VIIe. Stock weights-at-age.

Table 3 Stock weights at age (kg)

YEAR	1980	1981
AGE		
1	0.114	0.126
2	0.227	0.250
3	0.338	0.373
4	0.447	0.492
5	0.554	0.609
6	0.660	0.725
7	0.764	0.838
8	0.867	0.949
9	0.967	1.057
+gp	1.351	1.435

Table 3 Stock weights at age (kg)

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0.108	0.116	0.111	0.112	0.096	0.068	0.103	0.138	0.236	0.182
2	0.214	0.228	0.222	0.222	0.195	0.145	0.184	0.200	0.262	0.232
3	0.318	0.335	0.334	0.331	0.297	0.232	0.275	0.270	0.300	0.292
4	0.419	0.436	0.446	0.438	0.401	0.326	0.373	0.347	0.349	0.362
5	0.517	0.532	0.560	0.543	0.507	0.429	0.481	0.431	0.408	0.442
6	0.615	0.623	0.673	0.647	0.615	0.539	0.598	0.522	0.479	0.531
7	0.710	0.710	0.788	0.749	0.727	0.659	0.723	0.620	0.561	0.631
8	0.802	0.791	0.903	0.849	0.840	0.788	0.858	0.725	0.654	0.740
9	0.893	0.867	1.018	0.948	0.955	0.924	1.002	0.837	0.758	0.858
+gp	1.255	1.094	1.498	1.329	1.442	1.347	1.363	1.143	1.064	1.223

Table 3 Stock weights at age (kg)

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	0.235	0.188	0.188	0.191	0.134	0.171	0.169	0.069	0.082	0.139
2	0.269	0.241	0.248	0.262	0.233	0.248	0.225	0.171	0.181	0.204
3	0.317	0.302	0.314	0.336	0.333	0.329	0.254	0.270	0.279	0.277
4	0.378	0.371	0.385	0.413	0.434	0.414	0.382	0.365	0.376	0.356
5	0.454	0.447	0.462	0.495	0.535	0.503	0.507	0.457	0.472	0.441
6	0.543	0.531	0.545	0.580	0.637	0.596	0.629	0.545	0.567	0.531
7	0.646	0.623	0.633	0.668	0.739	0.694	0.749	0.631	0.660	0.627
8	0.763	0.723	0.728	0.760	0.842	0.795	0.866	0.712	0.752	0.729
9	0.893	0.830	0.828	0.856	0.945	0.901	0.980	0.791	0.842	0.836
+gp	1.274	1.145	1.150	1.064	1.191	1.176	1.326	1.040	1.122	1.253

Table 3 Stock weights at age (kg)

YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AGE										
1	0.180	0.100	0.246	0.205	0.177	0.156	0.175	0.026	0.138	0.064
2	0.233	0.211	0.282	0.266	0.248	0.229	0.243	0.169	0.224	0.177
3	0.293	0.319	0.327	0.334	0.323	0.305	0.317	0.308	0.314	0.291
4	0.360	0.425	0.383	0.406	0.405	0.385	0.396	0.442	0.409	0.406
5	0.435	0.529	0.448	0.484	0.492	0.467	0.481	0.571	0.508	0.523
6	0.516	0.630	0.523	0.567	0.584	0.551	0.572	0.696	0.612	0.640
7	0.605	0.728	0.608	0.656	0.682	0.639	0.668	0.816	0.721	0.759
8	0.701	0.824	0.702	0.749	0.786	0.730	0.769	0.931	0.833	0.879
9	0.805	0.918	0.807	0.849	0.895	0.823	0.876	1.042	0.950	1.000
+gp	1.148	1.263	1.160	1.095	1.139	1.078	1.207	1.288	1.197	1.123

Table 8.2.7 UK-WEC-BTS effort standardised plaice abundance indices

age	0	1	2	3	4	5	6	7	8	9	10+
year											
1985	0.00	82.16	75.37	72.36	113.06	20.35	15.83	8.29	0.75	0.00	2.26
1986	0.00	61.62	86.67	168.60	64.33	23.70	2.71	12.19	1.35	0.00	1.35
1987	0.74	398.98	110.17	104.21	54.34	27.54	21.59	10.42	5.95	5.95	2.98
1988	0.00	108.40	289.33	265.15	75.65	17.16	8.58	7.80	3.12	4.68	3.12
1989	0.00	18.71	42.26	169.63	113.49	13.88	6.64	8.45	4.83	3.62	10.87
1990	0.00	14.23	21.63	125.24	49.53	42.70	1.14	3.42	0.57	3.42	3.98
1991	1.16	12.81	15.73	36.70	46.02	36.11	23.88	5.24	0.00	0.58	1.75
1992	0.00	77.31	22.38	36.62	12.21	20.35	10.17	8.65	1.53	2.54	2.03
1993	0.00	11.10	37.00	31.71	12.69	6.87	13.21	6.87	5.81	1.06	1.06
1994	0.00	16.52	15.54	47.60	14.57	4.86	0.97	4.37	6.31	3.89	0.97
1995	0.00	26.72	24.58	24.04	25.65	6.41	2.14	2.67	3.21	0.53	2.14
1996	0.54	17.90	57.49	16.27	9.22	13.56	2.71	0.54	1.63	3.80	4.34
1997	0.00	28.69	66.04	106.63	12.99	3.25	6.50	3.79	0.54	0.54	3.79
1998	0.00	43.67	67.39	67.39	45.83	4.85	3.23	3.77	2.16	0.00	1.62
1999	0.53	20.22	23.42	96.86	28.21	15.97	1.60	1.06	3.19	2.13	1.06
2000	0.00	26.57	34.79	69.51	99.00	21.13	12.30	0.60	1.11	0.00	2.77
2001	11.52	17.91	35.78	28.65	62.57	54.75	13.79	7.08	0.00	1.69	2.81
2002	0.00	76.78	56.50	48.17	12.91	13.06	22.18	2.97	1.11	0.00	1.11
2003	0.00	15.82	75.35	32.84	27.52	2.47	9.91	14.86	3.96	0.00	1.10
2004	0.00	6.71	19.82	35.67	14.03	6.10	1.83	0.61	6.10	0.00	2.44
2005	0.80	16.31	40.42	48.71	37.42	6.90	1.71	1.43	2.81	1.18	1.47
2006	0.00	29.77	55.43	55.78	16.45	16.89	1.44	2.06	0.00	2.44	1.08
2007	0.00	20.44	50.35	66.58	18.67	14.93	3.31	3.04	0.28	1.38	2.21
2008	0.00	8.54	83.46	38.71	17.67	6.87	4.48	5.44	2.00	0.57	1.72
2009	1.74	9.40	90.88	124.18	16.93	8.50	6.36	4.65	2.68	0.58	1.45
2010	7.78	102.40	194.97	124.64	62.66	17.25	8.36	9.17	0.56	1.85	2.22
2011	0.00	118.05	328.50	199.49	53.58	31.14	4.97	4.69	1.70	0.57	3.69

Table 8.2.8 Plaice in VIIe. Tuning fleet data available (data in bold have been used for tuning)

W.CHANNEL PLAICE 2012 WGCSE									
105	**idh**	**09/05/2012**							
UK-WEC-BTS									
1986	**2011**								
1	**1**	**0.75**	**0.8**						
1	**8**								
147.68	**91**	**128**	**249**	**95**	**35**	**4**	**18**	**2**	0
134.34	**536**	**148**	**140**	**73**	**37**	**29**	**14**	**8**	8
128.23	**139**	**371**	**340**	**97**	**22**	**11**	**10**	**4**	6
165.66	**31**	**70**	**281**	**188**	**23**	**11**	**14**	**8**	6
175.66	**25**	**38**	**220**	**87**	**75**	**2**	**6**	**1**	6
171.68	**22**	**27**	**63**	**79**	**62**	**41**	**9**	**0**	1
196.6	**152**	**44**	**72**	**24**	**40**	**20**	**17**	**3**	5
189.19	**21**	**70**	**60**	**24**	**13**	**25**	**13**	**11**	2
205.87	**34**	**32**	**98**	**30**	**10**	**2**	**9**	**13**	8
187.15	**50**	**46**	**45**	**48**	**12**	**4**	**5**	**6**	1
184.37	**33**	**106**	**30**	**17**	**25**	**5**	**1**	**3**	7
184.74	**53**	**122**	**197**	**24**	**6**	**12**	**7**	**1**	1
185.49	**81**	**125**	**125**	**85**	**9**	**6**	**7**	**4**	0
187.89	**38**	**44**	**182**	**53**	**30**	**3**	**2**	**6**	4
180.37	**48**	**63**	**125**	**179**	**38**	**22**	**1**	**2**	0
177.98	**32**	**64**	**51**	**111**	**97**	**25**	**13**	**0**	3
179.74	**138**	**102**	**87**	**23**	**23**	**40**	**5**	**2**	0
182.24	**29**	**137**	**60**	**50**	**5**	**18**	**27**	**7**	0
163.99	**11**	**33**	**59**	**23**	**10**	**3**	**1**	**10**	0
186.6	**30**	**75**	**91**	**70**	**13**	**3**	**3**	**5**	2
184.74	**55**	**102**	**103**	**30**	**31**	**3**	**4**	**0**	5
181.02	**37**	**91**	**121**	**34**	**27**	**6**	**6**	**1**	3
174.66	**15**	**146**	**68**	**31**	**12**	**8**	**10**	**4**	1
172.05	**16**	**156**	**214**	**29**	**15**	**11**	**8**	**5**	1
179.93	**184**	**351**	**224**	**113**	**31**	**15**	**16**	**1**	3
176.18	**208**	**579**	**351**	**94**	**55**	**9**	**8**	**3**	1
UK-WECOT									
1988	**2011**								
1	**1**	**0**	**1**						
3	**9**								
53.402	**754.5**	**116.9**	**51.5**	**15.1**	**10**	**3.4**	**1.9**		
54.707	**494**	**359.7**	**77**	**26.5**	**7**	**5.9**	**0.8**		
53.05	**347.1**	**265.9**	**85.3**	**18.4**	**11.3**	**6**	**2.8**		
40.789	**89.5**	**134.9**	**64.8**	**30.3**	**6.3**	**2.7**	**1.9**		
39.909	**71.7**	**46.3**	**40.1**	**25.5**	**12.9**	**3.9**	**1.3**		
39.24	**76.1**	**33.1**	**12**	**12.2**	**9.8**	**7.7**	**1.7**		
38.768	**86.1**	**37.1**	**9.8**	**3.5**	**4.4**	**2.4**	**2.7**		
35.453	**47.8**	**48.8**	**10.8**	**5.7**	**1.3**	**2.7**	**2.2**		
30.541	**39.8**	**16.3**	**14.5**	**4**	**2**	**1**	**1.2**		
33.281	**180.1**	**14.6**	**5.5**	**4.3**	**1.6**	**0.6**	**0.3**		
29.802	**96.2**	**61.3**	**6.4**	**2.4**	**1.6**	**0.4**	**0.5**		
27.516	**90.1**	**34.6**	**14.3**	**2.8**	**1.1**	**0.9**	**0.3**		
30.493	**49.6**	**64.4**	**13.3**	**6.5**	**1.3**	**0.5**	**0.8**		
31.9	**31.3**	**29.3**	**31.5**	**4.4**	**2.6**	**0.5**	**0.3**		
28.346	**57.1**	**17.9**	**12.6**	**15.6**	**3.3**	**1.4**	**0.5**		
25.06	**33.2**	**15.8**	**5.1**	**3.5**	**4.3**	**1.2**	**0.6**		
25.584	**50.7**	**18.2**	**10.5**	**2.8**	**1.4**	**2.1**	**1.1**		
21.129	**24.1**	**17.6**	**5.7**	**2.6**	**0.8**	**0.8**	**0.8**		
21.058	**32.4**	**9.9**	**6.5**	**1.9**	**1**	**0.4**	**0.3**		
22.347	**36.6**	**18.6**	**5.3**	**2.8**	**1**	**0.3**	**0.1**		
19.855	**19.2**	**12.2**	**5.4**	**1.9**	**1.2**	**0.6**	**0.3**		
21.412	**43.7**	**8.6**	**3.5**	**1.8**	**0.7**	**0.5**	**0.1**		
26.062	**49**	**36.6**	**7.7**	**3**	**1.1**	**0.4**	**0.3**		
25.161	**66.4**	**28.6**	**6.8**	**1.4**	**0.9**	**0.4**	**0.1**		

Table 8.2.8 (Cont.) Plaice in VIIe. Tuning fleet data available (data in bold have been used for tuning)

UK-WECBT								
1989	2011							
1	1	0	1					
3	9							
109.947	922.6	784.7	210.1	96.9	48.9	35.2	7.5	
100.947	1053.9	826.9	326.5	77.2	54.4	23.5	13.1	
83.574	365.7	641.3	355.6	159.9	35.7	11.3	8.1	
80.865	465.5	308	293.7	172	89.2	25.9	9.7	
83.918	543.6	248.2	102.7	114.7	89.6	66.6	14.3	
100.415	659	312.7	104.4	43.1	53.3	34.7	38	
100.797	285.7	343.6	101.6	51.4	18.9	34.3	33.5	
116.446	221.8	115	126.4	41.1	21.5	12.6	19.2	
108.388	683.6	76.7	43.9	46.9	20.7	9.6	5.4	
111.171	413.3	297.9	48.6	26.1	26.7	8.8	8.8	
103.555	747.8	274.5	135.3	40	14.4	16	8	
118.833	388.4	529.8	111.8	54.7	11	5.4	6.8	
143.272	248.7	283.6	393.2	61	35	7.4	4	
139.832	497.3	164.6	148.5	197.6	46.8	19.2	4.5	
159.894	495.5	260.2	95	81.9	116.1	26.8	22.9	
158.681	690	299.6	168.3	49.9	40.1	51.6	24.9	
157.812	464.1	355.3	136.4	71.6	24.9	23	27.3	
161.44	599	202.1	159.3	52.5	27.5	11.2	8.3	
158.005	416.7	246.1	100.2	67.6	27.3	13.2	4.3	
158.501	261.7	187.1	94.7	41.4	25.5	14.1	6.3	
122.528	617.7	135.5	63.3	34.8	11.4	10.4	4	
128.448	388.1	291	89.4	50.2	19.3	7.3	9	
150.323	473.8	276.2	112.4	36.8	26.8	13.3	6.7	
UK-WECOT (historic)								
1976	1987							
1	1	0	1					
2	9							
22.771	13.7	80.4	20.2	14.2	7.5	7.7	4.8	1.8
21.194	60.1	29.4	25.8	8.1	4.8	3	4.5	1.4
16.823	18.8	71.1	8	10.6	3.8	2.3	2	1.6
16.981	42.5	57.1	44.5	5.7	6.1	2.9	1.9	1.2
13.647	53.1	50.8	14.7	13.4	4	4.2	1.4	1
15.172	76.6	216.2	44.4	11	10.3	1.8	5	1.6
14.422	27	169.1	111.9	19.5	7.1	7.3	1.1	2.6
19.117	103.7	102.2	173.4	75.3	12.4	4.8	5.5	0.3
15.8	100.5	155	49.7	40.6	16.3	7.7	2.2	3.2
17.545	60.5	129.6	102.4	12.9	21.2	13.4	2.1	0.4
20.758	108.3	254.8	77.8	44.1	8.2	12.9	7.4	3.3
17.995	116.3	208.7	124.7	62.2	22	5.6	4.2	4.1
UK(E+W) FSP								
2003	2011							
1	1	0.75	0.8					
2	8							
1	0.295	0.320	0.159	0.061	0.047	0.090	0.038	0.025
1	0.288	0.567	0.220	0.130	0.022	0.038	0.047	0.019
1	0.296	0.362	0.235	0.086	0.044	0.010	0.016	0.032
1	0.492	0.375	0.175	0.097	0.036	0.027	0.006	0.008
1	0.132	0.294	0.139	0.068	0.034	0.010	0.006	0.005
-9	-9	-9	-9	-9	-9	-9	-9	-9
1	0.362	0.373	0.153	0.049	0.028	0.019	0.006	0.003
1	0.711	0.567	0.436	0.046	0.034	0.014	0.010	0.003
1	0.953	1.206	0.304	0.146	0.017	0.012	0.016	0.002

Table 8.2.9. Plaice in VIIe Diagnostics.

```
Lowestoft VPA Version 3.1

   9/05/2012  17:24

Extended Survivors Analysis

W.CHANNEL PLAICE 2012 WGCSE

CPUE data from file c:\vpa\ple7etu5.dat

Catch data for  32 years. 1980 to 2011. Ages  1 to  10.

     Fleet,           First, Last, First, Last, Alpha,  Beta
                  ,    year, year,  age ,  age
UK-WEC-BTS         ,   1986, 2011,   1,     8,   .750,   .800
UK WECOT           ,   1988, 2011,   3,     9,   .000,  1.000
UK WECBT           ,   1989, 2011,   3,     9,   .000,  1.000
UK WECOT historic  ,   1980, 2011,   2,     9,   .000,  1.000
FSP-7e   UK(E+W)   ,   2003, 2011,   2,     8,   .750,   .800


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   4 oldest ages.

     S.E. of the mean to which the estimates  are shrunk =   2.500

     Minimum standard error for population
     estimates derived from each fleet =    .500

     Prior weighting not applied


Tuning converged after   28 iterations



Regression weights
      , 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000



Fishing mortalities
   Age,  2002,  2003,  2004,  2005,  2006,  2007,  2008,  2009,  2010,  2011

     1,  .032,  .006,  .005,  .005,  .007,  .000,  .001,  .001,  .001,  .000
     2,  .387,  .219,  .209,  .227,  .345,  .206,  .235,  .188,  .134,  .077
     3,  .587,  .615,  .602,  .600,  .697,  .691,  .638,  .510,  .393,  .342
     4,  .769,  .593,  .647,  .666,  .667,  .838,  .780,  .479,  .551,  .499
     5,  .688,  .601,  .719,  .656,  .658,  .834,  .726,  .425,  .653,  .378
     6,  .648,  .596,  .615,  .688,  .594,  .752,  .797,  .448,  .591,  .506
     7,  .501,  .597,  .509,  .663,  .614,  .750,  .767,  .478,  .426,  .536
     8,  .461,  .421,  .502,  .698,  .905,  .654,  .868,  .392,  .434,  .508
     9,  .632,  .812,  .651,  .516,  .696,  .783,  .717,  .449,  .676,  .607


XSA population numbers (Thousands)

                                    AGE
YEAR ,          1,         2,         3,         4,         5,         6,         7,         8,         9,

2002 ,    6.31E+03, 4.63E+03, 2.99E+03, 1.18E+03, 9.13E+02, 1.14E+03, 3.13E+02, 1.42E+02, 2.83E+01,
2003 ,    3.84E+03, 5.42E+03, 2.79E+03, 1.48E+03, 4.86E+02, 4.07E+02, 5.28E+02, 1.68E+02, 7.92E+01,
2004 ,    4.91E+03, 3.38E+03, 3.86E+03, 1.34E+03, 7.23E+02, 2.36E+02, 1.99E+02, 2.58E+02, 9.79E+01,
2005 ,    4.49E+03, 4.34E+03, 2.43E+03, 1.88E+03, 6.21E+02, 3.12E+02, 1.13E+02, 1.06E+02, 1.38E+02,
2006 ,    2.77E+03, 3.96E+03, 3.06E+03, 1.19E+03, 8.55E+02, 2.86E+02, 1.39E+02, 5.18E+01, 4.68E+01,
2007 ,    5.81E+03, 2.44E+03, 2.49E+03, 1.35E+03, 5.39E+02, 3.93E+02, 1.40E+02, 6.69E+01, 1.86E+01,
2008 ,    5.19E+03, 5.15E+03, 1.76E+03, 1.10E+03, 5.20E+02, 2.08E+02, 1.64E+02, 5.87E+01, 3.08E+01,
2009 ,    8.15E+03, 4.60E+03, 3.61E+03, 8.24E+02, 4.49E+02, 2.23E+02, 8.30E+01, 6.76E+01, 2.18E+01,
2010 ,    2.03E+04, 7.22E+03, 3.38E+03, 1.93E+03, 4.53E+02, 2.60E+02, 1.26E+02, 4.57E+01, 4.05E+01,
2011 ,    2.33E+04, 1.80E+04, 5.60E+03, 2.02E+03, 9.84E+02, 2.09E+02, 1.28E+02, 7.32E+01, 2.62E+01,
```

Table 8.2.9. Plaice in VIIe Diagnostics (continued).

Estimated population abundance at 1st Jan 2012

, 0.00E+00, 2.06E+04, 1.48E+04, 3.53E+03, 1.09E+03, 5.98E+02, 1.12E+02, 6.63E+01, 3.90E+01,

Taper weighted geometric mean of the VPA populations:

, 6.49E+03, 5.54E+03, 3.92E+03, 1.91E+03, 8.47E+02, 3.93E+02, 2.08E+02, 1.10E+02, 5.71E+01,

Standard error of the weighted Log(VPA populations) :

, .5445, .4982, .4906, .5537, .5492, .5827, .6175, .6559, .7496,

Log catchability residuals.

Fleet : UK-WEC-BTS

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	99.99	99.99	99.99	99.99	-.26	1.83	.84	-.06	-.40	-.63
2	99.99	99.99	99.99	99.99	.12	-.40	.86	-.85	-.62	-.94
3	99.99	99.99	99.99	99.99	.55	.01	.20	-.05	-.02	-.32
4	99.99	99.99	99.99	99.99	.38	.24	.32	.11	-.49	-.15
5	99.99	99.99	99.99	99.99	.11	.46	-.13	-.44	-.04	.05
6	99.99	99.99	99.99	99.99	-.64	.79	.07	-.17	-1.99	.22
7	99.99	99.99	99.99	99.99	.76	1.02	-.07	.28	-.46	-.24
8	99.99	99.99	99.99	99.99	-.94	.60	.45	.04	-1.74	99.99
9	No data for this fleet at this age									

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	1.03	-.14	.22	-.29	-.58	-.54	.61	.27	.28	-.26
2	-.70	-.36	-.44	-.02	-.17	.08	-.41	-.67	.14	-.08
3	-.26	-.57	-.34	-.20	-.69	.29	-.21	-.46	.11	-.32
4	-.57	-.52	-.45	-.13	-.38	-.09	.30	-.30	.24	.70
5	-.08	-.27	-.65	-.40	.15	-.50	-.27	.11	.30	.46
6	-.32	.36	-1.35	-.58	-.36	.36	.40	-.42	.73	.66
7	-.57	-.40	-.53	-.04	-1.63	.47	.07	-.34	-1.14	.45
8	-.90	-.37	.02	-.25	.28	-.95	.54	.51	.28	99.99
9	No data for this fleet at this age									

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	1.03	-.07	-1.18	-.22	.88	-.24	-.99	-1.37	.12	.13
2	.40	.39	-.46	.00	.50	.78	.56	.72	.99	.56
3	-.02	-.32	-.56	.20	.18	.57	.33	.67	.65	.58
4	-.29	.11	-.42	.24	-.13	.01	.11	.12	.64	.39
5	.01	-.97	-.47	-.24	.32	.80	-.02	.13	.98	.59
6	.53	.71	-.42	-.77	-.75	-.23	.77	.76	.98	.65
7	-.70	.52	-1.76	-.11	-.06	.47	.87	1.12	1.31	.71
8	-.86	.18	.28	.49	99.99	-.66	1.06	.79	-.44	.27
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	6	7	8
Mean Log q	-9.9217	-9.0140	-8.1585	-8.1520	-8.2573	-8.4771	-8.1442	-8.1442
S.E(Log q)	.7309	.5628	.4028	.3587	.4485	.7414	.7900	.6945

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	.90	.422	9.81	.44	26	.67	-9.92
2	.91	.465	8.98	.52	26	.52	-9.01
3	.91	.610	8.17	.67	26	.37	-8.16
4	.89	.960	8.09	.76	26	.32	-8.15
5	.88	.870	8.08	.68	26	.40	-8.26
6	1.02	-.063	8.52	.37	26	.77	-8.48
7	1.25	-.753	8.83	.28	26	.99	-8.14
8	1.48	-1.454	9.81	.31	23	1.00	-8.20

Table 8.2.9. Plaice in VIIe Diagnostics (continued).

Fleet : UK WECOT

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	99.99	99.99	99.99	99.99	99.99	99.99	.59	.39	.34	.17
4	99.99	99.99	99.99	99.99	99.99	99.99	.09	.52	.45	.44
5	99.99	99.99	99.99	99.99	99.99	99.99	.41	.60	.07	.31
6	99.99	99.99	99.99	99.99	99.99	99.99	.10	.57	.20	.15
7	99.99	99.99	99.99	99.99	99.99	99.99	.14	.00	.63	.16
8	99.99	99.99	99.99	99.99	99.99	99.99	.45	.14	.51	.07
9	99.99	99.99	99.99	99.99	99.99	99.99	-.12	-.26	.08	.28

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	.01	-.06	-.09	.21	.11	.59	.09	-.47	-.30	-.37
4	.30	.03	.03	.17	.03	-.25	.43	-.17	-.33	-.23
5	.29	.00	-.21	-.06	.16	-.12	.02	.07	-.21	-.16
6	.29	.00	-.33	.22	-.02	-.19	.09	.17	.07	-.53
7	.06	.18	-.25	-.43	.14	-.09	-.27	.24	.18	-.12
8	.26	.14	-.66	-.09	.18	-.48	-.63	-.18	-.01	-.20
9	-.12	.03	-.30	-.13	-.12	-.21	.24	-.17	.23	.07

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	.11	-.23	-.15	-.25	-.13	.14	-.07	-.10	-.17	-.36
4	-.07	-.37	-.13	-.30	-.41	.10	-.03	-.29	.14	-.14
5	.01	-.18	.17	-.12	-.30	-.03	.10	-.40	.28	-.70
6	.18	-.19	.12	-.01	-.28	-.20	.19	-.16	.06	-.48
7	.02	-.07	-.28	-.02	-.02	-.02	.13	.07	-.12	-.25
8	-.06	-.28	-.14	.06	.18	-.53	.50	-.10	-.11	-.52
9	.59	-.05	.25	-.28	-.10	-.29	.39	-.56	-.17	-.83

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
Mean Log q	-7.0823	-7.0503	-7.2585	-7.4503	-7.6213	-7.6213	-7.6213
S.E(Log q)	.2852	.2791	.2795	.2550	.2210	.3434	.3140

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	.84	1.708	7.26	.84	24	.23	-7.08
4	.80	2.806	7.15	.90	24	.20	-7.05
5	.87	1.492	7.19	.86	24	.24	-7.26
6	.88	1.638	7.27	.89	24	.22	-7.45
7	.95	.642	7.52	.90	24	.21	-7.62
8	.95	.520	7.53	.82	24	.32	-7.68
9	.97	.317	7.59	.86	24	.30	-7.69

Table 8.2.9 Plaice in VIIe Diagnostics (continued).

Fleet : UK WECBT

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.29	.19	.25
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.15	.19	.53
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.05	-.19	.34
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.04	-.15	-.04
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.01	.30	-.08
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.03	-.02	-.47
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.02	-.28	-.25

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	.56	.54	.38	.35	-.12	.13	-.38	-.29	-.21	-.41
4	.74	.53	.46	.33	-.10	-.52	-.06	-.17	-.33	-.21
5	.62	.43	.25	.18	.03	-.19	-.22	.04	-.40	-.10
6	.35	.34	.09	.23	-.17	-.12	.02	.37	-.30	-.54
7	.03	.37	.03	-.06	-.08	.03	-.03	.23	-.30	-.28
8	.18	.28	-.20	.15	.12	-.14	-.11	.12	-.25	-.26
9	-.07	.14	.14	.29	.06	.24	.54	.53	-.25	-.10

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	.07	.01	.02	.09	.14	.00	-.14	.20	-.30	-.79
4	-.20	-.17	.10	-.06	-.18	-.03	-.12	-.03	-.13	-.41
5	-.08	-.07	.17	.09	-.10	-.01	-.07	-.21	.18	-.64
6	-.02	-.03	.04	.15	-.13	-.11	.06	-.08	.15	-.14
7	-.18	.11	-.01	.15	.00	.07	-.15	-.15	-.11	.10
8	-.30	-.29	-.02	.16	.22	.04	.33	-.07	-.06	-.06
9	-.06	.48	.29	-.02	-.07	.26	.10	.13	.38	.33

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
Mean Log q	-6.4725	-6.3006	-6.3007	-6.3123	-6.3639	-6.3639	-6.3639
S.E(Log q)	.3260	.3218	.2717	.2126	.1674	.2084	.2720

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	1.21	-1.138	6.12	.59	23	.39	-6.47
4	.96	.368	6.35	.77	23	.31	-6.30
5	.97	.276	6.31	.83	23	.27	-6.30
6	1.00	-.021	6.31	.89	23	.22	-6.31
7	.93	1.344	6.29	.95	23	.15	-6.36
8	.98	.338	6.36	.92	23	.21	-6.39
9	1.07	-.933	6.39	.90	23	.26	-6.24

Table 8.2.9. Plaice in VIIe Diagnostics (continued).

Fleet : UK WECOT historic

Age	1980	1981
1	No data for this fleet at this age	
2	-.16	.08
3	-.25	.26
4	-.37	-.02
5	-.34	-.03
6	.38	-.12
7	-.41	.14
8	-.39	.16
9	.00	.23

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	No data for this fleet at this age									
2	-.06	.25	.54	-.30	.09	-.44	99.99	99.99	99.99	99.99
3	.02	.08	-.06	-.18	.12	.03	99.99	99.99	99.99	99.99
4	.22	.35	.11	-.05	-.40	.17	99.99	99.99	99.99	99.99
5	.05	.50	.08	-.50	-.18	.42	99.99	99.99	99.99	99.99
6	.29	.00	-.08	.11	-.53	-.05	99.99	99.99	99.99	99.99
7	-.02	.19	.23	.11	.02	-.26	99.99	99.99	99.99	99.99
8	.54	-.05	.34	-.57	-.02	-.36	99.99	99.99	99.99	99.99
9	.11	-.24	.17	-.41	.30	.19	99.99	99.99	99.99	99.99

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
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

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
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

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	-7.2667	-5.9582	-5.8025	-5.9626	-6.0633	-5.9747	-5.9747	-5.9747
S.E(Log q)	.3116	.1647	.2704	.3452	.2795	.2258	.3852	.2526

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.43	-1.130	6.58	.54	8	.44	-7.27
3	.83	1.325	6.37	.91	8	.13	-5.96
4	.79	1.603	6.19	.91	8	.19	-5.80
5	.73	1.527	6.18	.84	8	.23	-5.96
6	1.32	-1.443	6.10	.77	8	.34	-6.06
7	1.12	-.734	6.06	.87	8	.26	-5.97
8	1.47	-1.568	6.69	.65	8	.51	-6.02
9	.81	2.977	5.53	.98	8	.14	-5.93

Table 8.2.9. Plaice in VIIe Diagnostics (continued).

Fleet : FSP-7e UK(E+W)

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	No data for this fleet at this age									
2	99.99	-.29	.15	-.06	.63	-.30	99.99	.06	.24	-.43
3	99.99	-.14	.09	.11	-.01	-.05	99.99	-.33	.07	.28
4	99.99	-.33	.14	-.12	.05	-.19	99.99	.13	.38	-.07
5	99.99	-.03	.42	.11	-.09	.15	99.99	-.31	-.20	-.04
6	99.99	.04	-.16	.31	.13	-.12	99.99	.01	.16	-.38
7	99.99	.27	.32	-.34	.41	-.48	99.99	.47	-.29	-.37
8	99.99	.42	.27	.23	.12	-.33	99.99	-.54	.40	.45
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	2	3	4	5	6	7	8
Mean Log q	-9.2665	-8.3608	-8.2568	-8.3911	-8.5547	-8.3934	-8.3934
S.E(Log q)	.3477	.1822	.2217	.2260	.2154	.4027	.3914

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.23	-.829	9.43	.69	8	.44	-9.27
3	.79	1.081	8.30	.81	8	.14	-8.36
4	1.05	-.160	8.31	.62	8	.25	-8.26
5	.79	.935	7.97	.76	8	.18	-8.39
6	.77	.928	7.87	.72	8	.17	-8.55
7	.86	.576	7.91	.73	8	.36	-8.39
8	.86	.698	7.72	.80	8	.33	-8.27

Table 8.2.9. Plaice in VIIe Diagnostics (continued).

Terminal year survivor and F summaries:

Age 1 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
UK-WEC-BTS	,	23403.,	.745,	.000,	.00,	1,	.918,	.000
UK WECOT	,	1.,	.000,	.000,	.00,	0,	.000,	.000
UK WECBT	,	1.,	.000,	.000,	.00,	0,	.000,	.000
UK WECOT historic	,	1.,	.000,	.000,	.00,	0,	.000,	.000
FSP-7e UK(E+W)	,	1.,	.000,	.000,	.00,	0,	.000,	.000
F shrinkage mean	,	4965.,	2.50,,,,				.082,	.002

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
20623.,	.71,	.44,	2,	.620,	.000

Age 2 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
UK-WEC-BTS	,	21938.,	.454,	.212,	.47,	2,	.537,	.052
UK WECOT	,	1.,	.000,	.000,	.00,	0,	.000,	.000
UK WECBT	,	1.,	.000,	.000,	.00,	0,	.000,	.000
UK WECOT historic	,	1.,	.000,	.000,	.00,	0,	.000,	.000
FSP-7e UK(E+W)	,	9644.,	.500,	.000,	.00,	1,	.444,	.116
F shrinkage mean	,	4749.,	2.50,,,,				.019,	.222

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
14794.,	.33,	.27,	4,	.802,	.077

Age 3 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
UK-WEC-BTS	,	4953.,	.337,	.601,	1.78,	3,	.344,	.255
UK WECOT	,	2472.,	.500,	.000,	.00,	1,	.167,	.459
UK WECBT	,	1604.,	.500,	.000,	.00,	1,	.167,	.641
UK WECOT historic	,	1.,	.000,	.000,	.00,	0,	.000,	.000
FSP-7e UK(E+W)	,	4565.,	.354,	.019,	.05,	2,	.313,	.274
F shrinkage mean	,	1797.,	2.50,,,,				.009,	.589

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
3528.,	.20,	.25,	8,	1.247,	.342

Table 8.2.9. Plaice in VIIe Diagnostics (continued).

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2007

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
UK-WEC-BTS	,	1588.,	.288,	.285,	.99,	4,	.294,	.368
UK WECOT	,	937.,	.360,	.013,	.04,	2,	.209,	.561
UK WECBT	,	755.,	.360,	.053,	.15,	2,	.209,	.660
UK WECOT historic	,	1.,	.000,	.000,	.00,	0,	.000,	.000
FSP-7e UK(E+W)	,	1094.,	.298,	.045,	.15,	3,	.279,	.498
F shrinkage mean	,	745.,	2.50,,,,				.008,	.666

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
1090.,	.16,	.12,	12,	.724,	.499

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2006

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
UK-WEC-BTS	,	1055.,	.276,	.099,	.36,	5,	.279,	.231
UK WECOT	,	426.,	.313,	.273,	.87,	3,	.238,	.498
UK WECBT	,	427.,	.313,	.238,	.76,	3,	.238,	.497
UK WECOT historic	,	1.,	.000,	.000,	.00,	0,	.000,	.000
FSP-7e UK(E+W)	,	620.,	.313,	.178,	.57,	3,	.238,	.367
F shrinkage mean	,	292.,	2.50,,,,				.007,	.663

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
598.,	.15,	.13,	15,	.859,	.378

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 2005

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
UK-WEC-BTS	,	211.,	.287,	.145,	.50,	6,	.210,	.300
UK WECOT	,	90.,	.294,	.186,	.63,	4,	.262,	.600
UK WECBT	,	107.,	.294,	.079,	.27,	4,	.262,	.522
UK WECOT historic	,	1.,	.000,	.000,	.00,	0,	.000,	.000
FSP-7e UK(E+W)	,	88.,	.298,	.104,	.35,	4,	.258,	.611
F shrinkage mean	,	82.,	2.50,,,,				.009,	.640

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
112.,	.15,	.10,	19,	.669,	.506

Table 8.2.9. Plaice in VIIe Diagnostics (continued).

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
UK-WEC-BTS ,	108.,	.317,	.143,	.45,	7,	.169,	.361
UK WECOT ,	56.,	.280,	.087,	.31,	5,	.279,	.607
UK WECBT ,	69.,	.280,	.065,	.23,	5,	.279,	.520
UK WECOT historic ,	1.,	.000,	.000,	.00,	0,	.000,	.000
FSP-7e UK(E+W) ,	56.,	.292,	.134,	.46,	5,	.265,	.613
F shrinkage mean ,	56.,	2.50,,,,				.009,	.610

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
66.,	.15,	.07,	23,	.481,	.536

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2003

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
UK-WEC-BTS ,	61.,	.340,	.190,	.56,	8,	.155,	.353
UK WECOT ,	30.,	.267,	.099,	.37,	6,	.286,	.623
UK WECBT ,	36.,	.267,	.017,	.06,	6,	.286,	.538
UK WECOT historic ,	1.,	.000,	.000,	.00,	0,	.000,	.000
FSP-7e UK(E+W) ,	44.,	.284,	.145,	.51,	6,	.266,	.466
F shrinkage mean ,	28.,	2.50,,,,				.008,	.654

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
39.,	.14,	.07,	27,	.511,	.508

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2002

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
UK-WEC-BTS ,	16.,	.377,	.255,	.68,	8,	.107,	.518
UK WECOT ,	9.,	.268,	.168,	.62,	7,	.352,	.790
UK WECBT ,	14.,	.268,	.083,	.31,	7,	.352,	.563
UK WECOT historic ,	1.,	.000,	.000,	.00,	0,	.000,	.000
FSP-7e UK(E+W) ,	19.,	.318,	.050,	.16,	6,	.179,	.449
F shrinkage mean ,	17.,	2.50,,,,				.011,	.484

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
13.,	.15,	.09,	29,	.562,	.607

Table 8.2.10 Plaice in VIIe. Fishing mortality-at-age.

Run title : W.CHANNEL PLAICE 2012 WGCSE

At 9/05/2012 17:25

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1980	1981
AGE		
1	0.0024	0.0121
2	0.1242	0.1086
3	0.4330	0.5368
4	0.4919	0.5999
5	0.4283	0.4157
6	0.7306	0.3152
7	0.3468	0.5130
8	0.3917	0.4289
9	0.4648	0.5763
+gp	0.4648	0.5763
FBAR 3- 6	0.5210	0.4669

Table 8 Fishing mortality (F) at age

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0.0098	0.0005	0.0097	0.0004	0.0006	0.0055	0.0012	0.0024	0.0127	0.008
2	0.1092	0.1305	0.1835	0.1091	0.1506	0.0881	0.1773	0.0413	0.1114	0.1917
3	0.4804	0.4689	0.4635	0.4711	0.603	0.5303	0.5578	0.4083	0.6167	0.6152
4	0.6965	0.8102	0.7554	0.6906	0.5224	0.7309	0.5063	0.6735	0.754	0.795
5	0.5309	0.6422	0.578	0.3349	0.4961	0.7496	0.511	0.7771	0.579	0.5936
6	0.5655	0.3741	0.4107	0.5502	0.4036	0.4239	0.3532	0.589	0.5576	0.4812
7	0.4089	0.5064	0.608	0.5329	0.5438	0.5712	0.3517	0.4669	0.5889	0.3971
8	0.988	0.4189	0.7739	0.343	0.4751	0.3963	0.4888	0.5088	0.5797	0.3638
9	0.4383	0.2942	0.4907	1.1766	0.6201	0.6096	0.307	0.8256	0.5768	0.4662
+gp	0.4383	0.2942	0.4907	1.1766	0.6201	0.6096	0.307	0.8256	0.5768	0.4662
FBAR 3- 6	0.5683	0.5738	0.5519	0.5117	0.5063	0.6087	0.4821	0.612	0.6268	0.6212

Table 8 Fishing mortality (F) at age

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	0.0154	0.0134	0.0299	0.0008	0.0022	0.0007	0.0014	0.0059	0.0109	0.0012
2	0.2067	0.1787	0.1894	0.1877	0.1904	0.1766	0.072	0.1664	0.1491	0.1689
3	0.6795	0.6133	0.5917	0.6358	0.5587	0.6892	0.497	0.3978	0.5122	0.5619
4	0.7741	0.6906	0.8273	0.7458	0.6799	0.7545	0.7557	0.7157	0.6151	0.5989
5	0.6172	0.6181	0.5825	0.589	0.6854	0.6996	0.5361	0.6077	0.6529	0.5802
6	0.5534	0.5116	0.5127	0.541	0.555	0.5783	0.5239	0.6377	0.5312	0.3627
7	0.4292	0.5176	0.4012	0.5066	0.5228	0.7508	0.4305	0.5979	0.5243	0.4218
8	0.4706	0.4941	0.3405	0.4953	0.7448	0.5833	0.4529	0.5046	0.4219	0.4845
9	0.4397	0.4649	0.4529	0.4818	0.534	0.8102	0.7917	0.6504	0.5069	0.6493
+gp	0.4397	0.4649	0.4529	0.4818	0.534	0.8102	0.7917	0.6504	0.5069	0.6493
FBAR 3- 6	0.656	0.6084	0.6285	0.6279	0.6197	0.6804	0.5782	0.5897	0.5779	0.5259

Table 8 Fishing mortality (F) at age

YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	FBAR 09-11
AGE											
1	0.0321	0.0064	0.0046	0.0053	0.0071	0.0005	0.001	0.0007	0.001	0.0005	0.0007
2	0.3869	0.219	0.2087	0.2275	0.3454	0.2062	0.2347	0.1879	0.1341	0.0769	0.133
3	0.5869	0.6153	0.6019	0.5999	0.6969	0.6913	0.6376	0.5097	0.393	0.3423	0.415
4	0.769	0.5934	0.6471	0.6655	0.6674	0.8376	0.7797	0.4785	0.5508	0.4992	0.5095
5	0.6884	0.6012	0.7188	0.6561	0.6578	0.8343	0.7256	0.4253	0.6533	0.3777	0.4854
6	0.6482	0.5961	0.6149	0.6875	0.5937	0.7523	0.7968	0.4483	0.5914	0.5064	0.5154
7	0.5008	0.5971	0.5085	0.6627	0.6138	0.7503	0.7667	0.4776	0.4264	0.5362	0.4801
8	0.4607	0.4212	0.5017	0.6984	0.9053	0.6542	0.8681	0.3921	0.4342	0.5085	0.4449
9	0.6322	0.8116	0.6508	0.5161	0.6962	0.783	0.7172	0.4491	0.6763	0.6067	0.5773
+gp	0.6322	0.8116	0.6508	0.5161	0.6962	0.783	0.7172	0.4491	0.6763	0.6067	
FBAR 3- 6	0.6731	0.6015	0.6457	0.6523	0.654	0.7788	0.7349	0.4655	0.5471	0.4314	

Table 8.2.11 Plaice in VIIe. Stock numbers-at-age.

Run title : W.CHANNEL PLAICE 2012 WGCSE

At 9/05/2012 17:25

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1980	1981
AGE		
1	8426	3634
2	7401	7455
3	2418	5797
4	689	1391
5	700	374
6	128	404
7	228	55
8	76	143
9	38	46
+gp	392	230
TOTAL	20496	19529

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	7806	6933	8500	8784	17866	14311	10427	4449	4801	5432
2	3185	6855	6146	7467	7788	15836	12623	9236	3937	4205
3	5932	2532	5337	4538	5938	5942	12861	9376	7861	3124
4	3006	3254	1405	2978	2513	2881	3101	6530	5528	3763
5	677	1329	1284	586	1324	1322	1230	1658	2953	2307
6	219	353	620	639	372	715	554	655	676	1468
7	262	110	215	365	327	220	415	345	322	343
8	29	154	59	104	190	168	110	259	192	159
9	83	10	90	24	65	105	100	60	138	95
+gp	362	414	138	78	140	120	212	189	175	146
TOTAL	21559	21944	23794	25561	36522	41620	41634	32757	26583	21041

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
1	6266	2873	3033	8017	7137	10970	5302	3470	4552	5230
2	4779	5473	2514	2611	7105	6316	9723	4696	3060	3994
3	3079	3447	4059	1845	1919	5209	4695	8025	3527	2338
4	1497	1384	1656	1993	867	974	2319	2533	4781	1874
5	1507	612	615	642	838	389	406	966	1098	2293
6	1130	721	293	305	316	375	172	211	467	507
7	805	576	383	155	157	161	186	90	99	243
8	205	465	305	228	83	83	67	107	44	52
9	98	113	251	192	123	35	41	38	58	26
+gp	149	243	188	247	274	191	121	101	138	82
TOTAL	19515	15908	13297	16235	18819	24702	23032	20237	17824	16639

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	GMST 80-09	AMST 80-09
AGE													
1	6307	3837	4912	4487	2767	5812	5192	8148	20328	23264	0	5988	6656
2	4633	5417	3382	4337	3959	2437	5152	4600	7222	18012	20623	5280	5877
3	2992	2791	3860	2434	3064	2486	1758	3614	3381	5601	14794	3890	4427
4	1182	1475	1338	1875	1185	1354	1104	824	1925	2024	3528	1900	2242
5	913	486	723	621	855	539	520	449	453	984	1090	860	1007
6	1138	407	236	312	286	393	208	223	260	209	598	407	483
7	313	528	199	113	139	140	164	83	126	128	112	215	258
8	142	168	258	106	52	67	59	68	46	73	66	114	140
9	28	79	98	138	47	19	31	22	41	26	39	59	76
+gp	94	74	84	114	95	94	58	47	53	46	35		
TOTAL	17743	15263	15089	14539	12448	13340	14246	18078	33835	50368	40884		

Table 8.2.12 Plaice in VIIe. Summary

Run title : W.CHANNEL PLAICE 2012 WGCSE

At 9/05/2012 17:25

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 6
1980	8426	5045	2406	1215	0.5052	0.521
1981	3634	6249	3278	1746	0.5328	0.4669
1982	7806	5892	3463	1938	0.5597	0.5683
1983	6933	6222	3656	1754	0.4799	0.5738
1984	8500	6374	3477	1813	0.5212	0.5519
1985	8784	6667	3553	1751	0.4926	0.5117
1986	17866	7567	3740	2161	0.5779	0.5063
1987	14311	7075	3610	2388	0.6616	0.6087
1988	10427	9798	5145	2994	0.5818	0.4821
1989	4449	8983	5470	2808	0.5134	0.612
1990	4801	8578	5279	3058	0.5793	0.6268
1991	5432	6632	4293	2250	0.5241	0.6212
1992	6266	6551	3579	1950	0.5448	0.656
1993	2873	5138	3050	1691	0.5545	0.6084
1994	3033	4438	2706	1471	0.5437	0.6285
1995	8017	4857	2407	1295	0.5379	0.6279
1996	7137	4905	2364	1321	0.5588	0.6197
1997	10970	6412	2498	1654	0.6621	0.6804
1998	5302	5874	2662	1430	0.5371	0.5782
1999	3470	4958	2955	1616	0.547	0.5897
2000	4552	4793	3286	1678	0.5106	0.5779
2001	5230	4452	2717	1379	0.5075	0.5259
2002	6307	4921	2506	1608	0.6415	0.6731
2003	3837	4247	2502	1478	0.5908	0.6015
2004	4912	4862	2271	1402	0.6176	0.6457
2005	4487	4522	2252	1370	0.6085	0.6523
2006	2767	3814	2056	1466	0.7131	0.654
2007	5812	3467	1711	1184	0.692	0.7788
2008	5192	3776	1612	1144	0.7095	0.7349
2009	8148	3093	1720	1065	0.6192	0.4655
2010	20328	6893	2271	1241	0.5465	0.5471
2011	5988*	8016	3271	1505	0.4601	0.4314
Arith. Mean	7602	5783	3055	1713	0.5698	0.5915
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

* replaced with GM80-09 recruitment (23264)

Table 8.2.13 VIIe plaice : Catch forecast input data

MFDP version 1a
Run: p7enew
Time and date: 09:32 16/05/2012
Fbar age range: 3-6

2012

Age	*N*	*M*	*Mat*	*PF*	*PM*	*SWt*	*Sel*	*CWt*
1	5988	0.12	0	0	0	0.076	0.001	0.133
2	5311	0.12	0.26	0	0	0.190	0.133	0.247
3	14794	0.12	0.52	0	0	0.304	0.415	0.362
4	3528	0.12	0.86	0	0	0.419	0.510	0.476
5	1090	0.12	1	0	0	0.534	0.485	0.592
6	598	0.12	1	0	0	0.649	0.515	0.708
7	112	0.12	1	0	0	0.765	0.480	0.823
8	66	0.12	1	0	0	0.881	0.445	0.939
9	39	0.12	1	0	0	0.997	0.577	1.056
10	35	0.12	1	0	0	1.203	0.577	1.322

2013

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	5988	0.12	0	0	0	0.076	0.001	0.133
2	.	0.12	0.26	0	0	0.190	0.133	0.247
3	.	0.12	0.52	0	0	0.304	0.415	0.362
4	.	0.12	0.86	0	0	0.419	0.510	0.476
5	.	0.12	1	0	0	0.534	0.485	0.592
6	.	0.12	1	0	0	0.649	0.515	0.708
7	.	0.12	1	0	0	0.765	0.480	0.823
8	.	0.12	1	0	0	0.881	0.445	0.939
9	.	0.12	1	0	0	0.997	0.577	1.056
10	*.*	*0.12*	*1*	*0*	*0*	*1.203*	*0.577*	*1.322*

2014

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	5988	0.12	0	0	0	0.076	0.001	0.133
2	.	0.12	0.26	0	0	0.190	0.133	0.247
3	.	0.12	0.52	0	0	0.304	0.415	0.362
4	.	0.12	0.86	0	0	0.419	0.510	0.476
5	.	0.12	1	0	0	0.534	0.485	0.592
6	.	0.12	1	0	0	0.649	0.515	0.708
7	.	0.12	1	0	0	0.765	0.480	0.823
8	.	0.12	1	0	0	0.881	0.445	0.939
9	.	0.12	1	0	0	0.997	0.577	1.056
10	.	0.12	1	0	0	1.203	0.577	1.322

Input units are thousands and kg - output in tonnes

Table 8.2.14 VIIe plaice : management option table - status quo forecast

MFDP version 1a
Run: p7enew
W.CHANNEL PLAICE 2012 WGCSE forecast inputs
Time and date: 09:32 16/05/2012
Fbar age range: 3-6

2012 Biomass	SSB	FMult	FBar	Landings
8640	5070	1.0000	0.4813	2997

2013 Biomass	SSB	FMult	FBar	Landings	2014 Biomass	SSB
8117	5805	0.0000	0.0000	0	10400	8297
.	5805	0.1000	0.0481	355	10025	7939
.	5805	0.2000	0.0963	694	9667	7599
.	5805	0.3000	0.1444	1018	9326	7274
.	5805	0.4000	0.1925	1327	9000	6965
.	5805	0.5000	0.2407	1622	8689	6670
.	5805	0.6000	0.2888	1904	8393	6389
.	5805	0.7000	0.3369	2173	8109	6121
.	5805	0.8000	0.3851	2430	7839	5866
.	5805	0.9000	0.4332	2676	7581	5622
.	5805	1.0000	0.4813	2910	7335	5390
.	5805	1.1000	0.5295	3135	7100	5169
.	5805	1.2000	0.5776	3349	6875	4958
.	5805	1.3000	0.6257	3554	6661	4756
.	5805	1.4000	0.6739	3750	6456	4564
.	5805	1.5000	0.7220	3937	6261	4381
.	5805	1.6000	0.7701	4116	6074	4207
.	5805	1.7000	0.8183	4288	5895	4040
.	5805	1.8000	0.8664	4451	5725	3881
.	5805	1.9000	0.9145	4608	5562	3730
.	5805	2.0000	0.9627	4758	5406	3585

Input units are thousands and kg - output in tonnes

Table 8.2.15 VIIe plaice : forecast detailed results - status quo projection

MFDP version 1a
Run: p7enew
Time and date: 09:32 16/05/2012
Fbar age range: 3-6

Year:	2012	F multiplier:	1	Fbar:	0.4813				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0007	4	1	5988	455	0	0	0	0
2	0.133	624	154	5311	1009	1381	262	1381	262
3	0.415	4755	1720	14794	4502	7693	2341	7693	2341
4	0.5095	1334	635	3528	1478	3034	1271	3034	1271
5	0.4854	397	235	1090	582	1090	582	1090	582
6	0.5154	228	161	598	388	598	388	598	388
7	0.4801	40	33	112	86	112	86	112	86
8	0.4449	22	21	66	58	66	58	66	58
9	0.5774	16	17	39	39	39	39	39	39
10	0.5774	15	19	35	42	35	42	35	42
Total		7435	2997	31561	8640	14048	5070	14048	5070

Year:	2013	F multiplier:	1	Fbar:	0.4813				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0007	4	1	5988	455	0	0	0	0
2	0.133	623	154	5307	1008	1380	262	1380	262
3	0.415	1325	479	4124	1255	2144	653	2144	653
4	0.5095	3276	1560	8664	3630	7451	3122	7451	3122
5	0.4854	685	405	1880	1004	1880	1004	1880	1004
6	0.5154	227	161	595	386	595	386	595	386
7	0.4801	114	94	317	242	317	242	317	242
8	0.4449	21	20	61	54	61	54	61	54
9	0.5774	16	16	38	37	38	37	38	37
10	0.5774	15	20	37	44	37	44	37	44
Total		6307	2910	27011	8117	13903	5805	13903	5805

Year:	2014	F multiplier:	1	Fbar:	0.4813				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0007	4	1	5988	455	0	0	0	0
2	0.133	623	154	5307	1008	1380	262	1380	262
3	0.415	1324	479	4121	1254	2143	652	2143	652
4	0.5095	913	435	2415	1012	2077	870	2077	870
5	0.4854	1681	995	4617	2465	4617	2465	4617	2465
6	0.5154	391	277	1026	666	1026	666	1026	666
7	0.4801	114	94	315	241	315	241	315	241
8	0.4449	59	56	174	153	174	153	174	153
9	0.5774	15	15	35	35	35	35	35	35
10	0.5774	15	20	37	45	37	45	37	45
Total		5141	2525	24035	7335	11804	5390	11804	5390

Input units are thousands and kg - output in tonnes

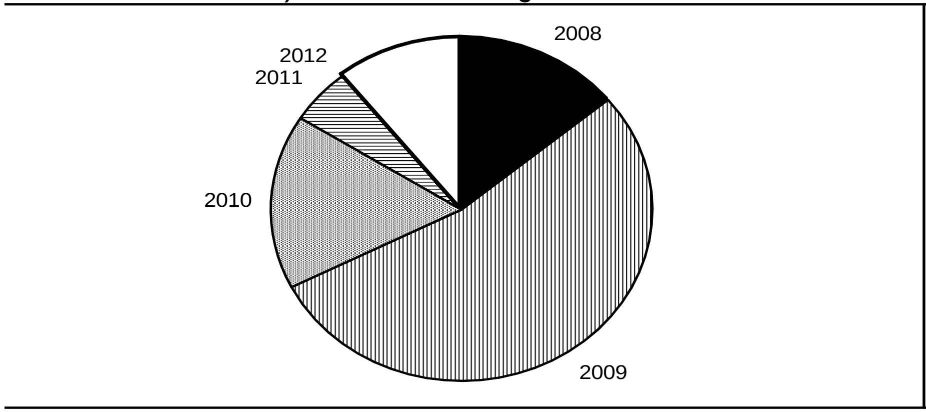
Table 8.2.16 **Plaice in VIIe**
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class	2008	2009	2010	2011	2012
Stock No. (thousands) of 1 year-olds	8148	20328	5988	5988	5988
Source	XSA	XSA	GM80-09	GM80-09	GM80-09
Status Quo F:					
% in 2012 landings	21.2	57.4	5.1	0.0	-
% in 2013	13.9	53.6	16.5	5.3	0.0
% in 2012 SSB	25.1	46.2	5.2	0.0	-
% in 2013 SSB	17.3	53.8	11.3	4.5	0.0
% in 2014 SSB	12.4	45.7	16.1	12.1	4.9

GM : geometric mean recruitment

Plaice in VIIe : Year-class % contribution to

a) 2013 landings



b) 2014 SSB

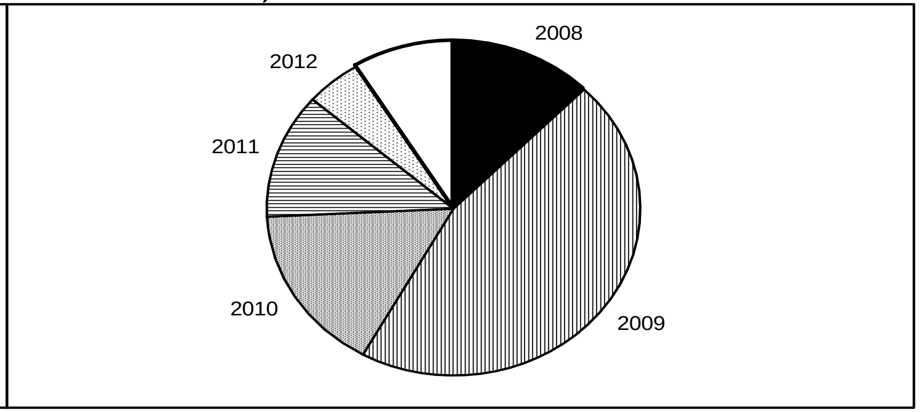


Table 8.2.17 VIIe plaice : Yield per recruit

MFYPR version 2a
Run: P7eWG12
Time and date: 11:09 13/05/2012
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	8.8433	6.2096	6.7118	5.8530	6.7118	5.8530
0.1000	0.0481	0.2425	0.2040	6.8262	3.9983	4.7049	3.6455	4.7049	3.6455
0.2000	0.0963	0.3698	0.2790	5.7687	2.9094	3.6573	2.5602	3.6573	2.5602
0.3000	0.1444	0.4492	0.3087	5.1096	2.2738	3.0078	1.9280	3.0078	1.9280
0.4000	0.1925	0.5040	0.3195	4.6558	1.8637	2.5634	1.5213	2.5634	1.5213
0.5000	0.2407	0.5443	0.3218	4.3227	1.5809	2.2392	1.2417	2.2392	1.2417
0.6000	0.2888	0.5754	0.3202	4.0668	1.3762	1.9920	1.0401	1.9920	1.0401
0.7000	0.3369	0.6001	0.3169	3.8637	1.2225	1.7973	0.8894	1.7973	0.8894
0.8000	0.3851	0.6203	0.3130	3.6982	1.1037	1.6400	0.7734	1.6400	0.7734
0.9000	0.4332	0.6371	0.3088	3.5606	1.0096	1.5103	0.6821	1.5103	0.6821
1.0000	0.4813	0.6513	0.3047	3.4443	0.9335	1.4017	0.6087	1.4017	0.6087
1.1000	0.5295	0.6636	0.3008	3.3445	0.8709	1.3094	0.5488	1.3094	0.5488
1.2000	0.5776	0.6743	0.2971	3.2580	0.8187	1.2301	0.4991	1.2301	0.4991
1.3000	0.6257	0.6836	0.2937	3.1822	0.7746	1.1613	0.4574	1.1613	0.4574
1.4000	0.6739	0.6920	0.2906	3.1152	0.7368	1.1011	0.4220	1.1011	0.4220
1.5000	0.7220	0.6994	0.2876	3.0554	0.7042	1.0479	0.3916	1.0479	0.3916
1.6000	0.7701	0.7061	0.2849	3.0017	0.6757	1.0007	0.3654	1.0007	0.3654
1.7000	0.8183	0.7122	0.2824	2.9532	0.6507	0.9585	0.3425	0.9585	0.3425
1.8000	0.8664	0.7177	0.2800	2.9092	0.6285	0.9206	0.3224	0.9206	0.3224
1.9000	0.9145	0.7227	0.2778	2.8690	0.6087	0.8863	0.3047	0.8863	0.3047
2.0000	0.9627	0.7274	0.2757	2.8321	0.5910	0.8551	0.2889	0.8551	0.2889

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.0000	0.4813
FMax	0.4971	0.2393
F0.1	0.2321	0.1117
F35%SPR	0.2769	0.1333

Weights in kilograms

Figure 8.2.1 VIIe plaice: UK(E&W) commercial fleet LPUE and effort; and survey CPUE

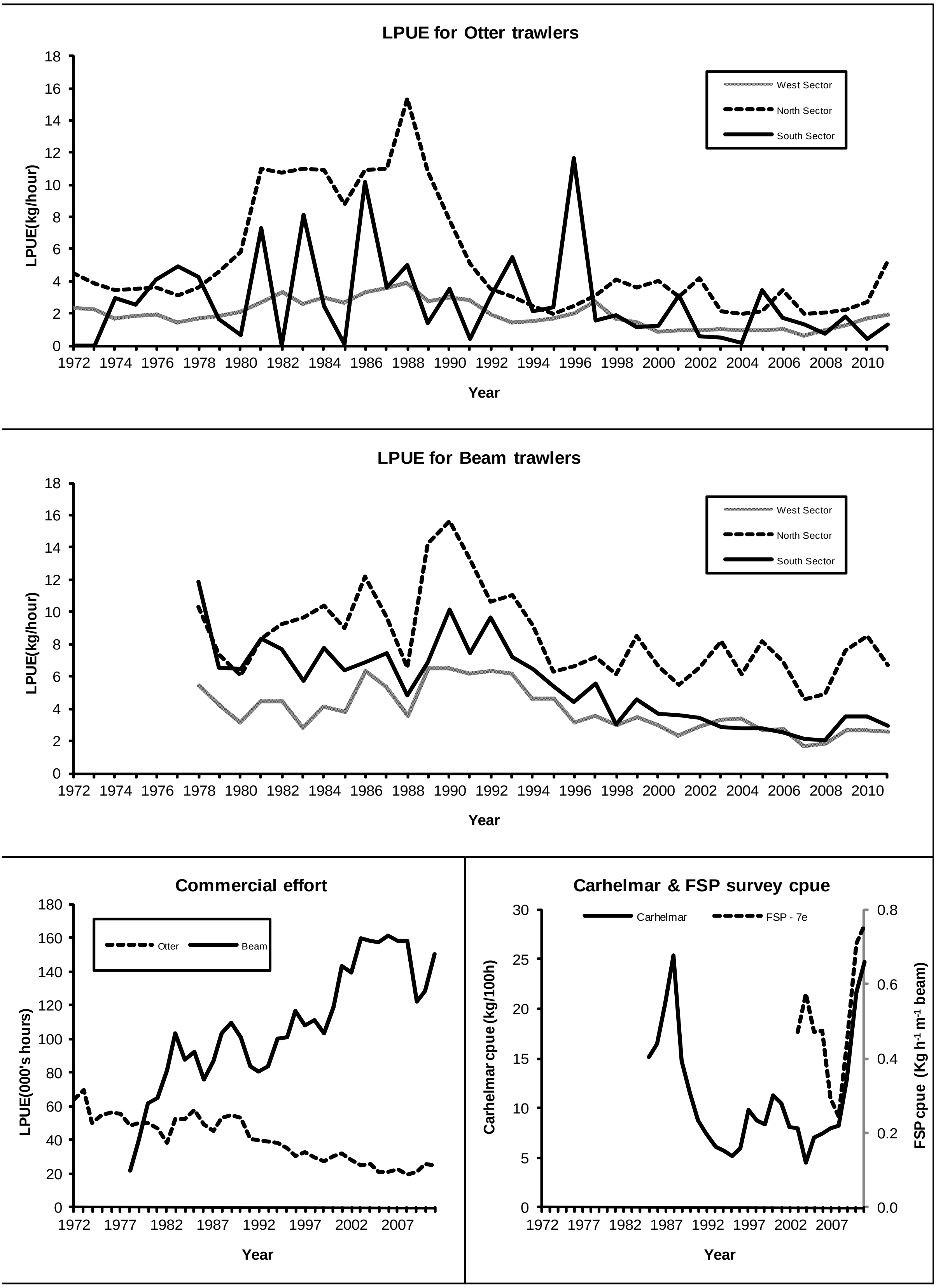


Figure 8.2.2 Plaice VIIe Discards - UK by Quarter (2011)

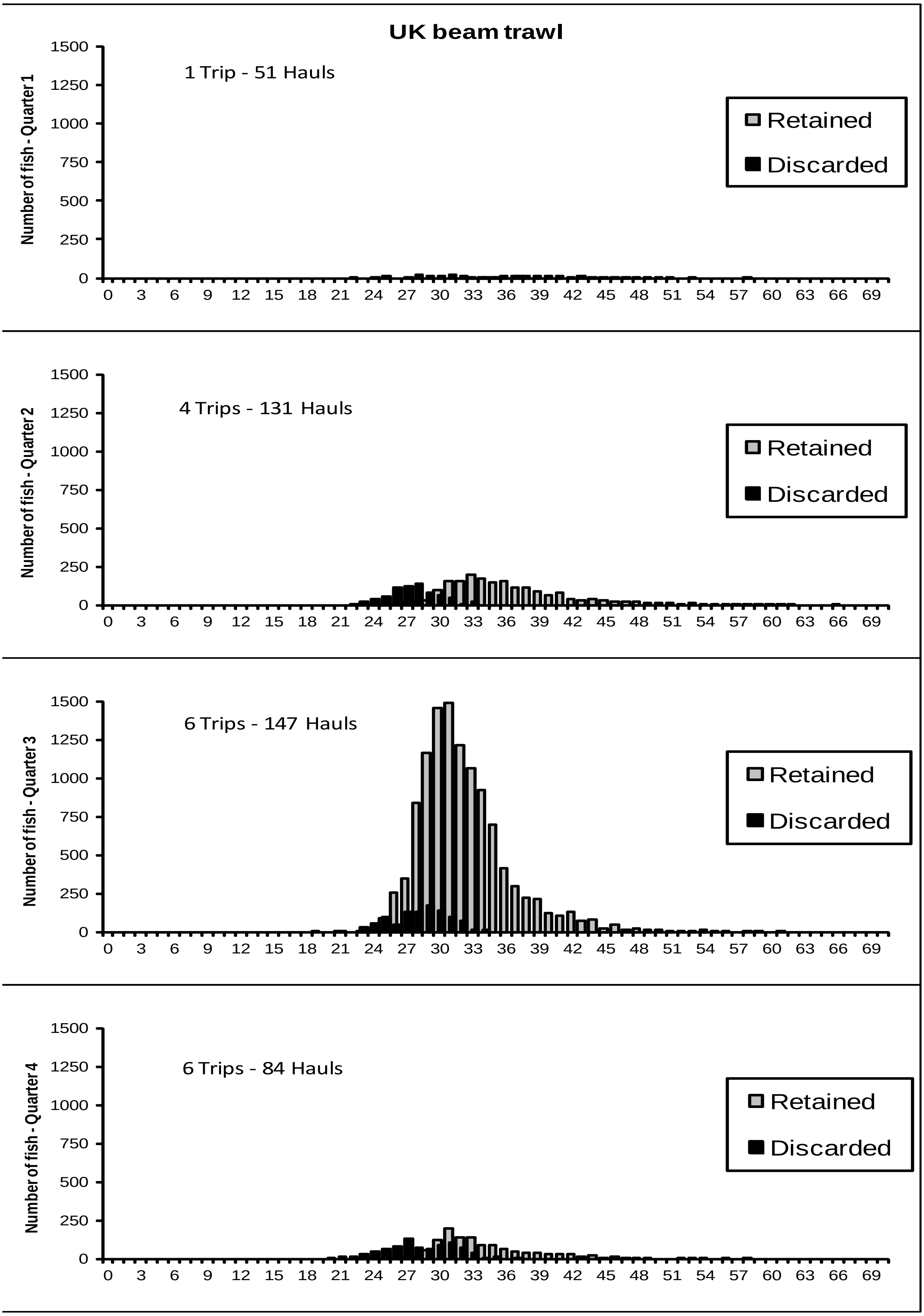


Figure 8.2.2 (cont.) Plaice VIIe Discards - UK by Quarter (2011)

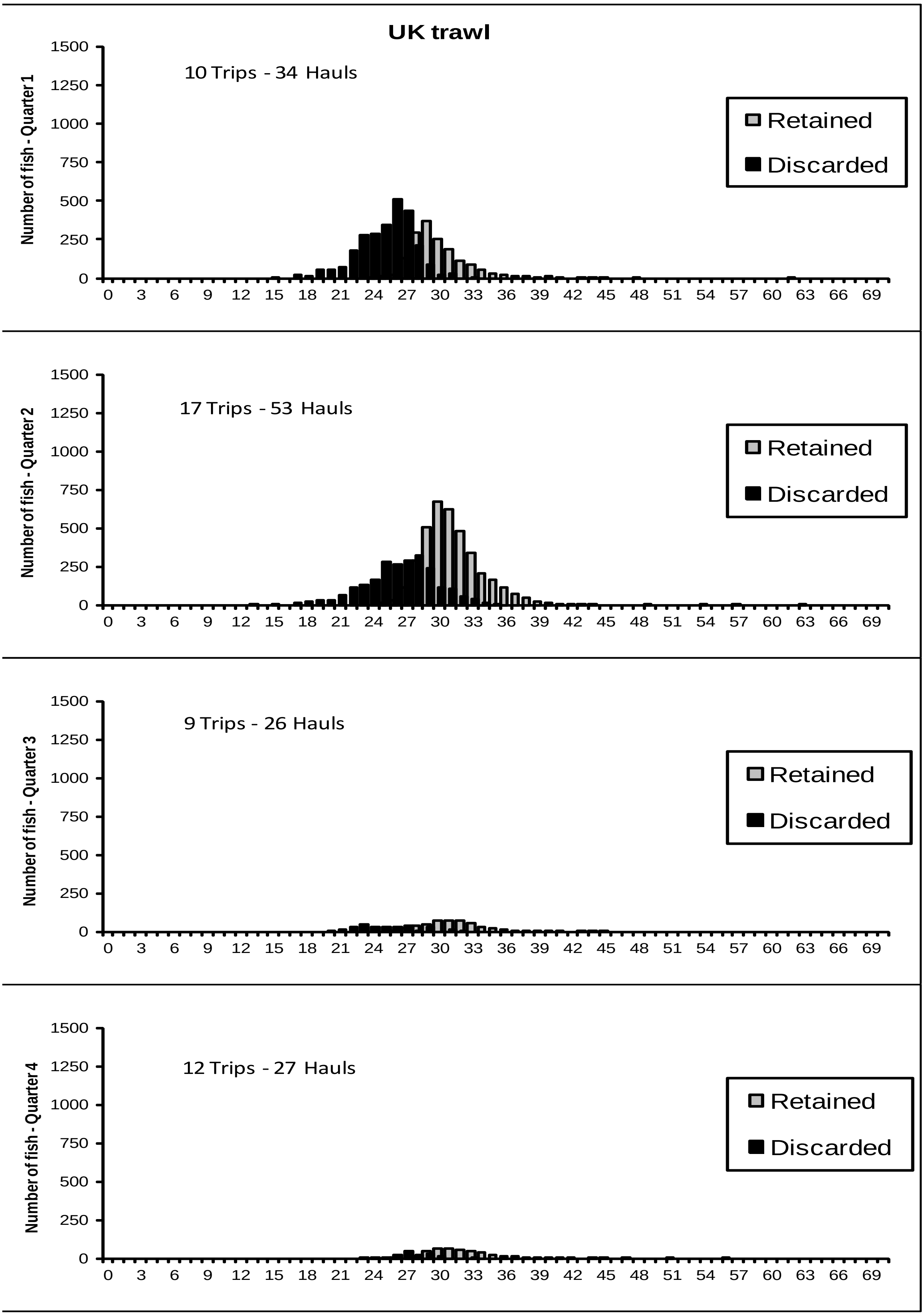


Figure 8.2.2 (cont.) Plaice VIIe Discards - French Trawl by Quarter (2011)

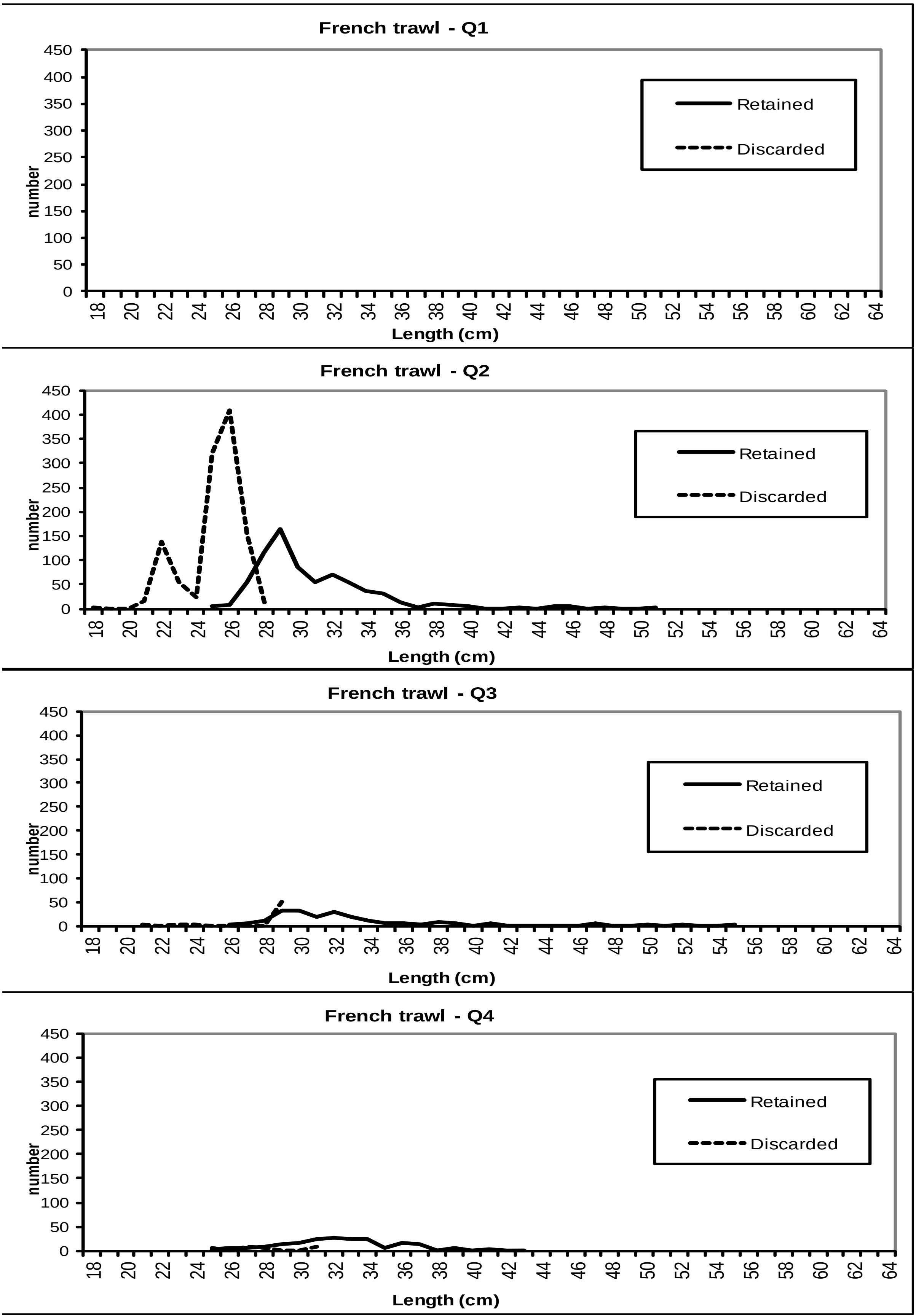


Figure 8.2.2 (cont.) Plaice VIIe Discards - French Trawl by Quarter (2011)

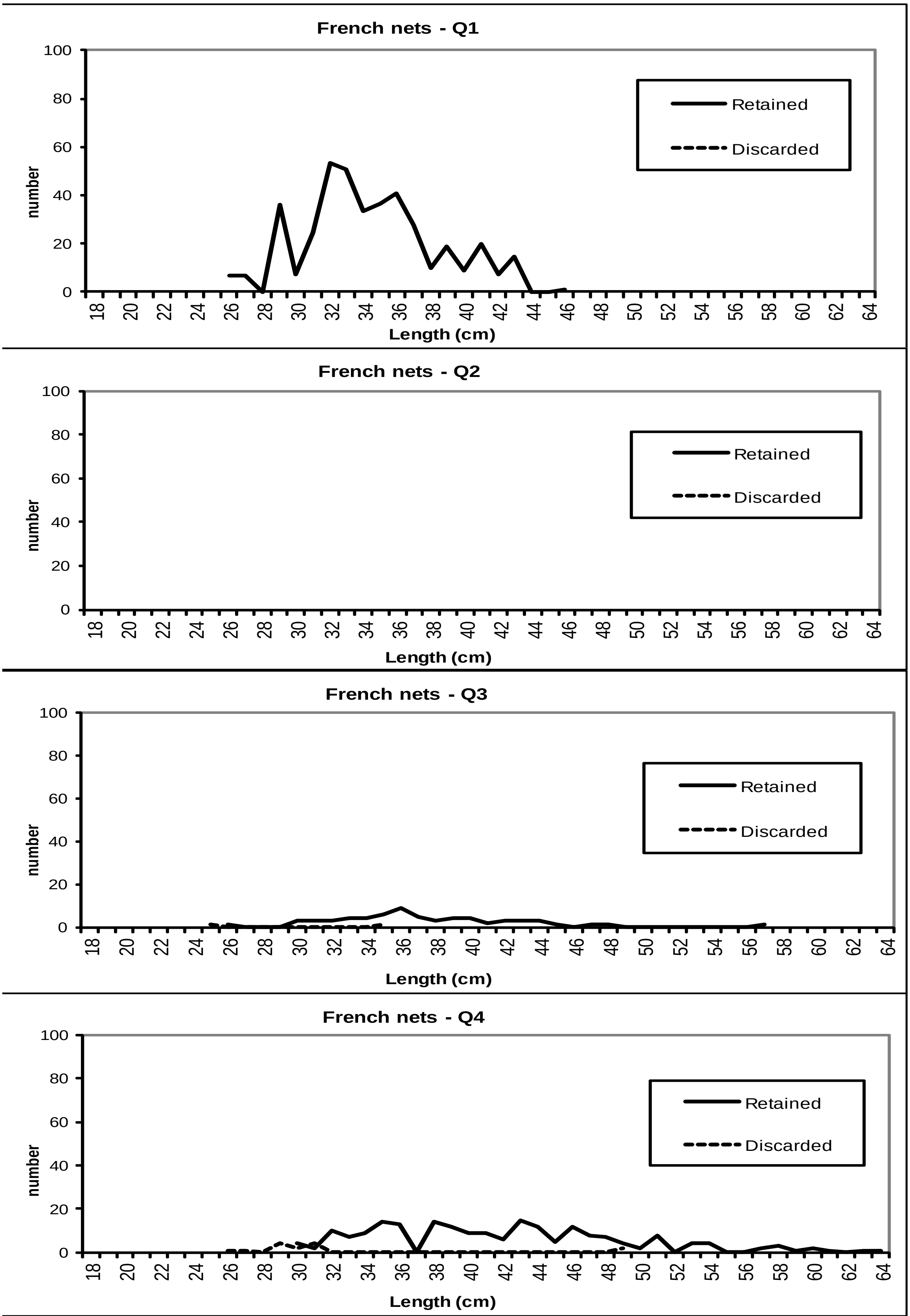


Figure 8.2.2 (cont.) Plaice VIIe Discards - Belgium by Quarter (2011)

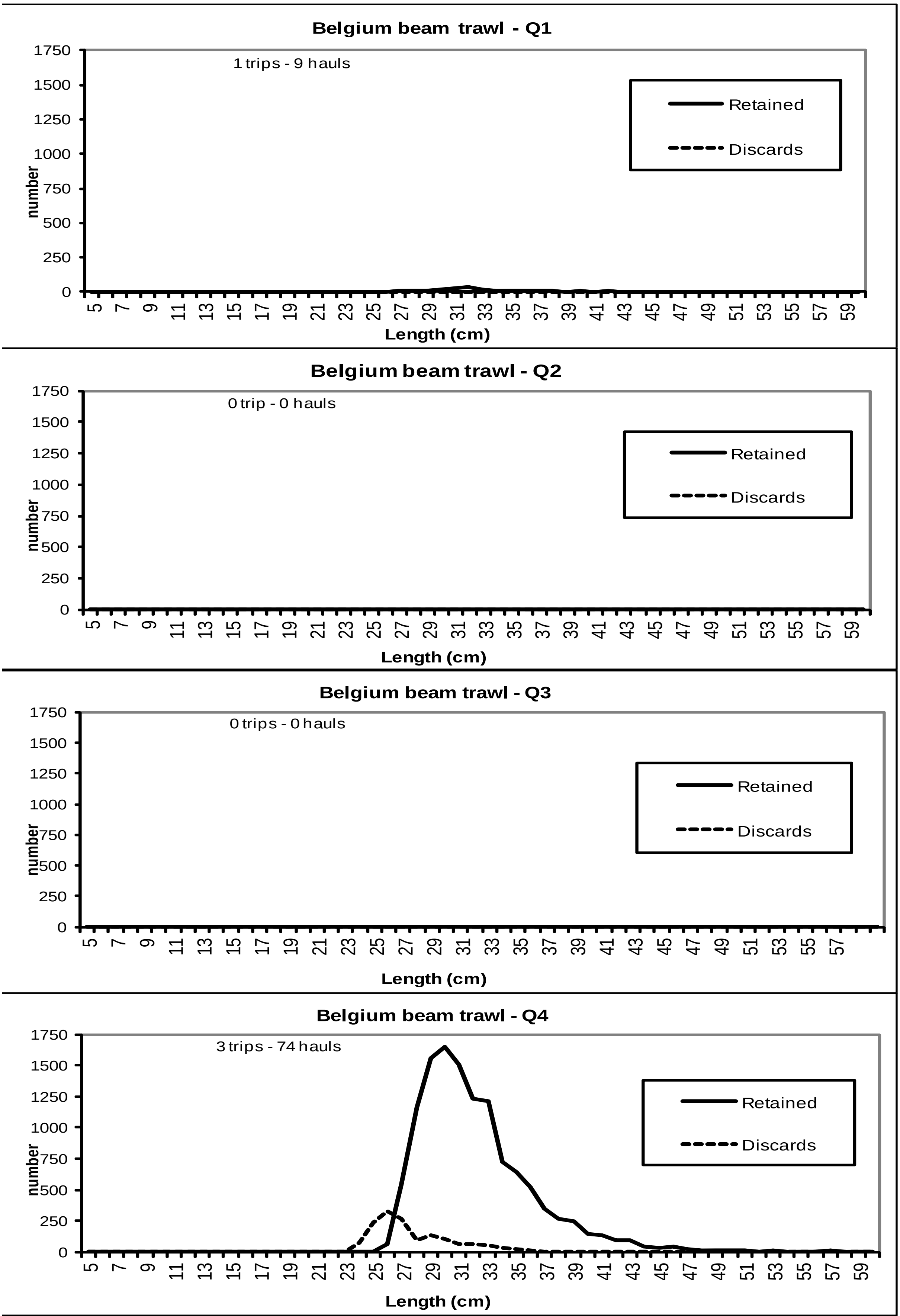


Figure 8.2.3 : Plaice in Division VIIe Length distributions of UK (England & Wales) landings from 2002 to 2011

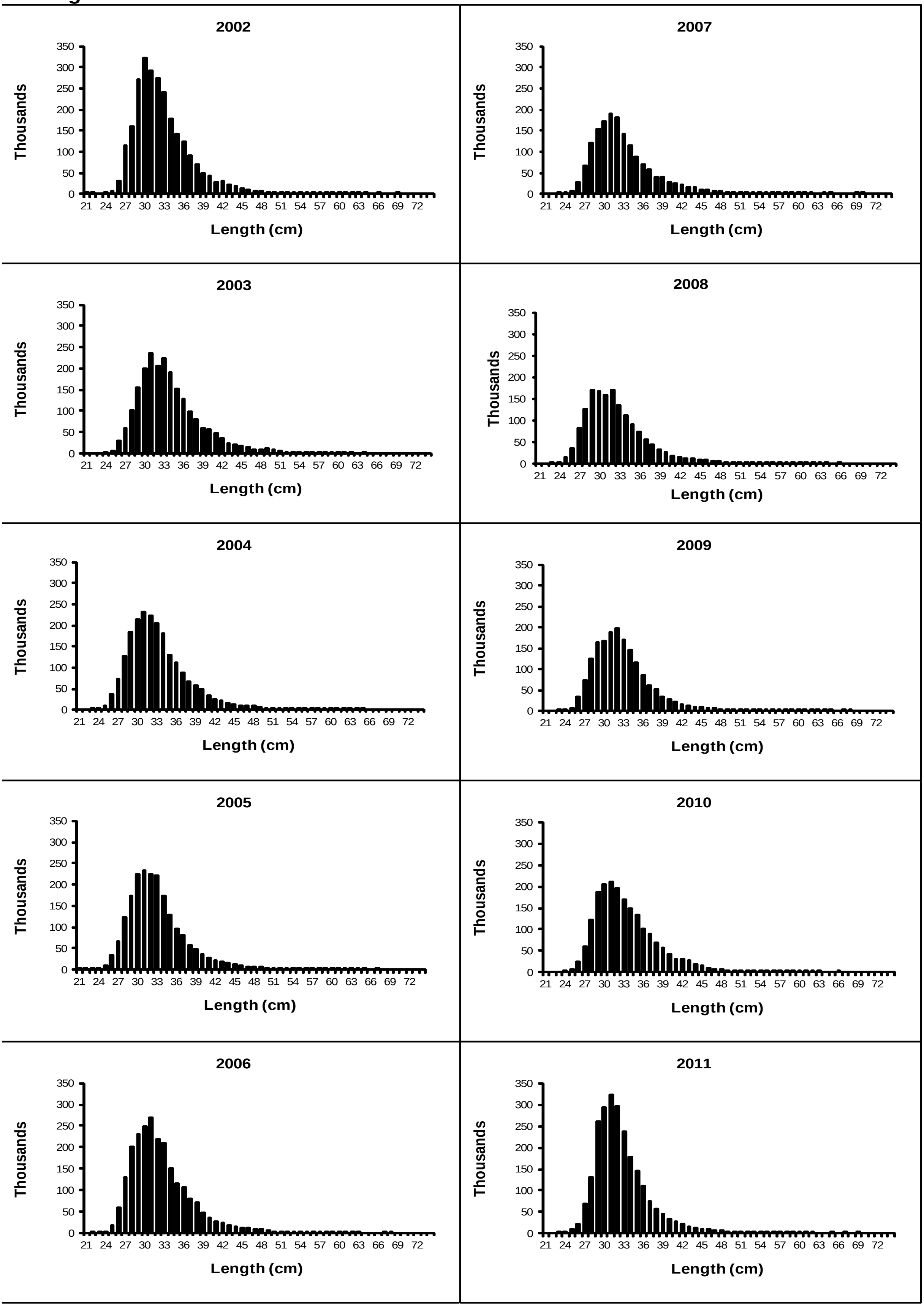


Figure 8.2.4 : Plaice in Division VIIe Age composition of international landings 2002-2011

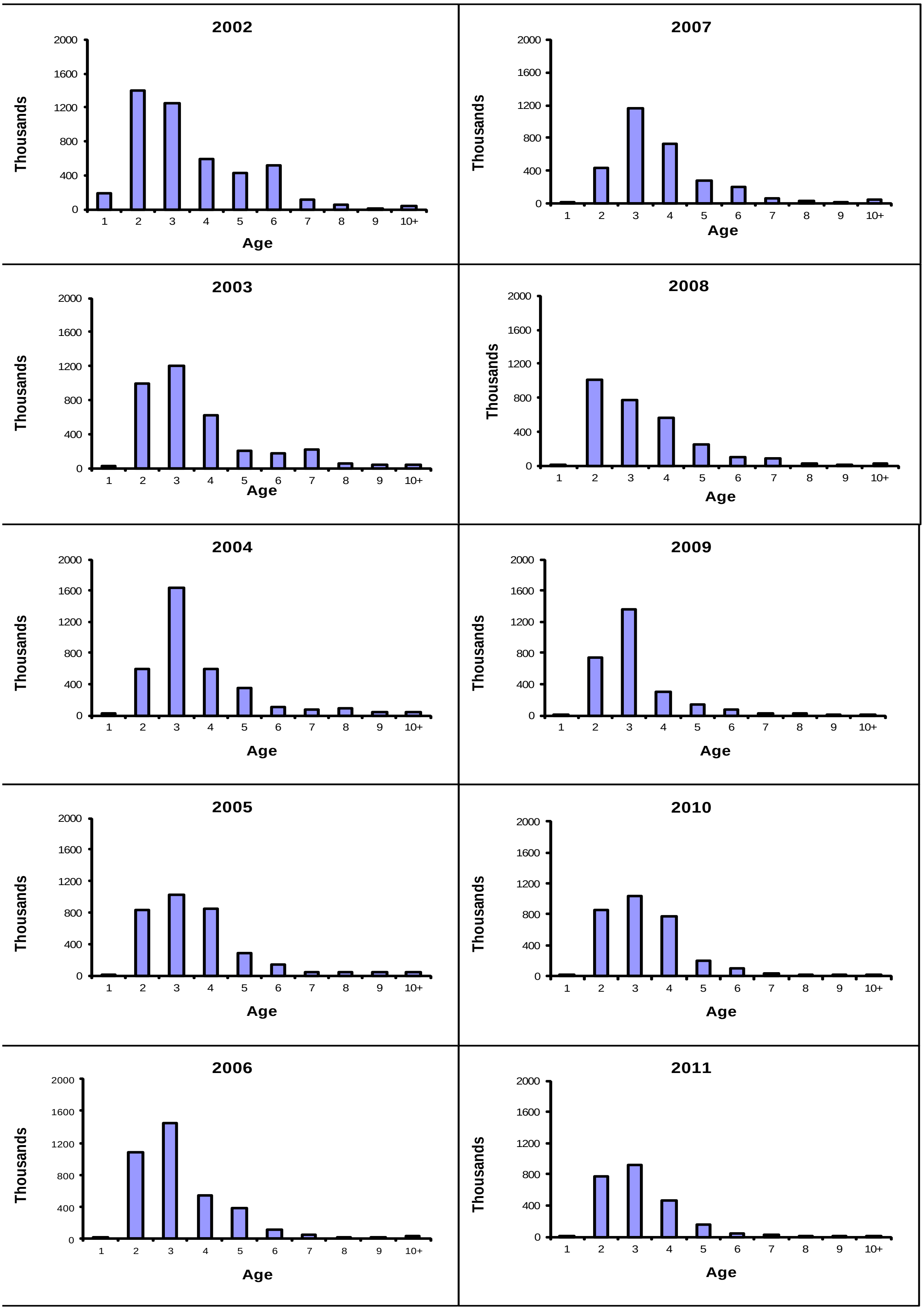


Figure 8.2.5 VIIe Plaice fleet log catchability residuals from the final run

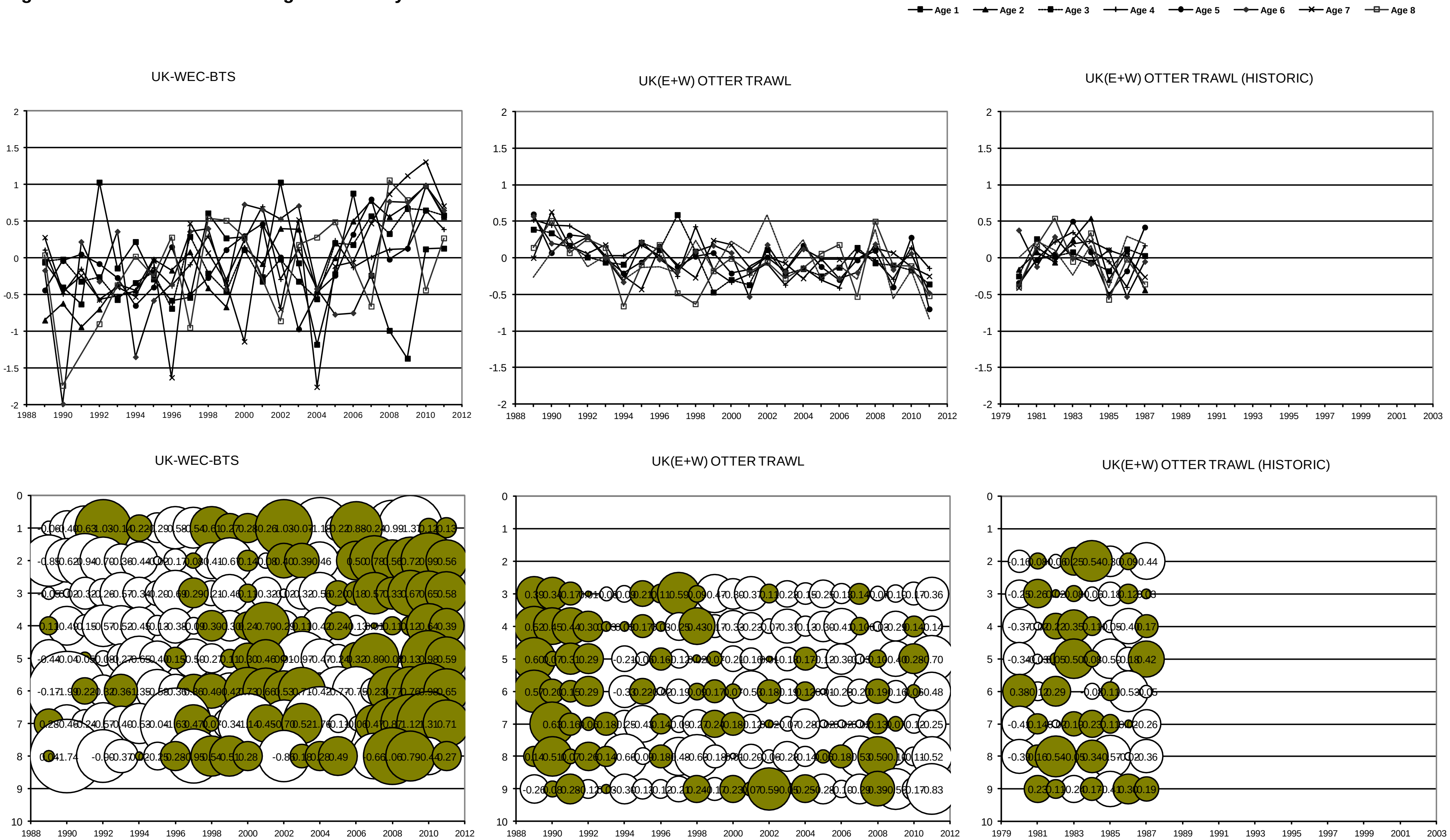


Figure 8.2.5 (cont.) VIIe Plaice fleet log catchability residuals from the final run

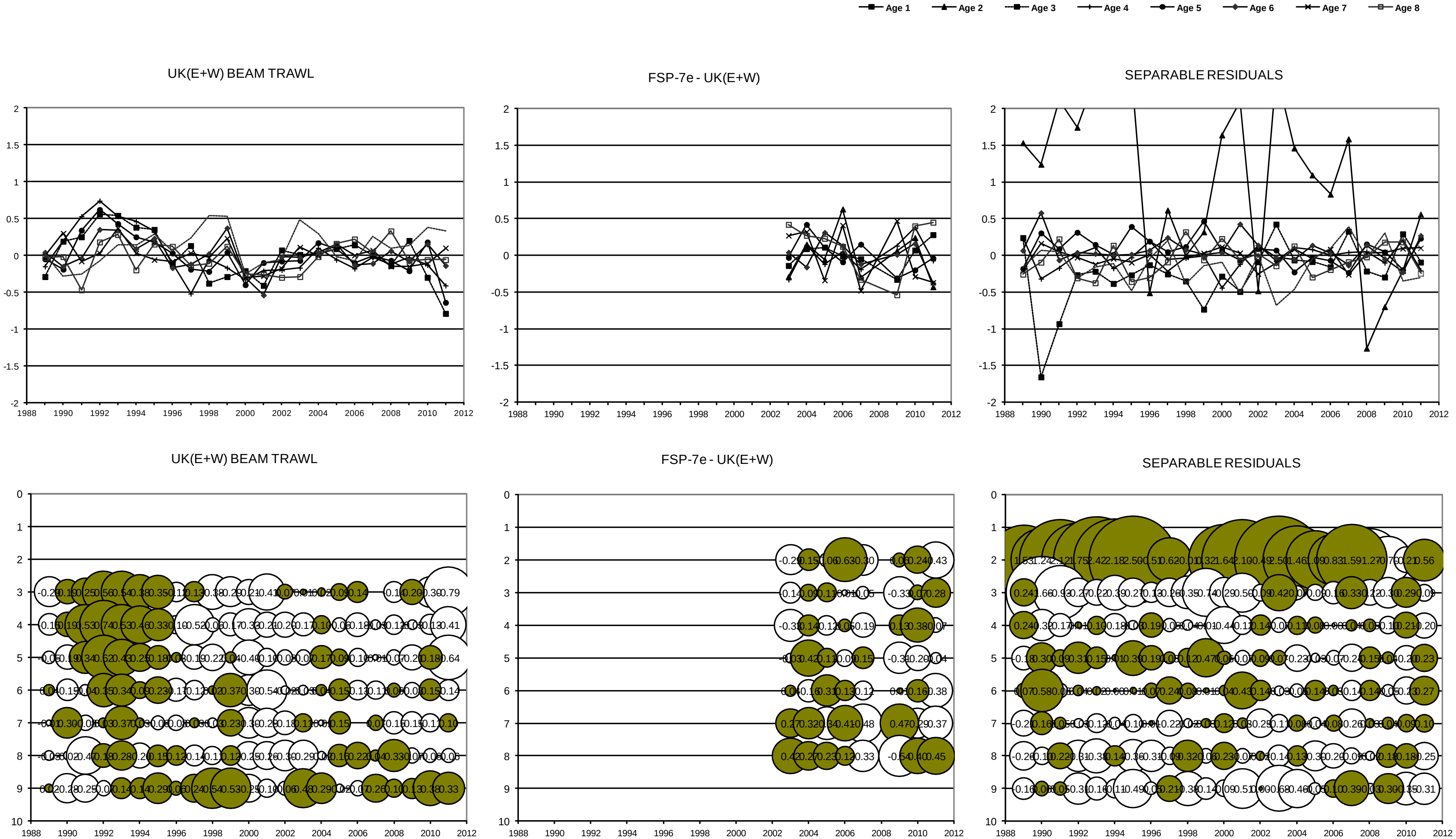
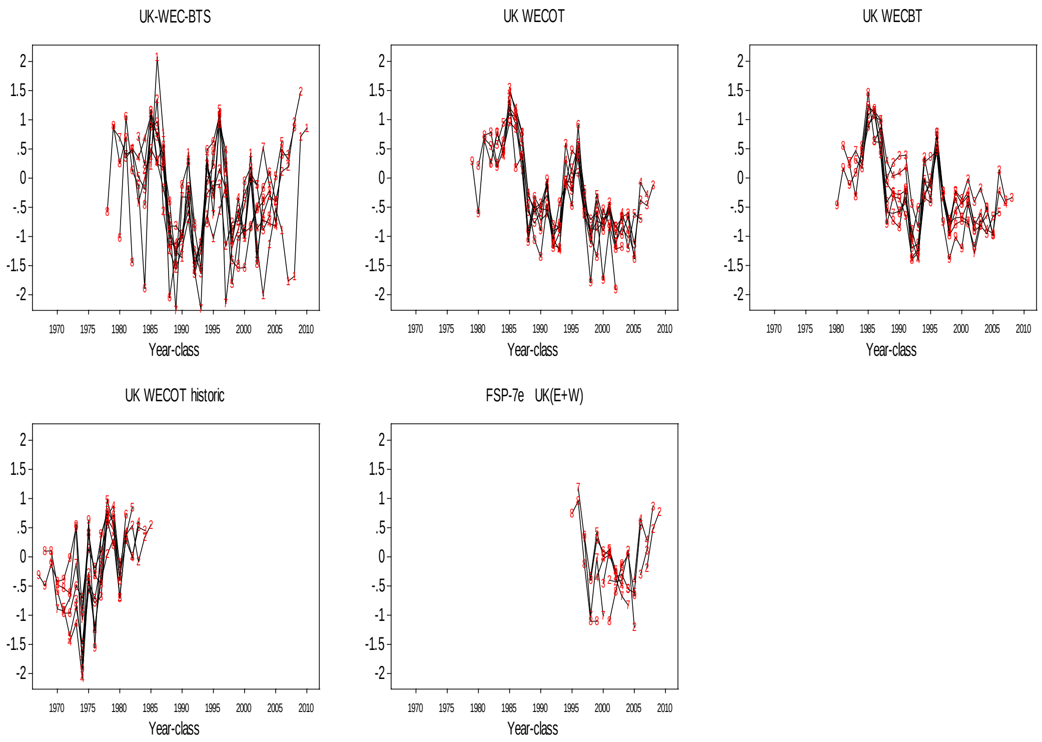


Figure 8.2.6 VIIe Plaice – Surba results

Tuning fleets by year-class



Tuning fleets by year

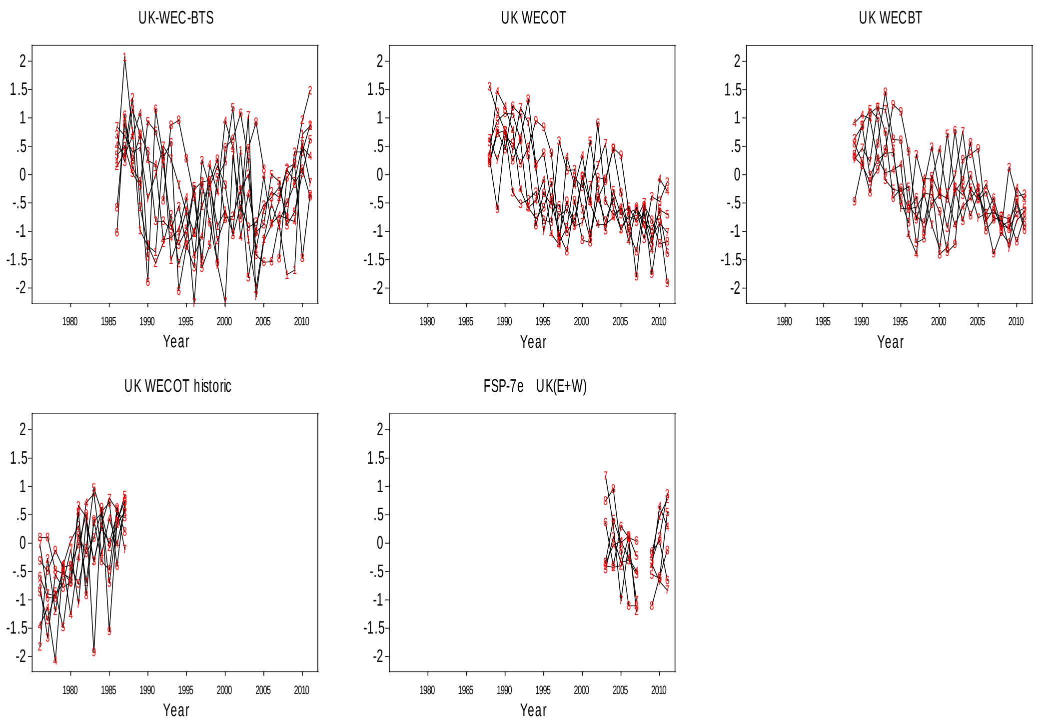
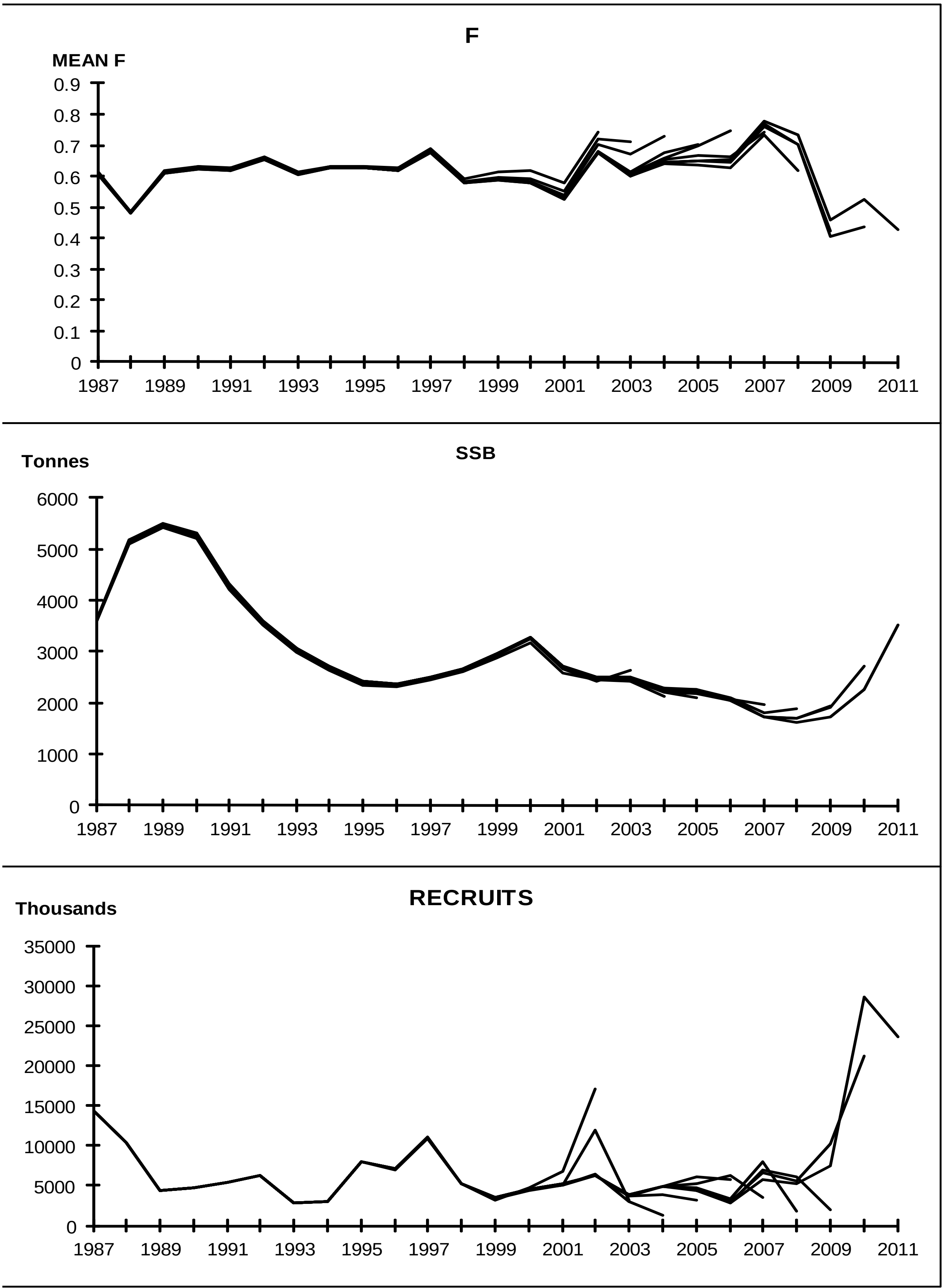


Figure 8.2.7 **VIIe Plaice: Retrospective XSA results**
(Shrinkage SE=2.5)



Note: the retrospective analysis was run without the short FSP survey

Figure 8.2.8 Plaice in Division VIIe (Western Channel)

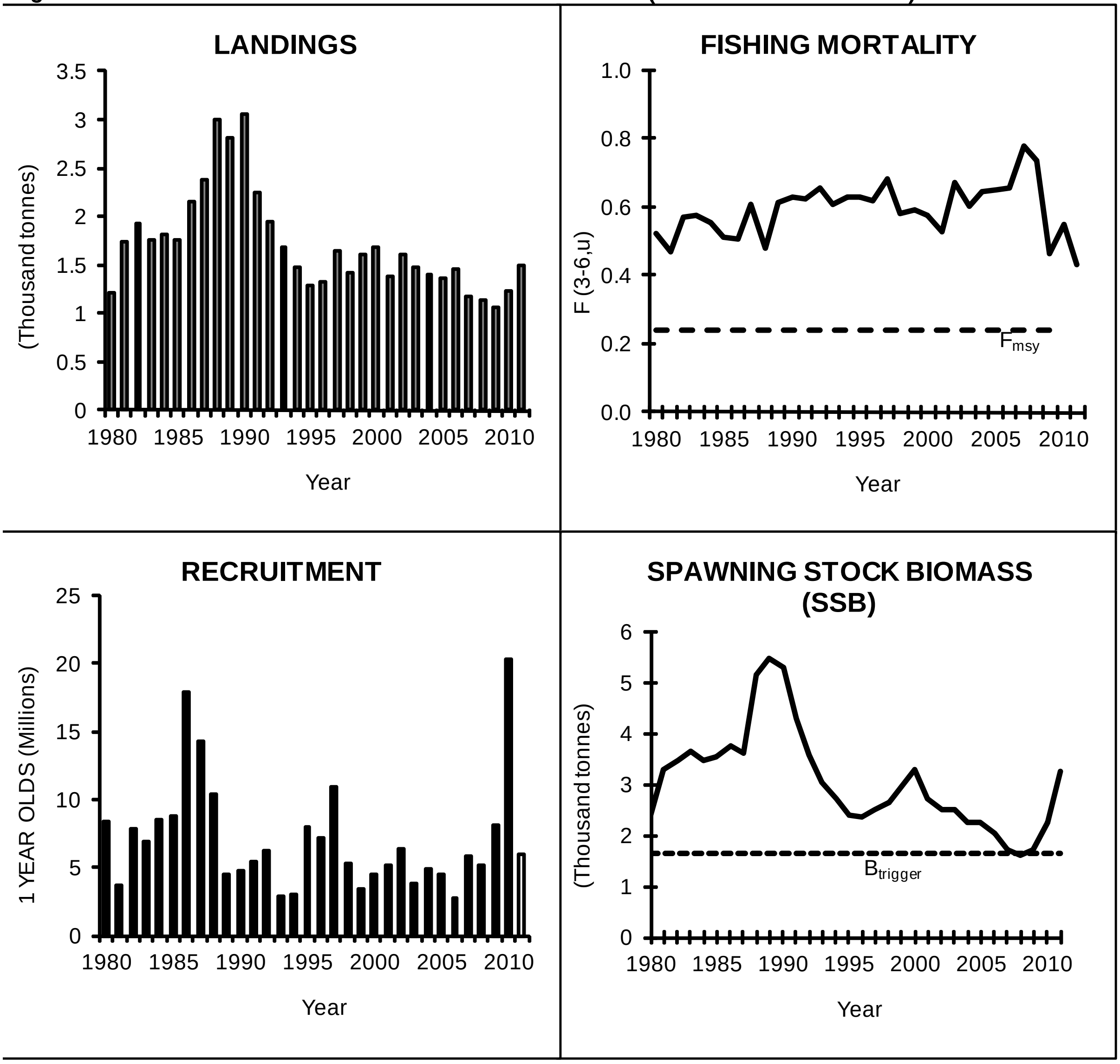
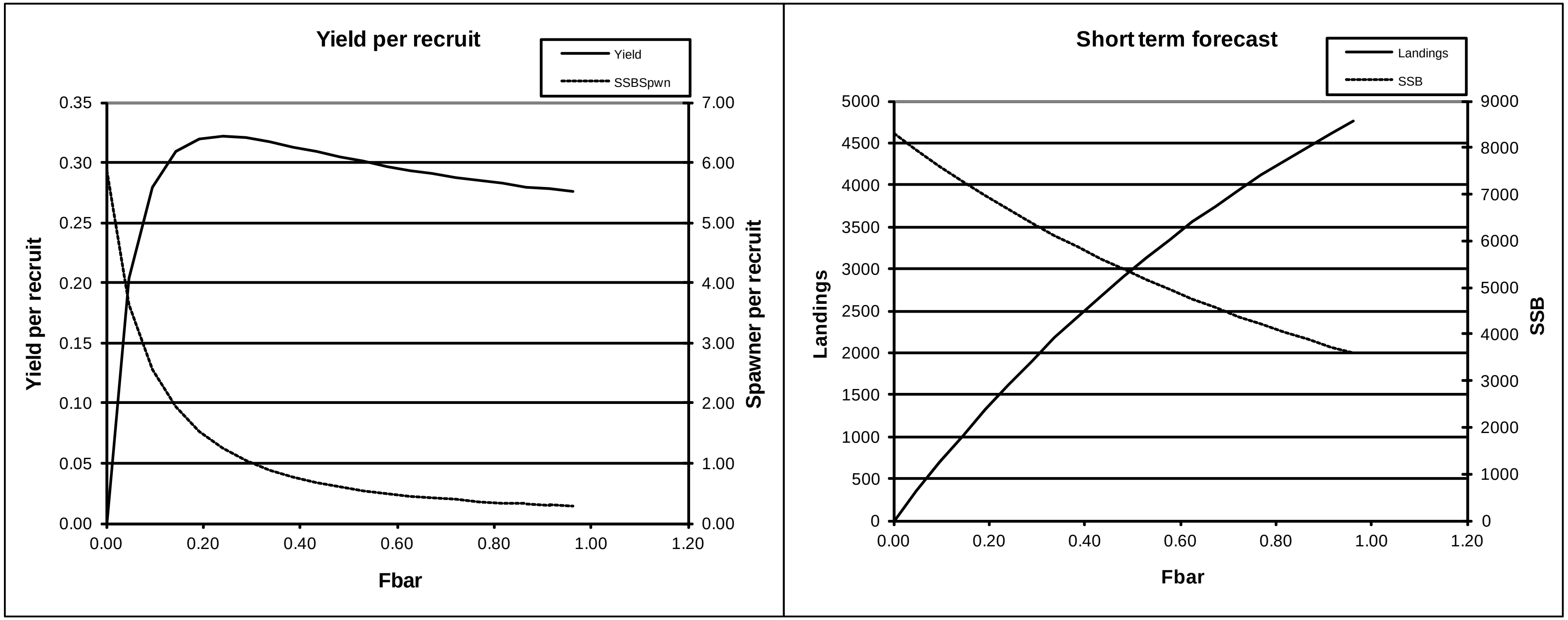


Figure 8.2.9 VIIe Plaice : Yield per recruit and short term forecast results



MFYPR version 2a
Run: P7eWG12
Time and date: 11:09 13/05/2012

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.0000	0.4813
FMax	0.4971	0.2393
F0.1	0.2321	0.1117
F35%SPR	0.2769	0.1333

Weights in kilograms

MFDP version 1a
Run: p7enew
W.CHANNEL PLAICE 2012 WGCSE forecast inputs
Time and date: 09:32 16/05/2012
Fbar age range: 3-6

Input units are thousands and kg - output in tonnes

Figure 8.2.10 Plaice in VIIe. Stock-Recruitment

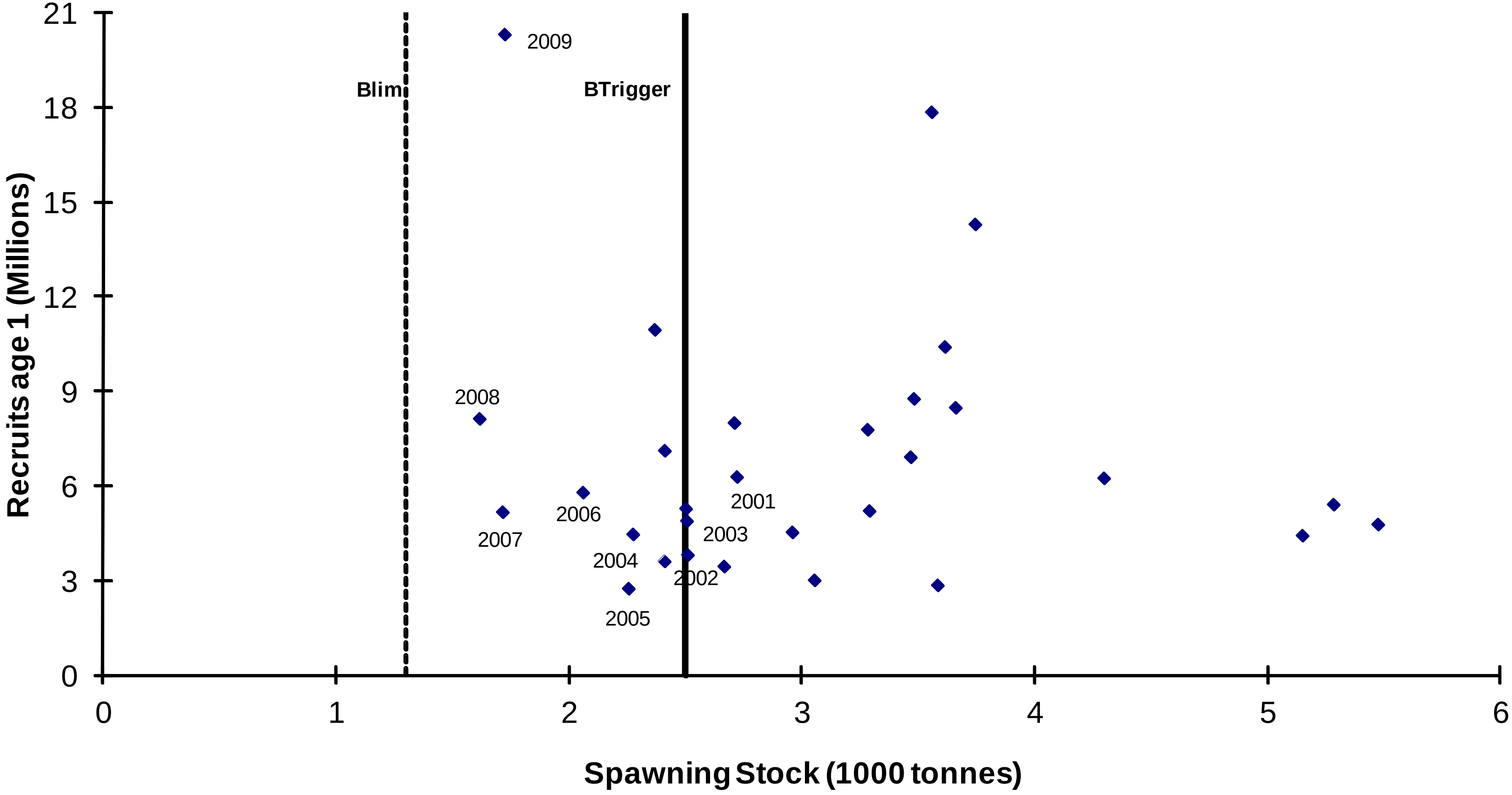
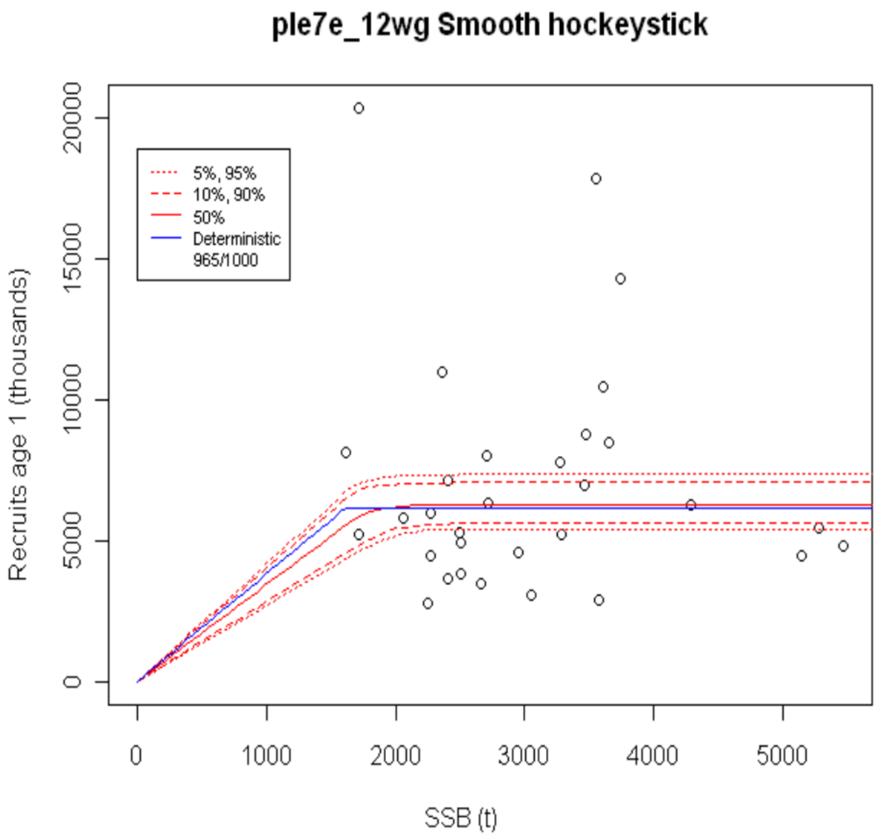
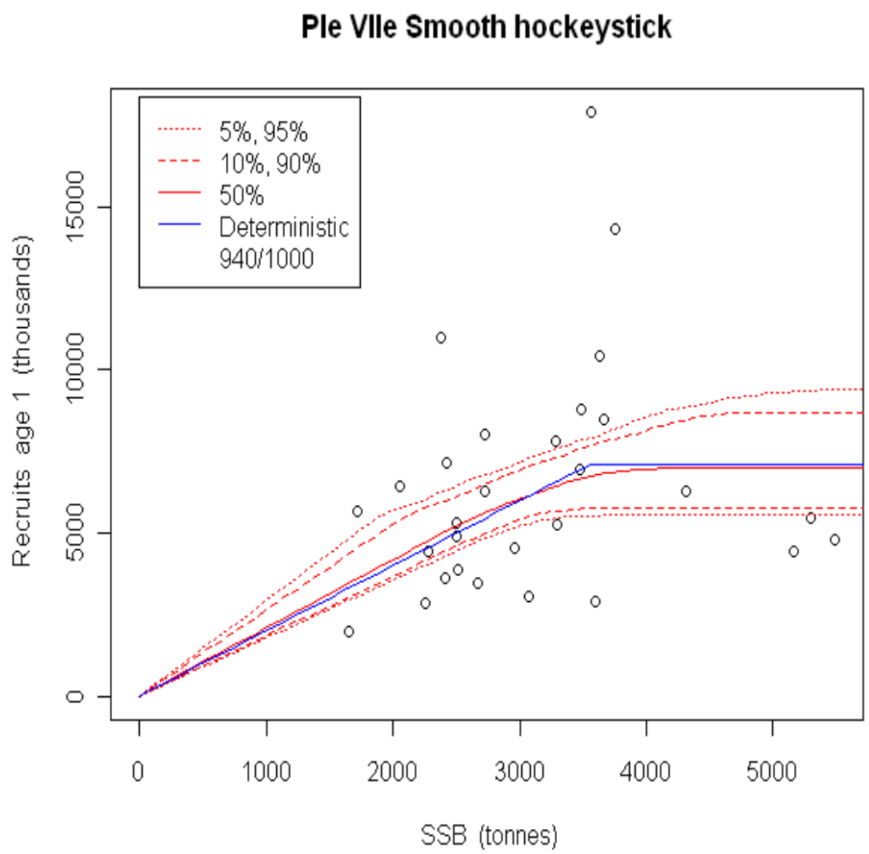


Figure 8.2.11 Plaice in Divisions VIIe : MSY fitted stock and recruit relationship for smooth hockeystick model. Blue line indicates the deterministic estimate; red line median and percentiles of curves with converged estimates of Fmsy. The legends for the model show the number of converged values of FMSY from the 1000 re-samples.

2012 Working group run



2010 Working group run



8.3 Sole in Division VIIe

Type of assessment in 2012

This stock was placed on the observational list in 2004 and has been subject to a full assessment in subsequent years. A management plan for this stock was agreed in May 2007 (Council Regulation (EC) No 509/2007). Since 2009 the stock has been exploited below F_{MSY} resulting in a recovery of the biomass to levels well above $B_{MSYtrigger}$.

In 2012 WKFLAT benchmarked provided the second benchmark of this stock and provided a new analytical assessment based on two commercial tuning fleets, the UK-EW-BTS survey and two new spatially more expansive surveys.

WGCSE followed the procedure prescribed by the benchmark process to conduct an update assessment.

ICES advice applicable to 2011

Stock status:

Fishing mortality	2007	2008	2009
F_{MSY}	Above	Above	Below
F_{PA}/F_{lim}	Not defined	Not defined	Not defined
Spawning–Stock Biomass (SSB)	2008	2009	2010
MSY $B_{trigger}$	Below	Below	Below
B_{PA}/B_{lim}	Not defined	Not defined	Not defined

MSY approach

Following the ICES MSY framework implies fishing mortality to be at 0.24 (14% lower than F_{MSY} because SSB is 14% below MSY $B_{trigger}$). This implies landings of less than 660 t in 2011.

Management plan

Council Regulation (EC) No. 509/2007 establishes a multiannual plan for the sustainable exploitation of Division VIIe sole. Years 2007–2009 were deemed a recovery plan, with subsequent years being deemed a management plan. For 20010, 2011, and 2012 the TAC shall be set at the highest value resulting from either a 15% reduction in F compared to average F (2007–2009) or an F of 0.27, with a maximum TAC variation of no more than 15%.

Following the agreed management plan implies an F for 2011 of 0.3 (15% lower than the average F (2007–2009) or 0.85*0.35). Since this would result in a TAC increase of more than 15%, the resulting TAC is the maximum 15% increase of 710 t in 2011. This is expected to lead to a SSB increase of 7% in 2012. This plan has not been evaluated by ICES.

ICES advice applicable to 2012

F (Fishing Mortality)	2008	2009	2010	
MSY (F_{MSY})	✗	✓	✓	Appropriate
Precautionary approach (F_{pa},F_{lim})	?	?	?	Undefined

SSB (Spawning Stock Biomass)	2009	2010	2011	
MSY ($B_{trigger}$)	✗	✗	✗	Below trigger
Precautionary approach (B_{pa},B_{lim})	?	?	?	Undefined

Management plan

Council Regulation (EC) No. 509/2007 establishes a multi-annual plan for the sustainable exploitation of Division VIIe sole. Years 2007–2009 were deemed a recovery plan, with subsequent years being deemed a management plan. For 2010, 2011, and 2012 the TAC shall be set at the highest value resulting from either a 15% reduction in F compared to average F (2007–2009) or an F of 0.27, with a maximum TAC variation of no more than 15%.

Following the agreed management plan implies an F for 2011 of 0.27 (F_{MP}, the management plan long-term target), suggesting a TAC of 777 t in 2012 which is less than the 15% TAC increase cap in the plan. This is expected to lead to a SSB increase of 5% in 2013. This plan has not been evaluated by ICES.

MSY approach

Following the ICES MSY framework implies fishing mortality to be at 0.26 (6% lower than F_{MSY} because SSB is 6% below MSY $B_{trigger}$). This implies landings of less than 740 t in 2012.

Technical consideration

General comments

- The RG found no errors in the assessment and forecast, and the results were carried over correctly to the advice.
- In 2009 WKFLAT benchmarked this assessment, but failed to develop an update procedure, as it was not possible to address the cause of the substantial retrospective bias in F and SSB. The 2010 WGCSE assessment was based on previous accepted XSA formulations described in the Stock Annex, with a decrease in the F-shrinkage SE from 1.0 to 0.5 (stronger shrinkage) and an increase in the time period for shrinkage from five to ten years. A change in F_{bar} from 3–7 to 3–9 also was made. The same settings were used this year. The new settings still shows retrospective bias in the past, while the pattern for recent years seem satisfactory.

- WKFLAT 2012 developed a new benchmark process for this stock, and while the historic retrospective pattern is still discernible, it is minimized and absent in the most recent years.
- The report Section 8.3.3 contains some unchanged text from last year, giving the impression that several changes are made, while those changes already took place a year ago.

This has been corrected.

- An important mixed fishery issue is the bycatch of plaice in the sole fishery in VIIe. A key finding last year was that F on both sole and plaice declined sharply by about the same amount between 2008 and 2009 (just under 40% reduction), although this is greater than the 23% reduction in beam trawl effort in VIIe between 2008 and 2009. Otter trawl effort has been declining over a longer period. For sole the 2011 assessment shows a 30% F reduction between 2008 and 2009.

The benchmark group examined the evidence and concluded that the beamtrawl fleet has been operating increasingly further south where lower abundance of sole and plaice are encountered in favour of other stock under less pressure. This leads to the non linearity between effort and F. In 2011 effort in gross registered tonnage has increased with a slight increase in F in the final year, again indicating the link between F and effort, though the relationship is not linear.

- The 2010WG decided to use the results of the stochastic simulations carried out by WGSSDS in 2006 to propose an F_{MSY} of 0.27. No further work on MSY reference points were presented this year.

WKFLAT 2012 repeated the evaluation to determine an appropriate F_{MSY} and concluded 0.27 was still the most appropriate estimate of F_{MSY}.

Technical comments

- The RG agrees to the justifications for benchmark raised in report Section 8.3.9.

Advice sheet

- The WG-report Section 8.3.7 describes an ICES evaluation of the management plan, and the advice sheet gives the advice according to management plan on the first page. Further down in the advice sheet it is stated that the management plan has not been evaluated, and that the advice has been based on the MSY framework.

The description of the management plan relates to the STECF evaluation of the management plan. ICES has failed to review this plan and consequently provides information on the basis of MSY.

- Should the MSY $B_{trigger}$ based on a former B_{PA} still be used? (ADG to decide?)

It certainly should NOT have been as the former B_{PA} was rejected on the basis of scientific evidence by WKFLAT2009. The WG was illogically forced to use this value due to procedural restrictions. WKFLAT2012 reviewed the available information and has provided new reference points on a more scientific basis.

8.3.1 General

Stock description and management units

The TAC is specified for ICES Area VIIe 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 2011 were 740 t, in line with the TAC. WG landings included information based on French sales slips indicated total international landings were 801 t in 2011, 8% above 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 VIId and has brought UK landings into line with the national quota. Previously landings had been stable at around 1000 t over the previous five years, with the UK taking about 65% of the TAC and France reporting the majority of the remainder.

Management applicable to 2011 and 2012

2011 (Council Regulation (EC) No57/2011)

Species: Common sole *Solea solea*		Zone: VIIe (SOL/07E.)
Belgium	25 (1)	
France	267 (1)	
United Kingdom	418 (1)	
EU	710	
TAC	710	Analytical TAC

In addition to this quota, a Member State may grant to vessels participating in trials on fully documented fisheries additional allocation within an overall limit of an additional 5% of the quota allocated to that Member State, under the conditions set out in Article 7 of this Regulation.

In addition, Annex IIc, restricts the number of days at sea to 164 for beam trawlers of mesh size equal to or greater than 80 mm, and for static nets including gillnets, trammelnets and tanglenets, with mesh size less than 220 mm, with an additional twelve days for the UK beam trawl fleet due to a reduction in capacity of the fleet. In November 2008 the UK introduced a single area licence scheme to eliminate the opportunity for UK vessels to misreport catches to Area VIId.

2012 (Council Regulation (EC) No43/2012)

Species: Common sole *Solea solea*		Zone: VIIe (SOL/07E.)
Belgium	27 (1)	
France	293 (1)	
United Kingdom	457 (1)	
Union	777	
TAC	777	Analytical TAC

(1) In addition to this quota, a Member State may grant to vessels flying its flag participating in trials on fully documented fisheries additional allocation within an overall limit of 5 % of the quota allocated to that Member State, under the conditions set out in Article 7 of this Regulation.

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8.3.2 Data

Landings

Levels of landings have been above or near 1000 t for this stock for most of the time-series, but have dropped significantly since 2009 to a level closer to 700 t. Total international landings in 2010 were reported to be 740 t 8% higher than those landings used by the working group.

There were revisions to the 2010 reported landings (+1.60t UK; -0.1t Guernsey; +7.5t France; +0.03t Belgium), with appropriate revisions made to the estimates used by the WG.

Data

Total international catch numbers-at-age (Table 8.3.2, Figure 8.3.1), catch weights and stock weights, -at-age (Table 8.3.3, 8.3.4, Figure 8.3.2) as used in the assessment were derived mostly by the procedure described in the Annex, except in 2009 and 2010 where some UK age information was used to supplement sparse French age information at larger lengths. The differences in the length distributions between the different fleets are shown in Table 8.3.5.

Sampling levels are detailed in Section 2 (Table 2.1).

Discards

Discard data suggests that discarding in 2011 is again minor in this stock (Figure 8.3.3 a–e) for all fleets (UK, French and Belgian fleets), although occasional trips may show some discarding. Discarding in the French otter trawl fleet is also insignificant with respect to its fleet targeting sole. But significant discards are shown in the French trawl fleet due to a single beam trawl trip monitored in 2011 (and included in the trawl fleet. It is unclear whether this is representative of other beam trawl trips, but would suggest that if it were, discards in this fleet may be significant. (Figure 8.3.3b).

More generally discarding by number in the towed gears using 80 mm mesh sizes,which are responsible for the large majority of the landings is very small by number (<5%) and small (5–10%) for the much smaller gillnet fishery. Other spatially or temporally restricted métiers show higher values of discarding (10–40% averaged over years) but have limited effort and hence contribute only a very small percentage to the landings (<5%). The selectivities of the gears used to target sole in the UK is highly selective for fish above the MLS, and only a few sporadic cases of high-grading (included in the numbers above) have been observed.

No discard information is included in this assessment as currently it is not possible to provide this information for the entire time-series.

Biological

Natural mortality and maturity were used as in previous assessments and described in the stock annex. The review group suggested developing temporally variable maturity data for this stock. However, the surveys, usually used for such estimates due to the much better quality control on staging individuals, occur in September. 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

Aggregated cpue has substantially increased from the low point of the time-series observed in 2005 to the highest values in the time-series. (Figure 8.3.4, Table 8.3.6).

The abundance for the UK-WEC- BTS survey carried out on the chartered beam trawler *FV Carhelmar* is given in Table 8.3.7 and shown in Figures 8.3.5 and 8.3.6, plotted by cohort and by years. The figures show few clear year effects and good year-class tracking for the survey at all ages until about the mid 1990s. Since then, the estimate of year class strength at age 1 and at ages greater than 7 has deteriorated slightly. This may partly be associated with the change of vessel that occurred in 2002 and 2004 (*RV Corystes* used), but it seems likely this is not the only cause and weather may play a part in the catchability. Notable differences between the commercial and survey tuning-series are the 1998 year class. This is well represented in the commercial data, but much less clearly so in the survey data. This YC was also seen to be very strong in the VIIf&g stock and may represent some overspill of recruitment from that stock in the adjacent western part of VIIe, not covered by the survey. The 2001YC is also well defined and estimated to be above average in the survey and implied to be strong particularly at the older ages, but lacking in the commercial data.

The UK fisheries science partnership (FSP) again conducted a survey, now in its 9th year, of sole and plaice abundance in the western channel. The results indicate that sole continue to be wide spread 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. A full description of the survey is included in WD 1 and not discuss further here.

The Q1SWBeam survey

This is the first consideration in an assessment of the new survey-series starting in 2006. Important considerations for WKFLAT were that it is based on a stratified random survey approach and covers the entire region of the management area and some adjacent waters which may not fully conform to the delineation. The survey shows strong gradients in species composition within the western 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.

Given sampling effort, fundamentally this survey is more variable than fixed stations survey designs of equal effort, but also inherently is less biased when there are potential changes in the distribution of the species within the area. Although estimates of survey variance of the limited dataseries are available, these are unlikely to reflect the full range of the variance that would be encountered in a longer time-series as variance estimates are unlikely to have reached their asymptote, particularly since the range of SSBs observed by the survey is very restricted.

The survey-series was started in 2006 and surveys have been conducted consistently since then. To include as much information as is available at the time of the assessment working group the survey that is conducted in the first quarter has been shifted to back by one year and one age. This practical, because it adds further available information on the abundance of recruitment into the assessment, particularly important since there is uncertainty regarding the estimation of recruits from the UK-BTS which otherwise is the sole source of information of this parameter. The benefits of shifting the series were thought to out-weight the potential error that may be introduced by this procedure if the seasonal pattern of true F were to change in future.

Age information provides estimates of abundance for all ages in the assessment, despite the fact that the survey only catches between 250 and 300 sole in a given year. Theoretically this removes the necessity of retaining the commercial lpue (at age) series required as the UK-BTS survey does not cover the full age range in the assessment. 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 reasonable cohort tracking is apparent and the signal matches the cohort signal from other survey-series, particularly the FSP survey.

Commercial fleets effort and lpue

Effort for both UK over and under 24 m beam trawlers in hours fished increased until 2000 when it levelled off until 2006 (Figure 8.3.4, Table 8.3.6). Since then >24 m boats 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 2011 data indicates an increase in the beam trawl effort but this must be weighed up against a decrease in cpue due to a further offshore migration with the assessment indicating that F has remained relatively stable. Otter trawl effort (UK-COT) has been in continual decline since the early 1970s and is currently around the series minimum (shown 1988 onwards in Figure 8.3.4 and Table 8.3.6) at values roughly a third of those seen in the 1970s. Gross registered tonnage corrected effort used in the assessment also shown in Figure 8.3.4

shows a strong decline in effort in the main fleet exploiting the stock in 2009 as vessels moved out of the area as a result of the UK single area licensing scheme (Figure 8.3.4, Table 8.3.7) and this has continued in 2010.

Otter trawl effort, as used in the tuning information has been declining steadily since the late 1990s and is now at historically low levels, but takes only a small proportion of the landings.

Cpue for both over and under 24 m beam trawlers has declined steadily since 1988. Lpue from the survey is variable, but stable across this period, it is representative only of the younger ages in the fishery (1 to ~6) and only a proportion of the area exploited by the fishery.

Age disaggregated commercial abundance indices used in the assessment are the commercial beam trawl fleet (UK-CBT) and the otter trawl fleet (UK-COT) are given in Table 8.3.7, and plotted log converted by cohort and year in Figure 8.3.5 and 8.3.6 (historic fleets are retained for assessment stability). The UK-CBT shows very good year-class tracking indicated by the consistent estimation of strong and weak year classes at different ages, and demonstrates a decline in the abundance-at-age from 1975 to 1990, after which the observed decline continues but at a much smaller rate. This series has now been split in 2002, the year when area misreporting was officially recognised as a problem and a response by enforcement caused a change in the behaviour of the fleet. There is little indication of year effects in this time-series. The UK-COT fleet also shows good year-class tracking over the middle of the time period and also gives some indication of a decline in lpue in the early 1980 although this is much less clear than in the beam trawl fleet. 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.

The historic fleet data used in previous assessments is no longer used in the new methodology and included here only for the comparison run with previous settings.

Information from the fishing industry

The fisheries–science partnership, conducted cooperatively between CEFAS and the UK industry has provided evidence for the wide dispersal and wide-ranging age distribution for this stock. This information has now been formally included in the assessment process following WKFLAT 2012. The industry indicates that the southward movement shown in the VMS data is real and is driven by the multi species nature of this fishery in conjunction with a restrictive TAC and suitable enforcement since the introduction of the single area license scheme.

8.3.3 Stock assessment

Model used: XSA assessment as described in the Annex by WKFLAT 2012.

Software used: FLR – FLXSA (FLCore 1.4-3 - "Golden Jackal" ; R 2.4.1).

Model Options chosen: Data used were as in previous years although some alterations to the French age compositions were necessary due to a lack of age information in Q1 and Q4 as well as the higher ages.

Input data types and characteristics: catch numbers-at-age without discards, five tuning fleets, three surveys, three current commercial lpue series (the previously used beam trawl fleet having been split into an early and a late part).

Data screening

Data screening of the catch-at-age, weights, tuning information and ancillary qualitative information was carried out by the procedures set out in the Annex.

Single fleet XSA's for the current tuning fleets (see Annex for procedures) were run. Residuals for all single fleet runs were generally small (Figure 8.3.7). Residuals of the single fleet runs indicated a small but persistent decreasing trend for the CBT fleet, two large negative residuals in the COT fleet in 1992 and 2003–2004 and more variable, but largely unbiased residuals for the UK-WEC-BTS. The characteristics of the individual tuning fleets are consistent with those shown previously in the screening of the tuning fleet data and hence suggest that all tuning fleets are largely consistent with the available landings data.

Summary plots of the single fleet runs are shown in Figure 8.3.8 indicate F, SSB and recruitment estimates are consistent between the fleets overall. The recent estimates of F are similar between the otter trawlers (UK-OTB) and the survey (UK-WEC-BTS), with SSB trends differing only because of a difference in the perception of recent recruitment not yet seen in the commercial fleet which uses ages ≥3. UK-CBT provides the highest F estimates and a commensurate lower SSB estimate and like the UK-OTB fleet misses recent recruitment values because it uses the same age range.

Final update assessment

The WG fitted the XSA model as developed by WKFLAT 2012 and the addition of the 2011 data had no major consequences on the diagnostics or the interpretation of the assessment. Settings used are shown in the text table below, with previous settings having been included in the stock annex at the benchmark.

Figures 8.3.9–8.3.11 show the residual plots from the final fitted model, a comparison with the 2011 assessment including a run replicating the settings used prior to the benchmark (WKFLAT 2009), and the respective XSA survivor weightings. XSA diagnostic tables, fishing mortality-at-age, and stock number-at-age for the final assessment are shown in Tables 3.8.8–3.8.10.

A 5-year retrospective analysis was run (Figure 8.3.12), which still shows some retrospective bias in the earlier period, but confirms that the more recent period is more stable with respect to F and SSB trends. Some of the retrospective bias still observed in the assessment is undoubtedly due to the loss of influence of the FSP and Q1SWBeam survey indices which are too short for an unbiased retrospective analysis.

	2012WG
Assmnt Age Range	1–12+
FBAR Age Range	F(3–9)
Assmnt Method	XSA
Tuning Fleets	
Q1SWBeam (offset by 1y 1a)	2006–2012 2–12
UK-FSP	2004–2011 2–11
UK combined beam Ages (early)	1988–2002 3–11
UK combined beam Ages (late)	2003–2011 3–11
UK otter trawl Ages	1988–2011 3–11
UK BTS yrs Ages	1988–2011 1–9
Time taper	No
Power model ages	No
P shrinkage	No
Q plateau age	6
F shrinkage S.E	0.5
Num yrs	3
Num ages	5
Fleet S.E.	0.6

State of the stock

Stock trends are shown in Table 8.3.11 and plotted in Figure 8.3.10.

SSB is estimated to have increased from 1970 to 1980 following successive strong recruitments. Subsequently it has declined until 1993 after which it remained stable until 2009 since when there has been an increase in the most recent time in response to the reduction in F. In 2012 SSB is estimated to be 3340 t.

The base level of recruitment has remained stable during the whole time-series in the range 4–5 million recruits. The main development has been a reduction in recruitment variability since 1991 with none of the substantial year classes that maintained a higher level of biomass during the early period.

Fishing mortality was stable at a low level until 1977 after which it increased sharply until 1982, remained relatively constant until 2004 (peaking briefly in 1989–1990) and then increased until 2007. F then decreased slightly in 2008 and then sharply to a below 0.25 in 2009 and 10, commensurate with the improved compliance associated with the single area licensing scheme introduced in the UK. F in 2011 was estimated to be 0.235.

Information that is consistent with the decrease in fishing mortality in the most recent year is provided by the decline in UK effort (Figure 8.3.4) and landings. International landings are around the TAC, but variable year to year.

The age structure of the VIIe sole stock 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 individual of ages 33–38 in recent years.

8.3.4 Short-term projections

Last year the WG assumed that the TAC might be observed as the opportunities for the UK beam trawl fleet to area misreport had been eliminated but this year saw another overshoot of the TAC for different reasons. Reported landings and WG estimates are now tending around the TAC estimate, but French landings are still subject to a lag between reaching the TAC and closure of the fishery so that an F_{sq} interim year assumption remains prudent. F estimates 2009–2011 do not indicate a trend so that mean F_{09-11} at age is considered appropriate for the forecast as per the stock annex. The mean catch and stock weights-at-age 2009–2011 were also used.

Estimating year-class abundance

As implemented previously, the geometric mean recruitment over the entire time-series (1969–2009) was used as there is no evidence of a significant relationship between SSB and subsequent recruitment over the range of SSB values observed in the assessment.

Year-class	Thousands	Basis	Surveys	Commercial	Shrinkage
2009	3920	XSA	77%	-	23%
2010	4332	GM (69–09)			
2011	4332	GM (69–09)			
2012	4332	GM (69–09)			

Complete input data for the short-term forecast is shown in Table 8.3.12, and resulting forecast estimates landings in 2012 to be 780 t, 10 t more than the TAC (Table 8.3.13).

SSB estimated at 3340 t in 2012 will rise to 3450 t in 2013 at the current level of F assuming GM (69–09) recruitment for the 2011 year class the estimate of which is considered highly uncertain as in previous years (XSA estimate = 1880).

The proportions that the 2009–2013 year classes will contribute to the landings in 2012, and to the SSB in 2013, are given in Table 8.3.14. 22% of the landings for 2013, and 33% of the SSB for 2014 rely on year-classes for which GM recruitment has been assumed. The 2010 year class that has been replaced with GM (69–09) contributes to 19% of the landings in 2013 and 21% of the SSB in 2014.

A full management options table is provided in Table 8.3.15. The management plan for this stock requires exploitation at F_{MSY}=0.27 leading to a projected yield of 960 t in 2013. This is the basis of ICES advice, however there is also a 15% limit on the maximal annual change in TAC within the management plan regulations suggesting the TAC for 2013 should be 894t, equivalent to an F_{2013} = 0.25.

8.3.5 Biological reference points

The most recent reference points for this stock were developed by WKFLAT2012 and are shown in the text table below. No F based limit reference points were proposed as the management plan provides an F-target of F=0.27 and given the SSB limits only small deviations of F from this target are to be expected. There is only very small risk to the stock at these levels of exploitation under current stock dynamics and assessment uncertainty.

	Type	Value	Technical basis
Precautionary approach	B_{lim}	1300 t	WKFRAME 2 metaanalysis (ICES, 2011)
	B_{PA}	1800 t	WKFRAME 2 metaanalysis (ICES, 2011)
	F_{lim}	Undefined	
	F_{PA}	Undefined	
MSY approach	F_{MSY}	0.27	Based on a suitably defined F_{MAX} and stochastic LT simulations
	MSY $B_{trigger}$	2800 t	Based on the lower 95% confidence limits of exploitation at Fmax from LT simulations.

8.3.6 MSY-evaluation

The WG did not conduct any further MSY-evaluations given the repeat of the evaluation at WKFLAT 2012 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=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}) (WG 2005, WG 2006).

The methodology of reaching the long-term target in 3-year stepped reductions in F is also acceptable. However, the size of further steps is based on observed fishing mortalities within the period of the management plan. This can only have the desired effect if management measures (TAC) are effective and if estimates of recent levels of F from the assessment are accurate. In 2009 newly introduced enforcement measures appear to have resulted in increased compliance with the TAC; continued development of the SSB will be dependent on effective controls of fishing effort.

8.3.8 Uncertainties in assessment and forecast

The methodology provided is as robust as possible as assessed by WKFLAT 2012 at present does not appear to currently suffer from a retrospective pattern. This is largely because the differences in trends from the different indices are well balanced and cancel each other out, rather than due to an absence of trends. Qualitatively there are explanations for these differences in trend associated with movements in the fishery, however these effects have not been explicitly tested so there is some chance that retrospective patterns may again develop in the future. 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.

In addition the short-term forecast suffers from two specific uncertainties the size of which cannot quantitatively determined by the assessment. The first is the likely F in 2012. For this WG there is little difference between the Fsq forcast and one assuming a catch constraint in line with the quota (10 t) and with the constraint of the management plan in relation to a maximum increase in TAC there is no difference in the likely TAC for 2013. The other uncertainty relates to the size of the 2010 year class estimated to be weak in the assessment, however this has not been seen to be reliable in recent times (irrespective of whether this value was low or high so that this value has been replaced with $GM_{(69\text{-}09)}$ potentially overestimating the yield in 2012 and SSB in 2013. The choice of options means that the uncertainties are opposing, but does suggest that uncertainties in the estimates are larger than those suggested by the assessment and forecast.

Discarding

Despite the small scale of discarding in this fishery a times-series of available discard information raised to the fleet level should be developed to quantify the scale of assessment uncertainty caused by this practice.

Surveys

The new assessment methodology now includes three surveys, one of which covers the whole of the management area in an area weighted stratified random design leaving little chance for the development of permanent bias. In addition this survey now provides fisheries independent age data for all ages in the assessment. However, some of this accuracy will come at the expense of an increase in variance and particularly now where the time-series is still short, a balanced approach is necessary so that it is important to continue using the commercial information to stabilise the assessment. Survey information for the recruiting year class is still highly variable.

Sampling

Age and length sampling for this stock is mostly adequate. Age data from the largest two sectors prosecuting this fishery (UK and France, together about 95% of landings) are included in the assessment. French age data in 2009–2010 were insufficient at older ages to raise the length compositions, so that UK data was used to cover the larger fish.

Consistency

The interim assessment provided by the WG is generally consistent in terms of scale with previous assessments, though the perception of the recent increase in F and decline of SSB have been reversed as it is likely they would have been in future runs of the previous methodology as this suffered from a retrospective bias.

Misreporting

Area misreporting, mainly to Area VIId had declined to low levels in recent years, through a combination of enforcement and a substantial increase in the TAC in 2005. There have also been some attempts to prosecute UK fishermen for misreporting to Area VIIh, although to date none of those prosecutions have been successful for 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 underreporting are also much lower now, no quantitative information is available on the size of the problem.

Landings of the UK beam trawl fleet, historically the main contributors to area misreporting, in 2009–2011 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 reduction in F observed in the plaice VIIe stock, a major bycatch of the sole fishery.

8.3.9 Recommendation for the next Benchmark

Year	Candidate Stock	Supporting Justification	Suggested time	Indicate expertise necessary at benchmark meeting.
2012	VIIe Sole	Currently no major issues for a benchmark to consider. WKFLAT2012 suggested the level of shrinkage should be reviewed at the WG in 2013 as it will be more appropriate to do so with longer time-series of the new surveys.		

8.3.10 Management considerations

Effort restrictions have not been sufficient to ensure an observable decrease in F in recent years. Decommissioning in the UK fleet in 2007–2008 did not reduce fleet capacity sufficiently. UK single area licensing appear 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 VIIe 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 in excess of the likely discarding in the fleet considered to be in single figures by number. Consequently as this concession is granted to an increasing number of boats (five in 2012, up from three in 2011) this may increase fishing mortality, though at least for this year it is unlikely to raise F above F_{MSY}. Due to the constraint in TAC variation associated with the management plan.

Plaice are taken as a bycatch in this fishery, so that management advice for sole must also take into account the advice for plaice. The effort reductions in 2009 have also positively impacted the plaice stock with a sizeable reduction in F indicated for that stock also. Angler fish, cuttle fish, 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

Beam trawling, especially using chain-mat gear, is known to have a significant impact on the benthic communities, although less so on soft substrates and in areas which have been historically exploited by this fishing method. Discard rates of non-commercial species and commercial species of unmarketable size are substantial, but total discards are lower compared to some other gears due to the relatively small area swept by the gear.

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 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/overcapacity in the beam trawl fleet despite decommissioning. WKFLAT 2012 observed a change in the distribution of the fleet due to multi species 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 highgrading to the total mortality. However if the availability of other resources such as monk fish, scallops, cuttlefish and lemon sole were to decrease, then economics may drive the fishery back to areas of higher sole cpue in which case current effort restrictions may not be sufficient to ensure an appropriate relationship between TAC and effort restrictions.

In November of 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 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 has applied for MSC certification in 2009 commensurate with which it has started to adopt larger cod end meshes and square mesh panels to limit the impact on benthic ecosystems. However these changes appear to minimally affect the catch rates of sole, nor is the degree of uptake of these measures in the fleet clear. Changes in fishing pattern to make the most of available opportunities for other species in this multi species 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

WGRED 2008 overall indicated that there were no consistent environmental drivers altering the ecosystem in Celtic Sea Area, although it did provide some more detailed description of the environmental changes occurring in the system, including climate change, NAO and changes in plankton productivity and species composition.

The winter NAO experienced a strong negative phase in the 1960s, becoming more positive in the 1980s and early 1990s. It remained mainly negative from 1996 to 2004, but became positive in 2005 (6.7 mbar).

Although the assessment only goes back to 1969, relative year class for sole VIIe from catches indicates some very strong recruitment for example in 1963, following which recruitment appears to have declined coinciding with the strong negative phase of the NAO. Positive NAOs in the 1980s and 1990s coincide with some of the highest recruitments seen in the assessment, which have declined since then along with NAO values. Since 2005 the NAO again shows more favourable conditions although this has not immediately resulted in returns very large year classes, there is some evidence that recruitment is higher now, but more consistent so that we aren't seeing the extreme recruitments seen earlier in the time-series.

Table 8.3.1 Sole VIIE Nominal landings (t) as used by the WG

Year	Belgium	Denmark	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	0	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	-82	701
2010	17		375			2	3	361	2	-62	698
2011	22		290			2	4	422		62	801

Table 8.3.2 Sole VIIE Catch Numbers at Age in 000's

Age	1969	1970	1971	1972	1973
1	0	0	0	0	0
2	89	53	51	146	71
3	322	232	200	412	396
4	80	322	246	167	433
5	148	90	198	115	89
6	210	83	65	112	99
7	21	112	80	14	120
8	50	13	156	25	17
9	26	35	10	134	52
10	20	52	35	38	30
11	9	22	54	54	4
+gp	63	113	113	106	136
Total	1037	1127	1207	1323	1446
Landings	353	391	432	437	459

Table 8.3.2 Sole VIIE Catch Numbers at Age in 000's continued

Age	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	0	0	0	0	0	0	0	0	0	0
2	45	82	167	426	250	227	175	245	128	91
3	349	567	419	318	1123	803	559	806	1451	753
4	220	170	472	384	347	811	497	651	916	1573
5	178	199	161	206	214	250	630	467	553	583
6	71	115	135	102	189	229	126	389	352	351
7	80	28	92	70	103	174	183	179	240	267
8	43	53	46	74	72	103	140	126	136	294
9	32	26	58	10	77	90	65	76	113	119
10	24	22	51	24	38	104	56	58	81	73
11	55	24	14	32	27	28	130	55	61	37
+gp	106	171	213	159	203	290	342	211	294	262
Total	1202	1456	1830	1804	2644	3108	2902	3262	4324	4401
Landings	427	491	616	606	861	1181	1269	1215	1446	1498

Table 8.3.2 Sole VIIE Catch Numbers at Age in 000's continued

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0	0	0	0	0	0	0	0	0	0
2	333	287	246	487	443	390	341	450	316	209
3	663	1700	1618	808	1438	871	902	415	1434	704
4	826	756	971	1090	596	1233	581	482	417	1107
5	758	469	421	427	728	497	553	289	297	350
6	325	585	321	204	374	509	244	220	115	219
7	204	179	336	224	153	225	264	93	112	151
8	129	97	84	229	162	110	143	111	61	78
9	152	103	75	47	109	107	103	68	74	60
10	54	85	90	50	39	113	75	37	26	56
11	28	29	74	41	50	48	85	31	23	31
+gp	255	125	127	162	171	214	235	145	90	79
Total	3727	4414	4363	3770	4262	4316	3525	2341	2964	3045
Landings	1370	1409	1419	1280	1444	1390	1315	852	895	904

Table 8.3.2 Sole VIIE Catch Numbers at Age in 000's continued

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0	0	0	0	0	0	0	0	0	0
2	97	95	365	216	265	280	307	145	332	598
3	657	308	445	831	606	915	599	1401	1251	835
4	558	629	364	724	536	500	751	531	843	953
5	558	427	298	325	336	398	367	497	387	645
6	112	411	235	180	209	255	229	268	322	130
7	106	131	257	194	151	114	107	178	129	74
8	49	101	68	173	80	103	53	100	105	50
9	57	61	61	44	127	54	68	55	94	58
10	44	33	49	20	35	107	51	43	33	63
11	50	18	37	40	34	25	88	42	18	14
+gp	99	142	143	88	162	123	91	159	85	61
Total	2388	2356	2321	2835	2543	2874	2710	3419	3599	3482
Landings	800	856	833	949	880	957	914	1069	1106	1078

Table 8.3.2 Sole VIIE Catch Numbers at Age in 000's continued

Age	2004	2005	2006	2007	2008	2009	2010	2011	geom mean 09-11	arith mean 09-11
1	0	0	0	0	0	0	0	0	0.00	0.00
2	398	258	500	201	281	166	68	91	101.14	108.54
3	1080	468	786	852	752	540	348	499	454.46	462.52
4	448	834	472	755	678	385	394	476	416.68	418.61
5	445	449	606	293	376	333	329	405	353.97	355.60
6	526	366	250	362	163	202	204	233	212.80	213.25
7	164	293	224	179	184	66	127	156	109.53	116.57
8	116	113	185	130	105	74	49	80	66.24	67.69
9	61	80	85	110	71	37	71	39	46.90	49.06
10	54	45	56	55	67	50	20	34	32.72	34.91
11	35	24	31	27	39	35	34	28	32.17	32.32
+gp	85	96	87	99	89	65	78	93	77.92	78.74
Total	3412	3027	3282	3062	2805	1955	1723	2136	1930.33	1937.80
Landings	1075	1039	1023	1015	908	701	698	801	731.82	733.33

Table 8.3.3 Sole VIIE Catch Weights at Age in kgs

Age	1969	1970	1971	1972
1	0.000	0.000	0.113	0.000
2	0.188	0.187	0.151	0.194
3	0.245	0.223	0.222	0.227
4	0.332	0.294	0.296	0.272
5	0.329	0.314	0.367	0.369
6	0.367	0.354	0.350	0.408
7	0.522	0.434	0.359	0.458
8	0.455	0.498	0.431	0.495
9	0.463	0.442	0.455	0.402
10	0.606	0.512	0.476	0.454
11	0.647	0.528	0.388	0.508
+gp	0.660	0.593	0.653	0.600

Table 8.3.3 Sole VIIE Catch Weights at Age in kgs continued

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.000	0.144	0.142	0.139	0.118	0.000	0.000	0.000	0.000	0.120
2	0.203	0.183	0.181	0.170	0.197	0.180	0.187	0.189	0.174	0.213
3	0.224	0.224	0.214	0.217	0.248	0.241	0.237	0.254	0.226	0.208
4	0.262	0.281	0.299	0.286	0.302	0.303	0.327	0.343	0.322	0.276
5	0.310	0.379	0.358	0.323	0.356	0.390	0.423	0.389	0.382	0.345
6	0.381	0.434	0.403	0.390	0.399	0.439	0.460	0.525	0.478	0.424
7	0.414	0.372	0.435	0.454	0.502	0.377	0.468	0.560	0.515	0.495
8	0.459	0.464	0.497	0.413	0.463	0.486	0.477	0.609	0.534	0.507
9	0.466	0.475	0.591	0.475	0.517	0.489	0.565	0.646	0.599	0.520
10	0.537	0.487	0.651	0.478	0.484	0.488	0.522	0.655	0.620	0.523
11	0.654	0.474	0.535	0.583	0.552	0.540	0.569	0.600	0.710	0.561
+gp	0.561	0.731	0.676	0.628	0.681	0.670	0.725	0.783	0.661	0.659

Table 8.3.3 Sole VIIE Catch Weights at Age in kgs continued

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.000	0.088	0.000	0.106	0.098	0.091	0.110	0.158	0.105	0.088
2	0.188	0.209	0.162	0.174	0.174	0.170	0.167	0.216	0.182	0.166
3	0.251	0.242	0.225	0.237	0.245	0.244	0.222	0.270	0.255	0.238
4	0.272	0.304	0.296	0.297	0.310	0.312	0.275	0.322	0.323	0.305
5	0.307	0.379	0.358	0.354	0.370	0.375	0.326	0.370	0.386	0.366
6	0.390	0.389	0.389	0.407	0.425	0.432	0.375	0.416	0.445	0.423
7	0.419	0.478	0.469	0.456	0.474	0.484	0.422	0.458	0.499	0.474
8	0.475	0.539	0.520	0.502	0.518	0.531	0.467	0.498	0.549	0.520
9	0.532	0.559	0.531	0.544	0.557	0.572	0.510	0.534	0.594	0.561
10	0.610	0.601	0.519	0.583	0.590	0.608	0.551	0.567	0.634	0.597
11	0.553	0.722	0.584	0.618	0.618	0.639	0.590	0.597	0.669	0.627
+gp	0.667	0.639	0.817	0.703	0.665	0.694	0.692	0.664	0.742	0.684

Table 8.3.3 Sole VIIE Catch Weights at Age in kgs continued

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.000	0.122	0.133	0.164	0.000	0.000	0.158	0.141	0.000	0.123
2	0.146	0.183	0.192	0.214	0.186	0.191	0.208	0.201	0.203	0.181
3	0.209	0.241	0.248	0.262	0.244	0.247	0.257	0.257	0.245	0.236
4	0.268	0.295	0.301	0.308	0.300	0.300	0.303	0.309	0.287	0.290
5	0.324	0.347	0.351	0.354	0.354	0.350	0.347	0.357	0.326	0.342
6	0.376	0.396	0.397	0.399	0.406	0.397	0.389	0.400	0.365	0.391
7	0.425	0.442	0.441	0.442	0.455	0.441	0.429	0.440	0.402	0.439
8	0.470	0.484	0.481	0.484	0.503	0.482	0.467	0.475	0.438	0.485
9	0.513	0.524	0.518	0.524	0.548	0.520	0.502	0.507	0.472	0.529
10	0.551	0.561	0.552	0.564	0.592	0.555	0.535	0.534	0.505	0.570
11	0.587	0.595	0.583	0.602	0.633	0.586	0.566	0.557	0.537	0.610
+gp	0.672	0.671	0.652	0.695	0.734	0.661	0.636	0.645	0.615	0.705

Table 8.3.3 Sole VIIE Catch Weights at Age in kgs continued

Age	2003	2004	2005	2006	2007	2008	2009	2010	2011	mean 09-11
1	0.101	0.122	0.123	0.106	0.117	0.147	0.094	0.000	0.000	0.031
2	0.173	0.176	0.180	0.168	0.183	0.197	0.176	0.169	0.200	0.182
3	0.241	0.230	0.235	0.226	0.244	0.245	0.252	0.258	0.261	0.257
4	0.306	0.282	0.289	0.280	0.299	0.292	0.322	0.339	0.319	0.327
5	0.367	0.334	0.342	0.331	0.350	0.337	0.385	0.412	0.375	0.391
6	0.425	0.385	0.393	0.378	0.395	0.382	0.443	0.476	0.428	0.449
7	0.479	0.435	0.443	0.421	0.436	0.425	0.494	0.532	0.480	0.502
8	0.530	0.485	0.492	0.461	0.471	0.468	0.540	0.580	0.528	0.549
9	0.577	0.533	0.539	0.497	0.501	0.509	0.579	0.619	0.575	0.591
10	0.620	0.581	0.585	0.529	0.526	0.549	0.612	0.650	0.618	0.627
11	0.660	0.628	0.629	0.558	0.546	0.588	0.639	0.673	0.660	0.657
+gp	0.746	0.756	0.746	0.667	0.616	0.652	0.702	0.699	0.750	0.717

Table 8.3.4 Sole VIIE Stock Weights at Age in kgs

Age	1969	1970	1971	1972
1	0.040	0.045	0.030	0.055
2	0.125	0.120	0.090	0.130
3	0.200	0.195	0.170	0.200
4	0.270	0.255	0.240	0.265
5	0.330	0.305	0.295	0.325
6	0.380	0.355	0.345	0.380
7	0.425	0.395	0.390	0.420
8	0.460	0.430	0.420	0.460
9	0.490	0.465	0.445	0.490
10	0.520	0.490	0.470	0.520
11	0.550	0.510	0.490	0.540
+gp	0.609	0.541	0.544	0.558

Table 8.3.4 Sole VIIE Stock Weights at Age in kgs continued

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.035	0.040	0.071	0.095	0.086	0.090	0.064	0.052	0.038	0.038
2	0.105	0.125	0.144	0.146	0.156	0.156	0.141	0.125	0.119	0.117
3	0.170	0.200	0.221	0.198	0.221	0.217	0.216	0.206	0.197	0.195
4	0.235	0.265	0.267	0.247	0.278	0.276	0.287	0.288	0.276	0.265
5	0.290	0.320	0.327	0.294	0.332	0.330	0.352	0.360	0.358	0.335
6	0.340	0.370	0.385	0.338	0.382	0.380	0.414	0.436	0.427	0.398
7	0.390	0.410	0.435	0.380	0.425	0.425	0.463	0.513	0.490	0.455
8	0.435	0.455	0.479	0.417	0.462	0.463	0.502	0.575	0.543	0.506
9	0.475	0.490	0.516	0.456	0.497	0.498	0.539	0.620	0.582	0.536
10	0.510	0.515	0.545	0.491	0.527	0.526	0.574	0.650	0.616	0.562
11	0.540	0.530	0.569	0.523	0.553	0.555	0.608	0.674	0.645	0.585
+gp	0.585	0.571	0.628	0.595	0.629	0.630	0.719	0.714	0.699	0.632

Table 8.3.4 Sole VIIE Stock Weights at Age in kgs continued

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.040	0.032	0.095	0.071	0.058	0.050	0.081	0.128	0.065	0.048
2	0.120	0.108	0.150	0.140	0.137	0.131	0.139	0.187	0.144	0.128
3	0.195	0.192	0.204	0.206	0.210	0.208	0.195	0.243	0.219	0.202
4	0.250	0.268	0.258	0.268	0.278	0.278	0.249	0.296	0.290	0.272
5	0.307	0.339	0.311	0.326	0.341	0.344	0.300	0.346	0.355	0.336
6	0.365	0.400	0.364	0.381	0.398	0.404	0.350	0.393	0.416	0.395
7	0.420	0.453	0.416	0.432	0.450	0.459	0.398	0.437	0.473	0.449
8	0.475	0.501	0.468	0.480	0.497	0.508	0.444	0.478	0.524	0.498
9	0.520	0.545	0.520	0.524	0.538	0.552	0.488	0.516	0.572	0.542
10	0.570	0.577	0.571	0.564	0.574	0.591	0.531	0.551	0.614	0.580
11	0.615	0.607	0.621	0.601	0.605	0.624	0.571	0.583	0.652	0.613
+gp	0.709	0.696	0.790	0.691	0.659	0.687	0.675	0.654	0.731	0.677

Table 8.3.4 Sole VIIE Stock Weights at Age in kgs continued

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.000	0.091	0.103	0.139	0.000	0.000	0.132	0.110	0.000	0.094
2	0.114	0.153	0.163	0.189	0.156	0.162	0.183	0.172	0.181	0.152
3	0.178	0.212	0.221	0.238	0.215	0.220	0.233	0.230	0.224	0.209
4	0.239	0.268	0.275	0.285	0.272	0.274	0.280	0.284	0.266	0.263
5	0.296	0.322	0.326	0.331	0.327	0.325	0.326	0.333	0.307	0.316
6	0.350	0.372	0.374	0.376	0.380	0.374	0.369	0.379	0.346	0.367
7	0.401	0.419	0.419	0.420	0.431	0.419	0.410	0.421	0.384	0.415
8	0.448	0.463	0.461	0.463	0.480	0.462	0.448	0.458	0.420	0.462
9	0.492	0.505	0.500	0.504	0.526	0.501	0.485	0.492	0.455	0.507
10	0.532	0.543	0.536	0.544	0.570	0.537	0.519	0.521	0.489	0.550
11	0.570	0.578	0.568	0.583	0.612	0.571	0.551	0.546	0.521	0.591
+gp	0.659	0.659	0.641	0.677	0.717	0.650	0.624	0.643	0.602	0.688

Table 8.3.4 Sole VIIE Stock Weights at Age in kgs continued

Age	2003	2004	2005	2006	2007	2008	2009	2010	2011	mean 09-11
1	0.063	0.095	0.094	0.074	0.083	0.122	0.051	0.000	0.000	0.017
2	0.137	0.149	0.152	0.138	0.151	0.172	0.136	0.121	0.169	0.142
3	0.207	0.203	0.208	0.197	0.214	0.221	0.215	0.215	0.231	0.220
4	0.274	0.256	0.263	0.254	0.272	0.268	0.287	0.300	0.290	0.292
5	0.337	0.308	0.316	0.306	0.325	0.315	0.354	0.376	0.347	0.359
6	0.396	0.360	0.368	0.355	0.373	0.360	0.415	0.445	0.402	0.421
7	0.452	0.410	0.419	0.400	0.416	0.404	0.469	0.505	0.454	0.476
8	0.505	0.460	0.468	0.442	0.454	0.447	0.518	0.557	0.504	0.526
9	0.554	0.509	0.516	0.479	0.486	0.489	0.560	0.600	0.552	0.571
10	0.599	0.557	0.562	0.514	0.514	0.529	0.596	0.636	0.597	0.610
11	0.641	0.605	0.607	0.544	0.536	0.569	0.626	0.663	0.639	0.643
+gp	0.732	0.734	0.726	0.661	0.614	0.640	0.698	0.696	0.738	0.711

Table 8.3.5 Sole VIIE Landings Length Frequency Distributions

Length	UK BeamTrawl	UK other	French Nets	French Trawl
14	0	0	87	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	321
19	0	0	0	0
20	0	0	0	167
21	0	0	175	0
22	71	0	262	925
23	309	135	561	416
24	1807	59	343	29053
25	5873	2526	725	27065
26	15539	6646	1505	46375
27	31957	9396	2523	79136
28	58102	12060	5293	70754
29	74957	12454	7649	71753
30	85858	10093	7424	54011
31	95063	9074	10345	53454
32	90490	10561	9272	52191
33	73280	10634	8848	41861
34	70018	13513	9205	44822
35	67837	9824	5207	22374
36	56662	11645	8826	22173
37	50387	6760	2418	27943
38	35766	7274	2632	20013
39	34430	3902	6175	8945
40	21879	13044	3583	10385
41	17297	7584	4478	15600
42	13758	6058	3207	7317
43	9317	1334	3801	5078
44	6952	722	2671	1962
45	4657	2293	2787	607
46	2347	2012	887	1192
47	1432	485	915	4301
48	1035	957	482	353
49	451	145	180	1992
50	408	179	480	321
51	142	90	572	0
52	30	42	43	0
53	33	42	0	0
54	50	0	178	0
55	0	0	264	0
56	15	42	43	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0
60	0	0	0	0
61	0	0	0	0
62	0	0	618	0
Total	928209	171585	114664	722860

Table 8.3.6 Sole VIIE landings, effort & mean standardised CPUE data

Year	Effort BT u24 000s h	Effort BT o24 000s h	Landings BT u24 t	Landings BT o24 t	Survey CPUE kg 100km	BTu24 LPUE kg hour	BTo24 LPUE kg hour	Survey CPUE MS	BTu24 LPUE MS	BTo24 LPUE MS
1988	46.33	60.90	332.79	441.99	74.24	7.18	7.26	1.22	1.55	2.05
1989	35.29	86.80	200.99	520.43	69.36	5.70	6.00	1.14	1.23	1.69
1990	36.35	78.51	238.56	474.06	43.72	6.56	6.04	0.72	1.41	1.70
1991	27.93	64.94	165.12	296.01	72.58	5.91	4.56	1.19	1.27	1.29
1992	29.47	61.95	169.31	291.50	78.13	5.74	4.70	1.28	1.24	1.33
1993	31.08	65.31	199.90	281.75	49.63	6.43	4.31	0.81	1.38	1.22
1994	34.77	73.47	189.29	317.87	40.66	5.44	4.33	0.67	1.17	1.22
1995	31.30	76.80	158.01	328.93	37.78	5.05	4.28	0.62	1.09	1.21
1996	33.16	94.91	164.71	300.93	48.72	4.97	3.17	0.80	1.07	0.89
1997	34.15	88.68	192.26	332.09	63.11	5.63	3.74	1.03	1.21	1.06
1998	43.41	83.09	186.94	306.70	65.83	4.31	3.69	1.08	0.93	1.04
1999	42.82	73.17	185.15	271.41	54.50	4.32	3.71	0.89	0.93	1.05
2000	49.07	79.58	202.29	250.02	51.94	4.12	3.14	0.85	0.89	0.89
2001	65.65	92.42	302.55	300.74	74.67	4.61	3.25	1.22	0.99	0.92
2002	61.55	92.19	293.79	298.56	43.18	4.77	3.24	0.71	1.03	0.91
2003	67.25	107.01	277.64	329.50	50.28	4.13	3.08	0.82	0.89	0.87
2004	56.25	108.64	206.17	239.23	57.99	3.67	2.20	0.95	0.79	0.62
2005	51.49	107.66	198.42	255.15	35.67	3.85	2.37	0.58	0.83	0.67
2006	50.87	110.87	225.31	238.63	49.10	4.43	2.15	0.81	0.95	0.61
2007	65.32	94.07	237.46	213.78	62.91	3.64	2.27	1.03	0.78	0.64
2008	76.21	83.37	222.79	170.25	73.55	2.92	2.04	1.21	0.63	0.58
2009	63.66	58.99	184.35	115.31	77.38	2.90	1.95	1.27	0.62	0.55
2010	74.52	54.00	202.08	93.77	99.20	2.71	1.74	1.63	0.58	0.49
2011	100.70	49.71	257.40	90.10	89.40	2.56	1.81	1.47	0.55	0.51

Table 8.3.7 Tuning information as used in the assessment

```
W CHANNEL SOLE 2011 WGCSE, 1-14, SEXES COMBINED,
106
UK-CBT-early
1988 2002
1 1 0 1
3 14
107.23 747.49 382.4  497.05 225.59  71.83  70.57 66.73 14.92 24.57 15.09 31.15  7.87
122.09 480.71 603.07 295.68 344.28 124.29  52.66 52.11 48.82 30.47 18.98 21.01 12.79
114.86 478.16 361.27 271.68 174.70 170.90  65.40 49.23 31.81 27.42 14.67 24.04 12.60
 92.87 229.74 240.99 186.87 121.76  52.87  67.89 37.54 17.79 12.29 22.67  5.38  9.83
 91.43 773.74 216.51 152.49  57.61  60.04  28.95 41.72 10.80  7.61  7.45  7.99  7.08
 96.39 382.12 602.61 186.88 114.16  81.18  41.21 31.94 31.52 15.68  4.58 11.85  8.02
108.24 443.52 361.70 347.10  69.39  62.83  30.89 34.86 26.44 29.61 14.09 10.91  5.74
108.10 173.64 357.84 240.49 233.61  71.61  56.73 33.47 18.33 10.07 22.33  9.28  6.44
128.07 239.43 194.61 165.43 133.04 143.67  38.10 34.80 27.59 20.80 22.58 20.66  8.37
122.83 474.85 387.28 181.39  95.01 104.45  92.27 23.00 10.67 21.69  8.71 10.14  7.52
126.50 352.44 311.69 194.66 115.68  83.44  44.32 66.82 18.37 18.30 15.18 16.05  7.08
115.99 471.41 244.17 181.40 114.13  48.08  45.38 23.67 47.22 10.45 17.65  5.01  5.30
128.65 308.67 374.19 177.98 110.37  53.08  26.86 31.31 23.64 41.62  4.51  6.91  2.95
158.07 832.95 295.63 281.48 143.95  95.75  53.72 28.03 23.25 22.22 25.86  9.65  7.28
153.74 775.07 469.78 172.07 172.99  77.14  54.40 23.91 10.98 12.98  7.28 13.62  6.31
UK-CBT-late
2003 2011
1 1 0 1
3 14
174.26 425.77 550.11 423.34  69.80  59.67  33.48 43.96 21.73  7.15  6.69 10.92  9.19
164.89 494.01 207.46 180.26 253.67  38.28  50.45 25.25 20.16 14.39  7.15  3.98  6.39
159.15 223.71 346.97 141.36 165.05 140.46  29.15 34.66 23.97 15.14  8.83  6.32  5.14
161.74 380.29 188.15 245.65  86.37 109.33 107.95 37.56 20.86 13.81 13.74  6.74  3.01
159.39 488.97 280.33 113.45 110.97  58.13  66.53 55.17 16.44 11.91 11.16  9.05  8.76
159.57 314.87 306.44 135.02  72.71  70.10  45.39 42.38 38.92 15.58 12.62  4.60  6.40
122.65 190.42 183.01 153.14  89.78  26.07  27.96 13.26 16.14 12.94  4.86  3.75  1.92
128.52  80.65 180.67 158.21 101.65  52.18  25.40 22.65  8.29 16.83 25.49  7.46  3.90
150.41 241.99 147.50 185.30 120.55  81.07  35.30 15.67 20.10 10.75 14.01  8.20  2.08
UK-COT
1988 2011
1 1 0 1
3 14
53402 33.38 16.95 20.78  9.30 2.75 2.75 1.98 0.38 0.82 0.43 0.93 0.27
54707 16.22 19.72  9.91 12.63 5.08 2.60 2.54 2.16 1.51 1.20 1.07 0.70
53050 19.09 13.10  9.60  6.35 5.76 2.17 1.91 1.16 0.94 0.65 1.00 0.53
40789 10.04  7.04  4.12  2.46 0.96 1.44 0.42 0.41 0.24 0.27 0.08 0.18
39909 26.15  5.98  3.59  1.19 1.14 0.48 0.65 0.17 0.09 0.07 0.17 0.10
39240 12.22 17.24  5.29  3.38 2.44 1.24 0.98 0.90 0.55 0.13 0.32 0.29
38768 12.67 11.69 12.60  2.55 2.65 1.25 1.38 1.05 1.20 0.63 0.46 0.27
35453  5.26  9.75  6.34  6.18 1.89 1.49 0.91 0.52 0.25 0.59 0.32 0.18
30541  9.46  6.52  4.36  3.14 3.53 0.95 0.75 0.67 0.45 0.44 0.42 0.18
33281 15.05  8.74  4.75  2.81 2.88 2.52 0.62 0.28 0.43 0.31 0.26 0.27
29802  8.50  7.38  4.14  2.42 1.49 0.90 1.43 0.31 0.43 0.37 0.34 0.12
27516 11.35  5.73  4.83  2.84 1.42 1.44 0.72 1.47 0.38 0.56 0.19 0.19
30493  6.40  8.07  3.87  2.53 1.19 0.57 0.77 0.59 0.95 0.09 0.20 0.05
31900 17.90  5.23  4.93  2.67 1.99 1.11 0.70 0.51 0.50 0.65 0.24 0.22
28346  9.77  6.05  2.36  2.64 1.26 0.81 0.33 0.20 0.24 0.17 0.27 0.10
25060  4.49  5.72  4.67  1.01 0.83 0.47 0.52 0.26 0.12 0.15 0.22 0.17
25584  5.98  2.55  2.20  3.21 0.45 0.57 0.29 0.24 0.18 0.13 0.07 0.09
21129  6.34  9.41  3.47  4.07 3.39 0.73 0.89 0.57 0.45 0.25 0.19 0.14
```

```
21058  6.85  3.24  4.08  1.34 1.61 1.73 0.59 0.30 0.20 0.19 0.12 0.05
22347  9.16  5.35  2.26  2.28 1.17 1.39 1.11 0.35 0.21 0.23 0.20 0.20
19855  5.58  4.81  2.06  1.14 1.17 0.74 0.74 0.70 0.31 0.23 0.11 0.10
21412  7.94  5.45  3.91  2.16 0.64 0.82 0.39 0.52 0.44 0.18 0.12 0.08
26062  2.70  5.84  4.73  3.14 1.63 0.81 0.73 0.30 0.59 0.83 0.28 0.16
25161  6.46  3.29  3.86  2.44 1.62 0.58 0.31 0.37 0.19 0.36 0.18 0.06
UK-WEC-BTS
1988 2011
1 1 0.75 0.8
1 9
128.2  2  39 129  52 75 22  0 12  3
165.7  5  56 120 107 34 40 17  5  7
175.7 23  52  76  31 24  7 15  3  6
171.7 11 231  79  51 23 21  5 17  4
196.6  5 140 316  44 36 12  7  5 11
189.2  5  54 115 105 14 10  9  3  3
205.9  6  47 106  62 44  5  5  2  3
187.2 14  37  44  42 26 31  4  5  5
184.4 28 112  67  25 32 20 17  3  2
184.7 11 130 126  43 14 16 13 14  5
185.5 11 141 114  76 22 10 14  6  8
187.9 11  97 128  47 23  8  4  4  4
180.4 12 136  70  52 23 16  5  3  5
178.0  9 197 162  52 31 12 12  4  1
180.0  6  37 113  48 27  6  3  2  0
170.7 23 158  57  50 19  4  4  6  1
164.9 16 110 120  24 15 10 16  9  4
186.6  8 110  39  53 12 12  6  2  4
184.7  5 120  95  26 37 10  7  9  0
181.0  7 188 135  50 11 23  3  3  1
174.7 10  85 158  77 40  2 14  3  6
172.0 11 104 126  96 49 13 13 12  1
179.9 20 175 154  84 59 31 20  7 12
176.2  9 156 231  62 39 25 24  8  2
Q1SWBeam-offset
2005 2011
1 1 0.95 1
1 14
1  94001 113998  62225 103018 48544 54439 56793 22432 27006 35279  3988 12146  3120 10522
1  92172 239570 101387  18155 62736 16883 23594 32739 20652 29497  1810  6856  9460  4558
1 101385 185010 151595  78338 60931 20751 51105 43538 33596 16775 11018 15347 10556  4558
1  27993 154131 110973  80631 44529 15942 21406  6701 29431 40894  5123  3291  1832  4750
1 157202 171595 174803  87035 64353 51894 15281 16685 10263  8762 13813  5350  4657  4373
1  85753 159546 110635  83064 37066 23554 31016 15019  3677  8563  7567  2159  2773   867
1  17757 150426 166151  66950 53531 62480 30847 20671   918  9631 15150  1802  6735   717
FSP-UK
2004 2011
1 1 0.7 0.75
2 11
1  0.130 0.663 0.288 0.337 0.115 0.027 0.087 0.027 0.008 0.012
1  0.102 0.208 0.269 0.119 0.159 0.134 0.036 0.032 0.014 0.018
1  0.146 0.335 0.152 0.202 0.09  0.107 0.117 0.025 0.021 0.017
1  0.150 0.496 0.203 0.067 0.1   0.051 0.057 0.087 0.018 0.014
1  0.150 0.264 0.205 0.1   0.041 0.027 0.014 0.029 0.03  0.002
1  0.094 0.246 0.227 0.127 0.052 0.032 0.025 0.03  0.025 0.022
1  0.104 0.201 0.227 0.157 0.092 0.034 0.035 0.037 0.024 0.028
1  0.026 0.231 0.259 0.173 0.142 0.069 0.031 0.012 0.01  0.011
Updated sk 03/05/12
```

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics
FLR XSA Diagnostics 2012-05-13 09:28:40

CPUE data from index.final
Catch data for 43 years. 1969 to 2011. Ages 1 to 12.

fleet	first age	last age	first year	last year	alpha	beta
UK-CBT-early	3	11	1988	2002	0	1
UK-CBT-late	3	11	2003	2011	0	1
UK-COT	3	11	1988	2011	0	1
UK-WEC-BTS	1	9	1988	2011	0.75	0.8
Q1SWBeam-offset	1	11	2005	2011	0.95	1
FSP-UK	2	11	2004	2011	0.7	0.75

Time series weights :
Tapered time weighting not applied

Catchability analysis :
Catchability independent of size for all ages
Catchability independent of age for ages >5

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 = 0.5
min. S.E. for population estimates derived from each fleet = 0.6

Regression weights

Year

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	1	1	1	1	1	1	1	1	1

Estimated population abundance at 1st Jan 2012

Age

1	2	3	4	5	6	7	8	9	10	11	12
0	1698	2623	2785	1242	1203	930	633	306	130	144	72

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

XSA fleet diagnostics for UK-CBT-early

Fleet q-residuals

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	0.337	0.232	0.302	-0.007	0.271	0.106	0.261	-0.377	-0.609	0.095	-0.118	-0.018	-0.303	-0.153	-0.019
4	0.257	0.358	0.283	0.081	0.107	0.177	0.107	0.276	-0.315	0.088	-0.155	-0.226	-0.133	-0.384	-0.521
5	0.321	0.354	0.236	0.265	0.025	0.345	-0.118	0.096	-0.236	0.060	-0.204	-0.220	-0.252	-0.175	-0.496
6	0.399	0.386	0.526	0.244	-0.473	0.183	-0.260	-0.072	-0.162	-0.284	0.161	-0.155	-0.322	-0.121	-0.051
7	-0.140	0.195	0.237	-0.008	-0.046	0.170	-0.124	0.156	-0.361	0.082	-0.033	-0.123	-0.636	-0.236	-0.250
8	-0.046	-0.151	0.156	-0.081	-0.247	-0.118	-0.561	0.180	-0.214	-0.416	-0.381	-0.092	-0.376	-0.479	-0.319
9	-0.079	0.004	0.384	0.335	-0.242	0.184	-0.038	-0.174	-0.023	-0.294	-0.424	-0.581	-0.075	-0.083	-0.809
10	-0.643	-0.097	0.104	0.141	-0.500	-0.273	0.351	-0.333	-0.153	-0.802	-0.150	-0.309	-0.312	-0.059	-0.432
11	-0.009	0.368	-0.049	-0.131	-0.246	0.204	-0.122	-0.174	0.008	0.096	0.088	-0.184	-0.094	-0.111	-0.142

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

	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11
MeanLogq	-6.6272	-6.4174	-6.3829	-6.4541	-6.4541	-6.4541	-6.4541	-6.4541	-6.4541
S.ELogq	0.2755	0.2713	0.2655	0.2991	0.2356	0.2177	0.3181	0.3027	0.1644

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

XSA fleet diagnostics for UK-CBT-late

Fleet q-residuals

Age	2003	2004	2005	2006	2007	2008	2009	2010	2011
3	0.340	0.213	0.127	0.214	0.387	0.029	-0.180	-0.839	-0.291
4	0.400	-0.163	0.089	0.123	0.135	0.086	-0.156	-0.219	-0.295
5	0.256	-0.243	-0.108	0.197	0.110	-0.131	0.023	-0.065	-0.039
6	-0.459	0.274	0.153	-0.098	-0.015	0.186	0.174	-0.074	-0.140
7	-0.219	-0.667	0.178	0.165	0.008	0.026	-0.180	-0.050	-0.151
8	-0.238	-0.003	-0.491	0.330	0.094	0.274	-0.234	0.070	-0.260
9	0.380	-0.136	0.086	0.193	0.083	0.003	-0.270	-0.136	-0.233
10	0.152	0.101	0.255	0.017	-0.131	0.111	-0.375	-0.492	-0.060
11	0.141	0.400	0.311	0.123	-0.104	0.353	-0.399	-0.068	-0.054

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

	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11
MeanLogq	-7.2967	-7.0611	-7.0401	-7.0772	-7.0772	-7.0772	-7.0772	-7.0772	-7.0772
S.ELogq	0.3865	0.2223	0.1621	0.226	0.2556	0.2726	0.2123	0.2488	0.2596

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

XSA fleet diagnostics for UK-COT

Fleet q-residuals

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
3	0.400	0.120	0.327	0.159	0.186	0.036	0.206	-0.285	0.068	0.423	0.077	0.169	-0.266	0.081	-0.227	-0.468	-0.534	0.387	0.041	0.179	-0.115	0.193	-0.836	-0.322
4	0.396	0.299	0.297	-0.071	-0.095	0.080	0.261	0.347	0.281	0.161	0.106	0.019	0.029	-0.260	-0.624	-0.312	-0.784	0.415	0.015	0.056	-0.069	-0.010	-0.140	-0.395
5	0.440	0.359	0.263	-0.130	-0.297	0.276	0.190	0.172	0.159	0.320	-0.011	0.190	-0.044	-0.022	-0.498	-0.372	-0.846	0.144	0.078	0.098	-0.290	0.041	-0.039	-0.182
6	0.478	0.454	0.554	-0.264	-0.953	0.132	0.033	-0.019	0.095	0.071	0.310	0.161	-0.087	0.063	0.028	-0.808	-0.285	0.417	-0.278	0.011	0.062	0.139	-0.009	-0.305
7	-0.135	0.371	0.190	-0.624	-0.611	0.134	0.307	0.207	-0.063	0.367	-0.042	0.364	-0.424	0.061	-0.103	-0.608	-1.300	0.420	-0.067	0.014	-0.036	-0.194	0.027	-0.329
8	-0.023	0.214	0.093	-0.541	-0.948	-0.152	-0.171	0.225	0.098	-0.140	-0.262	0.467	-0.218	-0.187	-0.265	-0.618	-0.675	-0.211	0.182	0.138	0.189	-0.071	0.167	-0.633
9	-0.329	0.356	0.477	-0.765	-1.004	0.169	0.330	-0.093	0.143	-0.031	-0.252	-0.065	0.229	0.398	-0.831	-0.170	-0.792	0.391	0.025	0.089	-0.014	-0.104	-0.028	-0.420
10	-1.045	0.159	0.135	-0.236	-1.252	-0.359	0.722	-0.210	0.133	-0.566	-0.216	0.231	0.007	0.292	-0.177	-0.387	-0.519	0.483	-0.239	-0.069	0.124	-0.118	-0.268	-0.319
11	-0.142	0.737	-0.079	-0.674	-1.284	0.323	0.270	-0.184	0.178	0.052	0.353	0.511	0.136	0.266	0.129	-0.059	-0.171	0.761	-0.126	-0.230	0.467	-0.088	0.124	-0.354

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

	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11
MeanLogq	-16.009	-15.8836	-15.8879	-15.9322	-15.9322	-15.9322	-15.9322	-15.9322	-15.9322
S.ELogq	0.3198	0.3083	0.2995	0.3605	0.4057	0.3462	0.4161	0.4352	0.4385

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

XSA fleet diagnostics for UK-WEC-BTS

Fleet q-residuals

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	-1.206	-0.275	0.273	0.149	-0.638	-0.230	-0.500	0.281	1.162	-0.063	0.174	-0.466	-0.147	-0.076	-0.841	1.211	0.535	-0.424	-0.730	-0.335	0.338	0.103	0.958	0.748
2	-0.525	-0.411	-0.258	0.284	0.253	-0.541	-0.413	-0.936	0.081	0.377	0.160	0.033	-0.244	0.314	-0.972	0.206	0.562	0.020	0.015	0.587	-0.113	0.371	0.465	0.685
3	0.234	0.367	-0.129	0.092	0.414	0.025	-0.015	-0.531	-0.480	0.171	0.163	0.000	-0.336	-0.103	-0.289	-0.505	-0.065	-0.656	-0.175	0.103	0.375	0.174	0.567	0.597
4	0.404	0.719	-0.262	0.227	0.058	0.073	0.006	-0.077	-0.432	-0.180	0.356	-0.049	-0.119	0.069	-0.666	-0.289	-0.672	-0.271	-0.299	-0.017	0.284	0.487	0.307	0.343
5	0.851	0.528	0.028	0.140	0.399	-0.300	-0.259	-0.080	0.339	-0.300	-0.187	-0.174	-0.041	0.110	0.091	-0.905	-0.813	-0.780	0.134	-0.396	0.497	0.449	0.510	0.160
6	0.785	0.820	-0.221	0.739	0.011	-0.056	-0.705	0.208	0.434	0.374	0.224	-0.425	0.266	0.166	-0.674	-1.104	-0.703	-0.381	-0.137	0.558	-1.246	0.128	0.604	0.334
7	NA	0.794	0.251	-0.140	-0.119	0.162	-0.457	-0.403	-0.020	0.474	0.670	-0.211	-0.507	0.444	-0.794	-0.716	0.694	-0.891	-0.475	-0.815	0.576	0.994	0.872	0.678
8	0.881	0.058	-0.445	0.750	0.067	-0.571	-1.130	0.076	-0.268	0.127	0.075	-0.124	-0.059	-0.343	-0.912	0.256	0.512	-1.091	-0.048	-0.903	-0.267	0.789	0.654	0.305
9	-0.519	0.577	0.791	0.358	0.484	0.013	-0.287	0.219	-0.375	0.619	-0.090	-0.007	0.641	-0.632	NA	-1.155	0.251	0.012	NA	-1.825	0.167	-0.985	1.123	-0.233

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

	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9
MeanLogq	-11.1823	-8.7092	-8.3165	-8.6046	-8.8458	-9.1923	-9.1923	-9.1923	-9.1923
S.ELogq	0.6232	0.4576	0.3452	0.3523	0.449	0.5813	0.6067	0.577	0.6924

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

XSA fleet diagnostics for Q1SWBeam-offset

Fleet q-residuals

Age	2005	2006	2007	2008	2009	2010	2011
1	0.004	0.138	0.271	-0.734	0.645	0.342	-0.666
2	-0.432	0.218	0.049	-0.070	0.301	-0.162	0.096
3	-0.278	-0.204	0.103	-0.132	0.319	0.091	0.101
4	0.214	-0.841	0.235	0.079	0.094	0.046	0.173
5	0.037	0.077	0.705	-0.054	0.028	-0.608	-0.185
6	0.336	-0.416	-0.354	-0.028	0.622	-0.531	0.371
7	0.559	-0.069	1.209	0.143	0.253	0.460	0.049
8	0.526	0.434	0.934	-0.312	0.216	0.561	0.377
9	1.124	0.918	0.853	0.872	0.442	-0.902	-1.884
10	1.922	1.684	1.209	1.412	-0.019	0.526	0.368
11	0.242	-0.600	1.073	0.607	0.618	0.138	1.508

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

	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11
MeanLogq	3.0104	3.9497	3.981	3.8038	3.9714	3.8292	3.8292	3.8292	3.8292	3.8292	3.8292
S.ELogq	0.5176	0.2476	0.2111	0.3777	0.3899	0.4506	0.4298	0.3805	1.1448	0.7293	0.6804

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

XSA fleet diagnostics for FSP-UK

Fleet q-residuals

Age	2004	2005	2006	2007	2008	2009	2010	2011
2	0.551	-0.106	0.148	0.281	0.338	0.139	-0.139	-1.212
3	0.529	0.029	0.084	0.383	-0.168	-0.224	-0.189	-0.445
4	0.279	-0.061	0.040	-0.064	-0.216	-0.140	-0.142	0.303
5	0.602	-0.065	0.240	-0.199	-0.229	-0.251	-0.118	0.020
6	-0.222	0.367	0.214	0.157	-0.128	-0.399	-0.173	0.184
7	-0.740	0.379	0.407	0.149	-0.669	-0.017	-0.465	-0.152
8	0.822	-0.035	0.672	0.178	-0.631	-0.388	0.397	-0.227
9	0.204	0.256	0.061	0.778	-0.153	0.505	0.379	-0.329
10	-0.518	-0.037	0.297	0.226	0.083	0.021	0.562	-0.600
11	0.549	0.721	0.599	0.291	-1.408	0.082	0.442	0.156

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

	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11
MeanLogq	-10.3462	-9.0236	-8.8917	-8.9704	-9.0577	-9.0577	-9.0577	-9.0577	-9.0577	-9.0577
S.ELogq	0.5395	0.3265	0.1948	0.2912	0.2658	0.4493	0.5129	0.3556	0.3948	0.6782

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2010 at terminal Age 1

Source	Age 1
fshk	1
	0.0000
FSP-UK	1
	0.0000
Q1SWBeam-offset	873
	2.7778
UK-CBT-late	1
	0.0000
UK-COT	1
	0.0000
UK-WEC-BTS	3588
	2.4721

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	NaN	NA	NA	NA	0	NA	0.000
FSP-UK	NaN	NA	NA	NA	0	NA	0.000
Q1SWBeam-offset	873	0.600	Inf	Inf	1	0.529	0.000
UK-CBT-late	NaN	NA	NA	NA	0	NA	0.000
UK-COT	NaN	NA	NA	NA	0	NA	0.000
UK-WEC-BTS	3588	0.636	NaN	NaN	1	0.471	0.000

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
1698	0.436	0.706	2	Var Ratio	0.000

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2009 at terminal Age 2

Source	Age 1	Age 2
fshk	1	1570
	0.0000	4.0000
FSP-UK	1	781
	0.0000	2.6886
Q1SWBeam-offset	3691	2888
	2.6886	2.6886
UK-CBT-late	1	1
	0.0000	0.0000
UK-COT	1	1
	0.0000	0.0000
UK-WEC-BTS	6840	5206
	2.3927	2.6886

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	1570	0.492	NaN	NaN	1	0.233	0.054
FSP-UK	781	0.600	Inf	Inf	1	0.157	0.106
Q1SWBeam-offset	3265	0.424	0.123	0.289	2	0.314	0.026
UK-CBT-late	NaN	NA	NA	NA	0	NA	0.000
UK-COT	NaN	NA	NA	NA	0	NA	0.000
UK-WEC-BTS	5920	0.436	0.136	0.312	2	0.296	0.015

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
2623	0.238	0.341	6	Var Ratio	0.033

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2008 at terminal Age 3

Source	Age 1	Age 2	Age 3
fshk	1	1	2040
	0.0000	0.0000	4.0000
FSP-UK	1	2423	1786
	0.0000	2.3311	2.3730
Q1SWBeam-offset	5308	2368	3082
	2.3311	2.3311	2.3730
UK-CBT-late	1	1	2081
	0.0000	0.0000	2.3730
UK-COT	1	1	2018
	0.0000	0.0000	2.3730
UK-WEC-BTS	3087	4436	5061
	2.0745	2.3311	2.3730

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	2040	0.462	NaN	NaN	1	0.147	0.209
FSP-UK	2077	0.424	0.153	0.360	2	0.173	0.206
Q1SWBeam-offset	3382	0.346	0.237	0.684	3	0.258	0.131
UK-CBT-late	2081	0.600	Inf	Inf	1	0.087	0.205
UK-COT	2018	0.600	NaN	NaN	1	0.087	0.211
UK-WEC-BTS	4158	0.353	0.145	0.411	3	0.249	0.108

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
2785	0.176	0.12	11	Var Ratio	0.157

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2007 at terminal Age 4

Source	Age 1	Age 2	Age 3	Age 4
fshk	1	1	1	1681
	0.0000	0.0000	0.0000	4.0000
FSP-UK	1	1427	1029	1682
	0.0000	1.6244	1.7297	2.0352
Q1SWBeam-offset	596	1678	1360	1477
	1.6244	1.6244	1.7297	2.0352
UK-CBT-late	1	1	537	924
	0.0000	0.0000	1.7297	2.0352
UK-COT	1	1	539	836
	0.0000	0.0000	1.7297	2.0352
UK-WEC-BTS	1742	1800	2188	1750
	1.4456	1.6244	1.7297	2.0352

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	1681	0.428	NaN	NaN	1	0.130	0.238
FSP-UK	1367	0.348	0.146	0.420	3	0.175	0.286
Q1SWBeam-offset	1208	0.301	0.228	0.756	4	0.228	0.318
UK-CBT-late	720	0.426	0.271	0.636	2	0.122	0.486
UK-COT	683	0.426	0.219	0.515	2	0.122	0.507
UK-WEC-BTS	1863	0.306	0.055	0.179	4	0.222	0.217

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
1242	0.147	0.108	16	Var Ratio	0.310

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2006 at terminal Age 5

Source	Age 1	Age 2	Age 3	Age 4	Age 5
fshk	1	1	1	1	1253
	0.0000	0.0000	0.0000	0.0000	4.0000
FSP-UK	1	1687	961	1044	1227
	0.0000	1.3124	1.4230	1.7337	2.1043
Q1SWBeam-offset	1578	1122	1655	1260	999
	1.3124	1.3124	1.4230	1.7337	2.1043
UK-CBT-late	1	1	1005	966	1157
	0.0000	0.0000	1.4230	1.7337	2.1043
UK-COT	1	1	1459	1045	1003
	0.0000	0.0000	1.4230	1.7337	2.1043
UK-WEC-BTS	860	1074	1432	1635	1412
	1.1679	1.3124	1.4230	1.7337	2.1043

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	1253	0.435	NaN	NaN	1	0.109	0.267
FSP-UK	1188	0.305	0.114	0.374	4	0.179	0.280
Q1SWBeam-offset	1267	0.273	0.098	0.358	5	0.215	0.265
UK-CBT-late	1050	0.351	0.057	0.164	3	0.143	0.312
UK-COT	1125	0.351	0.113	0.321	3	0.143	0.294
UK-WEC-BTS	1296	0.276	0.109	0.393	5	0.211	0.260

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
1203	0.131	0.036	21	Var Ratio	0.277

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2005 at terminal Age 6

Source	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
fshk	1	1	1	1	1	679
	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
FSP-UK	1	1232	786	809	826	1118
	0.0000	1.0794	1.1404	1.4888	1.8001	2.2428
Q1SWBeam-offset	1068	977	815	1022	506	1347
	1.0794	1.0794	1.1404	1.4888	1.8001	2.2428
UK-CBT-late	1	1	957	796	871	808
	0.0000	0.0000	1.1404	1.4888	1.8001	2.2428
UK-COT	1	1	828	921	894	685
	0.0000	0.0000	1.1404	1.4888	1.8001	2.2428
UK-WEC-BTS	448	1672	1353	1514	1548	1298
	0.9606	1.0794	1.1404	1.4888	1.8001	2.2428

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	679	0.449	NaN	NaN	1	0.094	0.282
FSP-UK	943	0.279	0.089	0.320	5	0.182	0.211
Q1SWBeam-offset	922	0.255	0.153	0.598	6	0.207	0.215
UK-CBT-late	846	0.309	0.038	0.124	4	0.156	0.232
UK-COT	812	0.309	0.072	0.235	4	0.156	0.241
UK-WEC-BTS	1275	0.258	0.169	0.657	6	0.204	0.160

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
930	0.121	0.064	26	Var Ratio	0.213

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2004 at terminal Age 7

Source	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7
fshk	1	1	1	1	1	1	462
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
FSP-UK	1	734	929	510	493	532	544
	0.0000	0.6962	0.7859	1.0379	1.4451	1.8365	2.2492
Q1SWBeam-offset	635	787	702	685	651	372	665
	0.6962	0.6962	0.7859	1.0379	1.4451	1.8365	2.0464
UK-CBT-late	1	1	933	690	648	588	544
	0.0000	0.0000	0.7859	1.0379	1.4451	1.8365	2.2492
UK-COT	1	1	757	591	659	628	456
	0.0000	0.0000	0.7859	1.0379	1.4451	1.8365	2.2492
UK-WEC-BTS	414	643	702	841	992	1158	1247
	0.6196	0.6962	0.7859	1.0379	1.4451	1.8365	2.0956

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	462	0.450	NaN	NaN	1	0.091	0.279
FSP-UK	570	0.266	0.085	0.319	6	0.184	0.231
Q1SWBeam-offset	596	0.251	0.103	0.410	7	0.195	0.222
UK-CBT-late	629	0.285	0.080	0.280	5	0.168	0.212
UK-COT	581	0.285	0.087	0.305	5	0.168	0.227
UK-WEC-BTS	933	0.252	0.129	0.511	7	0.194	0.148

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
633	0.116	0.057	31	Var Ratio	0.211

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2003 at terminal Age 8

Source	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8
fshk	1	1	1	1	1	1	1	230
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
FSP-UK	1	275	333	287	243	205	192	244
	0.0000	0.4281	0.4592	0.6086	0.9294	1.3087	1.7288	2.2254
Q1SWBeam-offset	1	198	249	386	290	569	484	446
	0.0000	0.4281	0.4592	0.6086	0.9294	1.3087	1.5729	2.1705
UK-CBT-late	1	1	379	350	268	364	291	236
	0.0000	0.0000	0.4592	0.6086	0.9294	1.3087	1.7288	2.2254
UK-COT	1	1	318	323	229	351	314	162
	0.0000	0.0000	0.4592	0.6086	0.9294	1.3087	1.7288	2.2254
UK-WEC-BTS	522	312	257	301	502	347	731	415
	0.3810	0.4281	0.4592	0.6086	0.9294	1.3087	1.6107	2.2254

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	230	0.448	NaN	NaN	1	0.096	0.285
FSP-UK	233	0.262	0.064	0.244	7	0.185	0.281
Q1SWBeam-offset	409	0.265	0.121	0.456	7	0.180	0.170
UK-CBT-late	290	0.275	0.078	0.284	6	0.174	0.232
UK-COT	252	0.275	0.142	0.515	6	0.174	0.262
UK-WEC-BTS	437	0.253	0.120	0.473	8	0.191	0.160

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
306	0.116	0.058	35	Var Ratio	0.221

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2002 at terminal Age 9

Source	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
fshk	1	1	1	1	1	1	1	1	131
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
FSP-UK	1	225	134	135	107	114	128	193	94
	0.0000	0.2851	0.3347	0.4328	0.6425	0.9617	1.3846	1.7244	2.1601
Q1SWBeam-offset	1	1	98	56	263	126	167	228	20
	0.0000	0.0000	0.3347	0.4328	0.6425	0.9617	1.2598	1.6819	0.5008
UK-CBT-late	1	1	148	147	145	157	109	139	103
	0.0000	0.0000	0.3347	0.4328	0.6425	0.9617	1.3846	1.7244	2.1601
UK-COT	1	1	191	132	143	138	107	154	85
	0.0000	0.0000	0.3347	0.4328	0.6425	0.9617	1.3846	1.7244	2.1601
UK-WEC-BTS	436	228	67	96	87	37	351	250	103
	0.2537	0.2851	0.3347	0.4328	0.6425	0.9617	1.2901	1.7244	1.5463

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	131	0.441	NaN	NaN	1	0.099	0.249
FSP-UK	128	0.254	0.107	0.420	8	0.196	0.254
Q1SWBeam-offset	137	0.280	0.294	1.052	7	0.144	0.240
UK-CBT-late	125	0.263	0.068	0.259	7	0.189	0.259
UK-COT	120	0.263	0.103	0.394	7	0.189	0.270
UK-WEC-BTS	143	0.253	0.267	1.058	9	0.185	0.231

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
130	0.114	0.057	39	Var Ratio	0.251

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2001 at terminal Age 10

Source	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
fshk	1	1	1	1	1	1	1	1	1	135
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
FSP-UK	1	1	244	135	183	168	74	98	210	79
	0.0000	0.0000	0.2047	0.2772	0.3973	0.6092	0.9402	1.3531	1.6828	2.2642
Q1SWBeam-offset	1	1	1	178	155	101	166	178	58	208
	0.0000	0.0000	0.0000	0.2772	0.3973	0.6092	0.8554	1.3197	0.3901	0.4116
UK-CBT-late	1	1	178	157	175	142	148	114	125	135
	0.0000	0.0000	0.2047	0.2772	0.3973	0.6092	0.9402	1.3531	1.6828	2.2642
UK-COT	1	1	84	218	155	145	139	134	140	104
	0.0000	0.0000	0.2047	0.2772	0.3973	0.6092	0.9402	1.3531	1.6828	2.2642
UK-WEC-BTS	62	177	135	110	164	251	256	316	442	1
	0.1611	0.1810	0.2047	0.2772	0.3973	0.6092	0.8760	1.3531	1.2046	0.0000

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	135	0.451	NaN	NaN	1	0.109	0.215
FSP-UK	117	0.261	0.164	0.627	8	0.211	0.245
Q1SWBeam-offset	147	0.308	0.146	0.473	7	0.116	0.201
UK-CBT-late	134	0.261	0.044	0.170	8	0.211	0.217
UK-COT	129	0.261	0.069	0.262	8	0.211	0.225
UK-WEC-BTS	261	0.265	0.164	0.619	9	0.143	0.118

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
144	0.119	0.046	41	Var Ratio	0.204

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2000 at terminal Age 11

Source	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11
fshk	1	1	1	1	1	1	1	1	1	1	108
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
FSP-UK	1	1	1	95	68	89	84	38	119	126	84
	0.0000	0.0000	0.0000	0.2167	0.2811	0.4191	0.6007	0.9132	1.3767	1.7200	1.3057
Q1SWBeam-offset	1	1	1	1	75	48	242	53	112	122	326
	0.0000	0.0000	0.0000	0.0000	0.2811	0.4191	0.5466	0.8907	0.3192	0.3127	0.8297
UK-CBT-late	1	1	101	61	65	65	73	95	55	44	68
	0.0000	0.0000	0.1563	0.2167	0.2811	0.4191	0.6007	0.9132	1.3767	1.7200	2.0260
UK-COT	1	1	45	33	83	55	73	87	65	55	51
	0.0000	0.0000	0.1563	0.2167	0.2811	0.4191	0.6007	0.9132	1.3767	1.7200	2.0260
UK-WEC-BTS	67	27	44	37	33	63	32	55	27	1	1
	0.1264	0.1421	0.1563	0.2167	0.2811	0.4191	0.5597	0.9132	0.9855	0.0000	0.0000

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	108	0.427	NaN	NaN	1	0.119	0.221
FSP-UK	90	0.263	0.145	0.551	8	0.203	0.260
Q1SWBeam-offset	118	0.336	0.313	0.933	7	0.107	0.204
UK-CBT-late	62	0.252	0.086	0.342	9	0.229	0.356
UK-COT	60	0.252	0.076	0.301	9	0.229	0.369
UK-WEC-BTS	39	0.268	0.119	0.442	9	0.113	0.519

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
72	0.12	0.07	43	Var Ratio	0.315

Table 8.3.9 Sole VIIE Stock Numbers at Age in 000's

Age	1969	1970	1971	1972	1973	1974
1	1481	4212	2829	2493	3425	3267
2	1871	1340	3811	2560	2256	3099
3	2375	1608	1162	3401	2178	1973
4	624	1843	1235	860	2685	1594
5	964	489	1361	883	619	2018
6	1510	731	357	1043	689	476
7	159	1167	582	262	837	530
8	506	124	949	451	223	643
9	571	411	100	711	384	186
10	261	493	339	81	516	299
11	90	217	396	274	37	439
+gp	635	1121	819	541	1218	846
Total	11047	13756	13941	13559	15069	15371

Table 8.3.9 Sole VIIE Stock Numbers at Age in 000's continued

Age	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	3068	7196	5106	4778	5131	8842	5113	4131	6513	7674
2	2956	2776	6512	4620	4323	4643	8000	4626	3738	5894
3	2762	2597	2353	5487	3942	3696	4034	7006	4065	3296
4	1453	1960	1951	1826	3896	2804	2812	2884	4959	2962
5	1233	1154	1324	1400	1323	2753	2064	1925	1738	2991
6	1657	926	891	1002	1063	960	1893	1423	1215	1018
7	363	1390	709	708	727	745	749	1343	953	766
8	404	302	1170	576	543	493	500	508	987	608
9	541	315	229	988	452	393	313	332	330	613
10	138	465	230	198	821	324	294	211	193	186
11	247	104	372	185	142	644	240	211	114	106
+gp	1748	1590	1855	1376	1481	1686	922	1018	807	944
Total	16571	20775	22701	23144	23846	27981	26934	25618	25613	27057

Table 8.3.9 Sole VIIE Stock Numbers at Age in 000's continued

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	4160	6357	4125	4045	3085	7733	4287	3738	2583	3731
2	6944	3765	5752	3733	3661	2791	6997	3879	3382	2337
3	5016	6010	3172	4741	2956	2941	2201	5903	3210	2861
4	2352	2921	3899	2101	2922	1846	1803	1597	3977	2235
5	1894	1409	1719	2491	1335	1472	1118	1173	1048	2546
6	1986	1268	875	1149	1561	735	806	736	779	615
7	612	1241	842	598	684	929	433	520	557	496
8	499	384	803	549	395	405	589	304	363	360
9	427	359	268	509	343	253	230	427	217	254
10	410	289	253	198	356	208	131	144	317	139
11	116	291	176	182	142	215	117	84	106	233
+gp	505	497	694	621	634	593	554	325	267	457
Total	24922	24790	22579	20916	18074	20121	19266	18829	16806	16265

Table 8.3.9 Sole VIIE Stock Numbers at Age in 000's continued

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	4385	3689	4925	3870	7241	5981	4234	5998	3116	4414
2	3376	3967	3338	4456	3501	6552	5412	3831	5427	2819
3	2022	2964	3243	2815	3780	2902	5636	4759	3151	4342
4	1964	1537	2259	2143	1971	2550	2056	3768	3116	2057
5	1491	1179	1044	1356	1429	1308	1593	1355	2607	1913
6	1773	943	783	636	907	915	834	969	858	1746
7	450	1213	630	538	376	578	610	500	570	653
8	348	283	853	385	343	231	421	383	330	445
9	279	219	191	607	273	213	159	285	246	251
10	175	194	140	132	429	195	128	92	169	168
11	84	128	129	107	86	286	128	75	52	93
+gp	644	497	282	505	425	296	481	347	230	223
Total	16991	16813	17818	17549	20759	22007	21693	22362	19873	19122

Table 8.3.9 Sole VIIE Stock Numbers at Age in 000's continued

Age	2005	2006	2007	2008	2009	2010	2011	2012 survivors	geom mean 05-11	arith mean 05-11
1	5087	4360	4198	3168	4480	3310	4332[a]	0	3624	3783
2	3994	4603	3945	3798	2867	4054	2995	3920	3705	3751
3	2173	3368	3689	3379	3170	2436	3603	2623	3064	3117
4	2901	1520	2300	2528	2342	2354	1873	2785	2219	2260
5	1435	1832	927	1363	1643	1752	1755	1242	1496	1529
6	1308	871	1081	560	876	1170	1273	1203	985	1020
7	1080	836	550	634	352	600	864	930	665	702
8	434	698	543	327	398	256	422	633	420	440
9	292	285	456	368	196	290	185	306	283	296
10	170	189	177	308	265	142	195	130	200	207
11	100	111	118	107	215	192	109	144	130	136
+gp	396	310	435	242	396	446	360	310	362	369
Total	19369	18982	18419	16783	17199	17003	15511			

[a] XSA estimate (1877) replaced with GM recruitment69-09

Table 8.3.10 Sole VIIE Fishing Mortality at Age

Age	1969	1970	1971	1972
1	0.000	0.000	0.000	0.000
2	0.051	0.043	0.014	0.062
3	0.154	0.164	0.200	0.136
4	0.144	0.203	0.235	0.229
5	0.177	0.214	0.166	0.148
6	0.158	0.127	0.213	0.120
7	0.151	0.107	0.156	0.059
8	0.109	0.115	0.189	0.059
9	0.048	0.093	0.109	0.220
10	0.084	0.118	0.114	0.691
11	0.110	0.112	0.156	0.231
+gp	0.110	0.112	0.156	0.231
$Fbar_{3-9}$	0.134	0.146	0.181	0.139

Table 8.3.10 Sole VIIE Fishing Mortality at Age continued

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.034	0.015	0.030	0.065	0.071	0.059	0.057	0.040	0.033	0.029
3	0.212	0.206	0.243	0.186	0.153	0.242	0.241	0.173	0.236	0.246
4	0.186	0.157	0.131	0.292	0.232	0.223	0.247	0.206	0.279	0.407
5	0.164	0.097	0.186	0.159	0.178	0.175	0.221	0.275	0.272	0.360
6	0.163	0.171	0.076	0.167	0.129	0.221	0.256	0.148	0.243	0.301
7	0.163	0.172	0.083	0.072	0.109	0.166	0.289	0.298	0.289	0.208
8	0.081	0.072	0.148	0.176	0.069	0.141	0.223	0.355	0.309	0.331
9	0.152	0.199	0.051	0.217	0.048	0.085	0.234	0.190	0.293	0.442
10	0.063	0.090	0.182	0.123	0.115	0.227	0.143	0.200	0.233	0.513
11	0.125	0.141	0.108	0.151	0.094	0.168	0.230	0.239	0.274	0.360
+gp	0.125	0.141	0.108	0.151	0.094	0.168	0.230	0.239	0.274	0.360
$Fbar_{3-9}$	0.160	0.153	0.131	0.181	0.131	0.179	0.244	0.235	0.274	0.328

Table 8.3.10 Sole VIIE Fishing Mortality at Age continued

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.026	0.061	0.044	0.071	0.093	0.133	0.119	0.138	0.070	0.089
3	0.217	0.238	0.441	0.333	0.312	0.384	0.371	0.389	0.221	0.295
4	0.406	0.347	0.412	0.430	0.348	0.354	0.586	0.402	0.330	0.321
5	0.435	0.310	0.301	0.377	0.303	0.367	0.496	0.502	0.317	0.310
6	0.362	0.408	0.370	0.309	0.281	0.419	0.419	0.429	0.338	0.179
7	0.349	0.328	0.366	0.335	0.328	0.314	0.425	0.356	0.256	0.258
8	0.376	0.253	0.230	0.261	0.356	0.371	0.346	0.463	0.220	0.237
9	0.475	0.302	0.291	0.249	0.204	0.256	0.397	0.556	0.371	0.200
10	0.504	0.366	0.244	0.397	0.232	0.232	0.405	0.474	0.350	0.210
11	0.415	0.332	0.301	0.311	0.281	0.340	0.436	0.535	0.321	0.341
+gp	0.415	0.332	0.301	0.311	0.281	0.340	0.436	0.535	0.321	0.341
$Fbar_{3-9}$	0.374	0.312	0.345	0.328	0.305	0.352	0.434	0.442	0.293	0.257

Table 8.3.10 Sole VIIE Fishing Mortality at Age continued

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.067	0.045	0.030	0.102	0.070	0.065	0.088	0.051	0.029	0.096
3	0.262	0.276	0.175	0.172	0.314	0.257	0.294	0.245	0.303	0.323
4	0.346	0.305	0.411	0.286	0.411	0.305	0.310	0.370	0.317	0.268
5	0.433	0.262	0.358	0.308	0.397	0.302	0.346	0.350	0.397	0.357
6	0.351	0.212	0.279	0.303	0.276	0.425	0.351	0.306	0.411	0.430
7	0.336	0.254	0.364	0.252	0.392	0.350	0.385	0.217	0.366	0.316
8	0.257	0.156	0.362	0.291	0.239	0.246	0.378	0.274	0.289	0.341
9	0.342	0.271	0.262	0.347	0.274	0.249	0.234	0.407	0.452	0.424
10	0.205	0.406	0.218	0.308	0.166	0.327	0.306	0.320	0.435	0.469
11	0.368	0.256	0.262	0.359	0.395	0.410	0.361	0.389	0.426	0.299
+gp	0.368	0.256	0.262	0.359	0.395	0.410	0.361	0.389	0.426	0.299
$Fbar_{3-9}$	0.333	0.248	0.316	0.280	0.329	0.305	0.328	0.310	0.362	0.351

Table 8.3.10 Sole VIIE Fishing Mortality at Age continued

Age	2003	2004	2005	2006	2007	2008	2009	2010	2011	mean F_{09-11}
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.123	0.160	0.070	0.121	0.055	0.081	0.063	0.018	0.033	0.038
3	0.327	0.303	0.257	0.282	0.278	0.267	0.197	0.163	0.157	0.173
4	0.388	0.260	0.360	0.395	0.423	0.331	0.190	0.194	0.311	0.232
5	0.301	0.280	0.399	0.427	0.403	0.342	0.240	0.220	0.278	0.246
6	0.174	0.381	0.348	0.360	0.434	0.365	0.278	0.203	0.214	0.232
7	0.148	0.307	0.336	0.330	0.419	0.364	0.219	0.252	0.211	0.228
8	0.172	0.321	0.321	0.326	0.289	0.411	0.218	0.225	0.222	0.222
9	0.284	0.293	0.339	0.377	0.292	0.228	0.223	0.297	0.251	0.257
10	0.500	0.417	0.325	0.372	0.400	0.262	0.221	0.164	0.204	0.196
11	0.329	0.510	0.294	0.349	0.272	0.487	0.190	0.203	0.316	0.236
+gp	0.329	0.510	0.294	0.349	0.272	0.487	0.190	0.203	0.316	0.236
$Fbar_{3-9}$	0.256	0.306	0.337	0.357	0.363	0.330	0.224	0.222	0.235	0.227

Table 8.3.11 Sole VIIE Summary Table

Year	Recruits[000']	TSB[t]	SSB[t]	Landings[t]	Yield//SSB	FBar3-9
1969	1480	2980	2432	352.72	0.15	0.134
1970	4212	3206	2646	389.61	0.15	0.146
1971	2829	2915	2383	431.92	0.18	0.181
1972	2492	3218	2388	436.55	0.18	0.139
1973	3425	3373	2767	458.25	0.17	0.160
1974	3267	3628	2883	426.52	0.15	0.153
1975	3068	4626	3652	500.63	0.14	0.131
1976	7196	4765	3385	614.25	0.18	0.181
1977	5106	5746	4073	604.58	0.15	0.131
1978	4777	5821	4046	868.31	0.21	0.179
1979	5131	6289	4825	1170.17	0.24	0.244
1980	8841	6775	5281	1268.10	0.24	0.235
1981	5112	6065	4507	1217.81	0.27	0.274
1982	4131	5970	4491	1437.95	0.32	0.328
1983	6513	5511	4270	1503.84	0.35	0.374
1984	7673	5543	4287	1362.66	0.32	0.312
1985	4160	5794	3856	1400.09	0.36	0.345
1986	6356	5531	3843	1418.02	0.37	0.328
1987	4125	5343	3918	1279.28	0.33	0.305
1988	4045	5073	3820	1443.13	0.38	0.352
1989	3084	4322	3222	1389.36	0.43	0.434
1990	7733	4928	3021	1306.25	0.43	0.442
1991	4286	4230	2749	852.20	0.31	0.293
1992	3737	3958	2636	895.68	0.34	0.257
1993	2583	3387	2621	903.83	0.34	0.333
1994	3730	3965	2896	800.26	0.28	0.248
1995	4384	4180	2935	855.85	0.29	0.316
1996	3688	4418	2812	833.38	0.30	0.280
1997	4924	3614	2702	949.66	0.35	0.329
1998	3869	3774	2733	880.05	0.32	0.305
1999	7240	4804	2737	955.93	0.35	0.328
2000	5981	4860	2770	911.73	0.33	0.310
2001	4234	4468	2856	1068.62	0.37	0.362
2002	5998	4777	3038	1105.32	0.36	0.351
2003	3115	4527	3213	1078.12	0.34	0.256
2004	4413	4378	3037	1073.92	0.35	0.306
2005	5087	4484	3134	1036.77	0.33	0.337
2006	4359	4018	2727	1015.53	0.37	0.357
2007	4197	4181	2805	1014.65	0.36	0.363
2008	3168	4056	2607	908.12	0.35	0.330
2009	4480	3967	2936	700.48	0.24	0.224
2010	3310	4047	3239	698.15	0.22	0.222
2011	4332[a]	4160	3190	801.28	0.25	0.235

[a] replaced XSA estimate (1877) with GM recruitment69-09

Table 8.3.12 Sole VIIE Short-term Forcast Input Table

2012

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	4332	0.10	0.00	0.00	0.00	0.017	0.000	0.031
2	3920	0.10	0.14	0.00	0.00	0.142	0.038	0.182
3	2623	0.10	0.45	0.00	0.00	0.220	0.173	0.257
4	2785	0.10	0.88	0.00	0.00	0.292	0.232	0.327
5	1242	0.10	0.98	0.00	0.00	0.359	0.246	0.391
6	1203	0.10	1.00	0.00	0.00	0.421	0.232	0.449
7	930	0.10	1.00	0.00	0.00	0.476	0.228	0.502
8	633	0.10	1.00	0.00	0.00	0.526	0.222	0.549
9	306	0.10	1.00	0.00	0.00	0.571	0.257	0.591
10	130	0.10	1.00	0.00	0.00	0.610	0.196	0.627
11	144	0.10	1.00	0.00	0.00	0.643	0.236	0.657
12	310	0.10	1.00	0.00	0.00	0.711	0.236	0.717

2013

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	4332	0.10	0.00	0.00	0.00	0.017	0.000	0.031
2		0.10	0.14	0.00	0.00	0.142	0.038	0.182
3		0.10	0.45	0.00	0.00	0.220	0.173	0.257
4		0.10	0.88	0.00	0.00	0.292	0.232	0.327
5		0.10	0.98	0.00	0.00	0.359	0.246	0.391
6		0.10	1.00	0.00	0.00	0.421	0.232	0.449
7		0.10	1.00	0.00	0.00	0.476	0.228	0.502
8		0.10	1.00	0.00	0.00	0.526	0.222	0.549
9		0.10	1.00	0.00	0.00	0.571	0.257	0.591
10		0.10	1.00	0.00	0.00	0.610	0.196	0.627
11		0.10	1.00	0.00	0.00	0.643	0.236	0.657
12		0.10	1.00	0.00	0.00	0.711	0.236	0.717

2014

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	4332	0.10	0.00	0.00	0.00	0.017	0.000	0.031
2		0.10	0.14	0.00	0.00	0.142	0.038	0.182
3		0.10	0.45	0.00	0.00	0.220	0.173	0.257
4		0.10	0.88	0.00	0.00	0.292	0.232	0.327
5		0.10	0.98	0.00	0.00	0.359	0.246	0.391
6		0.10	1.00	0.00	0.00	0.421	0.232	0.449
7		0.10	1.00	0.00	0.00	0.476	0.228	0.502
8		0.10	1.00	0.00	0.00	0.526	0.222	0.549
9		0.10	1.00	0.00	0.00	0.571	0.257	0.591
10		0.10	1.00	0.00	0.00	0.610	0.196	0.627
11		0.10	1.00	0.00	0.00	0.643	0.236	0.657
12		0.10	1.00	0.00	0.00	0.711	0.236	0.717

Table 8.3.13 Sole VIIE Single Option Output

Year=2012 F / F09-11= 1.000 Fbar= 0.227

Age	F	Catch No	Yield	Stock No	Biomass	SS No	SSB
1	0.000	0	0	4332	74	0	0
2	0.038	138	25	3920	557	549	78
3	0.173	396	102	2623	578	1180	260
4	0.232	549	179	2785	814	2451	717
5	0.246	258	101	1242	446	1217	437
6	0.232	237	107	1203	506	1203	506
7	0.228	181	91	930	443	930	443
8	0.222	120	66	633	333	633	333
9	0.257	66	39	306	174	306	174
10	0.196	22	14	130	79	130	79
11	0.236	29	19	144	92	144	92
12	0.236	62	45	310	220	310	220
Total		2059	787	18557	4316	9052	3339

Year=2013 F / F09-11= 1.000 Fbar= 0.227

Age	F	Catch No	Yield	Stock No	Biomass	SS No	SSB
1	0.000	0	0	4332	74	0	0
2	0.038	138	25	3920	557	549	78
3	0.173	516	133	3415	753	1537	339
4	0.232	394	129	1997	584	1758	514
5	0.246	415	162	1999	718	1959	703
6	0.232	173	78	879	370	879	370
7	0.228	168	84	863	411	863	411
8	0.222	127	70	670	353	670	353
9	0.257	99	59	459	262	459	262
10	0.196	36	23	214	130	214	130
11	0.236	19	13	97	62	97	62
12	0.236	65	47	324	230	324	230
Total		2151	821	19169	4502	9308	3452

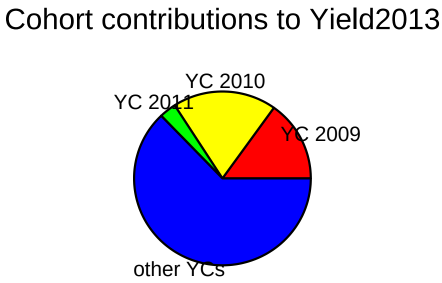
Year=2014 F / F09-11= 1.000 Fbar= 0.227

Age	F	Catch No	Yield	Stock No	Biomass	SS No	SSB
1	0.000	0	0	4332	74	0	0
2	0.038	138	25	3920	557	549	78
3	0.173	516	133	3415	753	1537	339
4	0.232	513	167	2600	760	2288	669
5	0.246	298	116	1434	515	1405	504
6	0.232	279	125	1415	595	1415	595
7	0.228	122	61	631	300	631	300
8	0.222	118	65	622	327	622	327
9	0.257	105	62	486	277	486	277
10	0.196	55	34	321	196	321	196
11	0.236	32	21	159	102	159	102
12	0.236	60	43	301	214	301	214
Total		2236	854	19635	4669	9713	3601

input units are in 000's and kg, output in t

Table 8.3.14 Sole VIIE Contributions and Source of Cohort for Short-term Forecast

YC	Source	Yield2012	Yield2013	SSB2012	SSB2013	SSB2014
2009	XSA	12.4	15.1	7.5	14.3	15.6
2010	GM 69-09	2.9	19	2.2	10.5	21
2011	GM 69-09		3.1		2.4	10.1
2012	GM 69-09					2.3
2013	GM 69-09					



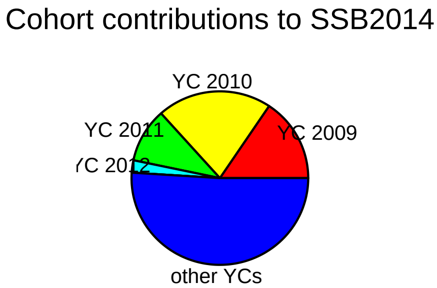


Table 8.3.15 Sole VIIE Management Options Output

SSB 2013	TSB 2013	F-mult	F	basis	Yield 2013	SSB 2014	TSB 2014	%SSB-Change	%TAC-Change
3452	4502	0.0	0.000	Fsq	0	4405	5509	28	-100
3452	4502	0.1	0.023	Fsq	90	4316	5416	25	-88
3452	4502	0.2	0.045	Fsq	179	4230	5326	23	-77
3452	4502	0.3	0.068	Fsq	265	4145	5237	20	-66
3452	4502	0.4	0.091	Fsq	350	4062	5151	18	-55
3452	4502	0.5	0.113	Fsq	433	3981	5066	15	-44
3452	4502	0.6	0.136	Fsq	514	3902	4983	13	-34
3452	4502	0.7	0.159	Fsq	593	3824	4902	11	-24
3452	4502	0.79	0.179	Fsq	663	3756	4831	9	-15
3452	4502	0.8	0.182	Fsq	671	3748	4823	9	-14
3452	4502	0.9	0.204	Fsq	747	3674	4745	6	-4
3452	4502	0.94	0.213	Fsq	777	3645	4714	6	0
3452	4502	1.0	0.227	Fsq	821	3601	4669	4	6
3452	4502	1.1	0.250	Fsq	894	3530	4595	2	15
3452	4502	1.2	0.272	Fsq	965	3461	4522	0	24
3452	4502	1.3	0.295	Fsq	1035	3393	4451	-2	33
3452	4502	1.4	0.318	Fsq	1103	3327	4381	-4	42
3452	4502	1.5	0.340	Fsq	1170	3262	4313	-6	51
3452	4502	1.6	0.363	Fsq	1236	3198	4246	-7	59
3452	4502	1.7	0.386	Fsq	1300	3136	4181	-9	67
3452	4502	1.8	0.408	Fsq	1363	3075	4117	-11	75
3452	4502	1.9	0.431	Fsq	1424	3015	4054	-13	83
3452	4502	2.0	0.454	Fsq	1484	2957	3993	-14	91
3452	4502	1.1894	0.270	Fmsy	958	3468	4530	0	23
3452	4502	1.1	0.250	Fmp F	894	3530	4595	2	15

Figure 8.3.1 Sole VIIE International Landings Age Compositions

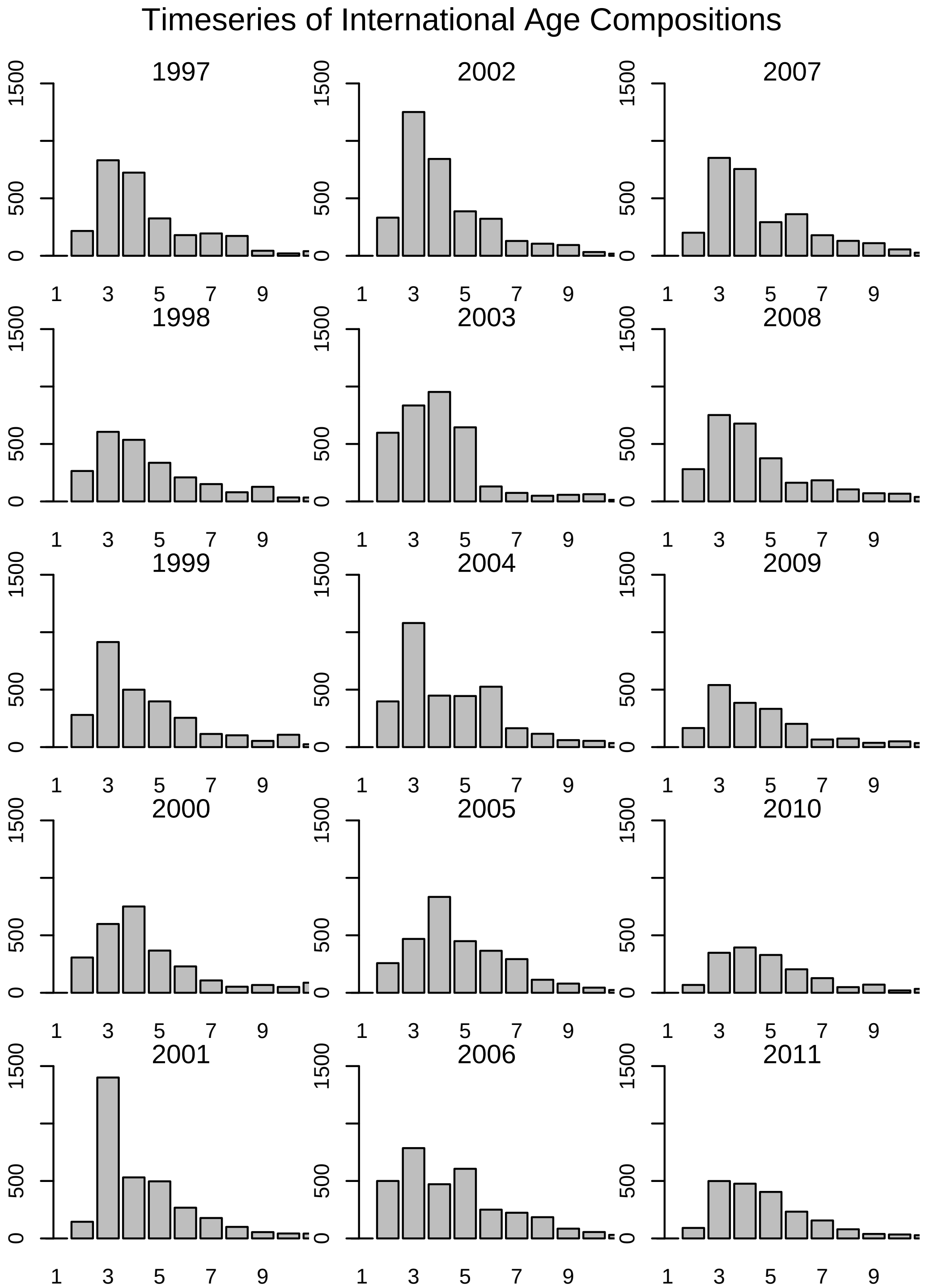
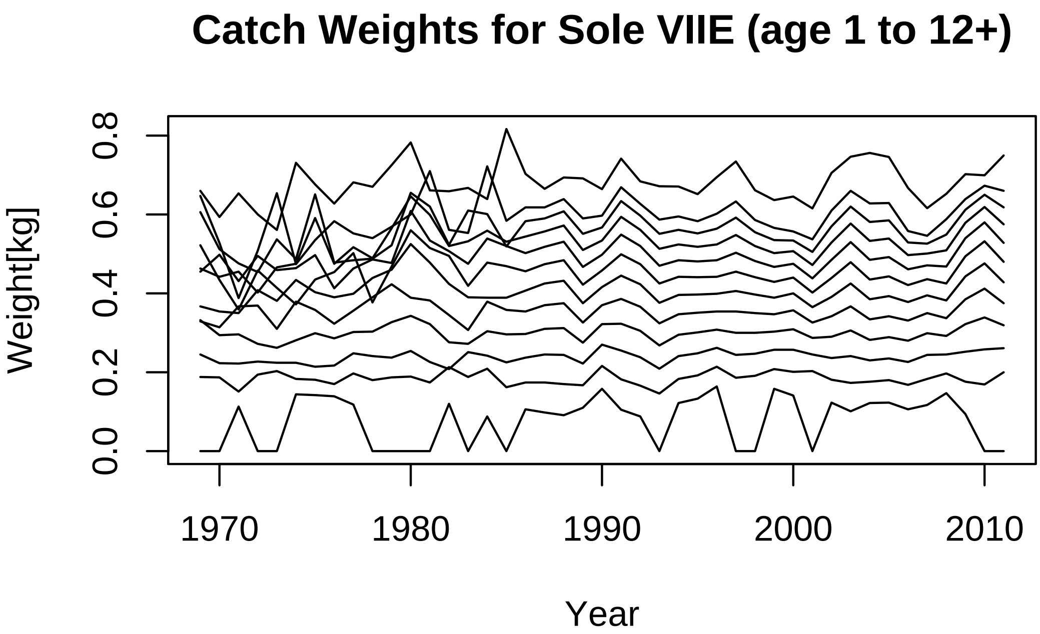


Figure 8.3.2 Sole VIIE Catch and Stock Weights at Age



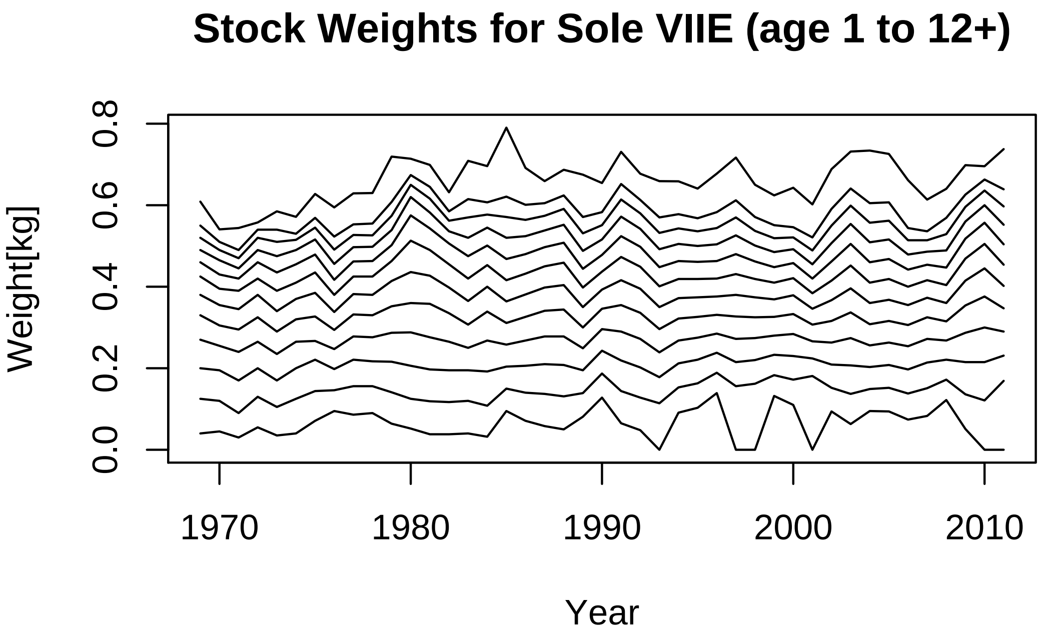


Figure 8.3.3a Sole VIIE Discards by Quarter, Fleet

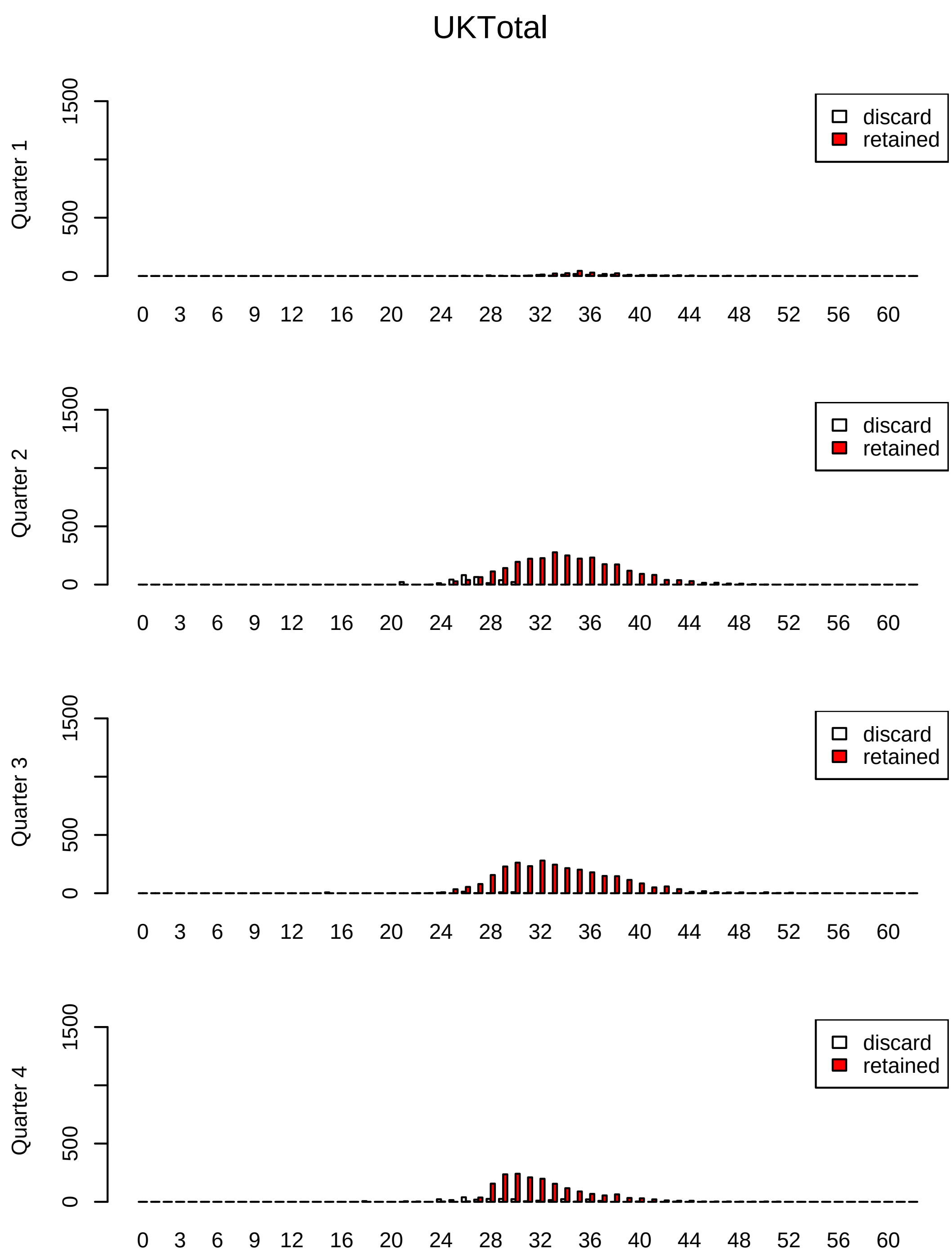


Figure 8.3.3b Sole VIIE Discards by Quarter, Fleet continued

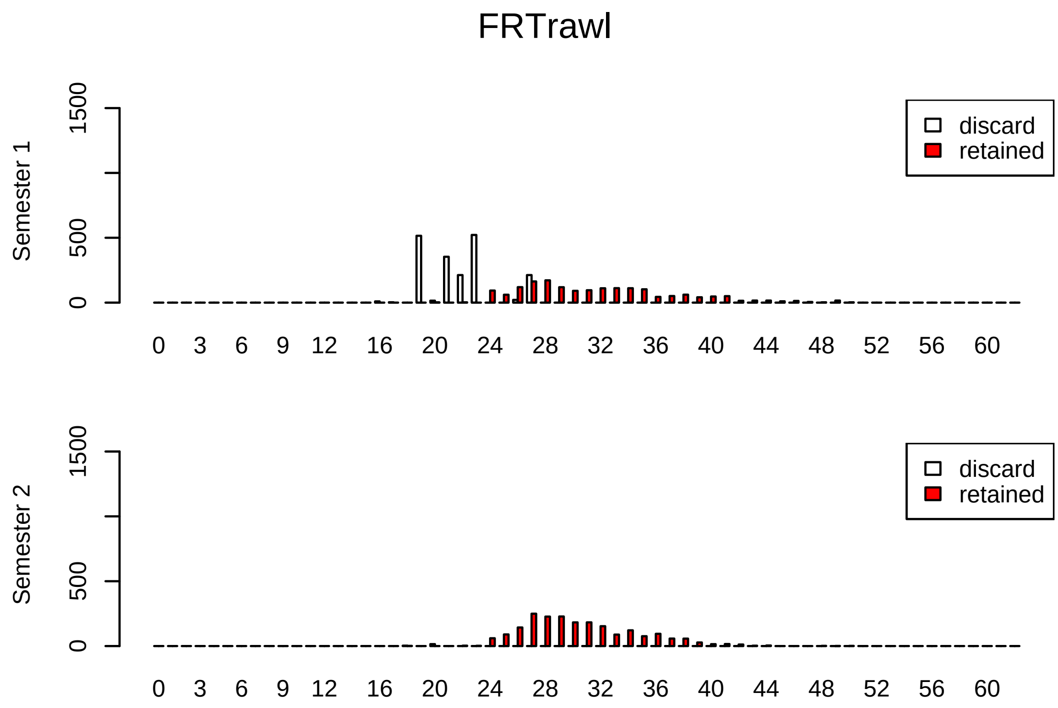


Figure 8.3.3c Sole VIIE Discards by Quarter, Fleet continued

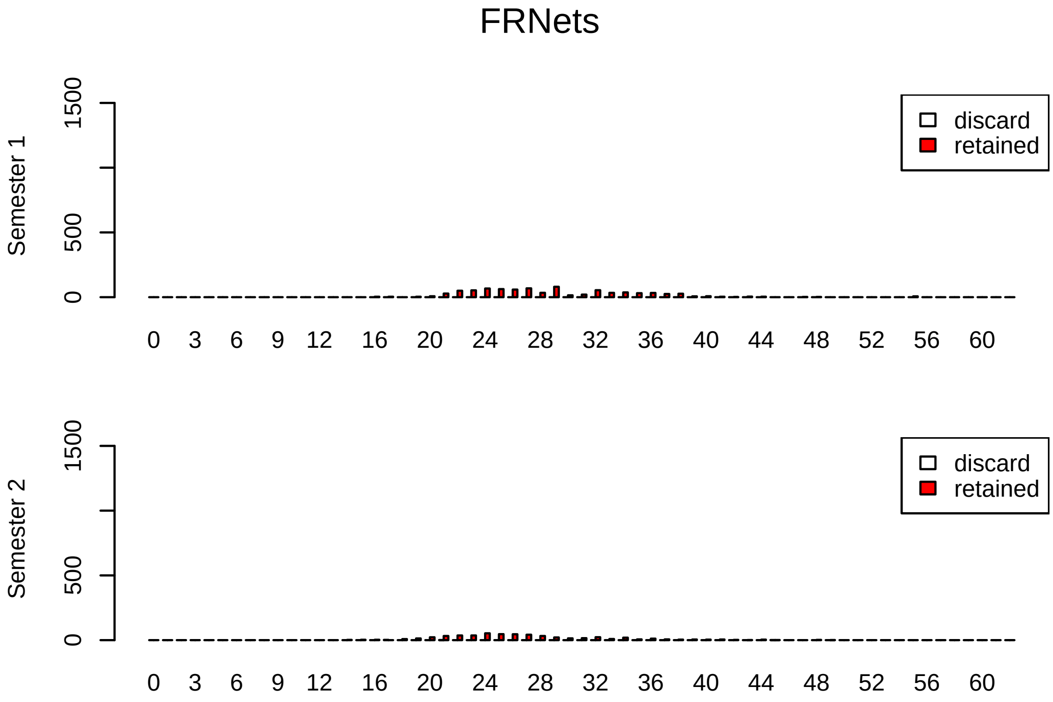


Figure 8.3.3d Sole VIIE Discards by Quarter, Fleet continued

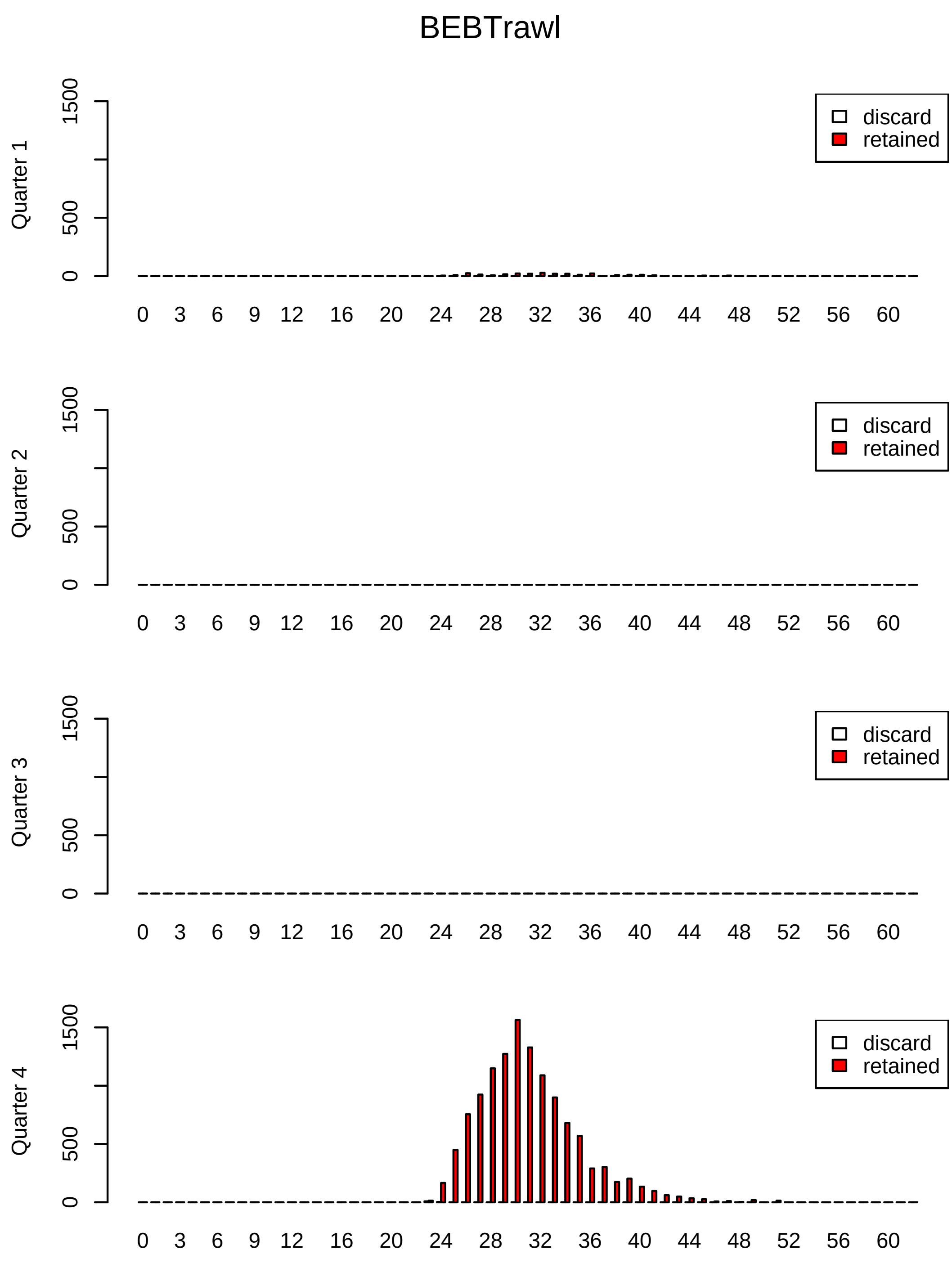


Figure 8.3.4 Sole VIIE LPUE and effort

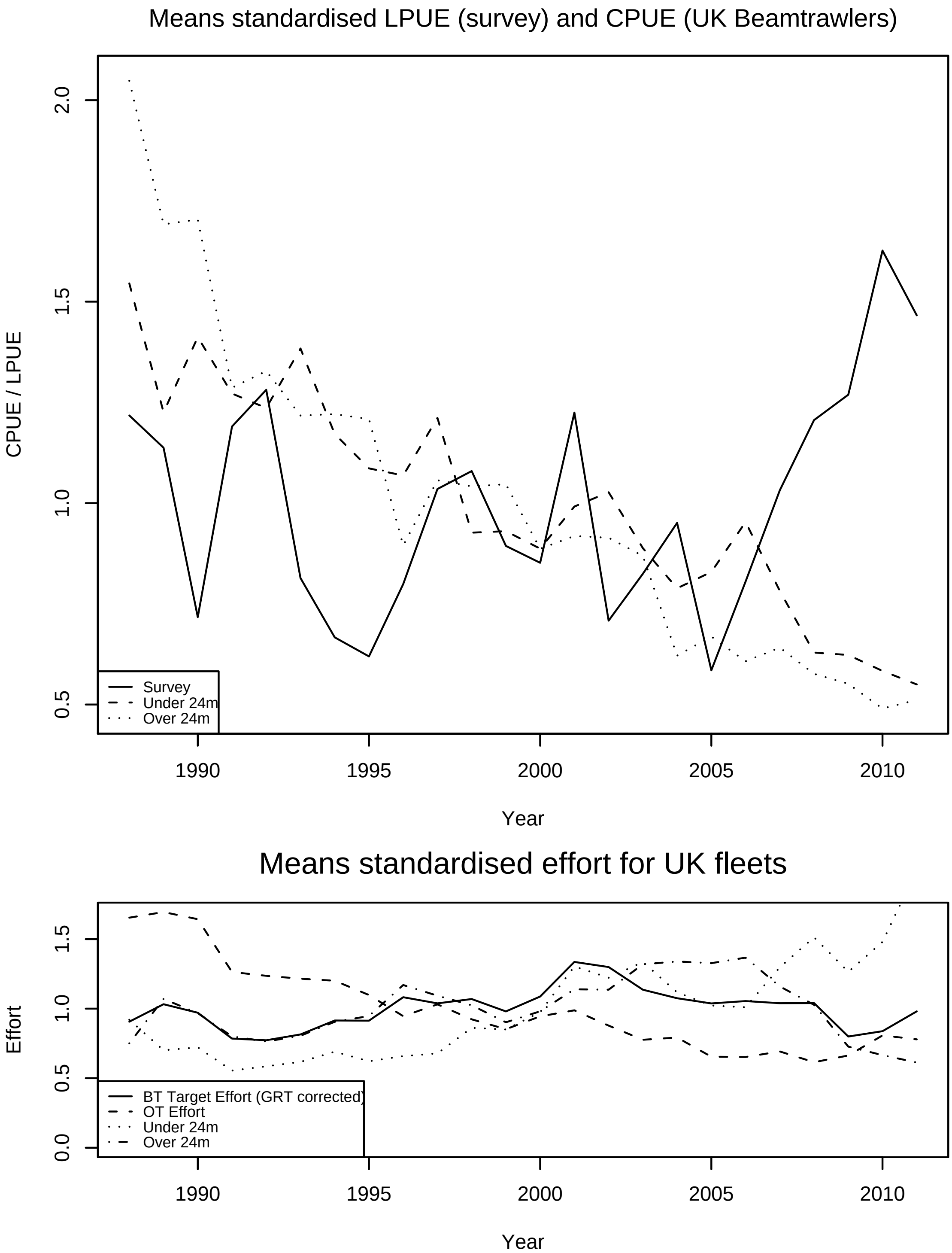


Figure 8.3.5 Sole VIIE Log CPUE by Yearclass

note the cohorts differ on the x-axes due to the differences in the length and age range of the tuning series

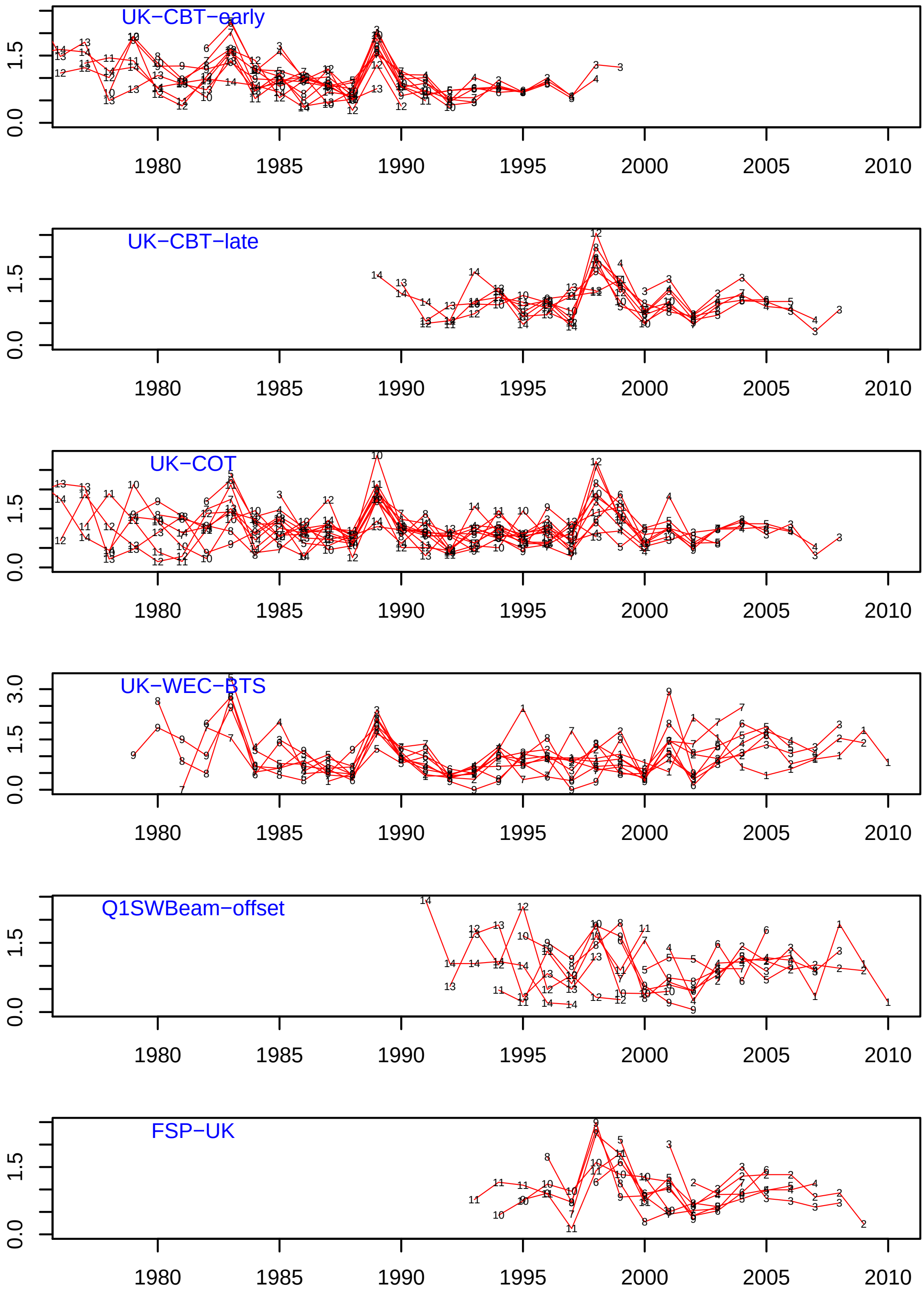


Figure 8.3.6 Sole VIIE Log CPUE by Year

note the cohorts differ on the x-axes due to the differences in the length and age range of the tuning series

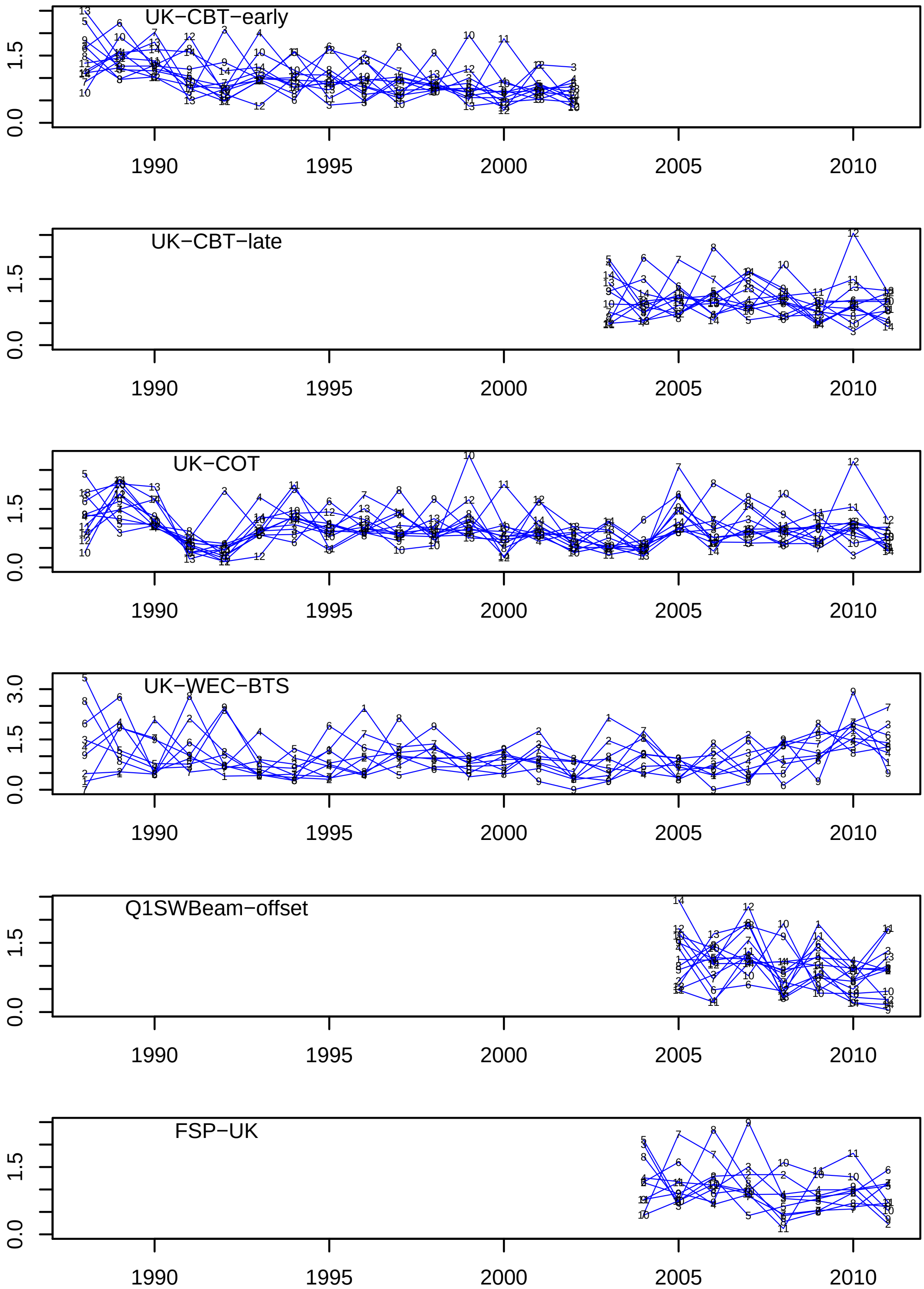


Figure 8.3.7 Sole VIIE Single Fleet log catchability Residuals

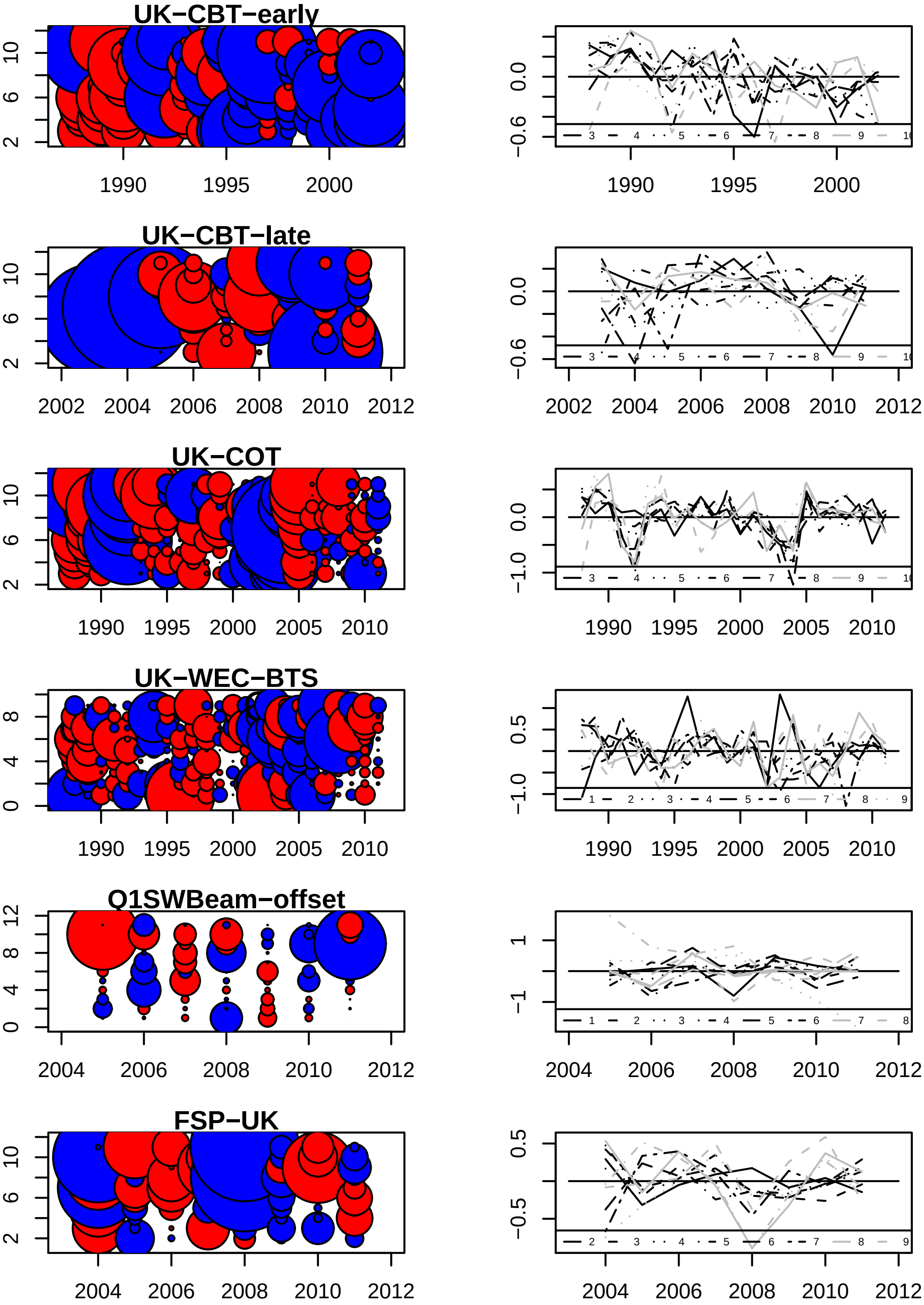


Figure 8.3.8 Sole VIIE Single Fleet Summary

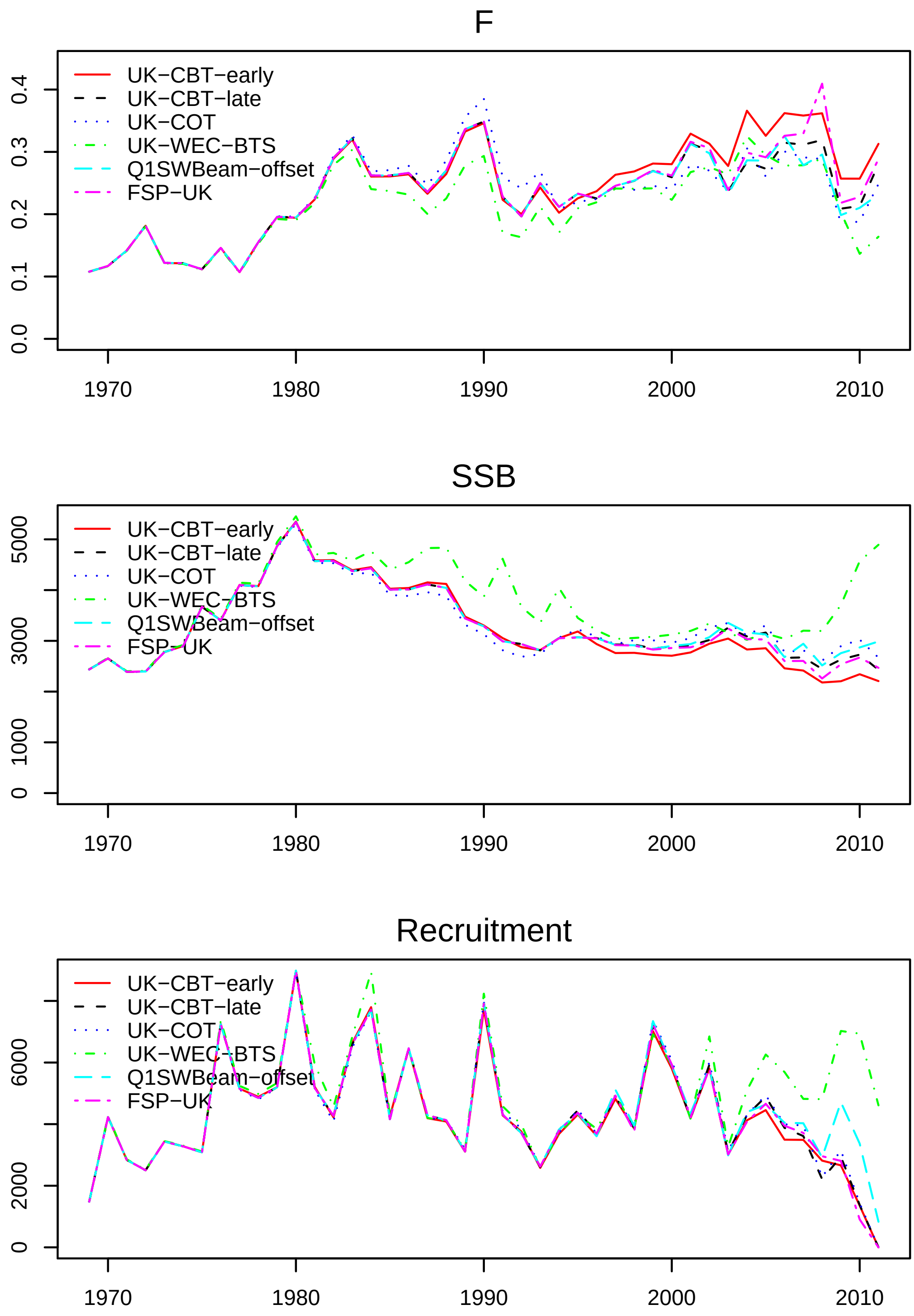


Figure 8.3.9 Sole VIIE Final XSA Fleet log catchability Residuals

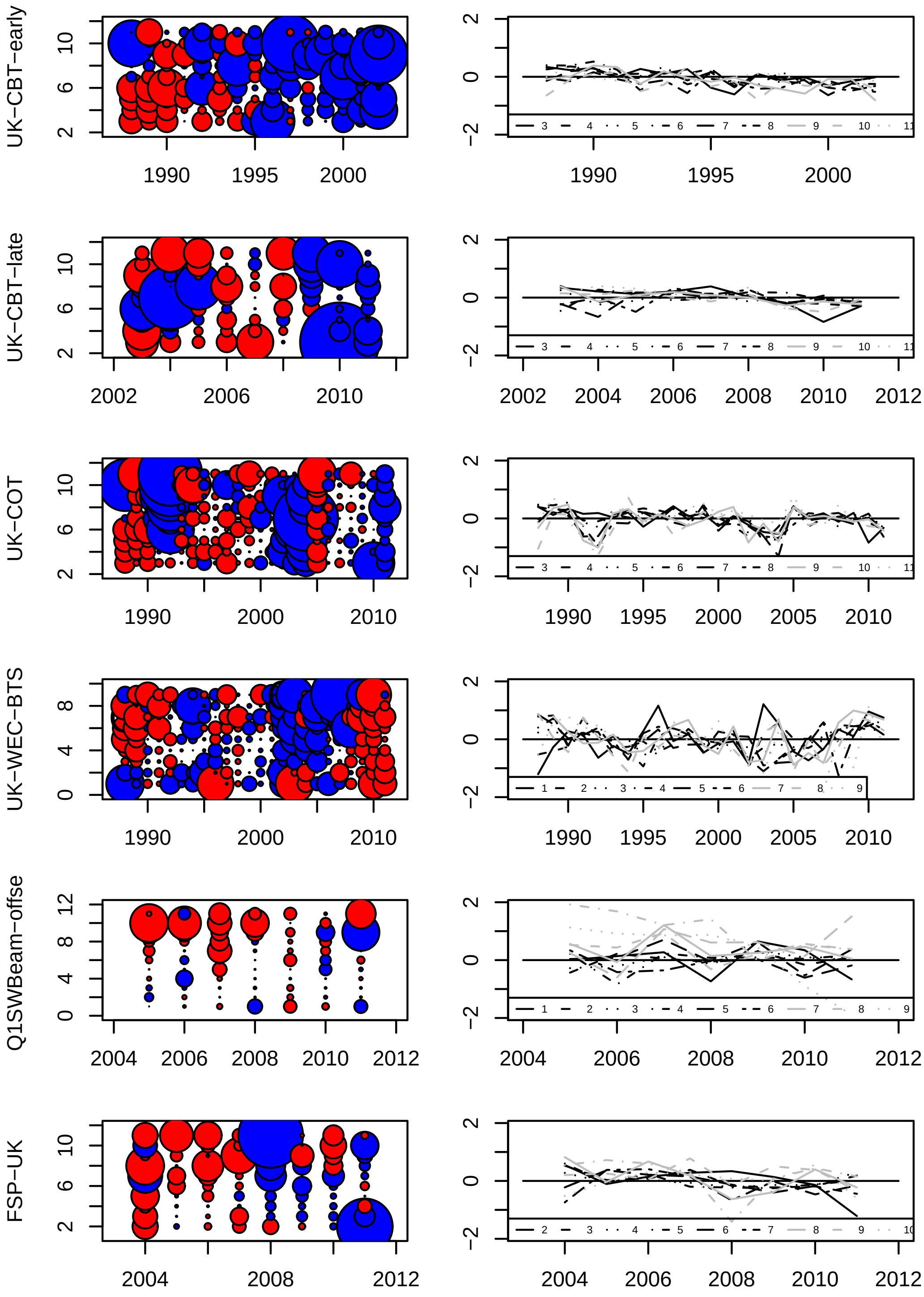
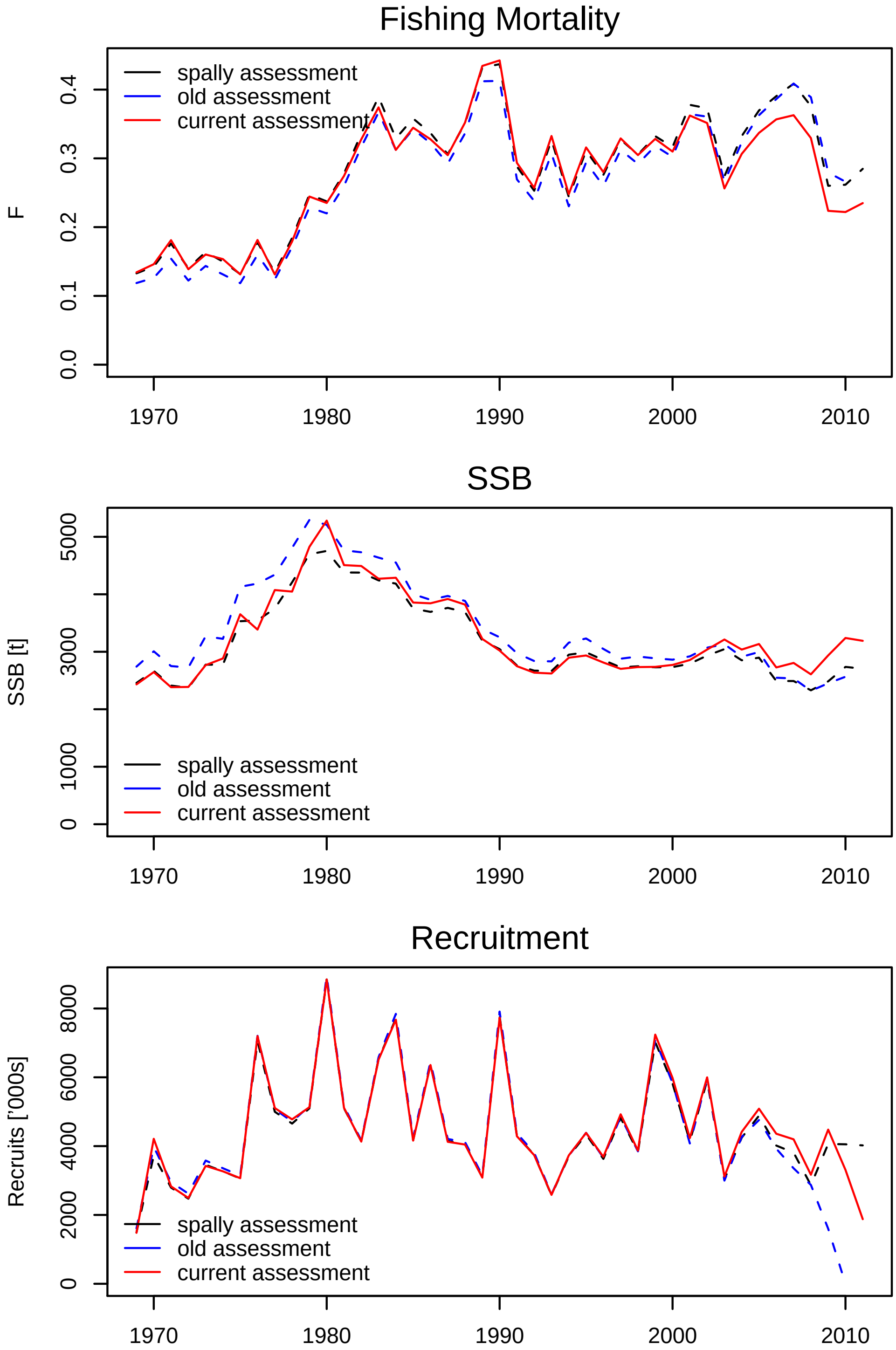


Figure 8.3.10 Sole VIIE Final XSA and previous XSAs



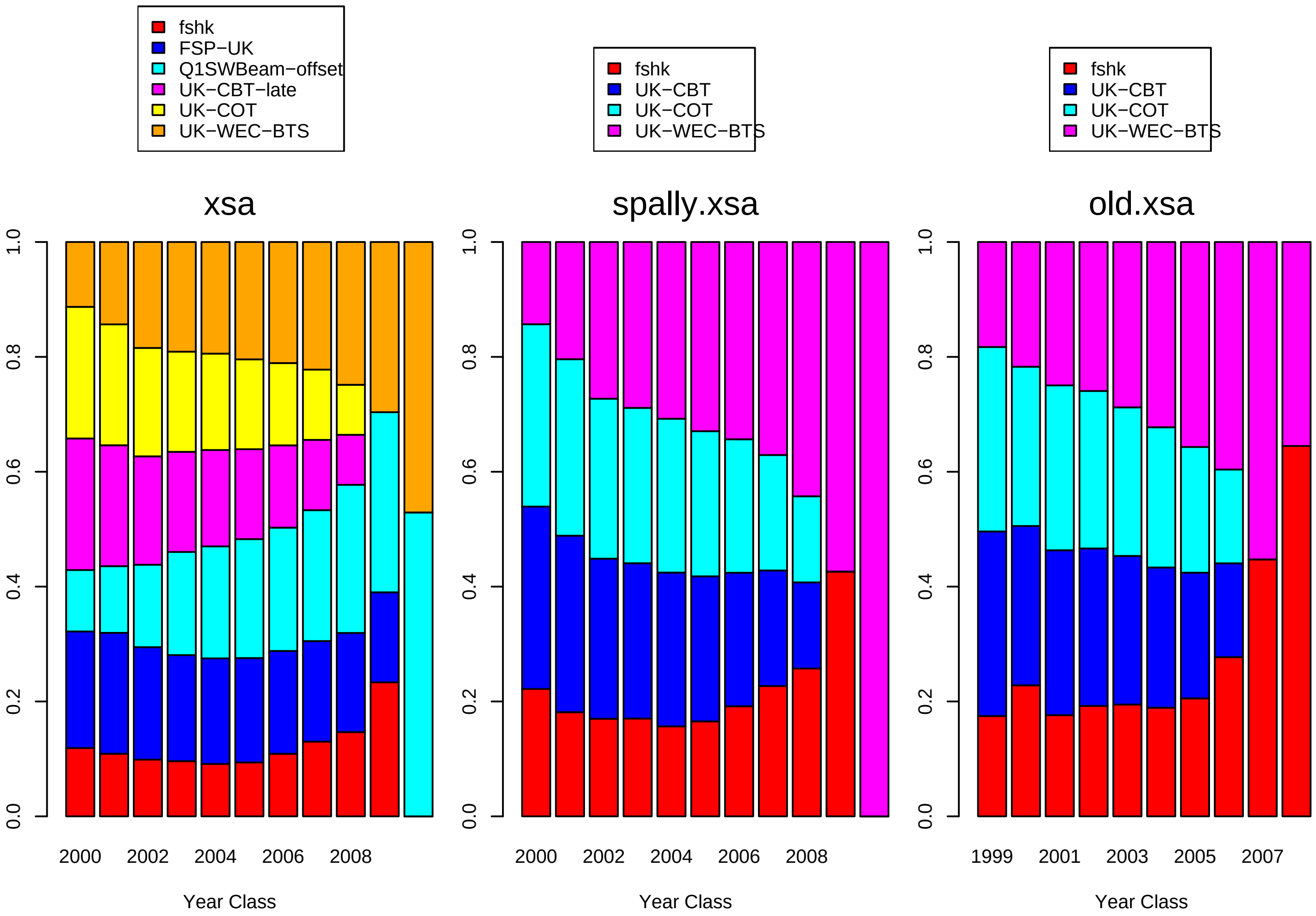
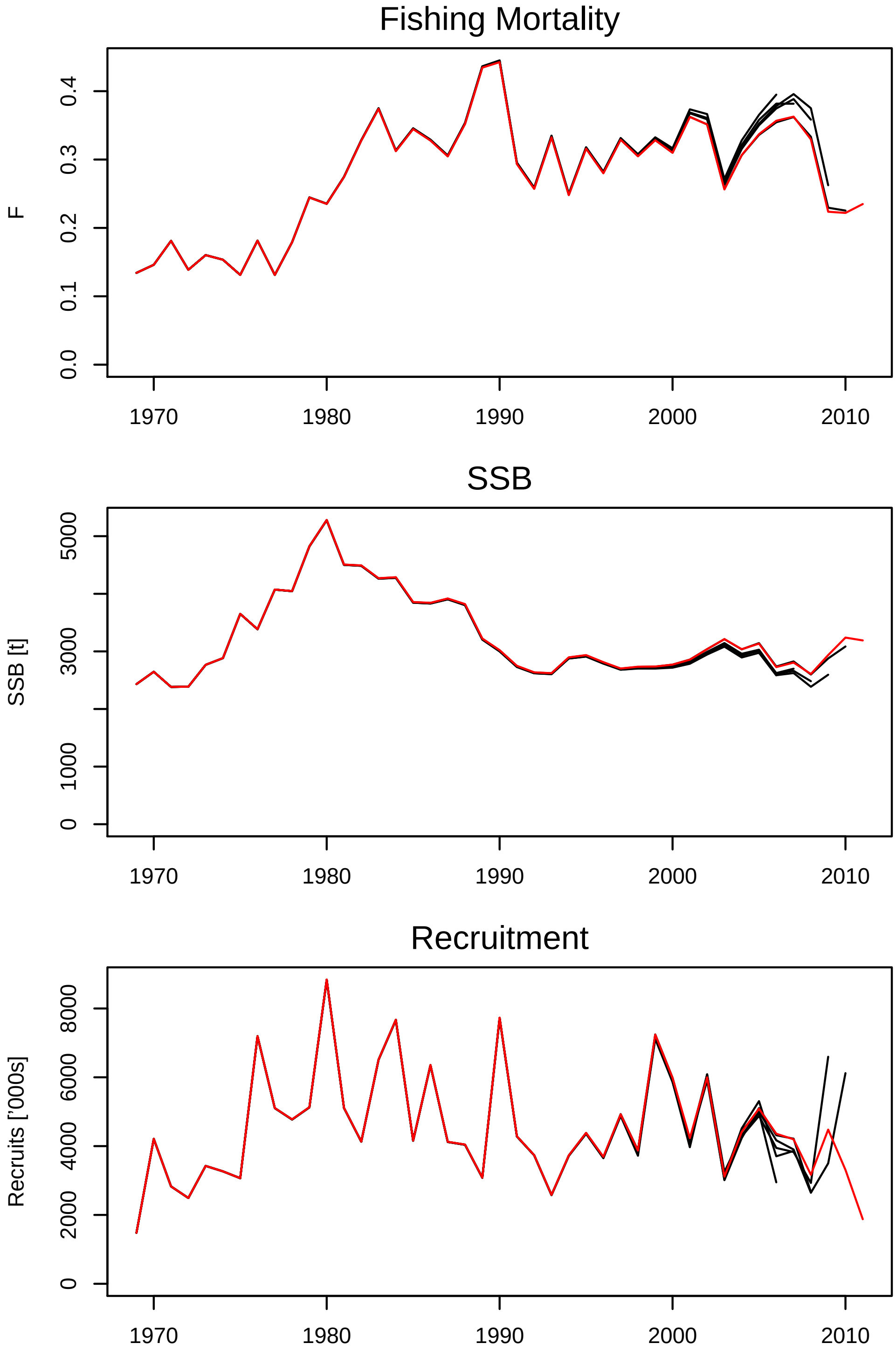


Figure 8.3.11 Sole VIIE Final and previous Assessment weights

Figure 8.3.12 Sole VIIE XSA Retrospective Plots



9.2 Pollack in the Celtic Seas (ICES Subareas VI and VII)

Type of assessment in 2012

No assessment.

ICES advice applicable to 2012

This was the first time in 2012 that ICES analysed data for pollack in the Celtic Sea and West of Scotland and the advice, based on precautionary considerations, was:

"*Currently it is not clear whether there should be one or several management units. There is insufficient information to evaluate the status of pollack in this area. Therefore, based on precautionary consideration, ICES advises that catches should not be allowed to increase in 2012.*"

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 is available. The stock structure of pollack populations in this ecoregion is not clear. ICES does not necessarily advocate that VI and VII constitutes a management unit for pollack, and further work is required. More information can be found in WGNEW (ICES 2012).

Management applicable to 2011 and 2012

The TAC for Pollack is set for ICES Subareas VI and VII separately, and for 2012 as follows:

Species:	Pollack *Pollachius pollachius*	**Zone:**	VI; EU 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		
Spain	25		
France	9 667		
Ireland	1 030		
United Kingdom	2 353		
Union	13 495		
TAC	13 495		Precautionary TAC Article 11 of this Regulation applies.

The article 11 referred to for the Subarea VII prohibits to fish or retain on board pollack, amongst other species, in the Porcupine Bank during the period from 1 May to 31 July 2012.

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 VI a zone in which fishing activities are prohibited. These regulations essentially make directed fisheries for pollock in the West of Scotland illegal.

Technical comments made by the Review Group (RGCS 2011)

The RG (ICES 2011, Annex IV) would have liked to see the following data in order to advise on future directions for supporting ICES advice on pollack in western waters:

- Full description of the fisheries taking pollack, directed and as bycatch, including historical reported landings by gear type/mesh band; spatial distribution (landings by rectangle);
- Mixed fishery information; i.e. associations with other species such as ling, conger eel and saithe;
- Available fishery length compositions by gear/area;
- Discard rates and discard size compositions where available;
- Documented (referenced) information on size and maturity-at-age.

There are no data allowing an assessment of stock trends, and very little useful information other than long-term landings trends which may reflect development of the fisheries rather than stock trends.

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. 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. Growth is thus fairly rapid, approaching 10 cm per year. There is a migration from the coast to deeper waters as it grows. Maturity occurs at approximately three years and spawning occurs mainly in the first half of the year, at about 100 m depth.

The fisheries

Most Pollack in the Celtic Sea ecoregions is caught by trawls and gillnets, and other gears come to complement the landings, such as trollingline, seinenets or beam trawls (Figure 9.2.1). The overall gear contribution is unknown due to the lack of complete statistics. In 2010, 98% of the landings originated from the Subarea VII, and Ireland, UK and France together comprised 99% of the official landings.

Surveys

Pollack may be caught by bottom trawl surveys such IGFS-WIBTS-Q4 (Figure 9.2.2) and EVHOE-WIBTS-Q4 (Figure 9.2.3). The low number of individuals caught by EVHOE-WIBTS-Q4 makes it hardly informative the trends of abundance indexes.

9.2.2 Data

Landings

The nominal landings are given in Table 9.2.1 and 9.2.2 for ICES Subarea VI and VII respectively.

The French fishing locations for Pollack (Figure 9.2.4) shows a predominance of ICES Division VIIe and inshore areas, although observations on-board fishing trips over the period 2004–2011 indicates that fishing Pollack may sporadically occur offshore.

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 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, 2007).

The inputs to the DCAC method are further detailed:

Sum of catch: The period over which the catches are summed is 1986–2011, i.e. 26 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 VII, the French landings in 1999 are missing and are replaced by the mean of the previous and following year. The value used is 138 624 tonnes for Subarea VII and 6408 tonnes for Subarea VI.

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 (Figure 9.2.5).

F_{MSY} to M: MacCall (2007) proposes a value of 0.8 and a value 0.6 for vulnerable stocks. Values of 0.6, 0.7 and 0.8 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 (2007).

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 VI, values of 0.8, 0.9 and 1, for Subarea VII, values of 0.5, 0.6 and 0.7 will be used.

The results are as below:

		F_{MSY} to M				F_{MSY} to M		
	Subarea VI	0.6	0.7	0.8	Subarea VII	0.6	0.7	0.8
Depl. delta	0.8	156	171	182	0.5	3926	4119	4418
	0.9	151	159	166	0.6	3785	4075	4273
	1.0	140	161	172	0.7	3613	3923	4137
Average		162 tonnes			Average	4008 tonnes		

The DCAC (Depletion-Corrected Average Catch) outputs (table above and Figure 9.2.6) suggest that yield in Subarea VI could be increased up to 160 tonnes. 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 Subarea VII, the range of sustainable yield estimated by DCAC averaged 4000 tonnes. 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).

9.2.4 Uncertainties in assessment and forecast

The weakness of the DCAC analysis resides in the non inclusion of the significant removals from the recreational fisheries. If managers want to actively manage Pollock fisheries in VI and VII 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.

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), more information is needed on:

- stock identity of pollack within the ICES area;
- 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 (surveys and commercial sampling);
- recreational fisheries (catch and effort statistics).

9.2.5 Ecosystem considerations

No information.

9.2.6 Management considerations

TAC for Subarea VII includes ICES Division VIId, which is not in the remit of the Celtic Sea ecoregion. TAC set for both Subarea VI and VII are not in line with the current estimates of catches and estimated sustainable yields, and therefore are not constraining.

9.2.7 References

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.

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).

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: 000–000.

Table 9.2.1. Landings of Pollack in Subarea VI 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*	2010*
Belgium	-	-
Denmark	-	-
France	4	3
Germany	-	-
Ireland	34	8
Netherlands	-	-
Norway	<0.5	-
Portugal	-	-
Spain	-	-
Sweden	-	-
UK	39	34
Subarea VI	78	45

* provisional

Table 9.2.2. Landings of Pollack in Subarea VII 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*
Belgium	35	28
Denmark	-	-
France	1709	1415
Germany	-	-
Ireland	935	912
Netherlands	2	1
Norway	-	-
Spain	-	-
UK	1384	1716
Subarea VII	4065	4072

* provisional

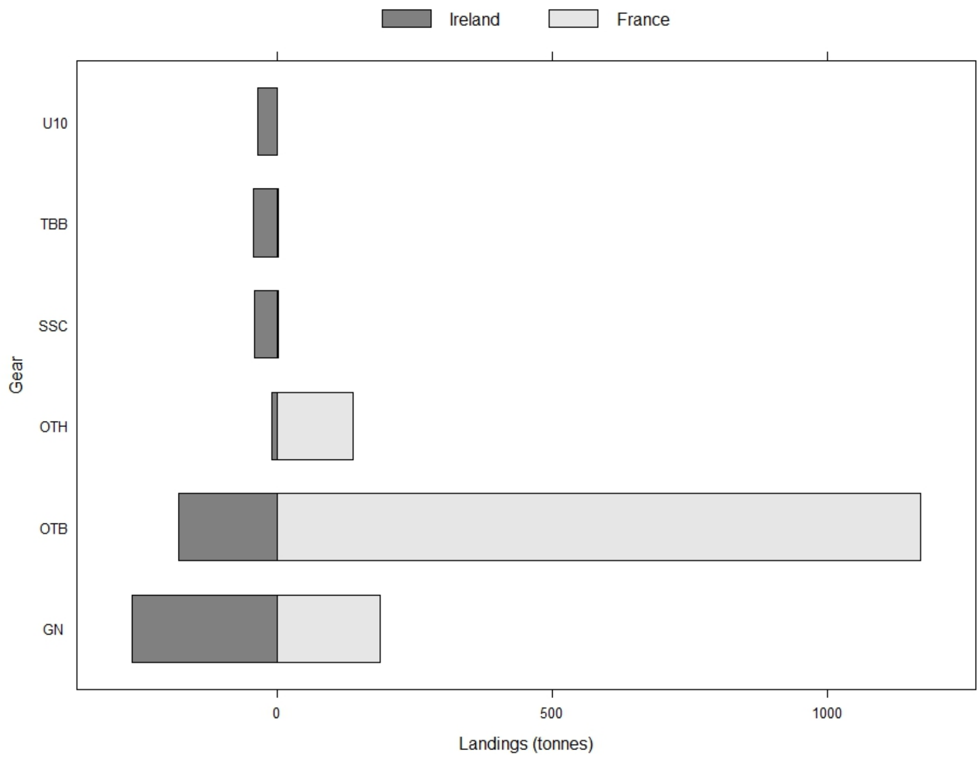


Figure 9.2.1. Pollack in the Celtic Seas. Catches per gear over the period 2003–2010 for Ireland and France.

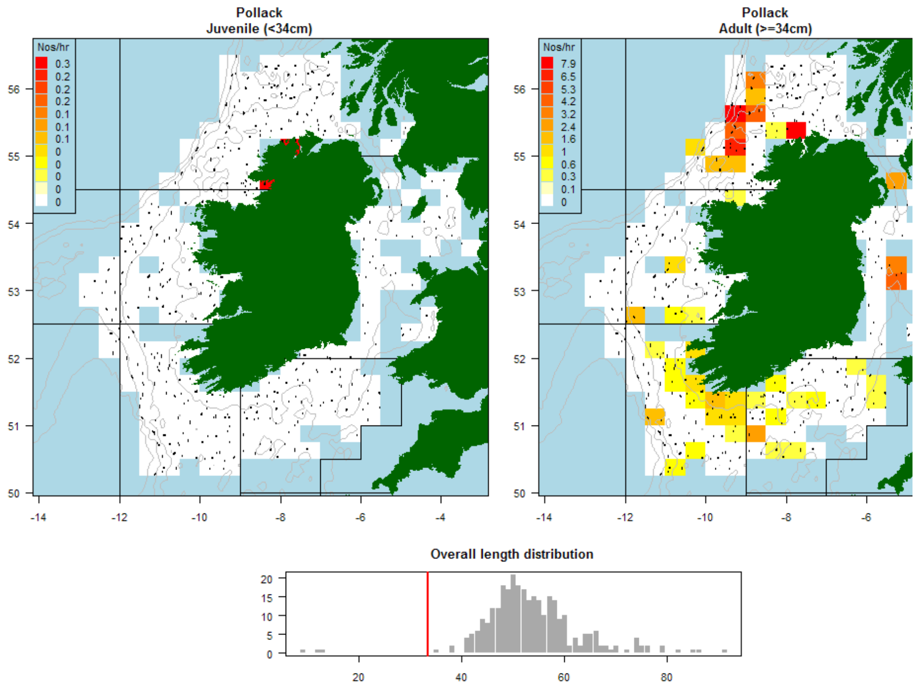


Figure 9.2.2. Pollack in the Celtic Seas. Distribution of catches and length distribution profile from IGFS-WIBTS-Q4.

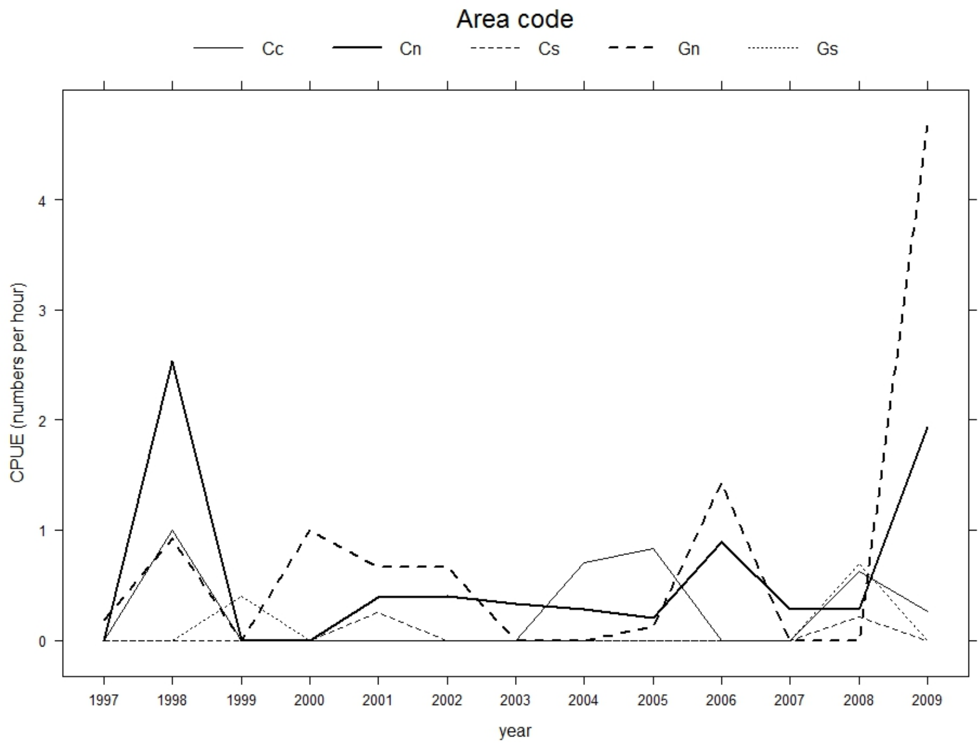


Figure 9.2.3. Pollack in the Celtic Seas. Abundance index from the EVHO-WIBTS-Q4 survey.

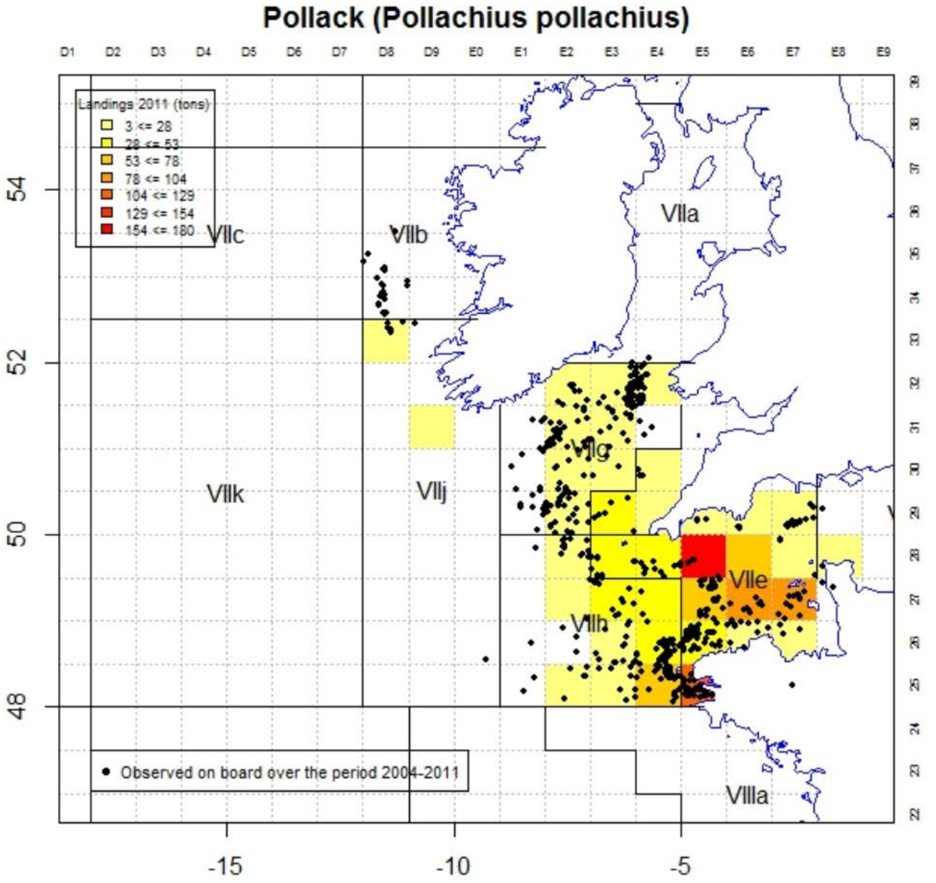


Figure 9.2.4. Pollack in the Celtic Seas. Distribution of catches in the French landings 2011 and in trips observed at sea (over the period 2004–2011).

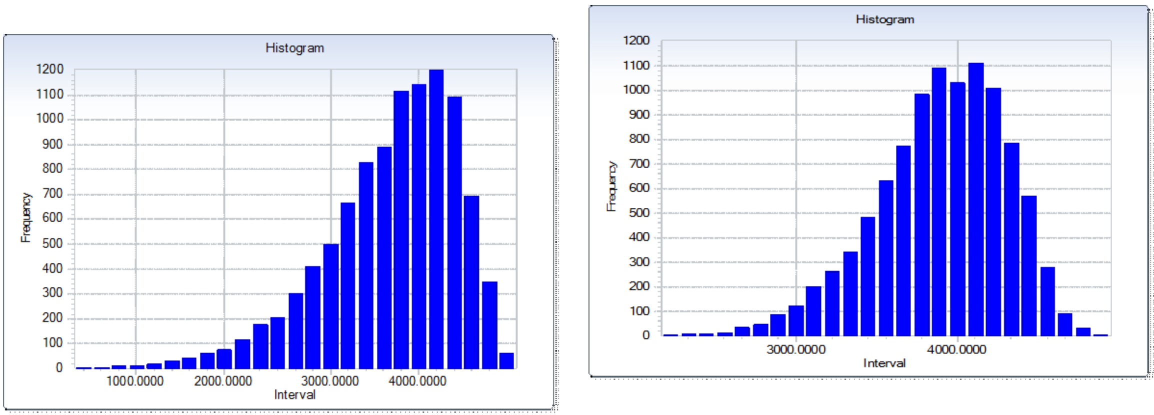


Figure 9.2.5. Pollack in the Celtic Seas. Distribution of the DCAC mean sustainable catches. Left: M=0.2 (lognormal distribution, CV=0.4), F_{MSY}/M (normal distribution, CV=0.2), B_{MSY}/B_0 (CV=0.1, value bounded between 0 and 1), Depleted delta (normal distribution, CV=0.1). Right: M=0.2 (lognormal distribution, CV=0.4), F_{MSY}/M (lognormal distribution, CV=0.1), B_{MSY}/B_0 (CV=0.1, value bounded between +/-0.2), Depleted delta (CV=0.1, value bounded between +/-0.3).

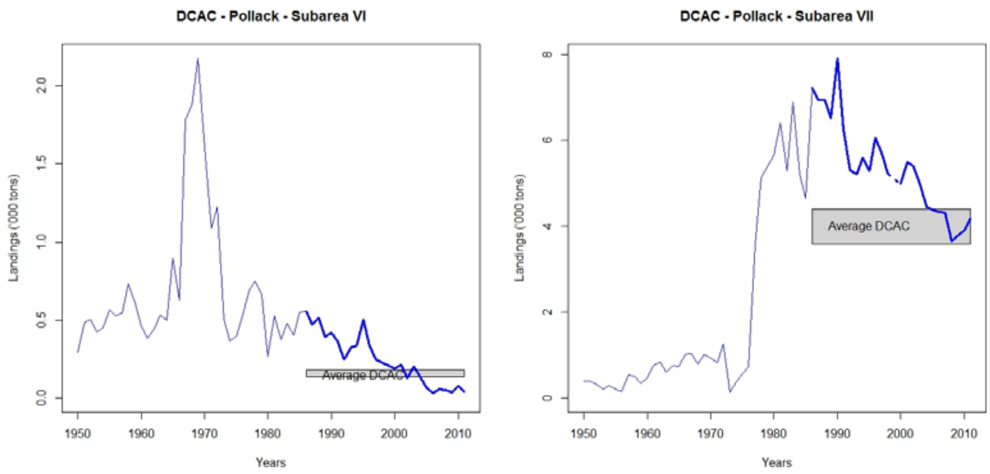


Figure 9.2.6. Pollack in the Celtic Seas. Results of DCAC for Subarea VI (left panel) and Subarea VII (right panel).

9.3 Grey gurnard in the Celtic Seas (ICES Subareas VI and VIIac and VIIe-k)

Type of assessment in 2012

No assessment.

ICES advice applicable to 2012

This is the first time that ICES has provided advice for grey gurnard. Currently there is no TAC for this species and the stock structure of the species is unknown. There is insufficient information to evaluate the status of the grey gurnard in the Northeast Atlantic. Therefore, based on precautionary considerations, ICES advises that catches should not be allowed to increase in 2012

9.2.1 General

Stock Identity

WGNEW 2012 concluded that in the absence of specific information on stock structure, the ICES ecoregions are chosen as minimum level of disaggregation for the definition of stock units. This is an interim solution until more information is available on stock. ICES does not necessarily advocate that VI and VII constitutes a management unit for grey gurnard, and further work is required. More information can be found in WGNEW (ICES 2012).

The fisheries

Grey gurnard is a bycatch species in demersal fisheries mainly by trawlers. Catches are largely discarded.

9.2.2 Data

Landings

The nominal landings are given in Table 9.3.1 for ICES Subarea VI and VII respectively. In the past, gurnards were often landed in one generic category of "gurnards". Catch statistics are incomplete for several years: some countries reporting no landings at all, other countries reporting exceptionally high landings. Because the species is largely discarded, landing data will not reflect the actual catches, and only DCF programme by observation at sea could provide with an accurate estimate of catches.

Surveys

The EVHOE-WIBTS-Q4IBTS survey in Celtic Sea VIIfghj can be used as a good indicator of abundance of grey gurnard only in this area. The availably of the time-series of abundance from the UK (Scotland), Ireland and Northern Ireland surveys should provide with indications of trend in the northern and central parts of the ecoregion (VIa, VIb, VIIa, VIIb,c).

9.2.3 Ecosystem considerations

No information.

9.2.4 Uncertainties in the assessment

The two priority sources of information for this species are (i) the sampling information from on-board sampling programmes and (ii) the demersal surveys. This is of primary priority since this species is known to be heavily discarded and captured in abundance by the surveys. Information from Russian surveys at Rockall VIb (2003, 2005, 2010) are also available and should be taken into account in further analysis. Progress on processing all this information 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.

9.2.5 References

ICES. 2012. Report of the Working Group on Assessment of New MoU Species (WGNEW).

Table 9.3.1. Landings of Grey grunard in Subarea VI and VII (excl. VIId) as officially reported to ICES.

	Belgium	Denmark	France	Ireland	Nether-lands	Russian Fed.	UK
1950	0	0	0	0	0	0	0
1951	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0
1978	0	0	206	0	0	0	0
1979	0	0	165	0	0	0	0
1980	0	0	155	0	0	0	0
1981	0	0	0	0	0	0	0
1982	0	0	407	0	0	0	0
1983	0	0	271	0	0	0	0
1984	0	0	157	0	0	0	2
1985	35	0	130	0	0	0	2
1986	0	0	280	0	0	0	0
1987	37	0	216	0	0	0	0
1988	30	0	211	0	0	0	21
1989	34	0	646	0	0	0	0
1990	18	0	538	16	0	0	0

	Belgium	Denmark	France	Ireland	Nether-lands	Russian Fed.	UK
1991	17	0	298	15	0	0	4
1992	13	0	123	17	0	0	0
1993	11	0	113	10	0	0	1
1994	11	0	107	0	0	0	2
1995	7	0	101	0	0	0	0
1996	6	0	117	0	0	0	2
1997	8	0	61	0	0	0	2
1998	13	0	59	38	0	0	0
1999	11	0	0	0	0	0	0
2000	13	0	109	0	7	26081	0
2001	3	0	116	0	0	3155	13
2002	7	0	81	0	0	60	11
2003	3	0	66	0	1	263	0
2004	5	0	61	0	7	1401	0
2005	9	0	59	0	8	2456	0
2006	4	0	28	0	10	138	6
2007	4	0	24	0	1	0	4
2008	7	0	1	0	3	0	1
2009	11	0	33	0	1	0	8
2010	14	0	45	0	5	0	12
2011	17	0	42	0	3	1	19

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Annex 2: Stock Annexes

3.2 Stock Annex VIa Cod

Stock specific documentation of standard assessment procedures used by ICES.

Stock	West of Scotland Cod (Division VIa)
Working Group	Celtic Seas Ecoregion (WGCSE)
Date	February 2012
Revised by	WKROUND/Steven Holmes

A. General

A.1. Stock definition

Cod west of Scotland are believed to comprise of at least two subpopulations of cod that remain geographically separate throughout the year. The latitudinal boundary of these groups is between 57 and 58°30′ N. The southern component is characterized by coastal groups with a tendency towards year-round residency, although there is some exchange with the Irish Sea. The northern component appears to inter-mix with cod in IVa at all stages of the life history (ICES 2012, WD 4).

A.2. Fishery

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

The demersal fisheries in Division VIa are predominantly conducted by otter trawlers fishing for cod, haddock, anglerfish and whiting, with bycatches of saithe, megrim, lemon sole, ling and skate *sp*.. Fishing in the area is conducted mainly by vessels from Scotland, France, Ireland, Norway and Spain with Scottish vessels taking the majority of cod catch. Since 1976, effort by larger Scottish trawlers and seiners has decreased. Records of effort trends since 2000 can be obtained from the (STECF) [https://stecf.jrc.ec.europa.eu/home]. Cod is believed to be no longer targeted in any of the fisheries now operating in ICES Division VIa. Cod are a bycatch in *Nephrops* and anglerfish fisheries in Division VIa. *Nephrops* fisheries use a smaller mesh size than the 120 mm mandatory for cod targeted fisheries, but landings of cod are restricted through bycatch regulations and from 2012 all fisheries are restricted to landings of cod through bycatch only (see below).

For 2009 Council regulation (EC) No 1342\2008 introduced a cod long-term management plan. The objective of the plan is to ensure the sustainable exploitation of the cod stock on the basis of maximum sustainable yield while maintaining a fishing mortality of 0.4.

For stocks above B_{pa}, but where mortality is above 0.4 the harvest control rule (HCR) requires:

1) setting a TAC that achieves a 10% decrease in the fishing mortality in the year of application of the TAC compared with the previous year, or a TAC that achieves a fishing mortality of 0.4, whichever is the higher.

2) limiting annual changes in TAC to ± 20%.

For stocks above B_{lim}, the HCR requires:

3) setting a TAC that achieves a 15% decrease in the fishing mortality in the year of application of the TAC compared with the previous year, or a TAC that achieves a fishing mortality of 0.4, whichever is the higher.

4) limiting annual changes in TAC to ± 20%.

For stocks below B_{lim} the Regulation requires:

5) setting a TAC that achieves a 25% decrease in the fishing mortality in the year of application of the TAC compared with the previous year.

6) limiting annual changes in TAC to ± 20%.

In addition the plan states:

- That if lack of sufficiently accurate and representative information does not allow a TAC affecting fishing mortality to be set with confidence then,
- If advice is for catches of cod to be reduced to the lowest possible level, the TAC shall be reduced by 25%,
- In all other cases the TAC shall be reduced by 15% (unless STACF advises this is not appropriate).
- TACs are to be set net of discards and fish corresponding to other sources of cod mortality caused by fishing.
- Initial baseline values for effort shall be set for effort groups defined by the Council then annual effort and cod catch calculated for those effort groups. For effort groups where the percentage cumulative catch is ≥20% of that for all fleets, maximum allowable effort shall be adjusted by the same amount as the TAC.
- If STECF advises cod stocks are failing to recover properly the EU Council will set a TAC and maximum allowable effort lower than those derived from the HCR.

For 2012 council regulation (EU) No 43/2012 set a zero TAC for cod in VIa and EU and international waters of Vb east of 12°00′ W with the proviso that:

Bycatch 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.

A.3. Ecosystem aspects

Geographical location and timing of spawning

Spawning has occurred throughout much of the region in depths <200 m. However, a number of spawning concentrations can be identified from egg surveys in the 1950s, 1992 and from recent surveys of spawning adult distribution. The most commercially important of these, range from the Butt of Lewis to Papa Bank. There are also important spawning areas in the Clyde and off Mull. The relative contribution of these areas is not known. Based on recent evidence there are no longer any significant spawning areas in the Minch. Peak spawning appears to be in March, based on egg surveys (Raitt, 1967). Recent sampling suggests that this is still the case.

The main concentrations of juveniles are now found in coastal waters.

Fecundity

Fecundity data are available from West, 1970 and Yoneda and Wright, 2004. Potential fecundity for a given length is higher than in the northern North Sea but lower than off the Scottish east coast (see Yoneda and Wright, 2004). There was no significant difference in the potential fecundity–length relationship for cod between 1970 (West, 1970) and 2002–2003 (Yoneda and Wright, 2004).

B. Data

B.1. Commercial catch

Raised landings and discards data, ages 1 to 7+. Discard data are available from1978 but sampling was very limited before 1981. Discards in years 1981–2003 raised according to Millar and Fryer (2005).

The following table gives the source of landings data for West of Scotland cod:

	Kind of data				
Country	Caton (catch-in-weight)	Canum (catch-at-age in numbers)	Weca (weight-at-age in the catch)	Matprop (proportion mature-by-age)	Length composition in catch
UK(NI)	X				
UK(E&W)	X				
UK(Scotland)	X	X	X	X	X
Ireland	X	X	X		X
France	X				
Norway	X				

B.2. Biological

Natural mortality-at-age (M) is assumed weight-dependent after Lorenzen (1996) with mortality assumed to be time invariant, M is calculated by finding the time-series means for stock weights-at-age before applying the Lorenzen parameters, i.e.

$$M_a = 3\overline{W}_a \exp(-0.29)$$

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

Maturities-at-age are given by

Age	1	2	3	4+
Proportion mature-at-age	0.0	0.52	0.86	1.0

Weights-at-age are supplied separately for landings and discards. Catch weights are derived using the sum of products from the landings and discards weights-at-age. Stock weights-at-age are assumed equal to the catch weights-at-age.

B.3. Surveys

ScoGFS – WIBTS – Q1: 1985–2010. Ages 1 to 6 where oldest age is a true age. Fixed station design.

ScoGFS – WIBTS – Q4: 1996–2009. Ages 1 to 6 where oldest age is a true age. Fixed station design. Modest to poor self consistency (a weak ability to track cohorts) and very limited influence on exploratory assessment runs means not included in assessment.

IGFS – WIBTS – Q4: 2003– . Ages 0 to 4 where oldest age is a true age. Sufficient non-zero entries only present for ages 1 and 2. Survey only extends to 56°30′N. Concerns survey not representative of full assessment area means not included in assessment.

UKSGFS – WIBTS – Q1: 2011– . Ages 1 to 6 where oldest age is a true age. Random stratified design. Replaced ScoGFS – WIBTS – Q1. ICES will consider inclusion as a tuning index through an inter-benchmark procedure when 4+ years of data have been gathered.

UKSGFS – WIBTS – Q4: 2011– . Ages 1 to 6 where oldest age is a true age. Random stratified design. Replaced ScoGFS – WIBTS – Q4. ICES will consider inclusion as a tuning index through an inter-benchmark procedure when 4+ years of data have been gathered.

B.4. Commercial cpue

Not used.

B.5. Other relevant data

Grey seal consumption of cod data from Hammond and Harris (2006). Supplementary model run only (used to test sensitivity of outcomes to assumptions about natural mortality).

C. Assessment: data and method

Model used: TSA

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

Model Options chosen:

Weight-dependent M after Lorenzen (1996); 'natural system' values.

- Mwght.b <- -0.29
- Mwght.Mu <- 3.0

Response: landings-at-age, discards-at-age and survey indices-at-age

Commercial data

- 1981–1990: treated as unbiased
- 1991–2005: age structure only used (with unaccounted mortality estimated)
- 2006–2010: adjusted to account for misreporting then treated as unbiased

Points given greater variance at WKROUND 2012

- landings cvmult-at-age = c(1, 1, 1, 1, 1, 2, 2): extra variability for ages 6 and 7+
- landings cvmult = 3 for age 2 in 1987 and 7+ in 1989
- discards cvmult = 2 for age 1 in 1988, age 2 in 1988, age 1 in 1992
- discards cvmult = 3 for age 2 in 1992
- discards cvmult = 5 for age 2 in 1998, age 2 in 2002

Discard model

- step model: random walk for each age, with a step function allowed
- 1981–2005: ages 1and 2 modelled
- 2006–2010: ages 1 to 4 modelled, with a step function for ages 1 and 2

Stock–recruit model

- Ricker
  - 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 class: 1986
  - Mean in Ricker model replaced by 5η1 S exp(−η2 S). The factor of 5 was chosen by comparing maximum recruitment to median recruitment from 1966–1996 for VIa cod, haddock, and whiting in turn using previous XSA runs. The coefficient of variation is again assumed to be constant.

Fishing selection model

- amat = 4: fishing selection flat (apart from noise) from age 4
- gudmundssonH1 = c(2, 1, 1, 1, 1, 1, 1): extra variability for age 1

Survey model (IBTS Q1)

- full model: separate catchability for each age
- ages 1 to 6 modelled
- transitory and persistent changes in catchability allowed

Points given greater variance at WKROUND 2012

- cvmult = 3 for age 4 in 2001, 2 in 2007, 4 in 2008, 2 in 2010
- cvmult = 5 for age 5 in 2001, 3 in 2008

The main diagnostics of the quality of the model fit come from consideration of the objective value (-2*log likelihood), prediction error results and a consideration of how well the model has replicated discard ratios in the input data. As new years of data become available these diagnostics will indicate the need to downweigh individual datapoints or that the data – be it landings, discards or survey - for a given age is more or less variable than previously thought. It is therefore important that changes to the variance structures used in the TSA models will be allowed if they improve model diagnostics.

Seal feeding model (supplementary model run only)

- $M2(y,a) = qaSyB_y^{\alpha}$ where
  - M2(y,a) = Seal predation mortality (in year y on age of cod a)
  - qa = Catchability coefficient (varies with age but not year)
  - Sy = Seal numbers in year y
  - By = Total biomass of cod in year y
  - α = Cod biomass (density) dependence term

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1981 onwards (excluded 1991–2005)	1 to 7+	Yes
??	Landings at-age in numbers	1981 onwards (excluded 1991–2005)	1 to 7+	Yes
??	Discards at-age in numbers	1981 onwards (excluded 1991–2005)	1 to 7+	Yes
??	Weight-at-age in the commercial landings	1981 onwards	1 to 7+	Yes
??	Weight-at-age in the commercial discards	1981 onwards	1 to 7+	Yes
West	Weight-at-age of the spawning stock at spawning time.	Not used		
Mprop	Proportion of natural mortality before spawning	Not used		
Fprop	Proportion of fishing mortality before spawning	Not used		
Matprop	Proportion mature at-age	1981 onwards	1 to 7+	No
Natmor	Natural mortality	1981 onwards	1 to 7+	No
For sensitivity analysis only	Numbers consumed by seals at-age	1985 and 2002	1 to 7+	na

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	ScoGFS – WIBTS – Q1	1985–2010	1 to 6
Tuning fleet 2	ScoGFS – WIBTS – Q4	Not used	1 to 6
Tuning fleet 3	IGFS – WIBTS – Q4	Not used	1 to 2

D. Short-term projection

Model used: Age structured

Software used: MFDP prediction with management option table and yield-per-recruit routines. MLA suite (WGFRANSW) used for sensitivity analysis and probability profiles.

The following configuration was agreed at WGNSDS 2008

Initial stock size: Taken from TSA for age 1 and older.

Weight-at-age in the catch: Average weight of the three last years.

Weight-at-age in the stock: Average stock weights for last three years. Assumed equal to the catch weight-at-age, (adopted because mean weights-at-age have been relatively stable over the recent past). CVs are calculated from the standard errors on weights-at-age.

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

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

Exploitation pattern: Average of the three last years.

Not partitioned to give landings, misreporting and discard F. If further work can solve this problem, this partition should be applied.

Intermediate year assumptions: Still open.

Stock–recruitment model used: None, recruitment in the intermediate year (terminal year year class at age 1) is taken from the TSA assessment, (the value is based largely on the ScoGFSQ1 survey datum from the terminal year). For the TAC year and following year the short-term (10 years to year before terminal year) geometric mean recruitment-at-age 1 is used.

Procedures used for splitting projected catches: Still open.

E. Medium-term projections

Not considered at the WKROUND benchmark.

F. Long-term projections

Not considered at the WKROUND benchmark.

G. Biological reference points

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$	22 000 t	B_{PA}
Approach	F_{MSY}	0.19	Provisional proxy by analogy with North Sea cod Fmax. Fishing mortalities in the range 0.17–0.33 are consistent with F_{MSY}
	B_{lim}	14 000 t	$B_{lim} = B_{loss}$, the lowest observed spawning stock estimated in previous assessments.
Precautionary Approach	B_{PA}	22 000 t	Considered to be the minimum SSB required to ensure a high probability of maintaining SSB above B_{lim}, taking into account the uncertainty of assessments. This also corresponds to the lowest range of SSB during the earlier, more productive historical period.
	Flim	0.8	Fishing mortalities above this have historically led to stock decline.
	Fpa	0.6	This F is considered to have a high probability of avoiding F_{lim}.

(unchanged since: 2010)

Since these reference points were established the assessment has adopted weight dependent natural mortalities (M) at-age. This has increased M values for younger ages and increased perceptions of SSB and recruitment in years where they were previously estimated using the old values for M. The differences were, however, judged too small to merit a revision of biomass reference points (ICES 2012).

The limit and MSY mortality reference points were also confirmed as still valid in 2012 (ICES 2012).

The F_{MSY} estimate was derived by WGCSE 2010 using the srmsymc package. Figures showing stochastic fits to three stock–recruit relationships, estimates of F_{MSY} and F_{crash} and estimates of yield-per-recruit, together with descriptive text, are given in Appendix 1.

H. Other issues

H.1. Change of Scottish Research Survey

For 2011 the rig and sampling design of the ScoGFS-WIBTS-Q1 survey was changed. A new groundgear capable of tackling challenging terrain was introduced broadly modelled around the rig used by Ireland for the IRGFS-WIBTS-Q4. The move to a more robust groundgear also allowed a move to a random stratified survey (which is again consistent with the IRGFS-WIBTS-Q4) as 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 was considered a bias prone method for surveying the area. It is hoped the greater compatibility between Scottish and Irish surveys will facilitate both being used to assess gadoids west of Scotland.

New survey strata were designed using cluster analysis on aggregated data from the previous ScoGFS-WIBTS-Q1 data (1999–2010) as well as the data collected from a dedicated gadoid survey which took place during quarter 1 of 2010. Species considered were cod, haddock, whiting, saithe and hake. Cluster analysis yielded four specific clusters. Two additional strata were added; the Clyde area and the 'windsock' which is an area that has been designated as a recovery zone since 2002 and has therefore experienced no mobile gear exploitation during this time. The new strata are shown in Figure H.1. Each individual polygon was treated as a separate stratum and the number of survey stations for each was allocated according to polygon size and the variability of indices within each stratum. Strata were weighted by surface area to build the final indices.

H.2. Historical overview of previous assessment methods

2004 to 2011.

Model used: TSA

Software used: Compaq visual FORTRAN using NAG library.

Model Options chosen:

Natural mortality (M) 0.2 at all ages.

Commercial data

- 1978–1994: treated as unbiased
- 1995–AY-1: omitted
- landings cvmult-at-age = c(1, 1, 1, 1, 1, 2, 2): extra variability for ages 6 and 7+

Discard model

- 1978–1994: ages 1and 2 modelled
- 1995–AY-1: omitted

Stock–recruit model

- ricker
- large year class: 1986

Fishing selection model

- amat = 4: fishing selection flat (apart from noise) from age 4
- gudmundssonH1 = c(4, 1, 1, 1, 1, 1, 1): extra variability for age 1

Survey model (IBTS Q1)

- amat = 4: catchability flat (apart from noise) from age 4
- survey catchabilities up to amat assumed to follow a log-linear model
- survey cvmult-at-age = c(2, 1, 1, 1, 2, 2): extra variability for ages 1, 5 and 6
- ages 1 to 6 modelled
- only transitory changes in catchability allowed; modelled using the additive scale.

Summary of data ranges used in recent assessments (no accepted assessment in 2011):

Data	2007 assessment	2008 assessment	2009 assessment	2010 assessment
Catch data	Years: 1978–(AY-1) Ages: 1–7+	Years: 1978–(AY-1) Ages: 1–7+	Years: 1978–(AY-1) Ages: 1–7+	Years: 1978–(AY-1) Ages: 1–7+
Survey: A_Q1	Years: 1985–AY Ages: 1–6	Years: 1985–AY Ages 1–6	Years: 1985–AY Ages 1–6	Years: 1985–AY Ages 1–6
Survey: B_Q4	Not used	Not used	Not used	Not used
Survey: C	Not used	Not used	Not used	Not used

AY – Assessment year

I. References

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.

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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.

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Raitt, D.F. S. 1967. Cod spawning in Scottish waters. Preliminary investigations. ICES C. M. 1967/F:29.

West, W. Q-B. 1970. The spawning biology and fecundity of cod in Scottish waters. PhD. thesis, Aberdeen University, Aberdeen.

Yoneda, M. and Wright, P. J. 2004. Temporal and Spatial variation in reproductive investment of Atlantic cod *Gadus morhua* in the northern North Sea and Scottish west coast. Marine Ecology Progress Series, 276: 237–248.

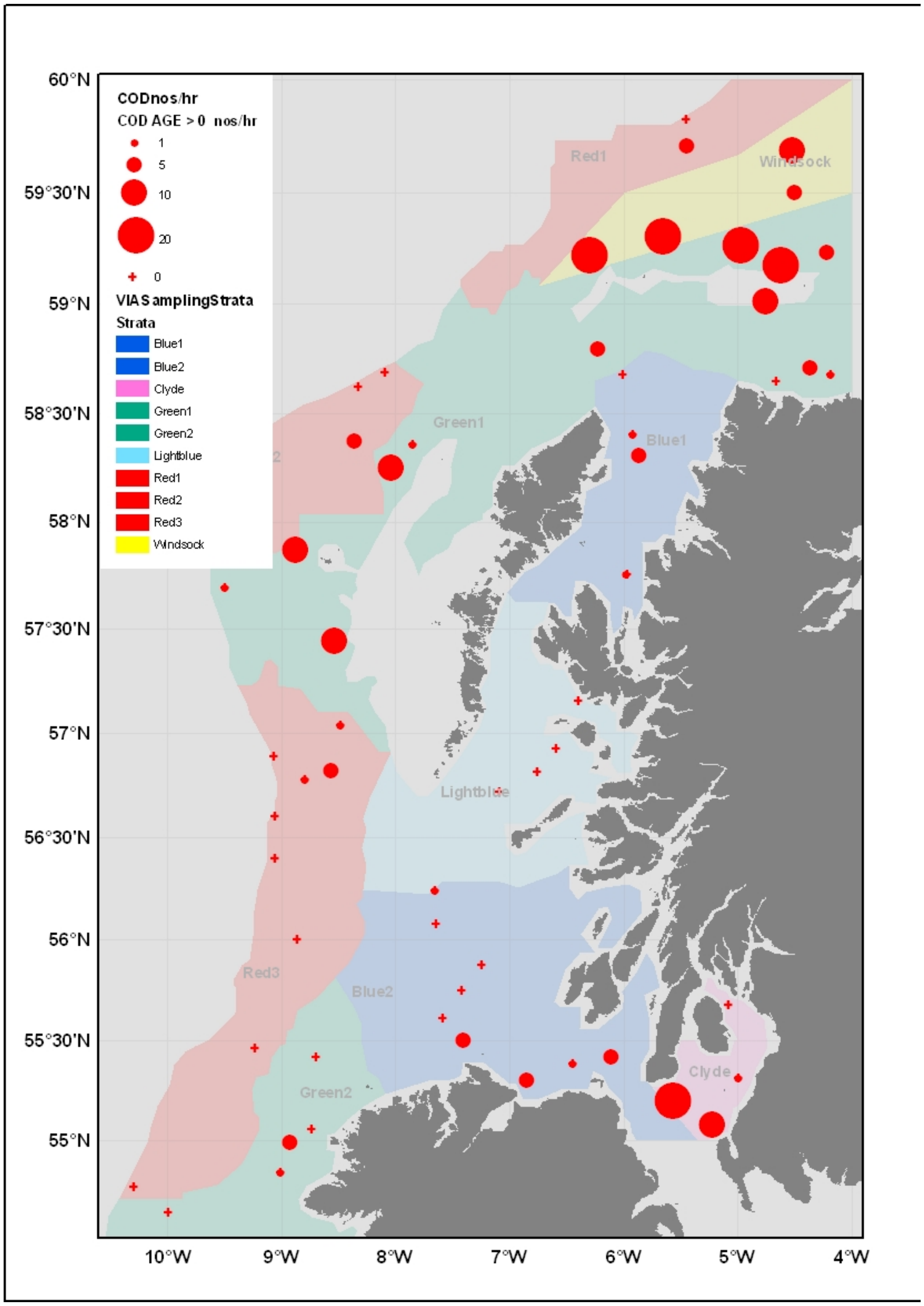


Figure H.1. Sampling strata of UKSGFS-WIBTS-Q1 survey. Figure also shows cpue numbers for fish aged at 1+ by haul for cod in 2011 (numbers standardized to 60 minutes towing).

Appendix 1: Investigations of F_{MSY} using the srmsymc package

The same input data files as used for the short-term forecast were used. An alternative run using ten year means for stock weights-at-age and mortality-at-age showed there to be little sensitivity to the averaging period used. Figure A.1 shows the three stock–recruit relationships fitted by the package; Ricker, Beverton–Holt and smooth hockey stick. Models were fitted using 1000 MCMC resamples. For all three stock–recruit relationships all resamples allowed F_{MSY} and F_{crash} values to be determined. As such, there was no basis to reject any of the recruitment models as unsuitable for this stock. For each of the stock–recruit relationships (SRR) Figures A.2 to A.4 show box plots of F_{MSY} and F_{crash} together with the values of F_{PA} and F_{lim}. For the Ricker and Beverton–Holt SRR the estimated value of F_{crash} is very close to F_{lim}. For the smooth hockey stick SRR F_{crash} is estimated between F_{lim} and F_{PA}. For all three SRR the current level of Z-02 is higher than the median F_{crash} value. Also the value of F_{MSY} is well defined and considerably lower than F_{PA} for all three SRR. The level of removals possible at the estimated F_{MSY} is poorly defined however. Circles showing the datapoints show values of Z-0.2 repeatedly in excess of the upper percentile for F_{crash}. As expected removals and SSB have declined such that values for both are now inside confidence limits for these metrics at the estimated Z-0.2 mortality rates.

Figure A.5 shows estimation of yield-per-recruit. F_{MAX} is well defined for this stock. Comparison of F_{MAX} to F_{MSY} estimated using the three SRRs (Figures A.2–4) shows F_{MSY} estimated as lower than F_{MAX} for the Beverton–Holt model, equal for the smooth hockey stick and higher than F_{MAX} in the Ricker model reflecting the downward slope of the stock–recruit relationship at higher SSBs.

In conclusion mortalities from removals in the range 0.17 to 0.33 were considered consistent with F_{MSY}.

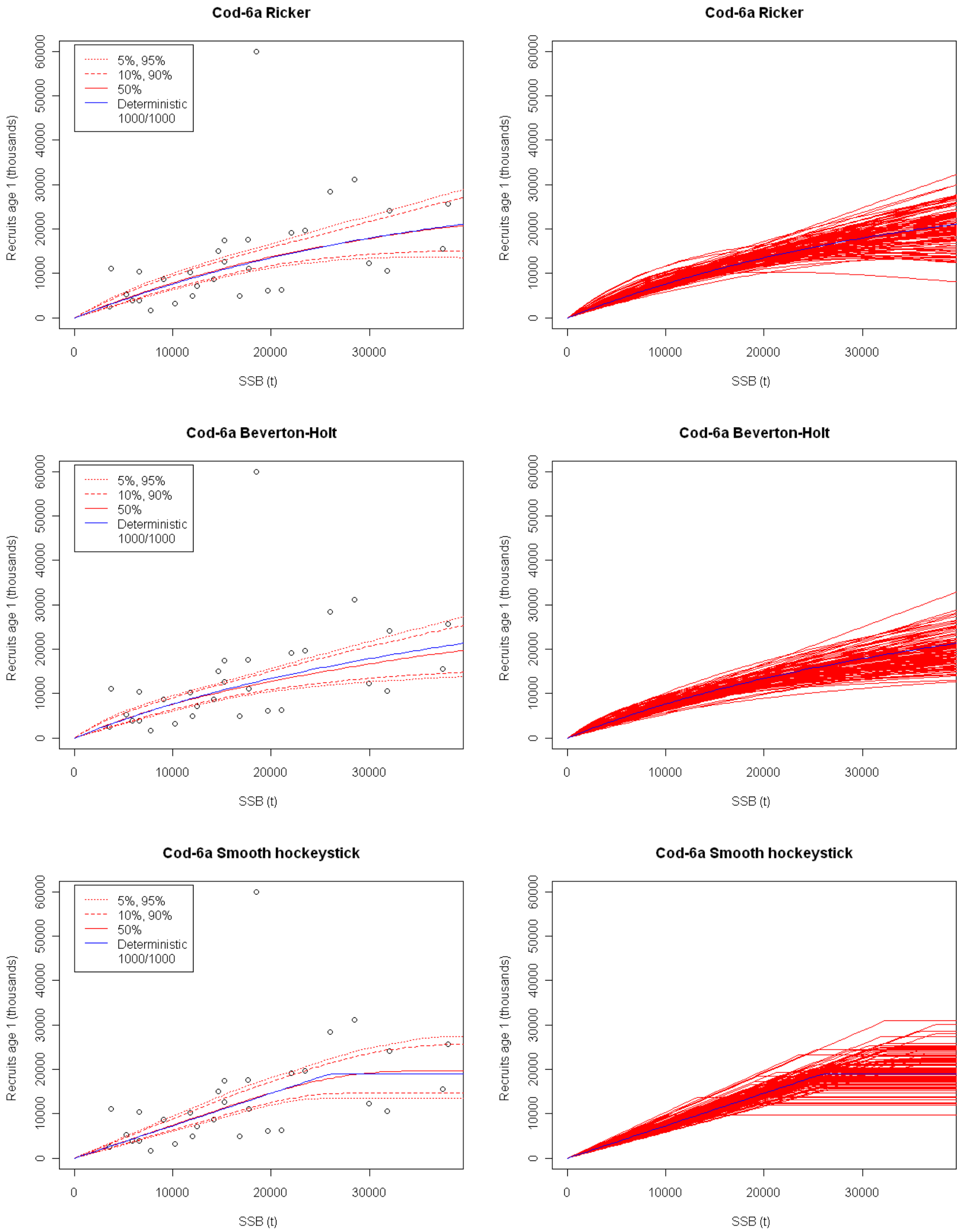


Figure A.1. Cod in Division VIa. Stock–recruit relationships fitted by srmsymc package. Models were fitted using 1000 MCMC resamples. Left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. The legends for each recruitment model show it was possible to converge on a value of F_{MSY} and F_{crash} for all 1000 iterations in each case.

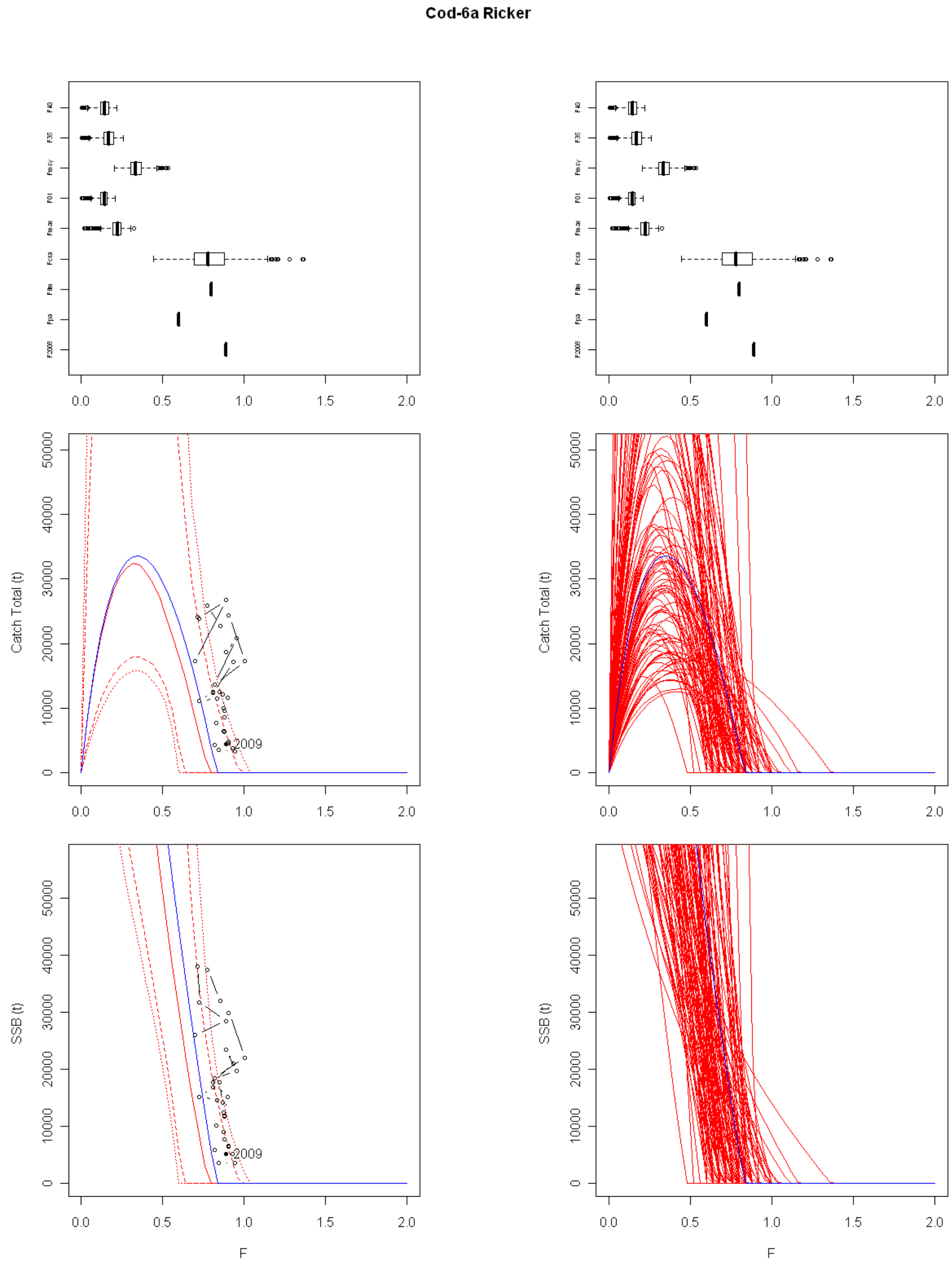


Figure A.2. Cod in Division VIa. srmsymc package. Estimation of F reference points and equilibrium yield and SSB against mortality using Ricker recruitment model. For yield and SSB plots left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. Circles show datapoints with the most recent year labelled. For VIa cod the model has been run using total removals over and above natural mortality, i.e. the x-axis represents Z-0.2.

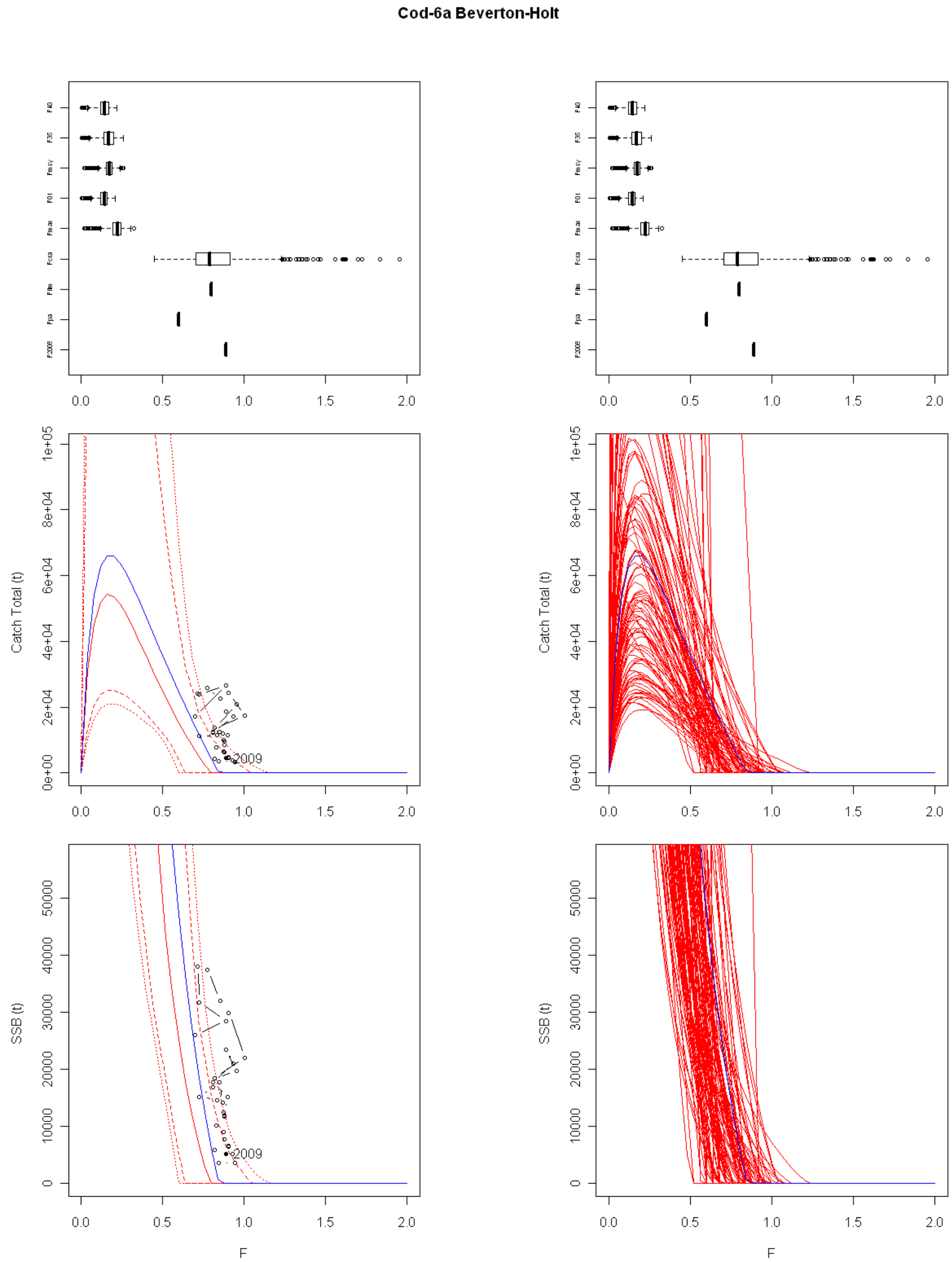


Figure A.3. Cod in Division VIa. srmsymc package. Estimation of F reference points and equilibrium yield and SSB against mortality using Beverton–Holt recruitment model. For yield and SSB plots left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. Circles show datapoints with the most recent year labelled. For VIa cod the model has been run using total removals over and above natural mortality, i.e. the x-axis represents Z-0.2.

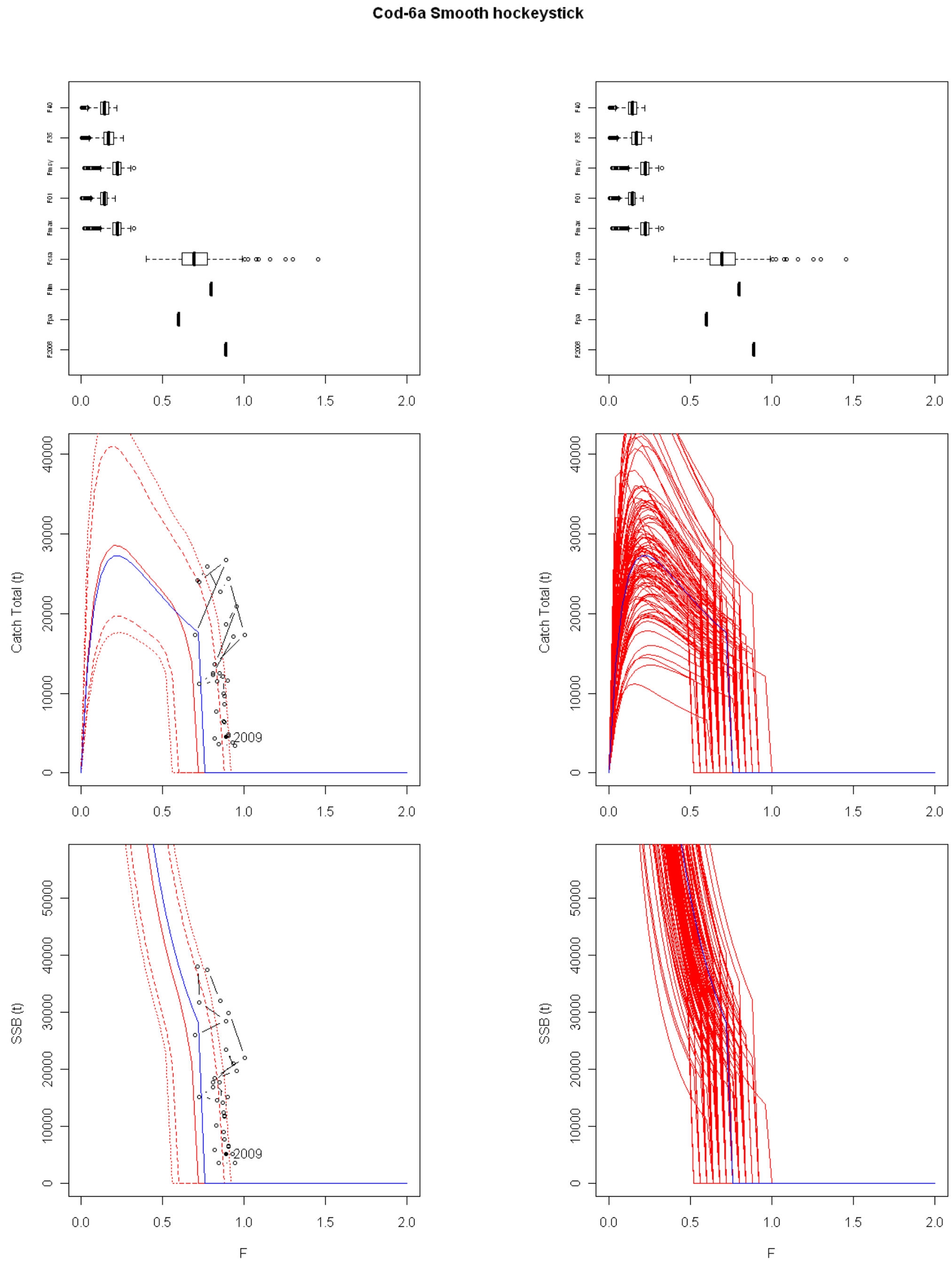


Figure A.4. Cod in Division VIa. srmsymc package. Estimation of F reference points and equilibrium yield and SSB against mortality using smooth hockey stick recruitment model. For yield and SSB plots left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. Circles show datapoints with the most recent year labelled. For VIa cod the model has been run using total removals over and above natural mortality, i.e. the x-axis represents Z-0.2.

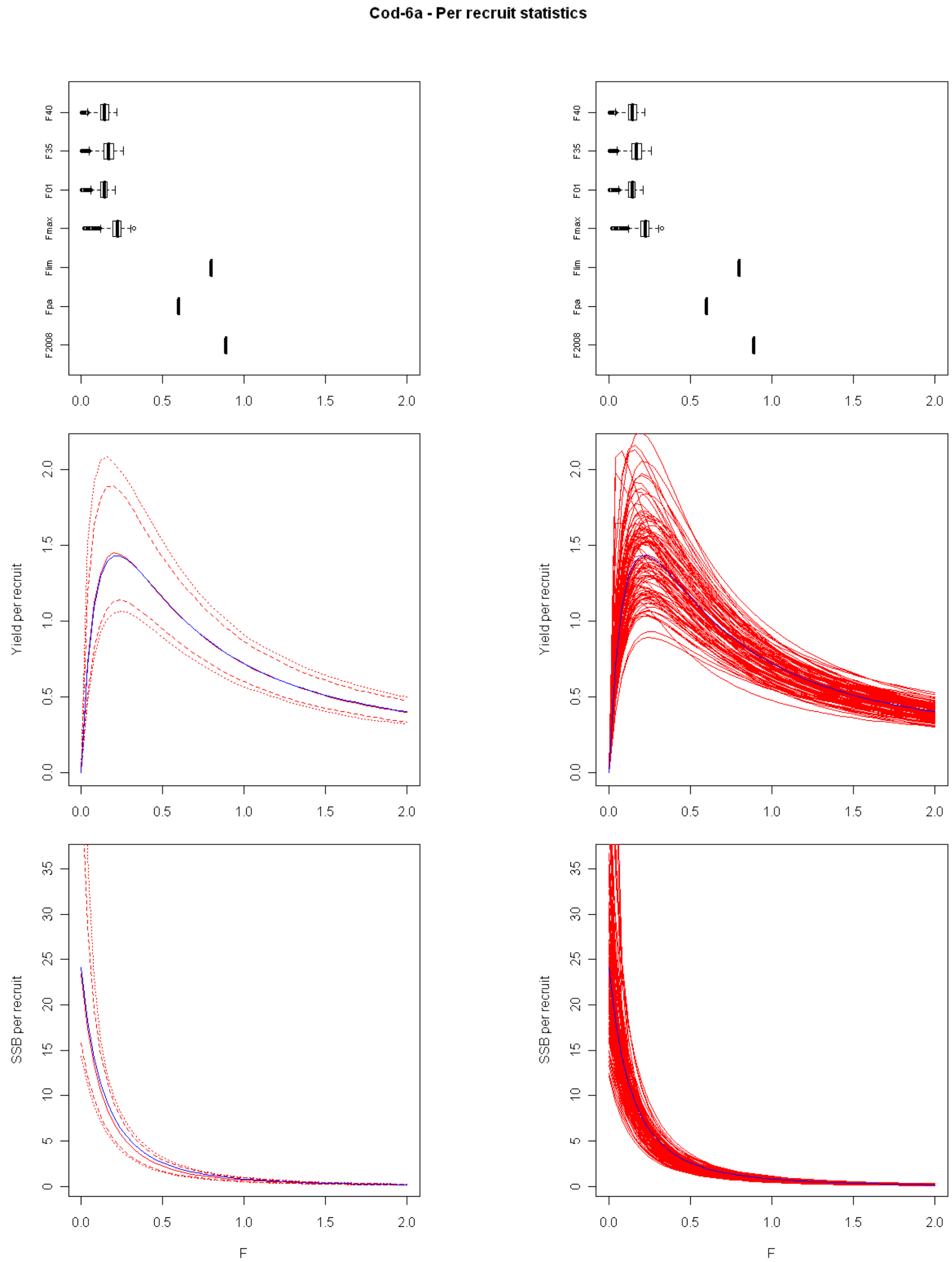


Figure A.5. Cod in Division VIa. srmsymc package. F reference points and yield-per-recruit and SSB per recruit against mortality. For VIa cod the model has been run using total removals over and above natural mortality, i.e. the x-axis represents Z-0.2.

Table A.1. Cod in Division VIa. Output from srmsymc ADMB package.

Stock name									
Cod-6a									
Sen filename									
sum_and_sen_files/codvia10runspalyhf075hf0563.sen									
pf, pm									
0	0								
Number of iterations									
1000									
Simulate variation in Biological parameters									
TRUE									
SR relationship constrained									
TRUE									
Ricker									
1000/1000 Iterations resulted in feasible parameter estimates									
	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta	AIC
Deterministic	0.83	0.35	107615.00	33631.40	0.77	0.32	0.86	1.22E-05	64.52
Mean	0.79	0.34	248654.55	80885.39	0.78	0.38	0.93	1.45E-05	
5%ile	0.59	0.26	42534.56	16130.92	0.61	0.05	0.68	1.73E-06	
25%ile	0.69	0.30	64432.03	23129.35	0.70	0.18	0.80	7.03E-06	
50%ile	0.78	0.33	94637.85	32832.15	0.77	0.35	0.90	1.35E-05	
75%ile	0.88	0.37	176432.50	56775.68	0.85	0.53	1.04	2.02E-05	
95%ile	1.03	0.42	692590.35	217198.55	0.97	0.82	1.32	3.16E-05	
CV	0.17	0.15	3.43	3.41	0.14	0.65	0.21	0.65	

Table A.5 (cont). Cod in Division VIa. Output from srmsymc ADMB package.

Beverton–Holt									
1000/1000 Iterations resulted in feasible parameter estimates									
	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta	AIC
Deterministic	0.85	0.18	401035.00	66296.50	0.39	1.31	53828.10	60405.70	64.48
Mean	0.83	0.17	830128.89	113018.89	0.54	1.41	91481.79	119568.27	
5%ile	0.59	0.11	110359.80	21448.08	0.07	1.10	18394.14	11822.00	
25%ile	0.70	0.15	195133.00	35526.05	0.28	1.26	28078.33	26150.93	
50%ile	0.79	0.17	322891.50	55212.35	0.48	1.40	44006.65	47156.45	
75%ile	0.91	0.19	630754.50	96558.98	0.76	1.55	76202.40	97400.13	
95%ile	1.15	0.21	2769898.00	341061.90	1.15	1.78	298192.60	417604.45	
CV	0.25	0.21	2.78	1.97	0.65	0.15	2.22	2.75	

Smooth hockeystick									
1000/1000 Iterations resulted in feasible parameter estimates									
	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta	AIC
Deterministic	0.75	0.22	135085.00	27314.90	0.45	1.54	0.37	26047.10	64.56
Mean	0.70	0.21	173441.36	30090.20	0.47	1.58	0.38	26727.73	
5%ile	0.53	0.13	68545.05	17722.69	0.37	0.99	0.30	16778.00	
25%ile	0.62	0.19	98326.80	23808.10	0.42	1.33	0.34	22442.08	
50%ile	0.69	0.22	129465.50	28856.20	0.46	1.58	0.37	26719.35	
75%ile	0.77	0.24	171332.00	34618.58	0.50	1.87	0.41	31474.53	
95%ile	0.89	0.27	306434.25	46886.99	0.58	2.17	0.47	36539.60	
CV	0.16	0.22	1.38	0.31	0.16	0.23	0.16	0.23	

Table A.5 (cont). Cod in Division VIa. Output from srmsymc ADMB package.

Per recruit								
	F35	F40	F01	Fmax	Bmsypr	MSYpr	Fpa	Flim
Deterministic	0.18	0.15	0.14	0.22	7.10	1.44	0.60	0.80
Mean	0.16	0.14	0.13	0.21	8.70	1.51		
5%ile	0.06	0.05	0.06	0.13	3.97	1.07		
25%ile	0.14	0.12	0.12	0.19	5.23	1.27		
50%ile	0.17	0.14	0.14	0.22	6.48	1.47		
75%ile	0.20	0.17	0.16	0.24	8.31	1.66		
95%ile	0.23	0.19	0.18	0.27	15.11	2.16		
CV	0.31	0.31	0.28	0.22	1.36	0.22		

3.3 Stock Annex Haddock VIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock	West of Scotland Haddock (Division VIa)
Working Group	Assessment of Northern Shelf Demersal Stock
Last updated	May 2009

A. General

A.1. Stock definition

The haddock is widely distributed around the west coast of Scotland and can be caught in most areas within the 200 m depth contour. The stocks occurring off the northwest coast of Scotland are usually identified according to the regions which support a fishery, but genetic and biological marker studies suggest the possibility of different populations of haddock. A continuous population of haddock is thought to extend from the west coast around to the north of Scotland. Results from tagging experiments and larval transport studies suggest that there may be links between west coast haddock and those in the North Sea.

A.2. The fishery

The minimum landing size of haddock in the human consumption fishery in this area is 30 cm.

The demersal fisheries in Division VIa are predominantly conducted by demersal trawlers fishing for cod, haddock, anglerfish and whiting, with bycatches of saithe, megrim, lemon sole, ling and several species of skate. Since 1976, effort by Scottish heavy trawlers and seiners has decreased. Light trawler effort has declined rapidly since 1997 after a long-term increasing trend.

2000 onwards

Emergency measures were introduced in 2001 to allow the maximum number of cod to spawn (see emergency measures below). Council Regulation (EC) No. 423\2004 introduced a cod recovery plan affecting Division VIa. This has been revised and updated (Council Regulation (EC) No. 1342/2008). The measures only take effect east of a line defined in Council Regulation No 51\2006. The days-at-sea limitations associated with the cod recovery plan and this seasonal closure has lead some of the Irish Demersal fleet to switch effort away from VIa.

Under Council Regulation (EC) No. 51/2006 the use of gillnets has been banned outside 200 m depth. WGFTFB 2006 report that this has greatly reduced effort at depths greater than 200 m in VIa. The measure was aimed to protect monkfish and deepwater shark and it is unclear what effect it will have on haddock.

Technical measures

The minimum mesh size for vessels fishing for haddock in the mixed demersal fishery in EC Zones 1 and 2 (West of Scotland and North Sea excluding Skagerrak) changed from 100 mm to 120 mm from the start of 2002. This came under EU regulations regarding the cod recovery plan (Commission Regulation EC 2056/2001), with a one-year derogation of 110 mm for vessels targeting species other than cod. This derogation was not extended beyond the end of 2002.

Since mid-2000, UK vessels in this fishery have been required to include a 90 mm square mesh panel (SSI 227/2000), predominantly to reduce discarding of the large 1999 year class of haddock. Further unilateral legislation in 2001 (SSI 250/2001) banned the use of lifting bags in the Scottish fleet.

Under Council Regulation No. 51/2006 the use of gillnets has been banned outside 200 m depth.

Emergency measures and effort limitation

Emergency measures were enacted in 2001, consisting of area closures from 6 March–30 April, in an attempt to maximize cod egg production. These measures were retained into 2003 and 2004.

In 2005 the following area closures were in effect:

1) The Greencastle codling fishery from mid-November to mid-February. This closure has been operating since 2003.
2) A closure in the Clyde for spawning cod from 14th February to 30th April. This closure has been operating since 2001 and was last revised by The Sea Fish (prohibited methods of fishing; Firth of Clyde) Order 2002.
3) A closure introduced in 2004 by Council Regulation No. EC 2287\2003, known as the 'windsock'.

Effort reductions for much of the international fleet to 16 days-at-sea per month have been imposed since February 2003 (EU 2003\0090). The maximum number-of-days in any calendar month for which a fishing vessel may be absent from port to the West of Scotland varies for particular gears and the allocations since 2003 are given below:

Gear	Maximum Days Allowed			
	2003:	2004:	2005:	2006:
Demersal trawls, seines or similar towed gears of mesh size ≥100 mm except beam trawls	9	10	8	91/12
Demersal trawls, seines or similar towed gears of mesh size between 70 mm and 99 mm except beam trawls1;	25	22	21	127/12
Demersal trawls, seines or similar towed gears of mesh size between 16 mm and 31 mm except beam trawls.	23	20	19	128/12

[1]: With mesh size between 80 mm and 99 mm in 2004.

The documents listing these days-at-sea limitations are,

2004: (EC) No 2287/2003

2005: (EC) No 27/2005-Annex IVa

2006: (EC) No 51/2006-Annex IIa

A Commission Decision (C (2003) 762) in March 2003 allocated additional days absent from port to particular vessels and Member States. UK vessels were granted four additional days-per-month (based on evidence of decommissioning programmes). An additional two days was granted to demersal trawls, seines or similar towed gears (mesh ≥100 mm, except beam trawls) to compensate for steaming time between home ports and fishing grounds and for the adjustment to the newly installed effort management scheme.

For 2006 one extra day was allocated to trawls >=100 mm if the mesh was >120 mm and the net contained a square mesh panel of 140 mm mesh size. Altogether 148 days in the year was allowed for vessels with mesh between 100 and 120 mm if the catch contained <5% cod in 2002. This allowance rises to 160 days in the year if the same 140 mm square mesh panel is used together with a mesh size >120 mm.

The new effort regulations provided an incentive for some vessels previously using >100 mesh in otter trawls to switch to smaller mesh gears to take advantage of the larger numbers of days-at-sea available. This would also require these vessels to be targeting *Nephrops* or anglerfish, megrim and whiting with various catch and bycatch composition limits after EC Regulation No 850/98.

Decommissioning schemes. Vessel decommissioning has been underway since 2002. Information on the number of vessels operating in the cod recovery zone to have been decommissioned in Division VIa between 2001 and 2004 was as follows:

	Total VIa 2001	Decomm. To 2004	Percentage
Number of vessels > 10 m	298	96	30.2%

A.3. Ecosystem aspects

Geographical location and timing of spawning

Spawning of haddock usually occurs in February and March and in almost any area where the fish are distributed. There is major spawning between the Butt of Lewis and Shetland. Some larvae from the west coast spawning grounds can be transported to the North Sea, which they enter through the Fair Isle/Shetland Gap or to the northeast of Shetland. Young haddock then spend the first few months of life in the upper water layers before adopting the demersal way of life. The survival rate of young haddock is very variable from year to year.

Fecundity

The majority of haddock mature-at-age two with usually all mature by age three. However, mature age two haddock spawn fewer eggs for a given size than an age three haddock. A three-year-old female of good size is able to produce around 300 000 eggs in a season and releases her eggs in a number of batches over many weeks.

Diet

The diet of haddock varies seasonally and according to location and body size. In winter, haddock of all sizes feed mainly on benthic invertebrates, for example, polychaetes, small crustaceans and echinoderms. In spring and summer, fish prey, especially sandeels, are important particularly for larger haddock. Norway pout is also important prey for haddock. During herring spawning seasons, haddock will feed heavily on herring eggs.

B. Data

B.1. Commercial catch

B1.1. Landings

The following table gives the source of landings data for West of Scotland haddock:

	Kind of data				
Country	Caton (catch-in-weight)	Canum (catch-at-age in numbers)	Weca (weight-at-age in the catch)	Matprop (proportion mature-by-age)	Length composition-in-catch
UK(NI)	X				
UK(E&W)	X				
UK(Scotland)	X	X	X	X	X
Ireland	X	X	X		X
France	X				
Norway	X				

Quarterly landings and length/age composition data are supplied from databases maintained by national Government Departments and research agencies. These figures may be adjusted by national scientists to correct for known or estimated misreporting by area or species. Data are supplied in the requested format to a stock coordinator, who compiles the international landings and catch-at-age data and maintains a time-series of such data with any amendments. To avoid double counting of landings data, each UK region supplies data for UK landings into its regional ports, and landings by its fleet into non-UK ports.

Quarterly landings are provided by the UK (Scotland), UK (E/W), UK (NI), France and Ireland .The quarterly estimates of landings-at-age by UK (Scotland) and Ireland are raised to include landings by France, UK (NI) and Norway (distributed proportionately over quarters), then summed over quarters to produce the annual landings-at-age.

B1.2. Discards

EU countries are now required under the EU Data Collection regulation to collect data on discards of haddock and other species. Up to 2003, estimates of discards were available only from UK (Scotland) and Ireland. Observer data are collected using standard at-sea sampling schemes. Results are reported to ICES.

The quantity, length and age of haddock discarded by Scottish *Nephrops* trawlers are collected during observer trips on board commercial vessels. Haddock discarded by boats using other gears (heavy trawl, seine, light trawl and pair trawl) are also collected by Scotland. Haddock discarded by otter board trawl and otter board/twin rig gears are collected by Ireland.

Discards from Scottish and Irish boats using several different gear types are estimated by observers.

B.2. Biological

Natural mortality is assumed to be constant (M=0.2, applied annually) for the whole range of ages and years. There are no direct estimates of M.

Proportion mature-at-age is currently assumed constant over the full time-series as follows:

Age	1	2	3+
Proportion mature	0.00	0.57	1.0

These maturity values were derived from a French survey carried out in Division VIa in 1983. They were first discussed in the 1984 meeting of the North Sea Roundfish Working Group (ICES-NSRWG 1984), and were first used at the 1985 meeting (ICES-

NSRWG 1985). Proportions of *F* and *M* before spawning were both set to 0.0, in order to generate abundance (and hence SSB) estimates dated to January 1st.

B.3. Surveys

Four research vessel survey series for haddock in VIa were available to the Working Group in 2009. In all surveys listed the highest age represents a true age not a plus group.

- Scottish first-quarter west coast groundfish survey (ScoGFSQ1): ages 1–7, years 1985–2009.

The survey gear is a GOV trawl, and the design is a minimum of one station per rectangle, but with more depending on logistics. Ages are reported from 0 to the maximum obtained. Sex/Maturity-Sex and Maturity (ICES 4-stage scale) are reported. The Scottish groundfish survey has been conducted with a new vessel and gear since 1999. The catch rates for the series as presented are corrected for the change on the basis of comparative trawl haul data (Zuur *et al.*, 2001).

- Irish fourth-quarter west coast groundfish survey (IreGFS): ages 0–3, years 1993–2002.

The Irish quarter four survey was a comparatively short series. It was discontinued in 2003 and has been replaced by the IRGFS (see below).

- Scottish fourth quarter west coast groundfish survey (ScoGFSQ4): ages 0–8, years 1996–2008.

As is the case for the European IBTS surveys (such as ScoGFS Q1 above) the survey gear is a GOV trawl, and the design is a minimum of one station per rectangle, but with more depending on logistics. Ages are reported from 0 to the maximum obtained. Sex/Maturity-Sex and Maturity (ICES 4-stage scale) are reported. The Scottish groundfish survey has been conducted with a new vessel and gear since 1999. The catch rates for the series as presented are corrected for the change on the basis of comparative trawl haul data (Zuur *et al.*, 2001).

- Irish fourth-quarter west coast groundfish survey (IRGFS); ages 0–3, years 2003–2008.

This survey used 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 randomized stations. Effort is recorded as minutes towed. There were 41 stations sampled in 2003, 44 in 2004 and 34 in 2005, corresponding to 1229, 1321 and 1010 minutes towed.

Plots of the spatial distribution of the ScoGFS Q1 survey mean catch rates per ICES statistical rectangle by age class are given in Figure 1. The numbers caught in the most recent Scottish Groundfish Surveys are indicated in Figure 2.

B.4. Commercial cpue

Three commercial Scottish cpue series have been made available in recent years. Irish otter trawl cpue data (IreOTR) were presented for the first time at the 2001 WG meeting. Updated series have been presented to subsequent meetings. Given the current concerns about misreporting of catch and effort, this series has not been considered further as a tuning fleet.

The commercial cpue data available consists of the following:

- Scottish seiners (ScoSEI): ages 1–6, years 1978–2005.
- Scottish light trawlers (ScoLTR): ages 1–6, years 1978–2005.
- Irish otter trawlers (IreOTR): ages 1–7, years 1995–2005.

Reported effort has declined in recent years to very low levels in both Scottish fleets for which effort data are available to the WG (pairtrawlers and light trawlers; see Table 1). The historical mean levels of lpue (landings-per-unit-effort) for these fleets were more constant, although variable. However, problems with effort recording mean that these estimates are unlikely to be valid: further details are available in the report of the 2000 meeting of ICES WG on the Assessment of Demersal Stocks in the North Sea and Skagerrak (ICES-WGNSSK 2000). For this reason, commercial Scottish lpue data has not been used in the current assessment. Data are also available (although not updated to 2007) from the Irish trawler fleet (IreOTB; Table 4.1.8), but are not used in the assessment as a consequence of concerns about targeting leading to hyperstability.

B.5. Other relevant data

None.

C. Historical stock development

In 2007 ICES changed its advisory structure: the previous committees (ACE, ACFM and ACME) were merged into a single committee now known as ACOM. Among many of the modifications to accompanying working practices, it was intended that all stock assessments conducted by the Expert Groups from 2008 should be update analyses based on the work conducted by the last benchmark meeting. For west of Scotland haddock, a benchmark assessment *per se* has not taken place for some time. However, at the 2004 WGNSDS, "a full and detailed examination" of the assessment was carried out following concerns of ACFM about the assumptions and parameter settings implemented in the TSA methods used to assess this stock (ICES, 2004). The investigation used Time Series Analysis (TSA) Extended Survivors Analysis (XSA) and Survey Based Assessment (SURBA) models. Although the results from this investigation were in some ways contradictory, and the WG remained uncertain about the most appropriate model for the stock, subsequent Review Groups concluded that a TSA assessment, using the Scottish Quarter 1 Groundfish Survey and excluding the catch and discard data from 1995 onwards, should be presented as the final assessment in 2005. In 2006 this assessment was modified slightly to incorporate an additional survey, the Scottish Quarter 4 Groundfish Survey (western division bottom-trawl survey). In 2007, concerns were raised about the potential impact on management advice of using a plus-group at-age 8 when the dominant large 1999 year class has reached that age in 2007, and also about the removal in the previous assessment of older ages in the Scottish Q4 Groundfish Survey (ScoGFS Q4). Several exploratory analyses were carried out, from which it was concluded that the same procedure should be used in 2007 as was used 2006, but with two additional ages in the ScoGFS Q4 dataset. In 2008, subject to the ACOM request, an update assessment was carried out using the same procedures as in 2007. In 2009 an update assessment was carried out using the same procedure as in 2008. This used the TSA assessment model and tuning data from the two Scottish Groundfish surveys.

Software used: Lowestoft VPA suite; Marine Scotland Science (Marine Lab Aberdeen) TSA and SURBA software.

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1966–last data year	1–8+	Yes
Canum	Catch-at-age in numbers	1966–last data year	1–8+	Yes
Weca	Weight-at-age in the commercial catch	1966–last data year	1–8+	Yes
West	Weight-at-age of the stock at spawning time.	1968–last data year	1–8+	Yes
Mprop	Proportion of natural mortality before spawning	1978–last data year	1–8+	No–set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1978–last data year	1–8+	No–set to 0 for all ages in all years
Matprop	Proportion mature-at-age	1978–last data year	1–8+	No–the same ogive for all years
Natmor	Natural mortality	1978–last data year	1–8+	No–set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Research Vessel Survey			
Tuning fleet 1	ScoGFS-Q1	1985–last data year	1–7
Tuning fleet 3	ScoGFS-Q4	1996–last data year	1–7

Summary of data ranges used in recent assessments:

Data	2006 assessment	2007 assessment	2008 assessment	2009 assessment
Catch data	Years: 1978–1994 Ages: 1–8+	Years: 1978–1994 Ages: 1–8+	Years: 1978–1994 Ages: 1–8+	Years: 1978–1994 Ages: 1–8+
Survey: ScoGFS Q1	Years: 1985–2006 Ages: 1–7	Years: 1985–2007 Ages 1–7	Years: 1985–2008 Ages 1–7	Years: 1985–2009 Ages 1–7
Survey: ScoGFS Q4	Years: 1996–2005 Ages: 1–5	Years: 1996–2006 Ages 1–7	Years: 1996–2007 Ages 1–7	Years: 1996–2008 Ages 1–7
Survey: IreGFS	Not used	Not used	Not used	Not used

TSA

TSA parameter settings for the 2003–2009 analyses.

Parameter	Notation	Description	2003	2004	2005	2006	2007	2008	2009
Initial fishing mortality	F (1, 1978)	Fishing mortality at age a in year y	0.42	0.28	0.26	0.23	0.25	0.40	0.40
	F (2, 1978)		0.67	0.5	0.51	0.50	0.56	0.71	0.70
	F (4, 1978)		0.53	0.51	0.51	0.51	0.52	0.56	0.57
Survey selectivities ScoGFS Q1	Φ(1)	ScoGFS Q1 survey selectivity at age a	3.99	2.25	2.35	2.49	2.58	2.60	2.58
	Φ(2)		4.84	2.71	2.45	2.55	3.01	3.07	3.01
	Φ(4)		2.1	1.51	2.11	2.19	2.04	1.92	1.94
Survey selectivities ScoGFS Q4	Φ(1)	ScoGFS Q4 survey selectivity at age a	-	-	-	1.99	1.62	1.77	1.75
	Φ(2)		-	-	-	1.99	1.76	1.88	1.84
	Φ(4)		-	-	-	2.25	2.39	2.61	2.64
Fishing mortality standard deviations	σF	Transitory changes in overall F	0.00	0.11	0.10	0.10	0.12	0.20	0.20
	σU	Persistent changes in selection (age effect in F)	0.05	0.04	0.01	0.00	0.09	0.03	0.03
	σV	Transitory changes in the year effect in F	0.27	0.23	0.22	0.23	0.23	0.33	0.35
	σY	Persistent changes in the year effect in F	0.00	0.14	0.09	0.09	0.07	0.00	0.00
Survey catchability standard deviations	σΩ1	Transitory changes in ScoGFS Q1 catchability	0.00	0.08	0.18	0.30	0.19	0.12	0.12
	σβ1	Persistent changes in ScoGFS Q1 catchability	0.14	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
	σΩ2	Transitory changes in ScoGFS Q4 catchability	-	-	-		0.16	0.20	0.19
	σβ2	Persistent changes in ScoGFS Q4 catchability	-	-	-		0.00*	0.00*	0.00*
Measurement coefficients of variation	cv landings	Coefficent of variation of landings-at-age data	0.22	0.25	0.23	0.20	0.20	0.24	0.25
	cv discards	Coefficent of variation of discards-at-age data	0.51	0.43	0.45	0.42	0.41	0.54	0.54
	cv survey	Coefficent of variation of ScoGFS Q1 survey data	0.40	0.34	0.53	0.57	0.33	0.35	0.36
	cv survey	Coefficent of variation of ScoGFS Q4 survey data	-	-	-	0.57	0.22	0.34	0.35
Discard curve parameters	σP	Transitory changes in overall discard proportion	0.50	0.19	0.20	0.19	0.18	0.20	0.20
	σα1	Transitory changes in discard-ogive intercept	0.00	0.15	0.02	0.00	0.14	0.00	0.00
	σν1	Persistent changes in discard-ogive intercept	0.26	0.21	0.22	0.21	0.32	0.26	0.25
	σα2	Transitory changes in discard-ogive slope	0.34	0.01	0.03	0.21	0.23	0.22	0.23
	σν2	Persistent changes in discard-ogive slope	0.02	0.61	0.43	0.23	0.002	0.000	0.000
Trend parameters	θν1	Trend parameter for discard-ogive intercept	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
	θν2	Trend parameter for discard-ogive slope	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
Recruitment	η1	Ricker parameter (slope at the origin)	9.10	9.63	9.71	9.73	9.06	11.35	11.08
	η2	Ricker parameter (curve dome occurs at 1/η2)	0.33	0.29	0.31	0.29	0.30	0.35	0.35
	cv rec	Coefficent of variation of recruitment curve	0.52	0.89	0.89	0.90	0.62	0.60	0.61

D. Short-term projection

TSA produces short-term forecasts as part of every standard model run. The recruitment values used in these forecasts have been discussed above. The model will also forecast fishing mortality rates. It does so by iterating forward the time-series model that had been fitted to historical data. These forecast mortalities therefore retain the time-series characteristics of the preceding data. However, it is not clear to the WG what the precise statistical properties of these mortality forecasts are. It is likely that they follow a pattern of damped oscillation towards an eventual steady state, but without further analysis the WG did not feel confident in using them as the basis for a forecast.

Model used: Age structured

Software used*:* MFDP prediction with management option table and yield-per-recruit routines. MLA suite (WGFRANSW) used for sensitivity analysis and probability profiles.

- Initial stock size. Taken from XSA or TSA for age 1 and older. The recruitment-at-age 0 in the last data year is estimated as a GM because of a perceived downward trend in recruitment in recent years.
- Natural mortality: Set to 0.2 for all ages in all years.
- Maturity: The same ogive as in the assessment is used for all years.
- F and M before spawning: Set to 0 for all ages in all years.
- Weight-at-age in the stock: based on either of simple three-year means or linear model projections: simple three year means are used for the younger ages (1–2) and linear model projections for the older ages (3–8+).

Weight-at-age in the catch: as above for stock weights.

- Exploitation pattern: Average of the three last years.
- Intermediate year assumptions: *status quo* F.
- Stock–recruitment model used: TSA estimate of recruits-at-age 1 for intermediate year, Ricker model from TSA used for intermediate year +1 and the long-term geometric mean recruitment-at-age 1 is used for intermediate year +2.

E. Medium-term projections

Stochastic medium-term projections were not produced for this stock. The reliance of the fishery on intermittent large year classes, and the fluid nature of the fishery and related management, make the usefulness of medium-term projections questionable in any case.

F. Yield and biomass per recruit/long-term projections

Model used: yield and biomass per recruit over a range of F values.

Software used: MFDP

- Selectivity pattern: mean F array from last three years of assessment (to reflect recent selection patterns).
- Stock and catch weights-at-age: mean of last three years.
- Maturity: Fixed maturity ogive as used in assessment.

G. Biological reference points

B_{pa} is set at 30 000 tonnes and is defined as B_{lim}*1.4. B_{lim} is defined as the lowest observed SSB, considered to be 22 000 tonnes when the current reference points were established in 1998. F_{pa} is 0.5 on the technical basis of a high probability of avoiding SSB falling below B_{pa} in the long term. F_{lim} is not defined. In the 2007 ACFM report, F_{max} was estimated at 0.44 and $F_{0.1}$ was 0.2.

H. Other issues

None.

I. References

ICES 2004 Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks (WGNSDS). ICES CM 2005/ACFM:01.

Table 1. Haddock in Division VIa. Commercial effort and tuning-series made available to the WG. Effort (first column) is given as reported hours fished per year; numbers landed are in thousands. Note that a) these data are not used in the final assessment, and b) 2006 data were not available to the WG in 2007.

Scottish pair trawl (ScoPTR)

		Age						
Year	**Effort**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1988	73448	1836.79	19333.629	2791.134	1561.027	3555.323	132.086	47.031
1989	69051	358.121	622.245	6453.549	833.344	617.05	1530.389	96.988
1990	24365	2656.973	1209.336	432.811	2413.249	161.21	59.431	119.9
1991	33826	2528.117	3815.61	267.76	165.98	1059.521	75.441	58.562
1992	24141	1531.621	1587.775	1068.706	80.518	28.226	195.827	17.505
1993	23975	1784.422	8049.086	3189.459	582.533	48.833	41.065	141.79
1994	21003	602.661	2354.895	2614.523	861.39	226.916	7.311	14.371
1995	22848	2494.133	1573.402	3915.253	1501.48	365.819	103.337	3.1
1996	22237	3993.635	7475.948	1085.826	2281.053	1002.653	282.516	73.796
1997	8552	1327.954	1136.375	3876.218	340.837	523.864	192.329	37.903
1998	8425	416.432	2137.106	1315.696	2734.416	232.941	149.879	35.896
1999	2483	450.826	1936.938	1521.928	399.642	641.984	47.192	34.913
2000	2335	1545.384	394.239	620.963	319.038	45.263	69.646	15.32
2001	1342	4.767	230.091	97.936	241.187	46.188	10.688	37.264
2002	14	31.473	115.105	120.723	2.223	2.909	1.247	0.356
2003	5	38.548	107.443	150.615	288.114	29.322	4.005	0.232
2004	88	52.807	141.598	40.075	98.517	221.673	13.792	2.687
2005	0	9.956	22.448	31.323	22.161	32.8	106.663	0.189

Irish otter trawl (IreOTB)

		Age						
Year	**Effort**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1995	56335	222	298	530	461	92	28	98
1996	60709	165	531	670	281	175	33	12
1997	62698	99	358	515	282	339	133	89
1998	57403	51	1092	552	312	186	218	232
1999	53192	98	315	437	266	198	109	123
2000	46913	50	131	188	303	158	76	65
2001	48358	14	304	144	101	126	100	44
2002	37231	31	162	388	27	65	97	47
2003	42899	4	36	108	231	29	36	29
2004	35140	0	33	82	71	82	11	13
2005	30941	1	23	41	56	87	29	7

Table 1. cont.

Scottish light trawl (ScoLTR)

		Age			
Year	**Effort**	**2**	**3**	**4**	**5**
1965	37387	22.091	1642.12	168.954	6.998
1966	40538	2.929	0	702.277	20.987
1967	80916	1326.106	72.823	6.981	188.483
1968	65348	514.409	132.176	9.014	13.019
1969	106586	6100.801	273.493	81.818	4.989
1970	129741	60.985	7188.79	93.986	17.997
1971	129187	426.996	323.964	7715.896	29.996
1972	154288	20885.215	447.018	197.01	4635.228
1973	93992	1171.622	1396.082	8.999	18.998
1974	88651	950.263	706.156	425.086	4.001
1975	132353	4525.993	476.288	360.261	320.234
1976	139225	11482.937	2002.98	171.894	208.87
1977	143547	362.858	3581.037	660.848	94.978
1978	127387	205.97	157.024	1412.263	205.04
1979	99803	2419.532	162.972	32.994	802.863
1980	121211	3869.366	1034.891	183.982	37.996
1981	165002	14862.966	4468.331	423.043	40.004
1982	135280	958.723	17379.104	1721.828	70.994
1983	112332	5747.308	1345.07	10272.253	662.105
1984	132217	2210.088	3687.112	809.84	6080.328
1985	142815	16310.439	905.133	691.017	214.069
1986	126533	2565.893	13292.803	408.899	163.349
1987	131653	4040.797	2770.494	6465.25	249.058
1988	158191	17326.463	2369.239	1008.226	2273.141
1989	217443	1459.316	10332.354	934.04	394.722
1990	131360	1293.654	541.378	3520.472	213.722
1991	209901	8386.068	414.358	218.113	1814.306
1992	189288	3850.242	2937.112	133.408	49.73
1993	189925	17312.309	6469.671	1479.199	89.402
1994	174879	7106.326	6307.283	1574.576	409.496
1995	175631	4850.552	9835.464	2704.111	551.303
1996	214159	15882.858	2665.141	4524.729	1511.694
1997	179605	4231.875	9987.962	882.602	1119.138
1998	142457	6845.462	3530.308	7753.948	573.554
1999	98993	6266.816	4506.559	1124.841	2152.395
2000	76157	2725.197	4725.382	2259.356	499.511
2001	35698	14958.081	1246.235	2075.946	687.201
2002	15174	4200.486	16918.947	400.382	421.166
2003	9357	2114.331	2803.164	6108.682	76.951
2004	7117	3675.178	1203.565	2307.81	3900.374
2005	3063	1643.009	1317.835	787.027	955.533

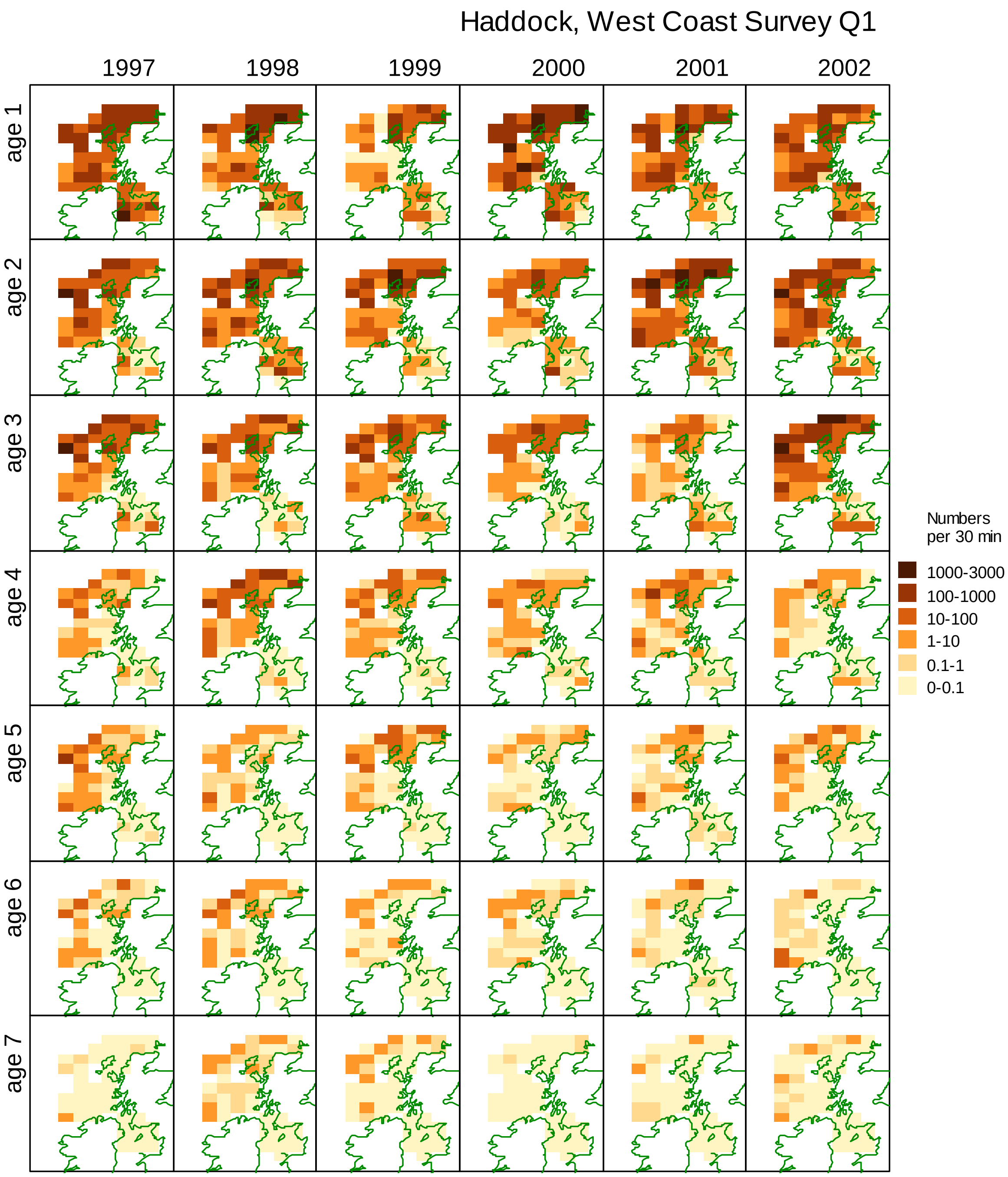


Figure 1. Haddock in Division VIa. Number per 30 min tow, averaged over ICES statistical rectangles from the west of Scotland groundfish Q1 (IBTS) survey 1997–2002, ages 1–7.

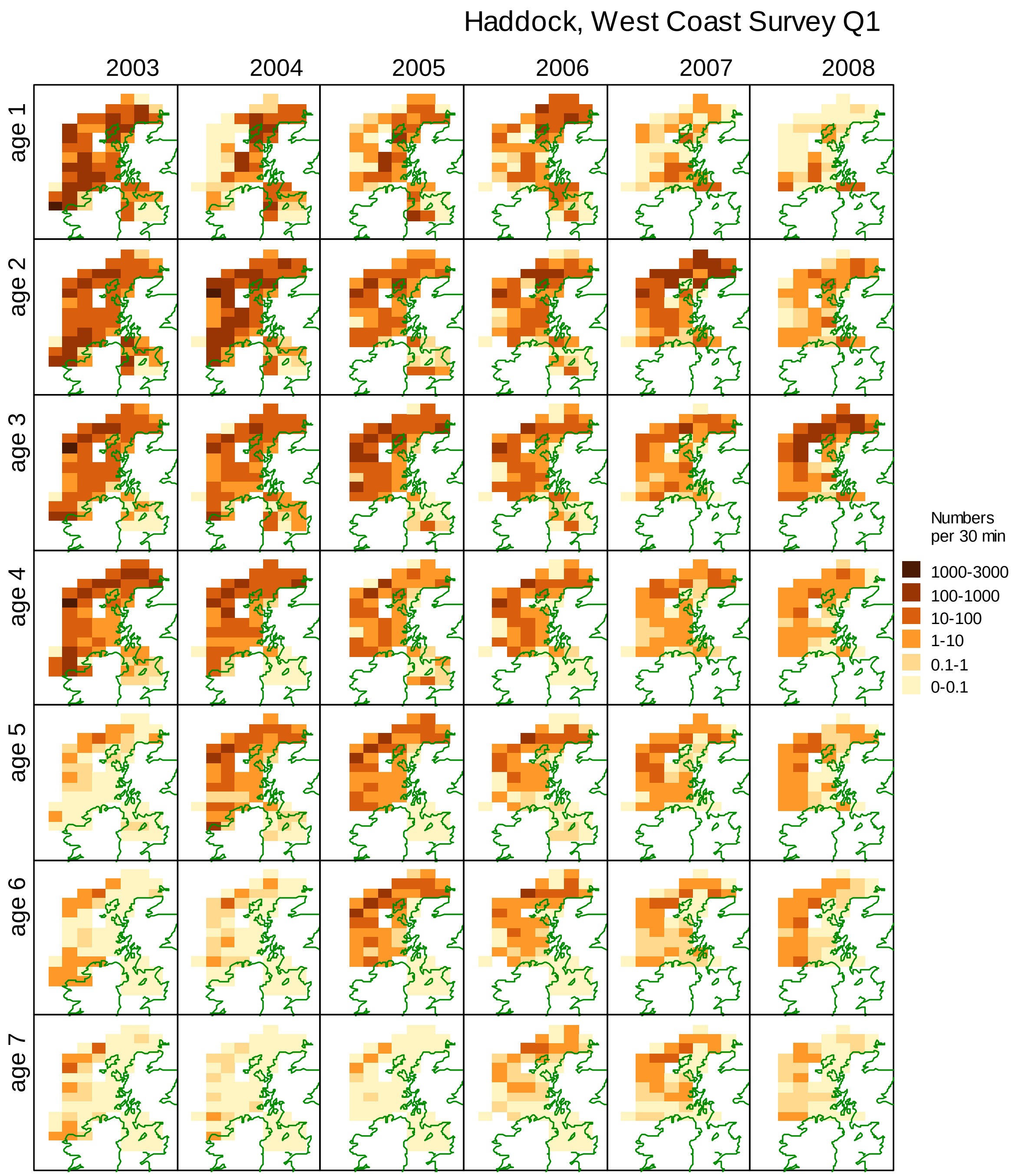


Figure 1. continued. Haddock in Division VIa. Number per 30 min tow, averaged over ICES statistical rectangles from the west of Scotland groundfish Q1 (IBTS) survey 2003–2008, ages 1–7.

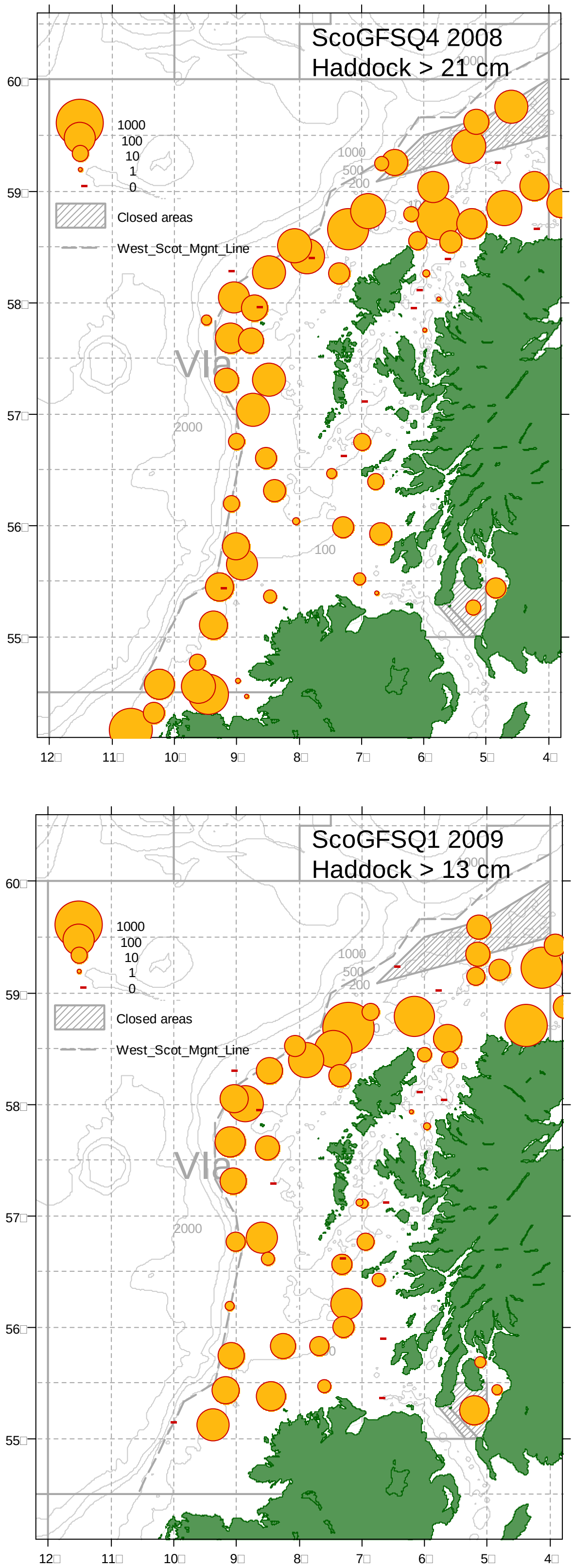


Figure 2. Haddock in Division VIa. Numbers per 30 min tow from the Scottish groundfish surveys (ScoGFS): Quarter 4 (2008) and Quarter 1 (2009).

3.4 Stock Annex Whiting in Subarea VI

Stock specific documentation of standard assessment procedures used by ICES.

Stock	West of Scotland Whiting (Subarea VI)
Working Group	Working Group for the Celtic Seas Ecoregion (WGCSE)
Date	February 2012
Author	Andrzej Jaworski
Revised by	WKROUND/Andrzej Jaworski

A. General

A.1. Stock definition

Whiting occur throughout Northeast Atlantic waters in a wide range of depths from shallow inshore waters down to 200 m. Adult whiting are widespread throughout Division VIa, while large numbers of juvenile fish occur in inshore areas. Whiting are less common in Division VIb, and it is likely these fish are migrants from VIa, rather than a separate stock.

Stock identity in Division VIa has recently been explored in greater detail. Tagging experiments on recruiting fish have shown that the whiting found to the south of 56°N and to the west of Ireland are distinct from those in the Minches, the Clyde and the Irish Sea. Five juvenile nursery areas have been discriminated off the west of Scotland and northern North Sea, three of them being found in VIa. The nursery areas on the Scottish west coast contribute individuals to the spawning aggregations in the Scottish coastal North Sea and Shetland, and there is no evidence of the converse (Tobin *et al.*, 2010). Within VIa, there is little indication of interaction between population components in the south and that off the northwest coast.

A.2. Fishery

The demersal fisheries in Division VIa are predominantly conducted by otter trawlers fishing for cod, haddock, anglerfish and *Nephrops*, with bycatch of whiting, saithe, megrim, lemon sole, ling and a number of skate species. Whiting are taken by trawlers using gear with mesh size between 80 mm and 120 mm. Since 1976, effort by Scottish heavy trawlers and seiners has decreased. Light trawler effort has declined rapidly since 1997 after a long-term increasing trend. More recently, days-at-sea limitations associated with the cod recovery plan and the seasonal closure of some areas has lead to some switching of effort away from VIa.

The demersal whitefish fishery in Subarea VI occurs largely in Division VIa with the UK, Ireland and France being the most important exploiters. Landings from Rockall (Division VIb) are generally less than 10 t. The whiting fishery in VIa is dominated by the UK (Scotland) and Irish fleets. French whiting landings have declined considerably since the late 1980s.

Landings of whiting in Division VIa are affected by emergency measures introduced in 2001 as part of the cod recovery programme. Council Regulation 423/2004 introduced a cod recovery plan affecting Division VIa. The measures only take effect, however east of a line defined in Council Regulation No 51/2006. Measures brought in 2002, such as a switch from 100 to 120 mm mesh codends at the start of 2002 (Commission Regulation EC2056/2001), are likely to have had some impact on whiting. The UK implemented a regulation requiring the fitting of a square mesh panel in certain towed gears.

Most catch of whiting comes in non-whiting directed fisheries, particularly the *Nephrops* trawl fishery. The *Nephrops* trawl fishery in VIa discards significant amounts of small whiting, making whiting landings figures a poor indicator of removals due to fishing. The proportion of whiting discarded has been very high and appears to have increased in recent years. Whiting also has a low market demand, which contributes to increased discarding and highgrading. In terms of the total weight of demersal fish landed by the Scottish fleet from the west coast, whiting is ranked fourth, with an annual value of £368 000 (in 2009).

The minimum landing size of whiting in the human consumption fishery in this area is 27 cm.

There have been some problems regarding area misreporting of Scottish landings during the early 1990s, which are linked to area misreporting of other species such as haddock and anglerfish into Division VIb. More recently there has been area misreporting of anglerfish from VIa to IVa, which may have affected the reliability of whiting landings distribution.

A.3. Ecosystem aspects

Unlike some species, whiting do not form distinct spawning shoals, and both ripe and immature fish are often found together. As the latitude increases, spawning of whiting occurs progressively later. This is closely associated with temperature changes, but spawning activity generally peaks in spring, just as sea temperatures begin to rise. On the west coast of Scotland whiting spawn between January and June. Within this period, the spawning season of an individual female lasts around fourteen weeks, during which time she releases many batches of eggs. At two years old most whiting are mature and able to spawn. By the time it reaches four years old, a single female fish of reasonable size can produce more than 400 000 eggs. Like many other fish, whiting spend their first few months of life in the upper water layers before moving to the seabed. Male and female whiting grow very quickly reaching around 19 cm in their first year. After this the growth rate becomes much slower. There are large differences between the growth rates of individual fish and a 30 cm fish can be as young as one year or as old as six.

Whiting are active predators. Juvenile fish eat mainly crustaceans (shrimps and crabs) but as whiting grow, the amount of fish in their diet increases. The exact composition of the diet depends on the size of the fish, the area and the time of the year. Whiting is one of the main predators of other commercially important species of fish. Norway pout, sandeels, haddock, cod and even whiting themselves are frequently eaten. It has been estimated that each year the whiting population consumes several hundred thousand tonnes of these species.

B. Data

B.1. Commercial catch

Monthly length frequency distribution data were available from Scotland for Division VIa. A total international catch-at-age distribution for Division VIa was obtained by raising this distribution to the WG estimates of total international catch from this area. Landings officially reported to ICES were used for countries not supplying estimates directly to the WG. The Scottish market sampling length–weight relationships (given below) have been used to raise the sampled catch-at-length distribution data Working Group estimates of total landings for Division VIa.

Month	b	a
1	2.9456	0.01
2	2.9456	0.0094
3	2.9456	0.009
4	2.9456	0.0088
5	2.9456	0.0088
6	2.9456	0.0089
7	2.9456	0.009
8	2.9456	0.0092
9	2.9456	0.0095
10	2.9456	0.0096
11	2.9456	0.0097
12	2.9456	0.0097

Discard data are available from 1978 but sampling was very limited before 1981. To reduced bias and increase precision, discards in years 1981–2003 were raised according to the procedure described in Millar and Fryer (2005). Discard age-compositions are generally available from both Scotland and Ireland, but in some recent years (2006 and 2007) lack of access to fishing vessels by Irish observers has meant that no Irish data have been collected.

B.2. Biological

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 grammes) and the numbers are the Lorenzen parameters for fish in natural ecosystems.

A combined sex maturity is assumed, knife-edged at age 2. The use of a knife-edged maturity ogive has been a source of criticism in previous assessments. However, recent research on gadoid maturity conducted by the UK gives no evidence of substantial change in whiting maturity since the 1950s, although there has been an increase in the incidence of precocious maturity-at-age 1, particularly in males, since 1998, in the Irish Sea.

B.3. Surveys

Six research vessel survey-series for whiting in VIa were available to the WKROUND 2012. 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 0–8, years 1996–2009).

The Q1 Scottish Groundfish survey was running in the period 1985–2010, 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 1996–2010, once again using the GOV survey trawl with groundgear 'C' and the fixed station format.

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. The largest obstacle preventing an earlier move to a more randomized survey design was the lack of confidence in the 'C' rig to tackle the potentially hard substrata that a new randomized survey was likely to encounter. The first step in the process of modifying the survey design was therefore to design a new groundgear that would be capable of tackling such challenging terrain. The introduction of the new design initiated two new time-series:

- Scottish first-quarter west coast groundfish survey (no acronym assigned yet): ages 1–7, years 2011–2012).
- Scottish fourth quarter west coast groundfish survey (no acronym assigned yet): ages 0–8, years 2011–).

ICES will consider inclusion of the above time-series to produce tuning indices through an inter-benchmark procedure when 4+ years of data have been gathered.

The Irish groundfish surveys:

- Irish fourth-quarter west coast groundfish survey (IreGFS): ages 0–5, years 1993–2002.

The Irish quarter four survey was a comparatively short series, was discontinued in 2003 and has been replaced by the IGFS.

- Irish fourth quarter west coast groundfish survey (IGFS-WIBTS-Q4): ages 0–6, years 2003–2010.

This survey used 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 randomized stations. Effort is recorded in terms of minutes towed. Further descriptions of these surveys and distribution plots of whiting catch rates obtained on these surveys can be found in the IBTS WG Report of 2011.

B.4. Commercial cpue

Due to a number of concerns regarding the non-mandatory recording of effort in terms of hours fished, the present assessment of the stocks does not make use of commercial catch per unit of effort data. The data are included here for completeness and include:

- Scottish light trawlers (ScoLTR): ages 1–7 years 1965–2005
- Scottish seiners (ScoSEI): ages 1–6 years 1965–2005
- Scottish *Neprhops* trawlers (ScoNTR): ages 1–6 years 1965–2005
- Irish Otter Trawlers (IreOTB): ages 1–7 years 1995–2005

Data to update these time-series were not available for the recent years.

B.5. Other relevant data

Fecundity data for a number of areas are available from Hislop and Hall (1974), and was estimated at 4.933 $L^{3.25}$ for whiting in Subarea VI.

C. Assessment: data and method

Model used: TSA

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

Model Options chosen:

Weight-dependent M after Lorenzen (1996)

- Mwght.b <- –0.29
- Mwght.Mu <- 3.0

Response: landings-at-age, discards-at-age and survey indices-at-age

Commercial data

- 1981–1994: treated as unbiased
- 1995–2005: age structure only used (with unaccounted mortality estimated)
- 2006–2010: treated as unbiased
- landings cvmult-at-age = c(2, 1, 1, 1, 1, 1, 2): extra variability for ages 1 and 7+
- discards cvmult-at-age = c(1, 1, 1, 1, 2): extra variability for age 5
- discards cvmult = 3 for age 1 in 1981, age 1 in 1987, age 3 in 1991, age 1 in 2000

Discard model

- full model
- 1981–2010: ages 1–5 modelled

Stock–recruit model

- hockey stick

Fishing selection model

- amat = 4: fishing selection flat (apart from noise) from age 4
- gudmundssonH1 = c(2, 1, 1, 1, 1, 1, 1): extra variability for age 1

Survey model (ScoGFS-WIBTS-Q1)

- full model: separate catchability for each age
- ages 1 to 6 modelled
- transitory and persistent changes in catchability allowed
- 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

Survey model (ScoGFS-WIBTS-Q4)

- full model: separate catchability for each age
- ages 1 to 6 modelled
- transitory and persistent changes in catchability allowed

- cvmult-at-age = c(1, 1, 1, 1, 1, 2): extra variability for age 6
- cvmult = 3 for age 4 in 2007, age 5 in 2007

Survey model (IGFS Q4 IGFS-WIBTS-Q4)

- full model: separate catchability for each age
- ages 1 to 4 modelled
- years 2003–2006 and 2008–2010 (year 2007 excluded due to a high prediction error)
- transitory and persistent changes in catchability allowed

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1981–2010	1 to 7+	Yes
Canum	Catch-at-age in numbers	1981–2010	1 to 7+	Not used
??	Landings-at-age in numbers	1981–2010	1 to 7+	Yes
??	Discards-at-age in numbers	1981–2010	1 to 7+	Yes
Weca	Weight-at-age in the commercial catch	1981–2010	1 to 7+	Not used
??	Weight-at-age in the commercial landings	1981–2010	1 to 7+	Yes
??	Weight-at-age in the commercial discards	1981–2010	1 to 7+	Yes
Weca	Weight-at-age in the commercial catch	1981–2010	1 to 7+	Not used
West	Weight-at-age of the spawning–stock at spawning time	1981–2010	1 to 7+	Not used
Mprop	Proportion of natural mortality before spawning	1981–2010	1 to 7+	No
Fprop	Proportion of fishing mortality before spawning	1981–2010	1 to 7+	No
Matprop	Proportion mature at-age	1981–2010	1 to 7+	No
Natmor	Natural mortality	1981–2010	1 to 7+	No

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	ScoGFS-WIBTS-Q1	1985–2010	1–6
Tuning fleet 2	ScoGFS-WIBTS-Q4	1996–2009	1–6
Tuning fleet 3	IGFS-WIBTS-Q4	2003–2010	1–4

D. Short-term projection

Not done.

E. Medium-term projections

No medium-term projections are carried out for this stock.

F. Long-term projections

No long-term projections are carried out for this stock.

G. Biological reference points

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$		No estimate
Approach	F_{MSY}		No estimate
	B_{lim}	16000 t	ICES proposition
Precautionary	B_{PA}	22000 t	ICES proposition
Approach	F_{lim}	1.0	ICES proposition
	F_{PA}	0.6	ICES proposition

H. Other issues

H.1. Historical overview of previous assessment methods

Data	2008 assessment	2009 assessment	2010 assessment	2011 assessment
Catch data	No assessment	No assessment	Years: 1965–2009 Ages: 1–7+	Years: 1965–1994 and 2006–2010 Ages: 1–7+
Survey: ScoGFS Q1	No assessment	No assessment	Years: 1985–2010 Ages 1–6	Years: 1985–2011 Ages 1–6
Survey: ScoGFS Q4	No assessment	No assessment	Not used	Not used
Survey: IRGFS Q4	No assessment	No assessment	Not used	Not used

I. References

Hislop, J. R. G., Hall, W. B. 1974. The fecundity of whiting, *Merlangius merlangus* (L.) in the North Sea, the Minch and at Iceland. Journal du Conseil International pour L'exploration de la Mer, 36: 42–49.

Millar, C. P., Fryer, R., J. 2005. Revised estimates of Annual discards-at-age for cod, haddock, whiting and saithe in ICES Subarea IV and Division VIa. Fisheries Research Services internal report No 15/05, July 2005, 23 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.

Tobin, D., Wright, P. J., Gibb, F. M., Gibb, I. M. 2010. The importance of life stage to population connectivity in whiting (*Merlangius merlangus*) from the northern European shelf. Marine Biology, 157: 1063–1073.

3.5 Stock Annex *Nephrops* FU11, North Minch

Stock specific documentation of standard assessment procedures used by ICES.

Stock	North Minch *Nephrops* (FU 11)
Date	09 March 2009 (WK*NEPH*2009)
Revised by	Sarah Clarke/Carlos Mesquita

A. General

A.1. Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 10–100% to excavate its burrows. This means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small-scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. The North Minch Functional Unit (FU 11) is located off the northwest coast of Scotland. The northern boundary of the FU is the 59°N line, although there are no areas of suitable sediment north of 58°30′N. The boundary with the South Minch FU is at 57°30′N. The North Minch includes areas of sediment in the Inner Sound, between Skye and the mainland, with other small, isolated areas of sediment.

A.2. Fishery

The North Minch *Nephrops* fishery is predominantly exploited by *Nephrops* trawlers using single rig gear with a 70 mm mesh, although about 15% of landings are currently made by creel vessels. About 15% of the trawl landings are made with a 100 mm mesh, and only 1% of landings appear to be made by twin-rig vessels.

All the creel vessels are local, and roughly three quarters of the trawl landings are made by vessels based between Mallaig and Kinlochbervie on the mainland, and Stornoway on the Isle of Lewis. The major landing ports are Ullapool, Gairloch and Stornoway. In all, about 135 trawlers contribute to the landings, 75% of which are local. Mean engine power is 206 kW, and mean vessel length 15.5 m. Most vessels were built between the 1960s and 1980s.

The minimum landing size for *Nephrops* in the North Minch is 20 mm CL, and less than 0.5 % of the animals are landed under size. Discarding takes place at sea, and landings are made by category for whole animals (small, medium and large) and as tails. The main bycatch species is haddock, although whiting and Norway pout also feature significantly in discards.

The fishery is exploited throughout the year, with the highest landings usually made in spring and summer. Vessels usually have a trip duration of one day in winter, but up to six days in summer.

The current legislation governing *Nephrops* trawl fisheries on the West coast of Scotland was laid down by the North Sea and West of Scotland cod recovery plan (EC 2056/2001), which established measures additional to EC 850/98. This regulation was amended in 2003 by Annex XVII of EC 2341/2002, which establishes fishing effort and additional conditions for monitoring, inspection and surveillance for the recovery of certain cod stocks. This regulation effectively limits vessels targeting *Nephrops* with

70–99 mm mesh size to 25 days at sea per month. The use of square mesh and headline panels are compulsory in this fishery.

Additional Scottish legislation (SSI No 2000/226) applies to twin trawlers operating North of 56°N, A mesh size of 100 mm or above must be used without a lifting bag and with not more than 100 meshes round the circumference but with up to 5 mm double twine. By comparison, vessels using a single trawl may use 70–89 mm mesh with a lifting bag and 120 meshes round the codend but with 4 mm single twine.

A.3. Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

B. Data

B.1. Commercial catch

Length and sex compositions of *Nephrops* landed from the North Minch are estimated from port sampling in Scotland. Length data from Scottish sampling are applied to all catches and raised to total international landings. Rates of discarding by length class are estimated for Scottish fleets by on-board sampling, and extrapolated to all other fleets. The proportion of discarded to landed *Nephrops* changes with year, often determined by strong year classes. Discard sampling started in 1990, and for years prior to this estimates have been made based on later data. Landings and discards at length are combined (assuming a discard survival rate of 25%) to removals. Removals are raised separately for each sex.

Scottish *Nephrops* trawler lpue remains at a high level in 2007, showing a marked increase for females; although lpue on males shows a reduction in 2007 (Table B1.1 and Figure B1.1). However, it is difficult to conclude whether these data are representative of actual lpue as improved reporting of landings in recent years (due to 'buyers and sellers') will have contributed to this increase and the trends also likely to be affected by non-mandatory effort recording (hours fished). These comments also apply to the paragraphs below.

In general, males make the largest contribution to the landings (Figure B1.2). Effort has traditionally been higher in the 2nd and 3rd quarters of the year in this fishery, but has declined in the 3rd quarter in the most recent years and it is now the 2nd quarter that exhibits the highest fishing effort. Male lpue declined between 1996 and 1998, but has increased since then, and has been particularly high in the 1st and 4th quarters of recent years. The lpue for females is highest in summer between the hatching and spawning periods.

Cpue data for each sex, for *Nephrops* above and below 35 mm CL, are shown in Figure B1.3. This size was chosen for all the Scottish stocks examined as the general size limit above which the effects of discarding practices and the addition of recruits were likely to be small. The data show a peak in cpue for smaller individuals in 1994 (and for females in 1995), with values declining to the longer term average until 2001. Since then, values have been increasing and reached a peak in 2006. The drop in 2007 may be associated with reduced recruitment and corresponds to the reduced UWTV densities (see report). The cpue for larger males show a similar pattern, although the cpue has increased further in 2007. Cpue for the larger females appears to be very stable, with small increases in the past two years.

Trawl and creel fisheries are sampled separately.

B.2. Biological

Mean weights-at-age for this stock are estimated from fixed Scottish weight–length relationships (Howard *et al.*, 1988, citation required). Relevant biological parameters are as follows: natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females.

Summary

Growth parameters:

Males; L_∞ = 70 mm, k = 0.16

Immature Females; L_∞ = 70 mm, k = 0.16

Mature Females; L_∞ = 60 mm, k = 0.06,

Size at maturity = 27 mm

Weight–length parameters:

Males a = 0.00028, b = 3.24

Females a= 0.00074, b = 2.91

Discards

Discard survival rate: 25%

Discard rate: 19.9%

Proportion of F and M prior to spawning was specified as zero to give estimates of spawning–stock biomass at January 1.

B.3. Surveys

Abundance indices are available from the following research-vessel surveys:

Underwater TV survey: years 1995–present. The survey usually occurs in June. The burrowing nature of *Nephrops*, and variable emergence rates mean that trawl catch rates may bear little resemblance to population abundance. An underwater TV survey has been developed, estimating *Nephrops* population abundance from burrow density raised to stock area. The survey provides a total abundance estimate, and is not age or length structured.

Because of this uncertainty in sediment distribution and suitability, the North Minch is divided into four arbitrary rectangles, roughly corresponding to discrete patches of mud in (or on the border of) the functional unit, for survey purposes (Figure B3.1). Samples are distributed randomly over the area of suitable sediment within each rectangle. In the assessment, burrow densities in the four rectangles are raised to the area of suitable sediment in each region.

A number of factors are suspected to contribute bias to the surveys. In order to use the survey abundance estimate as an absolute it is necessary to correct for these potential biases. The history of bias estimates are given in the following table and are based on simulation models, preliminary experimentation and expert opinion, the biases associated with the estimates of *Nephrops* abundance in the North Minch are:

	Time period	Edge effect	detection rate	species identification	occupancy	Cumulative bias
FU 11: North Minch	<=2009	1.38	0.85	1.1	1	1.33

B.4. Commercial cpue

Catch per unit of effort time-series are available from the following fleets:

Scottish *Nephrops* trawl gears: Landings at-age and effort data for Scottish *Nephrops* trawl gears are used to generate a cpue index. Cpue is estimated using officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for *Nephrops* single trawl and multiple *Nephrops* trawl is raised to landings reported by the four gears listed above. Discard sampling commenced in 1990 for this fishery, and for years prior to this, an average of the 1990 and 1991 values is applied. There is no account taken of any technological creep in the fleet.

For more information see Section B.1.

B.5. Other relevant data

C. Historical stock development

1) Survey indices are worked up annually resulting in the TV index.

2) Adjust index for bias (see Section B3). The combined effect of these biases is to be applied to the new survey index.

3) Generate mean weight in landings. Check the time-series of mean landing weights for evidence of a trend in the most recent period. If there is no firm evidence of a recent trend in mean weight use the average of the three most recent years. If, however, there is strong evidence of a recent trend then apply most recent value (don't attempt to extrapolate the trend further in future).

D. Short-term projection

1) The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and F_{MAX}. These values have been estimated by the Benchmark Workshop (see Section 9.2) and are to be revisited by subsequent benchmark groups. The values are FU specific and have been put in the Stock Annexes.

2) Create catch option table on the basis of a range of harvest ratios ranging from 0 to the maximum observed ratio or the ratio equating to F_{MAX}, whichever is the larger. Insert the harvest ratios from step 4 and also the current harvest ratio.

3) Multiply the survey index by the harvest ratios to give the number of total removals.

4) Create a landings number by applying a discard factor. This conversion factor has been estimated by the Benchmark Workshop and is to be revisited at subsequent benchmark groups. The value is FU specific and has been put in the Stock Annex.

5) Produce landings biomass by applying mean weight.

The suggested catch option table format is as follows.

	Implied fishery			
	Harvest rate	Survey Index	Retained number	Landings (tonnes)
	0%	12345	0	0.00
	2%	"	247	123.45
	4%	"	494	246.90
	6%	"	741	370.35
	8%	"	988	493.80
$F_{0.1}$	8.60%	"	1062	530.84
	10%	"	1235	617.25
	12%	"	1481	740.70
F_{MAX}	13.50%	"	1667	833.29
	14%	"	1728	864.15
	16%	"	1975	987.60
	18%	"	2222	1111.05
	20%	"	2469	1234.50
	22%	"	2716	1357.95
$F_{current}$	21.5%	"	2654	1327.09

E. Medium-term projections

None presented.

F. Long-term projections

None presented.

G. Biological reference points

Harvest ratios equating to fishing at $F_{0.1}$ and F_{MAX} were calculated in WK*Neph* (2009). These calculations assume that the TV survey has a knife-edge selectivity at 17 mm and that the supplied length–frequencies represented the population in equilibrium.

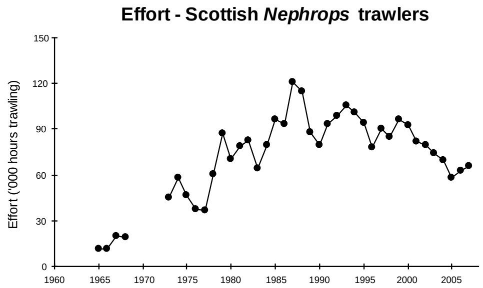
F-reference point	Harvest ratio
$F_{0.1}$	8.8%
F_{MAX}	15.4%

H. Other issues

I. References

Table B1.1. ***Nephrops*****, North Minch (FU 11): Landings (tonnes), effort ('000 hours trawling) and lpue (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981–2007 (data for all *Nephrops* gears combined, and for single and multirigs separately).**

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	2320	78.5	29.6	2320	78.5	29.6	na	na	na
1982	2323	82.4	28.2	2323	82.4	28.2	na	na	na
1983	2784	64.9	42.9	2784	64.9	42.9	na	na	na
1984	3449	79.3	43.5	3449	79.3	43.5	na	na	na
1985	3236	96.8	33.4	3236	96.8	33.4	na	na	na
1986	2642	93.2	28.4	2642	93.2	28.4	na	na	na
1987	3458	121.2	28.5	3458	121.2	28.5	na	na	na
1988	3449	115.0	30.0	3449	115.0	30.0	na	na	na
1989	2603	87.9	29.6	2603	87.9	29.6	na	na	na
1990	1941	79.8	24.3	1941	79.8	24.3	na	na	na
1991	2228	93.4	23.9	2123	90.5	23.5	105	2.9	36.7
1992	2978	99.4	30.0	2810	95.7	29.4	168	3.7	45.4
1993	2699	105.4	25.6	2657	104.4	25.4	42	1.0	43.4
1994	2916	100.8	28.9	2916	100.8	28.9	0	0.0	0.0
1995	2940	94.2	31.2	2937	94.1	31.2	3	0.1	60.0
1996	2355	78.0	30.2	2354	78.0	30.2	1	0.0	0.0
1997	2553	90.0	28.4	2510	88.8	28.3	43	1.2	35.8
1998	2023	84.9	23.8	1973	83.4	23.7	50	1.5	33.3
1999	2791	96.7	28.9	2750	95.5	28.8	41	1.2	34.2
2000	2695	92.6	29.1	2675	92.2	29.0	21	0.4	52.5
2001	2651	82.1	32.3	2599	80.9	32.1	51	1.2	43.3
2002	2775	79.3	35.0	2684	76.5	35.1	91	2.8	32.5
2003	2607	74.1	35.2	2589	73.9	35.0	17	0.2	85.0
2004	2400	69.7	34.4	2377	69.0	34.4	23	0.2	99.6
2005	2267	58.0	39.1	2241	57.7	38.8	26	0.2	114.5
2006	3446	62.4	55.2	3383	61.8	54.7	63	0.6	105.0
2007	3362	65.7	51.2	3304	65.4	50.5	58	0.3	193.3



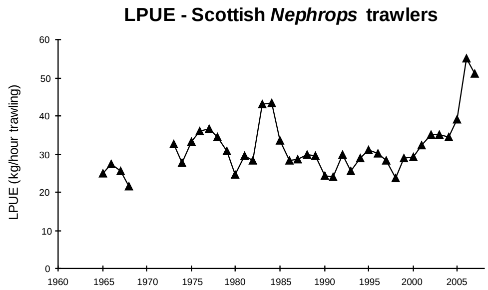


Figure B1.1. ***Nephrops*****. North Minch (FU11). Effort and lpue from Scottish *Nephrops* trawlers.**

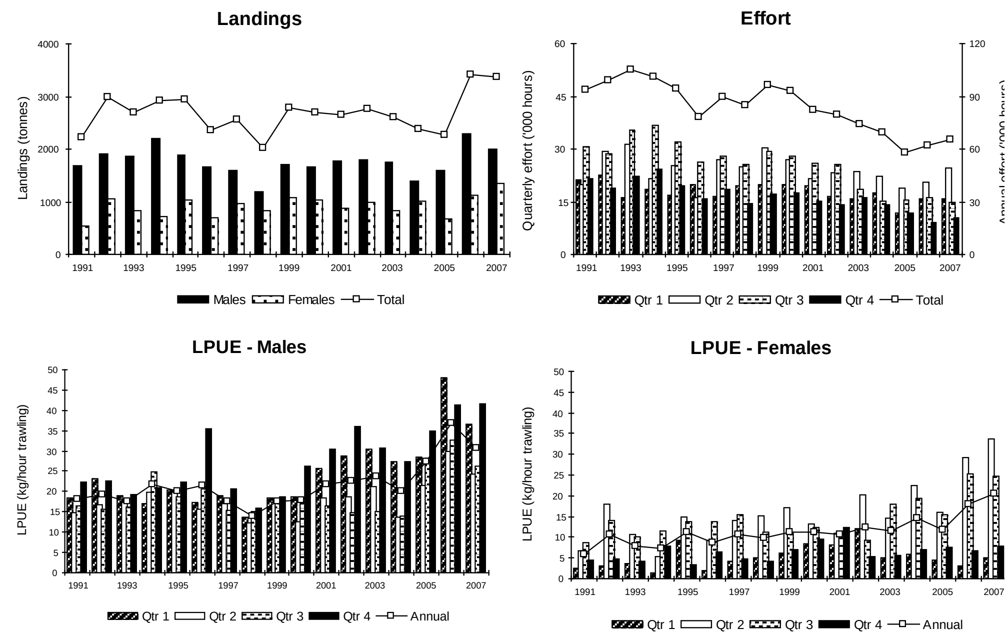


Figure B1.2. ***Nephrops*****. North Minch (FU11), Landings, effort and lpues by quarter and sex from Scottish *Nephrops* trawlers.**

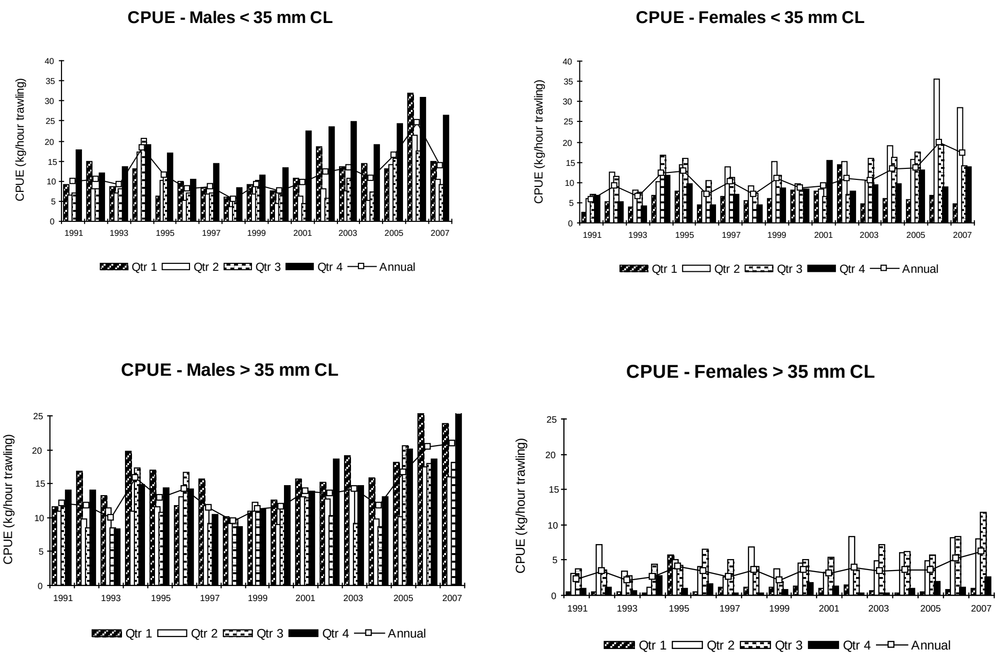


Figure B1.3. ***Nephrops*****, North Minch (FU11), cpues by sex and quarter for selected size groups, Scottish *Nephrops* trawlers.**

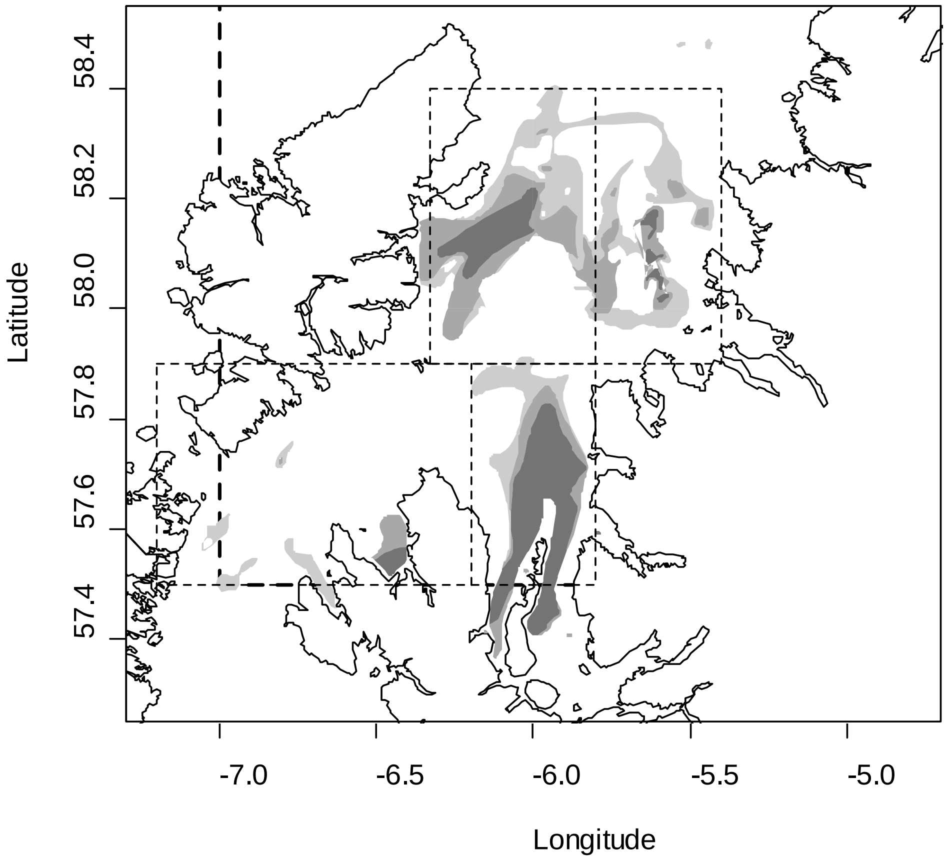


Figure B3.1. Distribution of *Nephrops* sediments in the North Minch. Thick dashed lines represent the boundary of the functional unit. Thin dashed lines represent the arbitrary rectangles used as survey strata. Sediments are: Dark grey – Mud; Grey – Sandy Mud, Light Grey – Muddy.

3.6 Stock Annex *Nephrops* FU12, South Minch

Stock specific documentation of standard assessment procedures used by ICES.

Stock	South Minch *Nephrops* (FU 12)
Date	09 March 2009 (WK*NEPH*2009)
Revised by	Sarah Clarke/Carlos Mesquita

A. General

A.1. Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 10–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small-scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the South Minch area the *Nephrops* stock inhabits a generally continuous area of muddy sediment extending from the south of Skye to the Stanton Bank, to the south of the Outer Hebrides. The South Minch functional unit (FU12) is located off the west coast of Scotland, and is bounded to the north and south by the 56°00′ and 57°30′ circles of latitude, and to the west by the 8°W meridian. Out with the functional unit, a mixed fishery for gadoids and *Nephrops* takes place on Stanton Bank, to the southwest of the Outer Hebrides.

A.2. Fishery

The South Minch *Nephrops* fishery is predominantly exploited by *Nephrops* trawlers, although about 15% of landings are made by creel vessels, which has increased in recent years. About 90% of trawler landings are made by vessels targeting *Nephrops*, and only 1% of landings are made by twin-rig vessels. Of the *Nephrops* trawlers, about 80% of landings are made with a 70 mm mesh.

All the creel vessels are local, and roughly half of the trawl landings are made by vessels based between Mallaig and Campbeltown. Visiting vessels originate in the North Minch (8% of landings) and the Scottish east coast. The east coast vessels tend to be larger than the local ones, and carry out longer trips. Mean engine power of the local vessels is 200 kW, and their mean length 15.0 m. Most vessels were built between the 1960s and the 1980s. The major landing ports are Oban and Mallaig. The smaller vessels usually have a trip duration of 1–3 days, while larger boats may stay out for 5–6 days.

The minimum landing size for *Nephrops* in the South Minch is 20 mm CL and less than 0.5% of animals are landed under size. Discarding takes place at sea and landings are made by category for whole animals (small and large) and as tails. The main bycatch species are whiting and haddock, with whiting in particular featuring heavily in discards. Of the non-commercial species caught, poor cod, Norway pout and long rough dab contribute significantly to the discards.

The fishery is exploited throughout the year, with the highest landings usually being made in spring and summer. A seasonal sprat fishery often develops in November and December, which is targeted by vessels of all sizes (including those that usually target *Nephrops*). Some vessels also turn to scallop dredging when *Nephrops* catches or prices drop, although the scope for this has been limited in recent years with ASP and PSP closures of the scallop fishery in some areas.

The current legislation governing *Nephrops* trawl fisheries on the West coast of Scotland was laid down by the North Sea and West of Scotland cod recovery plan (EC 2056/2001), which established measures additional to EC 850/98. This regulation was amended in 2003 by Annex XVII of EC 2341/2002, which establishes fishing effort and additional conditions for monitoring, inspection and surveillance for the recovery of certain cod stocks. This regulation effectively limits vessels targeting *Nephrops* with 70–99 mm mesh size to 25 days at sea per month. The use of square mesh and headline panels are compulsory in this fishery.

Additional Scottish legislation (SSI No 2000/226) applies to twin trawlers operating North of 56°N, A mesh size of 100 mm or above must be used without a lifting bag and with not more than 100 meshes round the circumference but with up to 5 mm double twine. By comparison, vessels using a single trawl may use 70–89 mm mesh with a lifting bag and 120 meshes round the codend but with 4 mm single twine.

A.3. Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

B. Data

B.1. Commercial catch

Length and sex compositions of *Nephrops* landed from the South Minch are estimated from port sampling in Scotland. Length data from Scottish sampling are applied to all catches and raised to total international landings. Rates of discarding by length class are estimated for Scottish fleets by on-board sampling, and extrapolated to all other fleets. The proportion of discarded to landed *Nephrops* changes with year, often determined by strong year classes. Discard sampling started in 1990, and for years prior to this estimates have been made based on later data. Landings and discards at length are combined (assuming a discard survival rate of 25%) to removals. The differences in catchability between sexes have lead to the two sexes being assessed separately. And hence removals are raised separately for each sex.

Reported *Nephrops* trawl effort in 2007 was similar to the four previous years, while total landings show a marked increase since 2006 (Figure B1.1), possibly as a result of more accurate reporting since the introduction of the "buyers and sellers" regulations in the UK in this year.

Reported effort by Scottish *Nephrops* trawlers showed a steady decline since 1990 to 2002 but has since stabilized (Figure B1.2 and Table B1.1). The reliability of these data (and the resulting lpue trends) is questionable since the logsheet recording of 'hours fished' is known to have been erratic in the past as it is a non-mandatory field on the logsheet. Scottish *Nephrops* trawler lpue remained stable between 1998 and 2001, but has shown an increase more recently; particularly over the last two years (2006 and 2007).

Males contribute more to the landings than females (Figure B1.2)., as in all other functional units. Effort is normally highest in the 2nd quarter in this fishery, and generally lowest in the 4th quarter. Male lpue has remained relatively stable over the time-series prior to 2006, but shows a marked increase in 2006 and 2007, possibly as a result of the aforementioned introduction of the "buyers and sellers" regulations.

Discarding of undersize and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discarding rates averaged over the period 2005 to 2007 for this stock were 21% by number or 12% by weight. This represents a decrease on the 2003 to 2005 period.

Cpue data for each sex, for *Nephrops* above and below 35 mm CL, are shown in Figure B1.3. This size was chosen for all the Scottish stocks examined as the general size limit above which the effects of discarding practices and the addition of recruits were likely to be small. The data show a peak in cpue for smaller individuals in 1995, with values declining to the longer term average after this, and a second rise in 2001 which has continued upwards to 2007. The higher values are particularly evident for males in the 1st and 4th quarters. The cpue for females over 35 mm has fluctuated without trend over the time period, and show consistently higher values in the 2nd and 3rd quarters of the year.

Trawl and creel fisheries are sampled separately.

B.2. Biological

Mean weights-at-age for this stock are estimated from fixed Scottish weight–length relationships (Howard *et al.*, 1988, citation required). Relevant biological parameters are as follows: natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females.

Summary

Growth parameters:

Males; L_∞ = 66 mm, k = 0.16

Immature Females; L_∞ = 66 mm, k = 0.16

Mature Females; L_∞ = 59 mm, k = 0.06,

Size at maturity = 25 mm

Weight–length parameters:

Males a = 0.00028, b = 3.24

Females a= 0.00074, b = 2.91

Discards

Discard survival rate: 25%

Discard rate: 16.7%

Proportion of F and M prior to spawning was specified as zero to give estimates of spawning–stock biomass at January 1.

B.3. Surveys

Abundance indices are available from the following research vessel surveys:

Underwater TV survey: years 1995–present. The survey usually occurs in June. The burrowing nature of *Nephrops*, and variable emergence rates mean that trawl catch rates may bear little resemblance to population abundance. An underwater TV survey has been developed, estimating *Nephrops* population abundance form burrow density raised to stock area. A random stratified sampling design is used, on the basis of British Geological Survey sediment strata. The survey provides a total abundance estimate, and is not age or length structured (Figure B3.1).

A number of factors are suspected to contribute bias to the surveys. In order to use the survey abundance estimate as an absolute it is necessary to correct for these potential biases. The history of bias estimates are given in the following table and are based on simulation models, preliminary experimentation and expert opinion, the biases associated with the estimates of *Nephrops* abundance in the South Minch are:

	Time period	Edge effect	detection rate	species identification	occupancy	Cumulative bias
FU 12: South Minch	<=2009	1.37	0.85	1.1	1	1.32

B.4. Commercial cpue

Landings per unit of effort time-series are available from: *Nephrops* single trawl, multiple *Nephrops* trawl, light trawl and multiple demersal trawl.

Scottish *Nephrops* trawl gears: Landings-at-age and effort data for Scottish *Nephrops* trawl gears are used to generate a cpue index. Cpue is estimated using officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for *Nephrops* single trawl and multiple *Nephrops* trawl is raised to landings reported by the four gears listed above. Discard sampling commenced in 1990 for this fishery, and for years prior to this, an average of the 1990 and 1991 values is applied. There is no account taken of any technological creep in the fleet.

For more information see Section B.1.

B.5. Other relevant data

C. Historical stock development

1) Survey indices are worked up annually resulting in the TV index.

2) Adjust index for bias (see Section B3). The combined effect of these biases is to be applied to the new survey index.

3) Generate mean weight in landings. Check the time-series of mean landing weights for evidence of a trend in the most recent period. If there is no firm evidence of a recent trend in mean weight use the average of the three most recent years. If, however, there is strong evidence of a recent trend then apply most recent value (don't attempt to extrapolate the trend further in future).

D. Short-term projection

1) The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and F_{MAX}. These values have been estimated by the Benchmark Workshop (see Section 9.2) and are to be revisited by subsequent benchmark groups. The values are FU specific and have been put in the Stock Annexes.

2) Create catch option table on the basis of a range of harvest ratios ranging from 0 to the maximum observed ratio or the ratio equating to F_{max}, which-

ever is the larger. Insert the harvest ratios from step 4 and also the current harvest ratio.

3) Multiply the survey index by the harvest ratios to give the number of total removals.

4) Create a landings number by applying a discard factor. This conversion factor has been estimated by the Benchmark Workshop and is to be revisited at subsequent benchmark groups. The value is FU specific and has been put in the Stock Annex.

5) Produce landings biomass by applying mean weight.

The suggested catch option table format is as follows.

			Implied fishery	
	Harvest rate	Survey Index	Retained number	Landings (tonnes)
	0%	12345	0	0.00
	2%	"	247	123.45
	4%	"	494	246.90
	6%	"	741	370.35
	8%	"	988	493.80
$F_{0.1}$	8.60%	"	1062	530.84
	10%	"	1235	617.25
	12%	"	1481	740.70
F_{MAX}	13.50%	"	1667	833.29
	14%	"	1728	864.15
	16%	"	1975	987.60
	18%	"	2222	1111.05
	20%	"	2469	1234.50
	22%	"	2716	1357.95
$F_{current}$	21.5%	"	2654	1327.09

E. Medium-term projections

None presented.

F. Long-term projections

None presented.

G. Biological reference points

Harvest ratios equating to fishing at $F_{0.1}$ and F_{MAX} were calculated in WK*Neph* (2009). These calculations assume that the TV survey has a knife-edge selectivity at 17 mm and that the supplied length frequencies represented the population in equilibrium.

F-reference point	Harvest ratio
$F_{0.1}$	9.6%
F_{MAX}	16.0%

Table B1.1. *Nephrops*. South Minch (FU 12).): Landings (tonnes), effort ('000 hours trawling) and lpue (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981–2007 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	2965	81.6	36.4	2965	81.6	36.4	na	na	na
1982	2925	93.1	31.4	2925	93.1	31.4	na	na	na
1983	2595	77.9	33.3	2595	77.9	33.3	na	na	na
1984	3228	93.4	34.6	3228	93.4	34.6	na	na	na
1985	3096	130.3	23.8	3096	130.3	23.8	na	na	na
1986	2694	105.8	25.5	2694	105.8	25.5	na	na	na
1987	2927	126.3	23.2	2927	126.3	23.2	na	na	na
1988	3544	120.9	29.3	3544	120.9	29.3	na	na	na
1989	3846	138.3	27.8	3846	138.3	27.8	na	na	na
1990	3732	153.5	24.3	3732	153.5	24.3	na	na	na
1991	3597	150.5	23.9	3109	134.6	23.1	488	15.8	30.8
1992	3479	127.3	27.3	3092	115.0	26.9	387	12.3	31.5
1993	3608	126.5	28.5	3441	122.5	28.1	167	4.0	41.5
1994	3743	144.4	25.9	3650	141.4	25.8	93	3.0	31.3
1995	3442	100.4	34.3	3407	99.6	34.2	35	0.9	39.8
1996	3108	106.4	29.2	3036	104.1	29.2	71	2.4	30.1
1997	3519	117.5	29.9	3345	112.1	29.8	174	5.4	32.0
1998	2851	101.4	28.1	2792	99.5	28.1	59	1.9	30.4
1999	3165	111.5	28.4	3111	109.3	28.5	54	2.2	24.6
2000	2939	106.2	27.7	2819	102.1	27.6	121	4.1	29.7
2001	2823	101.7	27.8	2764	99.8	27.7	59	1.9	30.8
2002	2234	75.7	29.5	2210	75.1	29.4	25	0.6	38.9
2003	2812	94.3	29.8	2716	93.5	29.0	96	0.8	113.9
2004	2865	89.8	31.9	2598	84.7	30.7	267	5.1	52.0
2005	2810	82.5	31.9	2566	79.3	32.4	244	3.2	76.8
2006	3569	93.3	38.3	3271	89.5	36.5	298	3.8	78.4
2007	4436	90.8	39.3	3820	83.1	46.0	616	7.7	80.0

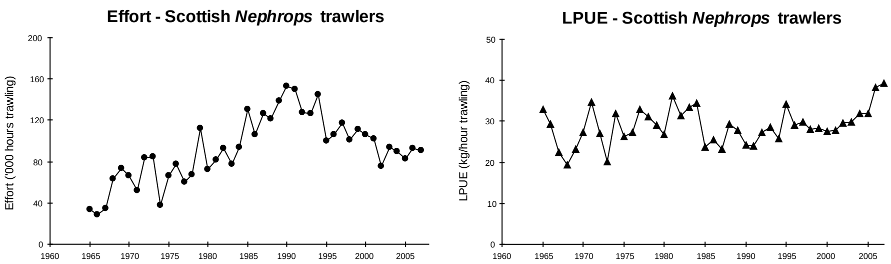


Figure B1.1. *Nephrops*, South Minch (FU12). Effort and lpue by Scottish *Nephrops* trawlers.

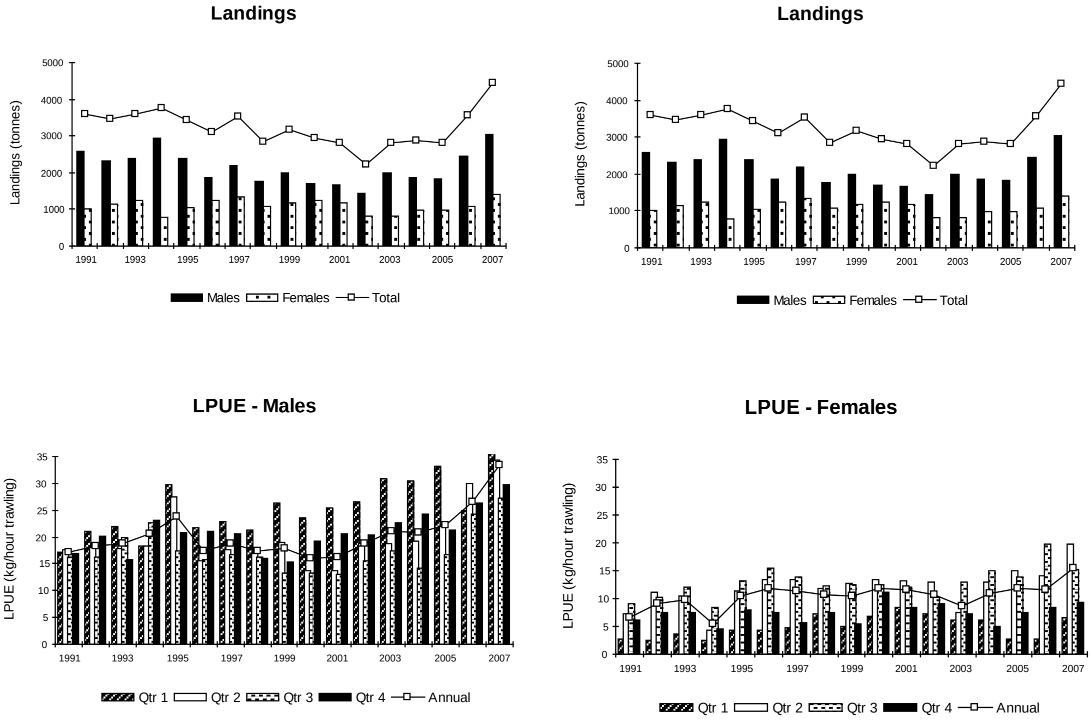


Figure B1.2. ***Nephrops*, South Minch (FU12), Landings, effort and lpues by quarter and sex from Scottish *Nephrops* trawlers.**

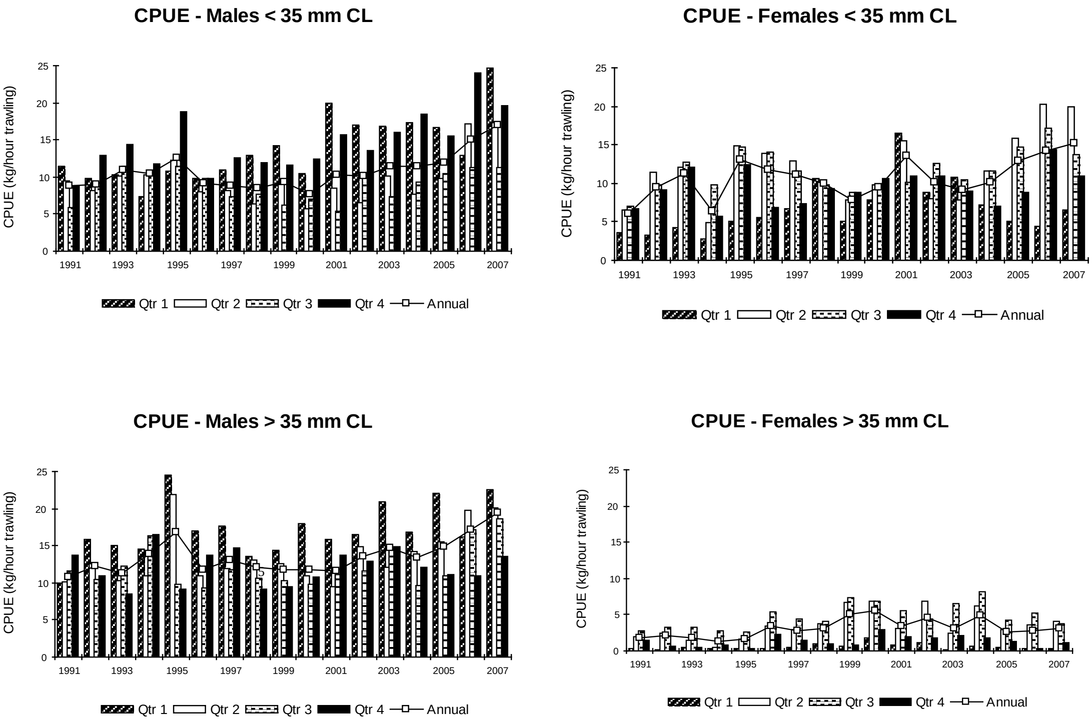


Figure B1.3. ***Nephrops*, South Minch (FU12), cpues by sex and quarter for selected size groups, Scottish *Nephrops* trawlers.**

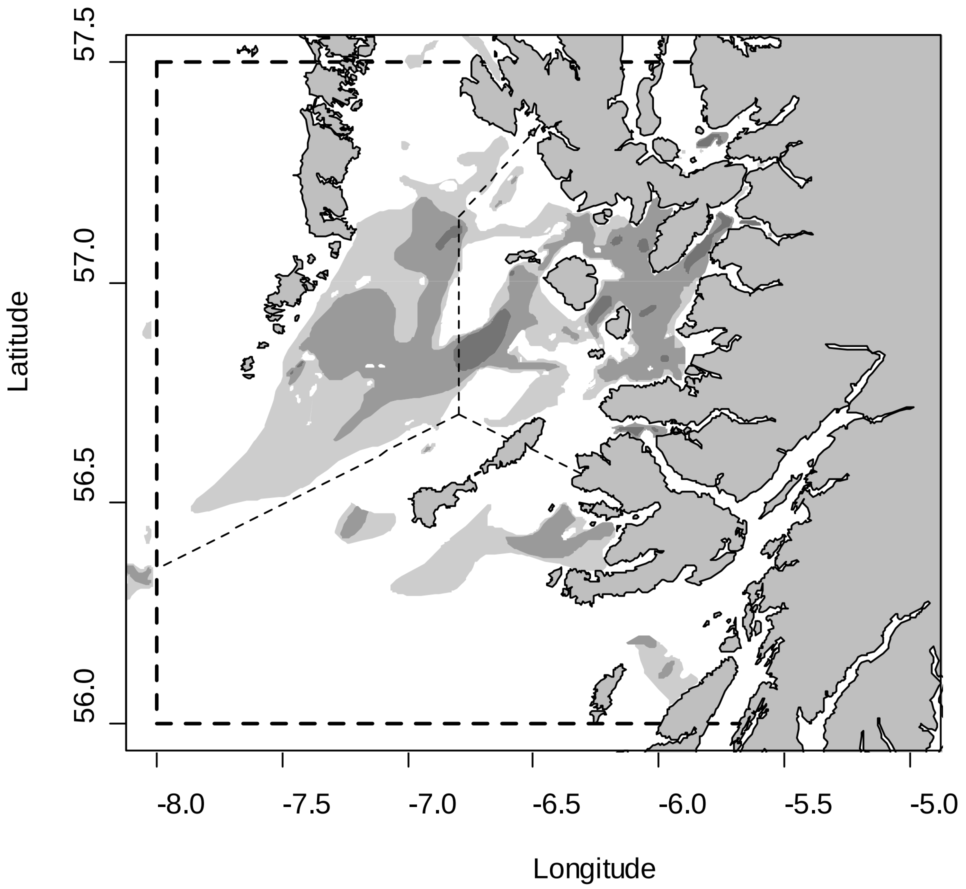


Figure B3.1. Sediment strata in the South Minch. Light Grey – Muddy sand, Grey – Sandy mud, Dark Grey – Mud. Light dashed lines represent spatial strata imposed on the sampling regime to ensure adequate spatial coverage.

3.7 Stock Annex *Nephrops* FU13, Clyde

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Clyde *Nephrops* (FU 13)
Date	09 March 2009
Revised by	Sarah Clarke/Carlos Mesquita

A. General

A.1. Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 10–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small-scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the Clyde area the *Nephrops* stock inhabits an area of muddy sediment extending throughout the Firth of Clyde, and another smaller area in the Sound of Jura, as shown in Figure B3.1. The two areas are separated by a large area of sandy gravely sediment around the Mull of Kintyre, and are treated as separate populations since they have differing population characteristics.

A.2. Fishery

Firth of Clyde

The Firth of Clyde *Nephrops* fishery is predominantly exploited by a dedicated *Nephrops* trawler fleet of approximately 120 vessels, with less than 2–3% of the landings made by creel vessels. The 90 resident Clyde trawlers make about 90% of the *Nephrops* landings. Under the Scottish 'Inshore Fishing Order' of 1989 (Prohibition of Fishing and Fishing Methods), fishing with mobile gear is prohibited within the Firth of Clyde over weekends, and with vessels >70 feet (about 21 m) in length.

The trawler fleet that fishes the Firth of Clyde mostly consists of vessels between 10 and 20 m in length (mean overall length 14 m), with a mean engine power of 185 kW. Almost half the fleet was built during the 1960s, with less than 20% built after 1979. Most vessels use single otter trawls with a 70 mm mesh codend, but just under a third of *Nephrops* landings are taken by vessels using twin-rig trawls with an 80 mm mesh codend. Vessels employing twin-rig gear are generally slightly more powerful than the single rig vessels (mean power 214 kW compared with 176 kW).

The regular fleet is comprised of Scottish vessels, but some catches are taken by Northern Ireland and Republic of Ireland vessels. The major landing ports are Troon, Campbeltown, Girvan and Tarbert, but smaller landings are also made at Carradale, Largs and Rothsay.

The minimum landing size for *Nephrops* in the Clyde is 20 mm CL. Compliance with the minimum landing size is good, with samples suggesting only a very small undersized component in the landings (< 0.5%).

Nephrops growth varies within the area, with low density animals growing to large sizes in the North, and with higher density animals reaching smaller sizes in the South. Far more *Nephrops* material (undersized individuals and 'heads' from tailed animals) is discarded in the South. Discarding usually takes place at sea and landings are made by category for whole animals (small, medium and large) and as tails. In poor weather or for the last haul of the day, discarding may take place within the harbour, thus increasing discard mortality.

Only a small fish bycatch is made in the Firth of Clyde, with whiting and cod being the most important species. The composition of the bycatch and discards varies within the Firth of Clyde, with more flatfish (common and long rough dab), echinoderms and crustaceans (other than *Nephrops*) caught in the North, while more roundfish (particularly whiting) are caught in the South. These differences reflect the different habitats and fish communities in the area.

The fishery is exploited throughout the year, with highest landings usually made between July and September. Vessels usually have a trip duration of one day, sailing to shoot before dawn, and carrying out 3–4 hauls of four hours per day.

Sound of Jura

The fishery for *Nephrops* in the Sound of Jura constitutes part of the Clyde FU, but is examined separately from the fishery within the Firth of Clyde, because of differences in the biological parameters of the *Nephrops* populations.

The fleet exploiting the Sound of Jura is also different from the Firth of Clyde, with vessels tending to be slightly smaller but more powerful. Most landings are taken by Scottish vessels (which are virtually all local to the area) with a very small proportion taken by boats from the rest of the UK. The local trawler fleet consists of vessels between 9 and 16 m in length, and with a mean engine power of 185 kW.

Just over half the landings are made by twin-rig *Nephrops* trawlers using 80 mm meshes, with most of the remainder landed by single rig vessels using 70 mm meshes. Vessels employing twin-rig gear are generally larger and more powerful than those using single rig trawls (15 m and 220 kW compared with 13 m and 160 kW). The main landing ports are Port Askaig, West Loch Tarbert and Crinan.

The minimum landing size for *Nephrops* in the Sound of Jura is 20 mm CL. *Nephrops* are found in high densities in this stock, but only grow to relatively small sizes. Discarding takes place at sea (this can be a large proportion of the catch by number, because of the small mean size of the animals caught), and landings are made by category for whole animals (small, medium and large) and as tails.

Catches of fish in the Sound of Jura area are generally poor, and *Nephrops* are clearly the target species, with only small bycatches of whitefish and flatfish.

The fishery is exploited throughout the year, with highest landings usually made between April and June. Vessels usually have a trip duration of one day, with 3–4 hauls per day.

For both areas the current legislation governing *Nephrops* trawl fisheries on the west coast of Scotland was laid down by the North Sea and West of Scotland cod recovery plan (EC 2056/2001), which established measures additional to EC 850/98. This regulation was amended in 2003 by Annex XVII of EC 2341/2002, which establishes fishing effort and additional conditions for monitoring, inspection and surveillance for the recovery of certain cod stocks. This regulation effectively limits vessels targeting *Nephrops* with 70–99 mm mesh size to 25 days at sea per month. The use of square mesh and headline panels are compulsory in this fishery. Additional UK legislation has also been applied in the southern areas of the Firth of Clyde in recent years, aimed at protecting the aggregating cod in the south of the Clyde during February, March and April.

A.3. Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

B. Data

B.1. Commercial catch

Length and sex compositions of *Nephrops* landed from the Firth of Clyde are estimated from port sampling in Scotland. Length data from Scottish sampling are applied to all catches and raised to total international landings. Rates of discarding by length class are estimated for Scottish fleets by on-board sampling, and extrapolated to all other fleets. The proportion of discarded to landed *Nephrops* changes with year, often determined by strong year classes. Discard sampling started in 1990, and for years prior to this estimates have been made based on later data. Landings and discards at length are combined (assuming a discard survival rate of 25%) to removals. Due to differences in catchability between sexes removals are raised separately for each sex.

Reported effort has declined from high levels in the mid 1990s until 2004, but has shown an increase since then (Figure B1.1). Landings also declined, to a lesser extent, over this time period and show a sharp increase over the past two years. Scottish *Nephrops* trawler lpue has increased markedly since 2001 (Figure B1.1 and Table B1.1). However this may be more of an artefact due to improved reporting of landings data due to the introduction of the buyers and sellers regulations in the UK in 2006. In addition, logsheet recording of 'hours fished' is known to be erratic as it is a non-mandatory field on the logsheet It is therefore not clear whether the observed inter-annual trends described below are actually indicative of real trends in lpue.

Males contribute more to the landings than females. Effort has previously been highest in the 3rd quarter in this fishery, but has become far more even through the year as the overall level of effort has declined (Figure B1.2). Male lpue showed an increase in 1995, to a relatively stable level, then a further increase between 2001 and 2005. It has increased again in 2006 and remains high in 2007 particularly in the first and fourth quarters. Female lpue is lower than that for males, but shows similar increases after 1995 and 2001; the highest rates are obtained in the second and third quarters.

Cpue data for each sex, for *Nephrops* above and below 35 mm CL, are shown in Figure B1.3. This size was chosen for all the Scottish stocks examined as the general size limit above which the effects of discarding practices and the addition of recruits were likely to be small. For both sexes the data show a series of increases in cpue for smaller individuals in 1995, 2003 and 2007 The cpue for larger males remained relatively stable prior to 2003, fell to a slightly lower level in 2005, then increased markedly in 2006; remaining high but falling in 2007. Cpue for the larger females has fluctuated around a stable level for the entire time-series, showing significantly higher values in the second quarter. These trends, are however, effected by the recent improvements in the reliability of catch data and erratic effort recording and are therefore difficult to interpret reliably.

B.2. Biological

Mean weights-at-age for this stock are estimated from fixed Scottish weight–length relationships (Howard *et al.*, 1988, citation required). Relevant biological parameters are as follows: natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females.

Summary

Growth parameters:

Males; L_∞ = 73 mm, k = 0.16

Immature Females; L_∞ = 73 mm, k = 0.16

Mature Females; L_∞ = 60 mm, k = 0.06,

Size at maturity = 25 mm

Weight–length parameters:

Males a = 0.00028, b = 3.24

Females a= 0.00074, b = 2.91

Discards

Discard survival rate: 25%

Discard rate: 18.6%

Proportion of F and M prior to spawning was specified as zero to give estimates of spawning–stock biomass at January 1.

B.3. Surveys

The burrowing nature of *Nephrops*, and variable emergence rates mean that trawl catch rates may bear little resemblance to population abundance. An underwater TV survey has been developed, estimating *Nephrops* population abundance from burrow density raised to stock area. A random stratified sampling design is used on the basis of British Geological Survey sediment strata and latitude (Tuck *et al.*, 1999/ see Figure B3.1). The survey provides a total abundance estimate, and is not age or length structured. A series of annual underwater TV surveys are available since 1995 for the Firth of Clyde and Sound of Jura. Whereas the survey in the Clyde has been continuous, the TV survey for the Sound of Jura was not conducted from 1997 to 2000, and again in 2004. Such large gaps in the series make interpretation of any trends from the data difficult. The number of valid stations in the survey has remained relatively stable throughout the time period. An average of 36 stations have been sampled in each year, then raised to a stock area of 2062.2 km^2 for the Firth of Clyde, and an average of ten stations have been considered valid each year for the Sound of Jura. Confidence intervals around the abundance estimates have remained relatively stable through the time period.

A number of factors are suspected to contribute bias to the surveys. In order to use the survey abundance estimate as an absolute it is necessary to correct for these potential biases. The history of bias estimates are given in the following table and are based on simulation models, preliminary experimentation and expert opinion, the biases associated with the estimates of *Nephrops* abundance in the Fladen are:

	Time period	Edge effect	detection rate	species identification	occupancy	Cumulative bias
FU 13: Clyde	<=2009	1.19	0.75	1.25	1	1.19

B.4. Commercial cpue

Landings per unit of effort time-series are available from the following fleets: *Nephrops* single trawl, multiple *Nephrops* trawl, light trawl and multiple demersal trawl.

Scottish *Nephrops* trawl gears: Landings-at-age and effort data for Scottish *Nephrops* trawl gears are used to generate a cpue index. Cpue is estimated using officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for *Nephrops* single trawl and multiple *Nephrops* trawl is raised to landings reported by the four gears listed above. Discard sampling commenced in 1990 for this fishery, and for years prior to this, an average of the 1990 and 1991 values is applied. There is no account taken of any technological creep in the fleet.

More information is contained in Section B.1.

B.5. Other relevant data

C. Historical stock development

1) Survey indices are worked up annually resulting in the TV index.

2) Adjust index for bias (see Section B3). The combined effect of these biases is to be applied to the new survey index.

3) Generate mean weight in landings. Check the time-series of mean landing weights for evidence of a trend in the most recent period. If there is no firm evidence of a recent trend in mean weight use the average of the three most recent years. If, however, there is strong evidence of a recent trend then apply most recent value (don't attempt to extrapolate the trend further in future).

D. Short-term projection

1) The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and F_{MAX}. These values have been estimated by the Benchmark Workshop (see Section 9.2) and are to be revisited by subsequent benchmark groups. The values are FU specific and have been put in the Stock Annexes.

2) Create catch option table on the basis of a range of harvest ratios ranging from 0 to the maximum observed ratio or the ratio equating to F_{MAX}, whichever is the larger. Insert the harvest ratios from step 4 and also the current harvest ratio.

3) Multiply the survey index by the harvest ratios to give the number of total removals.

4) Create a landings number by applying a discard factor. This conversion factor has been estimated by the Benchmark Workshop and is to be revisited at subsequent benchmark groups. The value is FU specific and has been put in the Stock Annex.

5) Produce landings biomass by applying mean weight.

The suggested catch option table format is as follows.

			Implied fishery	
	Harvest rate	Survey Index	Retained number	Landings (tonnes)
	0%	12345	0	0.00
	2%	"	247	123.45
	4%	"	494	246.90
	6%	"	741	370.35
	8%	"	988	493.80
$F_{0.1}$	8.60%	"	1062	530.84
	10%	"	1235	617.25
	12%	"	1481	740.70
F_{MAX}	13.50%	"	1667	833.29
	14%	"	1728	864.15
	16%	"	1975	987.60
	18%	"	2222	1111.05
	20%	"	2469	1234.50
	22%	"	2716	1357.95
$F_{current}$	21.5%	"	2654	1327.09

E. Medium-term projections

None presented.

F. Long-term projections

None presented.

G. Biological reference points

Harvest ratios equating to fishing at $F_{0.1}$ and F_{MAX} were calculated in WK*Neph* (2009). These calculations assume that the TV survey has a knife-edge selectivity at 17 mm and that the supplied length frequencies represented the population in equilibrium.

F-reference point	Harvest ratio
$F_{0.1}$	8.7%
F_{MAX}	15.1%

H. Other issues

I. References

Table B1.1. ***Nephrops*****, Firth of Clyde (FU 13): Landings (tonnes), effort ('000 hours trawling) and lpue (kg/hour trawling) of Scottish** ***Nephrops*** **trawlers, 1981–2007 (data for all** ***Nephrops*** **gears combined, and for single and multirigs separately).**

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	1861	108.8	17.1	1861	70.5	26.4	na	na	na
1982	1798	93.1	19.3	1798	148.0	12.1	na	na	na
1983	3258	131.9	24.7	3258	108.8	29.9	na	na	na
1984	2433	122.5	19.9	2433	93.1	26.1	na	na	na
1985	3154	131.6	24.0	3154	131.9	23.9	na	na	na
1986	2745	141.5	19.4	2745	122.5	22.4	na	na	na
1987	2126	126.8	16.8	2126	131.6	16.2	na	na	na
1988	3190	141.6	22.5	3190	141.5	22.5	na	na	na
1989	2393	144.3	16.6	2393	126.8	18.9	na	na	na
1990	2435	142.8	17.0	2435	141.6	17.2	na	na	na
1991	2489	152.9	16.3	1594	144.3	11.0	895	39.5	22.7
1992	2091	144.6	14.5	1316	142.8	9.2	775	42.4	18.3
1993	2650	156.8	16.9	1771	113.5	15.6	879	43.1	20.4
1994	1996	118.0	16.9	1484	102.2	14.5	512	27.6	18.6
1995	3501	133.8	26.2	2583	113.7	22.7	918	31.5	29.1
1996	3530	150.1	23.5	2474	90.4	27.4	1048	38.1	27.5
1997	3020	131.9	22.9	2158	98.0	22.0	861	33.9	25.4
1998	4107	150.8	27.2	2964	110.2	26.9	1142	40.5	28.2
1999	3175	117.2	27.1	2322	86.3	26.9	853	30.9	27.6
2000	2980	124.4	24.0	2100	90.9	23.1	880	33.5	26.3
2001	2711	111.6	24.3	2445	100.2	24.4	266	11.4	23.3
2002	3043	99.6	30.6	2896	94.0	30.8	147	5.6	26.3
2003	2937	84.2	34.9	2839	81.2	35.0	97	3.0	32.3
2004	2611	72.3	36.1	2531	69.6	36.4	80	2.7	29.6
2005	3133	79.8	39.3	3108	78.7	39.5	25	1.1	23.8
2006	4356	87.1	50.0	4348	85.4	50.9	8	1.7	4.7
2007	6069	113	53.7	6055	99	61.2	14	1.6	8.8

* provisional   na = not available, landings not recorded to Multirig trawl before 1991.

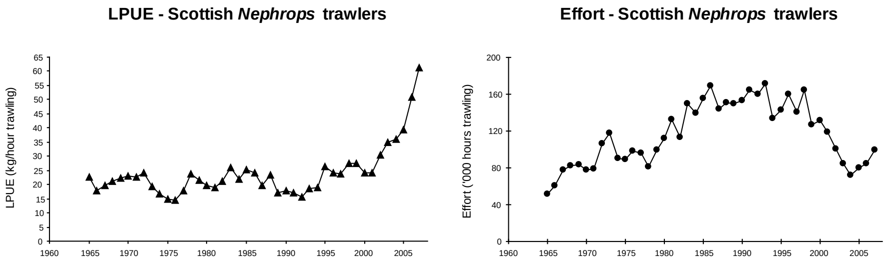


Figure B1.1. ***Nephrops*****, Firth of Clyde (FU13), Effort and lpue for Scottish** ***Nephrops*** **trawlers.**

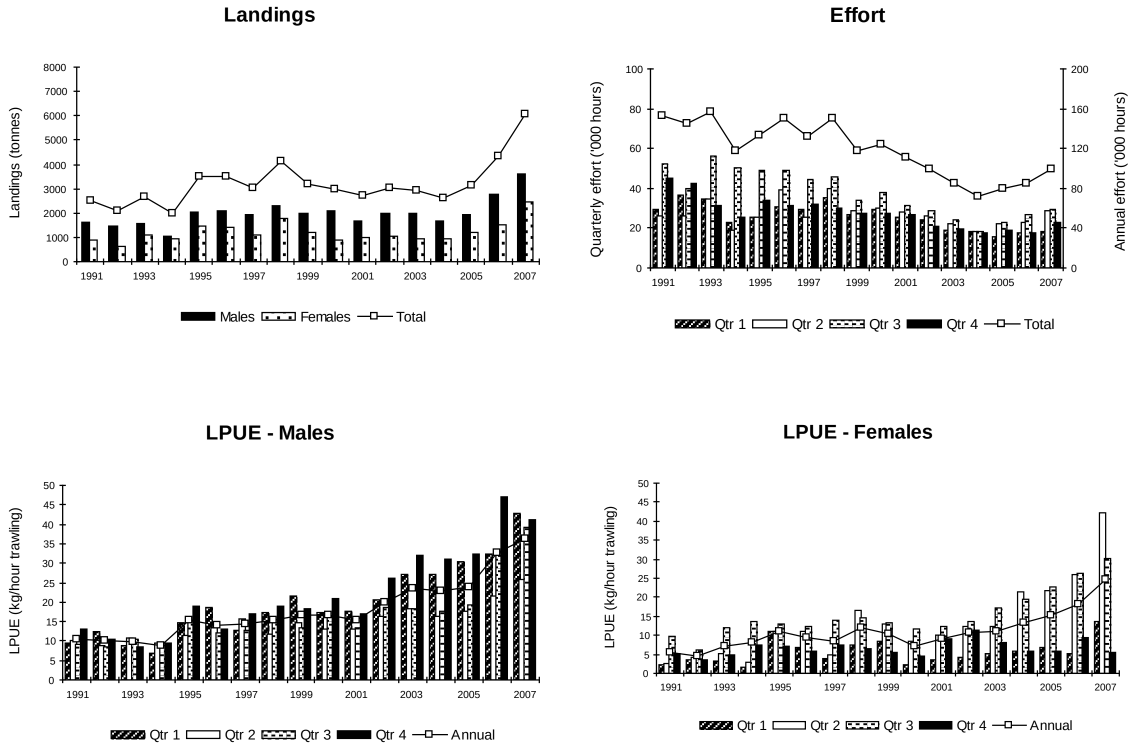


Figure B1.2. ***Nephrops*****, Firth of Clyde (FU13), Landings, effort and lpues by quarter and sex from Scottish** ***Nephrops*** **trawlers.**

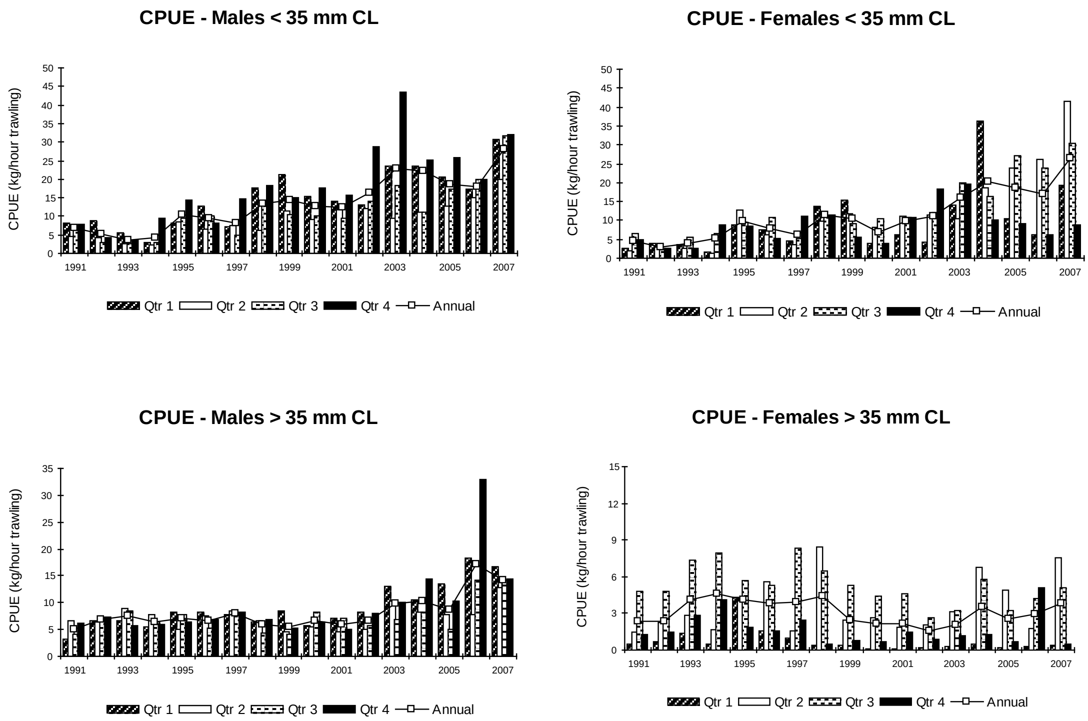


Figure B1.3. ***Nephrops*****, Firth of Clyde (FU13), cpues by sex and quarter for selected size groups, Scottish** ***Nephrops*** **trawlers.**

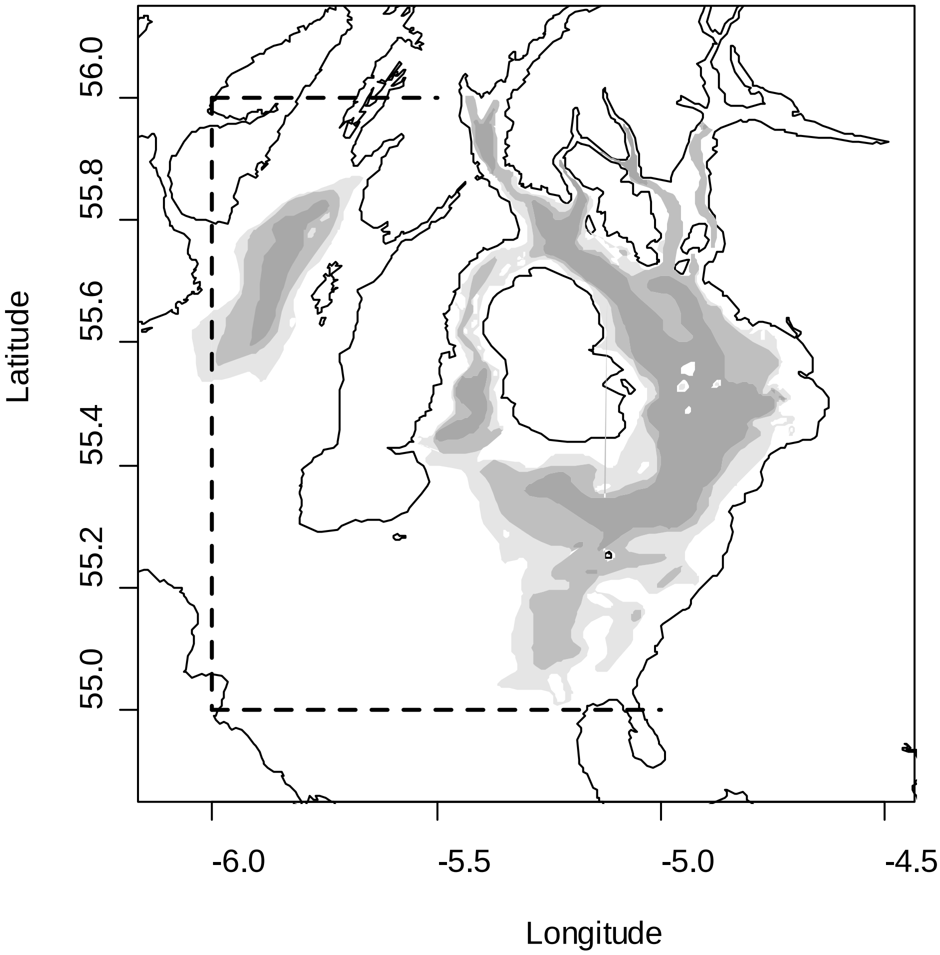


Figure B3.4. Distribution of suitable sediments in Clyde. Light grey - muddy sand; medium grey - sandy mud; dark grey - mud.

4.3 Stock Annex Haddock in Division VIb

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Haddock in Division VIb
Working Group	WGCSE
Date	20 May 2012
Revised by	Vladimir Khlivnoy

A. General

A.1. Stock definition

The haddock stock at Rockall is an entirely separate stock from that on the continental shelf of the British Isles (Chuksin and Gerber, 1976; Shestov, 1977; Blacker, 1982; Newton *et al*., 2008). The TAC for haddock VIb was previously (before 2004) set for Subarea Vb, VI, XII and XIV combined, with a limitation on the amount to be taken in Vb and VIa. In 2004, the TAC for Division VI was split and the VIb TAC for haddock was included with Divisions XII and XIV. This combined TAC has been in place since then.

A.2. Fishery

The development of the Rockall haddock fishery is documented in the 2001 Working Group Report (ICES-WGNSDS, 2001) and in the Report of the ICES group meeting on Rockall haddock convened in January 2001 (ICES, WGNSDS, 2002). That meeting was set up to respond to a NEAFC request for information on the Rockall haddock fishery. NEAFC agreed to consider regulation of the international fishery in 2001.

The Rockall haddock fishery changed markedly in 1999 when a revision of the EU EEZ placed the southwestern part of the Rockall plateau in international waters. This has opened opportunities for other nations, notably Russia, to exploit the fishery in this area. The table of official statistics includes Russian catches from the Rockall area.

The Russian fleet started fishing operations in international waters at Rockall in May–October 1999. The Russian haddock fishery uses bottom trawls with codend mesh size of 40–100 mm (mainly 40–70 mm) and retains haddock of all length classes in the catch. This fishery targets concentrations of haddock mainly during spring and the beginning of summer. Russian catches increased from 458 t in 1999 to 2154 t in 2000. In 2001, they were markedly reduced to 630 t due to the introduction of a closed area and low density of fish concentrations. Russian catches increased again in 2002–2004 from 1630 to 5844 t. In 2005–2007, they decreased from 4708 t to 1282 t, and are estimated to be 1669 t in 2008.

Prior to 1999, the UK and Ireland fisheries had been principally summer fisheries but in more recent years the Scottish and Irish fishery was conducted throughout the year with the peak in April–May. This shift in the fishery appears to have followed the discovery of concentrations of haddock in deeper water to the west of Rockall, at depths between 200 and 400 m. High catch rates attracted effort into the area. However, catch rates in 2000 were reported to be poor in deeper water. Anecdotal evidence suggests that increased discarding has been associated with the deeper-water fishery compared with the traditional fishery at northern Rockall. In 2004–2007, a considerable proportion of EU landings were taken in the international waters. Historical fishing patterns of the Scottish fleet at Rockall are presented by Newton *et al.* (2004).

There are some indications that, due to a general decline in catches by the Scottish and Irish fleets in Division VIa, there is an increasing focus in the Rockall fishery in Division VIb (ICES, WGFTFB, 2007). Paired gear (both seine and trawl) are to be tested by some Scottish fishermen, which, if it proves successful, can lead to a considerable increase in effective effort in VIb. The fishery at Rockall seems particularly attractive given the lack of effort restrictions in this area.

Information on the Russian fishery and biological investigations from commercial vessels fishing in Rockall during 2008 are presented in WD11 to WGCSE 2009.

An analysis of the spatial and depth distributions of Rockall haddock in association with oceanographic variables is presented by Vinnichenko and Sentyabov (2004), a WD to WGNSDS 2004. Changes in distribution have occurred over a period coincidental with changes in oceanographic variables. Information on oceanographic conditions on Rockall bank in spring 2005 was presented by Sentyabov at WGNSDS 2005.

A.3. Ecosystem aspects

In May 2001, the International Waters component of statistical rectangle 42D5, which is mainly at depths less than 200 m, was closed by NEAFC to all fishing activities, except with longlines. That area had the following coordinates:

Latitude	Longitude
57.000°N	15.000°W
57.000°N	14.700°W
56.575°N	14.327°W
56.500°N	14.450°W
56.500°N	15.000°W

In spring 2002, the EU component of this rectangle, again mostly shallow water, was also closed to trawling activities (EC No 2287/2003). The whole Rockall Haddock Box is bounded by the following coordinates:

Latitude	Longitude
57°00′N	15°00′W
57°00′N	14°00′W
56°30′N	14°00′W
56°30′N	15°00′W

At the 25th Annual Meeting of NEAFC (in November 2006), a closure of three areas on the Rockall Bank to bottom fishery was proposed to protect cold-water corals: Northwest Rockall, Logachev Mounds and West Rockall Mounds (NEAFC AM, 2006). This measure will be in force for the period January 2007–December 2009.

In 2007, ICES prepared advice for NEAFC and arrived at the conclusion about the expediency of establishing a new closed area on the so-called Empress of British Banks and adjusting the boundaries of the currently closed area of Northwest Rockall. At the 26th Annual Meeting of NEAFC (in November 2007), a new closed area (Empress of British Banks) was established, and the boundaries of the Northwest Rockall closure were slightly modified (NEAFC AM, 2007). Due to the complex shape of the boundaries of the Northwest Rockall closure proposed by ICES, which potentially could cause problems with enforcement, the introduced changes differed from the ICES recommendation. NEAFC also requested ICES to continue providing all available new information on distribution of vulnerable habitats in the NEAFC Convention Area and fisheries activities in and in the vicinity of such habitats.

WGDEC supported the ICES conclusion on the necessity of revising the boundaries of the Northwest Rockall area established to protect cold-water corals and recommended to consider proposals at the WGNSDS meeting. These recent proposals greatly simplify the boundaries, which would create better conditions for enforcement (see WD8 to WGNSDS, 2008).

B. Data

B.1. Commercial catch

Landings

Nominal landings as reported to ICES are given in Table 4.3.1 of the main Report, along with Working Group estimates of total estimated landings. Reported international landings of Rockall haddock in 1991–2005 were about 4000–6000 t, except for 2001–2002, when they decreased down to about 2300–3000 t. In 2006, they were also low at 2760 t, but increased slightly to 3348 in 2007, and 4221 t in 2008. 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 an estimation of overall magnitude is not possible.

Age composition and mean weight-by-age of Scottish and Irish landings were obtained from port sampling. Data on the volume, length–age and weight composition of landings for the period from 1988 to 1998 correspond to values used at this WG.

In 2002, there was no sampling of the Russian catch and therefore the length composition has to be estimated for this year.

In 2002 and 2003, the structure of the Russian fishery on the Rockall Bank was the same: the same vessels were operating with the same gear in the same fishing areas. The relationship between the haddock length composition obtained from the trawl survey and that in the Russian catches is assumed to be the same for 2002 and 2003; i.e. it is assumed that the length dependent selectivity pattern in 2002 is the same as that in 2003 as there no changes to the fishery in these years. The relationship is described as:

$$P_L = S_L p_L \qquad (1)$$

where P_L is the proportion of fish with length L in catches, p_L is proportion of fish with length L in the stock (survey), and S_L is the proportion of fish of length L taken aboard. S_L is determined using a theoretical selectivity curve (Stock Annex, Figure 4.3.2) which may be described by the following formula:

$$S_L = \frac{1}{1+\exp(S_1 - S_2 L)}. \qquad (2)$$

where SL is the proportion of fish of size L taken aboard, L is the size group, S1 and S2 are coefficients.

The selectivity curve (Stock Annex, Figure 4.3.2), fitted to the data on catch measurements in different periods of the Russian fishery in 2003 is described well by Equation

2 with coefficients S1 = 12.539 and S2 = 0.4951. The estimated length–frequency distributions for 2003 are compared with the measured length–frequency distributions for this year in Stock Annex, Figure 4.3.2. The size distribution in the Russian catch in 2002 is then estimated by applying the theoretical selectivity curve to the survey length frequency in 2002.

To determine the age composition in Russian catches in 2002, the combined age–length key for all years of Russian catches was used.

Discards

The haddock catch estimated by landings is underestimated as a result of unaccounted discarding of small individuals in the Scottish and Irish fisheries in most years. On Russian vessels, the whole catch of haddock is retained on board and therefore, total catch is equivalent to landings.

Haddock discards on board Scottish vessels in 1999 and 2001 and Irish vessels in 1995, 1997, 1998, 2000 and 2001 were determined directly. In other years, indirect estimates of discarding were calculated.

The direct estimates from the Scottish trawlers in 1985, 1999 and 2001 showed a larger proportion of discards of small haddock: from 12 to 75% by weight (Table 4.3.1) and up to 80–90% of catch numbers. Discard trips in 1995, 1997, 1998, 2000 and 2001 showed that discarding by Irish fishing vessels also reaches considerable values (Table 4.3.2). Discard trips in 1995, 1997, 1998, 2000 and 2001 showed that discarding by Irish fishing vessels is variable with a mean rate of 30% (Table 4.3.2).

Discard data were also obtained by Irish scientists from discard trips in 2007–2009 and 2011. They showed that 52, 87 and 63% of the catch in numbers, respectively, was discarded. The range of discarded sizes was 19–43 cm (mean 30 cm). In 2011 the discards are significantly reduced as a result of the small number of young haddock in the population. (Table 4.3.2 of main report). It should be noted that these estimates are based on very few trips (one, two and three for 2007, 2008 and 2009 respectively) and should therefore be treated with caution.

Total numbers and weight landed and discarded by age on the Scottish observer trips in 1999 and 2001 are presented in Stock Annex, Tables 4.3.3 and 4.34.

The analysis of the discard data collected by Scottish scientists in 1999 and 2001 indicated that only a relatively small proportion of fish taken aboard is landed (Stock annex Figure 4.2.3). The probability of being retained increases with increasing fish length (Stratoudakis *et al.*, 1999; Palsson *et al.*, 2002; Palsson, 2003; Sokolov, 2003). The relationship between the number of individuals caught and number discarded may be described by the following relationship:

$$ND_L = PD_L \times NP_L \qquad (3)$$

where ND_L is the number of discarded fish with length L, NP_L is the number of fish caught at length L, PD_L is the portion of discarded fish at length L.

The length composition of fish taken on board by Scottish and Irish trawlers was calculated by applying the logistic selectivity curve (Stock Annex, Figure 4.3.4) to the haddock stock length composition obtained from the survey. The selectivity parameters were calculated from Scottish and Irish catches taken by trawls with mesh size that are typical for the fleets of those countries operating at Rockall. The parameters were calculated as S_1 = 12.608 and S_2 = 0.4360 for the Scottish fleet. S_1 = 26.248 and S_2 = 0.8524 were used for Irish catches.

The catch-at-length compositions obtained by the theoretical curve of selectivity agree well with available results of catch measurements in 1999 and 2001and the distributions are compared in Stock Annex, Figure 4.3.5.

The proportion of fish discarded from catches at different sizes may be determined and modelled using a logistic curve (Stock Annex, Figure 4.3.6) described by the following equation:

$$PD_L = \frac{1}{1 + \exp(-b(L - DL_{50}))} \tag{4}$$

where L is size group, DL_{50} is the fish length at which 50% of this size fish caught are discarded and b is a constant reflecting the angle of curve slope. The parameters were determined from research on discards by Scottish vessels (Stock Annex, Table 4.3.5). The following values were used in subsequent calculations: $DL_{50} = 34.66$ cm, $b = -0.8764$. The logistic curve of discards may be found using Equation 2 and the coefficient values: $S_1 = -15.494$ and $S_2 = -0.4565$.

To determine abundance of discards the following procedure was used:

a) A theoretical catch-at-length distribution (%) was calculated by applying the theoretical selectivity curve to the survey length composition.

b) An estimate of total catch-at-length was made by summing the reported landings-by-length to the number of discards-at-length calculated from the assumed discard ogive and the landings-at-length data.

c) An intermediate theoretical catch size distribution in numbers is calculated by dividing the estimate of the total numbers retained (numbers greater than 34 cm) in B by the fraction retained from the theoretical catch length distribution calculated in a).

d) Theoretical discard size frequency is then calculated by applying the theoretical discard ogive to the intermediate theoretical catch size distribution.

The spreadsheet containing these calculations can be found in the stock file.

Calculations where the discard curve was applied agree well with the results of size composition measurements by Scottish vessels in 1999 and 2001 (Stock Annex, Figure 4.3.7).

Aboard Irish vessels, larger fish are retained (Stock Annex, Figure 4.3.8). The portion of discards was calculated using Equation 2 with coefficients $S_1 = -10.093$ and $S_2 = -0.2459$, from the combined 1995–2002 Irish discard trips.

The Russian fleet fish in the areas covered only partially by the bottom-trawl surveys. However, Russian vessels retain all haddock and therefore there is no need to calculate discards. There is no information on large-scale fisheries of other countries outside the surveyed area. In addition, available data on the real length composition of catches indicate a correspondence between length composition obtained by the results from surveys and commercial catches, including the catches obtained in the parts of Russian fishery (Stock Annex, Figures 4.3.2 and 4.3.6).

The amount of discarded haddock by age was determined using a length–age key derived by the data collected during the trawl survey allowing for selectivity of the fishery (Stock Annex, Figure 4.3.3).

In 1998 and 2000, the trawl survey for haddock in the Rockall Bank area was not carried out. To determine the haddock length composition in these years, the length distribution was calculated from the survey data in the previous and following years.

For this purpose, the length–age matrices characterizing the stock status in the years before and after the missing data year were obtained. The length–age distribution from the year before the missing year was projected forward on the basis of mean growth increment at-age and estimated total mortality. Similarly the distribution from the year after was projected backwards. The length composition in the missing year was then calculated from these two estimates.

The total loss (Z) used in the calculation described above was determined by minimization of values of deviation square sum between survey age-group abundance values in previous and following years by the data from surveys and calculated data. At that, the factor of age effect (S_a) was taken into account. The mean growth increment at-age was also estimated from the survey data. The method of calculation is explained further in WD8 to WGNSD 2004 and a spreadsheet showing the calculations is in the stock file.

B.2. Biological

Age composition and mean weight-at-age of Scottish and Irish landings were obtained from port sampling.

Age composition and mean weight-at-age of Russian landings were obtained by observers on board commercial fishing vessels. In 2002, there was no sampling of the Russian catch and therefore the length composition for that year had to be estimated (for estimation details, see Stock Annex). Observer data from commercial vessels are also available for Norwegian landings for 2006–2008.

In the absence of any direct estimates of natural mortality, M has been set at 0.2 for all ages and years.

Natural mortality coefficient and portion of mature individuals by age used for estimation correspond to those adopted by Working Group before.

Previous Working Groups have adopted a maturity ogive with knife-edge maturity-at-age 3 in assessments of this stock (see the Table below).

Age	1	2	3	4	5	6	7+
Proportion mature	0	0	1	1	1	1	1

The data from new Russian histological examination of haddock gonad samples mass sexual maturation occurs at age of two years with length of 25 cm (WGNSDS WD6 2006). These data agree well with the results of recent Scottish research in compliance with which the majority of fish become mature at the age of two years (ICES 2003; Newton *et al.*, 2004). Visual estimation of maturity stage of post-spawning haddock on the Rockall Bank in expeditions leads to considerable errors. For more precise estimation of length and age-at-maturity for haddock it is necessary to conduct investigations in prespawning and spawning periods as well as to collect gonads for further histological analysis (see WGNSDS WD6 2006 for further details).

Research on determining more precise values for natural mortality and maturity ogive parameters should be continued and new estimates could be used in future stock assessments.

In the absence of any direct estimates of natural mortality, M has been set at 0.2 for all ages and years. MSVPA estimates for the North Sea haddock stock give estimates of M of 2.05 at age 0, 1.65 at age 1, 0.40 at age 2, 0.25 at ages 2 and 4, and 0.20 at ages 5+ (ICES CM 2003/ACFM:02). Similarly, large values of M at the younger ages at Rockall would have implications for interpretation of fishing mortality patterns from survey-based methods such as SURBA which essentially estimate total mortality conditional upon assumptions regarding survey catchability-at-age.

ACFM in 2001 encouraged the WG to investigate a more realistic maturity ogive for this stock. At the 2002 Working Group combined sex maturity ogives were presented to the WG for Russian sampling in 2000–2001 and Scottish sampling in 2002. In 2003 new sex disaggregated maturity data were supplied to the Working Group for Russian sampling. The results of all these recent studies indicate that a large proportion of both females and males at age 2 were mature.

B.3. Surveys

There is only one research survey index available for VPA assessment of this stock from the Scottish survey conducted annually in September (Figure 4.3.1, Table 4.2.3 of main report). However, from 1997 onwards the Scottish survey was only conducted in alternate years. Due to concerns about the haddock stock at Rockall some extra time was allocated to carry out a partial survey in September 2002. Full surveys have been conducted since 2005 to improve the quality of assessment. The Scottish survey is currently conducted on about 40 (the target number for a survey) standard trawl stations. However, the survey area and number of stations varied in different years. The majority of stations are within the 200 m depth contour. In 2002 the survey was carried out in the central and northern parts of the bank. In 1999 the survey switched from using an Aberdeen 48′ bottom trawl to a GOV trawl and from 60 min tows to 30 min tows. The indices have been adjusted for tow duration, but no calibration has been made for gear changes. A 20 mm mesh size is used on the survey.

In spring 2005, the Russian trawl-acoustic survey (TAS) for haddock on the Rockall Bank was conducted for the first time (Oganin *et al*., 2005). However, no such survey has been carried out in subsequent years. In the 2005 survey, the trawl survey method estimated the total stock number at 190.63 million individuals and its biomass at 43 400 t (see the Table below). The acoustic survey yielded a haddock biomass estimate of 60 000 t with the abundance of 225.9 million (see the WGNSDS 2006 Report for more details of the trawl-acoustic survey). The estimates of haddock abundance and biomass from the two methods are quite similar. The results of the Russian trawl-acoustic survey are summarized in the Table below:

Survey type	Area component	Area (sq. miles)	Total stock Abundance (106)	Total stock Biomass (103 t)	Spawning stock Abundance (106)	Spawning stock Biomass (103 t)
Trawl survey	Whole	5554	190.6	43.4		
Acoustic survey	International waters	3374	144.2	41.1	133.0	38.5
	EU zone	2180	81.7	18.9	52.4	16.3
	Whole	5554	225.9*	60.0*	185.4	54.8

*** Pelagic component estimated to make up 13.7%.**

The Irish Fisheries Board (BIM) and the Marine Institute recently conducted a collaborative series of surveys to assess the length structure of haddock at various locations on the Rockall Bank and tested the selectivity of a number of codend configurations, which are typically used by both the Irish and Russian fleets.

B.4. Commercial cpue

Commercial cpue series are available for Scottish trawlers, light trawlers, seiners, Irish otter trawlers and Russian trawlers fishing in VIb. The effort data for these five fleets are shown in Figure 4.3.6 and Table 4.3.2 of main report. Commercial cpue series for the different fleets are shown in Figure 4.3.7 of main report.

In 2005–2007, the Russian effort in bottom fishery (in hours and number of vessels/days) decreased due to economic reasons. The effort in 2008 increased slightly compared with 2007. Haddock catches varied accordingly with the changes in fishing effort. In 2006–2007, fishing efficiency in the Russian haddock fishery (mainly with trawlers of tonnage class 10) increased compared with previous years. In 2008, with trawlers of class 8 and 9 only, it was still high (on average, 12.2 t per fishing day for trawlers of class 9), but lower than the efficiency in 2007 (on average, 16.9 t per fishing day for a trawler of class 10). In the period of the targeted fishery (April–May), the mean catch of haddock per hour trawling by a trawler of tonnage class 9 was 0.86 t (in 2007, it was 0.88 t for a trawler of class 10; Figure 4.3.7 of main report). The dynamics of catch per unit of effort for this type of vessels agrees well with year-to-year variations in total biomass of haddock (Figure 4.3.8 of main report).

The effort data from the Scottish fleets are known to be unreliable due to changes in the practices of effort recording and non-mandatory effort reporting (see the Report of WGNSSK 2000, CM 2001/ACFM:07, for further details). It is unknown what proportion of Scottish and Irish effort was applied directly to the haddock fishery. The apparent effort increase may just be the result of more exact reporting of effort due to VMS, but another suggestion is that it arises from a ‘days at sea’ measure. Working at Rockall keeps ‘days at sea’ elsewhere intact (the years in question do correspond to the introduction of the days at sea legislation) and it is possible that vessels are either working extra days in VIb or they are simply reporting extra days from VIb. It is difficult to conclude which of these scenarios is more likely.

The Irish otter trawl effort-series indicated low values between 2002 and 2005 with the lowest value in 2004. In 2006–2008, the effort increased considerably.

The WG decided that the commercial cpue 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.

B.5. Other relevant data

C. Historical stock development

Model used:

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

Software used:

XSA from Lowestoft suite of VPA programs

Model Options chosen:

Settings for the final XSA assessment in the recent years are shown in the Table below.

Assessment year	2005	2006	2007	2008	2009–2011
Assessment model	XSA	XSA	XSA	XSA	XSA
Time-series weights	none	none	none	none	None
Model	power	power	power	power	Power
Catchability dependent for ages <	4	4	4	4	4
Regression type	C	C	C	C	C
Q plateau	5	5	5	5	5
Shk se	1.0	1.0	1.0	1.0	1.0
Shk age-yr	4 yrs 3 ages	4 yrs 3 ages	4 yrs 3 ages	4 yrs 3 ages	4 yrs 3 ages
Min se	0.3	0.3	0.3	0.3	0.3
Plus group	7	7	7	7	7
F_{BAR}	2–5	2–5	2–5	2–5	2–5

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1991–2011	1–7+	Yes
Canum	Catch-at-age in numbers	1991–2011	1–7+	Yes
Weca	Weight-at-age in the commercial catch	1991–2011	1–7+	Yes
West	Weight-at-age of the spawning stock at spawning time.	1991–2011	1–7+	Yes
M_{prop}	Proportion of natural mortality before spawning	1991–2011	1–7+	No, set to 0 for all ages in all years
F_{prop}	Proportion of fishing mortality before spawning	1991–2011	1–7+	No, set to 0 for all ages in all years
Mat_{prop}	Proportion mature-at-age	1991–2011	1–7+	No, the same ogive for all years
Nat_{mor}	Natural mortality	1991–2011	1–7+	No, set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	SCOGFS	1991–2011	1–6

D. Short-term projection

Model used: Age-structured

Software used: MFDP prediction with management option table and yield-per-recruit routines. MLA used for probability profiles and sensitivity analysis.

Initial stock size: Taken from XSA for age 1 and older. The recruitment-at-age 1 in 2009 is estimated using RCT3. For forecasting recruitment in 2010 and thereafter, a geometric mean was used for 1991–2006.

Natural mortality: Set to 0.2 for all ages in all years.

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

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

Weight-at-age in the stock: Three year means (mean weights in the stock are assumed to be the same as catch weights, see below).

Weight-at-age in the catch: Three year means.

Exploitation pattern: Average of the three last years. Landings F are varied in the management option table.

Intermediate year assumptions: *Status quo* F.

Stock–recruitment model used: XSA estimate of recruits at age 1 for intermediate year. RCT3 model used for intermediate year +1 in 2009 and the long-term geometric mean recruitment-at-age 1 is used for forecasting recruitment in 2010 and thereafter.

Procedures used for splitting projected catches: F vectors in each of the last three years of the assessment are multiplied by the proportion landed at-age to give partial F for landings. The vectors of partial F are then averaged over the last three years to give the forecast values.

E. Medium-term projections

Model used: Age structured

Software used: MLA used for Medium-term projections.

Initial stock size: Taken from the XSA for age 1 and older. The recruitment-at-age 1 in 2009 is estimated using RCT3. For forecasting recruitment in 2010 and thereafter, a geometric mean was used for 1991–2006.

Natural mortality: Set to 0.2 for all ages in all years.

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

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

Weight-at-age in the stock: Three year means (mean weights in the stock are assumed to be the same as catch weights, see below).

Weight-at-age in the catch: Three year means.

Exploitation pattern: Average of the three last years.

Intermediate year assumptions:

Stock–recruitment model used: RCT3 model used for intermediate year +1 in 2009.

Uncertainty models used:

1) Initial stock size;
2) Natural mortality;
3) Maturity;
4) F and M before spawning;
5) Weight-at-age in the stock;

6) Weight-at-age in the catch;
7) Exploitation pattern;
8) Intermediate year assumptions;
9) Stock–recruitment model used.

F. Yield and biomass-per-recruit/long-term projections

Model used: Yield and biomass-per-recruit over a range of F values.

Software used: MLA and "st graf".

Maturity: Fixed maturity ogive as used in the assessment.

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

Weight-at-age in the stock: Three year means (mean weights in the stock are assumed to be the same as catch weights, see below).

Weight-at-age in the catch: Three year means.

G. Biological reference points

Biological reference points for this stock are given below:

B_{lim}: 6000 t (lowest observed SSB)

B_{pa}: 9000 t (B_{loss} × 1.4)

F_{pa}: 0.4 (by analogy with other haddock stocks).

H. Other issues

None.

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5.2 Stock Annex Northern Shelf Anglerfish

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Anglerfish (Northern Shelf, Division IIIa, Subarea IV and Subarea VI, and Norwegian Sea, Division IIa)
Working Group	Assessment of Northern Shelf Demersal Stocks
Date	17 May 2005
Last updated	19 May 2008

A. General

A.1. Stock definition

Anglerfish occur in a wide range of depths, from quite shallow inshore waters down to at least 1000 m. Small anglerfish occur over most of the northern North Sea and Division VIa, but large fish, the potential spawners, are more rarely caught. Little is known about when and where anglerfish spawn in northern European waters and consequently stock structure is unclear. This lack of knowledge is due to the unusual spawning habits of anglerfish. The eggs and larvae are pelagic, but whereas most marine fish produce individual free-floating eggs, anglerfish eggs are spawned in a large, buoyant, gelatinous ribbon which may contain more than a million eggs. Due to this strange behaviour, anglerfish eggs and larvae are rarely caught in conventional surveys.

An EU-funded research project entitled 'Distribution and biology of anglerfish and megrim in the waters to the West of Scotland' (Anon, 2001) did however, improve our understanding. A particle tracking model was use to predict the origins of young fish and indicates that post-larval anglerfish may be transported over considerable distances before settling to the seabed (Hislop *et al.*, 2001). Anglerfish in deeper waters to the west of Scotland and at Rockall could therefore be supplying recruits to the western shelf and the North Sea. Furthermore, results of microsatellite DNA analysis carried out as part of this project show no structuring of the anglerfish stock into multiple genetic populations within or among samples from Divisions IVa, Division VIa and Rockall. In fact this project also suggested that anglerfish from further south (Subarea VII) may also be part of the same stock. Fish tagged and released around the Shetland Islands (Division IVa) by Laurenson *et al.*, 2005 have occasionally been recaptured in Subarea V and also Division IIa.

The WGNSDS considered the stock structure on a wider European scale in 2004, and found insufficient evidence to indicate an extension of the stock area northwards to include Division IIa. Anglerfish in IIa is at present treated separately by the Working Group.

A.2. Fishery

A.2.1. Northern Shelf anglerfish fisheries

UK vessels account for more than 50% of the total reported anglerfish landings from the Northern Shelf area. The Danish and Norwegian fleets are the next most important exploiters of this stock in the North Sea while Irish and French vessels take a significant proportion of the landings to the West of Scotland. The fishery for anglerfish in Subarea VI occurs largely in Division VIa with the UK and France being the most important exploiters, followed by Ireland. Landings from Rockall (Division VIb) are generally less than 1000 t with the UK taking on average around 50% of the total. In the North Sea, the majority of landings are reported in Division IVa which reflects the northerly distribution of the species within the North Sea (Knijn *et al*., 1993).

A general description of the anglerfish fisheries of the most important nations taking part in this fishery is given below:

Scottish (UK) fishery

The Scottish fishery for anglerfish in Division VIa comprises two main fleets targeting mixed roundfish. The Scottish Light Trawl Fleet (SCOLTR) takes around 60% of landings and the Scottish Heavy Trawl Fleet (SCOTRL) over 20%. Around 10% of landings are bycatch from the *Nephrops* trawlers. The development of a directed fishery for anglerfish has led to considerable changes in the way the Scottish fleet operates. Part of this is a change in the distribution of fishing effort; the development of a directed fishery having led to effort shifting away from traditional roundfish fisheries in inshore areas to more offshore areas and deeper waters. The expansion in area and depth range fished has been accompanied by the development of specific trawls and vessels to exploit the stock. There has been an almost linear increase in landings from Division VIa since the start of the directed fishery until 1996 which has been followed more recently by a very severe decline, indicating the previous increase was almost certainly due only to the expansion and increase in efficiency of the fishery. More recent declines in landings (2002–2004) may have been due to restrictive TACs and the decline is not necessarily representative of the actual landings.

The Scottish fleet operating in VIb consists mainly of large otter trawlers (SCOTRL) targeting haddock and anglerfish at Rockall. Their activity depends on weather and the availability of haddock quota in VIb.

The Scottish fishery for anglerfish in the North Sea is located in two main areas: on the Shelf Edge to the north and west of Shetland and at the Fladen Ground. It expanded in a similar manner since the 1980s to that operating in Division VIa. The fishery to the north and west of Shetland operates as an extension to that in Division VIa and consists mainly of light trawlers targeting mixed round-fish. The highest reported landings in recent years (to 2007) come from the statistical rectangles around Shetland. The light-trawler fleet accounted for approximately 55% of Scottish reported landings in this area in 2007. The landings from the fishery at Fladen are lower but still significant (around 15% of the total) with anglerfish caught as a bycatch in the *Nephrops* fishery which consists of approximately 200 vessels in 2007. A small component of the landings (~10% in recent years) comes from the gillnet fishery which operates on the shelf edge in the far northwest of Division IVa. A large proportion of the landings in the gillnet fishery are taken by Spanish owned, UK registered vessels.

Ahead of the anglerfish STECF Review Group meeting in 2006 (SGRST-06-03), attempts were made to develop descriptions of the main Scottish anglerfish fisheries which were spatially more relevant to the stock distribution and activity of fishing vessels, rather than by ICES area. The descriptions used data on catch rates from various sources, including research vessel surveys, observer trips on board commercial boats, consultation with skippers and analysis of individual trip records. An 'anglerfish fishery' area was defined as the combined area of high abundance (catch-rates) from FRS/industry survey and observer data analysis. A '*Nephrops* fishery' area was assumed to cover the *Nephrops* grounds which are well defined by soft substratum and are described in the appropriate ICES WGs. The areas are mostly separate but where overlaps occur, these are taken to be part of the anglerfish area. A third area is defined to include all other statistical rectangles.

In the Scottish 'anglerfish' area, large meshed otter trawlers have the largest contribution to the total landings associated with anglerfish. This métier has a mixed species catch composition with haddock being the most important species and anglerfish and cod the next most important. In the *Nephrops* area the largest overall landings associated with anglerfish come from the <100 mm gear category with the dominant species being *Nephrops*, followed by haddock and anglerfish.

Previous studied have found it difficult to identify a specific anglerfish fishery as catch composition can vary a great deal over a small spatial scale (i.e. less than a statistical rectangle). Further analysis of the main, large mesh trawl operating in the 'anglerfish area' is required to provide a more comprehensive picture of catch composition. This has so far been beyond the scope of the WG.

Irish fishery

The Irish fleet which takes around 15–20% of the total Division VIa landings is a light trawl fleet targeting anglerfish, hake, megrim and other gadoids on the Stanton Bank and on the slope northwest of Ireland. This fleet uses a mesh size of 80 mm or greater. Irish Division VIa landings come mainly from the Stanton bank with some landings from Donegal Bay and the slope northwest of Ireland. Since 1996 there has been an increase in the number of vessels using twin rigs in this fleet. There have also been changes to the fleet composition since 2000, with around ten vessels decommissioned and four new vessels joining the fleet. The activity of this fleet is not thought to have been significantly affected by the recent hake and cod recovery plans.

The Irish fleet otter trawl in Division VIb take anglerfish as a bycatch in the haddock fishery on the Rockall Bank. The fleet targeting haddock uses 100 mm mesh and twin rig trawls. Occasionally Irish-Spanish flag vessels target anglerfish, witch and megrim with 80 mm mesh on the slope in VIb. Discarding practices of these vessels are not known although discarding of anglerfish from the fleet targeting haddock in Division VIb is not thought to be significant (Anon, 2001). The fleet composition changed in 2001. Four vessels have recently been decommissioned and two new vessels have joined the fleet that targets haddock. In 2006 and 2007, the effort of the Irish fleet operating at Rockall has increased with the increase in Rockall haddock TAC.

Danish fishery

According to logbook records, the majority of Danish anglerfish landings are taken in the northeastern North Sea, in the part constituting the Norwegian Deeps, situated in the Norwegian EEZ of the North Sea. Other important fishing areas for anglerfish are the Fladen Ground (also in IVa) and in the Skagerrak (IIIa). More than 80% of the Danish landings come from ICES Divisions IVa and IIIa. The remaining part is from the most northern part of Division IVb.

The majority of the Danish vessels are taking anglerfish with demersal trawls with over 90% of these vessels in the size range 20–40 m.

Fishery definitions by gear type and mesh size as currently used by Danish Fisheries Directorate for the North Sea are given in the following text table:

Fishery/gear	Mesh size, mm
Dem. Trawl	>= 100 mm
Nephrops trawl	70–99 mm
Shrimp trawl	33–69 mm
Industrial trawl	< = 32 mm
Beam trawl	>= 80 mm

Note that in the North Sea demersal trawls account for more than 90% of total Danish landings. However, it is necessary to further specify that at present the majority of the Danish catches of anglerfish are taken by fisheries in the Norwegian zone of IVa applying demersal trawls with mesh size >= 120 mm. In 2006, the fishery with demersal trawl in the Norwegian Deeps (in the Norwegian zone) accounted for around 75% of total Danish landings by all gears from the entire North Sea. In the Skagerrak (IIIa) the two main fisheries taking anglerfish are the (mixed) *Nephrops* fishery and the demersal trawl fishery. In both areas minor landings are taken in gillnets and as bycatch in fisheries for shrimp (*Pandalus*).

Information on the species composition of the landings from Danish fisheries taking anglerfish is available from the Danish logbook records and also from the Danish at-sea samples from observers on discard trips. Further details can be found in Section 6.2.1 of ICES WGNSDS 2007. Typically anglerfish constitutes less than 15% by weight of the landings from demersal trawlers fishing in the Norwegian Deeps.

Norwegian fisheries

A Norwegian directed gillnet fishery (360 mm mesh size), targeting large anglerfish, carried out by small vessels in coastal waters in the eastern part of the Northern North Sea started in the early 1990s. These vessels are responsible for around 60–70% of the total Norwegian landings from this area and they comprise around 6% of the total landings from Division IVa since 1999. The remaining Norwegian landings in IVa are mostly bycatch in various trawl fisheries. A similar pattern of fishing is found in the Skagerrak (IIIa). The third quarter has in recent years been the most important season for the directed fishery, while the second quarter is apparently most important for other gears.

Other fisheries

French demersal trawlers also take a considerable proportion of the total landings from this area. The vessels catching anglerfish may be targeting saithe and other demersal species or fishing in deep water for roundnose grenadier, blue ling or orange roughy.

Since the mid-1990s, a deep-water gillnet fishery targeting anglerfish has been conducting a fishery on the continental slopes to the West of the British Isles, North of Shetland, at Rockall and the Hatton Bank. These vessels, though mostly based in Spain are registered in the UK, Germany and other countries outside the EU such as Panama. Gear loss and discarding of damaged catch are thought to be substantial in this fishery. Until now these fisheries have not been well documented or understood and they seem to be largely unregulated, with little or no information on catch composition, discards and a high degree of suspected misreporting. There are currently (2005) around 16 vessels participating in the fishery, 12 UK registered and four German registered.

In response to the concerns with these gillnet fisheries for deep-water sharks and anglerfish in Subarea VI, the EC banned the setting of gillnets in waters greater than 200 m in 2006 (Council Regulation 51/2006). However, this regulation was reviewed in July 2006 and a new regulation put in place which is a permanent ban, but allows a derogation for entangling nets in waters less than 600 m, not exceeding 100 km in total length with a maximum soak time of 72 hours. (EC Regulation No 40/2008 Annex III, article 8). NEAFC have also introduced an indefinite ban. There is also legislation proposed which will extend the ban to other areas including Division IVa.

In addition, the EU has recently funded a ghost net retrieval programme, DEEPCLEAN, (coordinated by the Marine Institute, Ireland) which is due to commence in autumn 2007. The intention of this programme is to a) maximize the recovery of lost or abandoned gillnets and b) to quantify the scale and biological consequences.

A.2.2. Division IIa anglerfish fisheries

In Division IIa most of the anglerfish is caught by small vessels in a directed gillnet fishery close to the coast. The legal mesh size has, since 1995, been 360 mm and maximum two days soaking time. Offshore gillnetting, trawls and Danish seines are responsible for the other catches. For the directed gillnet fishery, the area between N 62° and N 64° has been the most important with maximum catches almost reaching 3000 tonnes in 1993. During recent years the catches have varied between 1000–2000 tonnes. A fishery north of N 64° has developed rapidly, with catches reaching 2400 tonnes in 2007, exceeding the level of catches in the southern part of IIa for the first time. For the other gears, catches have increased from around 100 tonnes in the early 1990s to approximately 300–500 tonnes during the last four years. Very low catch figures are reported from other nations north of N 62°.

A.3. Ecosystem aspects

No information.

B. Data

B.1. Commercial catch

B.1.1. Data compilation

Quarterly length–frequency distribution data were available from Scotland and Ireland for Division VIa and Spain for Subarea VI in the past. A total international catch-at-length distribution for Division VIa was obtained by summing national raised catch-at-length distributions then raising this distribution to the WG estimates of total international catch from this area. Landings officially reported to ICES were used for countries not supplying estimates directly to the WG. Since 2001, the Scottish market sampling length–weight relationships (given below) have been used to raise the sampled catch-at-length distribution data Working Group estimates of total landings for Division VIa. Length–frequency data availability for VIb has been limited to Scottish and Irish samples.

Year Range	Formula (L – length in cm, W – weight in g)	Source
1992–2000	W=0.01626L2.988	Coull *et. al.*, 1989
2001 onwards	W=0.0232L2.828	Scottish Market Sampling

For anglerfish in the North Sea, catch-at-age composition data are available from Scotland for the years 1992 to 2007. In the past the Scottish quarterly age–length keys were applied to the available length–frequency data and non-sampled catches were attributed to age assuming their length–frequency distributions to be equivalent to the combined sampled distribution.

As a first step in assembling assessment data for the North Sea component of the stock, length compositions from Scottish market sampling have been raised to Working Group estimates of total landings in the past. The Working Group estimate of total landings was assumed equal to the landings obtained by national scientists plus official landings as reported to ICES for those countries not providing landings data to the Working Group. The Scottish market sampling data are only available from 1993 onwards, and even for these years the level of sampling has been relatively low. More recently, additional length samples are available from the Danish and Norwegian fisheries since 2002 including samples from Division IIIa.

Total international catch-at-length distribution data for the whole Northern shelf (Division IIIa, Subarea IV and Subarea VI) have previously been obtained by summing the length distributions from the individual areas and assuming that this distribution is representative of the whole Northern Shelf. This was then raised to Working Group estimates of total landings for the Northern Shelf.

In addition, catch-at-length distribution data are available from the Norwegian directed coastal gillnetting in Division IIa from 1993 to 2007, although there are no data from 1997–2001. There are also catch-at-length distribution data from anglerfish caught as bycatch in the offshore gillnetting and longlining fleets for 2004–2007. No attempts have been made to present raised catch-at-length distribution for anglerfish from Division IIa.

B.1.2. Commercial catch data quality

For a number of years, anglerfish in Subarea VI, XII, XIV and Division Vb (EU zone) were subjected to a precautionary TAC (8600 t), based on average landings in earlier years. In 2002 the TAC was set at 4770 t and was further reduced to 3180 t in 2003 and 2004. The TAC was increased in 2005 to 4686 t and to 5155 t for 2007. At the WG in 2003, it was highlighted that the reduction off the TAC in 2003 to just two-thirds of that in 2002 would likely imply an increased incentive to misreport landings and increase discarding unless fishing effort was reduced accordingly (Section 6.4.6, ICES WGNSDS 2003). Anecdotal information from the fishery in 2003 to 2005 appeared to suggest that the TAC was particularly restrictive in these years. The official statistics for these years are, therefore, likely to be particularly unrepresentative of actual landings.

The absence of a TAC for Subarea IV prior to 1999 means that before then, landings in excess of the TAC in other areas, were likely to be misreported into the North Sea. In 1999, a precautionary TAC was introduced for North Sea anglerfish, but unfortunately for current and future reporting purposes, the TAC was set in accord with recent catch levels from the North Sea which includes a substantial amount misreported from Subarea VI. The area misreporting practices have thus become institutionalised and the statistical rectangles immediately east of the 4°W boundary (E6 squares) have accounted for a disproportionate part of the combined VIa/North Sea catches of anglerfish.

The Working Group historically (prior to 2005) provided estimates of the actual Division VIa landings by adjusting the reported data for Division VIa to include a proportion of the landings declared from Division IVa in the E6 ICES statistical rectangles. The correction has been applied by first estimating a value for the true catch in each E6 square then allocating the remainder of the catch into VIa squares in proportion to the reported catches in those squares. The 'true' catches in the E6 squares are estimated by replacing the reported values by the mean of the catches in the adjacent squares to the east and west. This mean is calculated iteratively to account for increases in catches in the VIa squares resulting from reallocation from the E6 squares. Such a reallocation of catches may still inadvertently include some landings taken legally in Division IVa on the shelf edge to the west of Shetland, but these are likely to comprise fish within the distribution of the Division VIa stock component. Due to technical problems associated with changes to the Scottish Executive database and lack of landings data provided to the Working Group by some of the major nations exploiting the fishery, WG estimates of the actual Division VIa landings have not been calculated for recent years (2005–2007).

At the 2010 WGCSE, for data in 2009, this procedure was adjusted to reallocate data to the whole of Area VI: i.e. not just VIa but including Rockall (VIb). This was based on information received from Marine Scotland Compliance indicating that some vessels fishing for anglerfish at Rockall are reporting large catches in the E6 squares from the same voyage. The distribution of landings this new scheme produced was more in keeping with the distribution of the stock as indicated from the anglerfish surveys.

B.2. Biological

Previous assessments of this stock used the natural mortality rate applied to anglerfish in Division VI adopted by an earlier Hake Assessment Working Group of 0.15 yr^1. This value is once more adopted for all ages and lengths in the absence of any direct estimates for this stock.

Historically, the catch-at-age analysis of anglerfish in Division VIa used the same maturity ogive as that applied to anglerfish in Subareas VII and VIII by the Working Group on the Assessment of Southern Shelf Demersal Stocks. However, a number of more recent maturity studies based on the VIa stock indicate that maturity does not occur until much later than previously estimated. Afonso-Dias and Hislop, 1996 give a length–maturity ogive for this stock, 50% maturity at approximately 74 cm in females, and 50 cm in males. However, this study was based on few samples. New information has become available from the EU-funded project (Anon, 2001) which indicates female 50% maturity at approximately 94 cm and males at 57 cm. The corresponding age based ogives indicate 50% maturity at approximately age 9 in females and age 5 in males. This has also been supported by more recent studies by Laurenson *et al.*, 2005.

B.3. Surveys

In previous length-based assessments of this stock, a recruitment index was used which had been obtained from the Scottish March West Coast survey. The index consists of numbers of anglerfish less than 30 cm caught per hour. However, at more recent meetings of this WG it has been concluded that the traditional groundfish surveys are ineffective at catching anglerfish and do not provide a reliable indication of stock size. As a result of this conclusion, and the urgent requirement for fishery-independent data, Marine Scotland Science began a new joint science/industry survey in 2005. This is a targeted anglerfish survey with a scientific design using commercial gear. In 2006, 2007 and 2009 Ireland extended the anglerfish survey to cover the remaining part of VIa (from 54°30′ to 56°39′). Further details of the survey including information on design, sampling protocol and gear and vessel are given in Fernandes *et al.*, 2007 and in annual working documents which describe the survey results.

B.4. Commercial cpue

B.4.1. Official logbook data

Previous length based assessments attempted to use effort data to constrain the temporal trend in fishing mortality. Scottish Light Trawl data, disaggregated into an inshore and offshore component, the latter of which is associated with the anglerfish fishery, for both West of Scotland and Shetland (N Sea) were provided to the Working Group. However, these data are no longer considered to be reliable due to non-mandatory recording of hours fished in the logbook data. Further details of the Scottish fleet effort recording problem can be found in the report of the 2000 WGNSSK (ICES, 2001). Since these data are considered unreliable, they are not presented here.

Irish lpue data in terms of hours fished has been presented to the WG for Division VIa and Division VIb for all fleets up to 2006 (shown in Table B.4.1). The measure of kWdays is believed to be a more reliable proxy for effort than hours fished due to reporting issues and these data are presented in the WG report.

Danish landings and effort data (hours fished) from logbook data are also available to the WG for Division IIIa and Division IVa. Although these data are considered to be reliable (in terms of accuracy of reporting), it is not know to what extent they are useful in providing an indicator of stock size due to management regulations in the Norwegian zone (TAC constraints) and technological creep.

No effort data have been made available to the WG for fisheries operating in Division IIa.

B.4.2. Tallybook data

Analysis of skippers' personal diary information collected in 2004 and 2005 in an attempt to improve knowledge of the state of the stock and of the Scottish anglerfish fishery provided valuable information to ICES (Bailey *et al.*, 2004) on temporal and spatial trends in catch rate. Following the success of these data collation exercise, ICES advised the process to continue and a more formal scheme was proposed by FRS.

Extensive discussions with the fishing industry during 2005 resulted in FRS implementing the monkfish tallybook project at the start off 2006. The project is part of a long-term approach to providing better information on the monkfish fishery and the state of the stock, and is being operated in conjunction with fishers' organizations (Scottish Fishermen's Federation, Fishermen's Association Limited and Pecheurs de Manche et Atlantique) and the North Atlantic Fisheries College (NAFC) Marine Centre, Shetland. These organizations have been responsible for distributing the tallybooks, coordinating the returns and allocating a vessel code before the anonymised tallybook sheets are forwarded to FRS. The tallybooks are filled in on a haul-by-haul basis to give weight caught by size category and information on haul location, duration and depth in a standardized format as well as gear and mesh being used. Additionally information on mature females has been requested. Data are stored in a database at FRS.

So far, the time-series is relatively short, with the first returns from fishing trips at the end of December 2005 and the most recent from March 2008. Initial participation in the scheme was high with returns received from up to 37 vessels with a wide spatial coverage (across Subarea VI, Division IVa, IIa and Vb) and different target species. Of the 37 vessels which have so far supplied information, two are French and these are operating towards the southern end of the shelf edge in Division VIa northwest of Ireland. The haul depth information collated so far indicates that most of the hauls are taken in depths between 100 and 400 m although there are a significant number of hauls from depths between 600 and 800 m. The records from the deeper water are largely from the French vessels although it does appear that a number of the Scottish vessels make occasional trips into deeper water. Average catch rates are similar to those previously seen in the diary data and observer data (presented in previous WG reports) and range from around 10 kg/h for boats targeting *Nephrops* to over 100 kg/h for some whitefish boats.

Analysis of the catch rate data is presented in the WG report and in Dobby *et al.*, 2007.

B.5. Other relevant data

None.

C. Historical stock development

Since 2003 the WG has been unable to provide an assessment of anglerfish. This is due to a combination of unreliable commercial data: landings misreporting in some of the main fleets involved in the fishery and uncertain effort data, and poor catchability of anglerfish in traditional research vessel surveys.

Although, the stock status has been classified as uncertain in recent years, TAC increases of 10% occurred in both the West of Scotland and North Sea areas on the basis of advice from the STECF Review Group meeting (SGRST-06-03) which examined trends in commercial catch rate data and fishery information.

In previous years the stock assessment has been conducted using a length based model for which the settings are outlined below.

Model used: Catch-at-length analysis (modified CASA-Sullivan *et. al.*, 1990; Dobby, 2002).

Software used: Fortran coded executable-LBAV4_1.

Model Options chosen:

Sex differentiated von Bertalanffy growth, variability distributed according to a beta function. Parameters taken from Scottish anglerfish survey in 2000: $L_4(F)=140.5$, $K(F)=0.117$, $L_4(M)=110.5$, $K(M)=0.154$.

Fishing mortality in 1993=1.0

Historical equilibrium fishing mortality fitted using mean of historical WG estimates of landings which is approximately 18 000 t over 1987–1991.

Logistic exploitation pattern with fitted parameters.

Trend in temporal fishing mortality equal to trend in recent SCOLTR effort data

Total recruitment normally distributed over length classes

Input data types and characteristics:

Name	Year range	Variable from year to year Yes/No
Catch in tonnes	1993–last data year	Yes
Catch-at-length in numbers	1993–last data year	Yes
Weight-at-length in the commercial catch	1993–last data year	Yes/No–2 weight-length relationships: covering 1993–2000, and 2001 onwards
Weight-at-length of the spawning stock at spawning time.	1993–last data year	Yes/No-assumed to be the same as weight-at-length in the catch
Proportion mature-at-length	1993–last data year	No–the same ogive for all years
Natural mortality	1993–last data year	No–set to 0.15 for all lengths in all years

Auxiliary data:

Type	Name	Year range	Size range
Recruitment index	Scottish March West Coast survey	1993–last data year	< 30 cm

D. Short-term projection

In previous years the short-term forecast has used a length structured method with settings outlined below.

Model used: Length-structured

Software used*:* Fortran coded executable LBForecast.exe

Initial stock size: taken from catch-at-length analysis. The long-term geometric mean recruitment is used in all projection years. Natural mortality: Set to 0.15 for all lengths in all years

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

Weight–length relationship: as used in the assessment (Scottish Market sampling)

Exploitation pattern: Fixed exploitation-at-length pattern is estimated in the catch-at-length analysis. This is assumed to apply in all further years.

E. Medium-term projections

No medium-term projections are carried out for this stock.

F. Yield and biomass-per-recruit/long-term projections

Previous yield and biomass-per-recruit calculations were carried out on the basis of the results of length-based assessments which are no longer carried out.

G. Biological reference points

Precautionary approach reference points: "ICES considers that there is currently no biological basis for defining B_{lim} or F_{lim}. ICES proposes that $F_{35\%SPR}$ =0.30 be chosen as F_{pa}. It is considered to be an approximation of F_{MSY}."

The statement included above first appeared in 1998, but the WG has been unable to find the basis of the derivation of this reference point and considers it no longer appropriate to include it.

H. Other issues

In previous ('catch-at-length') assessments of this stock, the SSB was always estimated to be at a very low level. The length data have been based on the UK landings only (in Subdivisions. IVa and VIa), where very few individuals over 80 cm appear in the catch and therefore the model predicts very few in the population. Since females do not mature until they are over 90 cm in length the SSB is estimated to be very low. The length data from the eastern part of the North Sea (Danish and Norwegian fisheries) for the recent years indicate a higher amount of larger individuals in the catches. Although the Danish and Norwegian landings are small in comparison with the UK landings, the inclusion of the Danish and Norwegian length frequencies in the data used for any future assessment may change the concept of the magnitude of the SSB.

The fact that mature female anglerfish are rarely observed either on scientific surveys or by observers on board commercial vessels supports a very low estimate of spawning–stock biomass, yet there is little evidence of reduction in spatial distribution as fish are still recruiting to relatively inshore areas. It has been hypothesized that females may become pelagic when spawning as they produce a buoyant, gelatinous ribbon of eggs, and would therefore not appear in the catch of trawlers. (Anglerfish have been caught near the surface, Hislop *et al*., 2000). This would imply different exploitation patterns for males and females: a dome-shaped pattern (decreased exploitation at larger sizes) for females and a logistic pattern for males. It is also not known whether anglerfish are an iteroparous or semelparous species. The latter would also account for the almost complete absence of spawning females in commercial catches or research vessel surveys.

The key features of the species' life history in relation to its exploitation are the location of the main spawning areas, and whether or not there is any systematic migration of younger fish back into the deeper waters to spawn. At present, despite the large increase in catches during the mid 1990s, there is no apparent contraction in distribution; fish are still recruiting to relatively inshore areas such as the Moray Firth in the northern North Sea. The fact that spawning may occur largely in deep water off the edge of the continental shelf may offer the stock some degree of refuge. However, this assumes that the spawning component of the stock is resident in the deep water, and is thus not subject to exploitation. It is not known to what extent this is true, but if such a reservoir exists then the currently used assessment methods which make dynamic pool assumptions about the population are likely to be inappropriate. Nevertheless, it is clear that further expansion of the fishery into deeper water is likely to have a negative effect on the SSB and given the spatial development of the fishery, it cannot be ruled out that the serial depletion of fishing grounds has been occurring. In addition, some life-history characteristics of anglerfish suggest that it may be particularly vulnerable to high exploitation. A detailed discussion of the fishery development and biology can be found in Sections 7.5.4 and 7.5.5 of the 2000 Report of this Working Group (ICES, 2001).

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Table B.4.1. Anglerfish in Subarea VI. Landings, effort and lpue from the Irish OTB fleet.

		IR-OTB-4-6			IR-TBB-4-6			IR-SCC-4-6			IR-GN-4-6	
		IV–VI			IV–VI			IV–VI			IV–VI	
Year	Landings (t)	Effort (h)	lpue (kg/h)	Landings (t)	Effort (h)	lpue (kg/h)	Landings (t)	Effort (h)	lpue (kg/h)	Landings (t)	Effort (h)	lpue (kg/h)
1995	769.21	66.54	11.56		0.00		5.70	2.65	2.15	0.87	1.57	0.55
1996	698.93	68.90	10.14	16.54	1.23	13.45	4.91	2.94	1.67	1.91	2.25	0.85
1997	680.78	72.71	9.36	2.055	1.07	1.93	7.79	3.00	2.60	3.40	1.83	1.86
1998	656.23	66.40	9.88	10.381	2.36	4.41	12.72	2.95	4.32	0.95	1.22	0.77
1999	512.92	63.23	8.11	1.939	1.12	1.73	12.14	4.22	2.87	6.19	0.49	12.65
2000	471.95	63.33	7.45	0.045	0.13	0.35	4.64	3.86	1.20	0.87	0.11	7.60
2001	408.46	55.99	7.30	0.12	0.12	0.98	2.95	1.31	2.26	22.23	0.43	51.69
2002	317.13	40.00	7.93		0.00		5.06	1.58	3.20	4.94	0.23	21.48
2003	299.17	44.44	6.73		0.00		3.84	2.22	1.73	1.86	0.54	3.45
2004	197.89	37.50	5.28	0.176	0.35	0.50	2.15	0.98	2.20	2.46	0.54	4.57
2005	350.33	34.79	10.07		0.04	0.00	1.07	0.69	1.56	0.00	0.04	0.00
2006	423.39	34.62	12.23	0.12	0.07	1.71	1.18	0.49	2.40	0.02	0.24	0.07

Table 4.3.1. Details of Scottish discard trips in the Rockall area (Newton *et al.*, 2003).

Trip no.	Date	Gear	No. of hauls	Hours fished	% (by weight) haddock landed of catch	% (by weight) discarded of haddock
1	May 85	Heavy Trawl	20	89.08	74	17.3
2	Jun 85	Heavy Trawl	28	127.17	74	18.6
3	Jun 99	Heavy Trawl	21	110.83	41	74.9
4	Apr 01	Heavy Trawl	11	47.33	96	12.4
5	Jun 01	Heavy Trawl	35	163.58	58	47.5
6	Aug 01	Heavy Trawl	26	130.08	31	69.7

Table 4.3.2. Landings and Discards haddock estimates at Rockall from discard observer trips conducted aboard Irish vessels between 1995 and 2001, and from an observer trip aboard the MFV (February–March 2000). (ICES CM 2004/ACFM:33).

	FAT/ KBG/ 00/4	FAT/ KBG/ 01/12	FAT/ KBG/ 95/1	FAT/ KBG/ 95/2	FAT/ KBG/ 97/7	FAT/ KBG/ 97/8	FAT/ KBG/ 98/4	Feb 2000	Discard rate
Landing	3021	942	12727	6893	14258	25866	23805	4400	
Discards	1864	926	1146	1893	6625	17926	3687	6200	
% discarded	38.16	49.57	8.26	21.54	31.72	40.90	13.40	58.49	27%

Table 4.3.3. Scottish landings and raised discards of haddock in 1999 estimates at Rockall from discard observer trips conducted on Scottish vessels.

	Age													
	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
Landing, N (*1000)	0	0	436.9	1211.9	1069.5	849.4	1220.6	1432.3	411.9	87.7	0.4	0	1.4	6722
Landing, tonnes	0	0	135.8	432.5	420.7	383.9	646	760.7	245.5	49.6	0.5	0	4.3	3079.5
Discards, N (*1000)[1]	22.4	14420.8	15276.9	6844.7	2534.8	1516	734.3	219.4	39.6	0	0	0	0	41609.1
Discards, tonnes[1]	1.5	2284.1	3658.2	1936.2	799.1	515.4	248.8	86.2	17.6	0	0	0	0	9547.2
Discards, N (*1000)[2]	12.5	13306.1	15895.9	7168.1	2588.9	1555.7	772.5	247.9	48.6	12.2	0.7	0	0	41609.2
Discards, tonnes[2]	0.3	2241.2	3791.3	2035.1	821.7	538.7	268	103.8	22.7	6.3	0.5	0	0	9829.6

[1] raised estimates from discard observer trips at Rockall.

[2] estimates obtained from a logistic discard curve for 1999.

Table 4.3.4. Scottish landings and raised discards of haddock in 2001 estimates at Rockall from discard observer trips conducted aboard Scottish commercial vessels.

	Age													
	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
Landing, N (*1000)	0	0	326.5	489.1	132.9	774.3	326	223.9	113.5	22.4	3.8	0	0	2412.3
Landing, tonnes	0	0	128.6	157	82.4	262.4	125.2	90.2	59.3	19.9	3	0	0	928
Discards, N (*1000)[1]	3.1	6309.9	549.7	228.4	66.3	8.1	1	0.1	0.1	0.1	0	0	0	7166.8
Discards, tonnes[1]	0.2	967.4	126.8	58.7	17.8	2.4	0.3	0.1	0	0	0	0	0	1173.8
Discards, N (*1000)[2]	531	5987.3	436.2	162.6	46.9	2.9	0.5	0.1	0	0	0	0	0	7167.6
Discards, tonnes[2]	14.3	936.2	93	38.6	11.6	0.9	0.2	0.1	0	0	0	0	0	1094.9

[1] raised estimates from discard observer trips at Rockall.

[2] estimates from a logistic discard curve for 2001.

Table 4.3.5. Values of DL_{50} by Scottish discard trips in the Rockall area.

Year	DL50	b
1999	36.62	–0.5923
2001	31.20	–0.8238
Theoretical:	34.66	–1.2328

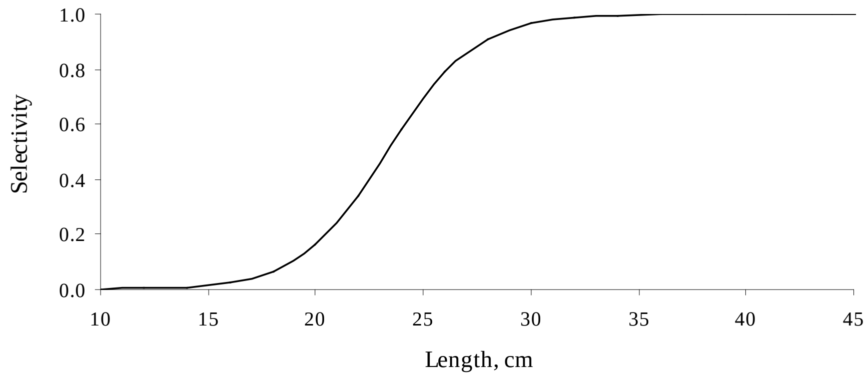


Figure 4.3.1. Theoretical haddock selectivity curve used to estimate the proportion of haddock lifted on board Russian trawlers.

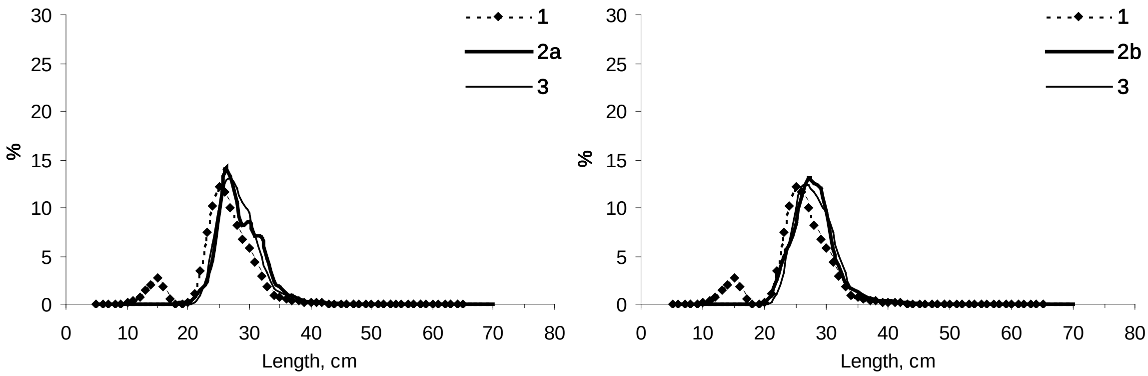


Figure 4.3.2. Length distribution of haddock in 2003: 1 – by Scottish groundfish survey, 2a – by commercial Russian trawlers in June, 2b – by commercial Russian trawlers in July, 3 – theoretically derived.

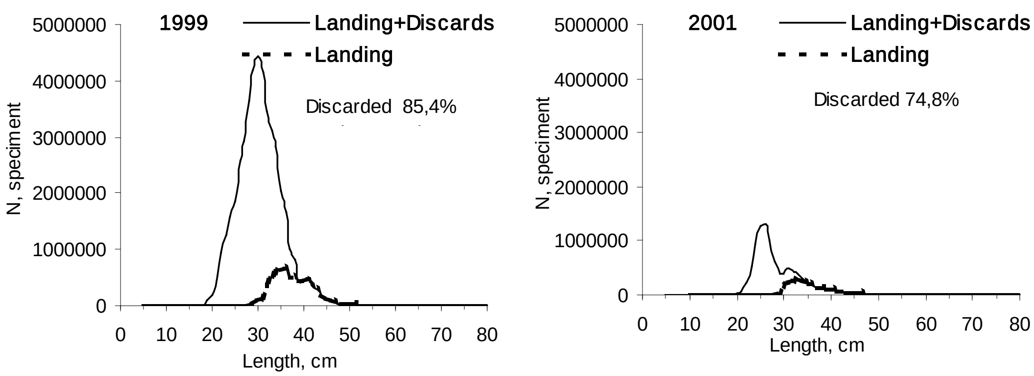


Figure 4.3.3. Length distribution and quantity of haddock lifted on board and landings by Scottish trawlers in 1999 and 2001 (unpublished data, Newton, 2004).

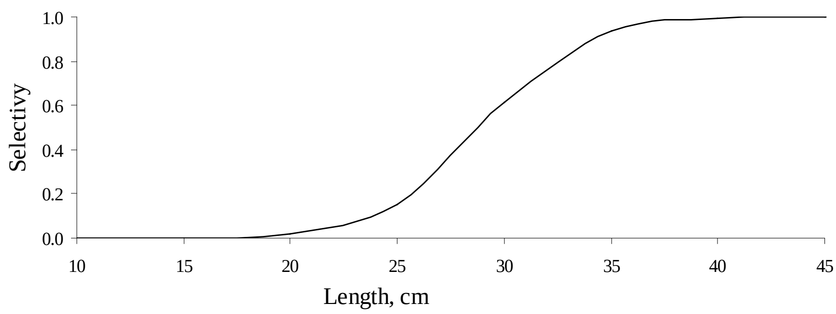


Figure 4.3.4. Theoretical haddock selectivity curve used to estimate the proportion of haddock lifted on board Scottish trawlers.

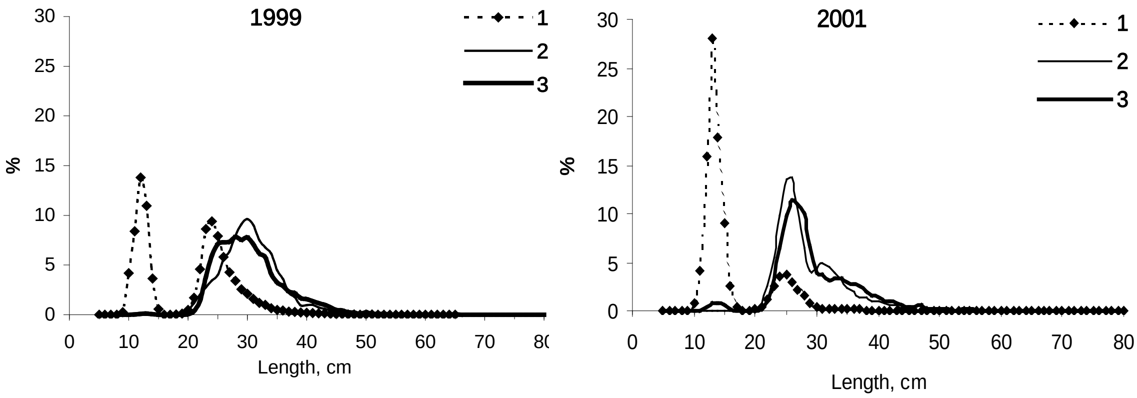


Figure 4.3.5. Length distribution of haddock in 1999 and 2001: 1 – by Scottish groundfish survey, 2 – by commercial Scottish trawlers, 3 – theoretically derived.

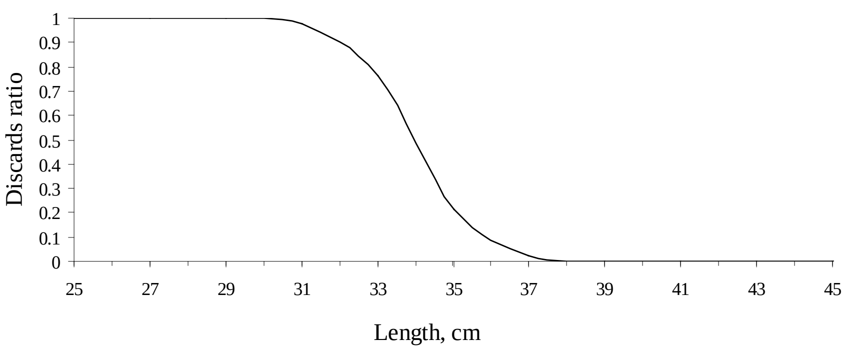


Figure 4.3.6. Selectivity curve used to estimate the proportion of discarded haddock in catches Scottish trawlers.

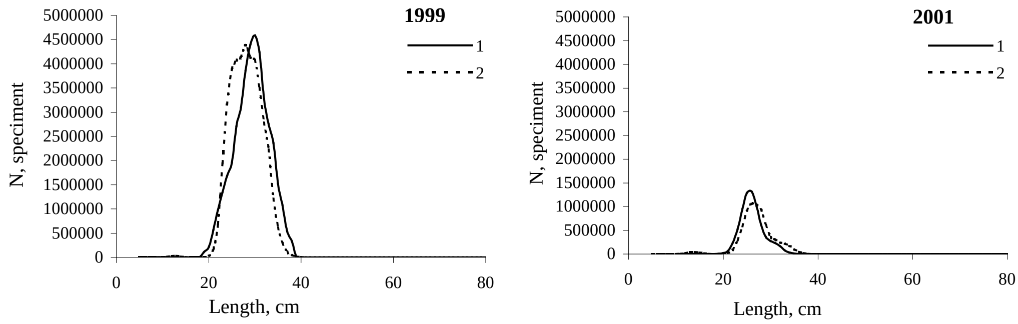


Figure 4.3.7. Length distribution of discarded haddock in catches Scottish trawlers in 1999 and 2001: 1 – research data; 2 – theoretically derived.

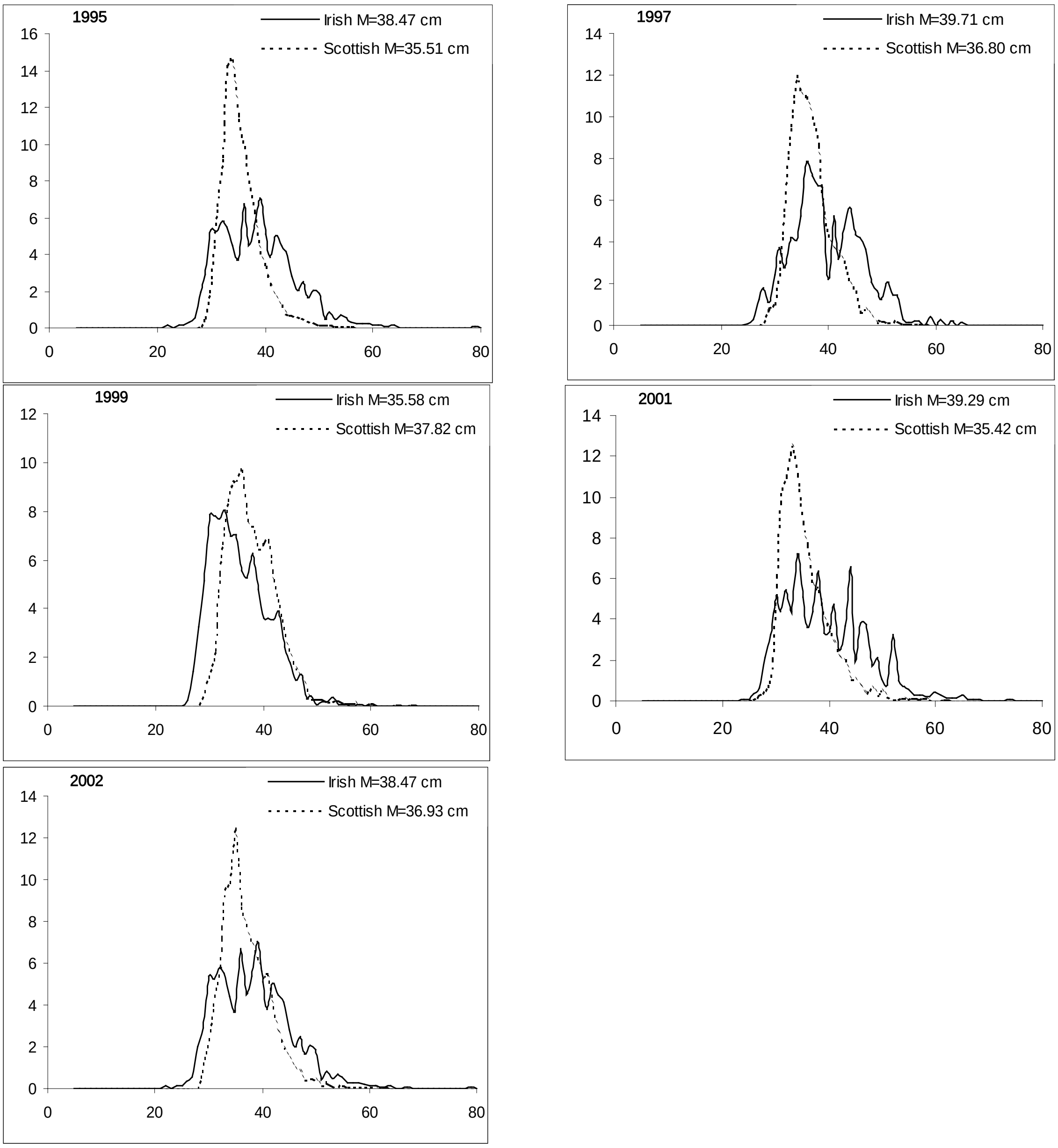


Figure 4.3.8. Length distribution of haddock landings in VI b (Scottish and Irish data).

6.3 Stock Annex Haddock VIIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Irish Sea Haddock (Division VIIa)
Working Group	Celtic Seas Ecoregion
Last updated	19 May 2009
Revised by	Pieter-Jan Schön

A. General

A.1. Stock definition

A.2. Fishery

Directed fishing for haddock in the Irish Sea is mainly carried out by UK (Northern Ireland) midwater trawlers using 100 mm mesh codends, particularly targeting aggregations that can be detected acoustically. These conditions prevail mainly during winter and spring when the hours of darkness are longest, and the fish are aggregating on the spawning grounds in the western Irish Sea. Other demersal whitefish vessels from Northern Ireland, Ireland and to a lesser extent Scotland, using single or twin trawls with 100 mm mesh, also target haddock when abundant. (Prior to the introduction of Council technical conservation Regulation 850/98 in 2001, most whitefish vessels in the Irish Sea used 80 mm codends.) Bycatches of haddock are made in the UK (NI) and Irish *Nephrops* fisheries using single nets with 70 mm codends or twin trawls with 80 mm codends. The haddock stock is mainly distributed in the western Irish Sea and south of the Isle of Man, preferring the coarser seabed sediments around the periphery of the muddy *Nephrops* grounds. Juveniles are taken extensively in the otter trawl fisheries in these areas, leading to substantial discarding (see Section B1.2).

The nature of the fishery has been modified by the cod closure since 2000 (Council Regulation (EC) No 304/2000). Targeted fishing with whitefish trawls was prohibited inside the closure from mid February to the end of April. Derogations for *Nephrops* fishing were allowed. Irish *Nephrops* trawlers were involved in an experiment to test inclined separator panels in 2000 and 2001, the object being to minimize the bycatch of cod. Fishing inside a small area of the western Irish Sea closed to all fishing in spring 2000 and 2001 was permitted if separator panels were used. These panels would also have allowed escapement of part of the haddock catch. Closure of the main whitefish fishing grounds in spring 2000 resulted in a shift in fishing activities of midwater trawlers and other UK(NI) whitefish vessels into the North Channel (Area VIIa) and Firth of Clyde (VIa south). A subsequent closure of the Firth of Clyde in spring 2001 under the VIa cod recovery programme (Council Regulation (EC) No 456/2001) resulted in a reduction in reported fishing activity in this region. Several rounds of decommissioning in 1995–1997, 2001 and 2003 have reduced the size of the commercial fleets. UK vessels decommissioned at the beginning of 2002 accounted for 17% of the haddock landings from the Irish Sea in 1999–2001. A further round of decommissioning in 2003 removed 19 out of 237 UK vessels that operated in the Irish Sea at the beginning of 2004, representing a loss of 8% of the fleet by number and 9.3% by tonnage.

Gear specific effort regulations (days-at-sea) have been introduced in the Irish Sea in 2004. Annex V to Council Regulation (EC) No 2341/2002 regulated the maximum number of days in any calendar month of 2004 for which a fishing vessel may be absent from port in the Irish Sea. Monthly effort limitation under this Regulation is as follows: ten days for demersal trawls, seines and similar towed gears with mesh size >=100 mm, 14 days for beam trawls of mesh size >= 80 mm and static demersal nets, 17 days for demersal longlines, and 22 days for demersal trawls, seines and similar towed gears with mesh size 70–99 mm. Additional days are available for vessels meeting certain conditions such as track record of low cod catches. In particular, an additional two days are available for whitefish trawlers (mesh >=100 mm) and beam trawlers (mesh >=80 mm) which spend more than half of their allocated days in a given management period fishing in the Irish Sea, in recognition of the area closure in the Irish Sea and the assumed reduction in fishing mortality on cod.

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

B.1.1. Landings

The following table gives the source of landings data for Irish Sea haddock:

	Kind of data				
Country	Caton (catch-in-weight)	Canum (catch-at-age/in-numbers)	Weca (weight-at-age in the catch)	Matprop (proportion mature-by-age)	Length composition in catch
UK(NI)	X	X	X	X	X
UK(E&W)	X				
UK(Scotland)	X				
UK (IOM)	X				
Ireland	X	X	X		X
France	X				
Belgium	X				

Quarterly landings and length/age composition data are supplied from databases maintained by national Government Departments and research agencies. These figures may be adjusted by national scientists to correct for known or estimated misreporting by area or species. Data are supplied in Excel files to a stock coordinator nominated by ICES Northern Shelf Demersal Working Group, who compiles the international landings and catch-at-age data and maintains a time-series of such data with any amendments. To avoid double counting of landings data, each UK region supplies data for UK landings into its regional ports, and landings by its fleet into non-UK ports.

Quarterly landings are provided by the UK (E&W), UK (Scotland), Belgium and France and annual landings are provided by UK (IOM). The quarterly estimates of landings-at-age into UK (NI) and Ireland are raised to include landings by France, Belgium, UK (E&W), UK (Scotland), UK (IOM) (distributed proportionately over quarters), then summed over quarters to produce the annual landings-at-age.

The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\wgnsds\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, as ASCII files on the Lowestoft format, under **w:\acfm\wgnsds\year\data\whg_7a**.

B.1.2. Discards

The potential magnitude of discarding was evaluated using limited data from the following fleets:

- Northern Ireland self sampling scheme for *Nephrops*. The fisher self-sampling scheme that provides discards data for VIIa whiting was altered in 1996 to record quantities of other species in the samples. The quantity of haddock discarded from the UK (NI) *Nephrops* fishery is estimated on a quarterly basis from samples of discards and total catch provided by skippers. The discards samples contain the heads of *Nephrops* tailed at sea. Using a length–weight relationship, the live weight of *Nephrops* that would have been landed as tails only is calculated from the carapace lengths of the discarded heads. The number of haddock in the discard samples is summed over all samples in a quarter and expressed as a ratio of the summed live weight of *Nephrops* in the discard samples (i.e. those represented as heads only in the samples). The reported live weight of *Nephrops* landed as tails only is then used to estimate the quantity of haddock discarded using the haddock:*Nephrops* ratio in the discard samples. Length–frequencies of haddock in the samples are then raised to the fleet estimate. No otoliths were collected, but the length–frequencies could be partitioned to age class based on appearance of modes and comparison with length-at-age distributions in March and October surveys. The age data from 2001and 2002 were derived using survey and commercial fleet ALKs. The UK (NI) estimates are available since 1996 but the reliability of these estimates has not been determined. Roughly 40 discard samples are collected annually. There are several limitations to these data: only a small subset of single-rig trawlers is sampled; the method of raising to the fleet discards will be affected by any inaccuracies in the reported landings of *Nephrops*; and there are no estimates of landings of whiting from these vessels with which to calculate proportions discarded-at-age. The WG has not used these data in past assessments.
- Northern Ireland observer sampling (all fleets): Length–frequencies from NI (AFBI) observer trips in specified fleet métiers are raised to the trip level, summed across trips during each year or by quarter (if requested) then raised to the annual number of trips per year in the NI fleet in VIIa to give raised annual LFDs for discards. An age–length key from discards trips is then applied to give annual discards by age class and métier.
- Irish otter trawl fleet (IR-OTB). Discards are estimated by observers on Irish trawlers operating in VIIa. Estimates for this fleet are given in the Report of ICES Study Group on Discards and Bycatch Information (ICES CM 2002 ACFM:09). The anomalous high estimate of discards for this fleet in 2001 was a result of an inappropriate raising procedure, and data for this year are not presented. No discard data were available for 2002 as a consequence of a very limited number of sampling trips (n=1). This sampling level has increased in 2003, but is still low (n=6). A re-analysis of the Irish discard data raised to the number of trips, instead of landings, was performed based on methods described by Borges *et al.*, 2005 and provided to the WG in 2005.

B.2. Biological

Natural mortality was assumed to be constant (M=0.2, applied annually) for the whole range of ages and years, in the absence of a direct estimate of natural mortality of Irish Sea haddock.

A combined sex maturity is assumed, knife-edged at age 2 for all years. Recent research on the changes in maturity of the Irish Sea haddock stock conducted by the UK (NI) demonstrated, using a GLM analysis on the effects of year, region, age, and length on the probability of being mature, that maturity is determined differently for male and female haddock. Maturity was found to be predominantly a function of length in male haddock, whereas age was the main factor in females. Interannual variation in the proportion mature was mostly confined to the age 2 group, whereas other age groups were either fully immature or fully mature. Over 99% of 3 year-olds were mature.

The proportion of F and M before spawning are set to zero to reflect a SSB calculation date of 1 January.

Working Groups prior to 2001 used constant weights-at-age over years based on analysis of some early survey data. However, evidence of a decline in mean length of adult haddock over time needed to be reflected in the stock weights-at-age. Since 2001 the WG calculated stock weights are calculated by fitting a von Bertalanffy growth curve to all available survey estimates of mean length-at-age in March, with an additional vector for parameters estimated to allow for year-class effects in asymptotic length. To increase the number of observations for older age classes, the mean lengths-at-age in UK (NI) first-quarter landings were included for age classes three and over. (Comparisons of survey and landings data demonstrated that values from landings were larger than from the survey at ages 1 and 2 because of selectivity patterns in the fishery, but very similar for ages 3 and over.) Stock weights-at-age were calculated from the model-fitted mean lengths-at-age, using length–weight parameters calculated from all March survey samples (2001 WG) or annual length–weight parameters (since 2002 WG). The time-series of length–weight parameters are listed below:

	Length-weight parameters		Expected weight-at-length	
Year	a	B	30 cm	40 cm
1993	0.01132	2.972	278	653
1994	0.00374	3.279	261	669
1995	0.00354	3.291	257	661
1996	0.00565	3.156	259	642
1997	0.00723	3.104	278	680
1998	0.00633	3.119	256	629
1999	0.00449	3.208	246	620
2000	0.00439	3.208	241	606
2001	0.00402	3.242	247	627
2002	0.00369	3.268	247	633
2003	0.00459	3.197	242	607
2004	0.00514	3.156	236	585
2005	0.00489	3.174	238	593
2006	0.00506	3.165	239	595
2007	0.00469	3.194	244	612
2008	0.00523	3.159	242	601

The following model was fitted to the length-at-age data:

$$L_{t,yc} = LI_{yc} .(1\text{-}\exp(\text{-}K(t\text{-}t_0)))$$

where LI_{yc} is the estimated asymptotic length for year class yc. Parameters were estimated using Microsoft Solver in Excel by minimizing $\Sigma(\ln(\text{observed } L_t / \text{expected. } L_t))^2$.

The year-class effects demonstrate a smooth decline from the mid-1990s coincident with the rapid growth of the stock, and may represent density-dependent growth effects. The year-class parameters effectively remove the temporal trend in residuals around a single von Bertalanffy model fit without year-class effects.

To estimate mean weight-at-age for year classes prior to 1990, represented as older fish in the early part of the time-series, the year-class effect for the 1990 year class and length–weight parameters for 1993 were assumed.

B.3. Surveys

Seven research vessel survey-series for haddock in VIIa were available to the Working Group in 2009. In all surveys listed the highest age represents a true age not a plus group.

- UK(NI) groundfish survey (NIGFS) in March (age classes 1 to 6, years 1992–2009)

The survey-series commenced in its present form in 1992. It comprises 45 3-mile tows at fixed station positions in the northern Irish Sea, with an additional 12 one mile tows at fixed station positions in the St George's channel from October 2001 (the latter are not included in the tuning data). The surveys are carried out using a rock-hopper otter trawl deployed from the R.V. Lough Foyle (1992–2004) and the R.V. Corystes since 2005. The survey designs are stratified by depth and seabed type. The mean numbers-at-length per three mile tow are calculated separately by stratum, and weighted by surface area of the strata to give a weighted mean for the survey or group of strata. The survey design and time-series of results including distribution patterns of whiting are described in detail in Armstrong *et al.*, 2003.

- UK(NI) groundfish survey (NIGFS) in October (age classes 0 to 5; years 1991 to 2008)

Description as for UKNI-GFS-March above.

- UK(NI) Methot Isaacs–Kidd (MIK) net survey in June (age 0; years 1994–2008)

The survey uses a Methot Isaacs–Kidd frame trawl to target pelagic juvenile gadoids in the western Irish Sea at 40–45 stations. The survey is stratified and takes place end of May/early June during the period prior to settlement of gadoid juveniles. Indices are calculated as the arithmetic mean of the numbers-per-unit sea area.

- Republic of Ireland Irish Sea-Celtic Sea groundfish survey (IR-ISCSGFS) in November (ages 0 to 5; years 1997–2002)

This survey commenced in 1997 and is conducted in October–November on the R.V. *Celtic Voyager*. The α and β of the series are set to account for the variable timing of this survey within the fourth quarter. The survey uses a GOV otter trawl with standard groundgear and a 20 mm codend liner. The survey operates mainly in the western Irish Sea but has included some stations in the eastern Irish Sea. The survey design has evolved over time and has different spatial coverage in different years. Indices are calculated as arithmetic means of all stations, without stratification by area. The survey was terminated in 2002 as a consequence of a vessel change.

```
IRE OTB [Irish Otter trawl - Effort in hours numbers-at-age in 1000's]
1995 2002
1 1 0 1
2 5
   80314   262     29      15    1
   64824  1257     33       1    1
   92178    96    191       7    1
   93533  1341     95     110    3
  110275    56    471       7    1
   82690   118     17      31    3
   77541   232    251      10    5
   77863    97    174      22    1
```

- Republic of Ireland groundfish survey (IR-GFS) in autumn (age classes 0 to 6, years 2003–2004)

This survey commenced in 2003 and is an IBTS-coordinated survey, conducted in October–November on the R.V. *Celtic Explorer*. The survey is an extension of a survey covering Divisions VI and VIIb–k. A GOV otter trawl with standard groundgear and a 20 mm codend liner is used. Indices are calculated as arithmetic means of all stations, without stratification by area. The survey operated for only two years within the Irish Sea.

```
IR-GFS Autumn [Irish groundfish survey in Autumn (Celtic Explorer)]
2003  2004
1 1 0.89 0.91
0 6
    1170   5520  1069   406     3   4   0   1
    1030   8132  2062   131    46   7   0   0
```

- UK(Scotland) groundfish survey (SCOGFS) in spring (age classes 1 to 6, years 1996–2006)

This survey represents an extension of the Scottish West Coast groundfish survey (Area VI), using the research vessel *Scotia*. The survey gear is a GOV trawl, and the design is two fixed-position stations per ICES rectangle from 1997 onwards (17 stations) and one station per rectangle in 1996 (9 stations). The survey extends from the Northern limit of the Irish Sea to around 53°30'. The survey was terminated in 2006.

```
SGFS Spring [Scottish groundfish survey in Spring – Effort: numbers
caught/10 h]
1997  2006
1 1 0.15 0.21
1 4
       1   6581    65   213     9   2   0
       1    564   472     4     9   0   0
       1    246    21   137     2   1   0
       1    819   338     8    15   0   0
       1     62   299    71     6   5   1
       1    944    72   111    16   0   0
       1    318  1420     7    16   3   0
       1   1591   242   355     0   3   0
       1    514   371    41    40   0   0
       1     97   252    91     0   3   0
```

- UK(Scotland) groundfish survey (SCOGFS) in autumn (age classes 0 to 6, years 1996–2004)

The survey covers a similar area to the ScoGFS in Spring, but has only 11–12 stations. The survey was terminated in 2005.

```
SGFS Autumn [Scottish groundfish survey in Autumn – Effort: numbers
caught/10 h]
1997 2005
1 1 0.83  0.88
0 3
        1     104     437      4     27   1   0   0
        1     291      29     41      2   2   0   0
        1    4988     473      0     22   2   0   0
        1     790     332     38      2   4   0   0
        1    1647     389   1462     27  62  60   7
        1     178     189      2     13   2   0   0
        1     601      86    100      5   2   0   0
        1     394     416     39     18   2   0   0
        1    1399     526    171      9   3   0   0
```

To allow the inclusion of the NIGFS-March and ScoGFS-Spring surveys for the year after the last year with commercial catch data, the surveys may be treated as if they took place at the end of the previous year, and the age range and year range of the surveys are shifted back accordingly in the data files.

B.4. Commercial cpue

Only one historical cpue dataseries were provided to the WG for VIIa haddock.

```
IRE OTB [Irish Otter trawl - Effort in hours numbers-at-age in 1000's]
1995 2002
1 1 0 1
2 5
   80314   262     29      15    1
   64824  1257     33       1    1
   92178    96    191       7    1
   93533  1341     95     110    3
  110275    56    471       7    1
   82690   118     17      31    3
   77541   232    251      10    5
   77863    97    174      22    1
```

B.5. Other relevant data

None.

C. Historical stock development

The 2004–2007 Working Group spent a considerable amount of time exploring the possibility of using TSA, ICA and B-Adapt (which allows for years with missing catch data). The results of these models were unsatisfactory. Because the assessment suffers from poor data quality with a relatively short time-series, from 2004 onwards the WG presented assessments of recent stock trends based on survey data only. The 2004 assessment focused on a Time-Series Analysis (TSA), which allows the 2003 commercial catch data to be treated as missing. Since 2005 a Survey Based Assessment (SURBA) was used; which is considered to give a reliable picture of the status of the stock at least for SSB and recruitment.

Model used: SURBA

Software used: SURBA version 3.0

Model Options chosen:

	WGNSDS 2005	WGNSDS 2006	WGNSDS 2007	WGNSDS 2008
Year range:	1992–2005	1992–2006	1992–2007	1992–2008
Age range:	1–4	1–5	0–5	1–5
Catchability:	1.0 at all ages	1.0 at all ages	1.0 at all ages	1.0 at all ages
Age weighting	1.0 at all ages	1.0 at all ages	1.0 at all ages	1.0 at all ages
Smoothing (Lambda):	1.0	1.0	1.0	1.0
Cohort weighting:	not applied	not applied	not applied	not applied
Reference age	2	2	1	2
Survey used	NIGFS-Mar	NIGFS-Mar	NIGFS-Mar, NIGFS-Oct	NIGFS-Mar

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 2	NIGFS-Mar	1992–(last data year)	1–5

The 2005 WG performed an extensive analysis of survey data for Irish Sea haddock. The effect of smoothing (lambda=1.0 and 0), fitting constant catchability (1.0 for all ages) or variable catchability-at-age and the choice of reference age were explored. The results indicated that the choice of catchability-at-age and using different values for the smoothing parameter had very little effect on the temporal trends in SSB or recruitment, and a lambda value of 1.0 reduces the noise in Z without over-smoothing the trends. Changing the reference age had very little effect on the results.

The VIIa haddock stock has been assessed prior to the 2004 WG using XSA with the following model setting and input data:

Model used: XSA

Software used: Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for ages 1–3

Catchability independent of age for ages >= 3

Survivor estimates shrunk towards the mean F of the final 5 years or the oldest age

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch-in-tonnes	1993 – last data year	0 – 5+	Yes
Canum	Catch-at-age in numbers	1993 – last data year	0 – 5+	Yes
Weca	Weight-at-age in the commercial catch	1993 – last data year	0 – 5+	Yes
West	Weight-at-age of the stock at spawning time.	1993 – last data year	0 – 5+	Yes: uses growth model from UK (NI) March GFS data
Mprop	Proportion of natural mortality before spawning	1993 – last data year	0 – 5+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1993 – last data year	0 – 5+	No – set to 0 for all ages in all years
Matprop	Proportion mature-at-age	1993 – last data year	0 – 5+	No – the same ogive for all years
Natmor	Natural mortality	1993 – last data year	0 – 5+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	NIGFS-Oct	1991–last data year	0–3
Tuning fleet 2	NIGFS-Mar (adjusted)	1991–(last data year-1)	0–3
Tuning fleet 3	ScoGFS-Spring (adjusted)	1996–(last data year-1)	0–3
Tuning fleet 4	MIK net May/June	1994–last data year	0

For details of procedures see WG reports from WGNSDS 1997–2007.

D. Short-term projection

No short-term forecast has been performed for this stock since 2003.

Short-term inputs prior to 2004 are given below:

Model used: Age structured

Software used*:* MFDP prediction with management option table and yield-per-recruit routines. MLA suite (WGFRANSW) used for sensitivity analysis and probability profiles.

Initial stock size. Taken from the XSA for age 1 and older. The recruitment-at-age 0 in the last data year is estimated as a short-term GM (1993 onwards).

Natural mortality: Set to 0.2 for all ages in all years

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

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

Weight-at-age in the stock: average stock weights for last three years.

Weight-at-age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years. Landings F's are varied in the management option table.

Intermediate year assumptions: status quo F

Stock recruitment model used: None, the short-term geometric mean recruitment-at-age 0 is used

Procedures used for splitting projected catches: F vectors in each of the last three years of the assessment are multiplied by the proportion landed-at-age to give partial Fs for landings. The vectors of partial Fs are then averaged over the last three years to give the forecast values.

E. Medium-term projections

No medium-term projections are done for this stock as the short time-series of stock and recruitment estimates precluded any meaningful prediction of the medium-term dynamics of the stock.

F. Yield and biomass per recruit/long-term projections

Last calculations of yield-per-recruit reference points was by WGNSDS 2004 based on the exploitation patterns from XSA fitted to data out to a 5+ group.

Model used: yield and biomass per recruit over a range of F values that may reflect fixed or variable discard F's.

Software used: MFYPR

Selectivity pattern: mean F array from last three years of assessment (to reflect recent selection patterns).

Stock and catch weights-at-age: long-term mean (1993 onwards).

Proportion discarded: partial F vectors are the recent average

Maturity: Fixed maturity ogive as used in assessment.

Procedures used for splitting projected catches: None required

G. Biological reference points

The ACFM view on this stock (ACFM, October 2002) is that there is currently no biological basis for defining appropriate reference points, in view of the rapid expansion of the stock size over a short period. ACFM proposes that F_{pa} be set at 0.5 by association with other haddock stocks. The absolute level of F in this stock at present is poorly known. The point estimate of F(2–4) for 2002 (0.89), however, is above F_{pa}.

H. Other issues

None.

I. References

Armstrong, M.J., Peel, J., McAliskey, M., McCurdy, W., McCorriston, P. and Briggs, R. 2003. Survey indices of abundance for cod, haddock and whiting in the Irish Sea (Area VIIaN): 1992–2003. Working Document No. 3 submitted to 2003 meeting of ICES Working Group on Assessment of Northern Shelf Demersal Stocks. 33pp.

Borges, L., Zuur, A.F., Rogan, E. and Officer, R. 2005. Choosing the best sampling unit and auxiliary variable for discards estimations. Working Document No. 3 submitted to 2005 meeting of ICES Working Group on Assessment of Northern Shelf Demersal Stocks. 25pp.

6.4 Stock Annex Irish Sea East *Nephrops* (FU14)

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Irish Sea East *Nephrops* (FU14)
Working Group	Assessment of Northern Shelf Demersal Stocks
Date	May 2010

A. General

A.1. Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 30–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small-scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the eastern Irish Sea the *Nephrops* stock inhabits an area of muddy sediment extending along the Cumbria coast and its fishery contributes to less than 10% of overall Irish Sea landings. There is little evidence of mixing between the east and west Irish Sea stocks due to the nature of water current movements in the Irish Sea. The two are treated as separate populations since they have differing population characteristics.

A.2. The fishery

Between 1999 and 2003 the number of vessels fishing for *Nephrops* in FU14 declined by 40% to a fleet of around 50 vessels. This was largely due to the reduction in the number of visiting UK vessels and the decommissioning of part of the Northern Irish and local English fleets. Since then the number of vessels fishing the area has returned to around 80 vessels mainly from Northern Ireland. Currently, around 30 of these vessels, between six and 23 m in length, have their 'home' ports in Whitehaven, Maryport and Fleetwood, England. The rest of the fleet is generally made up of larger vessels from Kilkeel or Portavogie, Northern Ireland.

Between 1987 and 2006, landings from FU14 appeared relatively stable, fluctuating around a long-term average of about 550 t. Landings in 2007, however bucked this trend, and are at their highest level since 1978 at 959 t, this is after landings dropped in 2003 to their lowest apparent level since 1974. The 2008 and 2009 figures of 676 and 694 t respectively are lower than 2007 still remains high, above any other figure recorded since 1990. The introduction of the buyers and sellers legislation in 2006 really precludes direct comparison with previous years as reporting levels are considered to have significantly improved since.

Over the last ten years UK vessels have landed, on average, 87% of the reported annual international landings. ROI vessels increased their share of the landings to 35% in 2002 but it has since declined to 2% in 2009. In 2009, most of the landings were made into England with a large proportion of these landings (67% of the directed landings and 62% of the total landings) being made by visiting Northern Irish vessels. UK *Nephrops* directed effort has fluctuated around a downward trend since 1993 but has remained relatively stable since 2003 fluctuating around a mean of 13 800 hrs. Changes to recording practices will affect interpretation of the scale of this decline but a decline is real.

The changes to the structure and landing practices of the Northern Irish fleet (see above) will have had some impact on this dataseries. From 2002–2004, fewer of the Northern Irish fleet were landing in England. The differences between lpue figures for individual vessels suggest that earlier years may have included less truly directed effort. Reductions in quota between 2002 and 2006 for VIIa cod and plaice may have restricted total effort in FU14 thereby reducing the more casual effort on *Nephrops*. Further research is needed to better define the directed fishery. From 2003 the main fleets targeting *Nephrops* include *Nephrops* directed single-rig and twin-rig otter trawlers operating out of ports in UK (NI), UK (E&W) and Ireland.

Regulations

Regulations introduced as part of a revised package of EC Fisheries Technical Conservation measures in 2000 remain in place. This legislation incorporates a system of 'mesh size ranges' for each of which has been identified a list of target species. In effect, nets in the 70–79 mm mesh size range must have at least 35% of the list of target species (which includes *Nephrops*) and the 80–99 mm mesh size range requires at least 30% of the list of target species. A square mesh panel (SMP) of 80 mm is required for 70–79 mm nets in the Irish Sea. Vessels using twin-rig gear in the Irish Sea must comply with a minimum mesh size of 80 mm (no SMP is required for nets with 80 mm meshes and above).

Other regulations restricting trawling in other fisheries within the Irish Sea will affect effort on these and other stocks. This could either attract local effort or even relocate effort to fisheries in other areas. Although unrestrictive the result of better catch information through the buyers and sellers legislation introduced to the UK from 2006 will have the same effect as quota uptake of stocks which used to be misreported will be quicker.

As well as an Area VII TAC other *Nephrops* conservation measures in the Irish Sea are a minimum landing size of 20 mm CL length (equivalent to 37 mm tail length or 70 mm total length).

In addition to *Nephrops* measures the cod spawning areas of the Irish Sea are closed to whitefish directed vessels between 14th February to 30th April part of the Irish Sea cod recovery plan. There is derogation for *Nephrops* vessels during this closure.

A.3. Ecosystem aspects

The Working Group has collated no information on the ecosystem aspects of this stock.

B. Data

B.1. Commercial catch

Length and sex compositions of *Nephrops* landed from the Irish Sea East are estimated from port sampling by England and Wales. Length data from this sampling are applied to catch samples collected at sea and raised to total international landings. Catch length samples are collected independently of landings length samples but both are considered representative. The independent raising process means that the final annual catch length frequency distribution still requires scaling to the reported landings. Using a discard ogive derived from samples collected in the early 1990s an initial estimate of discards is taken from the catch distribution. These are then added to the landings distribution to create a dummy catch distribution. The difference between the numbers-at-length for both the raised sampled and dummy catch distribution was then used to tune a raising factor by minimizing the sums of squares. Once the raising factor is derived, the final discard length distribution is the difference between the raised catch distribution and the landings distribution and a final catch distribution is a sum of the landings and discard distributions. In 2008 a new discard ogive was calculated from the discard samples collected from 2003 until March 2008 and applied to the 2003 data to date. The lack of discard and catch data between 1995 and 1999 is likely to adversely affect the quality of any analytical assessments. Apparent differences between catch LFDs and discard practices in 1992 to 1994 and 1999 to 2000 are discussed in the Section 5.12 of the 2001 WGNEPH report (ICES, 2001a). 2001 and 2002 catch and landings sampling provided catch compositions to help estimate the LFDs for the missing years. Quarterly discard distributions for the years 1995 to 1999 were estimated by using the discard LFDs for the two preceding and the two following years.

Trial XSAs using these data were attempted at the 2003 WG*NEPH*. In the absence of routine methods of direct age determination in *Nephrops*, age compositions of removals were inferred from length compositions by means of 'slicing'. This procedure, introduced at the 1991 WG, uses von Bertalanffy growth parameters to determine length boundaries between age classes. All animals in length classes between boundaries are assigned deterministically to the same age class. The method was implemented in the L2AGE programme which automatically generated the VPA input files. The programme was modified in 1992 to accommodate the two-stage growth pattern of female *Nephrops* (ICES, 1992) and again in 2001 to separate 'true' as opposed to 'nominal' age classes (ICES, 2001a). The age classes are 'true' to the extent that the first slicing boundary, i.e. lower length boundary for 'age' 0, is the *length-at-age* zero rather than the lowest length in the data. This was to ensure comparability of 'age' classes across stocks.

B.2. Biological

Mean weights-at-age for this stock are estimated from studies by Bailey and Chapman, 1983.

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

The time-invariant values used for proportion mature-at-age are: males age 1+: 100%; females age 1: 0%; age 2+: 100%. The source of these values is not known.

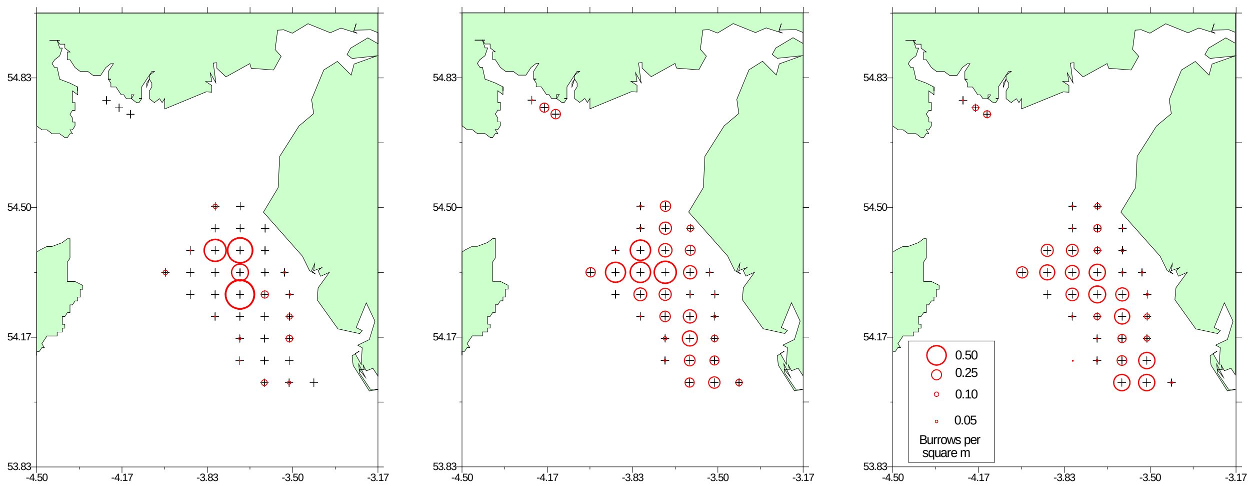
Proportion of F and M prior to spawning was specified as zero to give estimates of spawning–stock biomass at January 1. In the absence of independent estimates, the mean weights-at-age in the total catch were assumed to represent the mean weights in the stock.

B.3. Surveys

ACFM recommended that UWTV surveys could provide useful fishery-independent data on the status of *Nephrops* stocks. The UWTV surveys conducted in August 2007 and 2008 are presented here as a preliminary to future assessments. Two previous UWTV surveys were conducted for this fishery in 1997 and 1998 with limited success, because of weather. These surveys and their design were documented at WKNEPHTV (ICES, 2007). The surveys in 2007 and 2008 are consistent but follow a different design to the earlier surveys. For ease of comparison, and consistency, the survey has been based on the current ROI and NI survey in the Western Irish Sea. A randomized fixed grid (3.4 x 3.4 nm) of 34 stations plus a transect of three stations in Wigtown bay were sampled. Figure B.3.1 shows the distribution of stations in the TV surveys with the size of the symbol reflecting the *Nephrops* burrow density.

The survey protocols used were the same, and followed the standards set by WKNEPHTV (ICES, 2007). In 2007 poor visibility hampered the survey and despite repeated attempts at over 15 stations, turbidity scores precluded the use of some of the counts. On first analysis only 20 were considered usable. The 2008 and 2009 survey was far more successful, sea conditions were far better and the quality of the video data collected was much improved. 35 and 32 stations respectively were considered useable. Table B.3.1 provides the estimates for the burrow density and abundance.

These are the first two of a planned series of surveys. Because of uncertainties about the limits of the stock and characteristics of this fishery and in light of SGSURV and WK*NEPH* (2009) the data will require further analysis and a further survey to qualify the precision of these estimates. These results therefore are only presented as provisional.



2007 2008 2009

Figure B.3.1. Station distribution and relative burrow density, from August TV surveys 2007 to 2009.

Table B.3.1. Irish Sea East (FU14): Results from NI UWTV survey of *Nephrops* ground.

Year	Area	No. stations	Non Zero stations	Mean burrow density	Abundance
	km²			no./m²	millions
2007*	1043	20	18	0.38	393
2008*	1043	35	31	0.36	334
2009*	1043	32	28	0.25	257

*** provisional.**

A number of factors are suspected to contribute bias to the surveys. In order to use the survey abundance estimate as an absolute it is necessary to correct for these potential biases. The history of bias estimates are given in the following table and are based on expert opinion on those used in adjacent survey areas which used simulation models, and preliminary experimentation. The biases associated with the estimates of *Nephrops* abundance in the E. Irish Sea are:

	Time period	Edge effect	Detection rate	Species identification	Occupancy	Cumulative bias
FU14: Irish Sea East	<=2009	1.3	0.75	1.15	1	1.2

Edge effect: Same sledge and set up as Western Irish Sea. Larger burrows systems increase the edge effect.

Detection rate: Same sledge and set up as Western Irish Sea and same staff so detection rate maintained.

Species identification: Factor kept the same as Eastern Irish Sea; *Calocaris* spp not a perceived problem on Eastern Irish Sea grounds but *Goneplax* spp. are prevalent across the ground.

B.5. Other relevant data

When carrying out the XSA in 2003 the landings per unit of effort time-series for the following fleet was used:

England and Wales *Nephrops* trawl gears. Landings-at-age and effort data from this fishery are used to generate a cpue index. There is also a cpue series from 1995 for Republic of Ireland vessels. Catch-at-age are estimated by raising length sampling of discards and landings to officially recorded landings and slicing into ages (knife-edge slicing using growth parameters). Cpue is estimated using officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for *Nephrops* trawlers is raised to landings. Discard sampling commenced in 1992 for this fishery, though some years have been missed as discussed above. There is no account taken of any technological creep in the fleet.

C. Historical stock development

D. Short-term projection

E. Medium-term projections

F. Yield and biomass-per-recruit/long-term projections

G. Biological reference points

H. Other issues

I. References

Biological Input Parameters

Parameter	Value	Source
Discard Survival	0.00	
MALES		
Growth - K	0.160	Irish Sea West data ; Bailey and Chapman (1983)
Growth - L(inf)	60	"

Natural mortality - M	0.3	Brander and Bennett (1986, 1989)
Length/weight - a	0.00022	Hossein *et al*. (1987)
Length/weight - b	3.348	"
FEMALES		
Immature Growth		
Growth - K	0.160	Irish Sea West data ; Bailey and Chapman (1983)
Growth - L(inf)	60	"
Natural mortality - M	0.3	Brander and Bennett (1986, 1989)
Size-at-maturity	24	Briggs (1988)
Mature Growth		
Growth - K	0.100	Irish Sea West data ; Bailey and Chapman (1983)
Growth - L(inf)	56	"
Natural mortality - M	0.2	Brander and Bennett (1986, 1989)
Length/weight - a	0.00114	Hossein *et al*. (1987)
Length/weight - b	2.820	"

6.5 Stock Annex Irish Sea West *Nephrops* (FU15)

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Irish Sea West *Nephrops* (FU15)
Working Group	WK*NEPH* 2009 (WK*NEPH*2009)
Date	6 March 2009

A. General

A.1. Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 10–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small-scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the western Irish Sea the *Nephrops* stock inhabits an extensive area of muddy sediment between the Isle of Man and Northern Ireland and its fishery contributes to more than 90% of overall Irish Sea landings. There is little evidence of mixing between the east and west Irish Sea stocks due to the nature of water current movements, which is characterized in the west by a gyre, which has a retention effect on both sediment and larvae. The eastern and western *Nephrops* stocks are treated as separate populations as they have different population characteristics.

A.3. Ecosystem aspects

A number of studies have examined *Nephrops* larvae distribution in order to examine how recruitment may impinge upon the distribution of a "catchable" (adult) *Nephrops* population and the maintenance of the population. Hillis (1968) found that although generally the larvae occupied the same areas as the adults, there was some evidence of advective losses to the southeastern part of their range, most probably due to tidal currents (White *et al.*, 1988). More recent studies in the western Irish Sea have uncovered the existence of a seasonal cyclonic gyre which appears to facilitate retention of larvae over the mud patch (Dickey-Collas *et al.*, 1996; Hill *et al.*, 1996; Horsburgh *et al.*, 2000).

B. Data

B.1. Commercial catch

Length and sex compositions of *Nephrops* landed from the Irish Sea West are estimated from port sampling by Ireland and Northern Ireland and Ireland. A lack of cooperation by the Northern Ireland industry prevented sampling commercial catches over the period 2003–2007. The Irish LFDs are therefore raised to the international catch for these years. Northern Ireland sampling resumed in 2008 and these data are combined with those from Ireland for that year. Sample data are used to compute international removals (Landings + dead discards).

Landings per unit of effort time-series are available from the following fleets:

Northern Ireland *Nephrops* trawl gears. Landings-at-age and effort data from this fishery since 1986 are used to generate a cpue index. There is also a cpue series since

1995 for a subset of Republic of Ireland *Nephrops* vessels. Catch-at-age are estimated by raising length sampling of discards and landings to officially recorded landings and slicing into ages (knife-edge slicing using growth parameters). Cpue is estimated using officially recorded effort (hours fished). Discard sampling commenced in the mid-1980s by Northern Ireland and the Republic of Ireland. There is no account taken of any technological creep in the fleet.

B.2. Biological

Mean weights-at-length for this stock are estimated from studies by Pope and Thomas (1955).

A natural mortality rate of 0.3 was assumed for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

Maturity for females is taken as 22.1 mm carapace length (McQuaid *et al*., 2006).

Proportion of F and M prior to spawning was specified as zero to give estimates of spawning–stock biomass at January 1. In the absence of independent estimates, the mean weights-at-age in the total catch were assumed to represent the mean weights in the stock.

B.3. Surveys

Ireland and Northern Ireland jointly carry out underwater television (UWTV) surveys on the main *Nephrops* grounds in the western Irish Sea (Figure 1) since 2003. These surveys are based on a randomized fixed grid design. The methods used during the survey are similar to those employed for UWTV surveys of *Nephrops* stocks elsewhere and are detailed in WKNEPHTV, 2007 and WKNEPHBID, 2008.

Northern Ireland have carried out a spring (April) and summer (August) *Nephrops* trawl surveys since 1994. These surveys provide data on catch rates and length frequency distributions from of stations throughout in the western Irish Sea. These surveys generate data on *Nephrops* size composition, mean size, maturity and sex ratio.

A number of factors are suspected to contribute bias to the UWTV surveys. In order to use the survey abundance estimate as an absolute it is necessary to correct for these potential biases. The history of bias estimates are given in the following table and are based on simulation models, preliminary experimentation and expert opinion, the biases associated with the estimates of *Nephrops* abundance in the Irish Sea West are:

	Time period	Edge effect	detection rate	species identification	occupancy	Cumulative bias
FU15: Irish Sea West	<=2009	1.24	0.75	1.15	1	1.14

B.4. Commercial cpue

B.5. Other relevant data

Table 1 is a summary of available data along with an assessment of its reliability.

Table 2 is a summary of assessment parameters.

C. Historical stock development

1) Survey indices are worked up annually resulting in the TV index.

2) Adjust index for bias (see Section B.3). The combined effect of these biases is to be applied to the new survey index.

3) Generate mean weight in landings. Check the time-series of mean landing weights for evidence of a trend in the most recent period. If there is no firm evidence of a recent trend in mean weight use the average of the three most recent years. If, however, there is strong evidence of a recent trend then apply most recent value (don't attempt to extrapolate the trend further in future).

D. Short-term projection

1) The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and F_{max}. These values have been estimated by the Benchmark Workshop (see Section 9.2) and are to be revisited by subsequent benchmark groups. The values are FU specific and have been put in the Stock Annexes.

2) Create catch option table on the basis of a range of harvest ratios ranging from 0 to the maximum observed ratio or the ratio equating to F_{MAX}, whichever is the larger. Insert the harvest ratios from step 4 and also the current harvest ratio.

3) Multiply the survey index by the harvest ratios to give the number of total removals.

4) Create a landings number by applying a discard factor. This conversion factor has been estimated by the Benchmark Workshop and is to be revisited at subsequent benchmark groups. The value is FU specific and has been put in the Stock Annex.

5) Produce landings biomass by applying mean weight.

The suggested catch option table format is as follows.

			Implied fishery	
	Harvest rate	Survey Index	Retained number	Landings (tonnes)
	0%	12 345	0	0.00
	2%	"	247	123.45
	4%	"	494	246.90
	6%	"	741	370.35
	8%	"	988	493.80
$F_{0.1}$	8.60%	"	1062	530.84
	10%	"	1235	617.25
	12%	"	1481	740.70
F_{MAX}	13.50%	"	1667	833.29
	14%	"	1728	864.15
	16%	"	1975	987.60
	18%	"	2222	1111.05
	20%	"	2469	1234.50
	22%	"	2716	1357.95
$F_{current}$	21.5%	"	2654	1327.09

E. Medium-term projections

None presented.

F. Long-term projections

None presented.

G. Biological reference points

Harvest ratios equating to fishing at $F_{0.1}$ and F_{MAX} were calculated in WK*Neph* (2009). These calculations assume that the TV survey has a knife-edge selectivity at 17 mm and that the supplied length frequencies represented the population in equilibrium.

$F_{0.1}$ = 10.9%

F_{MAX}= 20.2%

I. References

Dickey-Collas, M., Gowen, R.J. and Fox, C.J. 1996. Distribution of larval and juvenile fish in the western Irish Sea: Relationship to phytoplankton, zooplankton biomass and recurrent physical features. *Marine and Freshwater Research* 47: 169–181.

Horsburgh, K.J., Hill, A.E., Brown, J., Fernand, L., Garvine, R.W., Angelico, M.M.P. 2000. Seasonal evolution of the cold pool gyre in the western Irish Sea. *Progress in Oceanography* 46: 1–58.

Hill, A.E., Brown, J. and Fernand, L. 1996. The western Irish Sea gyre: a retention mechanism for the Norway Lobster (*Nephrops norvegicus)* *Oceanologica Acta* 19: 357–369.

Hillis, J.P. 1968. Larval distribution of *Nephrops norvegicus* (L.) in the Irish Sea and North Channel. *ICRES C.M*. 1968. Doc. No. K6. (Mimeo).

McQuaid, N., Briggs, R.P.and Roberts, D. 2006. Estimation of the size of onset of sexual maturity in *Nephrops norvegicus* (L.). *Fisheries Research*.

White, R.G., Hill, A.E. and Jones, D.A. 1988. Distribution of *Nephrops norvegicus* (L.) larvae in the western Irish Sea: an example of advective control on recruitment. *Journal of Plankton Research* 10(4): 735–747.

Table 1. Summary table of available data.

FU15 Irish Sea West: Data Available															
Data															
Commercial Data	pre-1995	1994	1995	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Landings															
Effort															
cpue/lpue															
Mean size															
Sex ratio															
LFDs															
Catch															
Landings															
Discards															
Survey Data															
***Trawl survey*s**															
Catch rate															
mean size															
LFDs															
Sex ratio															
Camera Surveys															
Density estimate															
Data Quality															
Poor															
Acceptable															
Reliable															

Table 2. Biological Input Parameters.

Parameter	Value	Source
Discard Survival	0.10	ICES (1991a)
Discard rate	40.2%	2007 discard sampling.
MALES		
Growth - K	0.160	Hillis (1979) ; ICES (1991a)
Growth - L(inf)	60	"
Natural mortality - M	0.3	Brander and Bennett (1986, 1989)
Length/weight - a	0.00032	After Pope and Thomas (1955; data for Scottish stocks)
Length/weight - b	3.210	"
FEMALES		
Immature Growth		
Growth - K	0.160	Hillis (1979) ; ICES (1991a)
Growth - L(inf)	60	"
Natural mortality - M	0.3	Brander and Bennett (1986, 1989)
Size-at-maturity	22.1	McQuaid *et al*., 2006
Mature Growth		
Growth - K	0.100	Hillis (1979) ; ICES (1991a)
Growth - L(inf)	56	"
Natural mortality - M	0.2	Brander and Bennett (1986, 1989)
Length/weight - a	0.00068	After Pope and Thomas (1955; data for Scottish stocks)
Length/weight - b	2.960	"

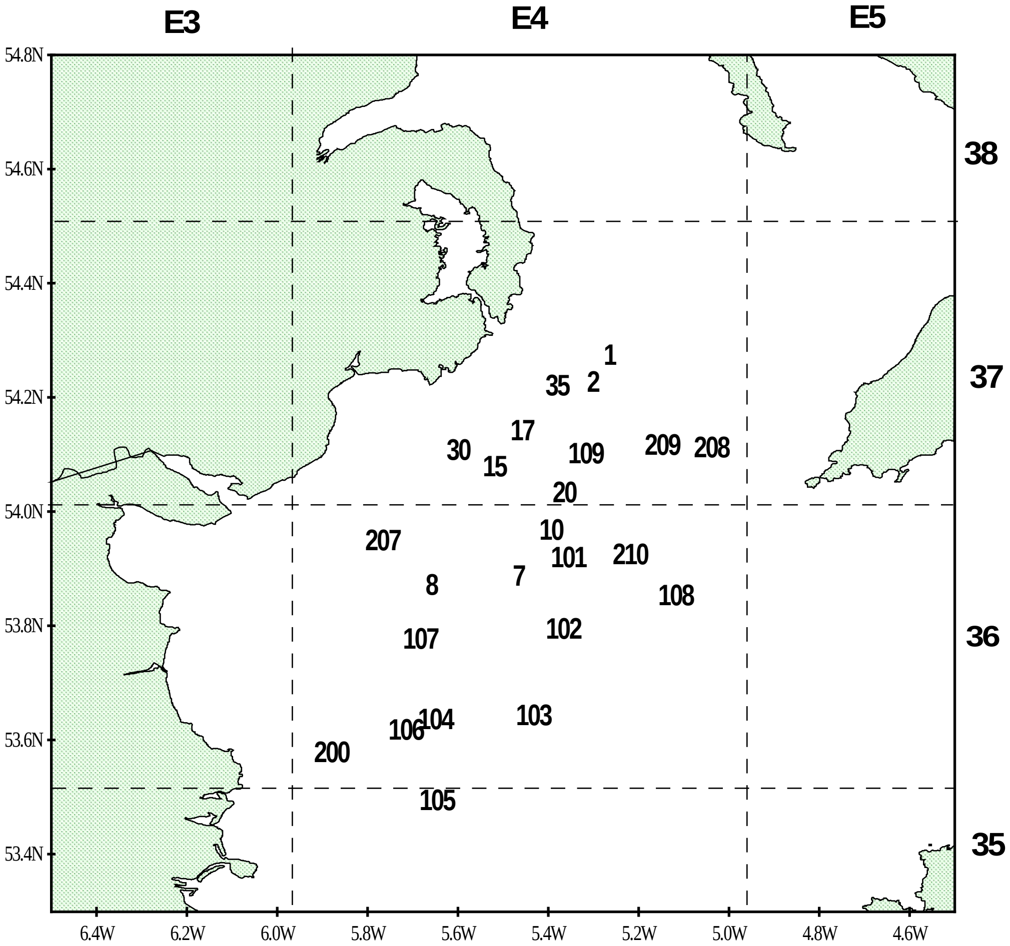


Figure 1: Western Irish Sea Nephrops stations

6.6 Stock Annex Whiting VIIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Irish Sea Whiting (Division VIIa)
Working Group	Assessment of Northern Shelf Demersal Stocks
Last updated	WGCSE 2011
Updates	Inclusion of Fishery Data from Ireland

A. General

A.1. Stock definition

Whiting in Division VIIa are considered a single stock for management purposes. In 2004 an informal meeting was established to review current knowledge of the distribution, movements and stock structure of whiting in the Irish Sea, and linkages between whiting in the Irish Sea and surrounding management areas. Information on egg and larval, tagging, survey studies was presented as a working document (WD10) in WGNSDS, 2005. The results of this are synopsized below:

UK egg and larva surveys have shown that whiting spawn in spring throughout the eastern Irish Sea and in the coastal waters of the western Irish Sea. This is supported by the distribution of actively spawning fish caught during trawl surveys in March.

Transport of whiting eggs, larvae or pelagic prerecruits from Celtic Sea spawning grounds into the Irish Sea is likely to be impeded by the Celtic Sea thermal front that becomes increasingly established from spring onwards.

Whiting recruitment grounds are in the same general area as the spawning grounds, and young whiting are widespread in the coastal bights of the Irish Sea. The gyre system that becomes established from late spring onwards in the western Irish Sea appears important in retaining larvae and pelagic prerecruits of whiting, as shown by the results of frame-trawl surveys of pelagic prerecruits in the western Irish Sea.

As the whiting become demersal from late summer onwards, they are found throughout the western Irish Sea although densities appear highest around the periphery of the mud patch in coastal waters and along the southern boundary between Ireland and the Isle of Man. This pattern is also noted by fishermen operating in this area. Densities of young whiting in the eastern Irish Sea appear highest off Cumbria and the Solway Firth in autumn, but are more widespread in spring.

Tagging studies in the late 1950s show some seasonal dispersal of whiting from the Irish Coast to as far as the Clyde, Liverpool Bay and the Celtic Sea, with evidence of return migrations. Whiting tagged in these studies ranged from about 20–40 cm, averaging around 30 cm. Whiting recaptured well away from the tagging sites off County Down in the western Irish Sea tended to be several cm larger, on average, than the tagged whiting.

Both the western Irish Sea and the Clyde have historically been characterized b catches of immature and first-maturing whiting, whereas the eastern Irish Sea has a broader age-range of whiting. This pattern persists to the present day.

The evidence of interchange of whiting between the western Irish Sea and other areas within the Irish Sea precludes treating different areas within the Irish Sea as containing functionally separate stocks. Spatial modelling of the populations would require information on rates of dispersal between areas.

Trawl surveys continue to show that juvenile whiting are very abundant in the coastal waters of the Irish Sea, and that whiting are one of the most abundant fish species taken in the surveys. Hence, there have been no indications of depressed recruitment associated with the apparent steep decline in abundance of large whiting. Length at 50% maturity in female whiting is only 20–21 cm in the Irish Sea and neighbouring management areas, and spawning appears predominantly by young whiting of 1–3 years old.

A.2. The fishery

Most landings by the Irish and UK (NI) fleet, which take the bulk of the Division VIIa whiting catch, are from the western Irish Sea (ICES CM 2003/ACFM:04) and are made predominately by single- and twin-rig trawlers. A small number of UK pairtrawlers also fish for whiting. The UK(E&W) fleet has declined substantially over time, and the bulk of its landings are from inshore otter trawlers targeting mixed flatfish and roundfish in the eastern Irish Sea. Discarding in this stock is thought to be high in all fleets, particularly in the *Nephrops* fishery. The *Nephrops* directed fishery operates on the main whiting nursery areas in the western Irish Sea, and is particularly intensive in summer. The mesh size mainly in use in the fishery is 70 mm in single trawls and 80 mm in twin trawls targeting *Nephrops*. The western Irish Sea fishery for whiting has declined substantially in recent years, and the increase in abundance of haddock has resulted in few vessels targeting whiting.

Vessels operating with 70 mm and 80 mm mesh are required to use square mesh panels. Square mesh panels were introduced as a technical measure to reduce fishing mortality on whiting. Square mesh panels have been mandatory for all UK trawlers (excluding beam trawlers) in the Irish Sea since 1993 and for Irish trawlers since 1994. While the effects of this technical measure have not been formally evaluated, the *Nephrops* fishery still generates substantial quantities of whiting discards. Effort by Irish *Nephrops* trawlers in the main areas of whiting bycatch has shown some reduction during the period of the Irish Sea cod recovery plan closures. However, the summer peak in activity of the *Nephrops* fishery was not affected by the recovery plans. As the activities of the *Nephrops* fleet were not restricted by the cod recovery plan, it is unlikely that the recovery plan was effective in reducing levels of discarding in this stock.

There has been some recent decommissioning of vessels in the Irish Sea. Ireland introduced a further decommissioning scheme in 2008 with the aim of removing 11 140 GT from the fleet register. This is targeted at vessels over 10 years of age and >18 m in length. The reported landings of whiting in 1999–2001 by UK vessels decommissioned in 2002 amounted to about 7% of the total international landings of whiting in those years. While few new Irish vessels have joined the fishery, some vessels from County Donegal have reported catches of whiting in VIIa. These vessels have been attracted into the Celtic Sea fishery in recent years in response to poor catches in other areas. Irish landings of whiting in the southwestern part of VIIa now contribute the bulk of the total Irish landings in the Division (ICES CM 2003/ACFM:04). The difference in grounds in the southern part of VIIa means that whiting in the area are more likely to function as part of the Celtic Sea stock rather than the Irish Sea stock.

Irish otter board trawlers fishing ICES area VIIa generally use twin-rig gear to fish for *Nephrops*. However there are also localized mixed fisheries both in the north and south ends of VIIa. The Irish Sea *Nephrops* fleet is highly opportunistic and of this fleet, there are only a handful of boats that fish the Irish Sea Prawn Grounds 100% of the time. The rest of the fleet divides its time between the Irish Sea, Smalls, Aran and Porcupine Grounds dependant on tides, weather and market forces. In late 2009 and 2010, a number of Irish vessels operating within the Irish Sea *Nephrops* fishery incorporated a Swedish grid into otter trawls, as part of the cod long-term management plan. It is expected that this will reduce the whiting catches of these vessels by ~60% in weight. Furthermore, a small number of vessels began utilizing an inclined separator panel expected to reduce whiting catch by ~75% in weight (STECF, 2010). Preliminary Irish discard data shows a reduction in 45% by number of whiting on boats using these gear technology mitigation measures.

In recent times, *Nephrops* landings from the Smalls grounds (VIIg) have surpassed those from the Irish Sea grounds. This reflects the increasing amount of effort by east coast vessels in VIIg where in general, better prices are obtained for their catch. The main species targeted by the otter trawl fleet are *Nephrops*, cod, ray, haddock, anglerfish and whiting. The Irish beam trawl fleet predominantly targets black sole and other high-quality flatfish and divides its effort between VIIa and VIIg depending on weather, tides and market forces.

For the UK NI fleet decommissioning at the end of 2003 removed 19 out of 237 UK vessels that operated in the Irish Sea, representing a loss of 8% of the fleet by number and 9.3% by tonnage. Of these vessels, 13 were vessels that used demersal trawls with mesh size >=100 mm. The previous round of decommissioning in 2001 removed 29 UK(NI) *Nephrops* and whitefish vessels and four UK(E&W) vessels registered in Irish Sea ports at the end of 2001. Of these, 13 were vessels that used demersal trawls with mesh size >=100 mm.

A.3. Ecosystem aspects

Recruitment in Irish Sea whiting appears less variable than in cod and haddock, although there is some similarity in the timing of strong and weak year classes that may indicate a similar response to changes in environmental conditions affecting spawning or early stage survival. The diet of Irish Sea whiting has been examined in some detail since the 1970s using samples collected from research vessels. Cannibalism occurs in adult whiting; however the effect of this on the assessment of the stock has not yet been investigated. Young whiting are common in the diets of larger predators such as cod and anglerfish.

B. Data

B.1. Commercial catch

B.1.1. Landings

The following table gives the source of landings data for Irish Sea whiting:

	Kind of data				
Country	Caton (catch-in-weight)	Canum (catch-at-age in numbers)	Weca (weight-at-age in the catch)	Matprop (proportion mature-by-age)	Length composition-in-catch
UK(NI)	X	X	X	X	X
UK(E&W)	X	X	X		X
UK(Scotland)	X		X		
UK (IOM)	X				
Ireland	X	X	X		X
France	X				
Belgium	X				
Netherlands	X				

Quarterly landings and length/age composition data are supplied from databases maintained by national Government Departments and research agencies. These figures may be adjusted by national scientists to correct for known or estimated misreporting by area or species. Data are supplied on paper or Excel files to a stock coordinator nominated by ICES Northern Shelf Demersal Working Group, who compiles the international landings and catch-at-age data, and maintains a time-series of such data with any amendments. To avoid double counting of landings data, each UK region supplies data for UK landings into its regional ports, and landings by its fleet into non-UK ports.

The UK(E&W) currently supplies raised quarterly length frequencies of landings but only sporadic age data. The catch and mean weight-at-age are estimated using combined UK (NI) and Irish quarterly length–weight relationships and age–length keys. Quarterly landings are provided by the UK(Scotland), Belgium and France and annual landings are provided by UK(IOM). The quarterly estimates of landings-at-age into UK(E&W), UK(NI) and Ireland are raised to include landings by France, Belgium, UK(Scotland), UK(IOM) (distributed proportionately over quarters), then summed over quarters to produce the annual landings-at-age.

The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the stock coordinator and for the current and previous year in the ICES computer system under **w:\acfm\wgnsds\year\personal\name** (of stock coordinator).

The result files (FAD data) can be found at ICES and with the stock coordinator, as ASCII files on the Lowestoft format, under **w:\acfm\wgnsds\year\data\whg_7a**.

B.1.2. Discards

The Irish Sea *Nephrops* fishery takes place on the whiting nursery grounds of the northwestern Irish Sea and has traditionally produced high whiting discarding. The quantity of whiting discarded from the UK (NI) *Nephrops* fishery in 2002 was estimated on a quarterly basis from samples of discards and total catch provided by skippers. The discards samples contain the heads of *Nephrops* tailed at sea. Using a length–weight relationship, the live weight of *Nephrops* that would have been landed as tails only is calculated from the carapace lengths of the discarded heads. The number of whiting in the discard samples is summed over all samples in a quarter and expressed as a ratio of the summed live weight of *Nephrops* in the discard samples (i.e. those represented as heads only in the samples). The reported live weight of *Nephrops* landed as tails only is then used to estimate the quantity of whiting discarded using the whiting:*Nephrops* ratio in the discard samples. The length frequency of whiting in the discard samples is then raised to the fleet estimate, and numbers and mean weight-at-age of discarded whiting is computed from the age–length key and length–weight parameters for whiting. The UK(NI) estimates are available since 1980 but the reliability of these estimates has not been determined. Roughly 40 discard samples are collected annually.

There are several limitations to these data: only a small subset of single-rig trawlers is sampled; the method of raising to the fleet discards will be affected by any inaccuracies in the reported landings of *Nephrops*; and there are no estimates of landings of whiting from these vessels with which to calculate proportions discarded-at-age. However, the WG has used these data in past assessments because removal of discards data would remove a large fraction of catch from the assessment.

A re-analysis of the Irish discard data raised to the *Nephrops* landings produced estimates of discards from the Irish *Nephrops* fleet that were more consistent with those of the UK (NI) *Nephrops* fleet. However, this method of raising could not be used to recalculate an entire time-series of discard estimates from the Irish *Nephrops* fleet. The quarterly UK (NI) discard ratios were therefore used by the Working Group to estimate the tonnage discarded from the Irish *Nephrops* fishery. Length–frequencies and age–length keys from the whiting discarded by the Irish *Nephrops* fleet are used to estimate the numbers discarded-at-age from the Irish *Nephrops* fleet.

At the WGCSE 2011 Irish discard estimates (1996–2011) raised according to the methods described in Borges *et al.*, 2005 were available to the Working Group See Table 1.0. These are available in the ICES files. Discard rates in this series were variable compared with previous estimates based on the UK NI self sampling scheme. Given the differences in raising procedure applied to the NI Discard estimates and the Irish discard estimates further examination of the discard data is needed before international estimates of discard numbers-at-age can be made. The Working Group did therefore not estimate international discard volumes and numbers-at-age since 2003.

B.2. Biological

Natural mortality was assumed to be constant (M=0.2, applied annually) for the whole range of ages and years.

A combined sex maturity is assumed, knife-edged at age 2. The use of a knife-edged maturity ogive has been a source of criticism in previous assessments. However, recent research on gadoid maturity conducted by the UK (NI) gives no evidence of substantial change in whiting maturity since the 1950s, although there has been an increase in the incidence of precocious maturity-at-age 1, particularly in males, since 1998.

As in previous years, SSB is computed at the start of each year, and the proportions of M and F before spawning were set to zero.

Stock weights are calculated using a procedure first described in the 1998 Working Group report. To derive representative stock weights for the start of the year for year *i* and age *j* the following formula is adopted:

$(CW_{i,j} + CW_{i+1,j+1})/2$ = SW at start of year.

These values are then smoothed using a three year moving average.

Recent investigations into the biological parameters (maturity, sex and growth parameters) of whiting in VIIa (funded under the Data Directive Regulation

(1639/2001)) took place during a Biological Sampling survey (BBS) in March 2004. Parameter estimates of maturity-at-length indicate the L_{50} for whiting in VIIa for males and females is 13.65 cm and 19.76 cm, respectively. Maturity-at-age for both sexes are similar for most stock area (VIIa, b, j and g) with the notable exception of age 1 males in the Celtic Sea where the estimates are outside the 95% CI bounds for VIIa and considerably lower than VIa. In most areas whiting were mature by age three and most were mature at age 2. The sex ratio for whiting tended to increase with length for nearly all the age classes in all areas indicating that females tend to have larger length at-age than males (Gerritsen, 2005).

Gerritsen *et al.*, 2002 describes the relationships between maturity, length and age of whiting sampled on a length-stratified basis from NI groundfish surveys of the Irish Sea during spawning in spring 1992–2001. Findings show that most one year old females were immature while most two year old females were mature; almost all 3 year olds of both sexes were mature. Length at 50 maturity average around 19 cm in males and 22 cm in females.

B.3. Surveys

Seven research vessel survey series for whiting in VIIa were available to the Working Group in 2011. In all surveys listed the highest age represents a true age not a plus group.

- UK(England and Wales) Beam Trawl Survey (**UK (E&W)-BTS-Q3**): ages 0 and 1, years 1988–2011: The survey covers the entire Irish Sea and is conducted in September on the R.V. *Corystes*. The survey uses a 4 m beam trawl targeted at flatfish. The survey is stratified by area and depth band, although the survey indices are calculated from the total survey catch without accounting for stratification. Numbers of whiting at-age per km towed are provided for prime stations only (i.e. those fished in most surveys).
- UK(Northern Ireland) October Groundfish Survey (**NIGFS-WIBTS-Q4-EAST & WEST**): ages 0–5, years 1992–2011: The survey-series commenced in its present form in 1992. It comprises 45 three mile tows at fixed station positions in the northern Irish Sea, with an additional 12 one mile tows at fixed station positions in the St George's channel from October 2001 (the latter are not included in the tuning data). The surveys are carried out using a rock-hopper otter trawl deployed from the R.V. *Lough Foyle*. The survey designs are stratified by depth and seabed type. The mean numbers-at-length per 3 mile tow are calculated separately by stratum, and weighted by surface area of the strata to give a weighted mean for the survey or group of strata. The strata are grouped into western Irish Sea and eastern Irish Sea, and a separate age–length key is derived for each area to calculate abundance indices by age class. The survey design and time-series of results including distribution patterns of whiting are described in detail in Armstrong *et al.*, 2003.
- UK(Northern Ireland) March Groundfish Survey (**NIGFS-WIBTS-Q1-EAST & WEST**): ages 1–5, years 1992–2012: Description as for **NIGFS-WIBTS-Q4-EAST & WEST** above.
- UK(Northern Ireland) Methot Isaacs–Kidd Survey (**NIMIK**): age 0, years 1994–2011: The survey uses a Methot Isaacs–Kidd frame trawl to target pelagic juvenile gadoids in the western Irish Sea at 40–45 stations. The survey

is stratified and takes place in June during the period prior to settlement of gadoid juveniles. Indices are calculated as the arithmetic mean of the numbers-per-unit sea area.

- Ireland's Irish Sea Celtic Sea Groundfish Survey (IR-ISCSGFS): ages 0–5, years 1997–2002: This survey commenced in 1997 and is conducted in October-November on the R.V. *Celtic Voyager*. The α and β of the series are set to account for the variable timing of this survey within the fourth quarter. The survey uses a GOV otter trawl with standard groundgear and a 20 mm codend liner. The survey operates mainly in the western Irish Sea but has included some stations in the eastern Irish Sea. The survey design has evolved over time and has different spatial coverage in different years. Indices are calculated as arithmetic means of all stations, without stratification by area.
- UK(Scotland) groundfish survey in Spring (ScoGFS-spring): ages 1–8, years 1996–2006: This survey represents an extension of the Scottish West Coast groundfish survey (Area VI), using the research vessel *Scotia*. The survey gear is a GOV trawl, and the design is two fixed-position stations per ICES rectangle from 1997 onwards (17 stations) and one station per rectangle in 1996 (nine stations). The survey extends from the Northern limit of the Irish Sea to around 53°30′.
- UK(Scotland) groundfish survey in autumn (ScoGFS-autumn): ages 0–5, years 1997–2005: The survey covers a similar area to the ScoGFS in spring, but has only 11–12 stations.
- IRGFS (Ireland) (IR-Q4 IBTS): This survey commenced in 2003 aboard the R.V. Celtic Explorer. It is a depth stratified survey using a GOV trawl with a 20 mm mesh liner on the codend. The survey currently covers VIIb, j, g and VIa. Protocols for the survey are governed by the International Bottom-trawl Survey Working Group (IBTS).

To allow the inclusion of the IR-Q4 IBTS and ScoGFS-Spring surveys for the year after the last year with commercial catch data in an XSA, the surveys may be treated as if they took place at the end of the previous year, and the age range and year range of the surveys may be shifted back accordingly in the data files.

The following research surveys were available to the 2011 Working group:

- UK(NI) groundfish survey: March 1992–2012.
- UK(NI) groundfish survey: October 1992–2011.
- UK(Scotland) groundfish survey: March 1996–2006.
- UK(Scotland) groundfish survey: autumn 1997–2005.
- Irish groundfish survey: autumn 2003 and 2004.
- UK(NI) MIK net surveys of pelagic-stage 0-group cod, western Irish Sea 1994–2011.
- UK(E&W) beam trawl survey: 0-1 gp cod, 1988–2011.

FSP surveys of Irish Sea round fish: 2004–2010.

Further details of the tuning data are given in Appendix 1 and 2 of the 1999 WG Report.

B.4. Commercial cpue

No cpue data have been provided for the French (Lorient) trawl fleet since 1992. Four commercial catch effort dataseries were available to the WG:

- Irish otter trawl (IR-OTB): ages 1–6, years 1995–2002: Effort and cpue data provided for the Irish fleet comprise total annual effort (hours fished, not corrected for fishing power) and total numbers-at-age in landings from otter trawlers. The data were revised to take account of updated logbook information. This fleet operates mainly in the western Irish Sea, targeting *Nephrops* and/or whitefish. The distribution of fishing is concentrated in the western part of the range of the whiting stock in the Irish Sea. Hence the catch rates will represent changes in abundance of whiting in the western part of VIIa. The use of this fleet as a tuning index therefore relies on the assumption that trends in abundance in the west of VIIa reflect those of the entire stock. The catch-at-age data comprise a large proportion of the total international catch. Hence, some correlation of errors can be expected between the tuning dataset and the catch-at-age data. The effect of such correlations has not been evaluated. The otter trawl catch-at-age data contained data for landings only. Hence the reliability of the tuning fleet will be limited for age groups which are heavily discarded.
- UK(Northern Ireland) pelagic trawl: ages 2–6, years 1993–2002: The pelagic trawl catch-at-age data contained data for landings only. Hence the reliability of the tuning fleet will be limited for age groups which are heavily discarded. This fleet currently targets haddock and cod in the deeper waters of the western Irish Sea and the North Channel. Bycatches of whiting are currently very small and are heavily discarded due to their low value. The fleet is considered unsuitable for indexing whiting abundance.
- UK(Northern Ireland) single-rig otter trawl: ages 0–6, years 1993–2002: This fleet operates mainly in the western Irish Sea. The distribution of fishing does not encompass the entire range of the whiting stock (which surveys suggest is distributed across the Irish Sea). Whiting discards from single-rig trawlers (estimated from fisher self-sampling scheme) are included.
- UK(England and Wales) otter trawl: ages 2–6, years 1981–2000: Estimates up to and including 2000 of commercial lpue from UK(E&W) otter trawlers contain data for landings only. Hence the reliability of the tuning fleet will be limited for age groups which are heavily discarded. This fleet operates mainly in the eastern Irish Sea. The distribution of fishing does not encompass the entire range of the whiting stock (which surveys suggest is distributed across the Irish Sea) or the main whiting nursery grounds (in the western Irish Sea). Age compositions in most years have been estimated from length frequencies using ALKs that were obtained from sampling of fleets operating mainly in the western Irish Sea. This has introduced additional uncertainties into the data.

B.5. Other relevant data

None.

C. Historical stock development

No assessment was carried out for this stock in 2011. The last assessment for this stock was a survey based assessment in 2007.

Model used:

XSA (up to 2002)

SURBA 2.0-2003

SURBA 3.0-2004

SURBA 2.2-2005–2011

Software used:

Lowestoft VPA suite

SURBA 2.2

XSA Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for ages >=4

Survivor estimates shrunk towards the mean F of the final five years or the two oldest ages

S.E. of the mean to which the estimate are shrunk =0.500

Minimum standard error for population estimates derived from each fleet =0.300

Prior weighting not applied

Input data types and characteristics for XSA:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1980–last data year	0–6+	Yes
Canum	Catch-at-age in numbers	1980–last data year	0–6+	Yes
Weca	Weight-at-age in the commercial catch	1980–last data year	0–6+	Yes
West	Weight-at-age of the stock at spawning time.	1980–last data year	0–6+	Yes: uses smoothed catch weights adjusted to start of year
Mprop	Proportion of natural mortality before spawning	1980–last data year	0–6+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1980–last data year	0–6+	No – set to 0 for all ages in all years
Matprop	Proportion mature-at-age	1980–last data year	0–6+	No – the same ogive for all years
Natmor	Natural mortality	1980–last data year	0–6+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	NIGFS-Oct	1992–last data year	0–5
Tuning fleet 2	NIGFS-Mar (adjusted)	1991–(last data year-1)	0–4
Tuning fleet 3	ScoGFS-Spring	1996–last data year	1–5
Tuning fleet 4	UK(E&W) BTS	1988–last data year	0–1

Input data types and characteristics for SURBA 2.2

Default settings used

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	NIGFS-Oct **NIGFS-WIBTS-Q4-EAST & WEST**	1992–2011	ALL
Tuning fleet 2	NIGFS-Oct **NIGFS-WIBTS-Q1-EAST & WEST**	1992–2012	ALL

D. Short-term projection

Currently, there is no analytical assessment for this stock.

Model used:

Age structured

Software used: MFDP prediction with management option table and yield-per-recruit routines. MLA suite (WGFRANSW) used for sensitivity analysis and probability profiles.

Initial stock size. Taken from the XSA for age 1 and older. The recruitment-at-age 0 in the last data year is estimated as a short-term GM (1992 onwards) because of a reduction in mean recruitment since then.

Natural mortality: Set to 0.2 for all ages in all years.

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

F and M before spawning:

Set to 0 for all ages in all years.

Weight-at-age in the stock:

average stock weights for last three years.

Weight-at-age in the catch:

Average weight of the three last years.

Exploitation pattern:

Average of the three last years. Discard F's, which are generated by the *Nephrops* fleet as there are no discard estimates for other fleets, are held constant while landings F's are varied in the management option table.

Intermediate year assumptions:

status quo F

Stock–recruitment model used:

None, the short-term geometric mean recruitment-at-age 0 is used.

Procedures used for splitting projected catches:

F vectors in each of the last three years of the assessment are multiplied by the proportion landed or discarded-at-age to give partial Fs for landings and discards. The vectors of partial Fs are then averaged over the last three years to give the forecast values.

E. Medium-term projections

No medium-term projections are done for this stock due to problems with estimating current F.

F. Yield and biomass per recruit/long-term projections

Model used: yield and biomass per recruit over a range of F values that may reflect fixed or variable discard F's.

Software used: MFY or MLA

Selectivity pattern:

mean F array from last three years of assessment (to reflect recent selection patterns).

Stock and catch weights-at-age:

mean of last three years (weights-at-age have declined as the stock has declined since the 1980s; it is not known if this is an environmental effect on growth that is independent of stock size).

Proportion discarded:

partial F vectors are the recent average.

Maturity: Fixed maturity ogive as used in assessment.

G. Biological reference points

Precautionary approach reference points have remained unchanged since 1999. B_{PA} is set at 7000 t and is defined as B_{lim}*1.4. B_{lim} is defined as the lowest observed SSB (ACFM, 1999), considered to be 5000 t. There is not considered to be clear evidence of reduced recruitment at the lowest observed SSBs. F_{PA} is set at 0.65 on the technical basis of high probabilities of avoiding F_{lim} and of SSB remaining above B_{PA} in the long term. F_{lim} is defined as 0.95, the fishing mortality estimated to lead to a potential stock collapse.

H. Other issues

None.

I. References

Armstrong, M.J., Peel, J., McAliskey, M., McCurdy, W., McCorriston, P. and Briggs, R. 2003. Survey indices of abundance for cod, haddock and whiting in the Irish Sea (Area VIIaN): 1992–2003. Working Document No. 3 submitted to 2003 meeting of ICES Working Group on Assessment of Northern Shelf Demersal Stocks. 33pp.

Borges, L.; Rogan, E. and Officer, R. 2005. "Discarding by the demersal fishery in the waters around Ireland", Fish. Res. (in press).

Gerritsen, H. 2005. Biological parameters for Irish Demersal Stocks in 2004. WD5 (WGNSDS, 2005).

Table 1.0. Discard estimates raised according to the method outlined in Borges *et al.,* 2005.

	1996		1997		1998		1999		2000		2001		2002		2003	
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	5631.20	0.015	4110.63	0.027	5073.57	0.027	187.26	0.036	7850.12	0.033	20981.54	0.016	29017.16	0.021	1921.76	0.016
1	5925.33	0.035	8361.19	0.044	5939.53	0.064	276.50	0.102	3098.24	0.047	8883.11	0.054	12097.93	0.033	2419.56	0.036
2	1802.90	0.111	3243.45	0.120	3826.20	0.107	150.99	0.174	137.80	0.153	1413.48	0.126	576.17	0.112	1287.21	0.178
3	144.34	0.217	696.18	0.200	440.05	0.185	43.70	0.235	30.31	0.229	479.38	0.133	152.95	0.105	603.20	0.246
4	6.02	0.206	68.71	0.241	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	108.64	0.268
5	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	22.95	0.136	17.66	0.123	0.00	0.000
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)		520.8		1024.1		1010.3		71.6		434.3		1054.5		1100.9		523.6
Sampling Information	1996		1997		1998		1999		2000		2001		2002		2003	
Number of Trips		8		8		7		4		10		2		1		9
Number of Hauls		48		44		58		40		111		34		7		60

	2004		2005		2006		2007		2008		2009		2010		2011	
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	17091.56	0.018	442.07	0.010	1534.97	0.016	5138.89	0.043	4585.77	0.025	13319.29	0.028	1406.81	0.016	6293.64	0.018
1	7347.29	0.034	2531.84	0.035	1483.43	0.060	23000.16	0.038	7879.78	0.040	12913.10	0.036	4513.61	0.038	4912.12	0.026
2	731.35	0.101	783.68	0.091	621.58	0.133	3282.67	0.095	1485.70	0.093	712.51	0.081	1383.11	0.084	307.09	0.080
3	142.50	0.165	129.28	0.159	99.02	0.218	916.09	0.145	161.03	0.119	2.60	0.175	129.68	0.133	30.38	0.164
4	96.30	0.218	40.12	0.154	16.82	0.312	10.96	0.276	13.46	0.130	0.89	0.257	5.41	0.163	2.73	0.198
5	0.00	0.000	24.48	0.371	0.00	0.000	1.92	0.304	0.00	0.000	0.00	0.000	0.47	0.167	0.18	0.199
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)		680.3		201.3		223.2		1544.7		585.3		892.3		329.8		268.8
Sampling Information	2004		2005		2006		2007		2008		2009		2010		2011	
Number of Trips		11		8		5		15		18		12		4		6
Number of Hauls		122		96		56		90		91		55		29		74

6.7 Stock Annex Irish Sea Plaice

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Plaice (Division VIIa)
Working Group	Celtic Seas Ecoregion
Date	17th May 2012
By	Christopher Lynam

A. General

A.1. Stock definition

There are considered to be three principle spawning areas of plaice in the Irish Sea: one off the Irish coast, another northeast of the Isle of Man towards the Cumbrian coast, and the third off the north Wales coast (Nichols *et al.*, 1993; Fox *et al.*, 1997; Figure A.1). Cardigan Bay has also been identified as a spawning ground for plaice in the Irish Sea (Simpson, 1959).

The level of mixing between the east and west components of the Irish Sea stock appears small. (Dunn and Pawson, 2002). Length-at-age measurements from research surveys as well as anecdotal information from the fishing industry suggests that plaice in the western Irish Sea grow at a much slower rate than those in the eastern Irish Sea. Earlier studies have suggested that the east and west components of the stock are distinct (Brander 1975; Sideek 1989). Morphometric differences have been observed between the east and west components of the stock; the 2004 WG indicated that the UK(E&W) beam trawl survey in September (from 1989) catches plaice off the Irish coast that are smaller-at-age than those caught in the eastern Irish Sea.

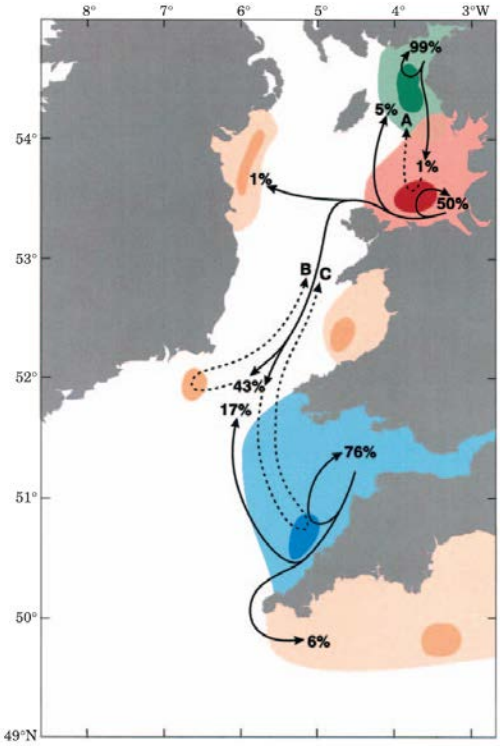


Figure A.1. (right) Principal substock areas and movements of plaice on the west coast of England and Wales. Percentages are the recaptures rates of tagged plaice <25 cm total length when released, and >26 cm when recaptured in English and Welsh commercial fisheries. Tagging exercises in 1979–1980 and 1993–1996 were combined based on the assumption that the dispersal patterns of plaice were consistent over time. For each substock, the main feeding area (derived from tag recaptures during April–December; light shading), and the main spawning area (derived from tag recaptures during January–March, and ichthyoplankton surveys; dark shading) are indicated. The substocks tagged have been coloured green, red and blue. The substocks coloured orange are less well determined, with the feeding area around southeast Ireland unknown. Letters represent return migrations, where A ≈6%, and B+C ≈46%. Reproduced from Dunn and Pawson (2002).

Although considered separate stocks, the stocks of plaice in the Irish Sea and the Celtic Sea do mix during spawning. Tagging studies have indicated a southerly movement of mature fish (or fish maturing for the first time) from the southeast Irish Sea, off North Wales, into the Bristol Channel and Celtic Sea during the spawning season, such that 43% of the new recruits are likely to recruit outside the Irish Sea (Figure A.1). While some of these migrant spawning fish will remain in the Bristol Channel and Celtic Sea, the majority (≥70%) are expected to return to summer feeding grounds in the Irish Sea (Dunn and Pawson, 2002).

Very little mixing is considered to occur between the Irish Sea and Channel stocks or between the Irish Sea and North Sea (Pawson, 1995). Nevertheless, time-series of recruitment estimates for all stocks in waters around the UK (Irish Sea, Celtic Sea, western and eastern Channel, North Sea) show a significant level of synchrony (Fox *et al.*, 2000). This could indicate that the stocks are subject to similar large-scale environmental forces and respond similarly to them, or alternatively that there are subpopulations that share a common spawning.

A.2. Fishery

The status and activities of the fishing fleets operating in ICES Subdivision VIIa are described by Pawson *et al.*, 2002 and also by Anon, 2002. Following the massive decline in effort (hours fished) by otter trawlers targeting demersal fish in the early 1990s, the majority of fisheries effort in the Irish Sea is now exerted by otter trawlers fishing for *Nephrops* in the western Irish Sea followed by beam trawlers targeting sole in the eastern Irish Sea. Only a small proportion of otter trawlers still target cod, haddock, whiting and plaice with bycatch of angler-fish, hake and sole. From 2001, trawlers for demersal fish adopted mesh sizes of 100–120 mm and other gear modifications depending on the requirements of recent EU technical conservation regulations and national legislation. However, in 2004 the effort exerted by UK trawlers with mesh 100–120 mm declined to low levels. In 2006, the effort by UK trawlers targeting demersal fish with mesh 80–99 mm also declined to low levels. Concomitantly, the effort by UK trawlers targeting *Nephrops* with mesh 80–99 mm increased to record highs. Square mesh panels have been mandatory for UK otter trawlers since 1993 and for Irish trawlers since 1994, but this will have little effect on plaice catches. Four Irish trawlers for *Nephrops* have made use of grids since 2009 and reported 75% drop in fish bycatch. Fishing effort in 2009 by the Irish and UK(E&W) otter fleets targeting demersal fish reached historic lows.

Beam trawling increased in the Irish Sea during the late 1980s, with vessels from England and Belgium exploiting sole. This fishery has important bycatch of plaice, rays, brill, turbot and angler-fish. The fishing effort of the Belgium beam trawl fleet varies according to the catch rates of sole in the Irish Sea relative to the other areas in which the fleet operates. In 2009, effort (hours fished) by the UK(E&W) beam trawl fleet fell to the lowest observed level.

A fleet of vessels primarily from Ireland and Northern Ireland take part in a targeted *Nephrops* fishery using 70 mm mesh nets with 75 mm square mesh panels. This fishery takes a substantial bycatch of whiting, most of which is discarded. Some inshore shrimp beam trawlers occasionally switch to flatfish when shrimp become temporarily unavailable. Other gear types employed in the Irish Sea to catch demersal species are gillnets and tanglenets, notably by inshore boats targeting cod, bass, grey mullet, sole and plaice.

The minimum landing size for plaice in the Irish Sea was set in 1980 to 25 cm (Council Regulation (EEC) No 2527/80). This was increased in 1998 to 27 cm (Annex XII of Council Regulation 850/98).

Since 2000, a recovery programme has been implemented to reduce exploitation of the cod spawning stock in the Irish Sea. In 2002 the European Commission regulations included a prohibition on the use of demersal trawl, enmeshing nets or lines within the main cod spawning area in the northwest Irish Sea between the 14th February and 30th April. Some derogations were permitted for *Nephrops* trawls and beam trawlers targeting flatfish.

A.3. Ecosystem aspects

Plaice are preyed upon and consume a variety of species through their life history. However, plaice have not as yet been included in an interactive role in multispecies assessment methods (e.g. ICES WGSAM 2008). Among other prey items, plaice typically consume a large proportion of polychaetes and molluscs.

Other than statistical correlations between recruitment and temperature (Fox *et al.*, 2000), little is known about the effects of the environment on the stock dynamics of plaice in the Irish Sea. Negative correlations between year-class strength of plaice (in either the Irish Sea, Celtic Sea, Channel and North Sea) and sea surface temperature are generally strongest for the period February–June. However, western (North Sea and Channel) and eastern (Irish Sea and Celtic Sea) stocks have been found to respond to different time-scales of temperature variability, which might imply that different mechanisms are operating in these stocks and/or that the Irish Sea and Celtic Sea share common spawning (Fox *et al.*, 2000).

B. Data

B.1. Commercial catch

Landings

International landings-at-age data based on quarterly market sampling and annual landings figures are available from 1964. Since 1978, quarterly age compositions have typically represented around 80–90% of the total international landings. Table B.1 details the derivation of international landings for the period since 1978.

Prior to 1983 the stock was assessed on a separate sex basis: the catch numbers of males and females were worked up separately and the numbers of males and females in the stock as estimated from each assessment combined to give a total biomass estimate. Since 1983 a combined sex assessment of the stock has been conducted and the numbers of males and females in the catch have been combined at the international data aggregation level prior to running a single assessment.

Data exploration

Data exploration for commercial landings data for Irish Sea plaice has involved:

1) expressing the total landings-at-age matrix as proportions-at-age, normalized over time, so that year classes making above-average contributions to the landings are shown as large positive residuals (and vice-versa for below-average contributions);

2) applying a separable VPA model in order to examine the structure of the landed numbers-at-age before they are used in catch-at-age analyses, in particular whether there are large and irregular residuals patterns that would lead to concerns about the way the recorded catch has been processed.

Given that discards now represent a larger proportion of the catch than the landings method 1 should be applied to the discard-at-age matrix in addition to the discard-at-age matrix and method 2 is unnecessary.

Discards

In 1986, the UK fleet was restricted to a 10% bycatch of plaice for almost the entire year. Estimates were made of the increased quantity of plaice that would have been discarded based on comparisons of lpue values for 1985–1986 with those for 1984–1985. The estimated quantity of 250 tonnes was added to the catch. A similar situation arose the following year and 250 tonnes was added to the catch for 1987.

The 10% plaice bycatch restriction was enforced again in 1988 to all UK(E&W) vessels in the 1st quarter and to beam trawlers in the 2nd and 3rd quarters. However, this time the landings were not corrected for discard estimates.

Discard information was not routinely incorporated into the assessment prior to benchmarking by WKFLAT in 2011.

B.2. Biological

Weights-at-age

A number of different methodologies have been employed to determine weights-at-age for this stock. Stock weights and catch weights-at-age were determined on a separate sex basis and remained unchanged from 1978 until 1983. Catch weights were derived from a von Bertalanffy length-at-age fit to Belgian (70–74), UK(E&W) (64–74) and Irish (62–66) catch samples. The estimated lengths-at-age were converted to weights-at-age using a Belgian length–weight dataset (ages 2–15 females; 3–9 males). Stock weights were calculated as the mean of adjacent ages from the catch weights, where catch weights represented 1st July values and stock weights 1st January.

From 1983 weights-at-age have been calculated on a combined sex basis. Catch weights were taken from market sampling measurements combined on a sex weighted basis and smoothed. For the period 1983 to 1987 catch weights were smoothed by eye, from 1988 onwards a smooth curve was fitted using a numerical minimization routine. Stock weights were derived from the smoothed international catch weights-at-age curve with values representing 1st January. In 1985 the stock weights-at-age were adjusted for ages 1 to 4. The difference between the smoothed catch weights and survey (F.V. *Silver Star*) observations were adjusted using the maturity ogive to give "best estimate" stock weights "for ages where growth and maturity differences can bias sampling procedures". The same procedure was adopted in 1986 (when stock weights in 1982 and 1983 were also revised so as to be consistent with this methodology) and 1987. In 1988 however, the *Silver Star* survey was discontinued and stock weights-at-ages 1 to 3 were calculated as means of the three previous years. Correction of the estimated stock weights of the younger age groups did not occur in 1989 or in subsequent years which explains the sudden increase in weight of the younger age groups for this stock from 1988 onwards.

WKFLAT 2011 rejected the use of the polynomial smoother for weights-at-age and suggested that raw annual catch weights are used in future. Raw data back to 1995 was obtained by WKFLAT and used to update the catch weights and stock weights files. Discard weight-at-age were also calculated back to 2004 from UK(E&W) and Belgian data. However, given that the discard weight prior to 2004 were unknown the stock weights file was not updated to include the discard component. This requires further work.

Males are smaller than females and mean weight-at-age and mean length-at-age of both sexes has generally declined since the mid 1990s. Commercial data indicate declines in mean weight-at-age of fish age 4 and older since 1995, particularly since 2004 (Figure A.2). Survey data indicate that males of ages 1–5 and females of age 1–3 are generally below minimum landing size (MLS, Figure A.3).

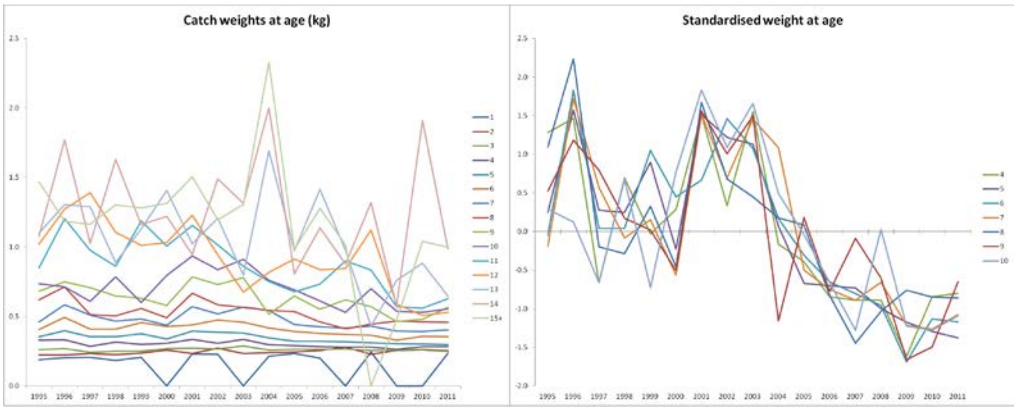


Figure A.2. Commercial weight-at-age data from 1995 (raw, left and standardized, right).

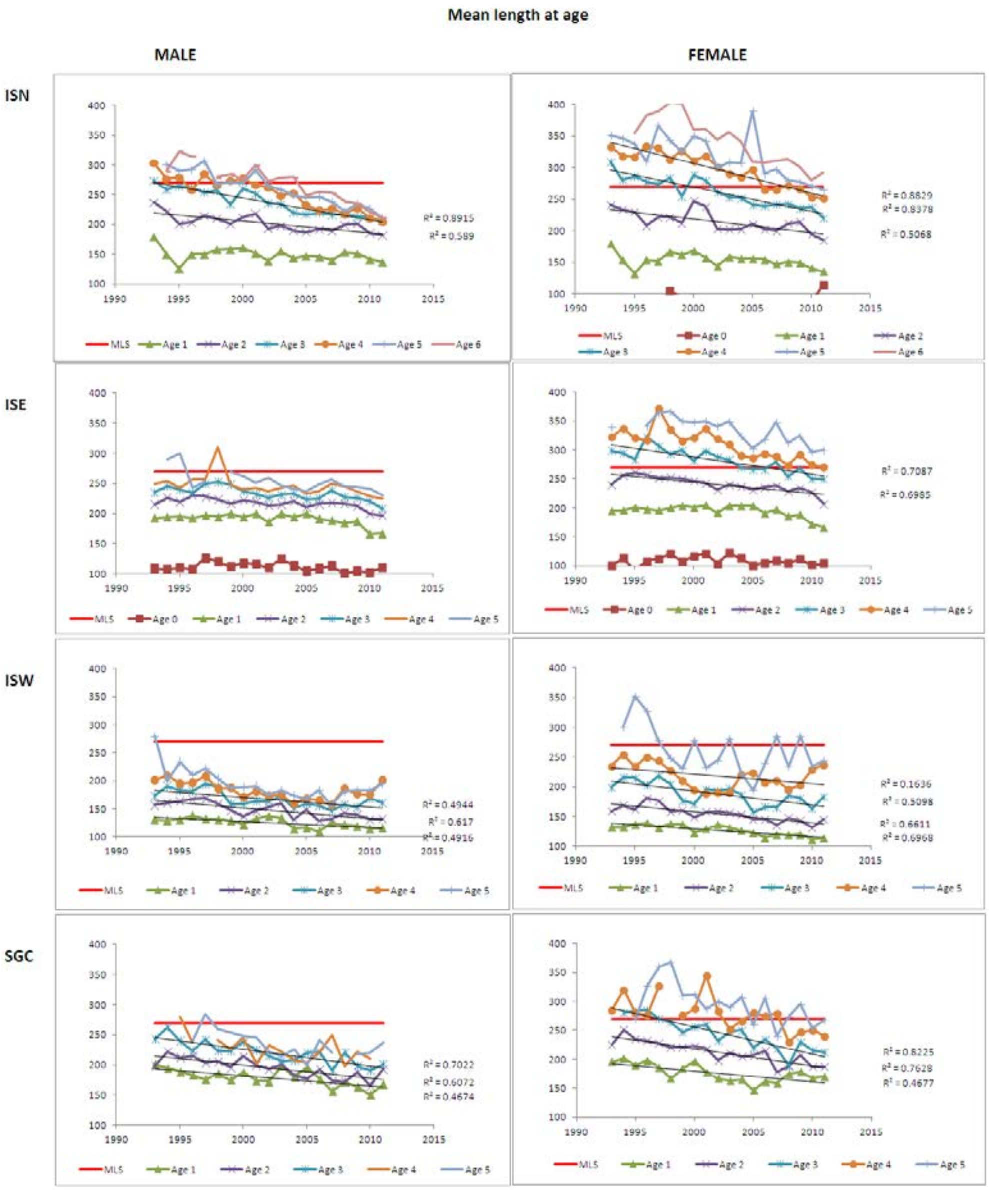


Figure A.3. Mean length-(cm) at-age data from 1993 by sex and area within the Irish Sea: Irish Sea North (ISN), Irish Sea East (ISE), Irish Sea West (ISW), St George's Channel (SGC).

Natural mortality and maturity ogives

As for the weights-at-age, natural mortality and maturity was initially determined on a separate sex basis. Natural mortality was taken as 0.15 for males and 0.1 for females. In 1983 when a combined sex assessment was undertaken a sex weighted average value of 0.12 was used as an estimate of natural mortality. This estimate of natural mortality has remained unchanged since 1983. The maturity estimates used prior to 1982 are not specified. A new separate sex maturity ogive (Sideek, 1981) was implemented in 1982. This ogive was recalculated as sex weighted mean values in 1983 when the assessment was conducted on a combined sex basis. The maturity ogive was revised again in 1992 based on the results of an EU project. Maturity ogives are applied as vectors to all years in the assessment.

WKFLAT 2011 was unable to update the maturity ogive due to time restraints. However, preliminary analysis indicated that the ogive may have changed over time, in each sector of the Irish Sea, such that plaice mature at a smaller size and age than previously.

Table A.1. Maturity ogives for Irish Sea plaice used in ICES WGs.

Age	WG 1978–1982		WG 1983–1992	WG 1992–2010
	M	F		
1	0	0	0	0
2	0.3	0.04	0.15	0.24
3	0.8	0.4	0.53	0.57
4	1.0	0.94	0.96	0.74
5	1.0	1.0	1.0	0.93
6	1.0	1.0	1.0	1.0

The proportion of fishing mortality and natural mortality before spawning was originally set to 0. It was changed in 1983 to a value of 0.2 on the grounds that approximately 20% of the catch was taken prior to March (considered to be the time of peak spawning activity). As for Celtic Sea plaice the proportion of F and M before spawning was reset to 0, as it was considered that these settings were more robust to changes in the fishing pattern, especially with respect to the medium-term projections.

B.3. Surveys

In 1993, the UK(E&W) beam trawl survey series that began in 1988 was considered to be of sufficient length for inclusion in the assessment. Since 1991, tow duration has been 30 minutes but prior to this it was 15 minutes. In 1997, values for 1988 to 1990 were raised to 30 minute tows. However, data for 1988 and 1989 were of poor quality and gave spurious results: thus, the series was truncated to 1990. A similar March beam trawl survey began in 1993 and was made available to the WG in 1998. The March beam trawl survey ended in 1999 but continued to be used as a tuning index in the assessment until 2003.

In 2011, the UK(E&W) beam trawl survey was re-examined and additional stations sampled in the western Irish Sea and St Georges Channel (Cardigan and Caernarfon Bays) since 1993 were included in the index. The extended index replaced the earlier ‘prime stations’ index since it was considered more representative of the entire stock (WKFLAT 2011).

An Irish juvenile plaice survey index was presented to the WG in 2002 (1976–2001, ages 2–8). Between 1976 and 1990 this survey had used an average ALK for that period. Serious concerns were expressed regarding the quality of the data for this period and the series was truncated to 1991. The stations for this survey are located along the coast of southeast Ireland between Dundalk Bay and Carnsore Point and there was some concern that this localized survey series would not be representative of the plaice population over the whole of the Irish Sea. Numerous tests were conducted at the 2002 WG to determine the validity of this and other tuning indices and it was concluded that this survey could be used as an index of the plaice population over the whole of the Irish Sea. This survey is no longer used in the assessment.

The SSB of plaice can be estimated using the Annual Egg Production Method (AEPM) (Armstrong *et al*., 2002 and WD 9, WGCSE 2011). This method uses a series of ichthyoplankton surveys to quantify the spatial extent and seasonal pattern of egg production, from which the total annual egg production can be derived. The average fecundity (number of eggs spawned per unit body weight) of mature fish is estimated by sampling adult females immediately prior to the spawning season. Dividing the annual egg production by average fecundity gives an estimate of the biomass of mature females. Total SSB can be estimated if the sex ratio is known. Although substantial discrepancies between absolute estimates of SSB from the Annual Egg Production method (AEPM) and the ICES catch-based assessments were observed, they do confirm that SSB of plaice in the Irish Sea is currently at high levels.

AEPM estimates of SSB for plaice (RSE = relative standard error, as %), based on production of Stage 1 eggs) are shown below (note 1995 and 2000 estimates were revised in 2010 and 2006 and 2008 estimates revised in 2011 see WD 9, WGCSE 2011):

Table A.3. AEPM estimates of SSB for Irish Sea plaice. All estimates from stratified mean (design-based) estimates.

	total		west		East	
Year	SSB(t)	RSE	SSB(t)	RSE	SSB(t)	RSE
1995	9081	21	3411	42	5670	22
2000	13 303	19	5654	36	7649	19
2006	14 417	16	3885	29	10 532	19
2008	14 352	19	4639	43	9713	18
2010	15 071	14	3435	20	11 636	18

Splitting the SSB estimate by substrata (Figure A.4 below) suggests that the perceived increase in plaice SSB is limited to the eastern Irish Sea. This finding agrees with an analysis of NIGFS-WIBTS data and UK (E&W)-BTS-Q3 by substrata, which also indicate increases in biomass limited to the eastern Irish Sea.

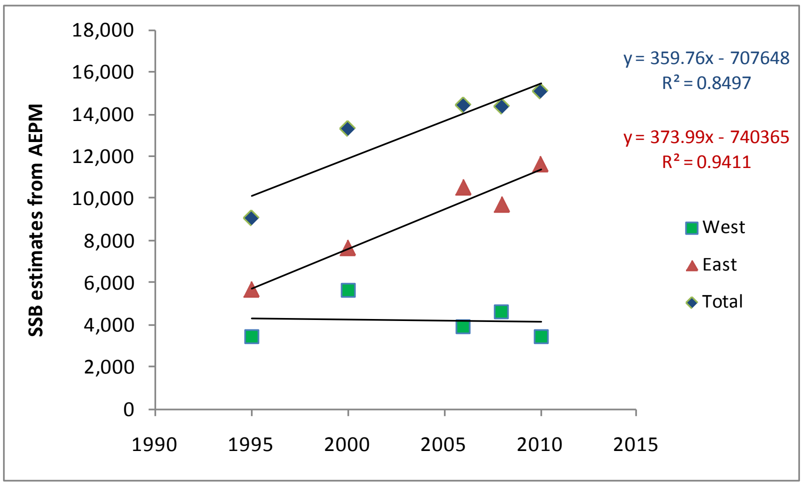


Figure A.4. AEPM estimates by year and substrata.

B.4. Commercial lpue

Prior to 1981 tuning data were not used in the assessment of this stock. A separable assessment method was used and estimates of terminal S and F were derived iteratively based on an understanding of the recent dynamics of the fishery.

In 1981 the choice of terminal F was determined from a regression of exploited stock biomass on cpue. Catch and effort series were available for the UK(E&W) trawl fleet and the Belgian beam trawl fleet for the period 1964 to 1980. In 1994 the Belgian and UK cpue series were combined to provide one mean standardized international index. The UK(E&W) trawl-series was revised in 1986 (details not recorded) and in 1987 was recalculated as an age based cpue index enabling the use of the hybrid method of tuning an *ad hoc* VPA.

The UK(E&W) trawl tuning-series was revised in 1999 and separate otter trawl and beam trawl tuning-series were produced using length samples from each gear type and an all gears ALK. Since the data could only be separated for 1988 onwards the two new tuning-series were slightly reduced in length. In 1996 UK(E&W) commercial effort data were rescaled to thousands of hours so as to avoid numerical problems associated with low cpue values and in 2000 the UK(E&W) otter trawl series was recalculated using otter trawl age compositions only rather than combined fleet age compositions as previously.

Two revised survey indices for the *Lough Beltra* were presented to the WG in 1996 though they were considered too noisy for inclusion in the assessment. They were revised again for the following year and found to be much improved but were again not included because they ended in 1996 and the WG felt that they would add little to the assessment. An Irish otter trawl tuning index was made available in 2001 (1995–2000, age 0 to 15). While this fleet mainly targets *Nephrops*, vessels do on occasion move into areas where plaice are abundant. Landings of plaice by this fleet were approximately 15% of total international landings in 2000 and the WG considered that this fleet could provide a useful index of abundance for plaice.

The effects of vessel characteristics on lpue for UK(E&W) commercial tuning-series was investigated in 2001 to investigate the requirement for fishing power corrections due to MAGP IV re-measurement requirements. It was found that vessel characteristics had less effect on lpue than geographical factors and unexplained noise and concluded that corrections were not necessary. However, vessels of certain size tended to fish in certain rectangles. This confounding may have resulted in the underestimation of vessel effects.

Currently, age based tuning data available for this assessment comprise three commercial fleets; the UK(E&W) otter trawl fleet (UK(E&W)OTB, from 1987), the UK(E&W) beam trawl fleet (UK(E&W)BT, from 1989) and the Irish otter trawl fleet (IR-OTB, from 1995). However, as a consequence of inconsistencies in these commercial tuning fleets and surveys in the Irish Sea no commercial tuning information is used in the assessment. The area and HP-correction employed to calculate the UK(E&W) commercial effort indices require re-evaluation since vessels have changed greatly since the relationship was modelled.

Commercial lpue data are no longer used in the assessment.

B.5. Other relevant data

Model used: Aarts and Poos (2009) (AP)

Software used: R version 2.10.1

Model Options chosen:

Input data types and characteristics:

ASSESSMENT YEAR		2011 WKFLAT
Assessment model		AP
Tuning fleets	UK-BTS Sept (Trad)	Series omitted
	UK(E&W)-BTS-Q3	1993–2009, ages 1–6
	UK(E&W)-BTS-Q1	Survey omitted
	UK(E&W) OTB	Series omitted
	UK(E&W) BT	Series omitted
	IR-OTB	Series omitted
	NIGFS-WIBTS-Q1	1993–2009
	NIGFS-WIBTS-Q4	1993–2009
Selectivity model		Linear Time Varying Spline at-age (TVS)
Discard fraction		Polynomial Time Varying Spline at-age (PTVS)
Landings num-at-age, range:		2–9+
Discards num-at-age, year range, age range		2004–2009, ages 1–5

C. Historical stock development

The stock of plaice in the Irish Sea has been assessed by ICES since 1977.

Assessment methods and settings

In 1987 the stock was assessed using a Laurec–Shepherd (hybrid) tuned VPA. Concerns about deteriorating data quality prompted the use in 1994 of XSA. A subsequent divergence in commercial cpue and survey data, and the wish to include biomass indices, prompted the use of ICA. The settings for each of the assessments between 1991 and 2009 are detailed in Table B.2. Since 2006, the assessment has been an update ICA assessment with the separable period increased by one year at each assessment working group. In 2009 and 2010, FLICA was used to run the assessment:

the R and FLR packages have been documented within the WG report. In 2011, WKFLAT estimated discards-at-age and proposed that the AP model is used to model the stock.

Over the years, trial runs have explored many of the options with regards XSA settings, including:

- The applicability of the power model on the younger ages was explored in: 1994; 1996; 1998; 1999; 2000 and 2001.
- Different levels of F shrinkage were explored in 1994; 1995; 1997.
- The effect of different time tapers was investigated in 1996.
- The S.E. threshold on fleets was examined in 1996.
- The level of the catchability plateau was investigated in 1994.

ICA settings explored since 2005 have included:

- The length of the separable period.
- The reference age
- The age range of the landings data
- The effect of including hypothetical discard reconstructions in the catch

AP model settings were trialled in 2011.

- The various combinations of time-variance for selectivity and discard fraction;
- The suitable age range of the discards was investigated.

The suitable starting year of the model was investigated with values from 1990 to 1993 trialled.

D. Short-term projection

Short-term projections are not made for Irish Sea plaice at present. However, the methodology last employed follows for reference by future working groups.

Software: Multi Fleet Deterministic Projection (MFDP)

Age based short-term projections were conducted for a three year period using initial stock numbers derived from ICA analyses. Numbers-at-age 2 were considered poorly estimated and generally overwritten using a geometric mean (GM) of past recruitment values. Population numbers at age 3 in the intermediate year (terminal year +1) were also overwritten with the GM estimate depreciated for F_{sq} and natural mortality. Recruitments since 1990 have been estimated to be at a lower level and to be less variable than those earlier in the time-series. Consequently a short-term geometric mean (from 1990 to two years before the terminal year) was used.

Previously, the exploitation pattern is an un-scaled three year arithmetic mean. However, alternative options may be used depending on recent F trajectories and the working group's perception of the fishery. Catch and stock weights-at-age were generally taken as the mean of the last three years and the maturity ogive and natural mortality estimates are those used in the assessment method.

E. Medium-term projections

Medium-term projections are not carried out for this stock

Previous Software: *MLA miscellany*

Input values to the medium-term forecast were the same as those used in the short-term forecast. Although a Beverton–Holt stock–recruit relationship has been assumed previously, a simple geometric mean may now be more appropriate.

F. Yield and biomass-per-recruit/long-term projections

Software: Multi Fleet Yield-per-recruit (MFYPR)

Yield-per-recruit calculations are conducted using the same input values as those used for the short-term forecasts. Currently the YPR calculations are used as a basis for determining the catch option for advice.

G. Biological reference points

WKFLAT have rejected the use of reference points given the current trends only assessment and indicated that these will need to be revised. Biological reference points, last used by WGCSE in 2010, were proposed for this stock by the 1998 working group; see below:

	Type	Value	Technical basis
Precautionary approach	B_{lim}	Not defined.	There is no biological basis for defining B_{lim} as the stock–recruitment data are uninformative.
	B_{PA}	3 100 t	$B_{PA} = B_{loss}$.
	F_{lim}	Not defined.	There is no biological basis for defining F_{lim} as F_{loss} is poorly defined.
	F_{PA}	0.45	$F_{PA} = F_{MED}$ in a previous assessment, and in long-term considerations. This is considered to provide a high probability of maintaining SSB above B_{loss} in the long term.
Targets	F_y	Not defined.	

Yield and spawning biomass per Recruit

F-reference points:

	Fish Mort	Yield/R	SSB/R
	Ages 3–6		
Average last three years	0.10	0.17	1.64
$F_{0.1}$	0.14	0.19	1.31
F_{MED}	0.43	0.21	0.53

Estimated by the WG in 2010.

MSY reference points were explored by WGCSE 2010 using the Cefas ADMB code presented to WKFRAME (ICES 2010). However, due to the high level of discards in the stock and unreliable estimates of recruitment, MSY reference points were rejected by the working group.

H. Other issues

None.

I. References

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Table B.1. Data sources and derivation of international landings and, from 2011, discards; where % sampled indicates the percentage of the total landings represented by sampling.

Year		Source					
of WG	Data	UK	Belgium	Ireland	Nether lands	Derivation of international landings and discards	% sampled
1978	Len. comp.	quarterly1	quarterly1	quarterly1		Irish raised to Irish and N.Irish; UK raised to UK (E&W) and Scotland	85
	ALK	quarterly1	quarterly1	quarterly1		Belgian raised to Belgian, Dutch and French	
	Age comp.	quarterly1	quarterly1	quarterly1		UK + Bel + IR combined to total int. separate sex	
1979							
1980	Len. comp.	quarterly1	quarterly1	quarterly1		Irish raised to Irish and N.Irish; UK raised to UK (E&W), Sco and IOM.	86
	ALK	quarterly1	quarterly1	quarterly1		Belgian raised to Belgian, Dutch and French	
	Age comp.	quarterly1	quarterly1	quarterly1		UK + Bel + IR combined to total int. separate sex	
1981							
1982		As for 1980	As for 1980	As for 1980		As for 1980, separate sex	92
1983		As for 1980	As for 1980	As for 1980		As for 1980; sexes combined	90
1984	Len. comp.	quarterly	2nd qtr	quarterly		Irish raised to Irish and N.Irish	90
	ALK	quarterly	2nd qtr	quarterly		UK raised to UK (E&W), Scotland, I.O.M., French, Dutch and Belgian	
	Age comp.	quarterly	2nd qtr	quarterly		UK + IR combined to total int. sexes combined	
1985	Len. comp.	quarterly	quarterly	quarterly		Irish raised to Irish and N.Irish; UK raised to UK (E&W), Sco and IOM	92
	ALK	quarterly	quarterly	quarterly		Belgian raised to Belgian, Dutch and French	
	Age comp.	quarterly	quarterly	quarterly		UK + Bel + IR combined to total int. sexes combined	
1986	Len. comp.	quarterly	quarterly	quarterly		Irish raised to Irish.,N.Irish and French	91
	ALK	quarterly	quarterly	quarterly		UK raised to UK (E&W), Scotland and I.O.M.; Belgian used alone	
	Age comp.	quarterly	quarterly	quarterly		UK + Bel + IR combined to total int.	
1987		As for 1986	As for 1986	As for 1986		As for 1986	84
1988		As for 1986	As for 1986	As for 1986		As for 1986 except Irish beam trawl raised using UK age comps	75

Year of WG	Data	Source UK	Belgium	Ireland	Nether lands	Derivation of international landings and discards	% sampled
1989		As for 1986	As for 1986	As for 1986		As for 1986 (Irish beam trawl now sampled)	86
1990							
1991		As for 1986	As for 1986	As for 1986		As for 1986	83
1992		As for 1986	As for 1986	As for 1986		As for 1986	83
1993		As for 1986	As for 1986	As for 1986		As for 1986	91
1994		As for 1986	As for 1986	As for 1986		As for 1986 (Belgian samples supplemented with UK data)	90
1995							
1996		As for 1986	As for 1986	As for 1986		As for 1986	89
1997		As for 1998	As for 1998	As for 1998	As for 1998	As for 1998	83
1998	Len. comp.	quarterly	quarterly	quarterly	quarterly	Irish raised to Irish., N.Irish and French; Belgian and Dutch used alone	87
	ALK	quarterly	quarterly	quarterly	quarterly	UK raised to UK (E&W), Scotland and I.O.M.	
	Age comp.	quarterly	quarterly	quarterly	quarterly	UK + Bel + IR + NL combined to total int.	
1999		As for 1986	As for 1986	As for 1986		As for 1986 (except UK raised to include NL landings)	89
2000		As for 1999	As for 1999	As for 1999		As for 1999	88
2001		As for 1998	As for 1998	As for 1998	As for 1998	As for 1998	87
2002		As for 1986	As for 1986	As for 1986		As for 1986	88
2003	Len. comp.	quarterly	1st qtr	quarterly		Belgium raised using 1st qtr values	70
	ALK	quarterly	1st qtr	quarterly		UK raised to Sco and France; Irish raised to Irish and N.Irish	
	Age comp.	quarterly	1st qtr	quarterly		UK + Bel + IR combined to total int.	
2004	Len. comp.	quarterly	quarterly	quarterly			52
	ALK	quarterly	-	quarterly		UK raised to Sco and France; Irish raised to Irish, N.Irish and Bel	
	Age comp.	quarterly	-	quarterly		UK + IR combined to total int.	
2005	Len. comp.	quarterly	quarterly	quarterly			81
	ALK	quarterly	qrts 1,2	quarterly		UK raised to Sco and France; Irish raised to Irish, N.Irish and Bel	

Year of WG	Data	Source UK	Belgium	Ireland	Nether lands	Derivation of international landings and discards	% sampled
	Age comp.	quarterly	qrts 1,2	quarterly		UK + IR combined to total int.	
2006	Len. comp.	quarterly	quarterly	quarterly			923
	ALK	quarterly	quarterly	quarterly		UK raised to Sco and France; Irish raised to Irish, N.Irish and Bel	
	Age comp.	quarterly	quarterly	quarterly		UK + IR combined to total int.	
2007	Len. comp.	quarterly	quarterly	quarterly			903
	ALK	quarterly	quarterly	quarterly		UK raised to Sco and France; Irish raised to Irish and N.Irish	
	Age comp.	quarterly	quarterly	quarterly		UK + Bel + IR combined to total int.	
2008	Len. comp.	quarterly	annual	quarterly			94
	ALK	quarterly	annual	quarterly		UK raised to Sco and France; Irish raised to Irish and N.Irish	
	Age comp.	quarterly	annual	quarterly		UK + Bel + IR combined to total int.	
2009	Len. comp.	quarterly	quarterly	quarterly			89
	ALK	quarterly	quarterly	quarterly		UK raised to Sco and France; Irish raised to Irish and N.Irish	
	Age comp.	quarterly	quarterly	quarterly		UK + Bel + IR combined to total int.	
2010	Len. comp.	quarterly	quarterly	quarterly			94
	ALK	quarterly	quarterly	quarterly		UK raised to Sco and France; Irish raised to Irish and N.Irish	
	Age comp.	quarterly	quarterly	quarterly		UK + Bel + IR combined to total int.	
2011	Len. comp.	quarterly	quarterly	quarterly			100
	ALK	quarterly	quarterly	quarterly		UK raised to Sco and France; Irish raised to Irish and N.Irish	
	Age comp.	quarterly	quarterly	-		UK + Bel + IR combined to total int.	
	Discard len comp	quarterly	quarterly	-		UK(raised) + Bel combined to total int.	
	Discard age comp	quarterly	-	-		UK(raised) + Bel combined to total int.	
2012	Len. comp.	quarterly	quarterly	quarterly			100

Year		Source					
of WG	Data	UK	Belgium	Ireland	Nether lands	Derivation of international landings and discards	% sampled
	ALK	quarterly	quarterly	quarterly		UK raised to Sco and France; Irish raised to Irish and N.Irish	
	Age comp.	quarterly	quarterly	-		UK + Bel + IR combined to total int.	
	Discard len comp	quarterly	quarterly	-		UK(raised) + Bel combined to total int.	
	Discard age comp	quarterly	-	-		UK(raised) + Bel combined to total int.	

[1] **Assumed – (not explicitly stated in report).**

[2] **Revised 2007.**

[3] **Revised 2008.**

Table B.2. Assessment model settings since 1991.

Assessment Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Assessment Age Range	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+
Fbar Age Range	3–8	3–6	3–6	3–6	3–6	3–6	3–6	3–6	3–6	3–6	3–6	3–6	3–6	3–6
Assessment Method	L.S.	L.S.	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA
Tuning Fleets														
UK trawl, years:	81–90	82–91	76–92	76–93	76–94	-	-	-	-	-	-	-	-	-
ages:	1–8	1–8	1–8	1–8	1–8									
UK otter, years:	-	-	-	-	-	86–95	87–96	88–97	89–98	90–99	91–00	87–01	87–02	87–03
ages:						2–8	2–8	2–8	2–8	2–8	2–8	2–8	2–8	2–8
UK beam, years:			-	-	-	-	-	-	89–98	90–99	91–00	89–01	89–02	89–03
ages:									2–8	2–8	2–8	2–8	2–8	2–8
Bel Beam, years:	-	-	-	-	85–94	86–95	87–96	88–97	-	-	-	-	-	-
ages:					2–8	3–8	3–8	3–8						
IR otter, years:					-	-	-	-	-	-	-	95–01	95–02	95–03
ages:												2–8	2–8	2–8
UKBTS Sept, years:			88–92	88–93	88–94	88–95	89–96	89–97	89–98	90–99	91–00	89–01	89–02	89–03
ages:			1–4	1–4	1–4	1–4	1–4	1–4	1–4	1–4	1–4	1–4	1–4	1–7
UKBTS Mar, years:								93–97	93–98	93–99	93–99	93–99	93–99	-
ages:								1–4	1–4	1–4	1–4	1–4	1–4	
IR-JPS, years:						-	-	-	-	-	-	91–01	91–02	-
ages:												1–6	1–6	
Time taper			20yr tri	20yr tri	20yr tri	No	No	No	No	No	No	No	No	No
Power model ages			1	0	1	1	1	1	1	0	0	0	0	0
P shrinkage			True	False	True	True	True	True	True	False	False	False	False	False
Q plateau age			5	5	5	5	5	5	5	5	5	5	5	5
F shrinkage S.E			0.3	0.3	0.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Number of years			5	5	5	5	5	5	5	5	5	5	5	5
Number of ages			5	5	4	4	4	4	4	4	4	4	4	4
Fleet S.E.			0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3

Assessment year		2005	2006	2007	2008	2009	2010
Assessment model		ICA	ICA	ICA	ICA	ICA	ICA
Tuning fleets	UK(E&W)OTB	-	-	-	-	-	-
	UK(E&W)-BTS-Q3	1989 – 2004	1989 – 2005	1989 – 2006	1989 – 2007	1989 – 2008	1989 – 2009
	ages:	1 – 7	2 – 7	2 – 7	2 – 7	2 – 7	2 – 7
	UK(E&W)-BTS-Q1	-	-	-	-	-	-
	UK(E&W)BT	-	-	-	-	-	-
	IR-OTB	-	-	-	-	-	-
	NIGFS-WIBTS-Q1	1992–2004	1992–2005	1992–2006	1992–2007	1992–2008	1992–2009
	Biomass index						
	NIGFS-WIBTS-Q4	1992–2004	1992–2005	1992–2006	1992–2007	1992–2008	1992–2009
	Biomass index						
Time-series weights		Full time-series - unweighted	Full time-series - unweighted	Full time-series - unweighted	Full time-series - unweighted	Full time-series - unweighted	Full time-series - unweighted
Num years for separable		5	5	6	7	8	9
Reference age		4	5	5	5	5	5
Terminal S		1	1	1	1	1	1
Catchability model fitted		linear	linear	linear	Linear	linear	linear
SRR fitted		No	No	No	No	No	No
Landings number-at -age, range:		1 – 9+	2 – 9+	2 – 9+	2 – 9+	2 – 9+	2 – 9+

Assessment year		2011	2012
Assessment model		AP	AP
Tuning fleets	UK-BTS Sept (Trad)	Series omitted	Series omitted
	UK(E&W)-BTS-Q3	1993 – 2010, ages 1 – 6	1993 – 2011, ages 1 – 6
	UK(E&W)-BTS-Q1	Survey omitted	Survey omitted
	UK(E&W) OTB	Series omitted	Series omitted
	UK(E&W) BT	Series omitted	Series omitted
	IR-OTB	Series omitted	Series omitted
	NIGFS-WIBTS-Q1	1993–2010	1993–2011
	NIGFS-WIBTS-Q4	1993–2010	1993–2011
Time-series weights		n/a	n/a
Num yrs for separable		n/a	n/a
Reference age		n/a	n/a
Terminal S		n/a	n/a
Catchability model fitted		n/a	n/a
SRR fitted		n/a	n/a
Selectivity model		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)
Landings num at-age, range:		1 – 9+	1 – 9+
Discards N at-age, yrs ages r		2004–2010, ages 1 – 5	2004–2011, ages 1 – 5

6.8 Stock Annex: Sole VIIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Irish Sea Sole (Division VIIa)
Working Group	WGCSE
Date	6 Feb 2011 (WKFLAT 2011)
Last updated	18 May 2012
By	Sofie Nimmegeers

A. General

A.1. Stock definition

Sole occur throughout the Irish Sea, but are found more abundant in depth less than 60 m. Recent information on stock identity, distribution and migration issues is included in the report of WKFLAT 2011. Cuveliers *et al*. (2011) combined the results obtained from ten microsatellite markers (long-term estimate of population structure) with results from otolith microchemistry analyses (short-term estimate of connectivity) on adult sole populations in the Northeast Atlantic area. Major large-scale differentiation was detected between three distinct regions (Baltic transition area, North Sea, Irish/Celtic Seas) with both types of markers. The assignment success of individuals to their collection location was much higher based on otolith edge microchemistry compared with the genetic assignments at all sampling locations, except for the Irish Sea. Only 28.6% of individuals (n=30) caught in the Irish Sea could be assigned to their catch location based on otolith edge microchemistry, whereas this region showed high genetic self-assignment scores (ca 60% of 91 individuals) suggesting a spawning population that is genetically distinct. 32% of the misclassifications based on otolith microchemistry were allocated to the neighbouring Celtic Sea. These results are consistent with tagging studies of sole in the Irish Sea and Bristol Channel, showing mainly local recruitment and limited movement of sole outside the management areas (Horwood *et al*., 1993). Therefore, the management unit is considered to correspond to the stock unit for Irish Sea sole.

A.2. Fishery

There are three main countries fishing for sole in the Irish Sea; Belgium, taking the bulk of the landings (60–80% in recent years). UK and Ireland taking about 20% and 10% respectively of the sole landings. Northern Ireland, Scotland, Isle of Man and France take the remainder. Approximately 25 Belgian beam trawlers are operating in the Irish Sea, targeting sole. The UK trawl fleet and the Belgian beam trawls operate predominantly in the eastern part of the Irish Sea (Liverpool Bay and Morecambe Bay). Sole catches from Ireland are mainly coming from bycatches in the *Nephrops* fishery (operation in the northwest of the Irish Sea).

When fishing in VIIa it is prohibited to use any beam trawl of mesh size range 70–90 mm unless the entire upper half of the anterior part of such a net consists of a panel of netting material attached directly to the headline of the net, extending towards the posterior of the net for at least 30 meshes and constructed of diamond-meshed netting material of which no individual mesh is of mesh size less than 180 mm. The Irish otter trawl fleet employs either a 70 mm mesh with square mesh panels or more commonly an 80 mm mesh. Similarly the Belgian and UK(E&W) beam trawls use 80 mm mesh gear. Otter trawlers targeting roundfish have, since 2000, used 100 mm mesh gear.

It was concluded at the 2000 working group and confirmed in 2001 that the cod recovery measures first enacted (EU Regulations 304/2000 and 2549/2000 + revisions in 2001–2003) in 2000 would have had little impact on the sole fishery. The closed area in 2001 covered a reduced area confined to the west of the Irish Sea and therefore is also expected to have had little effect on the level of fishing effort for sole The spawning closure for cod in 2002 is also unlikely to have had an impact on the sole fishery. The effort regulations and maximum daily uptake, implemented in 2003 will delay the uptake of the quota but is also unlikely to be restrictive for the total uptake. It is unlikely that any measures concerning the cod management plan in the Irish Sea had restrictions on the sole fishery after 2003.

Discard are estimated to be minor. Preliminary data indicate ranges from 0 to 8% by weight discarded.

Although no data are available on the extent of misreporting of landings from this stock, it is not considered to be a problem for this stock, given the partial uptake of the agreed TAC in recent years.

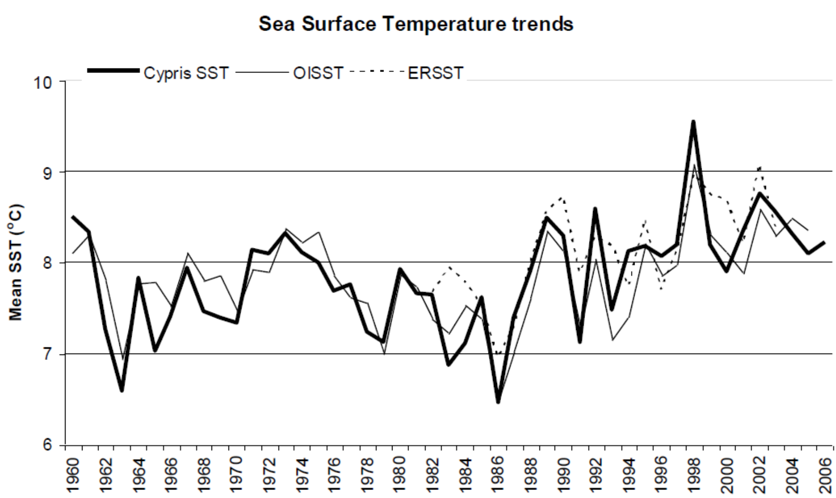
A.3. Ecosystem aspects

(1) Ecosystem overview for the Irish Sea

Physics	
Bathymetry	Shallow sea (less than 100m deep in most places), largely sheltered from the winds and currents of the North Atlantic.
Circulation	An inshore coastal current carries water from the Celtic Sea and St. Georges' Channel northwards through the North Channel, mixing with water from the outer Clyde. A seasonal gyre operates as a local retention mechanism in the western Irish Sea.
Fronts	The Celtic Sea front is situated at the southern entrance to the Irish Sea and the Islay Front is found between Islay and the Malin Shelf.
Temperature ***Salinity***	Time series from the SW coast of the Isle of Man (the Cypris station), western Irish Sea (Gowen, AFBI, Belfast), and two series of combined satellite and ship-records indicate a general warming trend in the Irish Sea since 1960, with particularly high temperatures in 1998 (see figure on following page).

Biology	
Benthos, larger invertebrate, biogenic habitats	The main commercial invertebrate species is Norway-lobster (*Nephrops norvegicus*). There are distinct benthic assemblages with plaice and dab on fine substrates in inshore waters and sea urchins and sun-stars on coarser substrates further offshore. Thickback sole (*Microchirus variegates*) and hermit crabs dominate the transitional zone, while Norway-lobster and Witch (*Glyptocephalus cynoglossus*) dominate on the muddy sediments in the central Irish Sea. Beds of *Alcyonium digitatum* (Dead man's fingers) occur on coarse substrates throughout. Biogenic reefs of horse mussels *Modiolus modiolus*, maerl and Serpulid worms occur in specific locations.
Fish Community	There are commercial fisheries for cod (*Gadus morhua*), plaice (*Pleuronectes platessa*) and sole (*Solea solea*). The most abundant species in trawl surveys are dab (*Limanda limanda*), plaice (*Pleuronectes platessa*), solenette (*Buglossidium luteum*) and common dragonet (*Callionymus lyra*) along with large numbers of poor-cod, whiting and sole. In recent years, abundance of dab, solenette and scaldfish (*Arnoglossus laterna*) and red gurnards *Aspitrigla cuculus* increased, whereas hake, dragonets and pogge *Agonus cataphractus* decreased. Lesser spotted dogfish *Scyliorhinus canicula* is abundant throughout. There are also ray assemblage on sand hills in Southern Irish Sea, and Cardigan Bay. Herring and sprat are the main pelagic species in the eco-region, with important spawning grounds for herring in the south.
Birds, Mammals & Elasmobranches	Basking sharks (*Cetorhinus maximus*) occur from April through to October but the stock seems severely depleted. Grey seals (*Halichoerus grypus*) are common and 5000-7000 individuals are thought to exist in the Irish and Celtic Seas. Gulls predominate the seabird populations, in particular black-headed, lesser black-backed and herring gulls as well as guillemots.

Environmental signals & implications	There has been a steady warming of sea surface temperatures (SSTs) in the area and this can potentially affect the recruitment and productivity of stocks. Herring recruitment has fluctuated widely, however studies to date have not been able to demonstrate any relationship to environmental changes. Irish Sea cod recruitment exhibited a decline in the 1990s. There is some indication that this reduction in cod recruitment may be due to a combination of small spawning-stock biomass and poor environmental conditions, coinciding with a shift towards above-average sea temperatures There has been a northward shift in the distribution of some fish such as an increase of seabass (*Dicentrarchus labrax*) and red mullet (*Mullus surmuletus*) populations around British coasts
Fishery effects on benthos and fish communities	This area has a number of severely depleted stocks e.g. cod, whiting and sole. Significant proportion of the catch of the demersal fleets is discarded these include a range of non-commercial or low value species together with undersized individuals of commercial species. Although a number of gear selectivity devices such as square mesh panels are mandatory, their effectiveness is variable in mixed fisheries. Sole and plaice are primarily targeted by beam trawl fisheries. Beam trawling, especially using chain-mat gear, is known to have a significant impact on the benthic communities, although less so on soft substrates 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. The high mud content and soft nature of *Nephrops* grounds means that trawling readily marks the seabed, trawl marks remaining visible for some time. Despite the high intensity of fishing (some areas are impacted >7 times/year) burrowing fauna can be seen re-emerging from freshly trawled grounds, implying that there is some resilience to trawling.



Sea surface temperature in the Irish Sea (1960 – 2006)

(Source: ICES 2006).

(Connolly, P.L. *et al*., 2009).

B. Data

B.1. Commercial catch

Quarterly age compositions are available from UK(E&W), Belgium and Ireland, as well as quarterly landings from France, Northern Ireland, Isle of man and Scotland. The total international age composition is obtained using a combined ALK from UK(E&W), Belgium and Ireland raw data, responsible for 99% of the total international sole landings. The combined ALK is applied to the length distributions of the separate countries to obtain an aggregated age composition.

Catch weights were obtained from the combined AWK (UK(E&W), Belgium and Ireland raw data).

Stock weights were obtained using the Rivard weight calculator (http://nft.nefsc.noaa.gov./) that conducts a cohort interpolation of the catch weights.

B.2. Biological

Currently there are no direct (from tagging) or independent (from survey information) estimates of natural mortality. Therefore, annual natural mortality (M) is assumed to be constant over ages and years, at 0.1 yr^{-1}.

The maturity ogive used in this and previous assessments is based on survey information for this stock.:

Age	1	2	3	4	5	6 and older
Mat.	0.00	0.38	0.71	0.97	0.98	1.00

Proportions of M and F before spawning were set to zero, as in previous years.

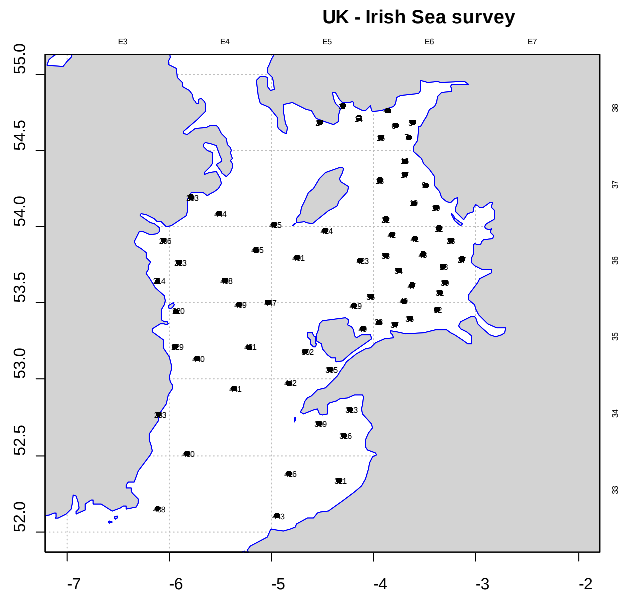
Males and females of this stock are strongly dimorphic, with males showing much reduced rates of growth after reaching maturity, while females continue to grow. Given the minimum landing size of 24 cm the majority of landings represent mature females.

B.3. Surveys

One survey is used in the assessment of VIIa sole: the UK beam trawl survey (UK (BTS-3Q)).

Area covered

Irish Sea; 52°N to 55°N; 3°W to 6°30′ W.



Target species

Flatfish species, particularly juvenile plaice and sole. Length data recorded for all finfish species caught; samples for age analysis taken from selected species.

Time period

1988–2011: September (continuing)

Gear used

Commercially rigged 4 m steel beam trawl; chain matrix; 40 mm codend liner.

Mean towing speed: 4 knots over the ground. Tow duration: 30 minutes. Tow duration for trips in 1988–1991 was 15 minutes; in 1992 comparative tows of 15 and 30 minutes length were carried out, and subsequent cruises used a standard 30 minute tow. The data from earlier years were converted to 30 minutes tow equivalent using relationships for each species derived from the comparative work in 1992.

Vessel used: R.V. *Endeavour* (Cefas).

Survey design

Survey design is stratified by depth band and sector (Depth bands are 0–20, 20–40, 40+). Station positions are fixed. Number of stations=35 in the eastern Irish Sea, 15 in the western Irish Sea, and 16 in St George's Channel (primary stations). Sampling intensity is highest in the eastern Irish Sea, in the main flatfish nursery and fishery areas.

Method of analysis

Raised, standardized length frequencies for each station combined to give total length distribution for a stratum (depth band/sector). Sector age–length keys applied to stratum length distributions 1988–1994; stratum age–length keys applied 1995 onwards. Mean stratum cpue (kg per 100 km and numbers-at-age per 100 km) are calculated. Overall mean cpue values are simple totals divided by distance in metres (or hours fished). Population number estimates derived using stratum areas as weighting factors.

The September beam trawl survey has proven to estimate year-class strength well, and providing 50% to over 90% of the weighting to the total estimates of the incoming year classes.

B.4. Commercial lpue

Lpue and effort series were available from the Belgium beam trawlers, UK(E&W) beam and otter trawlers, the Irish otter trawlers and from two UK beam trawl surveys (September and March).

Lpue for both UK and Belgian beam trawlers has declined since the beginning of the time-series, but has remained relatively constant over the last decade, with a renewed increase over the last few years (2008–2009 for Belgium and 2007–2009 for UK).

Effort from both commercial beam trawl fleets increased from the early seventies until the late eighties. Since then Belgian beam trawl effort has declined over the nineties, increased again in the period 2000–2005 and subsequently dropped to much lower values in 2008–2011 (the lowest values since 1984). In the nineties, the UK beam trawl effort fluctuated around a lower level than the late eighties, and dropped during the 21st century to a lower value of the time-series.

Indices of abundance derived from the UK September survey (UK (BTS-3Q)) (data from 1988 onwards) are shown in WGNSDS 2002 (Table 12.2.2). High abundance indices for the UK September survey (UK (BTS-3Q)) can be seen for year classes 1989, 1995 and 1996. The dataseries from the UK March beam trawl survey (UK (BTS-1Q)) is rather short (from 1993 to 1999), and therefore difficult to interpret.

B.5. Other relevant data

No information.

C. Assessment: data and method

Model used: XSA

Software used: IFAP/Lowestoft VPA suite

Model Options chosen since 2004:

ASSESSMENT YEAR	2004	2005	2006	2007–2010	WKFLAT 2011	2012
Assessment Model	XSA	SURBA	XSA	XSA	XSA	XSA
Fleets						
BEL-CBT	1975–2003 4–9		omitted	omitted	omitted	omitted
UK-CBT	1991–2003 2–9		omitted	omitted	omitted	omitted
UK (BTS-3Q)	1988–2003 2–9	1988–2004 1–9	1988–rec yr 2–7	1988–rec yr 2–7	1988–rec yr 2–7	1988–rec yr 2–7
UK (BTS-1Q)	1993–1999 2–9		1993–1999 2–7	1993–1999 2–7	omitted	omitted
Time-Ser. Wts	tricubic 20yrs		linear 20 yrs	linear 20 yrs	uniform	uniform
Power Model	none		none	none	none	none
Q plateau	5		5	7	4	4
Shk se	0.8		1.5	1.5	1.5	1.5
Shk Age-yr	5 yrs 5 ages		5 yrs 3 ages	5 yrs 3 ages	5 yrs 3 ages	5 yrs 3 ages
Pop Shk se	0.3		0.3	0.3	0.3	0.3
Prior Wting	none		none	none	None	None
Plusgroup	10		8	8	8	8
FBAR	4–7		4–7	4–7	4–7	4–7

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch-in-tonnes	1970–last data year	2–8+	Yes
Canum	Catch-at-age in numbers	1970–last data year	2–8+	Yes
Weca	Weight-at-age in the commercial catch	1970–last data year	2–8+	Yes
West	Weight-at-age of the spawning–stock at spawning time	1970–last data year	2–8+	Yes-but based on back calculated catch weights
Mprop	Proportion of natural mortality before spawning	1970–last data year	2–8+	No-set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1970–last data year	2–8+	No-set to 0 for all ages in all years
Matprop	Proportion mature-at-age	1970–last data year	2–8+	No-the same ogive for all years
Natmor	Natural mortality	1970–last data year	2–8+	No-set to 0.1 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	UK (BTS-3Q)	1988–last data year	2–7

Note : several other commercial tuning fleets – BEL-CBT (Belgian beam trawl fleet), UK-CBT (UK beam trawl fleet), UK-COT (UK otter trawl fleet), IRL-COT (Irish otter trawl fleet) – and two other surveys (UK (BTS-1Q) and Irish Juvenile Plaice Survey) have been used or made available in the past. A thorough investigation of the utility of these tuning indices was conducted at the 2002 working group. The results are summarized in the Stock Annexes of the reports of WGNSDS 2002–2008 and WGCSE 2009.

D. Short-term projection

Model used: Age structured deterministic projection

Software used: MFDP

Initial stock size: Taken from the XSA for ages 3 and older. The recruitment-at-age 2 in the last data year is estimated using RCT3. The short-term geometric mean recruitment (2002–2010) is used for age 2 in all projection years.

Maturity: the same ogive as in the assessment is used for all years (see table above)

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

Weight-at-age in the stock: average weight of the last three years

Weight-at-age in the catch: average weight of the three last years

Exploitation pattern: average of the three last years, not scaled to the last year's F_{BAR} (4–7) if no trend in F was detected (scaled to the last year's F_{BAR} (4–7) if a trend in F was detected).

Intermediate year assumptions: *status quo* F

Stock–recruitment model used: none

Procedures used for splitting projected catches: not relevant

E. Medium–term projections

Medium-term projections were not conducted at WKFLAT 2011. The last medium-term projections were carried out in 2008. The settings used are described below.

Model used: Age structured

Software used: IFAP single option prediction

Initial stock size: Same as in the short-term projections.

Natural mortality: Set to 0.2 for all ages in all years

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

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

Weight-at-age in the stock: Assumed to be the same as weight-at-age in the catch

Weight-at-age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the F_{BAR} (3–6) to the level of the last year

Intermediate year assumptions: F-factor from the management option table corresponding to the TAC

Stock–recruitment model used: None, the long-term geometric mean recruitment-at-age 2 is used.

Uncertainty models used: @RISK for excel, Latin Hypercubed, 500 iterations, fixed random number generator

- Initial stock size: Lognormal distribution, LOGNORM(mean, standard deviation), with mean as in the short-term projections and standard deviation calculated by multiplying the mean by the external standard error from the XSA diagnostics (except for age 2, see recruitment below)
- Natural mortality: Set to 0.2 for all ages in all years
- Maturity: The same ogive as in the assessment is used for all years
- F and M before spawning: Set to 0.2 for all ages in all years
- Weight-at-age in the stock: Assumed to be the same as weight-at-age in the catch
- Weight-at-age in the catch: Average weight of the three last years

- Exploitation pattern: Average of the three last years, scaled by the F_{BAR} (3–6) to the level of the last year
- Intermediate year assumptions: F-factor from the management option table corresponding to the TAC
- Stock–recruitment model used: Truncated lognormal distribution, TLOGNORM(mean, standard deviation, minimum, maximum), is used for recruitment age 2, also in the initial year. The long-term geometric mean, standard deviation, minimum, maximum are taken from the XSA for the period 1960–4th last year.

F. Long-term projections

Model used: age structured deterministic projection

Software used: MFYPR

Inputs as for short-term projection.

G. Biological reference points

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$	3100 t	Default to value of B_{PA}.
Approach	F_{MSY}	0.16	Provisional proxy based on stochastic simulations assuming a Ricker S/R relationship (range 0.1–0.25).
	B_{lim}	2200 t	$B_{lim} = B_{loss}$. The lowest observed spawning–stock (ACFM 1999), followed by an increase in SSB.
Precautionary	B_{PA}	3100 t	$B_{PA} \sim B_{lim} * 1.4$. The minimum SSB required ensuring a high probability of maintaining SSB above its lowest observed value, taking into account the uncertainty of assessments.
Approach	F_{lim}	0.4	$F_{lim} = F_{loss}$. Although poorly defined, there is evidence that fishing mortality in excess of 0.4 has led to a general stock decline and is only sustainable during periods of above average recruitment.
	F_{PA}	0.3	This F is considered to have a high probability of avoiding F_{lim}.

Precautionary approach reference points have not been changed during 1999–2006. In this period, F_{PA} was set at 0.45 on the technical basis of high probabilities of avoiding F_{lim} and of SSB remaining above B_{PA}. In 2007, F_{PA} was changed to 0.3 due to the rescaling of SSB estimates. In 2010, MSY reference points were added by WGCSE.

H. Other issues

A management plan for Irish Sea sole could be developed, also taking into account the dynamics of the plaice stock in that area.

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7.2 Stock Annex Cod VIIe-k

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Cod in VIIe–k (Celtic Sea cod)
Expert Group	Celtic Sea Working Group
Date	March 2012
Revised by	Colm Lordan, Lionel Pawlowski

A. General

A.1. Stock definition

Since 1997, this assessment has related to the cod in Divisions VIIe–k, covering the Western Channel and the Celtic Sea. Tagging information presented at WKROUND 2012 (WDs 9 and 11) confirms minimal movement of cod from VIIe–k to other areas. In fact even within VIIe–k there seems to be limited mixing between fish tagged in VIIg or VIIa South and those tagged in VIIf and VIIe.

Up to 2008, the management area was set in Divisions VIIb–k, VIII, IX, X, and CECAF 34.1.1 which does not correspond to the area assessed. The management area was revised in 2009 to exclude VIId. The new TAC covers ICES Areas VIIb–c, VIIe–k, VIII, IX, X, and CECAF 34.1.1(1). This is more representative of the stock area in recent years and landings from VIIbc, VIII, IX and X have been minimal.

The area assessed has gradually increased from VIIfg before 1994 to VIIfgh, to VIIefgh in 1996 and finally to VIIe–k. In 1994, at the request of ACFM, ICES Working Group on Southern Shelf Demersal Stocks (WGSSDS) studied the possible extension of the area assessed from VIIfg to VIIfgh. Examination of data from surveys and logbooks indicated a continuity of the distribution of VIIg cod into VIIh. Depending on the year, catches in Division VIIh represented 9–15% of the catches in VIIfg, with a coincidence of years of peak or low catches in both areas. Therefore, catches from VIIh were included in the assessment. In 1996, at the request of ACFM, WGSSDS studied the possible extension of the area assessed from VIIfgh to VIIefgh. The population dynamics parameters for VIIfgh and VIIe cod were examined and compared for the period 1988–1994, when independent tuning fleets, international catch-at-age, mean weights-at-age in the landings and in the stocks were available for both areas. Patterns of F were consistent between VIIe and VII fgh in earlier years (1988–1990), and SSBs trends were similar in the period 1988–1992. The patterns of recruitments (age 1) were found to be fairly consistent through this period 1988–1994, though it cannot be assumed that this consistency was also valid in earlier years when catch-at-age were only available in Divisions VIIf, g, h. It was therefore decided to combine Western Channel Cod with the Celtic Sea Cod assessment for the years 1988–1995, but an independent assessment of Celtic sea Cod in VIIfgh was maintained for the longer period available 1971–1995. This was to allow scaling of the historic (1971–1987) SSBs and recruitments values from VIIfgh to VIIe–h.

At WGSSDS 1997, due to the lack of a long independent series of catch-at-age in Divisions VIIj,k, the estimate of landings from Divisions VIIjk was discussed and it was decided to combine the data of Divisions VIIe,f,g,h and Divisions VIIjk for the period 1993–1996 and to raise the data in Divisions VIIe–h to landings in Divisions VIIe–k for the period 1988–1992. The results of an XSA assessment of this series in Divisions VIIe–k for 1988–1996 had been compared with the results of the assessment in Divisions VIIe–h in terms of trends of F, SSB and recruitment. Patterns of these parameters were found very similar and the merging of Divisions VIIjk with Divisions VIIe–h mainly resulted in a scaling upwards of SSB and recruitment. The new assessment areas comprised cod in Divisions VIIe–k.

At the 1999 WGSSDS meeting, an alternative procedure to the tedious re-scaling of SSB and recruitment of the earlier series 1971–1987 in VIIfgh to VIIe–k every year was proposed (Bellail, 1999). A long series of landings data from 1971–1987 was reconstructed. An average raising factor (1.24) from VIIfgh to VIIe–k in the period 1988–1997 was applied to VIIfgh landings of the series 1971–1987. Results of assessment in terms of SSB and R were very close to those obtained when these parameters were scaled. ACFM accepted this procedure.

In the past few biological criteria have been used to justify the widening the stock area. However, recent tagging work by Ireland and the UK supports the idea that there is a resident stock in the Celtic Sea and Western Channel (VIIe–k) and mixing with other areas appears to be minimal. The Irish Sea front, running from SE Ireland (Carnsore point) to the Welsh Coast, appears to act as boundary between the Irish Sea and Celtic Sea stock. Juveniles found close to the SE Irish Coast (south of VIIa) are considered part of the Celtic Sea stock.

Some migrations and mixing are known to occur in this cod stock. Both conventional and DST tagging information for VIIg (where the majority of landings are made) shows that distribution remained fairly constrained within VIIg. There was some preference to central areas within VIIg during January–March. Between April and June the cod appeared to be more widely dispersed within VIIg during Q1 & Q2. Fish tagged in VIIf tended to mix with those off shore in VIIg and h. Whereas some fish tagged in the western English Channel VIIe migrated into VIId for at least part of the year.

A.2. Fishery

The majority of the landings are made by demersal trawls targeting roundfish (i.e. cod, haddock and whiting), although, in recent years an increasing component have been from gillnets and otter trawls targeting *Nephrops* and benthic species.. Landings are made throughout the year but are generally more abundant during the first semester. Constraining TACs set since 2003 and the impact of the Trevose Head Closure applied since 2005 have reduced landings in Q1 somewhat and spread landing more throughout the year.

WGCSE should routinely monitor spatial and temporal changes in landings, effort and lpue for the main fleets catching cod in VIIe–k. This has previously been done using maps of landings and lpue by ICES rectangle.

A.3. Ecosystem aspects

Cod recruitment success has generally shown an increase over the period 1970–2006 during which time sea surface temperature in the Celtic Sea has increased (Lynam *et al*., 2009). Notably the highest recruitment success was for cod spawned in 1986, a year with an exceptionally cold spring. Lynam *et al*. (2009) also found that SST in spring (MAM) and *Calanus helgolandicus*, abundance in the Celtic Sea, did prove to be significant predictors of recruitment in Celtic Sea cod in a GAM model. The time-lag between availability of this SST and zooplankton information means that their model cannot be readily used in forecasting recruitment in advance of what groundfish surveys might detect. Nevertheless this research should be pursued further, particularly in the context ecosystem determinants of the strong 2009 and 2010 year classes.

B. Data

B.1. Commercial catch

Landings

On a quarterly basis, France, Ireland and UK (E+W) have provided catch numbers-at-age and catch weights-at-age for their landings. The Irish landings in VIIg are augmented with some landings made or reported off the southeast coast of Ireland in ICES rectangles 33E2 and 33E3. These rectangles are in the very south of VIIa. Landings only are available for Belgium.

France, UK and Ireland data are added quarterly and raised to international landings taking into account Belgian data. Then the quarterly datasets are summed up to the annual values.

As a consequence of an update to the French database of landings statistics, some minor revisions (downward) have been applied since 2002 and the updated datasets for international landings.

There is no information on the absolute level of misreporting for this stock but there is evidence that misreporting has increased from 2002 when quotas became restrictive with a maximum in 2008. Misreporting has decreased since then.

Discards

Discards data sampled under EU/DCR since 2003 have been generally presented in previous WGCSE but not used in the assessments as they do not cover all the main fleets and quarters yet.

Due to the annual management system adopted by the French POs since 2003 in response to the quota restrictions, highgrading has occurred in the French fishery, mainly in VIIfgh. A procedure using both the UK and French landings length data enabled estimation of the French highgrading for the years 2003–2005 (WD 1 WGSSDS 2006). The adjustments were reapplied to improved estimates of French landings from 2006 at ICES WKROUND 2009.

In 2008 the French self sampling programme on Celtic Sea cod has produced datasets enabling estimation of discarding and highgrading rates. Assuming the same pattern of discarding in recent years, estimates of French discarding and highgrading back to 2003 were also computed. Estimates of highgrading were also calculated for the French tuning fleets used in the analysis (ICES WKROUND, 2009, *WD 17)*. In 2009 and 2010, the low estimate of highgrading is likely to be related to the French vessels not being restricted by quota because of the decommissioning plan and the reports of effort directed towards more profitable species.

Discard estimates are available from Ireland since 1995 (see Marine Institute and Bord Iascaigh Mhara, 2011). For now the assumption is that the discards are mainly at age 1 and the estimates are very uncertain. There are indications that Irish discard rates have increased since 2005 this is something that WGCSE should monitor and discards should be included in the assessment if there are major changes or it is found to have a large impact on the assessment.

Lpue

Landings and effort data are available for all the main fleets operating in the area and catching cod. The table below summarizes the available data. WGCSE should monitor changes in these fleets over time.

Name	Area	Series
FR gadoid fleet [1]	VIIfgh	1983–onwards
FR *Nephrops* fleet [1]	VIIfgh	1983–onwards
FR otter trawlers [2]	VIIe	1983–onwards
FR otter trawlers [2]	VIIfgh	1983–onwards
FR otter trawlers [2]	VIIe–k	1983–onwards
UK otter trawlers	VIIe	1972–onwards
UK otter trawlers	VIIe–k	1972–onwards
UK beam trawlers	VIIe–k	1978–onwards
IR otter trawlers	VIIg	1995–onwards
IR beam trawlers	VIIg	1995–onwards
IR Scottish seiners	VIIg	1995–onwards
IR otter trawlers	VIIj	1995–onwards
IR beam trawlers	VIIj	1995–onwards
IR Scottish seiners	VIIj	1995–onwards

[1] For Q2+3+4 for consistency with the Trevose Head Closure since 2005 during the first quarter.

[2] Annual values, including the Fr gadoid and *Nephrops* fleets.

B.2. Biological

Weights-at-age

At the 1999 WGSSDS, data for the years 1971–1980 were set to the average 1981–1997. A revision was carried out at 2001 WGSSDS where the values for the period 1971–1980 were set to the average values 1981–2000. Depending on the annual datasets available by country for the period 1988–2001, catch weights-at-age data were calculated as the weighted means from French, Irish and UK datasets. Since 2002, VIIe–k catch weights-at-age have been calculated as the annual weighted means of French, Irish and UK datasets.

WKROUND 2012 reviewed the data and concluded that there is a downward trend in mean weights-at-age during the 1980s but they have been relatively stable since then at about 10% lower mean weights than observed in the 1980s. There is some evidence of year effects (e.g. 2001 and 2005) and cohort effects (e.g. 1999).

Stock weights-at-age are the catch weight-at-age data from the 1st quarter.

Maturity

The maturity ogive applied since 1999, was estimated from the datasets of the UK-WCGFS survey (1st quarter) has been used for the overall series. It replaced an assumed ogive used for the year prior to 1999, derived from Irish Sea cod data, when both stocks (VIIa and VIIfg) were assessed in the Irish Sea and Bristol Channel WG up to 1992. The table below summarizes the maturity ogives used.

Age	1	2	3	4	5+
Before 1999	0.00	0.05	1.00	1.00	1.00
Current	0.00	0.39	0.87	0.93	1.00

Natural mortality

In the assessments, natural mortality is assumed to be constant for the whole range of years and is age dependant The table below summarizes the values of M accordingly to age.

Age	0	1	2	3	4	5	6	7	8	9	10
M	1.12	0.51	0.37	0.30	0.269	0.247	0.233	0.223	0.216	0.210	0.207

B.3. Surveys

Three surveys-series are available.

The discontinued UK-WCGFS-Q1 (1986–2004), conducted during the first quarter, is generally truncated into a shorter series (1992–2004) as it showed a strong trend (dome-shaped) when using the full series. This pattern is related to the progressive extension of the studied area of this survey from VIIe to VIIefgh over the years. This time-series only contributes to the estimates at older ages (4 and older). Due to the lack of new data, the series is no longer used in the assessment.

The FR-EVHOE (EVHOE-WIBTS-Q4) survey (1997–), during the 4th quarter, covers the Divisions VIIfghj. The IrGFS (IGFS-WIBTS-Q4) survey (2003–), during the 4th quarter, in VIIg and VIIj is also used in the assessment.

The absolute numbers of cods caught in all of these surveys are extremely low. Attempts to combine survey data have been done at WKROUND 2009 and 2012 to overcome that problem. WKROUND 2012 tested two combinations: mixing data for the whole area and just those in the overlapping area.

WKROUND concluded that the overlap area combined index was an improvement on using the two surveys independently or using the full area index. This conclusion was based on the good cohort tracking and fairly consistent catch curves in the combined index Ages 1–4.

B.4. Commercial cpue

FR-OTDEF: a new time-series of tuning indices has been introduced at WKROUND 2012 upon French datasets considering landings and fishing efforts from otter trawlers (OTDEF métier) which catch per trip are at least 40% made of gadoids in Divisions VIIb–

k during quarters 2 to 4. FR-OTDEF is a substitute for the discontinued FR-Gadoid and FR-*Nephrops* fleet.

B.5. Other relevant data

Input from industry

No new datasets. There are several industry–science partnerships regarding cod:

- French industry self-sampling programme.
- Ireland-UK tagging programme in the Irish and Celtic Seas.
- Irish industry–science partnership quarter 1 cod survey 2010.

At the moment only the data from the French self-sampling programme are integrated into the observation-at-sea dataset used at the assessment working group. Information on tagging are however reviewed each year at the WG and by WKROUND. An Irish industry–science partnership survey was carried out in Q1 2010. This survey has not been repeated due to resource constraints. Any new information provided by the industry is also reviewed each year.

C. Historical stock development

Model to be used: XSA

Software: R 2.8.1 with FLR packages FLCore 2.2, FLAssess 2.0.1, FLXSA 2.0, FLEDA 2.0.

Model Options agreed at WKROUND 2012:

- Taper : no
- Age s catch dep. Stock size : none
- q plateau : 3
- F shrinkage se : 1
- F shrinkage year range : 5
- F shrinkage age range : 3
- F shrinkage age range of mean F : 2–5
- Fleet SE threshold : 0.3
- Prior weights : No

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1971–	1–7+	Yes
Canum	Landings-at-age in numbers	1971–	1–7+	Yes
Weca	Weight-at-age in the commercial catch	1971–	1–7+	Yes
West	Weight-at-age of the spawning stock at spawning time	1971–	1–7+	Yes

Mprop	Proportion of natural mortality before spawning	1971–	1–7+	No
Fprop	Proportion of fishing mortality before spawning	1971–	1–7+	No
Matprop	Proportion mature at-age	1971–	1–7+	No
Natmor	Natural mortality	1971–	1–7+	No

Tuning data:

Type	Name	Year range	Age range
French Otter Trawler in VIIek Q2-Q4	FR-OTDEF	2000–	1–7+
Combined EVHOE-WIBTS, IGFS-WIBTS	FR-IR-WIBTS	2003–	0–4+

D. Short-term projection

Model used: Age structured

Software used: MFDP

Initial stock size:

1) the survivors at age 2 and greater from the XSA assessment;

2) N at age 1 = long-term geometric mean omitting the last two years.

Maturity: same ogive as in the assessment

F and M before spawning: 0 (for all ages and years)

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

Exploitation pattern: The F vector used is the average F-at-age in the last three years, scaled by F_{bar} (2–5) to the level of last year unless there is strong indication of a significant trend in F. In the latter case the average selectivity pattern will be rescaled to the final F in the series.

E. Medium-term projections

Medium-term forecasts are not provided for this stock.

F. Yield and Biomass per Recruit

Software used: YPR 3.0 (NOAA fisheries toolbox)

- Stock/catch-at-age/spawning–stock weights-at-age: Average last five years
- Selectivity on Fishing mortality: Rescaled F Average last five years
- Selectivity on Natural mortality: Rescaled M-at-age (Lorenzen), M-at-age 1=1
- Fraction mature: same as maturity ogive
- Proportion of fishing/natural mortality before spawning: 0.0

G. Biological reference points

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$	8800 t	Provisionally set at B_{PA}.
Approach	F_{MSY}	0.40	Provisional proxy based on F_{MAX} (ICES, 2010).
	B_{lim}	6300 t	B_{lim}=B_{loss} (B76), the lowest observed spawning–stock biomass
Precautionary	B_{PA}	8800 t	B_{PA}=B_{lim}*1.4. Biomass above this value affords a high probability of maintaining SSB above B_{lim}, taking into account the variability in the stock dynamics and the uncertainty in assessments
Approach	F_{lim}	0.90	The fishing mortality estimated to lead to potential collapse
	F_{PA}	0.68	F_{PA}=5th percentile of F_{loss}. This F is considered to have a high probability of avoiding F_{lim} and maintaining SSB above B_{PA} in the medium term (assuming normal recruitment), taking into accounts the uncertainty assessments

H. Other issues

None.

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7.4 Stock Annex Haddock VIIb–k

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Haddock VIIb-k
Working Group	WGCSE
Date	last revision 29/02/12
Revised by	Hans Gerritsen

A. General

A.1. Stock definition

For assessment purposes, the stock is defined as VIIb–k excluding VIId. The TAC for haddock is set for VIIb–k, VIII, IX and X. However, official international landings from VIII, IX and X have been less than 2% of all landings in the TAC area in most years since 1973.

Adult haddock appear to be continuously distributed from the north of Biscay along the Irish coasts and the west of Scotland into the North Sea. It is not clear from their distribution if the VIIb–k stock is distinct from the surrounding areas. Irish Otter trawl lpue in the northernmost rectangles of VIIb is relatively high and similar lpue continues into VIa, suggesting that the haddock in the north of VIIb might belong to the same stock as those in VIa (Gerritsen, 2009). The pattern of lpue in the Irish Sea appears to be relatively distinct from VIIb–k with relatively high otter and beam trawl lpue in VIIg, low lpue in VIIa-South and high lpue in VIIa north (Gerritsen, 2009). Results from the French EVHOE-WIBTS-Q4 survey suggest that relatively low densities of haddock continue from VIIh into VIIIa. Irish Groundfish Survey (IGFS-WIBTS-Q4) data indicates two distinct nursery areas with high catches of 0-group haddock: one area off the southwest coast of Ireland (VIIb south and VIIj north) and one area off the southeast coast (VIIg north). Catches of older haddock in VIIb are generally low and it is not clear whether the young fish from VIIb move north to VIa or south to VIIj stock (Gerritsen and Stokes, 2006).

A.2. Fishery

Haddock in Divisions VIIb–k are taken as a component of catches in mixed trawl fisheries. France usually takes about 50–80% of the landings. French landings are made mainly by gadoid trawlers, which prior to 1980 were mainly fishing for hake in the Celtic Sea. Ireland has historically taken about 25–40% of the landings. Fleets from Belgium, Norway, the Netherlands, Spain, and the UK take the remainder of the landings. Landings reported between 1984 and 1995 varied between 2600 t and 4900 t, then increased sharply to 10 300 t in 1997. Since then the landings have varied between 5000 t and 10 000 t.

The vast majority of the landings are taken by otter trawls, most of the remainder of the landings are taken by seines and beam trawls.

A.3. Ecosystem aspects

Haddock are widely distributed throughout the stock area across a range of habitats. They have a varied diet but do not appear to be cannibalistic (Needle *et al*., 2003)

The mixed trawl fisheries impacts on benthic communities through bottom contact. Other ecosystem impacts result from discarding of non-target, undersize, over-quota or low-value fish.

Recruitment of haddock is highly variable. For North Sea haddock, no link could be found between temperature and recruitment (Cook and Heath, 2005). But parental condition has been linked to recruitment success in Northwest Atlantic haddock (e.g. Friedland *et al*., 2003; Marshall and Frank, 1999).

B. Data

B.1. Commercial catch

Sampling and data raising

Data on landings-at-age and mean weight-at-age-are available for fleets landing into Ireland since 1993, and from France and the UK since 2002. Irish age compositions from VIIgj were used to estimate the age compositions of the international landings. Note that Irish landings contributed around 30% of the international landings so there is considerable uncertainty about the age composition of the landings before 2002.

The UK landings numbers-at-age are supplied for the combined VIIe–k area and the landings data from each Division are used to scale the catch numbers to each Division. French VIIfgh landings numbers are combined with Irish VIIg data to estimate VIIfgh landings numbers. Since 2009, the French landings numbers-at-age are supplied for the whole stock area (VIIb–k). The table below shows the data available and the procedures used to derive quarterly length compositions, age compositions and mean weights-at-age.

		Data source:				
Division	**Data**	**UK**	**France**	**Ireland**	**Belgium**	**Derivation of international landings**
VII b,c	Length composition			VII b		
	ALK			VII b		
	Age Composition			VII b		IRL raised
	Mean weight at age			VII b		IRL VIIb
	Landings		VIIb,c	VIIb,c		
VII e	Length composition	VIIe-k				Derived from UK VIIe-k
	ALK	VIIe-k				Raised to international Landings
	Age Composition	VIIe-k				
	Mean weight at age	VIIe-k				
	Landings	VIIe	VIIe		VIIe	
VII f,g,h	Length composition		VII f,g,h	VII g		
	ALK		VII f,g,h	VII g		
	Age Composition		VII f,g,h	VII g		IRL & FRA raised
	Mean weight at age		VII f,g,h	VII g		IRL & FRA raised
	Landings	VIIf,g	VIIf,g,h		VIIf,g,h,j,k	
VIIe-h	Length composition					VIIf,g,h & VIIe
	ALK					
	Age Composition					
	Mean weight at age					
	Landings					
VII j-k	Length composition			VII j		IRL raised
	ALK			VII j		
	Age Composition			VII j		IRL raised
	Mean weight at age			VII j		IRL VIIj
	Landings	VIIj,k	VIIj,k	VIIk		
VII b,c,e,f,g,h,j,k	Length composition					
	ALK					
	Age Composition					VIIb,c + VIIe + VIIfgh + VIIjk
	Mean weight at age					Weighted mean by numbers caught
	Landings					

Weights-at-age

Discard weights were estimated from a fixed length-weight relationship (a = 11.809; b = 3.069). This was applied to the discard length distributions-at-age. For the landings weights, length–weight relationships were estimated for each year and quarter from the individual weights of the fish that were aged. Landings and discard weights are combined to estimate catch weights. The values are weighted by the numbers-at-age.

Quarter-1 catch weights were used as stock weights. If no data were available, quarter-2 weights were used. Previous to the WGSSDS 2004, a three year running average was applied to the stock weights-at-age. In 2004, the working group estimation of stock weights was done using a quadratic function fitted through cohorts to the first-quarter catch weight data. In 2005 the stock weights were modelled using a von Bertalanfy growth equation. The raw stock weight data show significant year-effects and although these might be due to changes in sampling or ageing errors, it is also possible that weights-at-age are subject to interannual variation in condition. As the modelled stock weight did not fit the data very well and because it is not clear whether stock weights-at-age are more influenced by cohort- or year-effects, it was decided in 2007 to revert to using a three year running average to smooth the data, and constraining the weights in older ages to at least those of the preceding age in the cohort.

B.2. Biological

Natural mortality estimates were derived from mean catch weights-at-age using the approach proposed by Lorenzen (1996). Parameter values were obtained from Table 1 in the Lorenzen paper (ocean ecosystems: $\alpha = 3.69$; $\beta = -3.05$).

Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
0.99	0.72	0.60	0.50	0.43	0.40	0.37	0.36	0.34

Maturity was assumed to be knife-edged at age 2. Recent Irish Survey data are generally in agreement with this maturity ogive, although males occasionally mature at age one.

F and M before spawning were set to 0 for all ages in all years.

B.3. Surveys and commercial tuning fleets

Description

The surveys described below are coordinated by the IBTSWG (International Bottom-trawl Survey Working Group).

The French 7fghj EVHOE-WIBTS-Q4 annual groundfish has been carried out since 1997 on the RV Thalassa. Age data are available from 2001 onwards. ALK data from Irish surveys were applied to the EVHOE data for the years 1997–2000 to estimate numbers-at-age for these years. The sampling design is a stratified random allocation. The number of hauls per stratum is optimized by a Neyman allocation taking into account the most important commercial species in the area (hake, monkfish and megrim). The fishing gear used is a GOV with an average vertical opening of 4 m and a horizontal opening of 20 m.

The Irish Groundfish Survey (IGFS-WIBTS-Q4) has been carried out since 2003 and covers VIa, VIIbgj. This survey is carried out on RV Celtic Explorer. The IGFS has a random stratified design and uses a GOV (with rock-hopper in VIa) with a 20 mm codend liner.

The two surveys were combined to provide a single index that covers nearly the full stock area. Gerritsen (2012a) describes the justification and for combining the surveys. The two indices are directly combined, weighted by the surface area covered by each survey (37 000 nm^2 for the IGFS and 30 000 nm^2 for the EVHOE). The combined survey starts in 2003. The EVHOE data before 2003 are not used.

A French commercial OTB DEF tuning fleet is available but this fleet takes the majority of the landings and is therefore not included as tuning fleet.

An Irish commercial OTB fleet is available from 1995 onwards. This fleet is based on the landings and effort from ICES Rectangles 32D9, 31D9, 31E0, 31E1, 31E2, 32E1 and 32E2. These rectangles were selected in order to avoid changes in lpue due to shifts in targeting behaviour. The selected rectangles do not include any major *Nephrops* or hake, monkfish or megrim fishing grounds or areas with seasonal closures.

Consistency

The survey shows good internal consistency for ages 0 to 4. The Irish tuning shows good consistency from the age of 2 to 7. However discards are not included in this index and it is not known if discarding patterns have been consistent over time, therefore ages 2 and 3 were not included.

B.4. Commercial cpue

Effort and lpue data are available from the Irish otter trawl fleets operating in Divisions VIIb, VIIj and VIIg since 1995, French demeral trawlers in VIIfgh since 2004 and effort data are available for the UK beam trawl fleet in VIIe–k and all other trawl gears in VIIe–k since 1983. The effort in the French gadoid fleet has decreased in recent years and is now at a similar level to the Irish and UK fleets. Effort in the Irish OTB VIIg fleet has increased in recent years, while the Irish OTB effort in VIIb and VIIj appears to have levelled off in recent years. The lpue of the French gadoid fleet is still much higher than that of the other fleets. The Irish and UK fleets have seen a minor increasing trend in lpue in recent years.

B.5. Other relevant data

Discard data

Discard data are available from the Irish fleet since 1995. Data were raised using effort (hours fished) as auxiliary variable and stratified by ICES division. The number of trips in some years is quite low, leading to concerns about the precision of the data.

French discard data are available since 2004. These data were also raised using effort (hours fished) as auxiliary variable. Data before 2008 are considered unreliable. Therefore French discards were estimated from the mean discard rate-at-age for the period 1993–2007. It was assumed that 90% of one-year-olds, 50% of two-year-olds and 10% of three-year-olds were discarded. These proportions were applied to the French catch numbers-at-age to estimate historic discards. For the period 1993–2001, no French age composition data were available, therefore Irish age composition data were raised to French landings and the discard numbers were estimated from these.

French and Irish discard data were combined and a further raising factor was applied to account for discards from other countries. This raising factor was estimated from the total landings of all countries as a proportion of the combined French and Irish landings. This raising factor did not exceed 1.15 in any year.

No French age data are available for the discards. Irish age data are available but there are some concerns about the reliability of these data. For this reason, a quarterly length split is applied to the smallest length classes (where the cohorts are quite distinct). For larger fish, quarterly ALKs from the French and Irish landings are used.

Length-splits applied to the discard data. For lengths where landings ALKs were available, these were used.

Country	Area	Quarter	Age 0	Age 1	Age 2	Age 3
Ireland	VIIb	1	≤10	11–18	19–27	≥28
		2	≤11	12–21	22–29	≥30
		3	≤14	15–23	24–33	≥34
		4	≤17	18–25	26–34	≥35
Ireland	VIIgj	1	≤15	16–23	24–34	≥35
		2	≤17	18–26	≥27	
		3	≤20	21–29	≥30	
		4	≤21	22–30	≥31	
France	VIIbk	1	≤18	19–23	24–32	≥33
		2	≤17	18–26	27–34	≥35
		3	≤20	21–29	≥30	

	4	≤21	22–29	≥30

C. Historical stock development

Model used:

ASAP; (XSA is also used for quality control purposes; if the two models disagree the differences will need to be explained.)

Software used:

ASAP V2.0 NOAA Fisheries toolbox (http://nft.nefsc.noaa.gov)

VPA95 (http://www.ices.dk/datacentre/software.asp)

FLR with R version 2.8.1 with packages FLCore 2.2, FLAssess 2.0.1, FLXSA 2.0 and FLEDA 2.0 (http://cran.r-project.org; http://flr-project.org)

ASAP is proposed as the main assessment model. However, due to the short time-series and noisy catch data, it is uncertain whether the separable assumption holds. Therefore it is proposed to also use XSA to monitor if the two models continue to provide similar trends and absolute estimates of SSB and F.

C.1. Input data types and characteristics

A plusgroup of 8+ was used. Age group 0 was included in the assessment data to allow inclusion of 0-group indices. However, catch numbers and selectivity-at-age 0 were set to zero in all years because catches at this age were very low or zero.

Discard estimates are included in the catch numbers and weights, therefore catch is explicitly defined here as landings + discards.

Data	Year range	Age range	Variable from year to year
Catch (tonnes)	1993–current	0–8+	Yes
Catch-at-age in numbers (thousands)	1993–current	0–8+	Yes
Weight-at-age in the commercial catch (kg)	1993–current	0–8+	Yes
Weight-at-age of the stock at spawning time (kg).	1993–current	0–8+	Yes
Weight-at-age of the stock at January 1 (same as stock weights)	1993–current	0–8+	Yes
Proportion of natural mortality before spawning (Lorenzen M)	1993–current	0–8+	No
Proportion of fishing mortality before spawning (XSA only)	1993–current	0–8+	No
Proportion mature-at-age	1993–current	0–8+	No
Natural mortality	1993–current	0–8+	No

C.2. Model Options

ASAP

Note that ASAP does not accommodate inclusion of data for age 0. Therefore the ages in ASAP are offset by 1 year. All age settings above refer to the real age, not the age group used by ASAP.

Option	Setting
Include discards separately	No
Use likelihood constant	Yes
Mean F (Fbar) age range	3–5
Number of selectivity blocks	1
Fleet selectivity	Fixed at 0 for age 0; freely estimated for age 1 and 2, fixed at 1 for ages 3–8+
Discards	Included in catch (not specified separately from landings)
Index units	2 (numbers)
Index month	FR_IR_IBTS: 11; IR_GAD: 7 (7 = July 1st, the middle of the year)
Index selectivity linked to fleet	-1 (not linked; the commercial index does not include discards)
Index age range	FR_IR_IBTS: 0-5; IR_GAD: 3–7
Index Selectivity – FR_IR_IBTS	Fixed at 1 for all ages
Index Selectivity - IR_GAD	Freely estimated at age 3, fixed at 1 for all other ages
Index CV & ESS – FR_IR_IBTS	CV 0.3 all years, estimated sample size 40 for all years
Index CV & ESS – IR_GAD	CV 0.2 all years, estimated sample size 40 for all years
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 (Assume constant catchability in indices)
Phase for unexploited stock size	1
Phase for steepness	-5 (Do not fit stock–recruitment curve)
Catch total CV	0.3 for 1993–2007; 0.2 for 2008-present (reliable discard data available)
Input effective sample size	25 for 1993–2001; 50 for 2002-present (only Irish age comp before 2002)
Lambda for recruit deviations	0 (freely estimated)
Lambda for total catch	1
Lambda for total discards	NA (discards included in catch)
Lambda for F-Mult in 1st year	0 (freely estimated)
Lambda for F-Mult deviations	0 (freely estimated)
Lambda for index	1 for both indices in the model
Lambda for index catchability	0 for all indices (freely estimated)
Lambda for catchability devs	NA (phase is negative)
Lambda N in 1st year deviations	0 (freely estimated)
Lambda devs initial steepness	NA (phase is negative)
Lambda devs unexpl stock size	0 (freely estimated)

Discards were not included separately because this resulted in undesirable residual patterns. Only one selectivity block was used due to the short time-series, as the time-series gets longer it may be appropriate to allow a separate block for the time period where observed discard data are available. Fleet selectivity was forced to be flat topped to reduce the number of parameters to be estimated. The F-pattern from XSA indicated flat-topped selectivity.

XSA

Option	Setting
Ages catch dep stock size	None
Q plateau	4
Taper	No
F shrinkage SE	1.5
F shrinkage year range	5
F shrinkage age range	3
Fleet SE threshold	0.3
Prior weights	No

There is no evidence to suggest that catchability depends on stock size; the linear regression fits the data well. The effect of releasing the q-plateau was investigated and catchability appeared to level off at age 4. There is no evidence to suggest that the tuning fleets have changed over time, therefore no tapered time weighting was applied. In recent years there has not been a clear retrospective pattern, therefore a relatively high F shrinkage SE was used with a short year and age range. The fleets are relatively well behaved so an SE threshold of 0.3 was applied.

Tuning data:

Type	Name	Year range	Age range
Survey	FR_IR_IBTS	2003–present	0–5
Commercial	IR_GAD	1995–present	3–7

D. Short-term projection

Model used: Multifleet Deterministic Projection. Landings and discards are modelled as separate fleets.

Software used: MFDP1a (http://www.ices.dk/datacentre/software.asp)

Option	Setting
Initial stock size	Long-term GM (omitting last two years) Stock numbers-at-age 1 and older from model
Natural mortality	Lorenzen M, as in model
Maturity	Knife-edged at age 2
F and M before spawning	0 for all ages in all years
Stock / catch weights-at-age	Average last three years
Exploitation pattern	Average last three years
Intermediate year assumptions	F in the last year – check retrospective pattern for evidence of bias
Stock–recruit model	None, long-term GM recruitment (omitting last two years)
Fbar range	5–5*
Rescale to last year	No

*** The F_{bar} age range used in the assessment model outputs is 3–5 this F refers to the catch (including discards). Ages 3-–5 are fully selected in the catch (but not landings). MFYPR output supplies YPR based on landings F. In order to compare (landings) F reference points with the (catch) F_{bar} it was decided to calculate F_{bar} only for age 5 because at this age the catch and landings are both fully selected and because a flat-topped selection pattern was applied in ASAP the result will be correct. So, in this context F_{max} refers to the catch F where the landings per recruit are maximized.**

E. Medium-term projections

None.

F. Yield and biomass per recruit

No stock–recruit relationship exists for this stock; recruitment is characterized by sporadic extreme recruitment events.

Software used: NOAA fisheries toolbox YPR V3.0.

Option	Setting
Stock / catch weights-at-age	Average last three years
Selectivity	Average last three years
Natural mortality	Lorenzen M, as in model
Maturity	Knife-edged at age 2

G. Biological reference points

No reference points have been defined for this stock. The following results from the analyses by WKROUND could be informative:

F_{max} (landings) = 0.28

$F_{0.1}$ (landings) = 0.19

$F_{msy} = F_{max} = 0.28$

B_{loss} = 7500 tonnes

H. Other issues

None.

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7.5 Stock Annex *Nephrops* FU17, Aran Grounds

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Aran Grounds *Nephrops* (FU17)
Date	06 March 2009 (WK*NEPH* 2009)
Revised by	Colm Lordan (WGCSE, 2011 to address RGCSE 2010 comments)

A. General

A.1. Stock definition

Nephrops is limited to muddy habitat, and requires sediment with a silt and clay content of between 10–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* probably only undertake very small-scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In FU17, the main *Nephrops* stock inhabits an extensive area of muddy sediment known as the Aran Grounds which lie to the west and southwest of the Aran Islands, there are also smaller discrete mud patches in Galway Bay and Slyne Head.

A.2. Fishery

In recent years the *Nephrops* stock in FU17 are almost exclusively exploited by Irish vessels. Figure A.2.1 shows the spatial distribution of landings and lpue for Irish otter trawl vessels in 2005 using logbook and VMS data linked together to give finer spatial resolution. The Aran groundfishery is clearly highlighted.

The *Nephrops* fishery 'at the back of the Aran Islands' can be considered the mainstay of the Ros a Mhíl fleet. Without this *Nephrops* fishery the majority of vessels in the fleet would cease being economically viable (Meredith, 1999). The Irish fishery consists of entirely of otter trawl vessels. The majority of vessels use twin-rigs and 80 mm. Smaller vessels do use 70 mm with a SMP. Some vessels have using 90 mm. Vessels from Ros a Mhíl, Dingle, Union Hall, Dunmore East, Clogherhead and Kinsale mainly exploit the fishery.

The number of Irish vessels reporting *Nephrops* landings from FU17 has fluctuated around 50/yr (Figure A.2.2). Around 18 vessels report landings in excess of 10 t. These are the main vessels in the fishery accounting for around 85% of the total landings. The majority of these vessels are between 20–22 m overall length (Figure A.2.3). There has been a slight shift to lager vessels over time. The majority of vessels are in the power range of 200–400 KW (Figure A.2.4). There has also been a shift to more powerful vessels over time with the introduction of twin-rigs to the fishery in the early 2000s. Most of the larger boats move freely between the *Nephrops* fisheries in FUs 15, 16, 20-22 and other areas depending on the tides and weather.

The fishery shows a distinctive seasonal pattern with highest landings, catches, lpue and cpue in April–June and October–November. The monthly landings time-series with the average pattern is shown in Figure A.2.5. The first period of elevated landings is associated with the emergence of females from their burrows post-hatching of their eggs. The sex ratio during this period is biased towards females (Figure A.2.6). Females mature quickly during the early summer and spawning occurs in July and August. This is coincident with a decline in landings and cpue in the fishery. The Ros a Mhíl fleet traditionally tie up in August each year for maintenance and refurbishment.

The following TCMs are in place for *Nephrops* in VII (excluding VIIa) after EC 850/98: Minimum Landing Sizes (MLS); total length >85 mm, carapace length >25 mm, tail length >46 mm. Mesh Size Restrictions; Vessels targeting *Nephrops* using towed gears having at least 35% by weight of this species on board will require 70 mm diamond mesh plus an 80 mm square mesh panel as a minimum or having at least 30% by weight of *Nephrops* on board will require 80–99 mm diamond mesh.

A.3. Ecosystem aspects

Physical oceanography

The Aran Ground is coincident with a pool of oceanic water, which is rich in nutrients and low in dissolved oxygen. The currents throughout the water column over the ground are generally weak although there is a well-documented bottom density front on the eastern flank of the ground (Nolan and Lyons, 2006). This is a seasonal feature, which establishes in May and persists until autumn. The front causes a persistent jet like flow from south to north close to the seabed through the *Nephrops* ground. The mean position of jet varies from year to year by up to 30 km. Timing and position of the jet may influence recruitment and settlement success of post-larval *Nephrops* since it could advect larval from the area. Salinity differences, due to over winter freshwater input, are thought to heavily influence the density structure and location of this front. Until a time-series of recruitment and jet dynamics is established it is not possible to draw any firm conclusions about the impact of this ecosystem feature on the stock and fishery. Potential sinks for advected larvae include Slyne head and possibly Galway Bay.

Temperature and salinity time-series

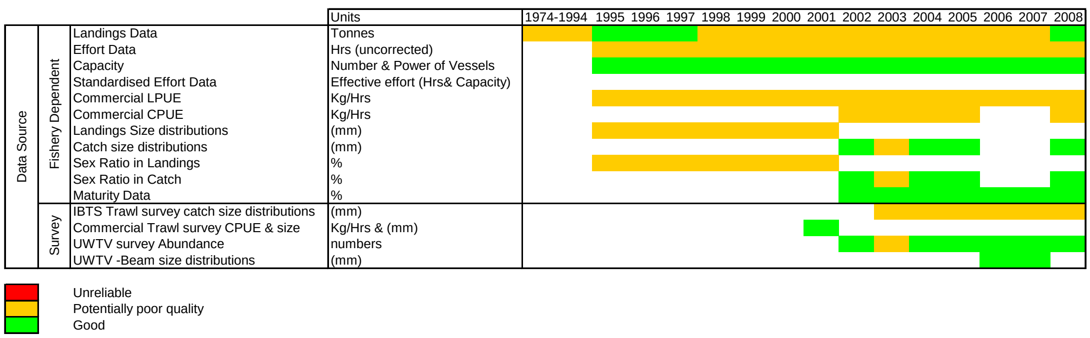
An emerging time-series of temperature and salinity data are available for a transect through the Aran Grounds (Nolan and Lyons, 2006). In all years since 1999 (except 2001) the 53°N section has exhibited positive anomalies in temperature of between 0.2°C and 2°C (Figure A.3.1). In 2001, the temperature anomaly from the long-term climatology was zero. Years with lower temperature anomalies seem to coincide with years of strongly negative salinity anomalies (e.g. 2001 and 2005, 2006) perhaps reflecting the limited influence of ENAW on the section in those years as the section is dominated by coastal discharges from the Loire and Shannon. Salinity anomalies along 53°N range from -0.3 to +0.1 psu over the period. The freshest years were 2001, 2005 and 2006. In 2000, 2003 and 2004 ENAW has a stronger influence on the salinity structure and positive anomalies in salinity from the long-term climatology are the result. The higher UWTV abundance in 2003 and 2004 is coincident with the warmest anomaly but the time-series remains too short to draw definitive conclusions.

Sediment distribution

There is a growing body of information on the spatial extent of the sediment suitable for *Nephrops* from UWTV surveys, seabed mapping programmes and the fishing industry. Figure A.3.1 depicts contour and post plots of the a) mean size (phi) and classification based on the Friedman and Sanders (1978) scales and b) sorting (σ_g) of the sediments on the Aran Grounds based on PSA results from samples collected from 2002–2006 UWTV surveys. The majority of the ground has similar mean particle size at around 4–5 µm. There are some patches of softer silt towards the middle of the ground. Figure A.3.2 is bathymetry of the Aran grounds obtained from seabed mapping programmes. The eastern flank of the ground shallows up quickly but the majority of the ground is gradually deepening from around 100 m to 110 m with the deepest parts to the southwest.

B. Data

The table below summarizes the available data for this stock and attempts to quantify the quality subjectively.



B.1. Commercial catch

Prior to 1988 landings data for this fishery are only available to the WG for France. Since 1988 reported landings data for the Irish fleet were obtained from EU logbooks. The quality of landings data is not well known. In earlier, years there are no landings from Ireland although there was probably some catch. The Irish landings have been close to quota for this TAC area since around 1997 (Figure B.1.1). In more recent years (2003–2005 and 2008) there are a few observations of both under and over reporting but it is not possible to correct landings using these as it is not known how representative they might be.

Landings length and sex compositions were estimated from port sampling by Ireland (between 1995–2001). There was a perception during this period that that discarding was not significant. In 2002 a new catch self-sampling programme was put in place. 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 (Table B.1.1). Sampling effort is stratified monthly but quarterly aggregations are used to derive length distributions and selection ogives. The length–weight regression parameters given in Table B.2.1 are used to calculate sampled weights and appropriate quarterly raising factors. The sampling intensity and coverage has varied over the time-series (Table B.1.1). The quality of the sampling has not yet been qualitatively assessed in terms of precision and accuracy.

Nephrops landings and discards from the Aran Grounds have not been sampled for the majority of 2006 and all 2007 due to a lack of cooperation by the industry. However, sampling resumed in 2008 and the intensity and coverage is considered the best to date.

Fish and other bycatches in the fishery have been collected by on-board observers since 1994. The number of trips is variable over time with a gap in the series in 2006 and 2007.

B.2. Biological

Biological parameters for this stock are outlined in Table B.2.1.

Length–weight

Mean weights-at-age for this stock are estimated from studies on Scottish stocks by Pope and Thomas (1955). This relationship was examined in 2003 and it seemed appropriate. Given the variability in length–weight parameters found in Allan *et al*., 2009 it would be worth monitoring these more closely in future.

Natural mortality

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation. The accuracy of these assumptions is unknown. Cod are not common on the Aran Grounds but other potential predators include dogfish, monkfish megrim and gurnards. Stomach contents data on the Irish GFS could be used to examine this in future.

Maturity

The L_{50} of females using a macroscopic visual maturity scale is known to vary depending sampling month (Lordan and Gerritsen, 2006). The L_{50} in July was chosen as the most appropriate estimate given the maturity schedules observed (Figure B.2.1). It is worth mentioning that commercial vessel surveys in November 2001 and in June 2002 demonstrated considerable differences between the maturity schedules of female *Nephrops* sampled in shallower waters of Galway Bay compared with the Aran Grounds.

Proportion of F and M prior to spawning was specified as zero to give estimates of spawning–stock biomass at January 1. In the absence of independent estimates, the mean weights-at-age in the total catch were assumed to represent the mean weights in the stock.

Discard survival

Given the trip durations (~5 days average) and behaviour of the fleet the majority of discards on the Aran Grounds are returned to the sea over suitable sediment. The proportion scavenged by birds is probably quite low. Tow durations, volume of catches, prolonged sorting on deck and relatively high density of *Nephrops* on the seabed probably results in relatively low discard survival. This is estimated to be around 10%.

B.3. Surveys

Since 2002 Ireland has conducted underwater television survey (UWTV) annually on the main *Nephrops* grounds - Aran grounds. Indicator camera stations are also carried out on the adjacent grounds of Galway Bay and Slyne Head weather and time permitting. The surveys were based on a randomized fixed grid design. The methods used during the survey were similar to those employed for UWTV surveys of *Nephrops* stocks around Scotland and elsewhere and are documented by WKNEPHTV (ICES, 2007).

A number of factors are suspected to contribute bias to the surveys. In order to use the survey abundance estimate as an absolute it is necessary to correct for these potential biases. The history of bias estimates are given in the following table and are based on simulation models, preliminary experimentation and expert opinion, the biases associated with the estimates of *Nephrops* abundance in the Aran Grounds are:

	Time period	Edge effect	detection rate	species identification	occupancy	Cumulative bias
FU17: Aran	<=2009	1.35	0.9	1.05	1	1.3

B.4. Commercial cpue

Prior to 1988 landings data for this fishery are only available to the WG for France. Since 1988 reported landings data for the Irish fleet were obtained from EU logbooks (Table B.4.1).

Effort data for FU17 is available from 1995 for the Irish otter trawl *Nephrops* directed fleet (Table B.4.2). A threshold of 30% of *Nephrops* in reported landings by trip is used to identify the catches and effort of this fleet. This threshold was based on an analysis of the trip-by-trip catch compositions. In 2007 this fleet accounted for ~90% of the landings and compared with an average of 70% over the time period. These data have not been standardized to take into account vessel or efficiency changes during the time period. Landings per unit of effort (lpues) have been fluctuating around an average of 39 kg/h with an increasing trend since 2004, to the highest observed (59 kg/h) in the time-series in 2007 (Figure B.4.1).

B.5. Other relevant data

C. Historical stock development

Age structured XSA assessment for this stock was carried *Nephrops* WG in 2003 (ICES, 2003). The results were considered unreliable for several reasons most importantly; inadequate historical sampling of catch, growth and natural mortality assumptions and concern about accuracy of tuning data. Since then the focus has been on developing a time-series of UWTV survey data as the basis of assessment and advice for this stock.

The 2009 Benchmark decided on the following procedure:

1) Survey indices are worked up annually resulting in the TV index.

2) Adjust index for bias (see Section B.3). The combined effect of these biases is to be applied to the new survey index.

3) Generate mean weight in landings. Check the time-series of mean landing weights for evidence of a trend in the most recent period. If there is no firm evidence of a recent trend in mean weight use the average of the three most recent years. If, however, there is strong evidence of a recent trend then apply most recent value (don't attempt to extrapolate the trend further in future).

D. Short-term projection

1) The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and F_{MAX}. These values have been estimated by the Benchmark Workshop (see Section 9.2) and are to be revisited by subsequent benchmark groups. The values are FU specific and have been put in the Stock Annexes.

2) Create catch option table on the basis of a range of harvest ratios ranging from 0 to the maximum observed ratio or the ratio equating to F_{MAX}, whichever is the larger. Insert the harvest ratios from step 4 and also the current harvest ratio.

3) Multiply the survey index by the harvest ratios to give the number of total removals.

4) Create a landings number by applying a discard factor. This conversion factor has been estimated by the Benchmark Workshop and is to be revisited at subsequent benchmark groups. The value is FU specific and has been put in the Stock Annex.

5) Produce landings biomass by applying mean weight.

The suggested catch option table format is as follows.

			Implied fishery	
	Harvest rate	Survey Index	Retained number	Landings (tonnes)
	0%	12345	0	0.00
	2%	"	247	123.45
	4%	"	494	246.90
	6%	"	741	370.35
	8%	"	988	493.80
$F_{0.1}$	8.60%	"	1062	530.84
	10%	"	1235	617.25
	12%	"	1481	740.70
F_{max}	13.50%	"	1667	833.29
	14%	"	1728	864.15
	16%	"	1975	987.60
	18%	"	2222	1111.05
	20%	"	2469	1234.50
	22%	"	2716	1357.95
$F_{current}$	21.5%	"	2654	1327.09

E. Medium-term projections

None presented.

F. Long-term projections

None presented.

G. Biological reference points

The time-series of available length frequencies were insufficient to generate reliable estimates of $F_{0.1}$ and F_{max}.

H. Other issues

I. References

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ICES. 2006. Report of the Workshop on *Nephrops* Stocks. Annex 6: Working Document by Lordan and Gerritsen. ICES CM 2006/ACFM:12.

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Colm Lordan and Hans Gerritsen. 2006. The accuracy and precision of maturity parameters from sampling of female *Nephrops* from stocks around Ireland. WD6 in the Report of the Workshop on *Nephrops* stocks. ICES CM 2006/ACFM:12.

Nolan,G.D. and Lyons. 2006. Ocean climate variability on the western Irish Shelf, an emerging time series., K., *Proceedings of ICES Annual Science Conference*, Theme Session C, C:28.

Table B.1.1. ***Nephrops*** **in FU17 (Aran Grounds) Landings and discard numbers by year and sex.**

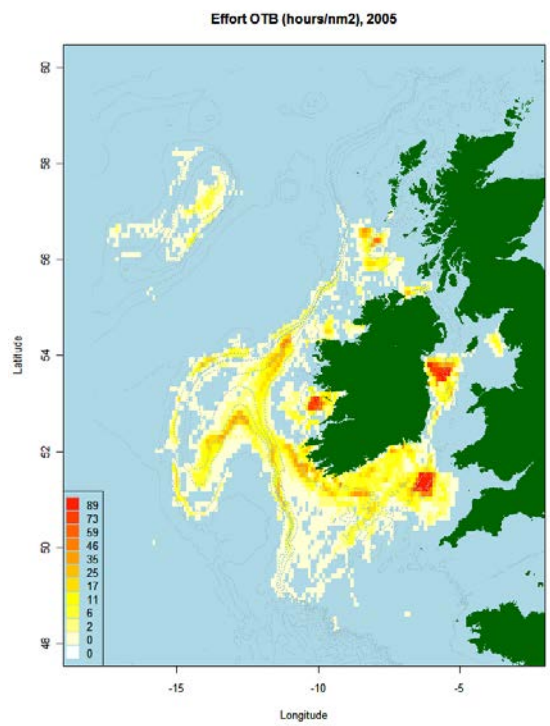
	Female Numbers '000s		Male Numbers '000s		Both sexes
Year	Landings	Discards	Landings	Discards	% Discard
2001	18,665	12,161	29,949	13,250	34%
2002	23,105	9,374	31,256	8,326	25%
2003	14,530	9,577	29,538	8,744	29%
2004	16,109	7,068	12,930	4,282	28%
2005	20,280	11,383	21,828	8,967	33%
2006	No Sampling				
2007					

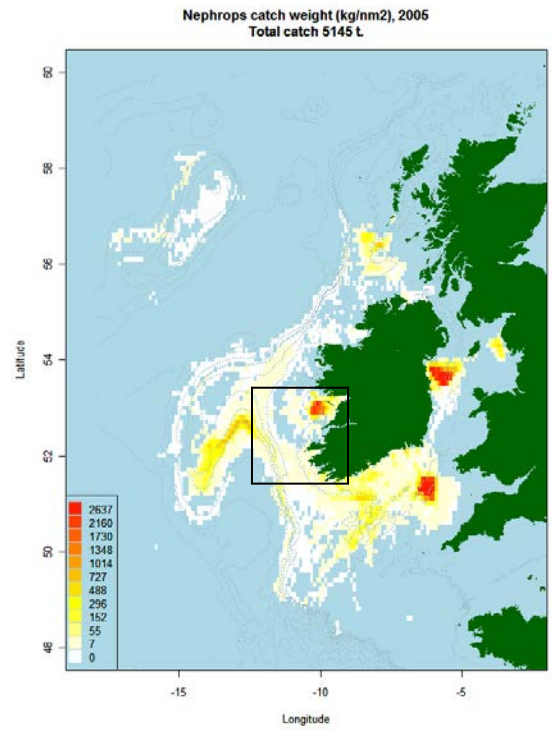
Table B.2.2. Numbers of samples and numbers measured for the FU17 ***Nephrops*** **Stock by year.**

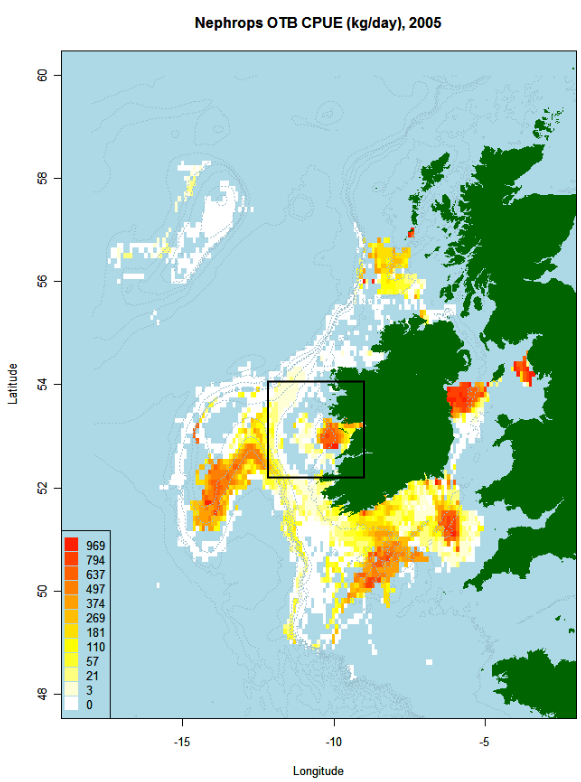
Number of Samples				Total numbers of *Nephrops* measured			
Year	Graded Landings	Catch	Discards	Year	Graded Landings	Catch	Discards
1990	24			1990	10451		
1991	20			1991	8260		
1992	0			1992	0		
1993	0			1993	0		
1994	0			1994	0		
1995	13			1995	6370		
1996	3			1996	1440		
1997	11			1997	5203		
1998	12			1998	5388		
1999	16			1999	6944		
2000	5			2000	2255		
2001	32	5	5	2001	13 231	3194	3891
2002		13		2002		9399	
2003	1	9	9	2003		6284	4829
2004		14	14	2004	578	12934	13 167
2005		13	9	2005		8729	7559
2006		2	0	2006		767	436
2007		0	0	2007			
2008		19	18	2008		4944	8701

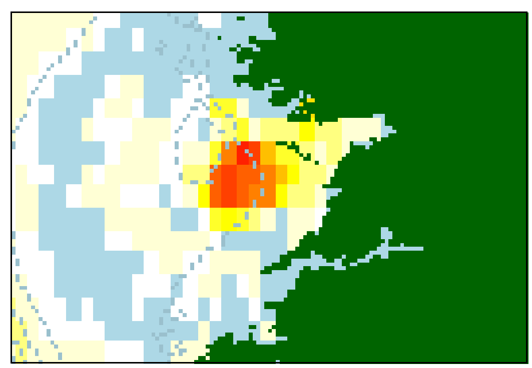
Table B.2.1. Biological Input Parameters for FU17 *Nephrops* Stock.

Parameter	Value	Source
Discard Survival	10%	WK*NEPH* 2009
MALES		
Growth - K	0.16	based on FU15
Growth - L(inf)	60	based on FU15
Natural mortality - M	0.3	assumed, in line with other stocks
Length/weight - a	0.000322	based on Scottish data (Pope and Thomas, 1955)
Length/weight - b	3.207	"
FEMALES		
Immature Growth		
Growth - K	0.16	based on FU15
Growth - L(inf)	60	based on FU15
Natural mortality - M	0.3	assumed, in line with other stocks
Size at maturity (L50)	22	ICES 2006 (Lordan and Gerritsen)
Mature Growth		
Growth - K	0.1	based on FU15 and FU16
Growth - L(inf)	56	based on FU15
Natural mortality - M	0.2	assumed, in line with other stocks
Length/weight - a	0.000684	based on Scottish data (Pope and Thomas, 1955)
Length/weight - b	2.963	"


Effort OTB (hours/nm2), 2005
Latitude
Longitude
89
73
59
46
35
25
17
11
6
2
0
0


Nephrops catch weight (kg/nm2), 2005
Total catch 5145 t.
Latitude
Longitude
2637
2160
1730
1348
1014
727
488
296
152
55
7
0


Nephrops OTB CPUE (kg/day), 2005
Latitude
Longitude
969
794
637
497
374
269
181
110
57
21
3
0



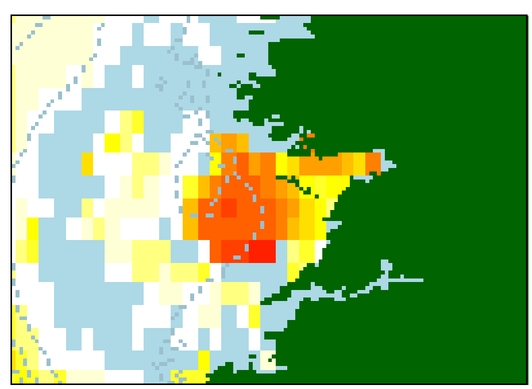


Figure A.2.1. Effort, catch and catch per unit of effort for *Nephrops*, Irish otter trawlers in 2005. The boxed and zoomed in plots show a zoomed in view of landings and lpue from the fishery on the Aran Ground.

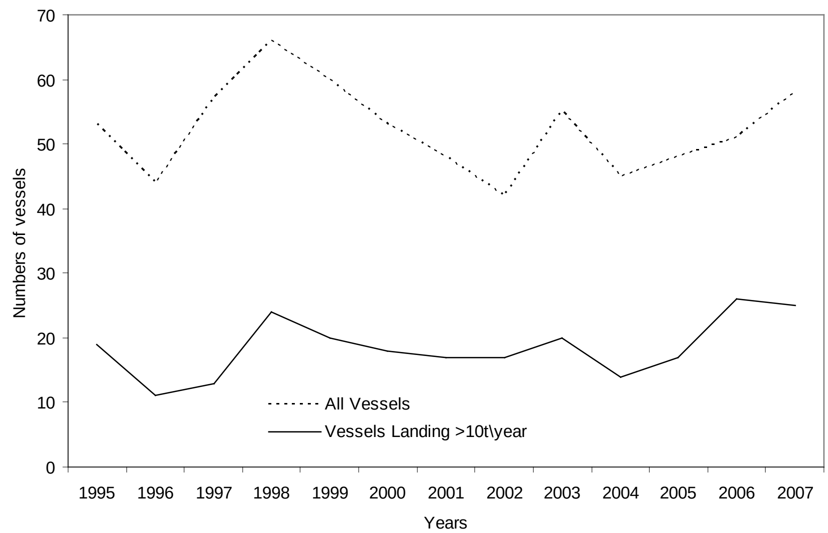


Figure A.2.2. Time-series of the number of Irish vessels reporting landings of *Nephrops* from FU17. The vessels with annual landings >10 t/yr can be considered the main participants in the fishery these general account for ~85% of the total landings.

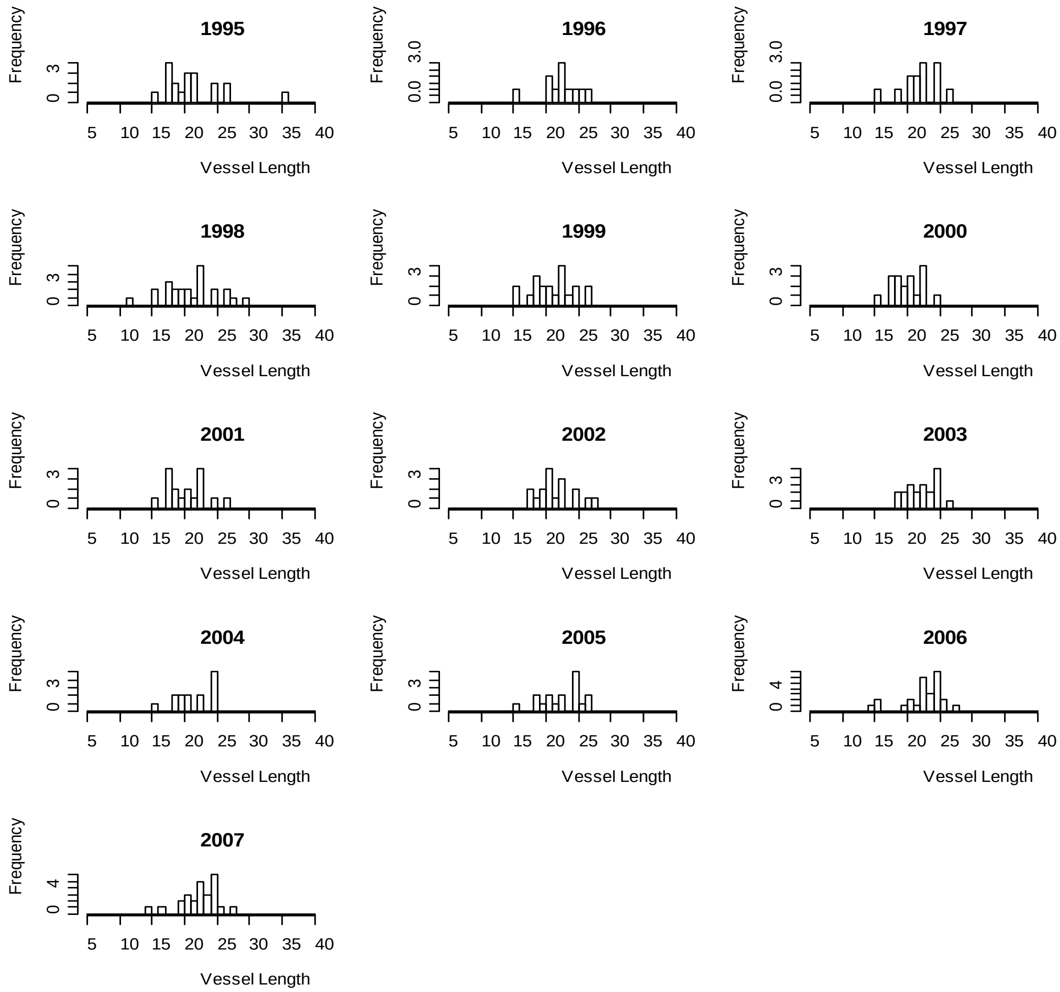


Figure A.2.3. The time-series of length distributions of Irish vessels landing >10 t of *Nephrops* from FU17.

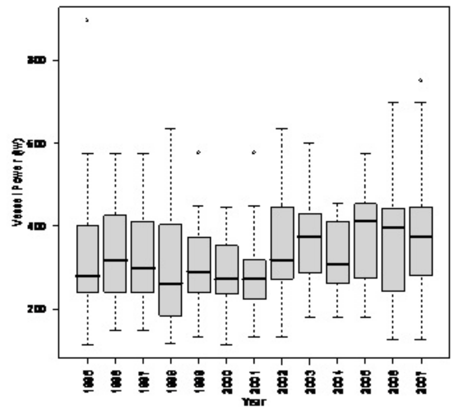


Figure A.2.4. Box plot of the time-series of vessel power in KW of Irish vessels landing >10 t of *Nephrops* from FU17.

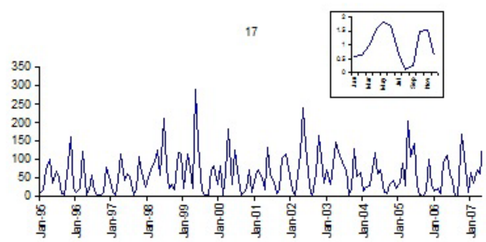


Figure A.2.5. Monthly landings of *Nephrops* from FU17 from 1995–2007. The inset shows the average pattern for all years.

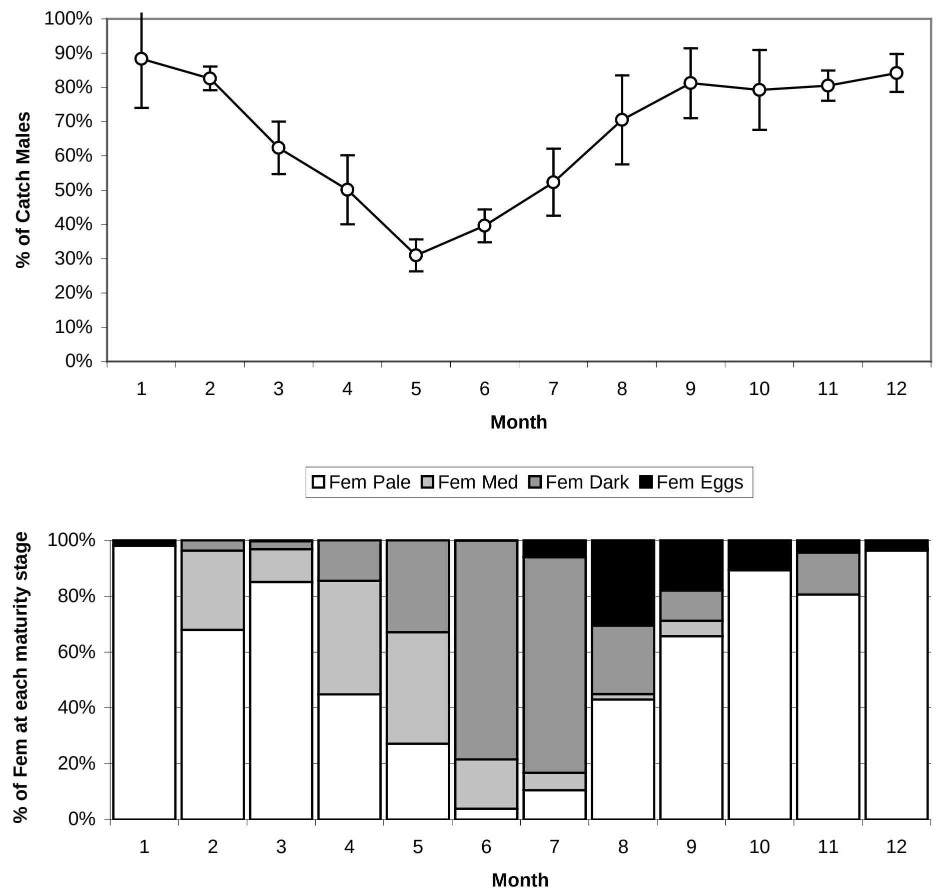


Figure A.2.6. The upper panel shows the sex ratio in sampled catches 2003–2008 (error bars = 95% confidence intervals). The low panel shows the female maturity schedule i.e. percentage at each maturity stage by month.

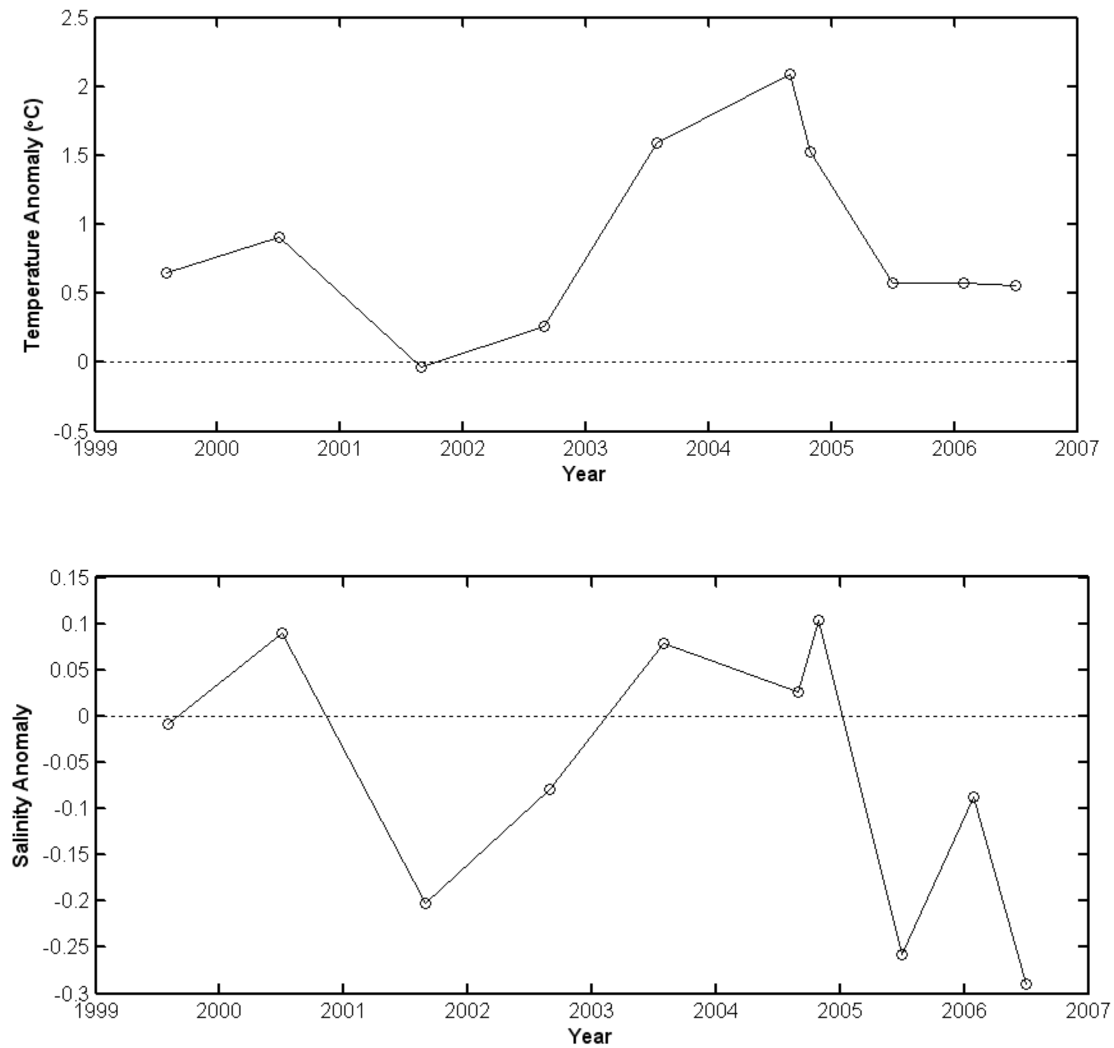
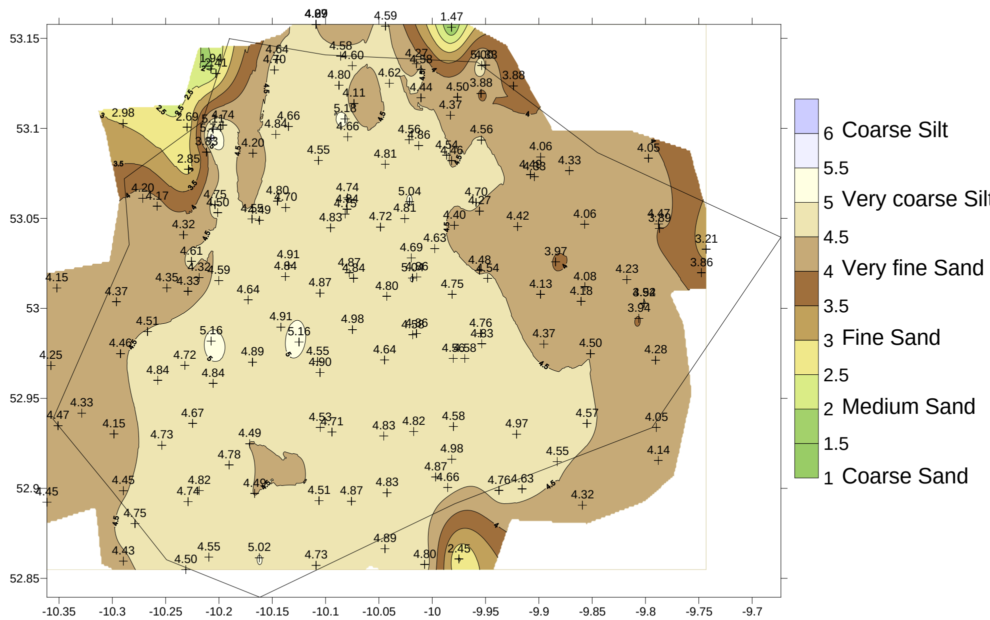


Figure A.3.1. Anomalies in temperature (upper panel) and salinity (lower panel) for the 53°N section running through the Aran Grounds (1999–2006).

a)



b)

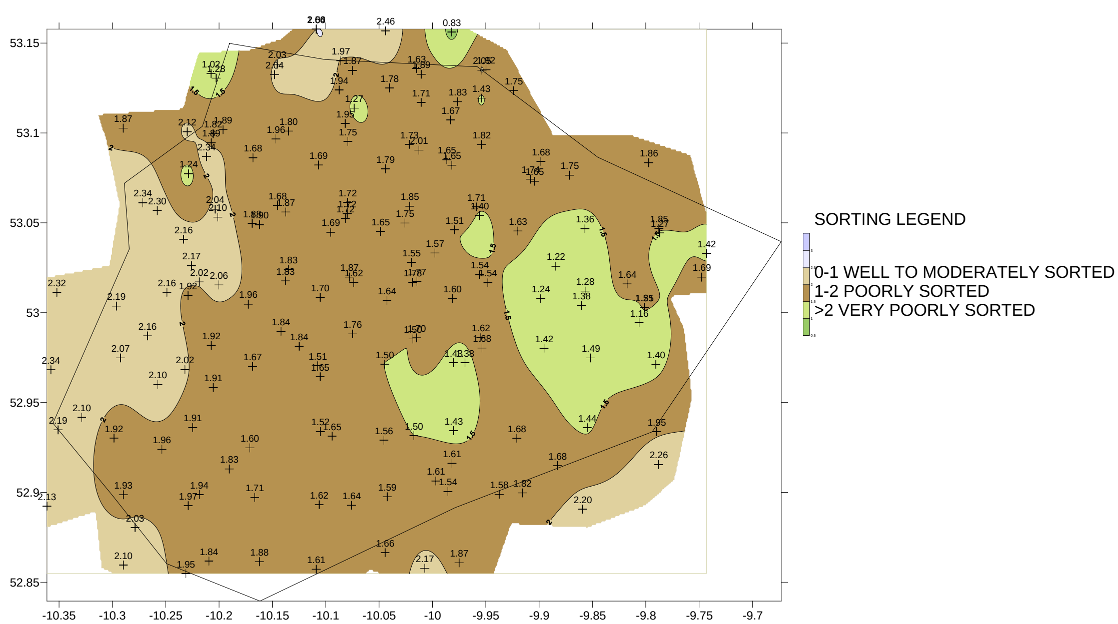


Figure A.3.1. Contour and post plots of the a) mean size (phi) and classification based on the Friedman and Sanders (1978) scales and b) sorting (σ_g) of the sediments on the Aran Grounds based on PSA results from samples collected from 2002–2006.

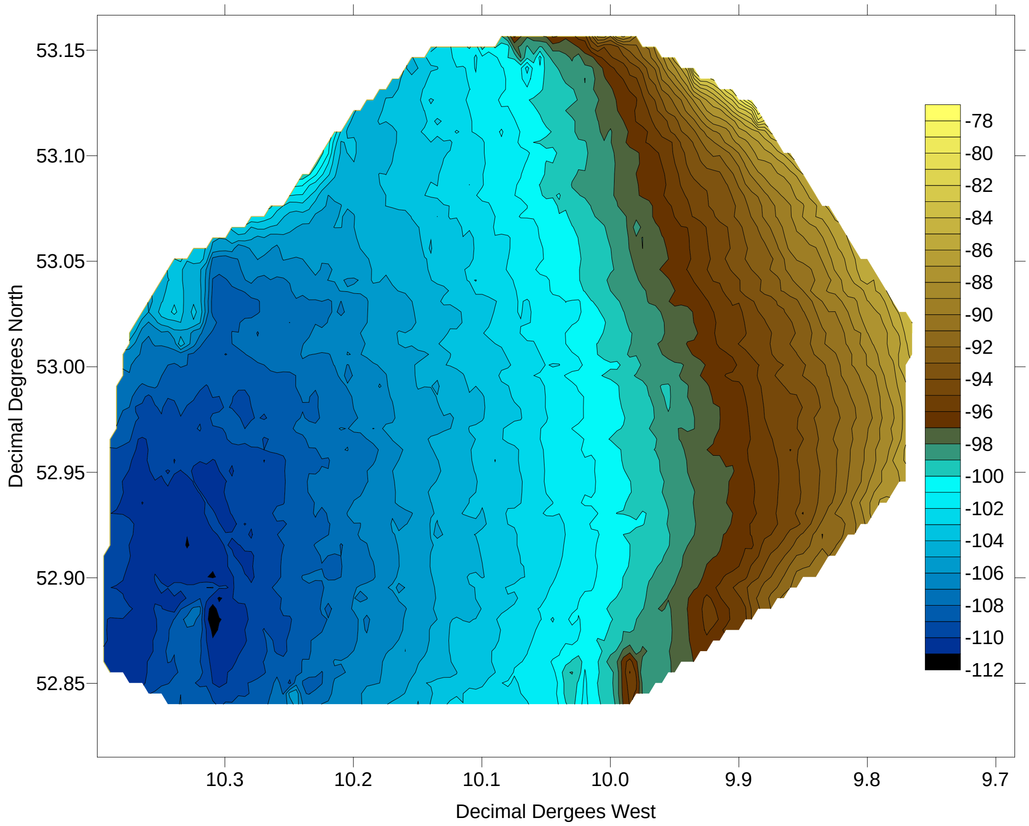


Figure A.3.2. The bathymetry of the Aran grounds.

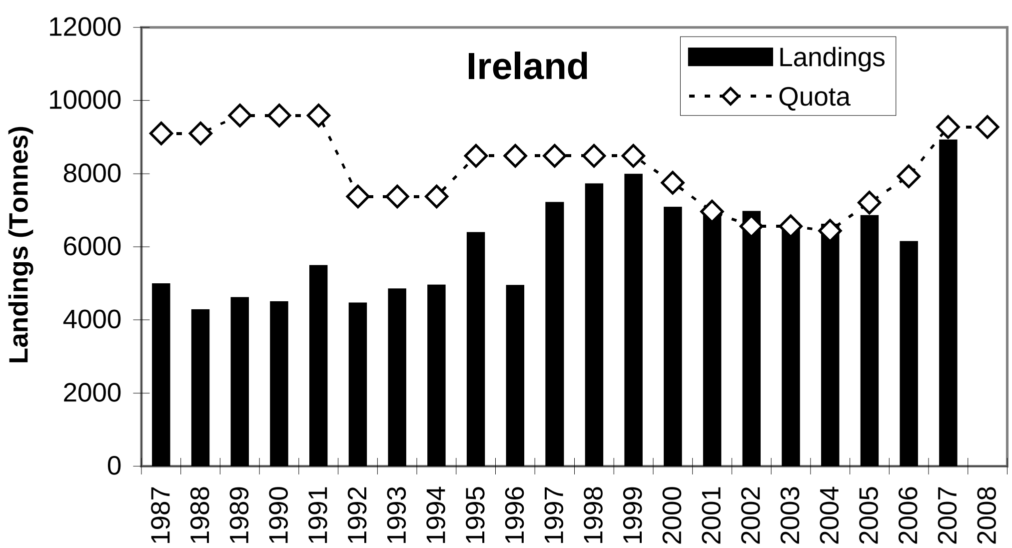


Figure B.1.1. ***Nephrops*** **landings and quota for Ireland since the introduction of TACs in 1987.**

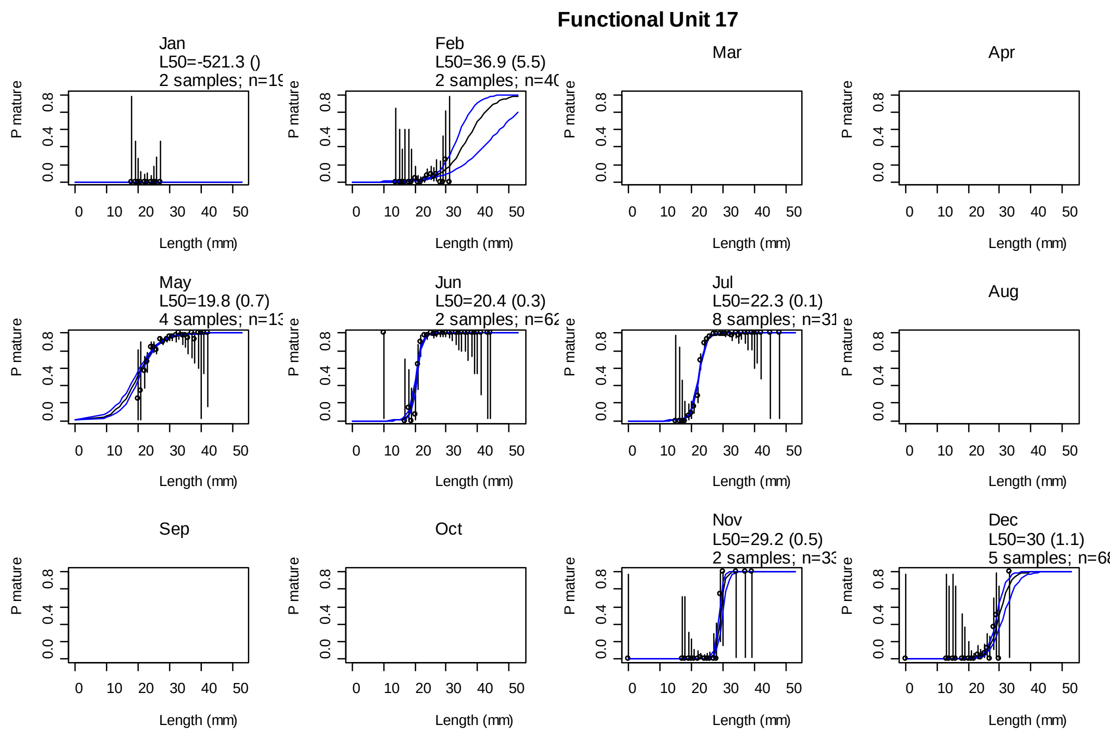


Figure B.2.1. Female proportions mature-at-length for FU17. The 95% confidence limits of the proportions mature-at-length are indicated by the vertical bars. The black curve indicates the model and its standard errors are given by the blue lines. The L_{50} is the estimated length at 50% maturity and its standard error is given between brackets. Blank plots indicate no sampling took place.

7.6 Stock Annex *Nephrops* FU16 Porcupine Bank

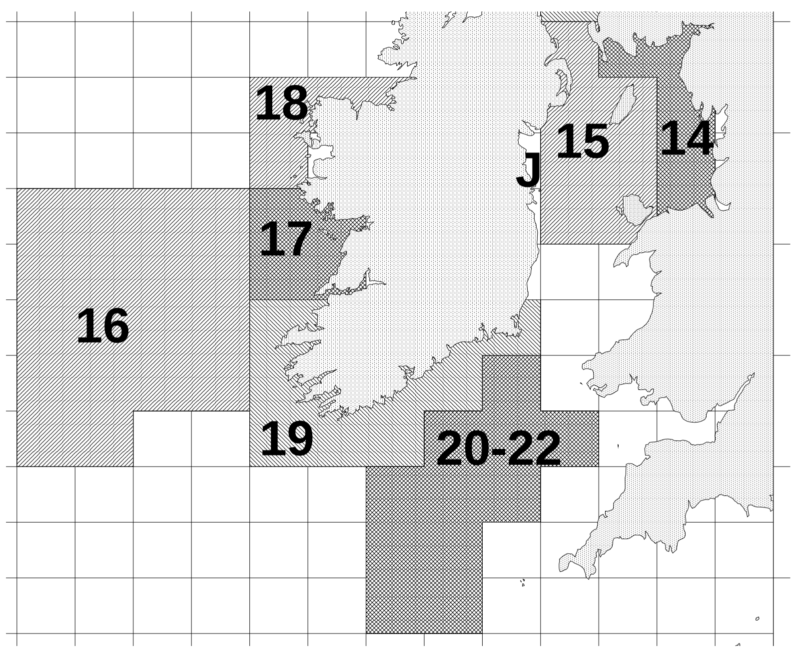
Stock specific documentation of standard assessment procedures used by ICES.

Stock	FU16 Porcupine Bank
Working Group	WGCSE 2010
Date	Version 1, 04/05/2010
Revised by	Jennifer Doyle

A. General

A.1. Stock definition

The Functional Unit for assessment includes some parts of the following ICES Divisions VIIb,c,j,k. The exact stock area is shown on the map below includes the following ICES Statistical rectangles: 31–36 D5–D6; 32–35 D7–D8.



A.2. Fishery

France

The French fleet fishing *Nephrops* in FU 16 also fishes in Division VIIg–h and was described in detail in the 1999 WG*NEPH* report (ICES, 1999a). The French fleet only lands large *Nephrops* from this FU. Investigation of the landings data by statistical rectangle carried out by WG*NEPH* in 2002. These indicated that the majority of the French landings between 1999–2000 were from the south of the Porcupine Bank.

Ireland

The fishery is mainly seasonal taking place mainly between April and July; landings for the remainder of the year are minimal. Most of the Irish vessels are multipurpose trawlers and are relatively large (between 20 and 35 m in total length). Irish vessels land both whole prawns and tails depending on markets from this FU and the sizes of the Irish landings are significantly smaller than those for the French and Spanish fleets. The Irish vessels are mainly using twin-rig trawls. Fishing is often weather dependent (particularly for the smaller vessels), with trip duration varying between seven and ten days. Investigation of the landings data by statistical rectangle provided to the WGNEPH in 2002 indicates that the majority of the Irish landings between 1995 and 2001 were from the south central area of the Porcupine Bank.

The recent spatial distribution of the fishery is shown in Figure 1.

Spain

The Spanish fishery in the Porcupine area is a typical multispecies fishery, targeting different demersal species, among them *Nephrops*. The fleet, which consists of about 35 vessels, is composed of side trawlers and is part of the so-called '300 fleet' in the Adhesion Treaty of Spain to the EEC in 1986. Within the Porcupine fleet, two components can be distinguished: one consisting of vessels fishing with finfish trawls (average engine power 980 hp), and the other fishing with *Nephrops* trawls (average engine power 680 hp). The average duration of their trips is 15 days, of which 10–12 are actual fishing days. The major landing port is La Coruña.

The target species for the finfish directed fleet are hake, megrim and anglerfish, with *Nephrops* as a valued bycatch. Vessels fishing with *Nephrops* trawls are much more directed towards *Nephrops* (especially in spring and summer), and fish is a bycatch. These two fleets not are currently disaggregated in the time-series.

A.3. Ecosystem aspects

Productivity of deep-water *Nephrops* stocks is generally lower that those on the shelf although individual *Nephrops* grow to relatively large sizes.

A persistent Taylor column circulation around Porcupine Bank provides an important mechanism for the retention of pelagic eggs and larvae of the various marine species spawning in the area. (Mohn *et al*., 2002). The *Nephrops* stock on the Porcupine Bank are distributed on mud patches in relatively deep waters 200–600 m. It is not know how larvae are retained over these grounds but the Taylor column may help with larval retention.

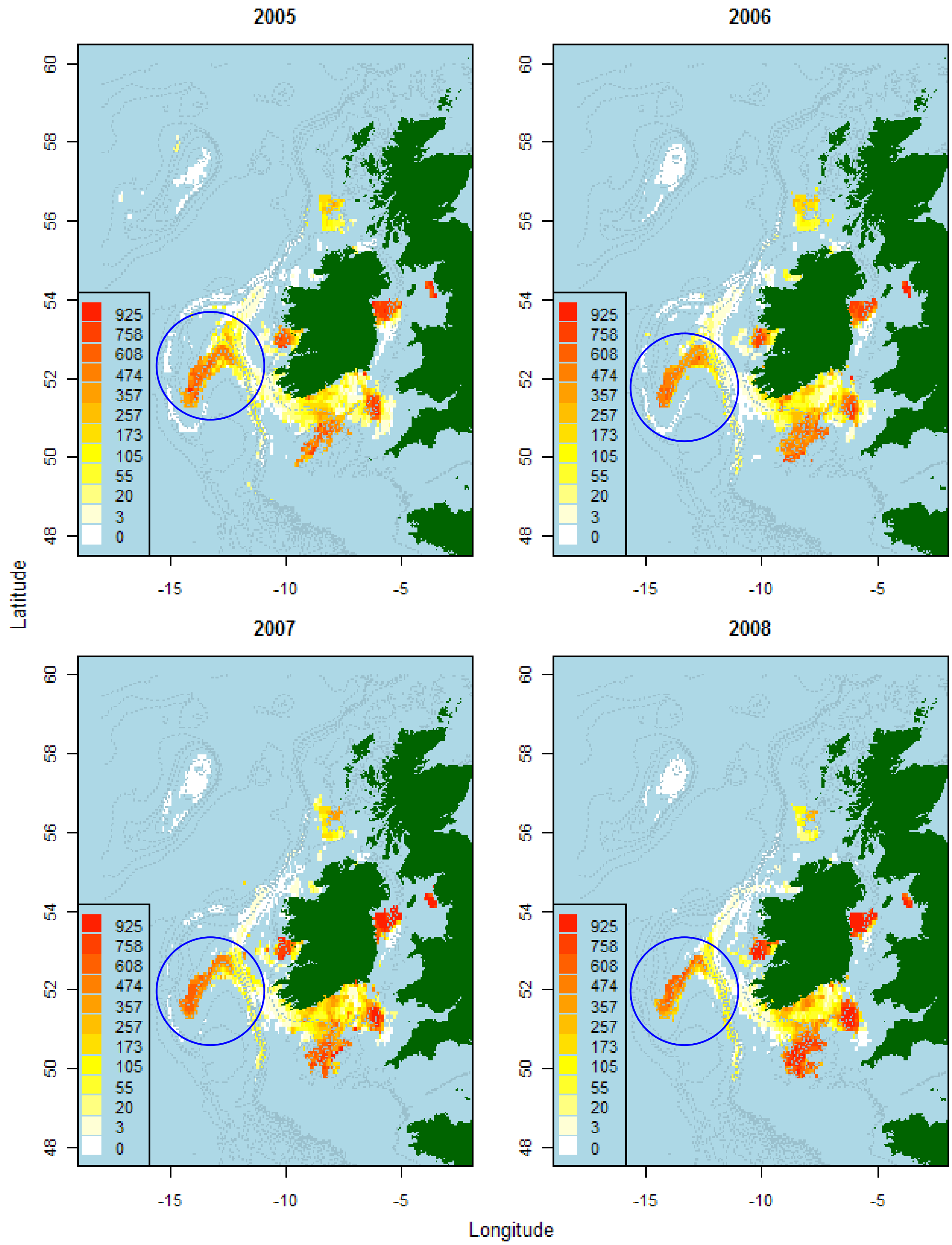


Figure 1. The spatial distribution of lpue of *Nephrops* caught by Irish otter trawlers between 2005–2008 derived using integrated VMS and logbook records.

B. Data

B.1. Commercial catch

Commercial catch and effort data are supplied by Ireland, France, Spain and the UK. These are the countries exploiting the stock.

B.2. Biological

BIOLOGICAL PARAMETERS		
Parameter	Value	Source
Discard Survival		Discards considered negligible
MALES		
Growth - K	0.140	based on values in other areas (Anon. 1991)
Growth - L(inf)	75	based on maximum sizes observed in samples
Natural mortality - M	0.2	Anon.1990 (estimated)
Length/weight - a	0.00009	based on Celtic Sea (FU 20–22)
Length/weight - b	3.550	"
FEMALES		
Immature Growth		
Growth - K	0.140	Not applicable
Growth - L(inf)	75	
Natural mortality - M	0.2	
Size-at-maturity	26.2	Fariña and González Herraiz (2001)
Mature Growth		
Growth - K	0.160	Anon.1991
Growth - L(inf)	60	based on maximum sizes observed in samples
Natural mortality - M	0.2	As for males
Length/weight - a	0.00009	"
Length/weight - b	3.550	"

B.3. Surveys

The only fishery-independent source of data is the Spanish Porcupine trawl survey which commenced in 2001. Further information on thus survey is provided in the IBTS report (ICES, 2010) and in previous IBTS reports.

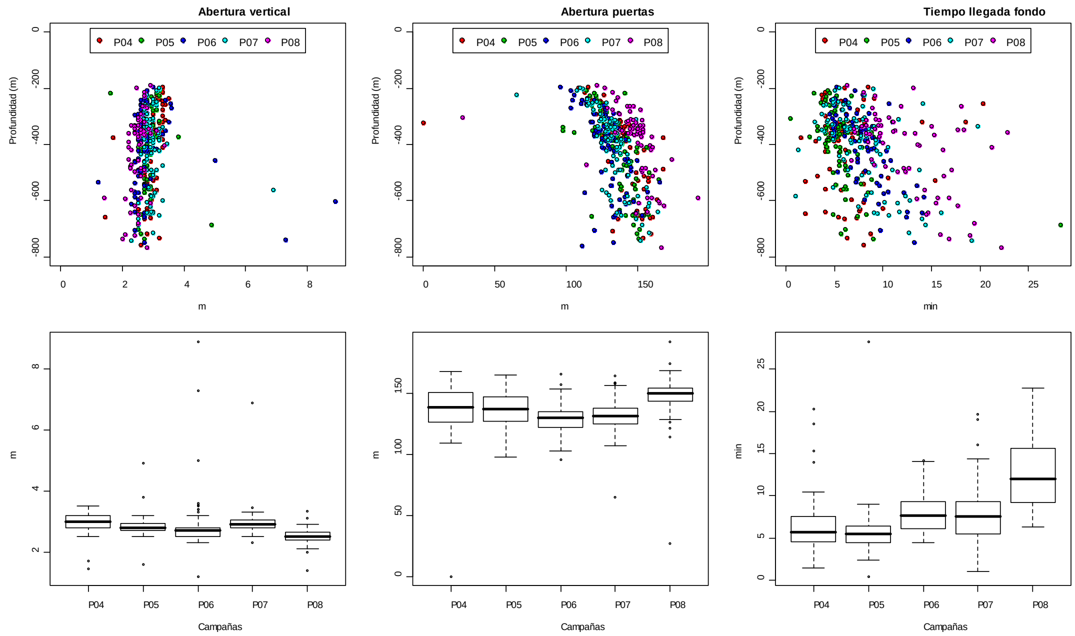


Figure 2. Door spread, vertical opening and time to settle on the ground between 2004 and 2008.

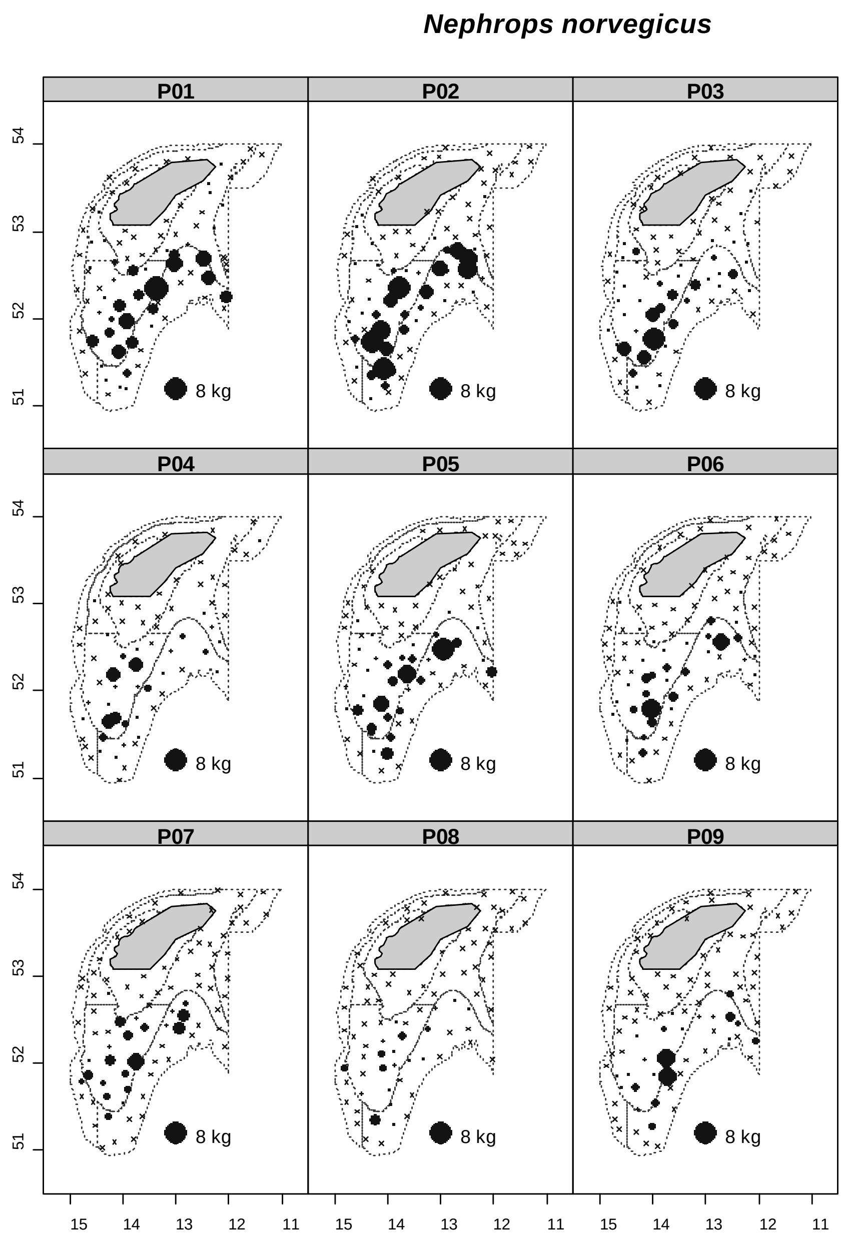


Figure 3. Distribution of *Nephrops norvegicus* catches in biomass in Porcupine surveys between 2001 and 2009.

B.4. Commercial lpue

The *Nephrops* fishery on the Porcupine Bank is both seasonal and opportunistic with increased targeting during periods of high *Nephrops* emergence and good weather.

Effort and lpue data are not standardized, and hence do not take into account vessel capabilities, efficiency, seasonality or other factors that may bias perception of lpue abundance trend over the longer term. The available effort time-series are summarized below:

Country	First year of effort data	Units	Comment
France	1983	Hours	For trips where *Nephrops* constituted 10% of the landed value
Ireland	2005	Hours	For trips where *Nephrops* constituted 30% of the landings in weight
Spain	1971	ay*BHP/100 (x1000)	

Only commercial landings data are available for all countries involved in the fishery.

B.5. Other relevant data

C. Historical stock development

An experimental age structured assessment for this stock was carried out by the *Nephrops* WG in 1993 (ICES, 1993), in 2003 (ICES, 2003) and by the WGHMM (ICES, 2005) in all cases the assessments being considered inadequate. This conclusion was based on poor quality, and unexplainable inconsistencies in the input data. Unknown growth rates and concern about the utility of age based assessment models impeded progress to an accepted assessment. In additional the lack of a time-series of reliable standardized cpue data was also perceived as a problem. This problem has been solved with the developing Porcupine trawl survey-series.

Model used: XSA, LCA

Software used: n/r

Model Options chosen: No Final model was accepted

G. Biological reference points

No reference points have been proposed or used for this stock.

H. Other issues

None.

I. References

Gerritsen, H. 2009. Working Document 1 ICES Working Group for the Celtic Seas Ecoregion13–19 May 2009.

7.7 Stock Annex *Nephrops* FU 20–22 (Celtic Sea; VIIfgh)

Stock specific documentation of standard assessment procedures used by ICES.

Stock	*Nephrops* (*Nephrops norvegicus*) Division VIIfgh
Working Group	WGCSE (Working Group for Celtic Seas Ecoregion)
Date created	June 2007
Last updated	May 2009

A. General

A.1. Stock definition

The management area for this stock is delimited in area VIIfgh (FU 20–22; Figure 1). The management unit is pertinent because of the sedentary feature of *Nephrops*. However, the sources of recruits are much more poorly defined. 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.

A.2. Fishery

Nephrops present particular ground features and in the FU 20–22 are known to occur in several areas of muddy sediment and the stock structure is uncertain. The *Nephrops* fisheries target different areas and have very different size structures in *Nephrops* catches and landings. These fisheries also have differences in non-*Nephrops* bycatch composition.

As for all crustaceans, *Nephrops* grow by successive moults which are to a large extent tied to reproduction. For this species moult occurs twice a year, in spring and autumn until sexual maturity. Once males are sexually mature, they continue to moult twice a year while females moult only once a year in the latter spring/summer right after the hatching of their eggs. In previous references (1970–1980s), it is pointed out that maturation of females happens at a median size of 31 mm CL (10 cm of total length) which corresponds to 3.5 years old individuals. There is no specific reference for the sexual maturation of males in the FU 20–22, but biological references on close areas with similar hydrological conditions (FU 15; Western Irish Sea) indicate a first size of functional maturity of 29–31 mm CL.

As reported by the WGNEPH 2004 and the WGSSDS 2005 and 2006, *Nephrops* in FU 20–22 is mainly exploited by trawlers from France, Republic of Ireland and UK although the contribution of other countries is lower. The spatial distribution of landings by statistical rectangles are provided below (Figure 2–5). It indicates heterogeneous spatial behaviour of the main fleets.

France

No major changes have taken place in the fishery for more than fifteen years apart from the implementation of a new mesh regulation in 2000 which increased the minimum codend mesh size from 80 to 100 mm (in fact, the regulation involves to 90 mm mesh size, but 100 mm meshes are adopted aiming to avoid problems with bycatch composition).

The 100 mm mesh size also allows them to switch to finfish (cod, whiting, haddock) when *Nephrops* catch rates are low (e.g. because of diurnal and seasonal variations of catchability for this species or during periods of bad weather). The MLS applied by the French Producers' Organisations is fixed at 11.5 cm total length (i.e. 35 mm CL). The total number of vessels from the harbours of the South Brittany remains stable (more than 90 declared *Nephrops* catches from the Celtic Sea in recent years, but around 70 are actually targeting this species). A part of these units (15–20) switch to other *Nephrops* stocks (FU16; Porcupine Bank; Figure 1) mainly in 2nd and 3rd quarters when the meteorological conditions are favourable. At the opposite, many trawlers (20–30) move towards the FU19 *Nephrops* (SE and SW Irish coast) mainly in autumn and winter according to difficulties due to weather.

Analytical investigations were carried out on the data collected in 2006 and 2007 involving in the French trawlers. Global indices for fishing effort and lpue provided by this fleet (97 trawlers composed by 73 exclusive in Celtic Sea, 15 switching to Porcupine Bank i.e. FU16 and eight also targeting *Nephrops* in the Bay of Biscay i.e. FU 23–24) seem to be pertinent: 99% of vessels*months registered for sales at auction can also be found in logbooks (94% of French landings in 2007). In 2006, almost 50% of French landings occurred in two ICES rectangles (29E2, 30E2; the rectangle 30E2 during the 2nd quarter concentrated 21% of yearly landings). In 2007, the contribution of the two rectangles 29E1 and 30E2 was 41% of yearly landings. In 2008, the rectangles 28E1 and 30E2 were represented by 44% of yearly landings. The peak of production is observed during the 2nd quarter of the year (Figure 4): in 2006, the maximum landings are obtained in June whereas a shift occurred in 2007 (maximum value in May which may be caused by bad meteorological conditions in June). In 2008, the shape of French landings vs. month was bi-modal (May and July were the mostly represented months).

The historical review of French landings shows that the contribution of the rectangle 31E3 (concentrating the major part of Irish landings) declined over the last ten years: from 41% of total French landings registered in 1999 this contribution is currently less than 10% (Figure 3). During the last ten years, the most productive rectangle for French trawlers was 30E2 mainly during the late 2000s: the average annual contribution of this rectangle was around 15% in the early 2000s, but this proportion reached more than 30% during the recent years. It seems that the French fleet moved gradually from 31E3 to 30E2 under the steeply increasing concentration of Irish trawlers on the "traditional" *Nephrops* grounds (Smalls, Labadie).

Republic of Ireland

More than 60 Irish vessels target *Nephrops* in the Celtic Sea. In 2007, 95 Irish trawlers were registered as landing *Nephrops*, but 63 of them exceeded threshold of 10 t (Figure 6). In 2008, 99 Irish vessels reported landings from this area whereas 67 of them landed more than 10 t. The fishery presents a more typical seasonal profile than the French vessels and most of the landings are made between March and July. These vessels are mid-size multipurpose trawlers, with a length of 18–23 m and engine power between 250 and 350 kW. Many of the vessels switch between FU15 and FU 20–22, depending on the tides in the Irish Sea. Other vessels switch from targeting finfish in winter to *Nephrops* in spring and early summer. The mesh size used by Irish vessels is 80 mm, and increasingly these vessels are using twin trawls. The MLS applied by Irish trawlers is the European one fixed at 8.5 cm total length (i.e. 25 mm CL).

The Irish landings seem to be more concentrated spatially than the French. During the period 2003–2006, 63–67% of the Irish nominal landings were provided by one ICES rectangle (31E3). The Irish fishing effort is located more northerly than the French one.

UK

The UK fishery in the Celtic Sea has generally remained unchanged. Since the early 2000s, the number of UK *Nephrops* directed vessels has increased from around ten to 15, but their contributions in total landings remains minor (usually less than 50 t of landings). The maximum historical value of UK landings is reported in 2008 (242 t).

A.3. Ecosystem aspects

Nephrops occur in discrete patches where the sediment is suitable for them to construct their burrows. There is a larval phase of long duration where there may be some mixing with *Nephrops* from other areas depending on the oceanographic conditions, but the mechanisms for this in the Celtic Sea are not currently known.

Cod has been identified as a predator of *Nephrops* in some areas, and the generally low level of the cod stock is likely to have resulted in reduced predation on *Nephrops*.

B. Data

B.1. Commercial catch

Landings are reported mainly by France and the Republic of Ireland. French landings fluctuated between 2000 and 3800 t. Irish landings rose from around 500 to more than 2000 t in the last 15 years. The highest value of Irish landings is observed in 2007 (more than 3200 t). A part of this trend is due to greater accuracy of reporting mainly after the end of the late 1990s. The contribution of French landings has gradually decreased from 80–90% at the end of 1980s to 50–60% at the beginning of 2000s. Between 2004 and 2005, French landings remained stable while Irish landings steeply increased and the total harvested quantity was the highest during the last decade. For the first time, in 2007, the Irish ladings exceeded the French ones (3230 t against 2080 t). This may be caused by constraints linked to the international context affecting fuel prices for fishing vessels. The overall fishing profile remains typically seasonal with a dominance of the 2nd and 3rd quarters (60–70%; the other quarters are less productive because of meteorological conditions and of less accessibility of females due to burrowing).

During the recent years, the evolution of the French fishing effort and lpue was sometimes considerably different from the evolution of the same indicators for the Irish fleet (e.g. between 2004 and 2005: -5% of fishing effort and +2% of lpue for French trawlers against +50% of fishing effort and +25% of lpue for Irish trawlers). In 2007, an increase occurred for lpue values of both main fleets: a slight upwards trend of French trawlers (+13% associated to a strong reduction of the fishing effort: -25% whereas the total number of vessels remained almost stable) and a steep one for the Irish fleet (+36% coinciding with +31% of the fishing effort which was displayed by an increasing number of trawlers operating in the Celtic Sea: +19% between 2006 and 2007). This underlines the divergence of features of the targeting vessels for each country and indicates the great heterogeneity of the area. A direct comparison between both countries cannot be undertaken because the fishing effort is not available in the same unit (France: otter trawlers getting at least 10% of their total landings by targeting this species; Ireland: otter trawl vessels where >30% of monthly landings in live weight were *Nephrops*). Furthermore, the actual fishing areas are different and the Irish fleet is more restricted spatially as already reported by WGSSDS 2005–2008.

B.2. Biological

Natural mortality and maturity-at-age

A natural mortality of 0.3 is applied to all *Nephrops* males whereas the mortality of females changes at the size of first maturity (occurring at 31 mm CL as explained previously): a value of 0.2 is usually applied on mature individuals.

The L2AGE slicing programme usually applied on *Nephrops* stocks allocates length classes into age groups by assuming von Bertalanffy model of individual growth. This slicing is applied to length distributions by sex. All parameters, L∞ and K by sex, calculated mean sizes by age for each sex, natural mortality and maturity by sex (assumed to be knife-edged for males and s-shaped for females) and combined are given below.

Table 1. *Nephrops* FU20–22 (Celtic Sea). Individual growth, natural mortality, maturity parameters by sex.

Males and immature females: L∞=68, K=0.17; mature females: L∞=49, K=0.10									
age		1	2	3	4	5	6	7	8+
Size (CL mm) mm	males	11	20	27	34	39	44	47	51
	females	11	20	27	32	33	35	36	37
M	males	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	females	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2
	combined	0.3	0.3	0.3	0.25	0.25	0.25	0.25	0.25
Maturity	males	0	0	1	1	1	1	1	1
	females	0	0	0	0.5	1	1	1	1
	combined	0	0	0.5	0.75	1	1	1	1

Biological sampling

Landings: The total French landings have been available since 1983 (on quarterly basis since 1987) whereas the Irish series began in 1987 (on quarterly basis since 1995).

Lpue and fishing effort: Lpue series are provided since 1987 in France while Irish data are available over 1996. It has to be noted that the French and Irish method of calculation of the fishing effort are not carried out by the same way (threshold of 10% in weight for *Nephrops* on total landings applied for French trawlers whereas 30% is the threshold used for Irish fleet), thus a direct comparison of those indices is not appropriate.

DLF of landings: French sampling plan at auction started in 1983, but only after 1986 the data can be used on quarterly basis. The Irish plan as written previously began in 2002 (in fact, solely 2003 has been entirely sampled in the FU 20–22 area; 2002s data involving the whole Management Area M: see processing by WGSSDS 2006; two quarters were not sampled in 2004 and 2005: see processing by WGSSDS 2006). For French landings, the increasing proportion of tailed individuals (see below) and the inappropriate method of sampling before the end of 2007 provided.

DLF of discards: French estimation of discards occurred only in three separate years (1985, 1991 and 1997), but only the data collected in 1997 can be included in analytical investigations. The available dataset is given for only one year of discard sampling (1997) because of unavailable quarterly data for landings for the first year of discard sampling (1985) whereas data collected in 1991 were considered as unreliable (samples sorted by fishermen). Irish sampling has been undertaken since 2002 (lack of information for two quarters in 2004; see processing by WGSSDS 2006).

Length compositions of the landings by sex are provided for the two main fleets, but the time-series are different. Sampling of French landings since 1984 has provided length frequencies by sex on a monthly basis. Due to uncertainty of the older datasets, the data for 1984–1986 were omitted from further analysis. The Irish sampling programme was launched in 2002 under the EU DCR and gave length frequencies for the period 2002–2006 (after simulation undertaken for some missing information in 2004 as explained during WGSSDS 2006).

French estimation of discards occurred only in several separate years (1985, 1991 and 1997; in 2005, samples for two quarters, 3rd and 4th, were also provided), but only the data collected in 1997 can be included in analytical investigations because of unavailable quarterly data on landings for the first year of discard sampling (1985) whereas data collected in 1991 were considered as unreliable (samples sorted by fishermen not representative of the discarding behaviour of the whole fleet). The 1997 French plan on board showed high spatial and temporal variability of discard size-composition vs. that of landings (CV>30%). The Irish sampling launched under DCR gave results as presented by Table 2.

The heterogeneity of the dataset in addition to that of the harvested area by each country affects the discard rate by fleet: it was higher for French vessels: 65% in 1997 against 37% for Irish in 2003 (the only one year with sampling , but only 11% during the quarters 2 and 3 in 2004) and by sex (stronger in the case of females growing less quickly).

Table 2. FU 20–22 Irish Sampling Summary.

		Number of samples			Numbers Measured		
Year	Quarter	Catch	Discards	Landings	Catch	Discards	Landings
2003	1	1	1		186	417	
	2	5	5		4057	3016	
	3	3	3		2535	3638	
	4	2	1		996	528	
2004	1	0	0		0	0	
	2	3	2		1634	2781	
	3	7	6		4284	7171	
	4	0	0		0	0	
2005	1	1	1		1330	2271	
	2	2	2		2208	3238	
	3	2	0		1634	0	
	4	2	0		1627	0	
2006	1	2	1	2	1891	1152	2252
	2	10	2	2	7241	1049	363
	3	5	1	0	3178	1101	0
	4	9	0	0	8266	0	0
2007	1	1	3	0	767	770	0
	2	12	0	0	9648	0	0
	3	15	4	2	7784	1862	411
	4	6	5	0	1959	1417	0
2008	1	2	5		680	1758	
	2	10	13		3409	5333	
	3	3	2		878	546	
	4	4	4		1356	1573	

Extrapolations

Landings: DLF of tailed Nephrops

The WGCSE 2009 pointed out a significantly increasing proportion of tailed individuals in French landings whereas this proportion was already high for Irish trawlers. In 2008, 20% of total French landings involved in tailed *Nephrops* (19% in 2007, 15% in 2006 and 11% in 2005; less than 5% until the beginning of 2000's). The overall upwards trend is illustrated by the Figure 7 presenting also monthly tailed fractions (after conversion of weight of tails to total one).

The seasonal variability of tailed *Nephrops* may be explained by biological features of the species (two peaks appear by year corresponding to the two moulting periods, spring and winter) and by the particular conditions of trips (12–15 days) compromising the conservation of *Nephrops*. As regards to the annual increasing proportion of tails (96% explained by using an exponential function), industry explained it by the economic difficulties of the vessels because of the rapidly increasing fuel prices. Tailed individuals are intended to compensate this loss for the crew participation at the total investment by trip. As the European MLS for FU20–22 *Nephrops* is fixed at 8.5 cm of total length (25 mm CL) and the MLS retained by the French Producers' Organizations is equal to 11.5 cm (35 mm CL), it was expected that tailed individuals should be comprised between these two sizes.

Before the end of 2007, the tailed *Nephrops* could not be sampled at auction and, as the sampling on board remains difficult to apply routinely (long trip duration for French trawlers); the problem was partially tackled by apportioning tailed individuals to the smallest category of landings at auction. Since the end of 2007, new biometric relationships established during the EVHOE survey have been used: they allow to fit CL vs. 2nd abdominal segment of tail by sex (Figure 8). The DLF of French landings for 2008 were estimated by two ways: one using the extrapolations from tails to CL, the other apportioning tails to the small category as for previous years. The resulting difference appears relevant (Figure 9): in 2008, 46 million *Nephrops* were provided by the previous method whereas 58 million were estimated by including tails (+28%). Almost 30% of landed individuals were below the French Producers' Organization MLS, but no *Nephrops* was undersized compared with European MLS. Moreover, the sex ratio seems to be affected by the tailing practice: 13% of *Nephrops* (7.4 million) were females although this percentage would be 7% (3.2 million) under the previous method. The mean size of French landings for 2008 decreases at around 2.5–5 mm CL by sex when tails are involved by sampling. However, the mean CL for 2008 remains larger than the Irish one.

Table 3. *Nephrops* in VIIfgh. Mean sizes (CL in mm) of French and Irish landings for 2008. French values are calculated (1) including the samples involving in tailed individuals and (2) using the previous method (no sampling of tails; the total tailed proportion was apportioned in the smallest category of entire *Nephrops* at auction).

French sampling			Irish sampling		
Males	Females	Total	Males	Females	Total
37.6	34.7	37.2	32.0	29.7	31.1
40.1	39.6	40.1			

This result emphasizes the WGSSDS 2008 conclusion that the size composition may be overestimated when raised to the composition of entire individuals.

Discards: years with no sampling on board

Generalities

As the sampling plan for both countries was not routinely undertaken, the whole time-series of landings by quarter either for the French fleet (years 1987–2007) or for the Irish one (years 1995–2007, years 1987–1994 are only represented by annual landings) misses information. Therefore, a methodology of extrapolation from sampled data to years or quarters with no information was developed (see WD 1; WGSSDS 2007).

The main concepts of the derivation (back-calculation) are summarized as:

1) The first step involves applying hand-sorting selection of retained catches which is explained by s-shaped (logistic) function vs. size. As statistically test-

ed by fleet, the hand-sorting function is stable within-quarter for given parameters of the exploitation pattern (if mesh size and MLS remain constant within period).

2) The second step consists in removing undersized individuals unusual in landings which can generate unreliably extreme values of discards due to sampling problems (very high CV of landings for the extreme size classes). Hence, size classes less than a tested threshold (e.g. 1 or 5% of cumulative landings) were eliminated.

3) The third step allows the generation of missing size classes by applying a probability density function which can be symmetrical or not. The whole calculation is based on multiple maximum likelihood function according to the number of missing years. Relationship as between mean sizes of landings and of discards tested on the FU 23–24 *Nephrops* (Bay of Biscay; WGHMM) can also be included in the final fitting.

Particularities for FU 20–22 Nephrops stock

The approach summarized above was already developed on the FU 23-24 *Nephrops* stock (Bay of Biscay) and its validation was investigated during the WGHMM 2007 (Figures 10–14). The WGSSDS 2007 examined statistical formulation and validation of this method on French (years 1987–2006) and Irish (years 2002–2006, investigation by quarter) discards for FU 20–22. There are some differences from the calculation applied on the Bay of Biscay as:

1) The available French dataset is given for only one year of discard sampling (1997). It means that the hand-sorting s-shaped curves by quarter are calculated on only one year[1] instead of six in the case of the Bay of Biscay stock.

2) The cumulative percentage level for removing of undersized generated discards (see above: 2nd stage) is fixed at 5% for French data and 1% for Irish data (also 1% for the Bay of Biscay *Nephrops* stock). In the case of the French fishery in Celtic Sea, this can be justified by the high variability of landing samples between trips (higher coefficients of variation at auction because of higher heterogeneity of the fished area and of long duration of trips i.e. 12–15 days and, hence, less availability of samples at auction).

3) For the French discards, with only one year of discard sampling, the initial value of the parameter Lm cannot be assumed to be equal to any expected mean size of discards *vs.* mean size of landings (see above 3rd stage). Furthermore, the interval in which Lm should be contained is not statistically calculable. Hence, Lm is initially introduced as the size corresponding to the maximum number of discarded individuals as provided by the 2nd stage of calculation (i.e. after removing extremely high values of discards obtained after the 1st stage: hand-sorting logistic function). Its interval is built by using an

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[1] The six trips sampled in 2005 provided new s-shaped curves of hand-sorting for Q3 and Q4 which were used for simulations of the recent period since 2000 i.e. since the mesh size change.

a priori coefficient of variation around the initial Lm (CV of 0.10 and 0.20 were tested). For the Irish data, no constraint on relationship between mean sizes of discards and landings was set because of lack of any information on that due to the short time-series.

4) The large mesh size of the French vessels in the FU 20–22 area indicates that the distribution of length frequencies of discards is probably no symmetrical because of selectivity effects which should be more significant than for the FU23–24 stock or for the Irish trawlers in the FU 20–22.

5) For French discards, the absence of reference about any relationship between mean sizes of landings and discards at the opposite of the Bay of Biscay, implies that the final fitting aims to provide the more linear as possible relationship (after log–log transformation) with only one reference point (year 1997). Hence, the optimization is more based on geometric concept than on statistical one.

1st stage: the s-shaped hand-sorting curve

Let j be a year with no dataset on discards. By quarter k, the number of discarded individuals by sex (m or f) and by size L, ND_{jklm} (or ND_{jklf}), is not calculated on data provided from other years, but from the number of landed individuals NL_{iklm} (or NL_{iklf}) during the same year, quarter k, sex (m or f) and size L:

$$ND_{jklm} = NL_{jklm}.\exp(-\alpha_k.(L-L50_k)) \quad \text{or} \quad ND_{jklf} = NL_{jklf}.\exp(-\alpha_k.(L-L50_k)) \qquad [1]$$

α_k and $L50_k$ are the parameters of the s-shaped curve (logistic model) fitted by quarter k describing the commercial *Nephrops* hand-sorting on board. For this fitting, both sexes are combined and the dependent variable is expressed by the number of landed individuals for size L and the independent one is the total number of catches by size L for the years with discard sampling on board.

The estimates α_k and $L50_k$ were calculated by assuming the stability of hand-sorting process on board if mesh size and MLS remain unchanged. The short Irish time-series 2002–2006 was considered as a common dataset, but, for the French trawlers, the overall time-series was divided into three periods:

1) *Years 1987–1990*: The results of sampling carried out in 1985 are not available on computing support. Thus, there is no formal information if the hand-sorting on board could be approximated by the more recent parameters of 1990s. α and L50 were not got fixed, but their values were estimated by the multiple likelihood function as for the parameters of the probability density by year (see below).

2) *Years 1991–1999*: The hand-sorting was fitted on data from 1997 (1991s data were not representative of the whole fleet). The missing data of years 1991–1996 and 1998–1999 were therefore estimated.

3) *Years 2000–2006*: Because of the mesh size change, the hand-sorting should be different from 1997s sampling data. However, there is no new information for the 1st and 2nd quarters (the 2005s sampling plan provided relevant results only for the 3rd and 4th quarters). Hence, α and L50 for the first two quarters

were fixed equal to 1997s parameters, but the simulation for the other two quarters is based on 2005s data.

2nd stage: removing of unreliable size classes of discards

This derivation approach reduces interdependence between yearly datasets which may induce lack of contrast in recruitment time-series. Despite that, some inconveniencies of the new approach have to be taken into account: (1) the hand-sorting on-board s-shaped curve implies that, for a given size class, no calculation of discards is possible while there is no landed individuals and (2) the exponential expression gives extremely unreliable high values of discards when undersized individuals are sampled in landings (mainly because of hand-sorting deviation due to sampling rate not representative for extreme size classes).

1) *Undersized individuals unusual in landings*. As written previously, undersized *Nephrops* sampled in landings should produce unreliable high discarded amounts by size because of the exponential calculation. All size classes representing less than a minimum cumulative percentage level in landings by year were removed (5% for French landings, 1% for Irish landings).

2) *Discarded individuals by size exceeding observed mean ratios discards/landings*. Generated discarded numbers were removed when the calculated ratio discards/landings by size (decreasing function *vs.* size) exceeded observed mean ratios by size[2]. Almost all size classes involved by (2) were already removed by (1). This operation was added at the aim of elimination of not normally high ratios discards/landings for large sizes (which has a little impact on total discarded number due to the s-shaped function of hand-sorting).

This calculation process retains only a part of the initial hand-sorting generated distributions of discards mainly the decreasing part of discarded individuals.

3rd stage: simulation of densities of probability of discarded individuals (yearly distribution for French and quarterly for Irish discards)

Finally, the assumed distribution of discards for the whole range of sizes was calculated from the descending part. This process needs to input the probability density of discards given by:

$$\varphi(L) = \frac{\alpha}{1 + \exp(\beta.(L - Lm)} \qquad [2]$$

where α, β, Lm are coefficients of the distribution (ϕ(L)=α/2 when L=Lm).

Because of the assumed skewness for the French discard distribution, as explained above, the whole function of the probability density is approximated by:

$$\varphi(L) = \frac{\alpha}{1 + \exp(-\gamma\beta.(L - Lm)} \text{ for } \qquad L \leq Lm$$

[2] This procedure is performed only on Irish dataset whereas it is not pertinent for French data (only one year dataset).

$$\varphi(L) = \frac{\alpha}{1 + \exp(\beta.(L - Lm)} \quad \text{for} \qquad L>Lm \qquad [3]$$

with a complementary coefficient γ: if $\gamma=1$ the whole probability density is symmetrical, if $\gamma<1$ the skewness of the distribution is positive if $\gamma>1$ the skewness is negative ($\gamma=1$ for Irish discards, $\gamma\neq1$ for French discards).

The fitting of $\phi(L)$ is processed on two stages:

- *Lm and α are fixed*: α is initially fixed at $2^*\phi max$ which is the maximum frequency retained after the 2nd stage of calculation (see above), Lm is fixed at the size corresponding to the maximum number of discarded individuals as provided by the 2nd stage of calculation (see previously) and, hence, β is given by:

$$\beta = \frac{1}{n}\sum_{L=L\min}^{L\min+n-1} \ln\left[2.\frac{\varphi\max}{\varphi(L)} - 1\right]^{\frac{1}{L-Lm}} \qquad [4]$$

(Lmin= first size represented by not null individuals and n= number of total size classes with discards different from zero).

All parameters are estimated: α, β, Lm got obtained by the 1st stage are input for the final calculation using Newton cancellation of gradient and assuming stochastic approach for Lm. Lm is assumed to be included in the interval defined accordingly to an *a priori* CV of Lm (see above)[3].

Otherwise, the final run includes constraints as:

- The sum of frequencies for descending part of distribution is equal to that calculated by the model i.e. the retained values of the 2nd stage of calculation described previously are assumed to be reliable.
- $Lm \geq Lmin$ [$Lmin=(1-Z_{1-\alpha/2}.CV)^*Lm$] (usually: $\alpha=0.05 \Rightarrow Z_{1-\alpha/2}=1.96$)
- $Lm \leq Lmax$ [$Lmax=(1+ Z_{1-\alpha/2}.CV)^*Lm$]
- For French discards, the coefficient of determination of the relationship between the mean sizes of landings and the mean sizes of discards for missing years has to be as close as possible to 1 (with no possibility of statistical test because of only one year dataset).
- Statistical formulation and validation

Calculation of variances

Matrix of variances–covariances of model parameters

The Generalized Reduced Gradient and the Complex method do not give an estimate of the matrix of variances–covariances of the four (three for Irish) parameters. In this case, it is usually recommended to apply non-parametric techniques such as the Bootstrap meth-

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[3] For French discards, are also included in the optimisation algorithm, the parameters α and L50 of the first period (1987–1990) which remained unknown.

od. The calculation can also be carried out according to parametric procedure (Lin, 1987; Fifas and Berthou, 1999; Fifas *et al.*, 2004) using Jacobian matrix (i.e. matrix of partial derivatives of the objective).

The matrix of variances–covariances is obtained by the following relationship:

$$[M] = s^2.[I]^{-1} \quad [5]$$

with:

[M]= matrix of variances-covariances; $[I]^{-1}$= inverse of matrix of information; s^2= sum of mean residual squares of the fitted function (s^2=SCE/DDL[4]):

$$SCE = \sum_{i=1}^{Lj<Lm} \left[\varphi(L_i) - \frac{\alpha}{1+\exp(-\gamma\beta.(L_i - Lm))}\right]^2 + \sum_{i=j+1}^{Lj>=Lm} \left[\varphi(L_i) - \frac{\alpha}{1+\exp(\beta.(L_i - Lm))}\right]^2 \quad [6]$$

The matrix of information is obtained by:

$$[I] = [J]'.[J] \quad [7]$$

[J] is the Jacobian matrix (nc rows and 4 columns for French data, 3 for Irish):

$$[J] = \begin{bmatrix} \frac{\partial\varphi(L_1)}{\partial\alpha} & \frac{\partial\varphi(L_1)}{\partial\beta} & \frac{\partial\varphi(L_1)}{\partial\gamma} & \frac{\partial\varphi(L_1)}{\partial Lm} \\ \frac{\partial\varphi(L_2)}{\partial\alpha} & \frac{\partial\varphi(L_2)}{\partial\beta} & \frac{\partial\varphi(L_2)}{\partial\gamma} & \frac{\partial\varphi(L_2)}{\partial Lm} \\ . & . & . & . \\ \frac{\partial\varphi(L_{nc})}{\partial\alpha} & \frac{\partial\varphi(L_{nc})}{\partial\beta} & \frac{\partial\varphi(L_{nc})}{\partial\gamma} & \frac{\partial\varphi(L_{nc})}{\partial Lm} \end{bmatrix} \quad [8]$$

[J]' is the transpose of [J], the partial derivatives of the equation [8], also defined as *absolute coefficients of sensitivity of order 1* written as a(α), a(β), a(γ), a(Lm) are given below:

$$\frac{\partial\varphi(L)}{\partial\alpha} = \frac{\varphi(L)}{\alpha} \quad [9]$$

$$\frac{\partial\varphi(L)}{\partial\beta} = \gamma.(L - Lm).\varphi(L).(1 - \frac{\varphi(L)}{\alpha}) \text{ if } L \le Lm \quad [10a]$$

$$\frac{\partial\varphi(L)}{\partial\beta} = -(L - Lm).\varphi(L).(1 - \frac{\varphi(L)}{\alpha}) \text{ if } L > Lm \quad [10b]$$

$$\frac{\partial\varphi(L)}{\partial\gamma} = \beta.(L - Lm).\varphi(L).(1 - \frac{\varphi(L)}{\alpha}) \text{ if } L \le Lm \quad [11a]$$

$$\frac{\partial\varphi(L)}{\partial\gamma} = 0 \text{ if } L > Lm \quad [11b]$$

[4] DDL is equal to nc-4 for French discards, but equal to nc-3 for Irish data (parameter γ is omitted).

$$\frac{\partial\varphi(L)}{\partial Lm} = -\beta.\gamma.\varphi(L).(1 - \frac{\varphi(L)}{\alpha}) \text{ if L} \le \text{Lm} \qquad [12a]$$

$$\frac{\partial\varphi(L)}{\partial\gamma} = \beta.\varphi(L).(1 - \frac{\varphi(L)}{\alpha}) \text{ if L} > \text{Lm} \qquad [12b]$$

Uncertainty of simulated discards

The matrix of variances–covariances of the four (three for Irish) parameters of the model and the use of partial derivatives of order 1 provide an approximate calculation of the variance of the variable Ψ(L) corresponding to simulated discards vs. size L. This procedure is based on limited developments of order 1 in Taylor's series (known as Delta methods: Laurec, 1986; Laurec and Mesnil, 1987; Chevaillier, 1990; Chevaillier and Laurec, 1990; Fifas and Berthou, 1999; Fifas *et al.*, 2004).

By using Taylor's polynomial on a function Φ against parameters $\theta_1, \theta_2, \ldots, \theta_k$ it is possible to present the variance of Φ by:

$$V[\Phi] \approx \sum_{i=1}^{k}\left(\frac{\partial\Phi}{\partial\theta i}\right)^2.V[\theta_i] + 2.\sum_{i=1}^{k-1}\sum_{j=i+1}^{k}\frac{\partial\Phi}{\partial\theta i}.\frac{\partial\Phi}{\partial\theta j}Cov[\theta_i,\theta_j] \qquad [13]$$

Then, the variance of simulated discards vs. size, V[Ψ(L)], is written as:

$$V[\Psi(L)] \approx a(\alpha)^2.V[\alpha] + a(\beta)^2.V[\beta] + a(\gamma)^2.V[\gamma] + a(Lm)^2.V[Lm] + 2.a(\alpha).a(\beta).Cov[\alpha,\beta] +$$

$$2.a(\alpha).a(\gamma).Cov[\alpha,\gamma] + 2.a(\alpha).a(Lm).Cov[\alpha,Lm] + 2.a(\beta).a(\gamma).Cov[\beta,\gamma] + 2.a(\beta).a(Lm).Cov[\beta,Lm] +$$

$$2.a(\gamma).a(Lm).Cov[\gamma,Lm] \qquad [14]$$

where the absolute coefficients of sensitivity of order 1 (partial derivatives) are defined above (equations [9] to [12]).

Validation

The generated by simulation values are tested against discards estimated by sampling. This procedure is undertaken on French data of 1997 and also on available Irish set (all quarters of 2003, 2004-Q2, 2004-Q3, 2005-Q1, 2005-Q2, 2006 apart from Q4 i.e. 11 quarters). As performed for the Bay of Biscay *Nephrops* stock, this validation involves in three main stages (Figures 10–14): (1) Examination of the total amount of discards calculated by simulation that should not be significantly different from that obtained by sampling. (2) Test by linear regression performed on simulated numbers vs. size as dependent variable against sampled numbers as independent one. The slope of this relationship should not be significantly different from 1 (bisecting line) and the intercept should not be significantly different from 0. (3) Test of cumulative frequencies of the sets, sampled and simulated, using non parametric approaches such as Kolmogorov–Smirnov.

Results

Hand-sorting s-shaped curves

The French and Irish hand-sorting logistic curves estimated by sampling are provided by Figure 15. In the Table 4, are also presented the French parameters involving in years

1987–1990 (simulated by the multiple likelihood function applied for probability density of discards; see above).

Table 4. Summary of parameters of s-shaped hand-sorting curves.

	FR (years 1987–1990)		FR (year 1997)		IRL (years 2003–2005)	
quarter	α	L50	α	L50	α	L50
Q1	0.797	32.685	1.006	32.776	0.480	25.876
Q2	0.494	35.573	0.718	36.019	0.426	26.016
Q3	0.331	32.227	0.851	33.654	0.559	25.785
Q4	0.697	31.138	0.815	32.381	0.412	24.886

These values indicate the high heterogeneity between the two fleets which accentuates the *a priori* high spatial heterogeneity of the targeted resource. Some weak differences are observed between the simulated values α and L50 of the first French period (1987–1990) and the sampling of 1997. Nevertheless, these parameters are given by deterministic way; therefore, there is no possibility of further statistical comparison.

Estimates of French discards

Estimates of French discards (1987–2006), total number of discarded individuals, parameters α, β, γ and Lm and corresponding coefficients of variation (CV, in %), are given below (Table 5). Table 6 and Figure 16 present discard rates by sex and combined for the overall time-series.

Table 5. French *Nephrops* trawlers, Celtic Sea (FU 20–22). Estimates of discards, coefficients of model and coefficients of variation of parameters.

year	disc	CV(disc)	Lm	CV(Lm)	α	CV(α)	β	CV(β)	γ	CV(γ)
1987	125752	4.62	30.278	3.25	25773	13.79	0.293	32.11	0.768	44.61
1988	425396	4.88	28.917	5.28	59518	16.97	0.260	39.24	0.534	56.57
1989	99536	4.02	31.061	4.36	14417	13.86	0.221	33.01	0.740	45.69
1990	81530	8.74	30.579	8.28	12219	28.86	0.221	61.77	0.866	92.51
1991	389726	5.69	29.479	5.70	57932	18.85	0.218	40.78	0.868	60.75
1992	377075	18.48	30.752	14.57	61039	58.97	0.314	142.51	0.534	193.98
1993	118210	199.42	31.299	147.10	20679	612.24	0.258	1356.53	0.879	1956.90
1994	93687	7.62	31.438	6.77	14384	24.84	0.232	54.91	0.830	79.80
1995	131541	136.57	31.808	95.39	25096	418.52	0.273	880.20	0.808	1323.18
1996	82811	6.05	32.357	5.61	12121	20.20	0.255	49.20	0.637	66.91
1997	***96612***	***6.21***	***32.403***	***2.11***	***18050***	***15.36***	***0.673***	***46.01***	***0.397***	***55.62***
1998	30494	7.62	31.393	10.98	3453	28.85	0.161	61.94	0.893	94.65
1999	36900	12.14	31.827	10.67	5618	40.01	0.236	84.90	0.791	127.28
2000	22234	46.41	33.790	56.24	2655	171.90	0.175	359.92	0.863	552.62
2001	98962	5.59	31.766	7.43	11594	20.94	0.191	46.64	0.682	69.25
2002	34283	18.42	33.466	21.52	4223	66.86	0.193	150.64	0.762	217.87
2003	59692	4.73	34.452	3.48	9659	15.04	0.285	36.31	0.638	49.26
2004	29493	9.36	33.546	9.20	4050	32.24	0.202	69.23	0.874	103.22
2005	15097	18.92	34.739	17.57	2098	65.03	0.205	136.51	0.873	206.98
2006	17286	6.86	36.327	7.29	2350	24.93	0.238	64.77	0.530	85.17

Note: the sampled year 1997 is given in bold and italic fonts whereas in coloured fonts are presented the years for which the model based on the probability density seems to be inappropriate (years 1993, 1995, 2000; extremely high CV of parameters and discarded numbers). The total discarded number cited for 1997 is the value obtained by sampling.

Table 6. French *Nephrops* trawlers, Celtic Sea (FU 20–22). Discard rate (%) by year.

year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
total	65.0	83.8	58.6	51.2	86.2	82.0	60.9	55.8	63.4	54.3	65.4	40.1	40.3	31.7	64.9	37.4	49.3	40.7	28.8	28.7
males	46.5	67.0	38.5	32.8	73.7	65.3	40.7	37.0	44.2	33.6	45.6	23.0	23.8	19.8	46.4	21.0	30.0	24.0	16.6	18.2
females	86.7	96.5	86.1	79.6	96.0	96.3	90.2	82.3	88.3	88.1	94.7	75.0	72.9	55.6	85.5	80.8	90.6	81.4	68.8	48.9

As presented above, the model based on probability density with skewness gives generally adequate results (see parameters' CV) except for three years on twenty of the overall time-series. Nevertheless, the provided CV are estimated by the model and do not necessarily reflect the actual uncertainty because of complex organization of samples (subsampling stratified plan applied on board). This is illustrated by the sampled year 1997 which showed high spatial and temporal variability of discard size-composition vs. that of landings (CV of samples>30%) although the estimated by the model CV seems unlikely (weak value of 6.21%). Moreover, the generated by the model total number of discarded *Nephrops* for 1997 was underestimated (66 millions i.e. 68% of the total number estimated by sampling: 97 millions). The use of the coefficient γ in the model was justified by the expected skewness of discard distributions due to the selectivity effect: in fact, all values of γ do not exceed 1. However, using the simulated model for the year 1997 with assumed symmetrical distribution of discards and with no constraint on relationship between mean sizes in discards and in landings provided more satisfactory results (Figure 17). The symmetrical simulation gave un estimate of 83 millions of discards i.e. 86% of the 97 millions calculated by sampling closer than the value generated with skewness. Moreover, the CV of parameters α, Lm and mainly β are less strong.

There is no current statistical evidence of choosing symmetrical or not distribution for simulations and there is no possibility to validate any relationship between mean sizes in discards and landings while the actual sampling is limited to only one complete year.

However, as underlined in the Stock Annex, the generated by model cpue (including discards calculated by the probabilistic simulation with skewness) show a good agreement with EVHOE groundfish survey indices for the period 1997–2005 (R^2=0.65) while the relationship between lpue and EVHOE indices seems more sparse (R^2=0.36). As also reported by WGSSDS 2007, throughout the overall time-series, some high (years 1988, 2001) or low (year 1990) values of simulated discard rates coincide with increase or decrease of lpue for 1–2 years later (increase in 1989–1990 and 2002-2003, decrease in 1991–1992). It is noticeable that no constraint was set for back-calculations on the relationship between discard rate (year i) and lpue (years i+1/i+2).

Estimates of Irish discards

Estimates of Irish discards by quarter (since 2002), total numbers of discarded individuals, parameters α, β and Lm and corresponding coefficients of variation (CV, in %), are provided below (Table 7).

A first examination of results shows an overall better statistical adequacy than for French discards. Except for one sampled quarter (coloured fonts; 2005-Q2), the coefficients of determination are strong and the CV of model parameters remain relatively low. Despite this initial overview, the adequacy of the probabilistic approach will be tested as regards the procedure developed for the Bay of Biscay stock.

The Table 8 and Figure 18 present quarterly discard rates by sex and combined for the overall time-series. Discard rates by sampling and by simulation can be directly compared for 11 quarters (Table 8): it seems that the average simulated discard percentage is slightly lower than the sampled one (26.0% against 27.3%), but for 8 quarters on 11, the simulated values are underestimated.

The Table 9 and Figure 19 give comparisons between sampled and simulated discarded numbers. Two sampled years (2003 and 2005) for the 1st quarter give low correlations between sampled and simulated discards. Despite more good correlation levels (9 on 11), the overall conclusion is that the null hypothesis (slope=1) is refused apart from one example (2004-Q2) which although provides biased results of simulated discards (very high ratio Nexp/Nobs). It is worth noting that the descending part of simulated DLF of discards seems to be more coherent with the sampled DLF than the ascending one (except for one case on 11, 2005-Q2 which is denoted by the less good statistical consistency of simulation in regards with the low value of ϱ^2: Table 7). Introduction of some constraint between mean sizes in discards and in landings as for the French example may give different results for the ascending DLF.

Table 7. Irish *Nephrops* trawlers, Celtic Sea (FU 20–22). Estimates of discards, coefficients of model and coefficients of variation of parameters (bold characters=sampled quarters).

year	Q	disc	Lm	CV(Lm)	α	CV(α)	β	CV(β)	ρ²
2002	Q1	2664	26.039	0.95	1282	13.89	0.674	18.09	0.990
2003	**Q1**	**6318**	**20.994**	**1.97**	**1476**	**11.52**	**0.319**	**15.53**	**0.855**
2004	Q1	2208	24.743	1.34	998	18.48	0.625	24.42	0.960
2005	**Q1**	**7613**	**25.929**	**0.88**	**3764**	**13.27**	**0.691**	**17.29**	**0.994**
2006	**Q1**	**11279**	**25.218**	**0.68**	**4594**	**8.56**	**0.564**	**11.32**	**0.929**
2002	Q2	1670	27.891	1.10	666	14.69	0.555	19.37	0.950
2003	**Q2**	**10236**	**25.119**	**0.72**	**4204**	**8.98**	**0.571**	**11.84**	**0.980**
2004	**Q2**	**4953**	**24.685**	**1.05**	**1003**	**6.39**	**0.278**	**8.59**	**0.951**
2005	**Q2**	**23437**	**25.139**	**1.42**	**3701**	**6.79**	**0.214**	**9.27**	**0.608**
2006	**Q2**	**15977**	**26.854**	**0.35**	**7902**	**5.61**	**0.688**	**7.35**	**0.987**
2002	Q3	729	27.444	0.77	363	13.40	0.686	17.73	0.982
2003	**Q3**	**15985**	**22.042**	**0.43**	**5780**	**4.04**	**0.504**	**5.33**	**0.940**
2004	**Q3**	**1291**	**28.143**	**0.26**	**571**	**3.90**	**0.615**	**5.13**	**0.969**
2005	Q3	4795	24.751	0.64	2562	10.55	0.739	13.85	0.960
2006	**Q3**	**2518**	**25.484**	**0.44**	**1144**	**6.48**	**0.626**	**8.60**	**0.927**
2002	Q4	11343	24.442	0.56	5197	7.89	0.631	10.46	0.990
2003	**Q4**	**2166**	**24.284**	**0.83**	**630**	**7.23**	**0.402**	**9.64**	**0.967**
2004	Q4	1561	27.543	0.93	713	14.91	0.630	19.77	0.992
2005	Q4	9249	24.318	0.67	4603	10.22	0.687	13.49	0.992
2006	Q4	10394	25.289	0.67	5666	11.50	0.753	15.11	0.990

Table 8. Irish *Nephrops* trawlers, Celtic Sea (FU 20–22). Discard rate (%) by quarter and year (for the sampled quarters: the cited percentages in bold correspond to the sampling results; those in brackets are obtained by the simulation).

year	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006
quarter	Q1	Q1	Q1	Q1	Q1	Q2	Q2	Q2	Q2	Q2	Q3	Q3	Q3	Q3	Q3	Q4	Q4	Q4	Q4	Q4
total	7.3	26.9	15.4	35.3	41.1	2.6	37.6	11.5	21.4	29.5	1.2	41.2	10.1	11.1	19.5	9.9	26.4	2.3	54.3	7.2
		(41.6)		(24.5)	(32.4)		(29.9)	(16.5)	(28.8)	(24.1)		(40.6)	(9.0)		(15.6)		(22.9)			
males	6.6	22.1	13.7	37.9	34.5	2.5	34.0	11.1	19.3	22.9	1.3	42.2	9.3	5.2	17.0	10.9	20.7	4.3	47.0	8.0
females	8.9	75.1	18.7	34.0	56.8	2.7	40.5	11.7	22.7	32.7	1.2	40.6	11.4	40.0	20.9	6.5	59.1	0.2	71.2	3.8

It would also be interesting to re-examine the comparisons after assuming skewness of discards distributions (use of coefficient $\gamma \neq 1$ as for the French fleet). It is noticeable that for 5 quarters on 11 (Figure 19) the DLF of samples deviates from the assumed symmetry of simulations, then small sized individuals are underestimated (however, the overestimation of the small *Nephrops* by the simulation occurs less often, but provides extremely divergent results). Although, there is no current basis for further analysis of this point because there is no evidence of any particular effect of some biological feature affecting the symmetry of distributions i.e. moulting which occurs in spring and autumn (example examined in the French fishery of the Bay of Biscay). The short time-series and the low sampling rate do not allow to generalize this first overview.

Table 9. Irish *Nephrops* trawlers, Celtic Sea (FU 20–22). Relationships between discarded numbers by sampling (Nobs) and by simulation (Nexp).

year/quarter		Nexp=Ψ(Nobs)	ρ²	p(slope)	Nexp/Nobs
2003	Q1	Nexp=0.87*Nobs+84.99	0.44	0.41	194%
2005	Q1	Nexp=0.60*Nobs-2.72	0.72	0.00*	60%
2006	Q1	Nexp=0.72*Nobs-12.49	0.89	0.00*	69%
2003	Q2	Nexp=0.72*Nobs-3.87	0.84	0.00*	71%
2004	Q2	Nexp=0.94*Nobs+45.90	0.85	0.38	152%
2005	Q2	Nexp=0.78*Nobs+267.45	0.85	0.00*	148%
2006	Q2	Nexp=0.83*Nobs-39.77	0.94	0.00*	76%
2003	Q3	Nexp=0.89*Nobs+32.24	0.94	0.00*	97%
2004	Q3	Nexp=0.86*Nobs+0.92	0.97	0.00*	88%
2006	Q3	Nexp=0.80*Nobs-2.90	0.91	0.00*	77%
2003	Q4	Nexp=0.74*Nobs+5.79	0.88	0.00*	83%

Note: *=significant result (1-α=0.95)

Conclusion

The biological sampling on board for *Nephrops* FU 20–22 stock remains poor for both main fleets. The duration of trips for French trawlers (12–15 days) restricts possibilities of regular participation of observers. Moreover, in agreement with results of sampling design applied in 1997, the long duration of trips implies a high spatial variability of harvested areas by trip and a low total number of trips sampled by quarter. Thus, the CV of discarded numbers estimated by sampling remains high. By the way, the simulations developed on French discards are hampered by the sampling of only one year throughout a long time-series. The discard practices during the whole period may change, but there is no current possibility to test the effect of such a modification on the hand-sorting on board. Despite that, some discard rates by year agree overall with independent indices as EVHOE groundfish survey indices (as pointed by last year's WG) and with the most notable changes in terms of lpue during the whole time-series.

The Irish dataset takes more promising because of a shorter duration of trips. Hence, conceptual problems of sampling design inherent to the French fleet should not affect the Irish data. As the Irish fleet seems to be more recruitment directed, the indices provided by the sampling on board should improve the diagnostic accuracy. In the meantime, the simulation based on the probabilistic approach indicated an overall consistent reconstitution of discards for more sampled quarters. Many further investigations have to be carried out in the order to validate extrapolations from French catches to Irish for the period before 2002.

B.3. Surveys

Direct *Nephrops* assessments by trawling are inappropriate because of notable diurnal variations of availability which is higher during dawn and dusk. The most adapted way is based on transect with video and TV runs of burrows (combined with hauls on area and geostatistical analysis of catches with the aim of separating burrows of *Nephrops* from those of squat lobster), but it needs heavy preliminary arrangements because the spatial heterogeneity of resource requires to well define the survey area and the sampling plan in order to avoid biased results. The current situation will be improved in future once a data time-series has been collected by the Irish specifically designed survey programme launched in 2006. However, the Irish and French exploited areas are different. On FU 20–22 the French groundfish survey EVHOE while not focusing on *Nephrops* does provide an indication of the length distributions and the strength of recruitment (Figure 20). An Irish groundfish survey giving size composition of *Nephrops* catches has also been carried out since 2003. Moreover, a UK bottom-trawl survey had occurred on the same area between 1984 and 2004, but only two sampling stations were within FU 20–22 area.

A comparative analysis conducted between lpue and cpue of French and Irish vessels with EVHOE indices shows a good agreement between commercial French cpue and EVHOE series for the period 1997–2005 (R^2=0.65) while the relationship is more sparse (R^2=0.36) when the commercial French lpue are used (Figure 21). The Irish data are not significantly linked to the French dataset probably due to the difference of harvested area and the short time-series.

The results of the UWTV survey initiated by Republic of Ireland in 2006 involving in the three first years, 2006–2008, are shown by Figures 20–25 and Tables 10–11. It is noticeable that the strongest values of this short time-series (2006) coincide with the highest level on "Smalls" as reported by Irish industry in 2007. In a time frame of around 2–4 years, this survey should provide valuable information to tune data for the FU20–22 *Nephrops* stock especially on the "Smalls" ground where are located more than the $^2/_3$ of the total Irish yearly production. Nevertheless, the historical longer series of French landings in the Celtic Sea is less involved by the area covered by UWTV (the contribution of the rectangle 31E3 in the total French production fell from 41% in 1999 at less than 10% in 2008). This implies the necessity to tune data for the whole area.

B.4. Commercial cpue

Between 2006 and 2007, the French fishing effort declined notably by -25% and the lpue increased (+13%) although the evolution of the same indicators for the Irish fleet was different (+31% of fishing effort and +36% of lpue). It is noticeable that the decrease of the French fishing effort was caused by the reduction of the number of trips by vessel whereas the total number of vessels remained almost stable. The evolution of the Irish fishing effort involves either in increase of the fishing vessels (95 Irish trawlers were listed in 2007 against 80 for 2006) or in increase of the number of trips by vessel.

Between 2007 and 2008, the effort of the French trawlers decreased slightly i.e. 99 789 hours against 101 980 hours for 2007 whereas the Irish fishing effort remained stable (59 727 hrs against 59 899 hrs in 2007). Lpue of both fleets increased mainly for French trawlers (+22%: 22.6 kg/h against 18.5 kg/h for 2007) and, to a lesser degree, for Irish (+11%: 55.2 kg/h against 49.4 in 2007).

C. Historical stock development

There is no currently specific development for analytical assessment of the stock. By the WG*NEPH* 2003, the FU20–22 *Nephrops* stock was analytically assessed by XSA (software VPA; Darby and Flatman, 1994). Because of the lack of long and consistent Irish series (before DCR), the analysis was limited on the male component involved by French trawlers (see input parameters: Table 1).

D. Short-term projection

No short-term projection is performed for this stock.

E. Medium-term projections

No medium-term projection is performed for this stock.

F. Long-term projections

No long-term projection is performed for this stock.

G. Biological reference points

There is no biological reference point for this stock.

H. Other issues

I. References

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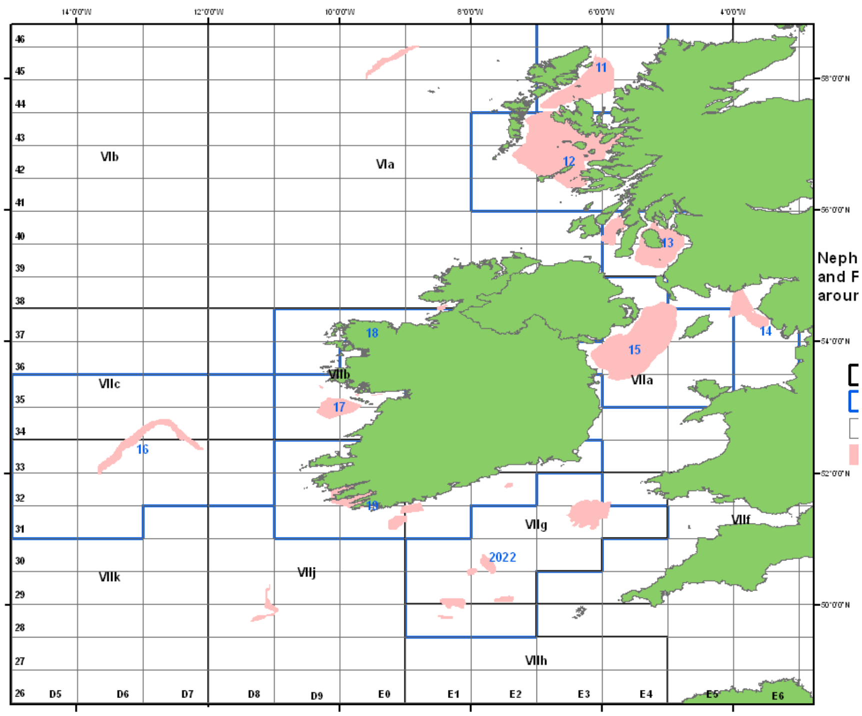


Figure 1. Functional units 20–22 (*Nephrops* grounds in Celtic Sea).

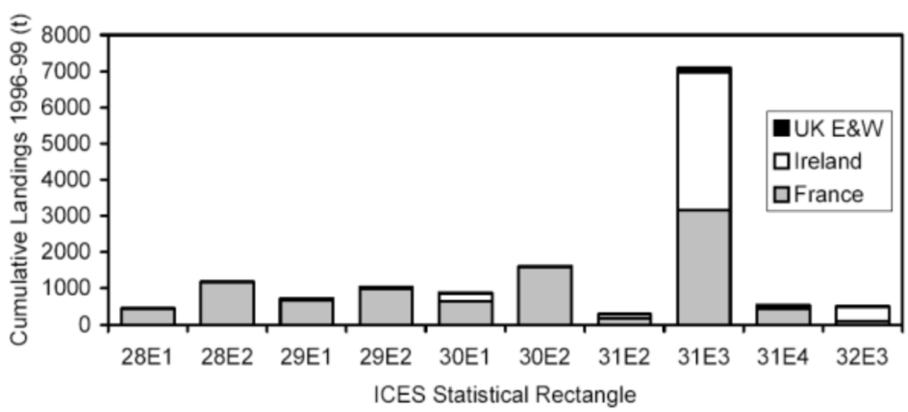
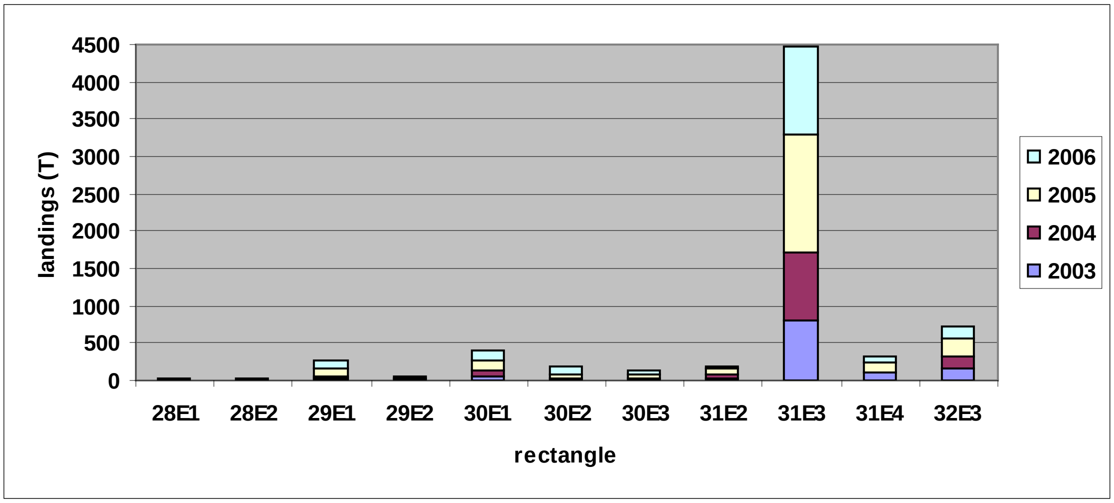


Figure 2. *Nephrops* FU 20–22 (Celtic Sea). Spatial distribution of landings of the main fleets (average value of the period 1996–1999).



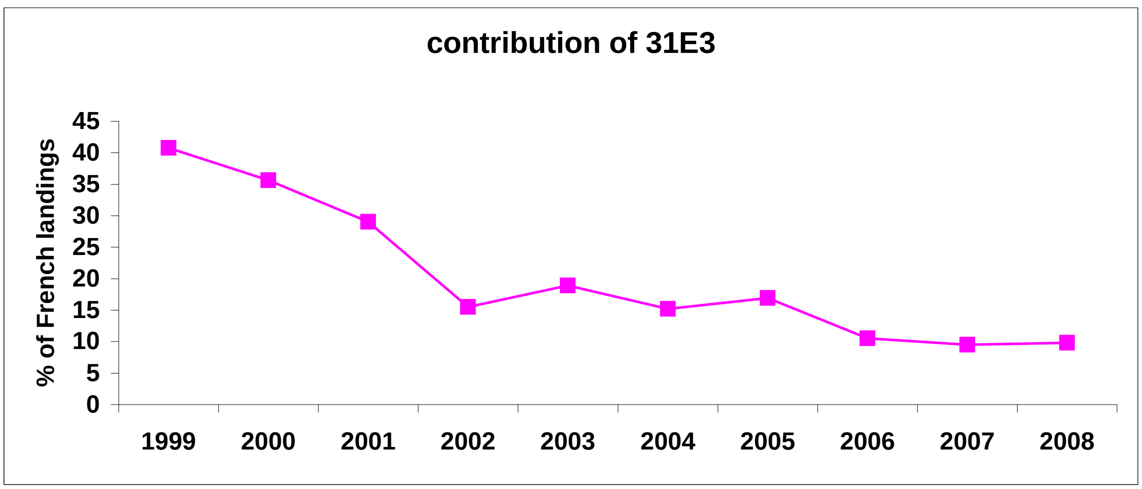
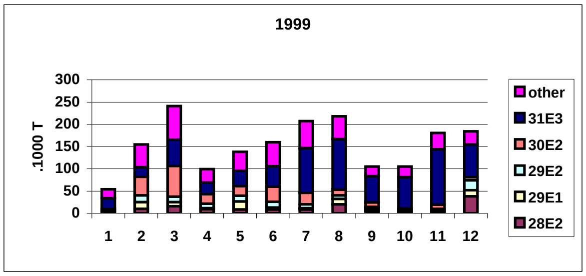


Figure 3. ***Nephrops*** **FU 20–22 (Celtic Sea). Above: Spatial and by year distribution of Irish landings. Below: Contribution of the rectangle 31E3 (concentrating more than ²/₃ of the total Irish production) in the total French landings. Years 1999–2008.**


1999
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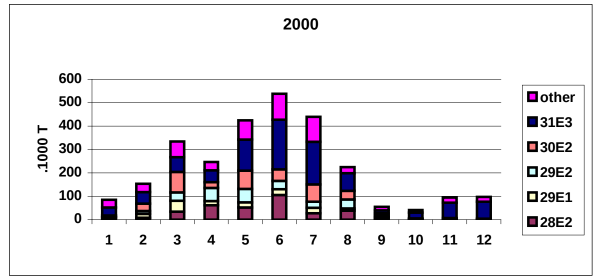
1 2 3 4 5 6 7 8 9 10 11 12
other
31E3
30E2
29E2
29E1
28E2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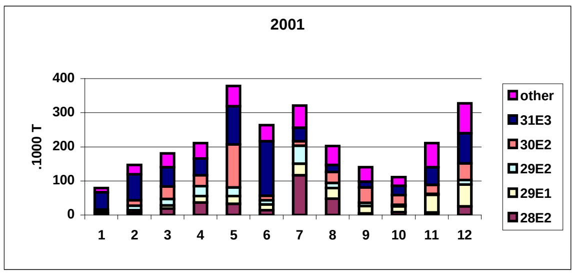
28E2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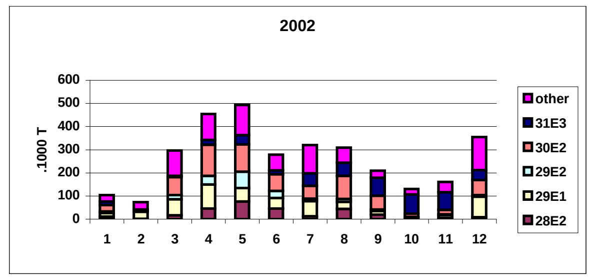
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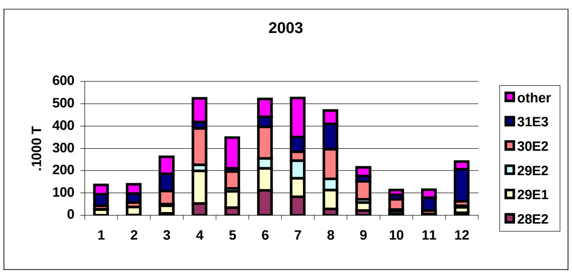
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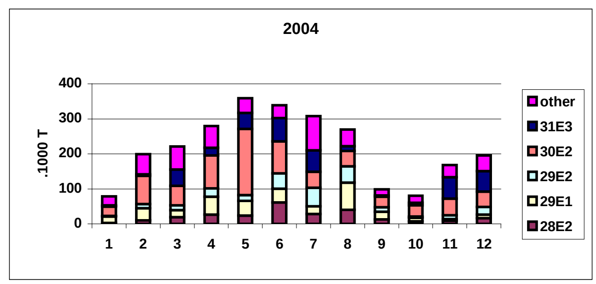
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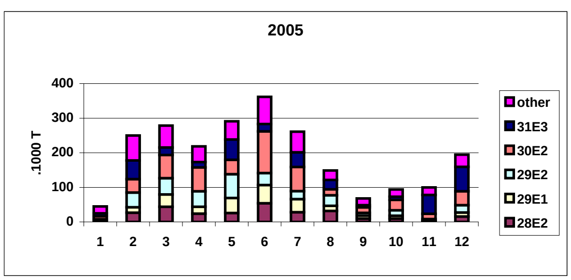
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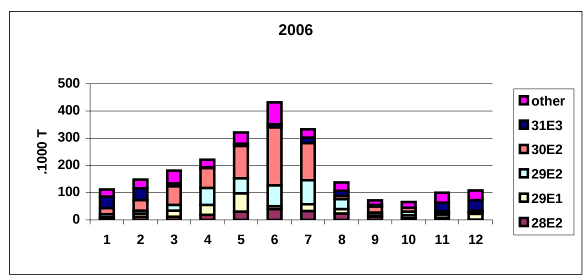
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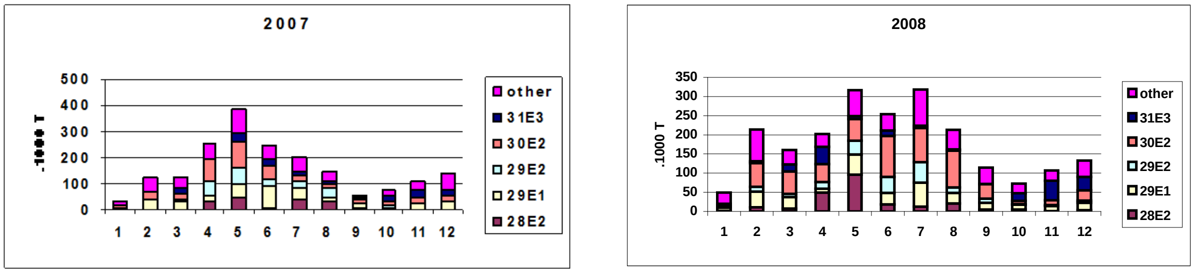


Figure 4. ***Nephrops*** **FU 20–22 (Celtic Sea). Spatial and monthly distribution of French landings.**

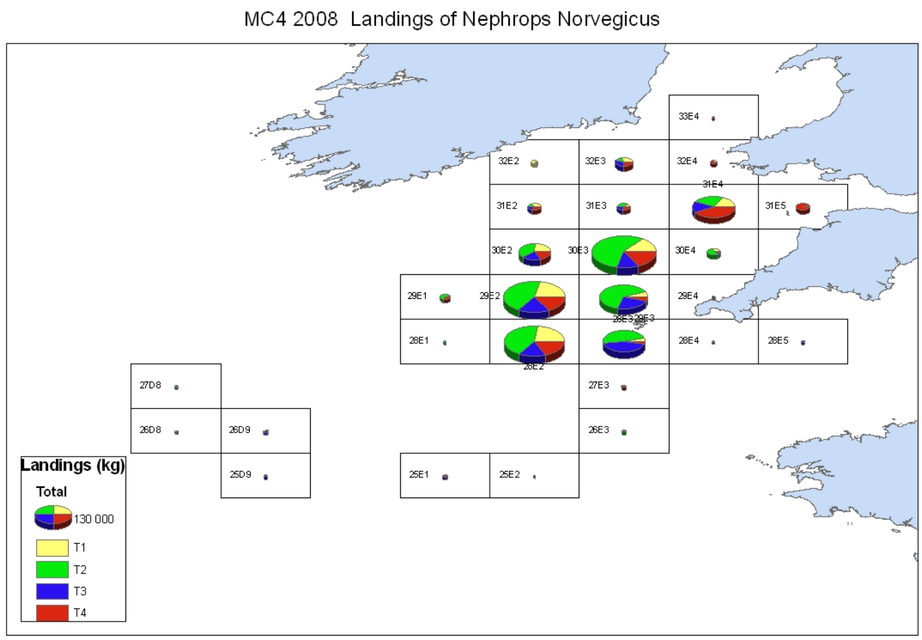


Figure 5. ***Nephrops*** **FU 20–22 (Celtic Sea). Spatial distribution of French landings in 2007.**

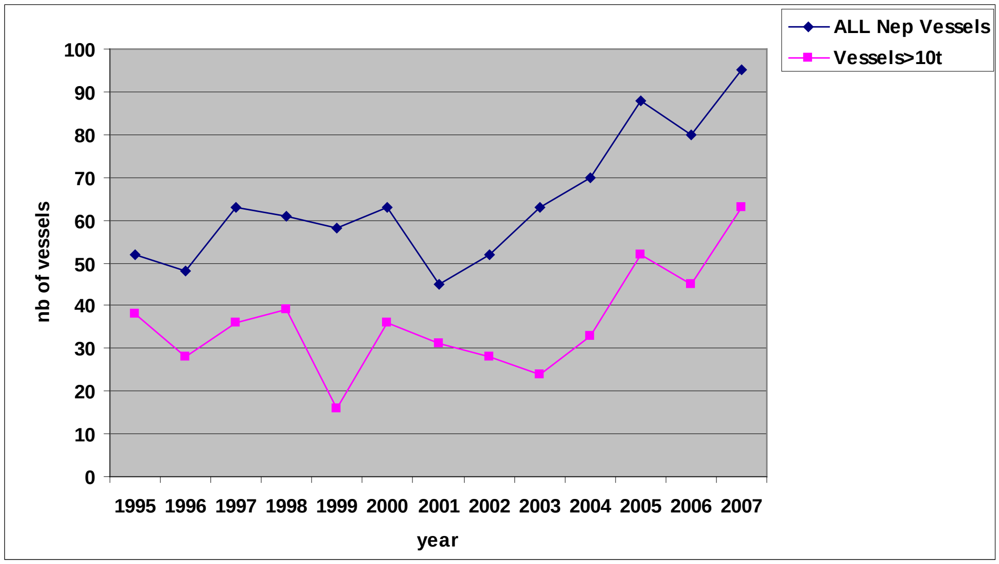


Figure 6. ***Nephrops*** **FU 20–22 (Celtic Sea). Number of Irish trawlers involving** ***Nephrops*** **landings.**

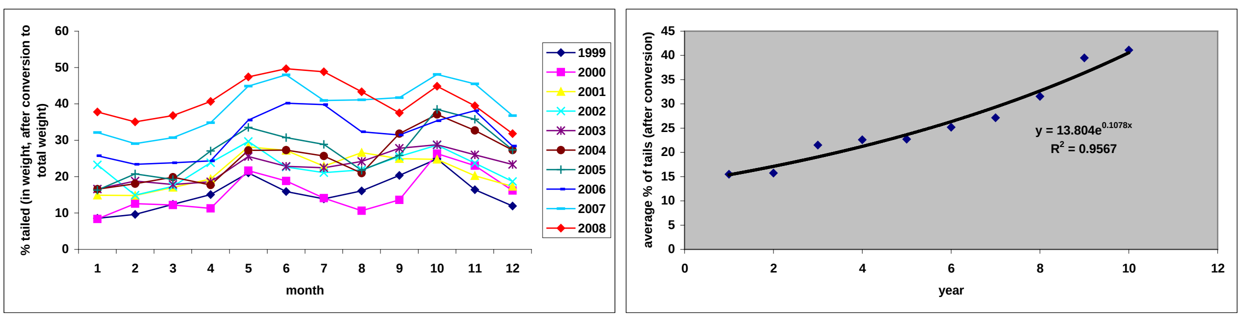


Figure 7. ***Nephrops*** **FU 20–22 (Celtic Sea). Tailed proportion (in converted weight) in landings by month (left) and by year (right).**

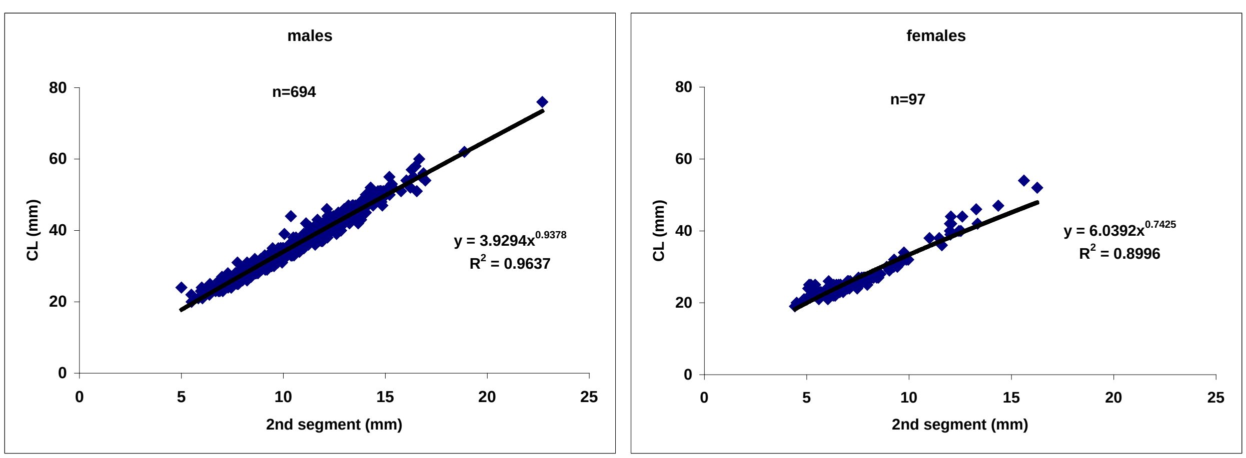


Figure 8. ***Nephrops*** **of the Celtic Sea (VIIfgh, FU20–22). Biometric relationships (CL vs. 2nd abdominal segment by sex). Data harvested during the survey EVHOE 2007.**

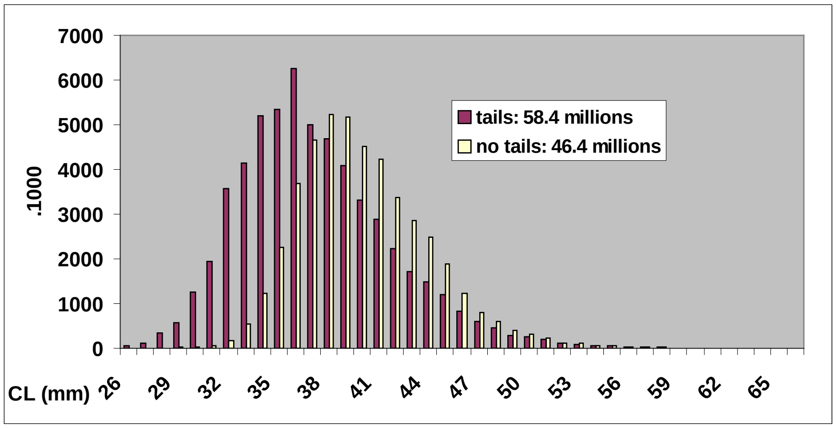


Figure 9. ***Nephrops*** **of the Celtic Sea (VIIfgh, FU20–22). French landings for 2008. Length distributions (1) including the data on tails and (2) using the previous method (no sampling of tails; the total tailed proportion was apportioned in the smallest category of entire** ***Nephrops*** **at auction).**

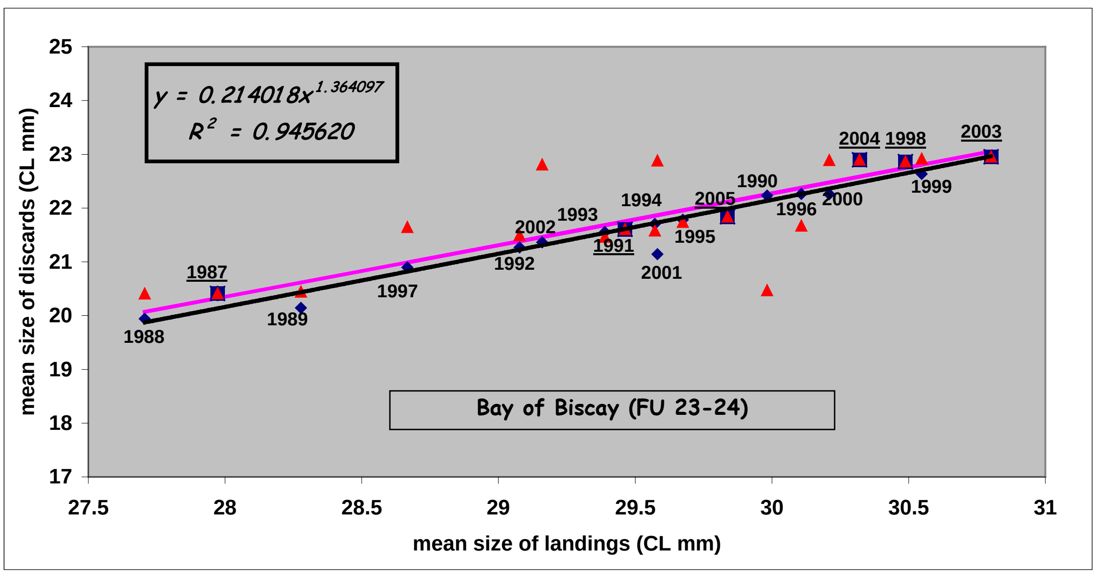


Figure 10. ***Nephrops*** **of FU 23–24 (Bay of Biscay). Final results of logistic derivation of discards. Relationship between mean sizes of landings and discards. The triangular fonts represent the results of the** ***status quo*** **(proportional derivation) method. The underlined years correspond to the available datasets of sampling on board. The rhombus fonts correspond to the logistic derivation. The dark curve is provided by the final fitting on the whole time-series. The bright curve is the result of the fitting on the years with available data.**

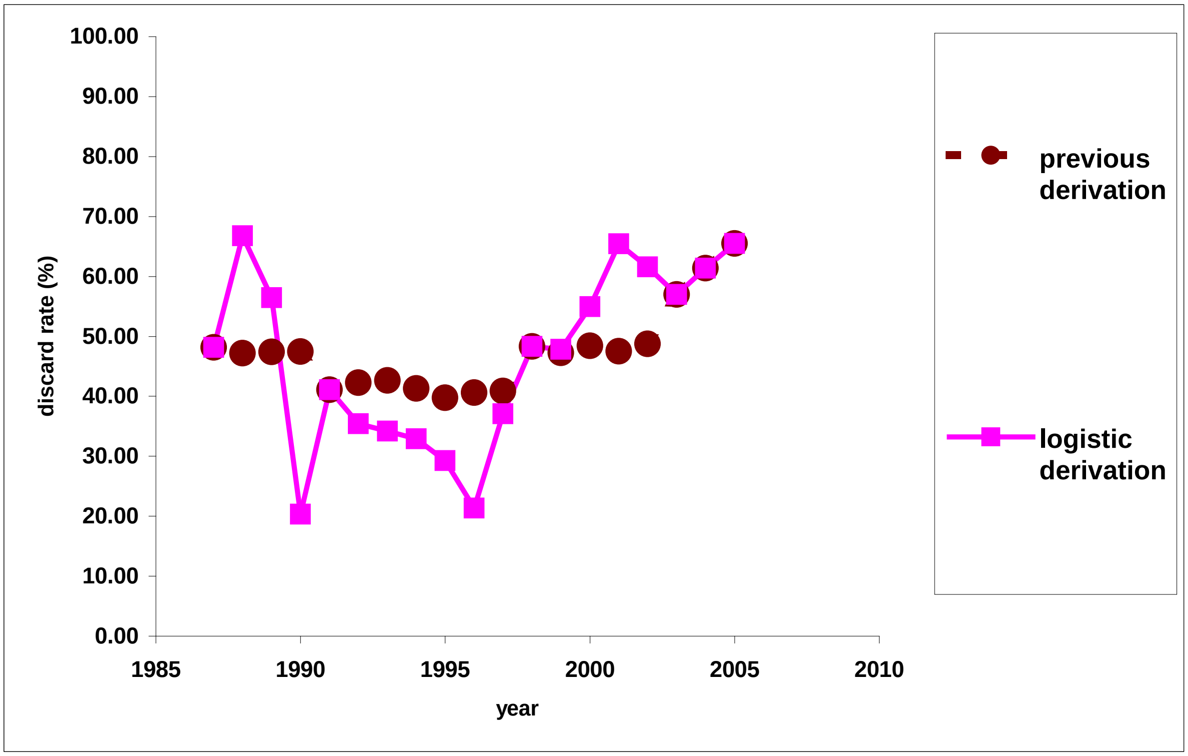


Figure 11. ***Nephrops*** **of FU 23–24 (Bay of Biscay). Comparison between discard rates obtained by previous (proportional) derivation and by logistic derivation. Combined sexes and whole year datasets.**

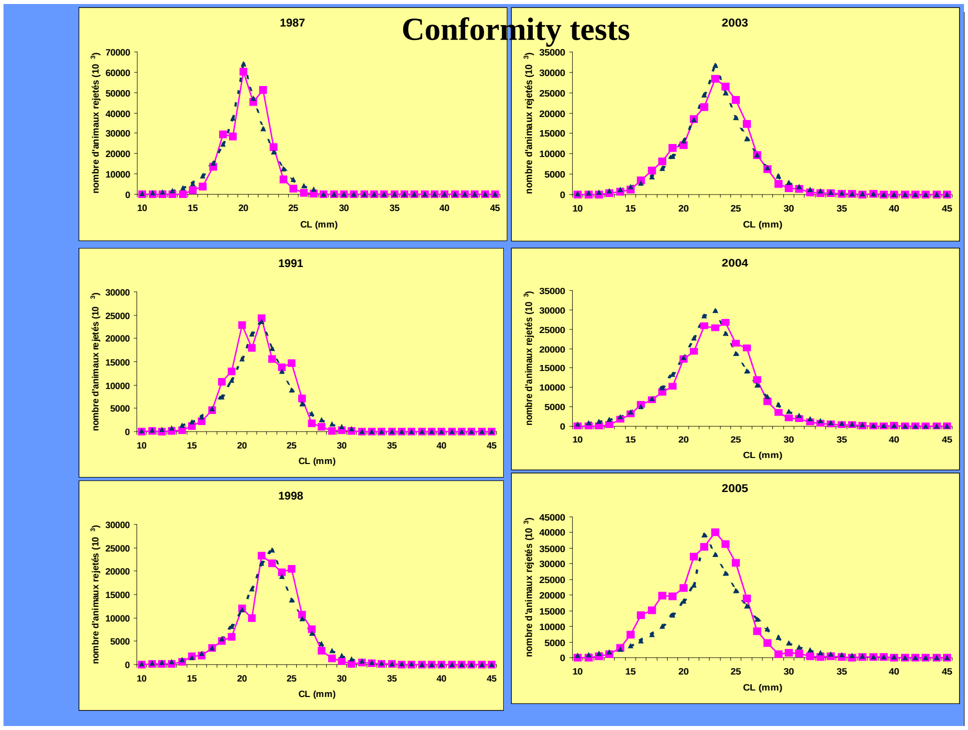


Figure 12. ***Nephrops*** **of FU 23–24 (Bay of Biscay). Comparison between distributions of length frequencies (carapace length, CL in mm) of discards obtained by sampling and by simulation (broken lines).**

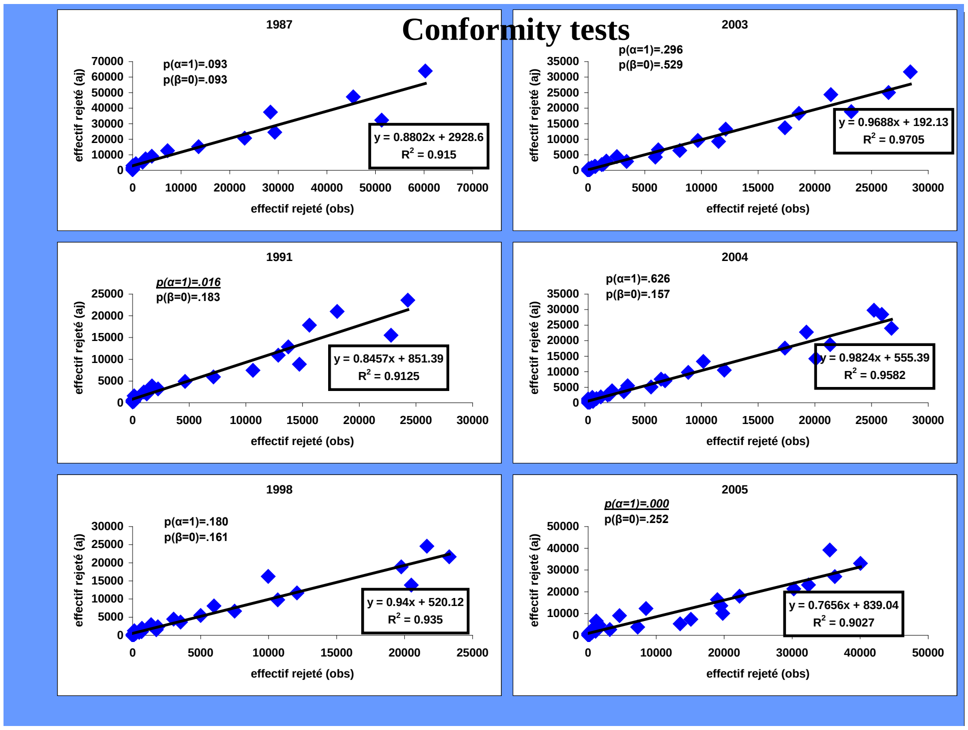
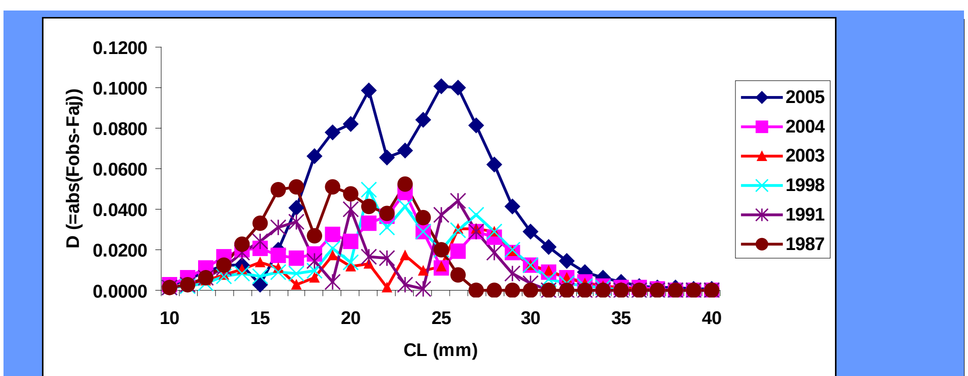


Figure 13. ***Nephrops*** **of FU 23–24 (Bay of Biscay). Comparison between discarded numbers of individuals obtained by simulation (y-axis) and by sampling (X-axis). Statistical tests on linear regressions of Y vs. X by year.**



year	Da	Dobs	%
2005	0.113	0.101	85
2004	0.127	0.048	107
2003	0.135	0.031	100
1998	0.154	0.049	106
1991	0.157	0.044	97
1987	0.115	0.052	108

Figure 14. ***Nephrops*** **of FU 23–24 (Bay of Biscay). Statistical test (Kolmogorov–Smirnov) between cumulated frequencies of sampled and simulated discards by year.**

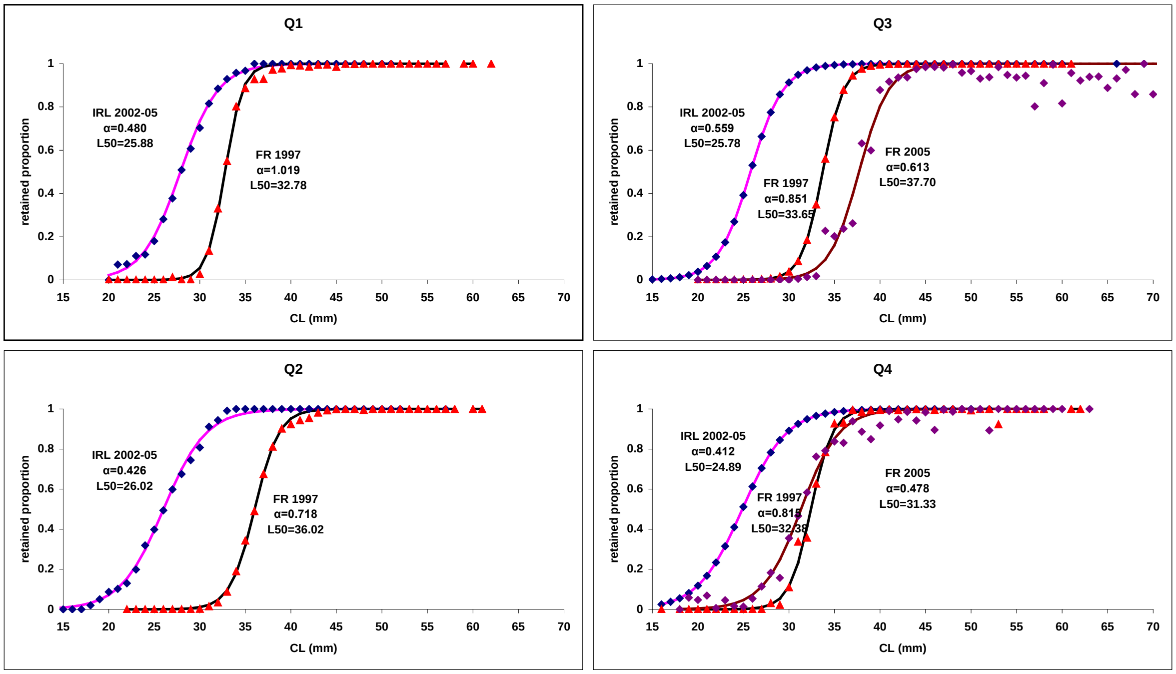


Figure 15. ***Nephrops*** **FU 20–22 (Celtic Sea). Different hand-sorting logistic curves by quarter, country and dataset. In 2005 no sample was collected in France during the 1st quarter and the 2nd quarter provided inconsistent results.**

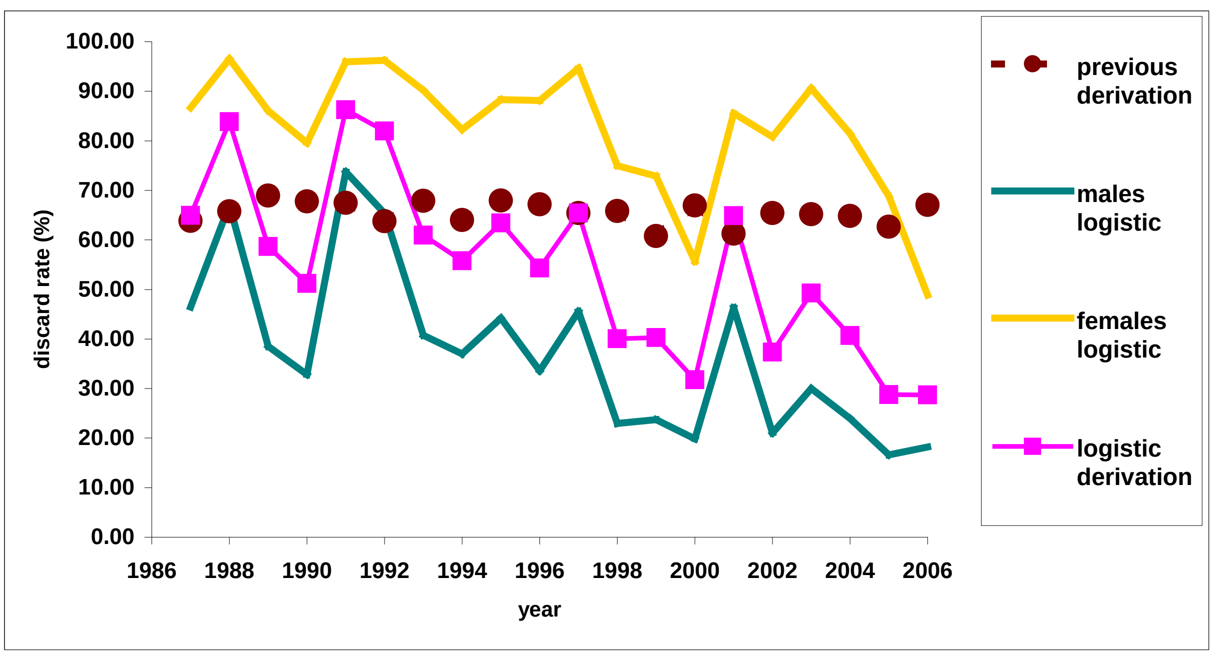
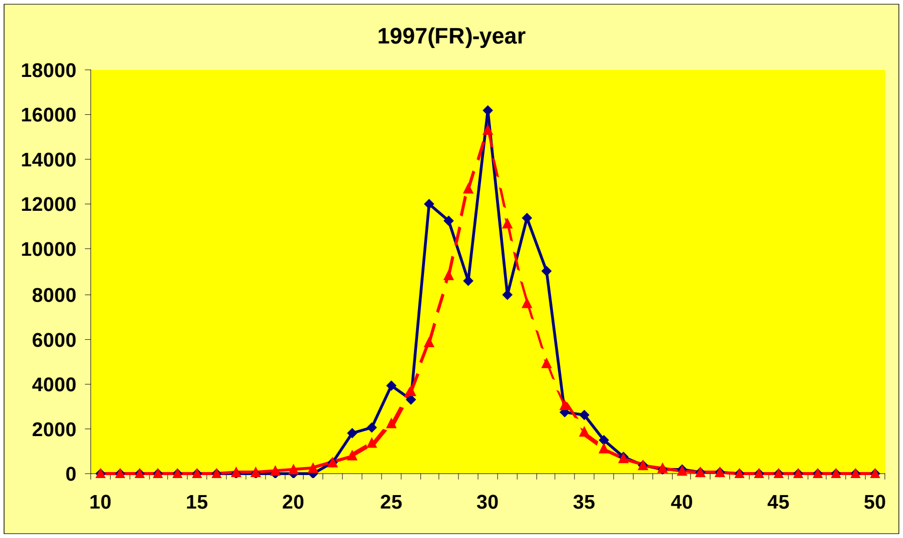


Figure 16. ***Nephrops*** **of FU 20–22 (Celtic Sea). Comparison between discard rates obtained by previous (proportional) derivation (used by WG*NEPH* until 2004) and by logistic derivation. Combined sexes and whole year datasets.**

Nexp=0.84*Nobs+54.76 ρ^2=0.85 p(slope)=0.01 [86%]



year	disc	Lm	CV(Lm)	α	CV(α)	β	CV(β)	ρ²
1997	83306	29.807	1.29	32335	9.42	0.538	6.43	0.913

Figure 17. *Nephrops* of FU 20–22 (Celtic Sea). French fleet. Results of the discard simulation on the year 1997. The distribution is assumed symmetrical and no constraint was set on relationship between mean sizes in discards and landings. Simulated number (Nexp) illustrated by broken line are compared to sampled one (Nobs).

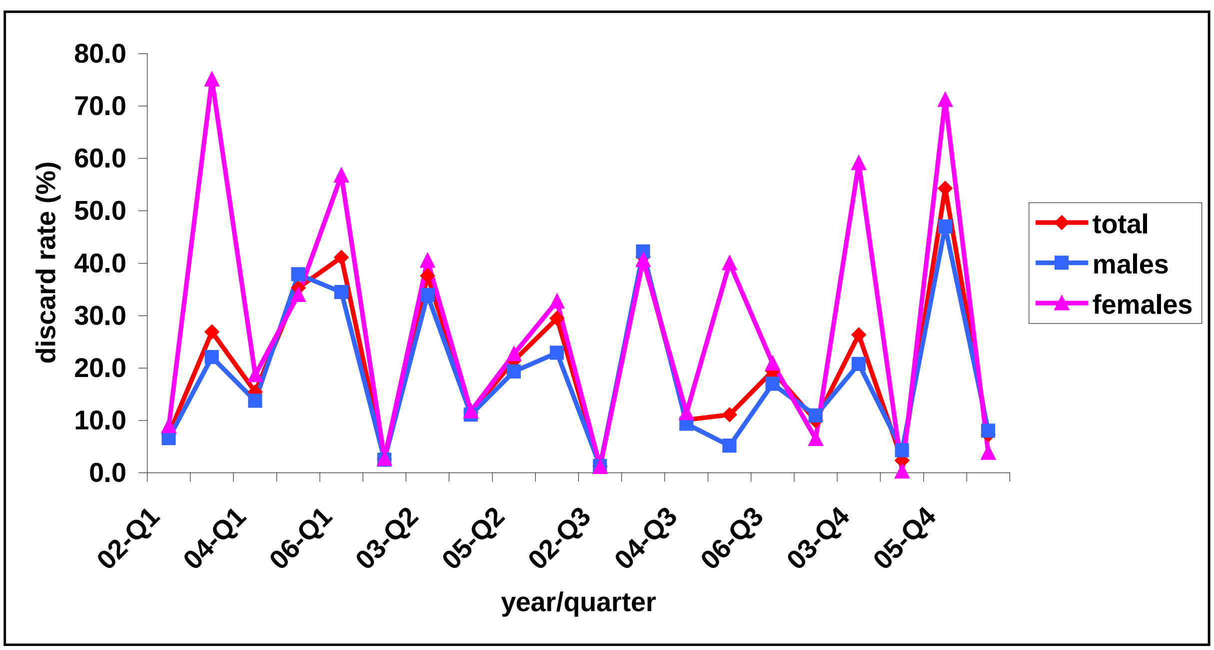


Figure 18. *Nephrops* of FU 20–22 (Celtic Sea). Discard rate (%) of Irish trawlers by year and quarter.

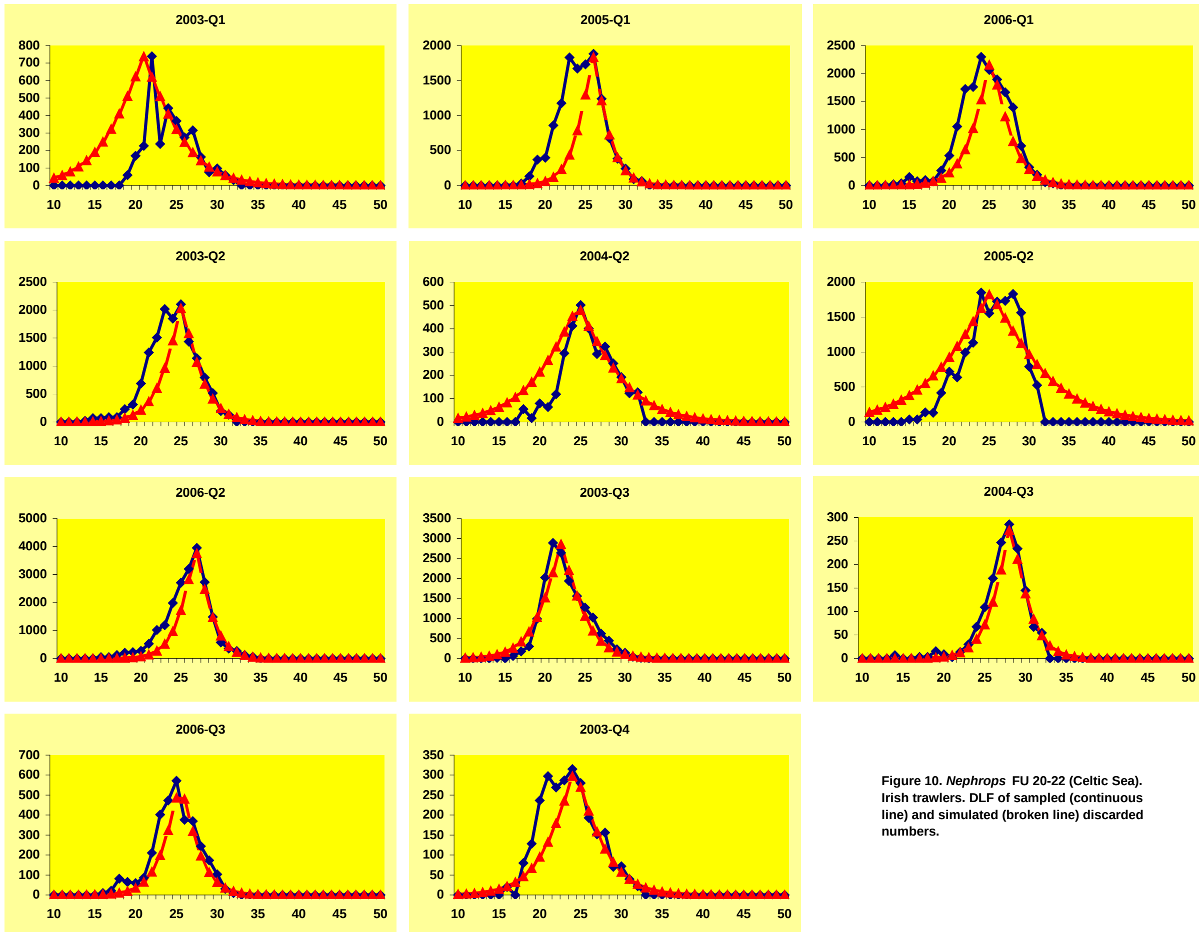


Figure 19. ***Nephrops*** **FU 20–22 (Celtic Sea). Irish trawlers . DLF of sampled (continuous line) and simulated (broken line) discarded numbers.**

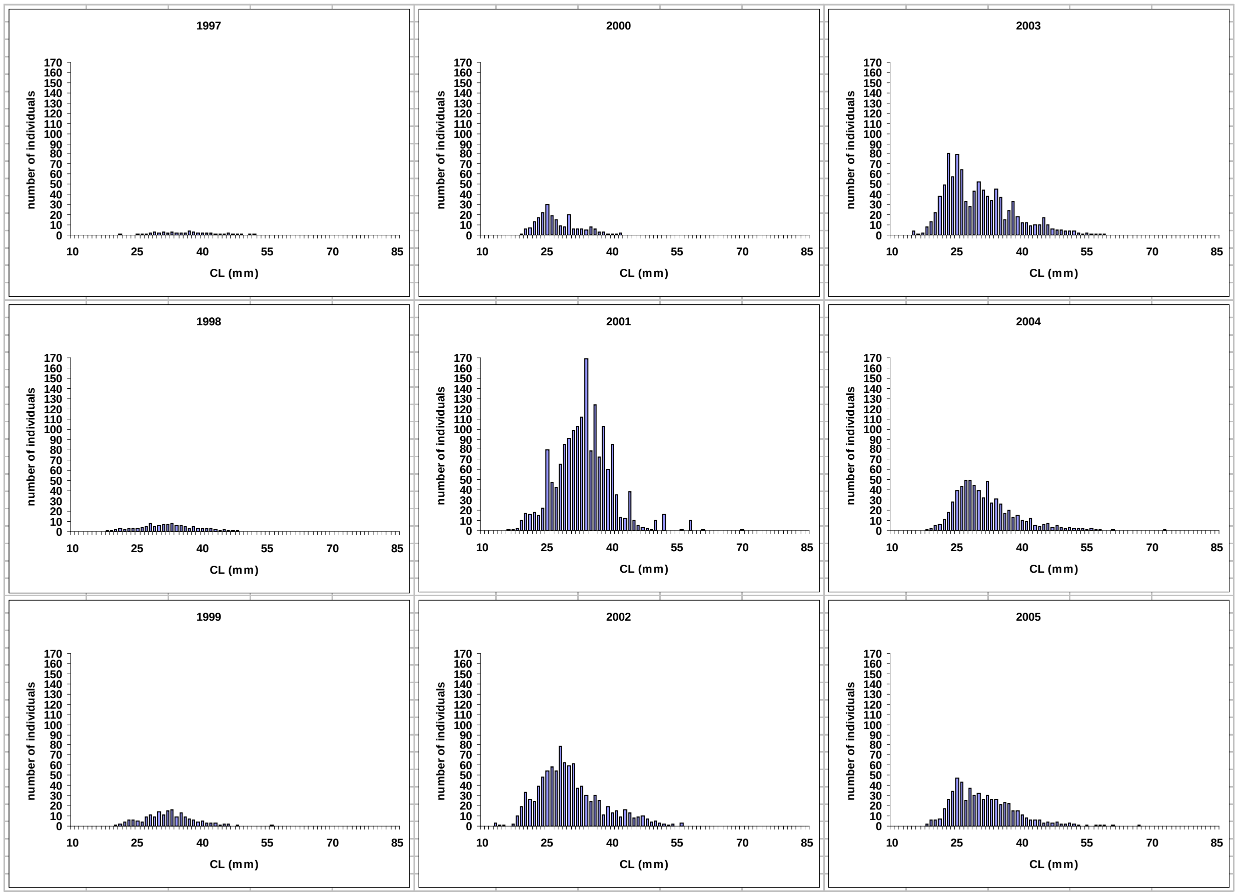


Figure 20. ***Nephrops*** **FU 20–22. Indices of the French groundfish survey EVHOE.**

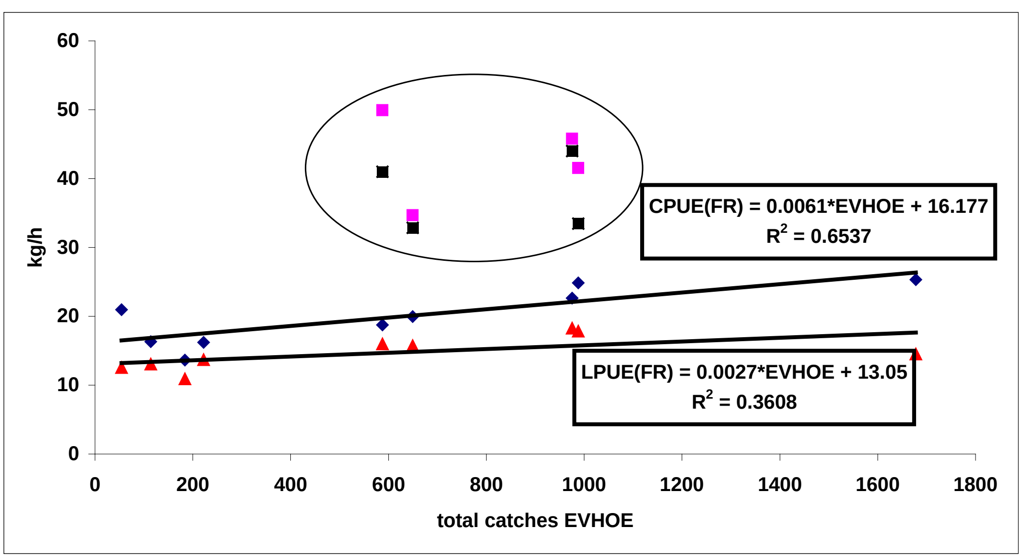


Figure 21. ***Nephrops*** **FU 20–22. Comparison of indices EVHOE and of commercial lpue and cpue for French and Irish trawlers.**

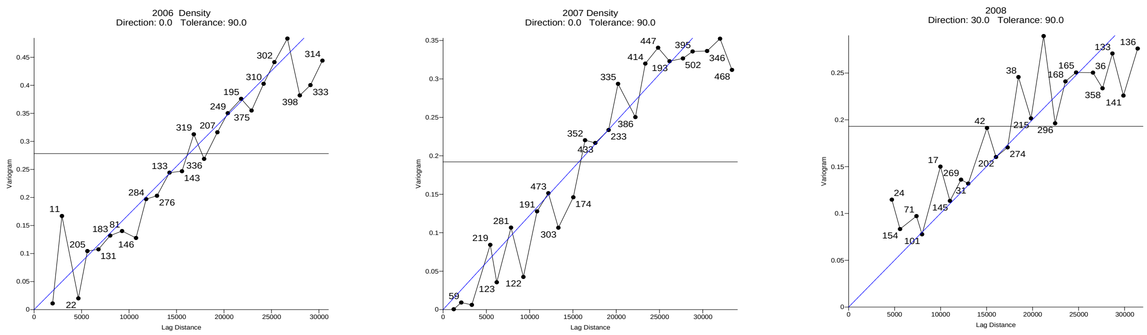


Figure 22. Omnidirectional mean variograms for the Celtic Sea FU20–22 by year from 2006–2008.

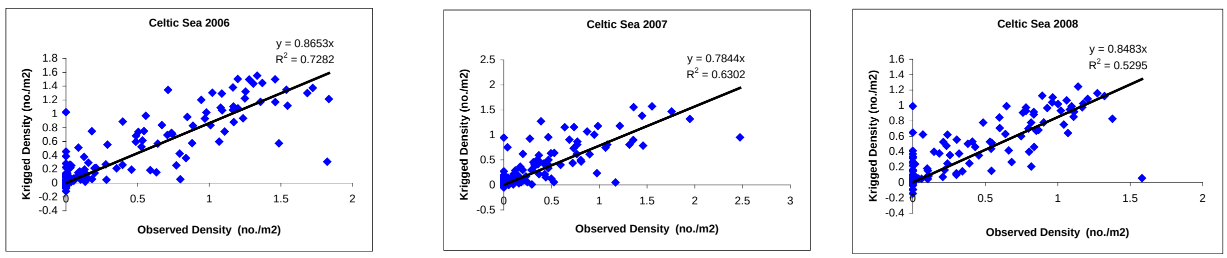


Figure 23. Cross validation plots for the Celtic Sea FU20–22 by year from 2006–2008.

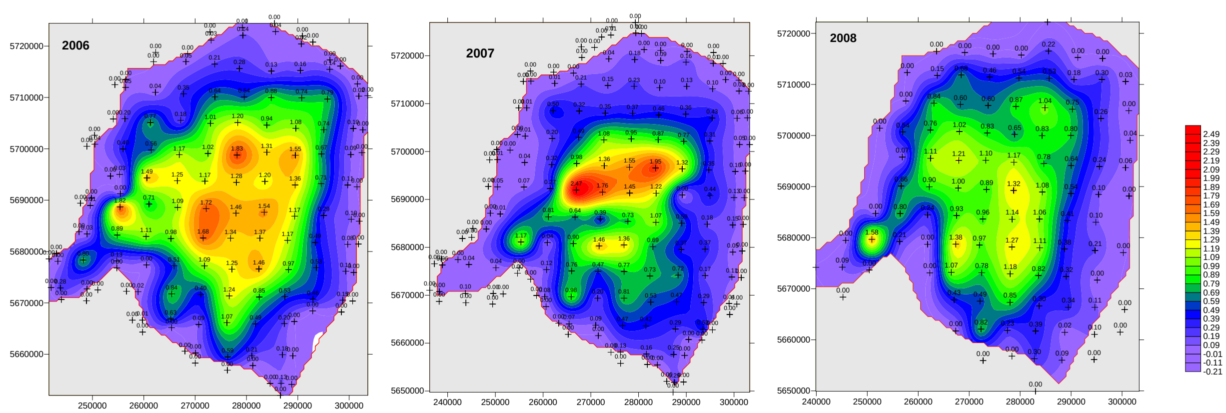


Figure 24. Contour plots of the krigged density estimates for the Celtic Sea FU20–22 by year from 2006–2008.

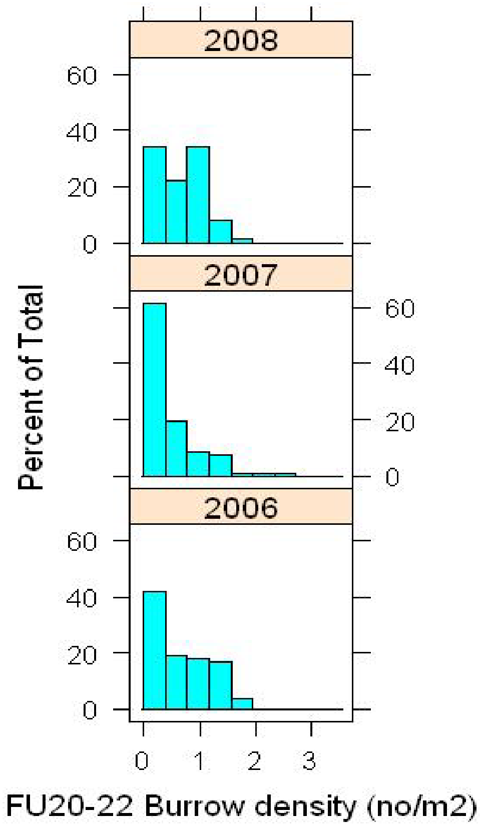


Figure 25. Burrow density distributions for the Celtic Sea FU20–22 by year from 2006–2008.

Table 10. Summary geostatistics for the *Nephrops* UWTV surveys of the Celtic Sea from 2006–2008.

Ground	Year	Number of stations	Number of boundary points	Mean Density (No./M2)	Standard Deviation	CVgeo (%)	Var	Domain Area (m2)	Raised abundance estimate (million burrows)
Smalls	2006	100	50	0.62	0.50	80%	0.25	2847	1914
Smalls	2007	107	63	0.46	0.44	96%	0.19	2915	1402
Smalls	2008	76	31	0.47	0.40	85%	0.16	2698	1448

Table 11. Summary statistics for the Nephrops UWTV survey indicator stations of the Labadie and Nymphe Bank and Seven Heads Grounds from 2006–2008.

Ground	Year	Number of stations	Mean Density (No./M2)*	Area Surveyed (M2)	Burrow count	Standard Deviation	95%CI	CV
	2006	9	0.42	1,322	760	0.37	0.28	29%
	2007	-	-	-	-	-	-	-
Labadie Bank	2008	-	-	-	-	-	-	-
	2006	2	0.27	195	89	0.39	3.47	100%
	2007	-	-	-	-	-	-	-
Nymphe Bank	2008	-	-	-	-	-	-	-
	2006	7	0.23	995	293	0.25	0.23	41%
	2007	-	-	-	-	-	-	-
Seven Heads	2008	-	-	-	-	-	-	-

*random stratified estimates are given for the Labadie Bank, Nymphe Bank and Seven Heads grou

- Area not surveyed in 2007 to 2008 due to weather

Table 7.7.3. ***Nephrops*** **in VIIfgh. Length distribution of landings by country in 2002. Quarterly and total values (10^3). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.**

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
17											1			1	
18											1			1	
19			4			5					2	24		2	33
20			13			6					3	126		3	145
21			37			4					5	172		5	213
22		1	72			17					7	564		8	653
23		1	124		1	85			6		12	1124		13	1340
24		2	236		1	136			67	81	78	1804	81	81	2243
25		3	421		2	216			75		30	1533		35	2245
26		5	538		4	245		1	182		47	1495		57	2459
27		10	778		7	326		2	202		75	1110		94	2417
28		17	760	83	71	577		5	607		120	1516	83	213	3459
29	21	48	639		22	776		11	470		289	1220	21	369	3104
30	41	88	510		39	741		23	1125	242	613	1107	283	763	3483
31	47	339	589		70	1075		51	1685	242	667	1284	289	1125	4632
32	132	399	565		125	1199		110	1558	242	626	1002	375	1260	4325
33	140	433	453	83	283	1624	37	266	1551	404	694	995	664	1676	4624
34	236	511	419	122	801	1654	165	791	1455	404	718	753	927	2822	4281
35	366	612	326	540	1436	1654	401	1427	1152	678	857	782	1985	4332	3913
36	503	693	256	995	2001	1376	1125	1745	599	601	777	512	3223	5217	2742
37	648	767	221	1541	2247	1361	706	1359	711	823	914	412	3718	5288	2705
38	797	832	198	1603	2131	1156	1603	1761	580	1146	1096	526	5150	5821	2460
39	847	827	198	2230	2404	820	1463	1504	341	824	849	270	5364	5584	1628
40	1078	963	116	2901	2690	907	1466	1320	313	1618	1388	270	7063	6361	1606
41	817	730	47	2757	2381	380	1028	896	249	1377	1156	171	5978	5163	847
42	1114	926	140	2365	1929	322	1186	958	207	669	578	156	5334	4391	825
43	509	434	12	2070	1598	249	781	629	129	836	671	85	4196	3332	474
44	604	493	47	1003	794	234	1076	837	129	771	625	28	3454	2749	438
45	352	288	23	1157	882	132	605	476	74	612	527	71	2727	2174	300
46	144	122		467	371	132	893	692	37	306	281	14	1811	1466	183
47	179	150		345	302	15	470	371	97	247	238	14	1241	1061	126
48	78	68	23	472	390	102	422	331	55	175	161	14	1147	949	195
49	87	74	12	133	124	59	202	164	37	55	59	14	477	420	121
50	73	62		242	207	15	158	129		87	91	14	560	490	29
51	48	41		166	142		126	106	18	95	83		435	371	18
52	32	29		72	73		120	100	18	94	74		318	276	18

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
53	30	28		76	77		45	43		24	25		175	172	
54	31	29		57	57		65	54	18	23	24		176	165	18
55	24	24		53	53		99	80	18	17	17		192	175	18
56	18	18		40	41		19	18		8	9		85	85	
57	11	11		42	42		9	9	18	15	15		77	78	18
58	11	11		23	23		8	8	18				42	42	18
59	10	10		12	12		2	2		1	1		25	26	
60	12	13		14	14		7	6	18	1	1		34	34	18
61	3	3		18	18		7	7		1	1		28	28	
62	4	4		20	21		1	1		1	1		26	26	
63	2	2					1	1		8	8		11	11	
64	2	2								1	1		2	2	
65	2	2					1	1					3	3	
66															
67															
68	1	1					1	1					2	2	
69															
70															
71															
72															
73															
74															
75															
Total	9056	10126	7774	21703	23884	17600	14293	16297	13821	12732	14516	19184	57783	64823	58378

- The French data are presented in two ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (simulation of hand-sorting s-shaped curve vs. CL: see Stock Annex).

- The Irish data reported from the whole MA M (See Stock Annex).

Table 7.7.4. ***Nephrops*** **in VIIfgh. Length distribution of landings by country in 2003. Quarterly and total values (10^3). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.**

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
17															
18						2									2
19						10									10
20			124			26			71			49			270
21			556			72			271		1	172		1	1071
22			567			169			399		1	198		1	1333
23			1452			319			596		1	211		2	2578
24			446		1	848		1	608		2	239		4	2141
25			150		1	1110		1	737		3	477		6	2474
26			2334		3	1836		3	1072		5	586		11	5827
27			321		5	1894		6	1644		8	514		19	4372
28		1	1675		9	1967		12	2065		13	948		35	6654
29		1	450		16	1895		25	2331		20	901		63	5578
30		2	372		29	1744		52	2545		31	445		115	5106
31	25	23	831		54	1682		107	1906	25	66	828	50	250	5247
32		7	1002	47	133	1796	211	370	1810	99	257	1307	357	767	5915
33		13	548	47	215	2035		1152	1360	99	273	437	146	1653	4380
34		24	428	328	1228	1565	739	2297	1374	124	427	477	1191	3975	3845
35	77	188	238	516	1412	1293	1689	3101	868	496	756	240	2778	5457	2639
36	75	310	190	563	1534	856	1901	2690	510	545	812	254	3083	5345	1809
37	298	494	190	1220	1892	639	1478	2008	378	595	776	233	3591	5169	1441
38	323	533	285	1313	1794	492	2649	2548	391	694	774	206	4979	5649	1374
39	497	666	95	1360	1691	359	2745	2356	434	694	703	137	5297	5415	1026
40	828	915		2224	2200	158	1496	1296	179	620	616	158	5168	5027	495
41	1024	1022	48	2499	2268	257	2217	1691	219	942	790	69	6683	5771	592
42	1044	978	95	2385	2054	197	1409	1078	223	697	593	34	5535	4703	549
43	1096	959	48	2478	2024	228	1224	925	112	737	582	27	5535	4490	415
44	761	660		1734	1410	80	1472	1100	96	501	401	27	4467	3570	203
45	751	627		1532	1242	70	1229	974	20	459	364	21	3971	3206	110
46	462	389	48	1692	1365	50	1193	931	20	312	270	14	3659	2954	131
47	298	267		1008	858	20	391	336	120	243	218	27	1941	1679	167
48	308	274		674	588	10	313	286	60	204	181		1498	1329	70
49	243	224		392	379	30	180	183	40	142	133	7	958	919	77
50	99	105		313	295	20	108	110	20	156	154		676	663	40
51	79	83		212	219	20	81	82	40	78	81		450	465	60

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
52	42	44		119	123	10	90	91		57	59	14	308	317	24
53	25	26		93	96		54	55		27	28		199	204	
54	12	13		86	89		18	18		9	9		126	129	
55	25	26		40	41		9	9		21	21		94	97	
56	10	10		33	34		36	36		3	3		82	84	
57	10	10		27	27	10	36	36		3	3		75	77	10
58	5	5		20	20								25	26	
59	2	3		13	14		9	9					25	25	
60															
61				7	7								7	7	
62	5	5											5	5	
63															
64															
65															
66															
67															
68															
69															
70															
71															
72															
73															
74															
75															
Total	8424	8907	12492	22977	25366	23767	22978	25977	22516	8581	9438	9258	62959	69688	68034

The French data are presented in two ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (simulation of hand-sorting s-shaped curve vs. CL: see Stock Annex).

Table 7.7.5. ***Nephrops*** **in VIIfgh. Length distribution of landings by country in 2004. Quarterly and total values (10[3]). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.**

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
17												1			1
18			3									2			6
19			16									4		1	20
20			30			1			1			8		1	40
21			46			11		1	1			19		2	77
22		1	69			8		2			1	57		3	134
23		1	108			25		3	4		1	107		6	245
24		2	161		1	100		6	13		2	207		11	480
25		4	213		1	189		12	37		3	368		19	807
26		6	298		2	446		22	107		4	565		35	1416
27		11	390		3	578		42	286		7	799		64	2053
28		19	443		6	705		80	699		12	1091		117	2938
29		34	538		10	1013		152	1126		20	1360		215	4037
30		59	681		16	1402		290	1652		32	1521		397	5255
31		102	737		27	1965	73	880	1798		53	1563	73	1063	6063
32	80	402	783	64	88	2493	254	1227	1606		88	1542	398	1805	6424
33	321	669	800	64	119	2870	363	1114	1403		145	1386	748	2047	6459
34	351	797	746		350	3038	327	983	1336	161	312	1144	838	2442	6264
35	728	978	634	191	592	2299	689	1193	988	183	589	908	1792	3352	4829
36	618	823	553	318	1177	1906	1161	1336	708	688	1078	738	2785	4414	3905
37	763	825	444	1080	1723	1702	871	978	449	1009	1224	544	3723	4749	3138
38	827	786	373	1080	1745	1302	1161	999	353	596	817	397	3664	4346	2426
39	537	514	298	1652	1741	799	798	674	224	688	700	297	3675	3628	1618
40	695	584	216	826	1027	499	980	747	134	573	558	223	3074	2916	1072
41	486	412	150	1525	1348	448	1161	841	135	573	508	162	3745	3109	894
42	612	487	105	1789	1421	249	762	547	82	688	543	118	3852	2998	554
43	516	409	68	837	699	162	726	509	57	575	437	79	2653	2054	366
44	461	369	41	1218	895	74	635	449	59	392	296	59	2706	2009	234
45	470	366	31	1092	831	50	527	370	30	482	345	46	2571	1912	156
46	129	119	21	827	603		142	111	22	432	298	29	1530	1130	72
47	309	249	16	457	370	50	408	310	24	90	75	17	1264	1004	107
48	178	166	11	661	570	25	278	225	11	182	136	14	1299	1099	61
49	178	166	9	352	320	25	282	229	11	123	102	6	935	816	51
50	125	120	5	395	361		149	155	5	69	63	4	739	698	14
51	149	143	4	193	198		145	151	3	54	56	3	541	548	10

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
52	117	118	2	215	219		126	131	3	58	60	3	516	528	7
53	81	81	2	204	208		114	106	8	81	83	2	479	478	12
54	60	60	2	129	131		37	39	3	61	63	2	287	293	6
55	60	60		64	66		37	39	3	48	49	3	209	214	6
56	36	37		54	55		37	39		36	37	3	164	167	3
57	26	26		54	55		37	39	16	17	18	3	134	137	19
58	18	18		11	11		26	27		12	12	3	66	68	3
59	3	3		32	33		4	4	5	10	10	3	48	49	8
60	3	3					15	15		6	6	1	23	24	1
61							15	15		2	2	1	17	17	1
62							11	12					11	12	
63							4	4					4	4	
64															
65										2	2		2	2	
66									3						3
67												1			1
68										2	2	1	2	2	1
69									3						3
70												1			1
71												1			1
72									3						3
73															
74															
75															
Total	8938	10029	9048	15381	17020	24434	12354	15106	13409	7892	8850	15412	44565	51005	62303

- The French data are presented in two ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (simulation of hand-sorting s-shaped curve vs. CL: see Stock Annex).

- The missing Irish data of the 1st and 4th quarters were calculated by likelihood function as explained (Stock Annex).

Table 7.7.6. *Nephrops* in VIIfgh. Length distribution of landings by country in 2005. Quarterly and total values (10^3). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
17															
18															
19														1	
20						17			12		1	73		1	102
21						74			29		1	355		2	459
22						92			46		1	415		2	553
23		1				271			110	1	3	783	1	4	1164
24		1	101		1	791			272		3	1565		5	2730
25		2	202		1	1833			381		5	1897		9	4313
26		4	378		2	2656		1	596	8	13	3003	8	20	6634
27	9	14	1088		3	4305		2	781	1	14	2380	10	33	8554
28		12	949		6	5367		3	849	2	24	1749	2	45	8913
29		21	1059		10	6785		6	816	1	35	1270	1	73	9930
30	9	42	1403		19	7049		13	945	4	63	1021	13	136	10418
31		61	2076		33	7768		25	974	21	109	998	21	228	11816
32	70	156	1655		60	7758	8	54	926	70	239	628	148	509	10966
33	44	355	1059	10	114	5684	18	108	788	162	468	423	233	1045	7954
34	131	506	1655		194	4222	58	593	615	471	826	624	660	2119	7116
35	289	734	1312	69	698	3430	196	804	609	769	1131	246	1323	3366	5597
36	464	845	933	223	1210	2467	297	931	412	1076	1309	323	2060	4294	4134
37	525	799	851	429	1394	1308	515	941	444	1188	1273	123	2656	4408	2726
38	578	762	936	483	1306	1356	558	859	261	1109	1076	191	2728	4004	2745
39	814	839	760	598	1132	862	761	832	245	934	830	177	3106	3634	2045
40	658	657	631	615	936	421	696	662	135	731	611	68	2700	2867	1255
41	735	654	296	617	788	378	545	475	94	589	460	40	2487	2377	809
42	780	646	166	744	725	233	493	392	62	415	323	27	2432	2087	488
43	570	465	268	588	545	64	412	312	34	450	324	13	2021	1647	380
44	613	480	166	598	491	40	276	214	24	288	216		1775	1401	230
45	547	423		746	554	17	247	193	8	271	201	13	1812	1371	38
46	520	406	129	701	502	47	161	135	25	182	141		1563	1183	201
47	400	314		752	520	17	199	164	3	135	111		1486	1109	19
48	258	219		757	516		158	136	11	75	67		1248	938	11
49	271	239		677	465		177	135		49	48		1174	886	
50	241	220		698	491	23	302	226	1	34	35		1275	973	24
51	263	240		476	351		271	203		40	42		1051	835	

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
52	179	171		349	278		215	165		21	22		764	636	
53	153	139		332	263		198	144		23	24		707	570	
54	101	101		241	194		181	133	1	20	20		543	448	1
55	89	88		193	167		205	149		16	16		502	421	
56	50	51		132	114		85	64		9	9		276	238	
57	58	56		140	106		73	56		9	9		280	228	
58	33	33		64	53		68	50		4	5		169	141	
59	31	32		48	41		48	35		5	5		133	113	
60	15	15		8	8		13	14		4	4		39	41	
61	15	15		9	9		18	13		1	1		43	39	
62	3	3		5	5		4	7					11	15	
63	3	3		3	3		10	8		1	1		17	15	
64							1	2					1	2	
65				2	2		1	2					2	3	
66				2	2		1	2					3	4	
67							1	2					1	2	
68							1	2					1	2	
69															
70							1	2					1	2	
71															
72							1	1					1	1	
73								1						1	
74								1						1	
75							1	3					1	3	
Total	9519	10828	18072	11307	14310	65334	7474	9276	10511	9190	10123	18409	37491	44537	112326

The French data are presented in two ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (simulation of hand-sorting s-shaped curve vs. CL: see Stock Annex).

Table 7.7.7. ***Nephrops*** **in VIIfgh. Length distribution of landings by country in 2006. Quarterly and total values (10³). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.**

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
17															
18									4						4
19						7			8						15
20			80			21			11			123			235
21			93			57			12			335		1	497
22			266			195		1	70		1	582		1	1113
23			559			488		1	123		1	1141		3	2312
24			1543		1	852		2	429		2	1705		5	4529
25		1	2000		1	1501		4	692		3	2210		8	6403
26		1	2946		2	3065		8	1333		5	2705		15	10050
27		2	3263		3	4601		15	1722		8	2869		28	12454
28		4	3245		6	5701	10	35	2049	6	17	2354	15	62	13349
29		7	2825		12	6459		58	1689		22	1442		99	12415
30		14	1951	13	30	6443	10	119	1437	11	43	1119	34	205	10950
31		25	1740		41	4632	20	234	1012		60	731	20	359	8115
32	18	58	990	26	91	4577	68	715	706	34	109	577	146	972	6849
33	53	319	673	13	148	3302	78	904	647	85	291	431	229	1662	5053
34	152	524	398	208	840	2438	205	907	573	312	538	346	877	2809	3755
35	286	676	412	312	1404	1679	254	982	269	431	729	332	1283	3791	2693
36	397	783	178	845	2036	1190	488	1055	274	738	915	265	2468	4789	1907
37	642	880	123	1430	2520	826	714	1160	144	772	880	248	3558	5440	1343
38	648	808	96	1963	2519	518	1143	1235	110	755	752	173	4509	5314	897
39	788	799	82	1769	2052	355	1133	1025	92	590	560	140	4281	4435	668
40	735	680	14	2015	1839	276	918	745	19	568	483	96	4237	3747	405
41	636	552	14	1755	1449	261	1026	709	51	540	420	67	3957	3130	393
42	722	577		1496	1121	126	791	525	11	319	250	52	3329	2474	189
43	674	518	14	1257	879	98	815	507	7	315	227	32	3061	2131	151
44	486	370		965	652	85	519	322	11	211	151	38	2181	1495	133
45	429	321		897	585	56	335	208	7	119	89	17	1781	1202	80
46	346	262		696	462	14	468	284	4	119	85	14	1629	1093	32
47	297	231	27	529	365	28	287	183		86	65	14	1198	844	69
48	262	209		465	333	7	138	107		48	38	12	913	687	19
49	168	145		248	203	14	138	98		66	51	3	619	497	17
50	87	84		216	185		117	89		23	22	6	443	381	6
51	71	72		100	98		115	92		27	25		313	286	

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
52	68	68		156	127	14	70	63		19	18		313	276	14
53	62	64		114	101		46	52		10	11		231	228	
54	42	44		72	69		42	39		9	10		166	161	
55	34	35		63	59		27	28		10	10		134	133	
56	33	35		39	41		23	24		8	9		105	108	
57	29	30		38	39		13	14		5	5		85	87	
58	17	18		38	39		12	12		5	5		71	74	
59	11	11	14	26	27		8	9		3	4		49	50	14
60	7	7		15	15		12	12		2	2		36	37	
61	4	4		10	11		6	6		1	1		21	22	
62	3	3		3	3		4	4		1	1		10	11	
63	1	1					1	1		1	1		3	3	
64	2	2		2	2		2	2					7	7	
65				1	1		1	1					2	2	
66															
67															
68															
69		1												1	
70															
71															
72															
73															
74															
75															
Total	8209	9244	23545	17796	20408	49887	10060	12597	13515	6249	6918	20179	42315	49167	107126

The French data are presented in two ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (simulation of hand-sorting s-shaped curve vs. CL: see Stock Annex).

Table 7.7.8. ***Nephrops*** **in VIIfgh. Length distribution of landings by country in 2007. Quarterly and total values (10^3). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.**

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
17															
18															
19						29									29
20			105			148			10			204			468
21			211			354			36						601
22			495			1048			167			650		1	2360
23			916		1	2897			539			3669		1	8021
24			2757		1	3975			1307		1	5096		2	13135
25		1	4218		2	5684			2576		1	5667		4	18144
26		2	5320		4	8822			2946		2	5620		7	22708
27		3	6276	21	18	9507		1	3386		3	3055	21	25	22225
28		6	5458	21	25	11331		2	4067		5	3630	22	37	24486
29		10	4525		25	11794		5	4174	5	10	3528	5	50	24021
30	5	21	1767	42	69	10040		10	3040		13	4662	47	113	19509
31	5	36	916		87	6477		22	2013	5	25	3376	10	170	12783
32	15	72	357	64	195	4084	22	60	1192	25	51	3386	125	378	9018
33	81	373	105	127	861	2757	54	504	1007	45	248	2526	307	1986	6395
34	161	490		255	1541	1430	194	917	383	121	407	2196	731	3354	4009
35	218	538	105	806	2141	1118	517	1286	288	226	544	1797	1768	4509	3309
36	328	563		1125	2539	707	862	1543	168	301	640	1697	2616	5286	2573
37	385	581		1804	2644	441	1412	1562	69	453	738	1248	4053	5525	1757
38	603	648		1973	2313	352	1121	1111	49	592	811	1073	4290	4883	1474
39	522	520		1783	1860	293	1013	812	32	744	801	823	4063	3993	1148
40	461	407		2295	1768	322	884	624	39	597	630	548	4238	3429	909
41	410	331		1490	1134	233	766	492	27	646	556	678	3312	2513	938
42	363	277		1429	946	72	540	332		515	413	374	2848	1967	447
43	334	245		1399	854	116	423	250	16	353	272	349	2510	1620	481
44	317	226		866	539	87	267	159	6	335	232	50	1784	1156	143
45	233	167		973	575	73	278	167		293	198	75	1777	1107	148
46	264	184		569	370	57	196	122	6	253	168	75	1282	844	138
47	116	88		328	242	14	98	72		205	135	50	747	537	64
48	136	100		391	281		72	60		176	115	50	774	555	50
49	91	71		158	147	14	46	44		126	89	75	421	350	89
50	68	56		160	125		38	35		86	60		352	275	
51	44	40		73	77		35	32		44	32		196	181	

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
52	34	31		70	62		19	20		20	19		142	132	
53	22	21		39	41		11	12		25	19	24	98	93	24
54	18	17		21	22		9	9		27	19		76	67	
55	19	18		17	18		8	8		6	6		50	50	
56	9	9		18	19		5	5		19	12		51	46	
57	7	7		7	7		2	2		8	6		24	22	
58	11	10		6	6	14	2	2		2	2		21	20	14
59	4	4		5	5					1	1		10	10	
60	5	5		6	6		1	1		2	2		13	13	
61	2	2		5	5		1	1		1	1		8	9	
62	2	2		3	4		1	1					7	7	
63	1	1		2	2								3	4	
64				1	1								2	2	
65													1	1	
66															
67															
68															
69															
70															
71															
72															
73															
74															
75															
Total	5296	6180	33532	18354	21584	84288	8897	10287	27541	6256	7289	56252	38803	45339	201614

The French data are presented in two ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (simulation of hand-sorting s-shaped curve vs. CL: see Stock Annex).

Table 7.7.9. *Nephrops* in VIIfgh. Length distribution of landings by country in 2008. Quarterly and total values (10^3). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
17															
18															
19															
20															
21						28									28
22						296									296
23						651			69			539			1258
24						1475			410			1736			3621
25			18			2557			913			3494			6981
26			958		27	4475		22	1136			5829		49	12397
27			1011		82	5408		22	1782			1578		104	9779
28		26	3759		218	6541		89	1582		10	2856		343	14738
29	6	4	3033		463	6436	10	72	2256	6	43	1777	22	582	13502
30	6	162	3336	12	742	7257		245	2116		108	1878	18	1256	14588
31	19	275	980	13	1042	7312		467	2969	18	167	1419	50	1951	12680
32	38	497	1087	61	1774	6648	20	989	3241	55	307	1460	174	3567	12436
33	89	752	1319	280	1527	4916	30	1372	3063	146	488	1520	544	4140	10817
34	247	1058	1123	536	1789	4829	181	1629	2363	273	721	1698	1236	5198	10013
35	438	977	1462	925	1818	4573	441	1720	1221	450	817	1939	2253	5332	9194
36	554	1167	1123	1448	1993	3000	941	2116	1383	753	979	1219	3697	6254	6725
37	668	920	677	1692	1596	2042	1422	1589	718	863	897	900	4645	5001	4337
38	647	751	659	1814	1383	1224	1682	1525	666	1087	1032	999	5231	4690	3548
39	669	567	356	1583	1242	915	2063	1434	244	844	828	780	5159	4071	2294
40	597	444	339	1558	1148	562	1462	965	213	911	750	600	4528	3306	1713
41	654	465	267	1418	946	378	1382	856	282	772	619	679	4226	2886	1606
42	560	383	178	1027	671	393	1052	595	182	744	566	439	3383	2215	1192
43	576	367	89	1044	607	267	703	368	91	521	378	280	2845	1720	726
44	511	316	89	812	471	321	782	414		374	291	60	2480	1493	470
45	598	371	53	568	342	84	455	245		255	233	160	1876	1190	297
46	345	225		405	259	84	277	180		198	171	40	1225	835	123
47	290	206		219	151		184	112		118	123	40	812	593	40
48	209	144		201	173	41	105	76		84	62	40	600	456	81
49	102	74		128	97	167	100	76		65	50	40	395	298	207
50	117	84		93	81	125	55	45		44	36	40	308	247	165
51	49	39		56	56	41	74	60		50	37	20	229	192	61

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
52	28	25		47	40	41	30	30		17	14		120	109	41
53	36	29		28	28		23	23		14	12		102	92	
54	11	11		21	21		16	16		6	16		55	65	
55	13	11		17	17		12	12		3	3		46	43	
56	8	8		12	12		7	7		1	1		28	28	
57	12	10		7	7		5	5		2	2		27	24	
58	14	12		4	4		1	1		1	1		20	17	
59	4	4		3	3		1	1					8	8	
60	1	1		3	3		1	1					4	4	
61				1	1								2	2	
62				1	1								1	1	
63				1	1								1	1	
64															
65															
66															
67															
68															
69															
70															
71															
72															
73															
74															
75															
Total	8117	10387	21914	16039	20836	73086	13516	17380	26900	8676	9763	34056	46348	58365	155956

The French data are presented in two ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (as performed since WGCSE 2009).

Table 7.7.10. *Nephrops* in VIIfgh. Length distribution of landings by country in 2009. Quarterly and total values (10^3). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
17															
18															
19															
20			116						11						127
21			167												167
22			399			35			31			102			566
23			1017			217			103			306			1643
24			2582			505			364			756			4207
25			3963			1284			879			1279			7405
26			6524			1969			1536			1495			11525
27			5825			3351			2396		4	759		4	12331
28			4684			3619		14	2953		21	489		35	11744
29			5095		107	3889		14	2804		30	831		151	12619
30		15	3619		253	3852		153	2735		68	658		490	10865
31		169	2509		587	3759		334	1813	5	161	549	5	1251	8630
32	12	238	2044		773	3074	10	646	2361	9	151	754	31	1808	8234
33	35	315	1671	32	898	2872	42	746	1716	23	292	472	132	2251	6731
34	127	606	1799	204	1370	2222	10	715	1273	92	367	400	434	3058	5694
35	197	697	1285	486	1453	2003	251	998	1117	129	479	242	1063	3627	4647
36	486	1008	1003	675	1762	1839	429	1024	774	268	433	417	1859	4228	4032
37	683	1013	1119	1160	1827	1433	639	1039	603	346	454	242	2828	4334	3397
38	857	1065	1054	1707	1821	1369	911	977	502	420	443	181	3895	4305	3106
39	1089	1093	694	1878	1732	1339	921	788	380	526	446	157	4414	4059	2569
40	1044	925	411	1832	1533	808	1141	906	209	466	398	199	4482	3761	1627
41	950	802	823	1963	1371	724	997	649	236	411	331	48	4322	3153	1831
42	927	695	308	1568	1075	420	840	481	113	491	340	24	3826	2592	864
43	744	531	334	1432	959	288	845	528	175	346	246		3367	2264	797
44	715	564	154	1201	748	231	658	427	84	315	217	48	2888	1957	517
45	503	341	102	687	447	89	304	201	25	173	140	24	1667	1129	240
46	495	380	77	409	302	160	334	222	44	192	135	12	1430	1039	293
47	280	207	77	445	331	29	193	162	8	118	95	24	1035	796	137
48	238	200	102	146	126	43	135	106		62	51	24	581	483	169
49	144	120		174	154	29	138	108		67	52	12	523	434	40
50	79	75		100	87	43	112	78	8	30	28		320	267	51
51	37	53		96	89	29	37	33		20	20		191	194	29

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
52	33	33		51	51	57	22	22	11	10	10		115	115	68
53	18	18		37	37	43	16	16		9	9		80	80	43
54	10	10		24	24	171	12	12		5	9		50	55	171
55	10	10		34	28	86	5	5		2	2		51	45	86
56	6	6		9	9	171	3	3		1	1		20	20	171
57	1	1		8	8	57	1	1		1	1		11	11	57
58	1	1		1	1	86	1	1		1	1		4	4	86
59	1	1		1	1	57				1	1		3	3	57
60	3	3		1	1	86							4	4	86
61				1	1	71				1	1		2	2	71
62						43									43
63						29									29
64						57									57
65						14									14
66															
67															
68						14									14
69						14									14
70						14									14
71															
72															
73															
74															
75															
Total	9725	11195	49557	16360	19967	42590	9010	11410	25263	4538	5438	10505	39633	48010	127915

The French data are presented in two ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (as performed since WGCSE 2009).

Table 7.7.11. ***Nephrops*** **in VIIfgh. Length distribution of landings by country in 2010. Quarterly and total values (10^3). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.**

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
17															
18															
19															
20															
21						43			34			92			169
22			181			97			59			228			564
23			699			301			207			319			1526
24			1032			691			481			360			2564
25			3177			1381			949			839			6346
26			5951		17	2344			1623		7	1128		24	11047
27		13	7952		17	3558		4	2014		2	1663		36	15188
28		9	5362		41	5352		8	1984		11	2048		69	14745
29		13	5254		70	6136		8	2736		45	1811		136	15938
30		28	3887		169	6558		76	2385		77	2570		350	15399
31		57	2667		256	6066		136	1915	2	141	1706	2	590	12355
32		94	2222		484	5360		236	1706	8	149	1586	8	962	10875
33		129	1968	6	522	4262		296	1337	25	162	1036	31	1109	8603
34	6	243	2079	18	430	3673	20	292	737	49	200	844	93	1165	7333
35	40	224	1151	121	606	2834	66	439	467	94	164	409	322	1432	4861
36	91	313	1559	200	610	2306	158	462	323	113	172	316	562	1557	4504
37	233	363	1596	400	545	1853	286	470	247	139	146	82	1058	1524	3778
38	335	447	1518	388	509	1375	449	460	99	168	145	122	1340	1561	3115
39	460	442	928	509	515	941	541	551	88	164	127	122	1674	1635	2079
40	443	412	705	588	484	627	557	508	24	219	169	20	1807	1573	1375
41	460	388	482	485	373	420	587	443	7	185	159	20	1717	1362	929
42	552	450	593	661	422	698	450	337	20	159	118	41	1822	1328	1352
43	473	351	441	548	340	331	508	384	7	167	105	20	1695	1180	800
44	518	385	441	548	378	224	503	343		132	101		1701	1208	665
45	326	257	441	357	248	89	391	256		127	101		1201	863	530
46	268	234	148	237	179	107	228	181		118	86		851	680	255
47	216	203	74	259	179	79	136	104		92	73		703	559	152
48	130	132	111	252	185	54	138	123		46	44		567	483	164
49	107	108	111	196	151	35	117	98		55	53		474	409	146
50	58	65		119	95	35	56	60		28	28		261	248	35
51	59	60		101	76	79	44	40		20	24		224	200	79

CL	Q1			Q2			Q3			Q4			Year		
(mm)	F		IRL	F		IRL	F		IRL	F		IRL	F		IRL
	no tails	tails		no tails	tails		no tails	tails		no tails	tails		no tails	tails	
52	30	30	74	34	34	35	24	28		13	17		100	109	109
53	17	17		29	29		19	23		10	10		76	80	
54	14	14		23	23		12	12		5	5		54	54	
55	10	10		16	22	17	8	8		3	3		37	43	17
56	3	3	36	5	5	17	3	3		3	3		14	14	53
57	4	4		4	4		1	1					9	9	
58				3	3		1	1					3	3	
59	1	1		1	1								2	2	
60															
61				2	2								2	2	
62															
63				2	2								2	2	
64				1	1								1	1	
65				1	1								1	1	
66															
67															
68				1	1								1	1	
69				1	1								1	1	
70				1	1	17							1	1	17
71															
72															
73															
74															
75				1	1								1	1	
Total	4853	5498	52839	6120	8033	57994	5303	6392	19450	2145	2647	17384	18420	22571	147667

The French data are presented in two ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (as performed since WGCSE 2009).

7.8 Stock Annex *Nephrops* VIIjg FU19

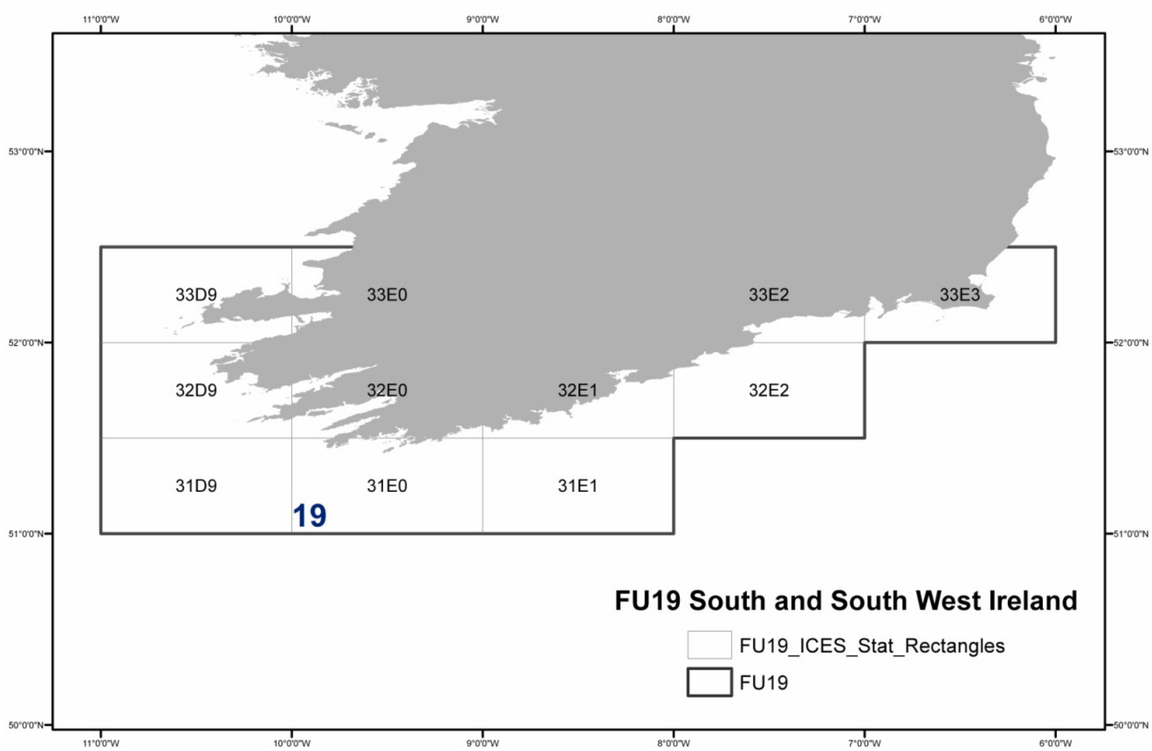
Stock specific documentation of standard assessment procedures used by ICES.

Working Group	WGCSE 2012
Date	Version 1, 21/05/2012.
Revised by	Jennifer Doyle

A. General

A.1. Stock definition

The Functional Unit for assessment includes some parts of the following ICES Divisions VIIb,j,g. The exact stock area is shown on the map below includes the following ICES Statistical rectangles:31–33D9–E0;31E1;32E1–E2;33E2–E3.



A.2. Fishery

Ireland

In recent years the *Nephrops* stock in FU19 are almost exclusively exploited by Irish vessels. Figure A.2.1 shows the spatial distribution of landings and lpue for Irish otter trawl vessels in 2005 using logbook and VMS data linked together to give finer spatial resolution (Gerritsen and Lordan 2011). Closer analysis of these data shows the many discrete patches of *Nephrops* grounds within FU19 (Figure A.2.2).

The number of Irish vessels reporting Nephrops landings from FU 19 has fluctuated around 50/yr (Figure A.2.3). Around eleven vessels report landings in excess of 10 t in 2011. These are the main vessels in the fishery accounting for around 40% of the total landings in 2011. The majority of these vessels are less than 18 m. There has been a slight shift to larger vessels over time. There has also been a shift to more powerful vessels over time with the introduction of twin-rigs to the fishery in the early 2000s. Most of the larger boats move freely between the *Nephrops* fisheries in FUs 15, 16, 20-22 and other areas depending on the tides and weather.

The fishery shows no distinctive seasonal pattern with the exception of May. The monthly landings time-series with the average pattern is shown in Figure A.2.4.

The following TCMs are in place for *Nephrops* in VII (excluding VIIa) after EC 850/98: Minimum Landing Sizes (MLS); total length >85 mm, carapace length >25 mm, tail length >46 mm. Mesh Size Restrictions; Vessels targeting *Nephrops* using towed gears having at least 35% by weight of this species on board will require 70 mm diamond mesh plus an 80 mm square mesh panel as a minimum or having at least 30% by weight of *Nephrops* on board will require 80–99 mm diamond mesh.

France

The numbers of French vessels reporting *Nephrops* landings from 19 has shown a decreasing trend. (Table A.2.1). 20 in 2009, 24 in 2008, 31 in 2007, 30 in 2006 and 35 in 2005.

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 (Marine Institute, 2012).

A.3. Ecosystem aspects

Physical oceanography

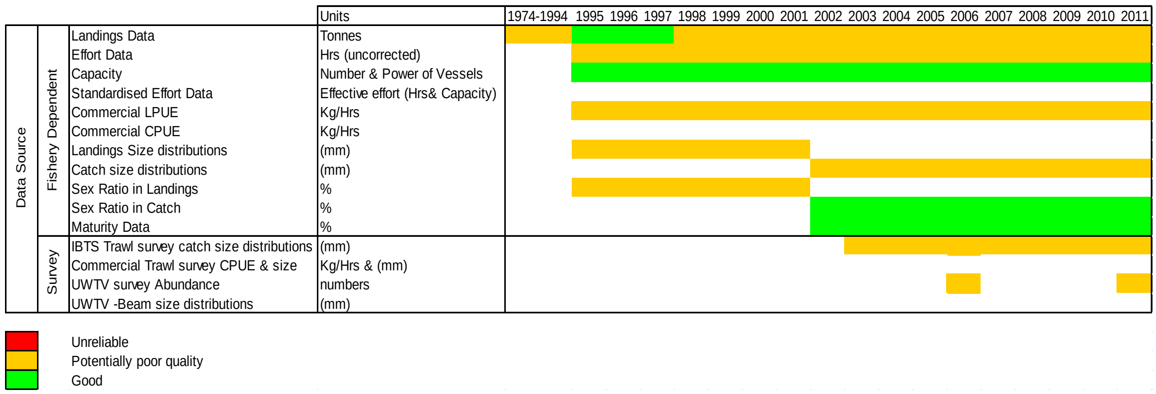
Nephrops occur in discrete patches where the sediment is suitable for them to construct their burrows. There is a larval phase of long duration where there may be some mixing with *Nephrops* from other areas depending on the oceanographic conditions, but the mechanisms for this in FU19 are not currently known.

Sediment distribution

There is a growing body of information on the spatial extent of the sediment suitable for *Nephrops* from UWTV surveys, seabed mapping programmes and the fishing industry. However, this information is patchy and has yet to be summarized for this area. In terms of bathymetry UWTV station depths ranged from 18 metres in Bantry Bay to 104 metres in the Galley Grounds.

B. Data

The table below summarizes the available data for this stock and attempts to quantify the quality subjectively.



B.1. Commercial catch

Commercial catch and effort data are supplied by Ireland. Catch data are also provided by France and the UK.

Since 1988 reported landings data for the Irish fleet were obtained from EU logbooks. The quality of landings data is not well known. The Irish landings have been close to quota for this TAC area since around 1997.

Length–frequency data of the landings were collected on an irregular basis in the years 1996 to 1997, 1999 and 2002 to 2006. Spatial and temporal coverage is also problematic with landings from FU19 coming from several discrete grounds. In 2005 length–frequency data are only available for quarters 2 and 3. The length frequencies for the remaining quarters have been derived by raising those length frequencies observed to the quarter 1 and 4 landings figures.

In 2002 a new catch self-sampling programme was put in place. 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 (Table B.1.1). Sampling effort is stratified monthly but quarterly aggregations are used to derive length distributions and selection ogives. The length–weight regression parameters given in Table B.2.1 are used to calculate sampled weights and appropriate quarterly raising factors. The sampling intensity and coverage has varied over the time-series (Table B.1.1). The quality of the sampling has not yet been qualitatively assessed in terms of precision and accuracy.

Figure B.1.2 shows the mean length from the commercial and survey sampling programme.

Fish and other bycatches in the fishery have been collected by on-board observers since 1994. Discarding by the *Nephrops* trawl fleet is around 47% of the total catch by weight. The main discards are small whole *Nephrops*. The main fish species discarded are dogfish, haddock, whiting and megrim (Anon, 2011).

B.2. Biological

Biological parameters for this stock are outlined in Table B.2.1.These have not been estimated in recent years and are based on those for FU22 "Smalls" component of the Celtic Sea.

Length–weight

Mean weights-at-age for this stock are estimated from studies on Scottish stocks by Pope and Thomas (1955). Given the spatial distribution of the discrete *Nephrops* patches it would be worth monitoring length–weight parameters more closely in future.

Natural mortality

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation. The accuracy of these assumptions is unknown. Stomach contents data on the Irish GFS could be used to examine this in future to determine potential predators.

Maturity

Maturity is assumed in line with other *Nephrops* stocks and is based on FU17 Aran grounds. This needs to be investigated for the discrete patches within FU19.

Discard survival

As for other *Nephrops* stocks given the trip durations (~5 days average) and behaviour of the fleet the majority of discards are returned to the sea over suitable sediment. The proportion scavenged by birds is probably quite low. Tow durations, volume of catches, prolonged sorting on deck and relatively high density of *Nephrops* on the seabed probably results in relatively low discard survival. This is estimated to be around 10% in line with other *Nephrops* stocks.

B.3. Surveys

UWTV surveys

In 2006 as part of the UWTV survey on the Celtic Sea which primary objective is to survey FU22 the "Smalls" grounds-6 indicator stations in FU19 (Galley Ground 4) were completed (Figure B.3.1). In 2011, 35 stations on the discrete patches within FU19 were completed (ICES 2011, WD09). The 2011 UWTV stations in FU19 were randomly picked from within polygons defined using integrated VMS data to determine the extent of the *Nephrops* patches. The discrete grounds have been named as: Bantry Bay, Galley Ground 1–4, Cork Channels and Helvick 1–3 and are shown in Figure B.3.2.

The methods used during the survey were similar to those employed for UWTV surveys of *Nephrops* stocks around Scotland and elsewhere and are documented by WKNEPHTV (ICES, 2007).The estimation of the areas within FU19 were calculated based on polygons using ArcGIS10 (Table B.3.1). The percentage contribution of the area of each of the discrete patches is shown in Table B.3.2 and Galley Ground 4 is the biggest *Nephrops* ground within FU19 (39%).

A number of factors are suspected to contribute bias to UWTV surveys. In order to use the survey abundance estimate as an absolute it is necessary to correct for these potential biases. The bias estimates are based on simulation models, preliminary experimentation and expert opinion. The biases associated with the estimates of *Nephrops* abundance for FU19 are:

FU	Area	Edge effect	detection rate	species identification	Occupancy	Cumulative bias
19	South and Southwest coast	1.25	0.9	1.15	1	1.3

Groundfish surveys

Fishery-independent source of data is also provided by the Irish Groundfish trawl survey which commenced in 2003. These data were used to investigate the mean size (CL mm) and mean size (g) of *Nephrops* in FU19 (Table B.3.3). Figure B.3.3 shows the mean size in the IGFS survey catches where mean size for males is around 33 CL mm and for females around 25 CL mm. However, as gear selectivity between survey and commercial gear is unknown.

B.4. Commercial lpue

The *Nephrops* fisheries in FU19 are opportunistic with increased targeting during periods of high *Nephrops* emergence and good weather.

Effort and lpue data are not standardized, and hence do not take into account vessel capabilities, efficiency, seasonality or other factors that may bias perception of lpue abundance trend over the longer term. The available effort time-series are summarized below:

Country	First year of effort data	Units	Comment
Ireland	2005	Hours	For trips where *Nephrops* constituted 30% of the landings in weight

Only commercial landings data are available for all countries involved in the fishery.

B.5. Other relevant data

C. Historical stock development

An experimental age structured assessment for this stock was carried out by the *Nephrops* WG in 1993 (ICES, 1993), in 2003 (ICES, 2003) and by the WGHMM (ICES, 2005) in all cases the assessments being considered inadequate. This conclusion was based on poor quality, and unexplainable inconsistencies in the input data. Unknown growth rates and concern about the utility of age based assessment models impeded progress to an accepted assessment. In additional the lack of a time-series of reliable standardized cpue data was also perceived as a problem.

Model used: XSA, LCA

Software used: n/r

Model Options chosen: No Final model was accepted

Since then the focus has been on developing a time-series of UWTV survey data as the basis of assessment and advice for this stock (ICES 2009).

The 2009 Benchmark decided on the following procedure:

1) Survey indices are worked up annually resulting in the TV index.
2) Adjust index for bias (see Section B.3). The combined effect of these biases is to be applied to the new survey index.
3) Generate mean weight in landings. Check the time-series of mean landing weights for evidence of a trend in the most recent period. If there is no firm evidence of a recent trend in mean weight use the average of the three most recent years. If, however, there is strong evidence of a recent trend then apply most recent value (don't attempt to extrapolate the trend further in future).

D. Short-term projection

1) The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and F_{MAX}. These values have been estimated by the Benchmark Workshop (see Section 9.2) and are to be revisited by subsequent benchmark groups. The values are FU specific and have been put in the Stock Annexes.
2) Create catch option table on the basis of a range of harvest ratios ranging from 0 to the maximum observed ratio or the ratio equating to F_{MAX}, whichever is the larger. Insert the harvest ratios from step 4 and also the current harvest ratio.
3) Multiply the survey index by the harvest ratios to give the number of total removals.
4) Create a landings number by applying a discard factor. This conversion factor has been estimated by the Benchmark Workshop and is to be revisited at subsequent benchmark groups. The value is FU specific and has been put in the Stock Annex.
5) Produce landings biomass by applying mean weight.

The suggested catch option table format is as follows:

	Implied fishery			
	Harvest rate	Survey Index	Retained number	Landings (tonnes)
	0%	12 345	0	0.00
	2%	"	247	123.45
	4%	"	494	246.90
	6%	"	741	370.35
	8%	"	988	493.80
$F_{0.1}$	8.60%	"	1062	530.84
	10%	"	1235	617.25

	12%	"	1481	740.70
F_{MAX}	13.50%	"	1667	833.29
	14%	"	1728	864.15
	16%	"	1975	987.60
	18%	"	2222	1111.05
	20%	"	2469	1234.50
	22%	"	2716	1357.95
$F_{current}$	21.5%	"	2654	1327.09

G. Biological reference points

The time-series of available length frequencies were insufficient to generate reliable estimates of $F_{0.1}$ and F_{MAX}.

H. Other issues

None.

I. 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. 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 Ref: LRC, PGCCDBS.

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ICES. 2011. Report of the Working Group for Celtic Seas Ecoregion (WGCSE). ICES CM: 2011/ ACOM:12. pp. 1573.

Marine Institute. 2012. Atlas of Irish Groundfish Trawl Surveys. Supporting fish stock assessment and new ecosystem advice, Marine Institute, May 2012. ISBN 978-1-902895-53-6. 61 pp.

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.

Table A.2.1. Numbers of French vessels reporting *Nephrops* landings for the FU19 *Nephrops* Stock by year.

Year	Number of French vessels reporting landings
2005	35
2006	30
2007	31
2008	24
2009	20
2010	12
2011	12

Table B.1.1. Numbers of samples and numbers measured for the FU19 *Nephrops* Stock by year.

Number of Samples				Total numbers of Nephrops measured			
Year	Graded Landings	Catch	Discards	Year	Graded Landings	Catch	Discards
2002		3	2	2002		2,235	1,081
2003	2	12	15	2003	763	3,173	7,234
2004	1	5	4	2004	152	1,278	1,169
2005		6	2	2005		3,221	1,670
2006		8		2006		4,716	
2007	2	13		2007	561	22,170	
2008		18		2008		12,311	
2009		16		2009		7,601	
2010	1	18		2010	331	7,662	
2011		15		2011		7,684	

Table B.2.1. Biological Input Parameters for FU19 *Nephrops* Stock.

Parameter	Value	Source
Discard Survival	10%	WK*NEPH* 2009 assumed in line with other stocks
MALES		
Growth - K	0.17	based on FU20–22
Growth - L(inf)	68	based on FU20–22
Natural mortality - M	0.3	assumed, in line with other stocks
Length/weight - a	0.000322	based on Scottish data (Pope and Thomas, 1955)
Length/weight - b	3.207	"
FEMALES		
Immature Growth		
Growth - K	0.17	based on FU20–22
Growth - L(inf)	68	based on FU20–22
Natural mortality - M	0.3	assumed, in line with other stocks
Size at maturity (L50)	22	ICES, 2006 (Lordan and Gerritsen)
Mature Growth		
Growth - K	0.10	based on FU20–22
Growth - L(inf)	49	based on FU20–22
Natural mortality - M	0.2	assumed, in line with other stocks
Length/weight - a	0.000684	based on Scottish data (Pope and Thomas, 1955)
Length/weight - b	2.963	"

Table B.3.1. Area estimation for the FU19 *Nephrops* grounds based on polygons derived from integrated VMS data (2005–2008).

Area Estimations ArcGIS10 Projections					
FU	Ground	Eckert VI (world) (km²)	Irish National Grid (km²)	Cylindrical Equal Area (km²)	Average (km²)
19	Helvick 1	38.52	38.58	38.58	38.56
19	Helvick 2	31.44	31.48	31.49	31.47
19	Helvick 3	12.65	12.67	12.67	12.66
19	Helvick 1–3	82.61	82.72	82.74	82.69
19	Bantry Bay	90.92	91.08	90.72	90.91
19	Galley Grounds 1	61.81	61.91	61.91	61.88
19	Galley Grounds 2	77.88	77.99	77.99	77.95
19	Galley Grounds 3	202.56	202.85	202.85	202.75
19	Galley Grounds 4	651.79	652.61	652.61	652.33
19	Galley Grounds 1–4	994.04	995.35	995.35	994.91
19	Cork Channels	484.28	484.93	485.02	484.75

Table B.3.2. Area estimation for the FU19 *Nephrops* grounds based on polygons derived from integrated VMS data (2005–2008).

% Area composition of *Nephrops* grounds in FU19		
Ground	Area (km²)	%
Bantry	90.91	5%
Cork Channels	484.75	29%
Galley Grounds 1	61.88	4%
Galley Grounds 2	77.95	5%
Galley Grounds 3	202.75	12%
Galley Grounds 4	652.33	39%
Helvick 1	38.56	2%
Helvick 2	31.47	2%
Helvick 3	12.66	1%
Total	1653.26	

Table B.3.3. Mean size (CL mm) and mean weights (g) from Irish Groundfish Survey (2003–2011) sampling in FU19.

Year	Mean Size in catch (CL mm)	Mean Size >25 mm (CL mm)	Mean Weight in catch (g)	Mean Weight >25 mm (g)	Number of samples	Numbers in samples
2003	31.41	33.16	20.37	24.25	11	1121
2004	25.88	28.17	10.94	14.37	3	562
2005	28.82	30.54	15.46	18.62	5	515
2006	30.28	32.22	18.11	22.09	4	237
2007	32.30	32.30	22.27	22.27	4	91
2008	29.82	30.72	17.25	18.97	15	845
2009	32.31	33.00	22.29	23.85	9	285
2010	28.85	30.27	15.51	18.10	13	1379
2011	29.76	30.71	17.14	18.96	21	4020
Average(2003–2011)	29.94	31.23	17.70	20.16	9	1006

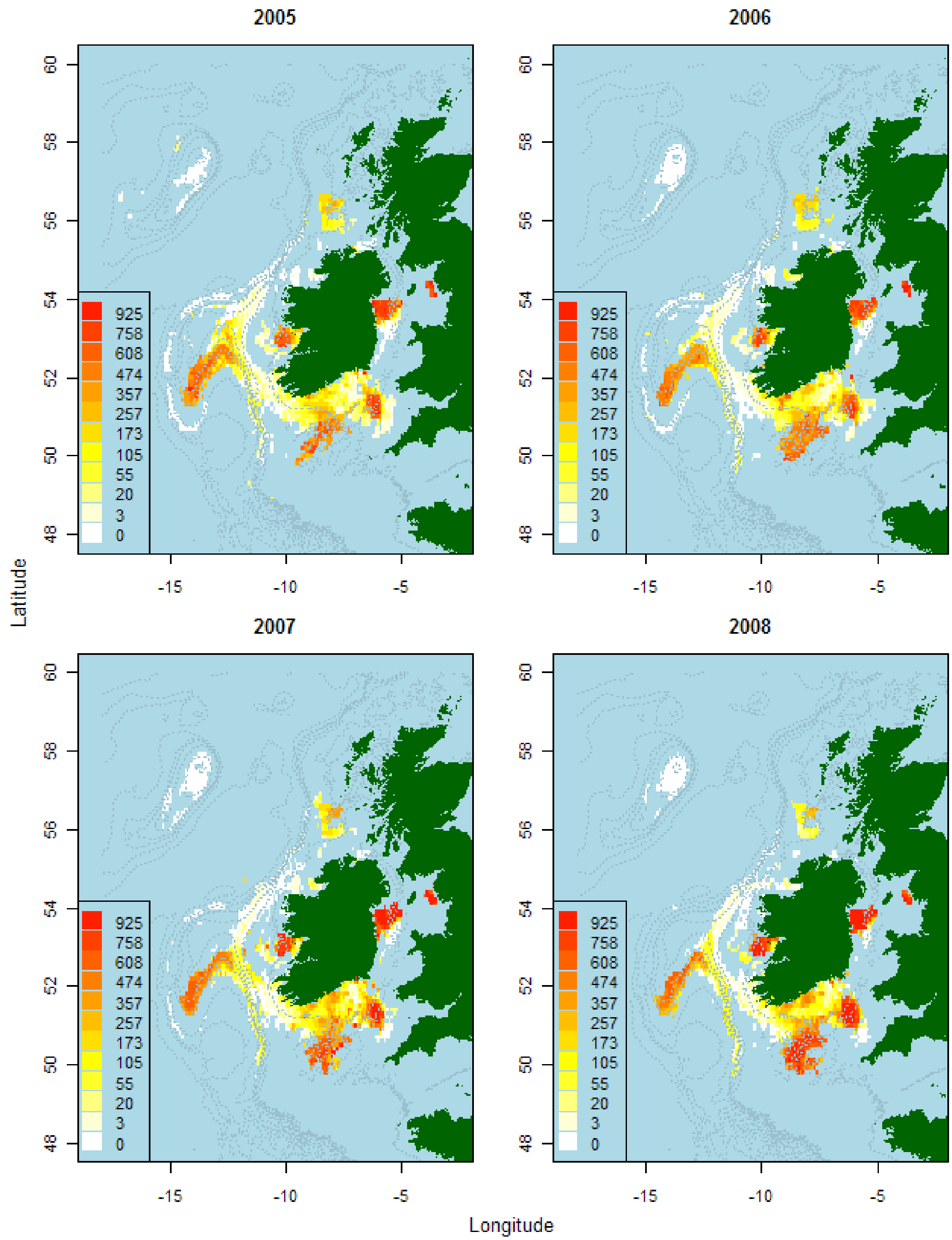


Figure A.2.1. The spatial distribution of LPUE of *Nephrops* caught by Irish otter trawlers between 2005–2008 derived using integrated VMS and logbook records.

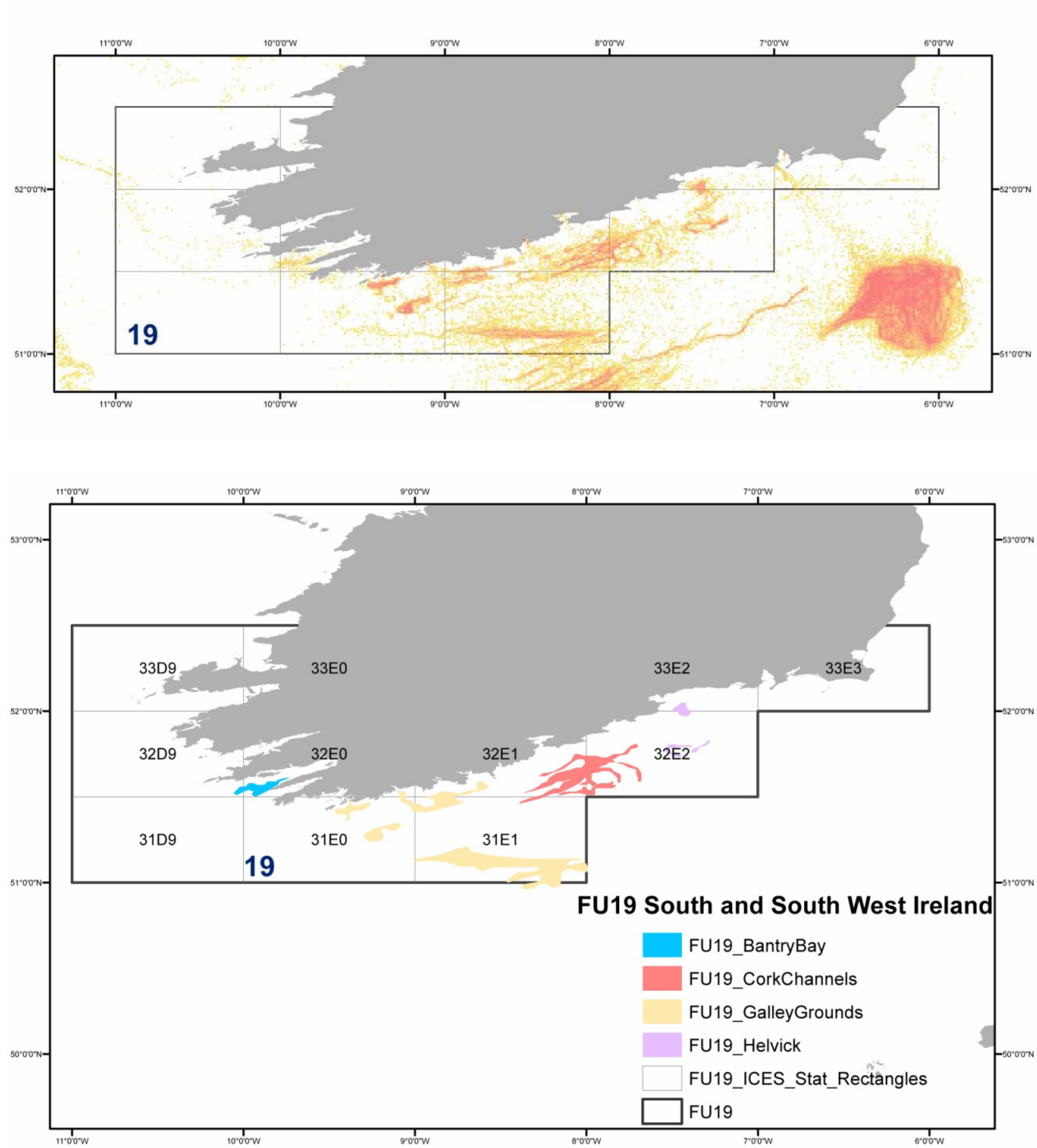


Figure A.2.2. Discrete *Nephrops* patches occurring in FU19; based on integrated VMS data (2005–2008).

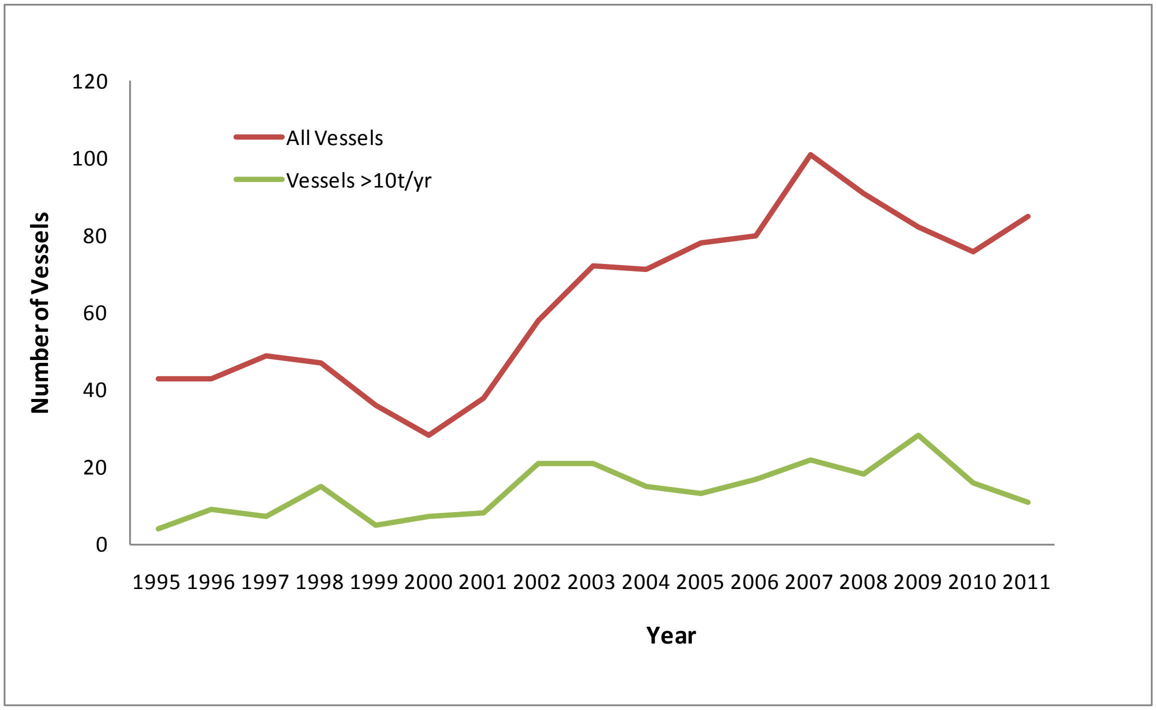


Figure A.2.3. Time-series of the number of Irish vessels reporting landings of *Nephrops* from FU19. The vessels with annual landings >10 t/yr can be considered the main participants in the fishery these general account for ~40% of the total landings in 2011.

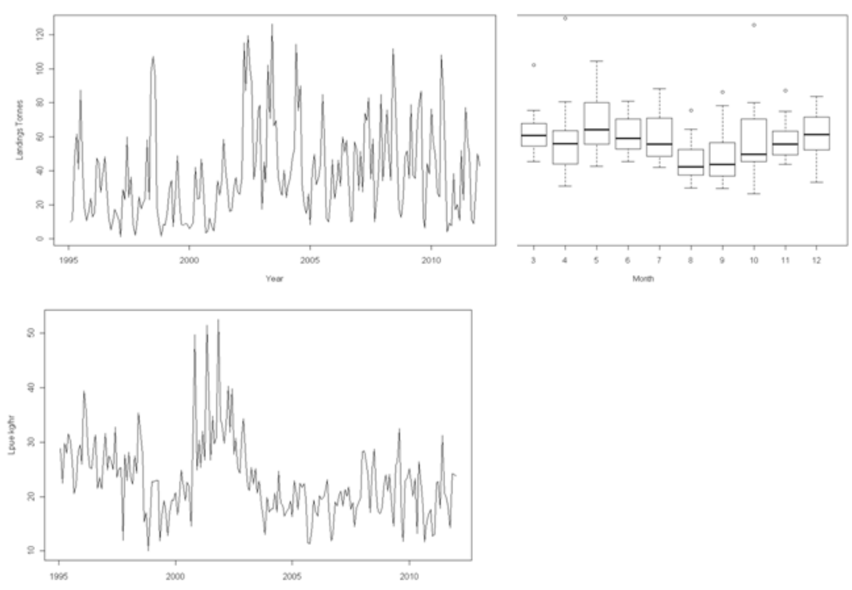


Figure A.2.4. Monthly *Nephrops* landings in FU19 (Top left); Boxplot of monthly lpue (top right), lpue trends in FU19 (bottom left).

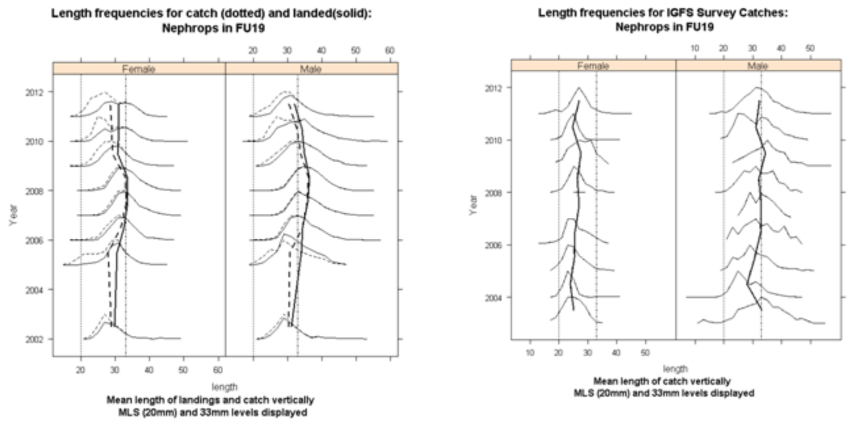


Figure B.1.2. FU19 Mean length for catch and landings from commercial and survey sampling.

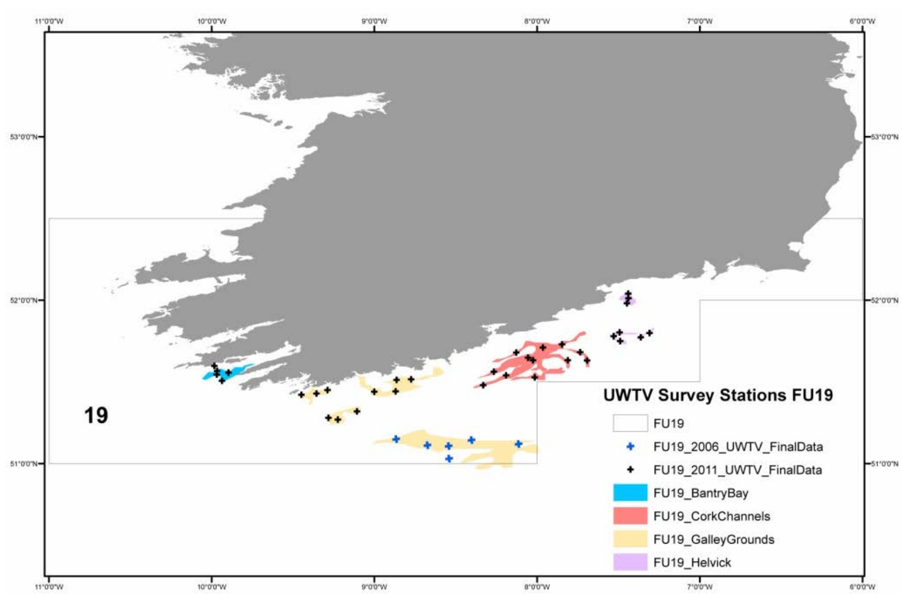


Figure B.3.1. UWTV stations completed in FU19 in 2006 and 2011.

7.10 Stock Annex Celtic Sea Plaice VIIf&g

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Plaice (Division VIIf&g)
Working Group	Celtic Seas Ecoregion
Date	March 2011
By	Chris Darby

A. General

A.1. Stock definition

The degree of separation between the stocks of plaice in the Celtic Sea and the Irish Sea is unclear. Historic tagging studies indicate a southerly movement of mature fish (or fish maturing for the first time) from the southeast Irish Sea, off North Wales, into the Bristol Channel and Celtic Sea during the spawning season (Figure A1). While some of these migrant spawning fish will remain in the Bristol Channel and Celtic Sea, the majority are expected to return to summer feeding grounds in the Irish Sea (Dunn and Pawson, 2002).

Very little mixing is considered to occur between the stocks (Pawson, 1995). Nevertheless, time-series of recruitment estimates for all stocks in waters around the UK (Irish Sea, Celtic Sea, western and eastern Channel, North Sea) show a significant level of synchrony (Fox *et al*., 2000). This could indicate that the stocks are subject to similar large-scale environmental forces and respond similarly to them.

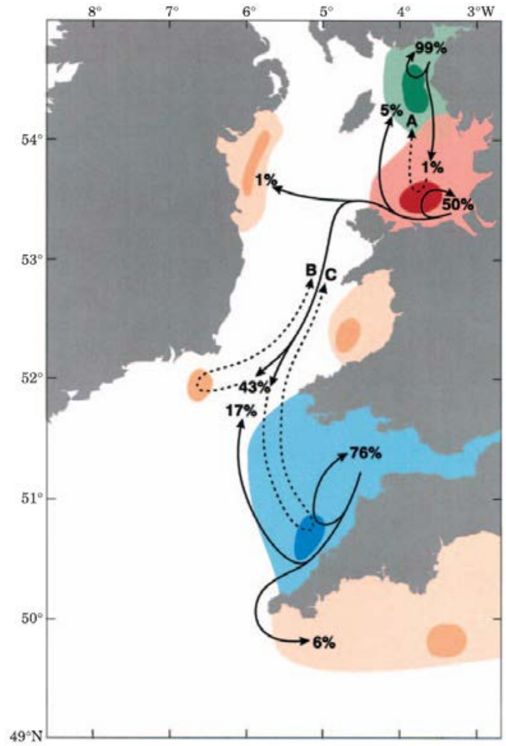


Figure A.1. (right) Principal substock areas and movements of plaice on the west coast of England and Wales. Percentages are the recaptures rates of tagged plaice <25 cm total length when released, and >26 cm when recaptured in English and Welsh commercial fisheries. Tagging exercises in 1979–1980 and 1993–1996 were combined based on the assumption that the dispersal patterns of plaice were consistent over time. For each substock, the main feeding area (derived from tag recaptures during April–December; light shading), and the main spawning area (derived from tag recaptures during January–March, and ichthyoplankton surveys; dark shading) are indicated. The substocks tagged have been coloured green, red and blue. The substocks coloured orange are less well determined, with the feeding area around southeast Ireland unknown. Letters represent return migrations, where A ≈ 6%, and B+C ≈ 46%. Reproduced from Dunn and Pawson (2002).

A.2. Fishery

The main fishery is concentrated on the Trevose Head ground off the north Cornwall coast and around Land's End. Although plaice are taken throughout the year, heaviest landings are in March, after the peak of spawning, with a second peak in September. The fisheries taking plaice in the Celtic Sea mainly involve vessels from Belgium, France, England and Wales.

A.3. Ecosystem aspects

Plaice are preyed upon and consume a variety of species through their life history. However, plaice have not as yet been included in an interactive role in multispecies assessment methods (e.g. ICES WGSAM, 2008). Among other prey items, plaice typically consume large proportions of polychaetes and molluscs.

Other than statistical correlations between recruitment and temperature (Fox *et al*., 2000) little is known about the effects of the environment on the stock dynamics of plaice in the Irish Sea. Negative correlations between year-class strength of plaice (in either the Irish

Sea, Celtic Sea, Channel and North Sea) and sea surface temperature are generally strongest for the period February–June. However, western (North Sea and Channel) and eastern (Irish Sea and Celtic Sea) stocks have been found to respond to different time-scales of temperature variability, which might imply that different mechanisms are operating in these stocks and/or that the Irish Sea and Celtic Sea share common spawning (Fox *et al*., 2000).

B. Data

B.1. Commercial catch

Landings

International landings-at-age data based on quarterly market sampling and annual landings figures are available from 1977. Landings rose to a maximum in the late 1980s, declined during the early 1990s, then fluctuated around 1000 t. The decline reach a low at 390 t in 2005 following which there has been a gradual increase. Estimates of the level of discarding have been collected since 2004 and have shown a consistent increase, apart from 2007 when a substantial increase occurred by all fleets, followed by a return to the previously lower levels.

For the period 1991 to 2005 quarterly age compositions have typically represented around 70% of the total international landings, though in 2002 this fell to around 25% when age compositions were not available for the Belgian fleet. Belgian age sampling in 1993 was at a reduced level and was augmented with UK data. There was no UK sampling in the 4th quarter of 1994 and landings of 1 year olds by the UK otter trawl fleet may be underestimated in this year. Sampling levels during the earlier years in the time-series are considered to be low for all fleets and the quality of the catch data, particularly for older ages, up until around 1992 is believed to be poor. In 1995 UK age compositions for the period 1984–1988 were revised using new ALKs which used data from adjacent time periods where necessary. In the 2005 benchmark assessment, it was noted that numbers-at-age 1 in the landings data were very sparse and variable, reflecting the selection on this age (and especially considering the probable substantial discarding), so the values were replaced by zero to avoid fitting to noise. Keeping age 1 in the assessment allows the survey data at age 1 to contribute.

Discards

Discard information was not routinely incorporated into the assessment prior to 2011. WG estimates of the combined, raised, level of discards are available from 2004, they have shown a consistent increase apart from 2007 when a substantial increase occurred in the discarding by all fleets followed by a return to the previously lower levels. Recent discard rates, although variable, are substantial in some fleets/periods. Total raised discard information is available for some fleets, and data raised to sampled vessels for others.

B.2. Biological

Weights-at-age

Landings

Historically, landings weights-at-age were constructed by fitting a quadratic smoother through the aggregated catch weights for each year. In 2011 WKFLAT decided not to continue with this approach, following concerns raised by WGCSE that the quadratic smoothing was resulting in the youngest ages having heavier weights than older ages. WKFLAT 2011 rejected the use of the polynomial smoother for weights-at-age and suggested that raw catch weights are used in future. Raw data back to 1995 was obtained by WKFLAT and used to update the catch weights and stock weights files.

Discards

Discard weight-at-age data were available for Belgium and UK(E+W). The UK weight-at-age data were derived from data collected by Cefas for each year (2002–2009). The Belgian weight-at-age data were derived using estimates of total catch biomass and total numbers-at-age for years 2004–2009. These values were used to derive a weight-at-age matrix in grammes for an individual fish. The two national weight-at-age matrices were 'combined' to a total international matrix by weighting the individual weights-at-age for each year, by the total discard tonnages from the two countries for that year. Where only one estimate of weight was available for an age/year, then that estimate was used.

The above processes also produced estimates of discard numbers-at-age for the two countries. The UK estimates were raised to incorporate equivalent levels of discards for the 'unsampled' countries of France, Ireland and N Ireland (on the basis of similar 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 total international discard numbers-at-age estimates.

Stock weights

For the years 2004–2009 where discard estimates were available, a revised set of stock weights-at-age were calculated. The stock weights-at-age based on landings – with SOP correction but no 'fitting' were combined with the international discard weights-at-age data. These were weighted by the relative landed or discarded international annual tonnages. The international annual discard tonnage was not readily available, as the 'unsampled' countries did not have estimates. These were derived using the ratio of UK(E+W) tonnages of landings and discards and this ratio was applied to these unsampled nations landings to produce an estimate of total discard biomass for each of these countries. For the years prior to 2004, a revised set of stock weights-at-age data based on the international landings only was produced. These new values were based on the 'observed' weight data, but were SOP corrected. For this series of data, the 'smoothing' of the data by fitting a curve through the observed data was removed.

Natural mortality and maturity ogives

Initial estimates of natural mortality (0.12 yr all years and all ages, from tagging studies) and maturity were based on values estimated for Irish Sea plaice. A new maturity ogive based on UK(E&W) VIIfg survey data for March 1993 and March 1994 (Pawson and Harley, 1997) was produced in 1997 and is applied to all years in the assessment.

Age	1	2	3	4	5+
Historic maturity	0	0.15	0.53	0.96	1.00
Revised maturity	0	0.26	0.52	0.86	1.00

The proportion of mortality before spawning was originally set at 0.2 since approximately 20% of the total catch was taken prior to late February–early March, considered to be the time of peak spawning activity. The proportion of F and M before spawning was changed to zero at the request of ACFM in 1996 as it was considered that these settings were more robust to seasonal changes in fishing patterns, especially with respect to the medium-term projections. No updated information was provided to WKFLAT and the estimates were retained.

B.3. Surveys

Indices of abundance are available from the UK (BTS-Q3) beam trawl survey in VIIf and the Irish Celtic Explorer IBTS survey (IBTS-EA-4Q).

The UK(E&W) beam trawl survey series that began in 1988; since 1991, tow duration has been 30 minutes but prior to this it was 15 minutes. In 1997, values for 1988 to 1990 were raised to 30 minute tows. However, data for 1988 and 1989 were of poor quality and gave spurious results: thus, the series was truncated to 1990. A similar March beam trawl survey began in 1993 and was made available to the WG in 1998. The March beam trawl survey ended in 1999 but continued to be used as a tuning index in the assessment until 2003.

Recent data have shown less correlation between ages than the historic time-series which should be monitored in case it is a developing problem. The log catch curves show good consistency over time and the reduction through time of the negative slope indicates that mortality rates have been declining.

The IGFS is a demersal trawl survey which started in 2003. It is coordinated through ICES International Bottom-trawl (IBTS) working group, providing annual indices of abundance for commercially exploited groundfish stocks on the Irish continental shelf (ICES VIa, VIIb,g&j) for Q3-4. Plaice are caught by the survey off the SE coast up to, and just over, the border of VIIg with VIIa (ICES rectangles (32E2, 32E3).

Year effects in the survey catch rates dominate the abundance indices. The year class and catch curve plots illustrates that the consistency of plaice year-class abundance estimates at each age is relatively poor. The survey was not fitted within the assessment model, but will be monitored as the time-series progresses.

B.4. Commercial lpue

Commercial tuning indices of abundance from the UK(E&W) beam trawl and otter trawl data are used in the assessment to provide information on the oldest ages in the population. Historically, only ages 4–8 have been used to calibrate the assessment because of concerns about the level of discarding at the youngest ages. The data show good historical consistency of year-class estimates throughout the time-series, especially for the beam trawls, with more noise resulting from two major year effects in the otter trawl data.

C. Stock assessment

Historically the stock was assessed using XSA, under the assumption that discarding had a minimal effect on the estimates. Recent increases in the level of discarding led to this assumption being untenable and so at the 2011 WKFLAT discard estimates were introduced to the assessment fitted using the AP model. The settings and data for the model fits are set out in the table below:

Assessment year		2011 WKFLAT
Assessment model		AP
Catch data		Including discards 1990–2009
Tuning fleets	UK(E&W)-BTSurvey	1990–2009 ages 1–5
	UK commercial beam trawl	1990–2009 ages 4–8
	UK commercial otter trawl	1990–2009 ages 4–8
	Ire GFS Q3/4	Series omitted
Selectivity model		Linear Time Varying Spline at-age (TVS)
Discard fraction		Polynomial Time Varying Spline at-age (PTVS)
Landings num-at-age, range:		1–9+
Discards num-at-age, year range, age range		2004–2009, ages 1–8+

Three AP models which could not be distinguished in terms of the AIC, similar residual patterns and fits to the dataseries; the TI_PTVS, TI_TVS and TV_PTVS models. WKFLAT 2011 concluded that the TV_PTVS model, which allows for variation in time in the selection patterns of both landings and discards, was the most plausible model; given the known changes in gear types and discarding. However, it was not statistically distinguishable from the models which maintain the landings selection pattern as constant throughout the time-series.

Comparison of the management and stock metrics from the three model fits showed very similar time-series trends in the estimates of fishing mortality, SSB and total estimated discards. WKFLAT therefore 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.

D. Short-term projection

For short-term forecasts based on the revised assessment it is recommended that the current methods be applied to the populations and fishing mortalities (separated into discard and landings mortalities) derived from the PV_TVS model (assuming that the previously discussed sensitivity analyses do not indicate a change of model); in order to provide indications of the expected trends in discards, landings and spawning biomass.

E. Medium-term projections

Medium-term projections are not carried out for this stock.

F. Yield and biomass-per-recruit/long-term projections

Yield-per-recruit calculations are conducted using the same input values as those used for the short-term forecasts. Currently the YPR calculations are used as a basis for determining the catch option for advice.

G. Biological reference points

The addition of discards increases the estimates of spawning biomass in the most recent years following the increased estimates of discards in time. Similarly fishing mortality averaged across ages 3–6, which include ages that are discarded also increases. Previous BRPs may therefore not be consistent with new assessment methodology and should not be used until the assessment methodology is considered sufficiently stable (a longer time-series of discard data) to evaluate new reference levels.

H. References

Fox, C.J., Planque, B.P., and Darby, C.D. 2000. Synchrony in the recruitment time-series of plaice (*Pleuronectes platessa* L) around the United Kingdom and the influence of sea temperature. Journal of Sea Research 44: 159–168.

Pawson, M.G. 1995. Biogeographical identification of English Channel fish and shellfish stocks. Fisheries Research Technical Report No. 99. MAFF Directorate of Fisheries Research, Lowestoft. http://www.cefas.co.uk/Publications/techrep/tech99.pdf.

Sideek. 1981. The estimation of natural mortality in Irish Sea plaice (*Pleuronectes platessa* L.) using tagging methods 206pp.

7.13 Stock Annex Celtic Sea Sole VIIfg

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Sole (Division VIIf,g)
Working Group	Assessment of Southern Shelf Demersal Stocks
Date	29th July 2004
Last updated	16th May 2012, Willy Vanhee

A. General

A.1. Stock definition

A description of the stock definition of sole in the Celtic Sea was given in the leaflet "Fisheries information – cod, sole, plaice and whiting in the southwest of the British Isles" published by Cefas under a EU funded project (SAMFISH: EU Study Contract 99-009, Improving sampling of western and southern European Atlantic Fisheries) and is taken over here.

In the coastal waters of western England and Wales, sole are found in greatest abundance in the northeastern Irish Sea and the eastern Celtic Sea. The main spawning areas for sole in the Celtic Sea are in deep waters (40–75 m) off Trevose Head, where spawning usually takes place between March and May. Sole nursery grounds are generally located in shallow waters such as estuaries, tidal inlets and sandy bays. Juvenile sole (0 and 1 year old fish) are found chiefly in depths up to 40 m, and adult sole (fish aged 3 plus) are generally found in deeper water. Spawning and nursery grounds are well defined.

Over 6000 sole were tagged on the nursery grounds of the Bristol Channel and the Irish Sea between 1977 and 1988. The majority of fish tagged in Swansea Bay and Carmarthen Bay were between 15 and 24 cm in length. Most of the recaptures of these tagged fish occurred two or more years after release, which meant that many fish tagged as juveniles were recaptured as adults. The majority of returned fish were reported off the north coasts of Devon and Cornwall, and over a wide area in the eastern Celtic Sea and St George's Channel. These results suggest that once an adult sole has recruited to an area, it tends to remain there, and that there is only limited movement of sole between the Celtic Sea and adjoining areas.

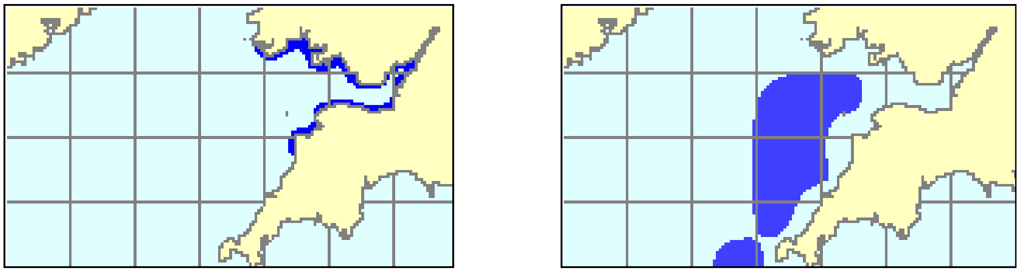


Figure A.1 Nursery and spawning areas of sole in the Celtic Sea (After Coull, K.A., Johnstone, R., and S.I. Rogers. 1998. Fisheries Sensitivity Maps in British Waters. Published and distributed by UKOOA Ltd.)

A.2. Fishery

Fisheries for sole in VIIf,g involve vessels from Belgium, taking approx. two thirds, the UK taking approximately one quarter, and France and Ireland taking minimal amounts of the total landings. Nominal landings are available from 1986 onwards. Sole are mainly targeted by beam trawlers and the fishery is concentrated on the north Cornish coast off Trevose Head and around Land's End. There is an average landing of 1000 tonnes throughout its history (See also Figures A.2 and A.3).

Discard information is being collated since 2004 and it seems to be minor. Discarding of sole in the UK(E&W) fleet was estimated to fluctuate between 1% and 9% in numbers. Discard rates of sole in the Belgian beam trawl fleet (responsible for the main uptake of this stock) account for about 2%–5% in weight.

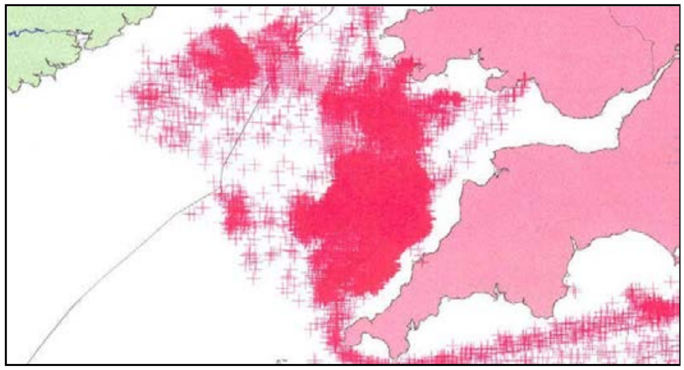


Figure A.2 Effort distribution of the Belgian beam trawl fleet operating in the Celtic Sea. (VMS data 2002)

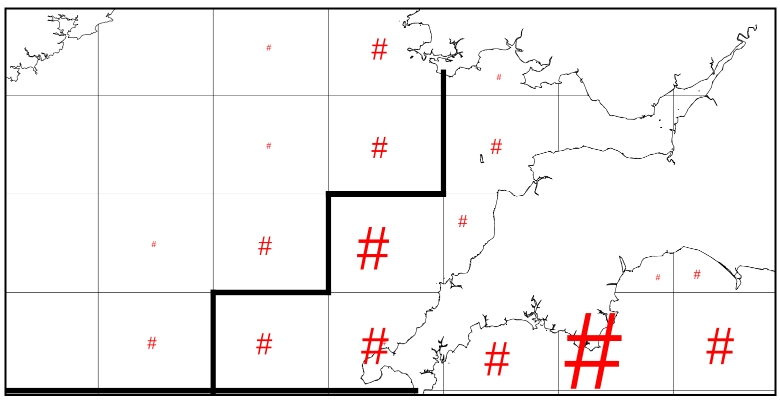


Figure A.3. Effort distribution of the English beam trawl fleet operating in the Celtic Sea. Data based on total demersal landings in 2003

A.3. Management

Celtic Sea sole is been managed by TAC. Other management measures are technical measures including minimum landing size (24 cm) and minimum mesh sizes (80 mm for beam trawlers).

Besides national authorities can impose additional management measures, such as temporal closures, trip catch controls and monthly catch controls.

Council Regulation (EC) No 27/2005, Annex III, part A 12 (b) prohibited fishing in ICES rectangles 30E4, 31E4 and 32E3 during January–March 2005. This prohibition did not apply to Beam trawlers during March.

Council Regulation (EC) No 51/2006, Annex III, part A 4.2 prohibited fishing in ICES rectangles 30E4, 31E4 and 32E3 during February and March 2006 with derogations for vessels using pots, creels or nets with less than 55 mm mesh size. The prohibition does not apply within 6 nautical miles from the baseline.

Council Regulation (EC) No 41/2007, Annex III, part A 7.2 prohibited fishing in ICES rectangles 30E4, 31E4 and 32E3 during February and March 2007 with derogations for vessels using pots, creels or nets with less than 55 mm mesh size. The prohibition does not apply within 6 nautical miles from the baseline.

Council Regulation (EC) No 40/2008, Annex III, part A 6.2 prohibited fishing in ICES rectangles 30E4, 31E4 and 32E3 during February and March 2008. The prohibition does not apply within 6 nautical miles from the baseline.

Council Regulation (EC) No 43/2009, Annex III, part A 6.2 prohibited fishing in ICES rectangles 30E4, 31E4 and 32E3 during February and March 2009. The prohibition does not apply within 6 nautical miles from the baseline.

Council Regulation (EC) No 1288/2009, Article 1 stipulates that the prohibited fishing in ICES rectangles 30E4, 31E4 and 32E3 during February and March referred to in Council Regulation (EC) No 43/2009, Annex III, part A 6.2 shall be applicable until 30 June 2011.

Council Regulation (EC) No 579/2011, Article 2 stipulates that the prohibited fishing in ICES rectangles 30E4, 31E4 and 32E3 during February and March stipulated in Council Regulation (EC) No 43/2009, Annex III, part A 6.2, and prolonged in Council Regulation (EC) No 1288/2009, Article 1, shall be applicable until 31 December 2012.

A.4. Ecosystem aspects

Physics

Bathymetry: Shelf sea south of Ireland, limited to the west by the slope of the Porcupine seabight and the Goban Spur.

Circulation: Along the shelf edge, there is a poleward flowing „slope current"; on the shelf a weaker current flows north from Brittany across the mouth of the English Channel. Thermal stratification and tidal mixing generates the Irish coastal current which runs westwards in the Celtic Sea and northwards along the west coast of Ireland. Several rivers discharge freshwater into the ecoregion and influence the circulation patterns. These are notably the River Loire, the Severn and the Irish rivers Lee and Blackwater.

Fronts: The Irish Shelf Front is located to the south and west of Ireland (at ca. 11°W), and consists of a tidal mixing front existing all year-round. On the shelf, there are the Ushant Front in the English Channel and the Celtic Sea front at the southern entrance to the Irish Sea.

Temperature: Sea surface temperatures measured in coastal stations northwest of Ireland since the 1960s show a trend of sustained positive temperature anomalies from 1990. An offshore weather buoy maintained off the southwest coast of Ireland (51.22°N 10.55°W) since mid 2002, indicated that 2003 and 2005 had the warmest summer temperatures of the record while 2007 saw the warmest winter temperatures. Temperatures in 2008 started above the time-series mean (2003–2008) until April and from July onwards, temperatures remained well below the time-series mean (WGOH 2009).

Biology

Phytoplankton: Productivity is reasonably high on the shelf with a rapid decrease west of the shelf break. Continuous Plankton Recorder (CPR) data suggests a steady increase in phytoplankton over at least the last 20 years. Toxic algal blooms occur around Irish coasts esp. along the southwest of Ireland.

Zooplankton: CPR data suggest an overall decline in the abundance of zooplankton in recent years. Calanus abundance is now below the long-term mean.

Benthos, larger invertebrate, biogenic habitats: The major commercial invertebrate species is Norway lobster (*Nephrops norvegicus*). Two epibenthic assemblages predominate in the Celtic Sea: one along the shelf edge and the slope dominated by the anemone *Actinauge richardi* and a more widely distributed assemblage on the continental shelf, dominated by *Pagurus prideaux* and other mobile invertebrates (shrimps and echinoderms).

Fish Community: The area is a spawning area for key migratory fish species, notably mackerel *Scomber scombrus* and horse mackerel *Trachurus trachurus*. On the continental shelf the main pelagic species are herring *Clupea harengus*, sardine *Sardina pilchardus* and sprat *Sprattus sprattus*. The groundfish community consists of over a hundred species with the most abundant 25 making up 99% of the total biomass. Surveys revealed a downward trend in the biomass and abundance of cod, whiting and hake.

Birds, Mammals and Elasmobranchs: Basking shark (*Cetorhinus maximus*) is seen throughout the area but the stock seems to be severely depleted. Blue sharks (*Prionace glauca*) are found during summer. The Harbour porpoise *Hocoena phocoena* is the most numerous cetacean in the region. Bottlenosed dolphins (*Tursiops truncates*) occur in large numbers while the common dolphin (*Delphinus delphis*) is also widely distributed in the area. White-beaked dolphin and White-sided dolphin (*Lagenorhynchus albirostris* and *L. acutus*) occur over much of the shelf area. Grey seals (*Halichoerus grypus*) are common in many parts of the area. Petrels (fulmar and storm-petrel) dominate the seabird populations in the west of Ireland and Celtic Sea region but there are also large breeding colonies of kittiwake, guillemot and gannet.

Environmental signals and implications: Increasing temperature and changes in zooplankton communities are likely to have an impact on the life histories of many species. Cod in the Celtic Sea are at the southern limit of the range of the species in the Northeast Atlantic. It is known that at the southern limits of their range, recruitment tends to decrease in warmer waters (above 8.5°C), and that cod are not found in waters warmer than 12°C. Celtic Sea cod has higher growth rates and mature earlier than other cod stocks. Although it is uncertain, Drinkwater (2005) has predicted that a sustained 1°C rise in seabed temperature, over the course of this century, could result in the disappearance of cod stocks from the Celtic Sea and the English Channel. Already there has been a northward shift in the distribution of some fish with an increase of sea bass *Dicentrarchus labrax* and red mullet *Mullus surmuletus* populations around British coasts. The region also recently experienced an unprecedented increase in the numbers of snake pipefish, *Entelurus aequoreus*. Abundance of herring *Clupea harengus* and pilchard *Sardina pilchardus* occurring off the southwest of England has been shown to correspond closely with fluctuations in water temperature. Sardines were generally more abundant and their distribution extended further to the east when the climate was warmer, while herring were generally more abundant in cooler times. The migration timing of squid (*Loligo forbesi*) and flounder (*Platichthys flesus*) off the southwest of England has also been linked to temperature (Sims *et al.*, 2001; 2004). Zooplankton abundance has declined in the region in recent years and the overall substantial decline in Calanus abundance, which is currently below the long-term mean, may have longer-term consequences given the fish community shift towards smaller pelagic species feeding on zooplankton.

Fishery effects on benthos and fish communities: Temporal analyses of the effects of fishing and climate variation suggest that fishing has had a stronger effect on size-structure than changes in temperature. A marked decline in the mean trophic level of the fish community over time has been documented and this has resulted from a reduction in the abundance of large piscivorous fish such as cod and hake, and an increase in *Nephrops* and smaller pelagic species such as boarfish (*Capros aper*) which feed at a lower trophic level. In the Celtic Seas, discarding levels differ between the different fleets but can be as high as two thirds of the total catch with increasing trends in recent years. Discarding of undersized fish is a problem in several fisheries (e.g. cod, haddock, *Nephrops* and megrim). Improving the selection pattern should benefit the stocks and result in a higher long-term yield. Sole and plaice are predominantly caught by beam trawl fisheries. Beam trawling, especially using chain-mat gear, is known to have a significant impact on the benthic communities, although less so on soft substrata 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. The high mud content and soft nature of *Nephrops* grounds means that trawling readily marks the seabed, trawl marks remaining visible for some time. Despite the high intensity of fishing (some areas are impacted >7 times/year) burrowing fauna can be seen re-emerging from freshly trawled grounds, implying that there is some resilience to trawling. Cetacean bycatch has been noted in some fisheries, including the pelagic trawl fishery for mackerel and horse mackerel in the SW of Ireland, although the numbers caught were low.

B. Data

B.1. Commercial Catch

Quarterly data are available for catch numbers for the Belgian, the Irish and UK fleets. These comprise around 95% of the international landings. Derivation of the age composition is shown in the table below. Quarterly total landings are available from France and also from Northern Ireland.

	Data source:			
VIIfg	BE	IR*	UK	Derivation of international landings in VIIfg
Length composition	VIIfg	VIIfg	VIIfg	
ALK	VIIfg	VIIfg	VIIfg	
Age Composition	VIIfg	VIIfg	VIIfg	B, IRE + UK, raised to total international landings*

*** From 2005 to 2009 no Irish Length compositions or ALK's therefore from 2005 to 2009, BE + UK age composition raised to total international landing.**

Numbers-at-age 1 in the catch are low in most years; therefore these were not considered to add useful information and are replaced by zeros.

Historical compilation of the commercial catch data not included yet.

B.2. Biological

Weights-at-age

The total international catch weights-at-age are calculated as the weighted mean of the annual weight-at-age data supplied by Belgium, UK(E&W) and Ireland, which account for 95% of the total international landings (weighted by landed numbers), and smoothed using a quadratic fit where catch weights-at-age are mid-year values (age = 1.5, 2.5, etc.). These quadratic fits through these points differ from year to year. Therefore they are provided for each year separately. The method is always the same; just the fit differs from year to year as the catch weights differ from year to year.

Catch weights-at-age have been scaled to give a SOP of 100%.

This technique has been used for many years (at least since stock has been assessed by the Southern Shelf Demersal WG. The same technique has been used in other stocks in the WGCSE (e.g. plaice VIIe).

The text table below shows the quadratic fit of the data, the R^2 of the fit, the periodicity of the data being collected and the countries that delivered the data to calculate the fit.

Year	Quadratic fit W(t) =	R^2	Periodicity data	Contributing countries
2002	-0.0659 + 0.0825*(AGE+0.5) - 0.0017*(AGE+0.5)²	0.93	Quarterly	B, IRE, UK
2003	0.0503 + 0.0484*(AGE+0.5) - 0.0001*(AGE+0.5)²	0.91	Quarterly	B, IRE, UK
2004	-0.0333 + 0.0671*(AGE+0.5) - 0.0006*(AGE+0.5)²	0.96	Quarterly	B, IRE, UK
2005	-0.0542 + 0.0846*(AGE+0.5) - 0.0019*(AGE+0.5)²	0.96	Quarterly	B, UK
2006	0.0023 + 0.0553*(AGE+0.5) - 0.0003*(AGE+0.5)²	0.95	Quarterly	B, UK
2007	0.0023 + 0.0553*(AGE+0.5) - 0.0003*(AGE+0.5)²	0.95	Quarterly	B, UK
2008	-0.0267 + 0.07*(AGE+0.5) - 0.0015*(AGE+0.5)²	0.88	Quarterly	B, UK
2009	+0.0093 + 0.0612*(AGE+0.5) - 0.0012*(AGE+0.5)²	0.90	Quarterly	B, UK
2010	Not available for the moment due to a hard disk crash		Quarterly	B, IRE, UK
2011	+0.0084 + 0.0566*(AGE+0.5) - 0.007*(AGE+0.5)²	0.97	Quarterly	B, IRE, UK
2012	-0.0388 + 0.069*(AGE+0.5) - 0.0012*(AGE+0.5)²	0.92	Quarterly	B, IRE, UK

For the period 2002–2002 the stock weights-at-age are the catch weights of the Belgian beam trawl fleet (BEL-BEAM) in the first quarter, smoothed by fitting a Gompertz function. The text table gives a historical overview of the parameters that have been used in the Gompertz function [$W(t) = a \times \exp(b \times (1 - \exp(c \times t)))$].

Year	Parameter a	Parameter b	Parameter c	R^2
2002	13.89	4.220	-0.3376	
2003	86.14	3.049	-0.1115	0.4
2004	3.77	3.47	-0.196	0.4

For the period 2005–2009, the stock weights were calculated as the weighted mean of the 1st quarter weights-at-age data supplied by Belgium and UK(E&W) (weighted by landed numbers) and soothed using a quadratic fit through these points. Since 2010 Ireland also provides this information and these data were included in the calculations.

The text table below shows the quadratic fit of the data, the R^2 of the fit, the periodicity of the data being collected and the countries that delivered the data to calculate the fit.

Stock weights-at-age have been scaled to give a SOP of 100%.

Year	Quadratic fit W(t) =	R^2	Periodicity data	Contributing countries
2005	$-0.0113 + 0.065*(AGE) - 0.0003*(AGE)^2$	0.96	1st quarter	B, UK
2006	$0.0381 + 0.0397*(AGE) + 0.0009*(AGE)^2$	0.97	1st quarter	B, UK
2007	$0.0381 + 0.0397*(AGE) + 0.0009*(AGE)^2$	0.97	1st quarter	B, UK
2008	$-0.0389 + 0.0638*(AGE) - 0.0006*(AGE)^2$	0.94	1st quarter	B, UK
2009	$+0.0112 + 0.0517*(AGE) - 0.0002*(AGE)^2$	0.98	1st quarter	B, UK
2010	Not available for the moment due to a hard disk crash		Quarterly	B, IRE, UK
2011	$-0.0472 + 0.0812*(AGE+0.5) - 0.022*(AGE+0.5)^2$	0.92	Quarterly	B, IRE, UK
2012	$+0.0786 + 0.0369*(AGE+0.5) - 0.006*(AGE+0.5)^2$	0.98	Quarterly	B, IRE, UK

Stock and catch weights have no explicit trends. The values for 2001 showed a strange convergence and were replaced by the mean of the 2000 and the 2002 weights.

At some ages, the weights in the stock are higher than the weights in the catch. This is because sole caught from spawning concentrations in the 1st quarter are heavier (10% to 15 %) than after spawning.

Historical compilation of the weight-at-age data not fully included yet.

Natural mortality and maturity ogives

Natural mortality was assumed to be 0.1 for all ages and years. This is consistent with the natural mortality estimates used for sole by other ICES working groups (WGNSSK: IV, VIId, WGNSDS: VIIa, WGSSDS: VIIfg, VIIIa,b) and consistent with estimates of M reported in Horwood (1993).

The maturity ogive applied to all years is, a combined sex maturity ogive taken from Area VIIfg attributed to Pawson and Harley, WD presented to WGSSDS in 1997.

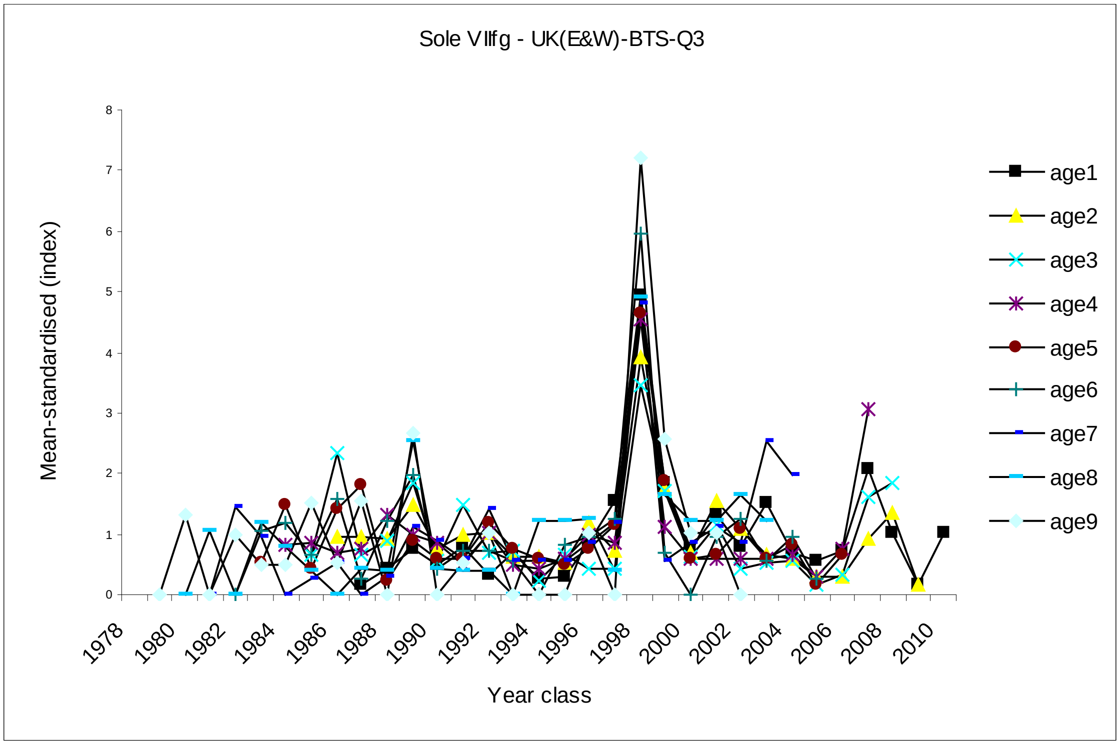
Age	1	2	3	4	5	6 and older
	0.00	0.14	0.45	0.88	0.98	1.00

The proportion of M and F before spawning was set to zero.

B.3. Surveys

Abundance indices for Celtic Sea sole are available for one survey, the UK beam trawl survey (UK(E&W)-BTS-Q3). The survey has been conducted in September for approximately 24 days annually since 1988. There are 101 core fishing and hydrographic stations distributed around the Irish Sea, Bristol Channel and Celtic Sea between 50 to 55 degrees N and between the English, Welsh and Irish coasts. The survey is coordinated by ICES BTS WG.

Abundance indices for all ages used in the assessment (standardized to the mean of the respective ages) are given in the figure below. The figure shows that the survey is able to track the strength of the year classes reasonably well.



B.4. Commercial cpue

Commercial cpue data are available from the Belgian, the UK(E&W) and the Irish beam trawl fleets, as well as the UK(E&W) and Irish Otter trawl fleets. There is also information on the cpue of the hardly significant Scottish seine fleet for the sole fisheries.

B.5. Other relevant data

No other relevant data included so far.

C. Historical stock development

During the eighties fishing mortality increased for this stock. In the following decades fishing mortality fluctuated around this higher level. However fishing mortality has decreased since the late 1990s and is estimated to be below F_{MSY} (0.31) since 2005. Fishing mortality in 2011 is estimated to be 0.24.

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 and the 2007 year class to be the second highest for this stock. The 2009 year class is by far the lowest in the time-series. The incoming recruitment (year class 2010) is estimated to be above average.

SSB has declined almost continuously from the highest value of 8000 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 and above average recruitment in 2009 and 2011 is predicted to keep SSB well above $B_{PA}/B_{trigger}$.

Tuning data

XSA tuning data that have been used in recent assessments are those from Belgium beam trawlers (BEL-CBT), 1971 onwards; from the UK beam trawl fleet (UK-CBT), Division VIIf, 1991 onwards; and from the UK Corystes September beam trawl survey (UK(E&W)-BTS-Q3 survey), 1988 onwards. The Belgian beam trawl fleet is temporally discontinued in 2003. This is due to a change in the calculation of the effort statistics from the official logbooks and sale slip notes in the most recent years. Before the next benchmark assessment, a new derivation of these data should become available.

There do exist other tuning data for this stock (e.g. UK otter trawl fleet), but these have not been included in the assessment as they were not considered to be representative for this stock.

The Irish Groundfish survey, held in the 4th quarter is available since 2003 but is not yet used in the XSA as the time-series is too short.

Assessment methods and settings

Celtic Sea sole has been assessed with XSA. An overview of the changes in parameter settings of the XSA are given below:

	assessment 1998-1999			2000 assessment			assessment 2001-2002		
Fleets	Years	Ages	α-β	Years	Ages	α-β	Years	Ages	α-β
BEL-CBT commercial	71-asses-year-1	2-9	0-1	86-asses-year-1	2-9	0-1	86-asses-year-1	2-9	0-1
UK-CBT commercial	91-asses-year-1	2-9	0-1	87-asses-year-1	3-9	0-1	91-asses-year-1	2-9	0-1
UK(E&W)-BTS-Q3 survey	88-asses-year-1	1-4	0.75-0.85	88-asses-year-1	1-4	0.75-0.85	88-asses-year-1	1-4	0.75-0.85
-First data year	1989			1986			1986		
-Last data year	assessment year-1			assessment year-1			assessment year-1		
-First age	1			1			1		
-Last age	10+			10+			10+		
Time series weights	None			None			None		
-Model	Mean q model all ages			Power model (ages 1 & 2)			Power model (ages 1 & 2)		
-Q plateau set at age	7			7			7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages			5 years / 5 ages			5 years / 5 ages		
-s.e. of the means	0.5			1.5			1.5		
-Min s.e. for pop. Estimates	0.3			0.3			0.3		
-Prior weighting	None			None			None		
Fbar (4-8)									

	2003 assessment			assessment 2004-2005			assessment 2006-Current		
Fleets	Years	Ages	α-β	Years	Ages	α-β	Years	Ages	α-β
BEL-CBT commercial	87-asses-year-1	2-9	0-1	71-asses-year-1	2-9	0-1	71-asses-year-1	2-9	0-1
UK-CBT commercial	91-asses-year-1	2-9	0-1	91-asses-year-1	2-9	0-1	91-asses-year-1	2-9	0-1
UK(E&W)-BTS-Q3 survey	88-asses-year-1	1-4	0.75-0.85	88-asses-year-1	1-4	0.75-0.85	88-asses-year-1	1-9	0.75-0.85
-First data year	1987			1971			1971		
-Last data year	assessment year-1			2011			2011		
-First age	1			1			1		
-Last age	10+			10+			10+		
Time series weights	None			None			None		
-Model	Power model (ages 1 & 2)			Power model (ages 1 & 2)			Mean q model all ages		
-Q plateau set at age	7			7			7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages			5 years / 5 ages			5 years / 5 ages		
-s.e. of the means	1.5			1.5			1.5		
-Min s.e. for pop. Estimates	0.3			0.3			0.3		
-Prior weighting	None			None			None		
Fbar (4-8)									

Short-term projection

Population numbers for ages 2 and older are taken from the XSA output (estimates of the year = the assessment year minus 1). The long-term geometric mean (starting year up to assessment year minus 3) is assumed for age 1 in the forecast.

Fishing mortality is set at the mean over the last three years, not rescaled. If a trend occurs in fishing mortality (three consecutive higher or lower estimates), the Working

Group may use a scaled F to the last year. In the 2007 assessment, the mean fishing mortality was rescaled to F 2006.

Weights-at-age in the catch and in the stock are averaged over the last three years.

E. Medium-term projections

Population numbers for ages 2 and older are taken from the prediction output (estimates of the year = the assessment year). The long-term geometric mean (starting year up to assessment year minus 3) is assumed for age 1.

Fishing mortality is set at the mean over the last three years, not rescaled. If a trend occurs in fishing mortality (3 consecutive higher or lower estimates), the Working Group may use a scaled F to the last year.

Weights-at-age in the catch and in the stock are averaged over the last three years.

Since 2007 no medium-term projections were done.

F. Yield and biomass-per-recruit/long-term projections

Population numbers for ages 2 and older are taken from the prediction output (estimates of the year = the assessment year). The long-term geometric mean (starting year up to assessment year minus 3) is assumed for age 1.

Fishing mortality is set at the mean over the last three years, not rescaled. If a trend occurs in fishing mortality (3 consecutive higher or lower estimates), the Working Group may use a scaled F to the last year. In the 2007 assessment, the mean fishing mortality was rescaled to F 2006.

Weights-at-age in the catch and in the stock are averaged over the last three years.

G. Biological reference points

Biological reference point values are given in the text table below:

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$	2200 t	B_{PA}
Approach	F_{MSY}	0.31	Provisional proxy based on stochastic simulations
	B_{lim}	Not defined	
Precautionary Approach	B_{PA}	2200 t	There is no evidence of reduced recruitment at the lowest biomass observed and B_{PA} can therefore be set equal to the lowest observed SSB.
	F_{lim}	0.52	F_{lim}: F_{loss}.
	F_{PA}	0.37	This F is considered to have a high probability of avoiding F_{lim} and maintaining SSB above B_{PA} in ten years, taking into account the uncertainty of assessments. F_{PA}: F_{lim} × 0.72 implies a less than 5% probability that ($SSB_{MT}<B_{PA}$).

H. Other Issues

No other issues so far.

I. 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. ISBN 978 1 902895 45 1.

7.15 Stock Annex Whiting VIIe-k

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Whiting VIIe–k
Working Group	Celtic Sea Ecoregion
Date	17 May 2010
Revised by	Sarah Davie

A. General

A.1. Stock definition

The degree of separation of whiting stocks between the Irish Sea, and ICES Divisions VIIb–c from the Celtic Sea, is currently unclear. SAMFISH (EU Study Contract 99-009, Improving sampling of western and southern European Atlantic Fisheries) described the stock unit as follows:

The main spawning areas of whiting in the Western Channel and Celtic Sea are off Start Point, off Trevose Head and southeast of Ireland. The spawning season is from February to May, and the larvae are found in midwater before moving to live near the seabed by September. For the next two years, juvenile whiting are found in shallow coastal and estuarine areas, being particularly abundant around Start Point. Nearly 4000 adult whiting were tagged and released off Start Point during August 1958 and 1960. Most returns were within three months of release and demonstrated little indication of movement. Subsequent recaptures indicated more movement of whiting into the Celtic Sea than between the western and eastern Channel. Whiting released in summer between 1957 and 1961 near Carmarthen Bay moved south and west towards the two spawning grounds off Trevose and southeast of Ireland. There was no evidence of emigration out of the Celtic Sea area. Returns of whiting tagged and released in the County Down spawning area in the Irish Sea demonstrate more movement south into the Celtic Sea than north to the west of Scotland.

A.2. Fishery

Whiting in Divisions VIIe–k are taken as a component of catches in mixed trawl fisheries. Whiting landings through the mid 1980s totalled between 10 000 t and 15 000 t, through the mid to late 1990s landings were elevated to around 20 000 t. Since the turn of the century, landings have been in decline and are now below 10 000 t. Through the 1980s and early 1990s France accounted for around 60–85% of landings. While Ireland accounted for between 10% and 20% of landings, the UK 10%, and Belgium had minimal contribution (1–2%). Landings from both the UK and Belgium have remained at similar levels over time. Since the early 1990s Ireland has accounted for a greater proportion of landings. Proportions since 2004 have been similar to France whose landings have been falling since the turn of the century.

French landings are made mainly by gadoid trawlers, which prior to 1980 were mainly fishing for hake in the Celtic Sea. Irish demersal trawlers from Dunmore East and Castletownbere and other ports in southwest Ireland have traditionally targeted Celtic Sea whiting in a mixed trawl fishery. In response to poor catches in other areas vessels have been attracted into this fishery in recent years from County Donegal.

A detailed description of the Irish fishery is given in the annual WD to WGSSDS: 'A summary of the Irish Fishery and Sampling of Whiting in VIIe–k'.

A.3. Ecosystem aspects

No relevant information has been made available to the Working Group.

B. Data

B.1. Commercial catch

Data on international landings-at-age and mean weight-at-age are available for Irish, French and UK fleets from 1999 to present. The following procedures have been applied to aggregate the data for the areas VIIe, VIIfgh and VIIj,k and build the database for VIIe–k. UK VIIe–k data were used to scale catch numbers according to the landings for each area. French VIIf,g,h data were used with Irish VIIg data to scale VIIf,g,h catch numbers. Irish VIIj data were used to scale VIIj,k catch numbers. The Table below demonstrates the data available and the procedures used to derive quarterly length compositions, age compositions and mean weights-at-age.

		Data source				
Division	Data	UK	France	Ireland	Belgium /Other	Derivation of international landings:
VII e	Length composition	VIIe–k				
	ALK	VIIe–k				
	Age Composition	VIIe–k				UK raised
	Mean weight-at-age	VIIe–k				UK VIIe–k
	Landings	VIIe	VIIe	VIIe	VIIe	
VII f,g,h	Length composition	VIIe–k	VIIf,g,h	VIIg		
	ALK	VIIe–k	VIIf,g,h	VIIg		
	Age Composition	VIIe–k	VIIf,g,h	VIIg		(UK + FR+ IRL) raised to international landings
	Mean weight-at-age	VIIe–k	VIIf,g,h	VIIg		Weighted mean by numbers caught
	Landings	VIIf,g,h	VIIf,g,h	VIIf,g,h	VIIf,g,h	
VII j,k	Length composition			VIIj		
	ALK			VIIj		
	Age Composition			VIIj		IRL raised
	Mean weight-at-age			VIIj		IRL VIIj
	Landings	VIIj,k	VIIj,k	VIIj,k	VIIj,k	
VII e,f,g,h,j,k	Length composition					
	ALK					
	Age Composition					VIIe + VII fgh + VIIjk
	Mean weight-at-age					Weighted mean by numbers caught
	Landings					VIIe + VII fgh + VIIjk

B.2. Biological

Age group 0 is included in the assessment data to allow inclusion of 0-group indices in the XSA, although in most years, no landings are recorded. Very small landings of 0-group whiting were not included in the catch-at-age datafile to avoid spurious F-shrinkage effects at this age. Mean weights-at-age in the catch were derived by combining French, Irish and English data, weighted by the numbers landed at-age.

Mean weight-at-age in the stock are taken as mean weights-at-age in the quarter 1 catch. Where age 1 was poorly represented in quarter 1 landings, quarter 2 values were used as estimates of mean weight-at-age 1 in the stock. Stock weights-at-age are smoothed using a three year rolling average across ages to dampen the noise exhibited by the stock weight dataset. This approach is also used in Irish Sea whiting and Celtic Sea haddock.

Natural mortality is assumed to be 0.2 over all age groups and years.

Maturity data collected in the Celtic Sea in November 2002 during the French EVHOE survey were presented to the WG (Working Document 1: WGSSDS 2003). Results indicated 13% of age 1 fish are mature, 97% at-age 2, and 100% at-age 3 and older. These results are similar to previous assumptions of knife-edged maturity at-age 2. Exploratory analyses indicated that use of the French maturity ogive made little impact on the assessment. The WG therefore retained the assumptions of knife-edged maturity at-age 2. Since 2006 the knife edge maturity ogive has been replaced with indices calculated based on data from the UK WCGFS (Working Document 3: WGSSDS 2006) but a fixed vector is still used. Maturity sampling by Ireland and the UK on dedicated surveys confirms the use of this ogive but is insufficient to provide annual data.

The proportions of F and M before spawning were both set to zero to reflect the SSB calculation date of 1 January.

The knife edge maturity ogive was replaced with new indices calculated based on data from the UK WCGFS as detailed in WD 3, WGSSDS, 2006.

Age	0	1	2	3	4	5+
Maturity	0	0.39	0.90	0.99	0.99	1.00

B.3. Surveys

The following surveys are available as survey tuning data input for the assessment of whiting VIIe–k:

- UK-WCGFS, 1987–2004

  The March UK groundfish survey was extended in 1992 to provide better coverage for gadoids in VIIf,g. The whiting tuning data calculated from this survey is for VIIf,g. The survey was carried out on the RV Cirolana until 2003. In 2004 it was carried out on the RV Endeavour and discontinued thereafter. The survey fished fixed station positions allocated by area and depth strata. The survey used a modified Portuguese High-Headline trawl (PHHT) with 350 mm rubber bobbins, a bunt tickler chain and a 20 mm codend liner. The mean log standardized index by year demonstrated some evidence of positive catchability in the last three years of the survey (2002–2004) and cohort tracking in the mean standardized index up to then was very noisy in the last three years. These years were not included in the final assessment.

- UK-BCCSBTS-S, 1988–2001

  The Autumn UK Bristol Channel beam trawl survey (VIIf) is commercially rigged (1989 style) with 4 m beam trawl fitted with a chain mat, flip-up ropes, and a 40 mm codend liner. The gear is towed at 4 knots (ground speed) for 30 minutes. This survey provides information for age 0 and age 1 whiting.

- FR-EVHOE, 1997–present

This fourth-quarter annual groundfish is carried out on the RV Thalassa. Age data are available from 2001 onwards. The sampling design is a stratified random allocation. The number of hauls per stratum is optimized by a Neyman allocation taking into account the most important commercial species in the area (hake, monkfish and megrim). The fishing gear used is a GOV with an average vertical opening of 4 m and a horizontal opening of 20 m.

- IR-WCGFS, 1993–2002

The fourth-quarter Irish west-coast groundfish survey (WCGFS) was carried out in VIaS and VIIbj on chartered commercial vessels. The sampling design attempted to allocate at least two stations per rectangle. Stations were selected randomly within each rectangle from known clear tow positions. A Rock-hopper GOV with 12 inch discs was used. The nets were fitted with a 20 mm codend liner. This survey was discontinued after the 2002 survey, giving way to a new Irish groundfish survey on board the RV *Celtic Explorer*.

- IR-ISCSGFS, 1997–2002

Ireland commenced a Celtic Sea research vessel survey on board the RV *Celtic Voyager* in 1997 carried out in VIIa and VIIg. The survey used a GOV Trawl with a mean vertical opening is 6 m and door spread 48 m. Data from this survey (IR-ISCSGFS) were presented for the first time to the 2003 WG. The data made available were from prime stations only in a limited area of Division VIIg. The survey was discontinued after the 2002 survey, giving way to a new Irish groundfish survey on board the RV *Celtic Explorer*.

- IR-GFS 7g and j, 2003–present

Ireland commenced a new fourth quarter survey in 2003 on board the RV *Celtic Explorer* which covers VIaS, VIIbgj as part of the internationally coordinated, Quarter 4 IBTS survey programme. The IGFS has a random stratified design and uses a GOV (with rock-hopper in VIa) with a 20 mm codend liner. This is a substantially different design to the Irish Sea/Celtic Sea groundfish survey (IR-ISCSGFS) it replaces. Data from this survey (IR-GFS) were presented for the first time to the 2004 WG.

- IR-IGFS Swept-area, 1999–present

This survey index constitutes a combination of the IR-ISCSGFS and IR-GFS surveys in the area of overlap between them (VIIg). The two surveys were standardized using a swept-area estimate of catches, described in WD 5 (WGSSDS 2006). This survey was presented for the first time to the 2006 WG. The mean standardized index by year demonstrated good tracking of the strong 1999 year class to age 7 with the exception of age 4 in 2003. Although the source data were checked, this is probably an anomaly of the year effect in 2003. This point has been removed from recent assessments to ensure the survey gets higher scaled weight in further runs. This compromise is not ideal but given the short time-series of the survey and apparently good performance otherwise the WG considered that the survey should be a good index for this stock.

B.4. Commercial cpue

Information on effort, and whiting landings and lpue are available from a number of commercial fleets. This includes two French (gadoid and *Nephrops* directed) since 1983, four Irish (VIIj, and VIIg otter trawlers, and Scottish seines) since 1995, in addition to effort only from UK England and Wales VIIe–k beam trawlers and VIIe–k otter trawlers since 1983.

Across the majority of commercial fleets lpue has fallen over time, as is the case with landings. In the mid 1990s at the start of the Irish Scottish seine dataseries lpue was high, falling steeply over several years. Lpue continues to remain at these lower levels with some annual fluctuation. In relation to otter trawlers, the French gadoid directed fleet consistently revealed the highest lpue. This too has declined over the period of data available to levels half those of the early 1980s. The Irish VIIg otter trawl fleet is the only one to demonstrate an overall increasing lpue trend although the increase has been relatively small.

B.5. Other relevant data

No other relevant data to report.

C. Historical stock development

Data screening: Exploratory data analysis carried out using FLR. A separable VPA was performed using the Lowestoft VPA95 software to screen for outliers in the catch numbers.

Model used: XSA

Software used: FLR under R version 2.4.1 in conjunction with FLCore 1.4–3, FLAssess 1.4.1, FLXSA 1.4–2 and FLEDA 1.4–2

Lowestoft VPA95 software also for XSA and separable VPA

Model Options:

Option	Setting
Ages catch dep stock size	None
Q plateau	5
Taper	No
F shrinkage SE	1.00
F shrinkage year range	5
F shrinkage age range	3
Fleet SE threshold	0.50
Prior weights	No

Input data types and characteristics:

Type	Name	Year range	Age range	Variable year to year
Caton	Catch in tonnes	1982–current	0–7+	Yes
Canum	Catch-at-age in numbers	1982–current	0–7+	Yes
Weca	Weight-at-age in the commercial catch	1982–current	0–7+	Yes
West	Weight-at-age of the stock at spawning time	1982–current	0–7+	Yes:
Mprop	Proportion of natural mortality before spawning	1982–current	0–7+	No
Fprop	Proportion of fishing mortality before spawning	1982–current	0–7+	No
Matprop	Proportion mature-at-age	1982–current	0–7+	No
Natmor	Natural mortality	1982–current	0–7+	No

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	FR-Gadoid Late	1993–current	3–6
Tuning fleet 2	FR-*Nephrops*	1993–current	3–6
Tuning fleet 3	FR-EVHOE	1997–current	0–4
Tuning fleet 4	UK-WCGFS	1987–current	1–6
Tuning fleet 5	IR-IGFS Swept-area	1999–current	0–6

Settings for each assessment since 1999 are detailed in Table 1. Trial runs have, over the years, explored most of the options with regards XSA settings. This stock has not had a benchmark assessment, however exploratory assessments have been carried out within the WGSSDS up until 2007.

D. Short-term projection

Model used: Multi Fleet Deterministic Projection

Software used: MFDP1a

Initial stock size: initial stock numbers derived from XSA analyses. Numbers-at-age 0 are not considered to be well estimated and are replaced with a geometric mean of the full time-series (1982–2007). Recruitment has been at a low level since 1995 with the exception of the 1999 year class. The two most recent years have displayed good recruitment, with last year's being revised downward. Recruitment is solely estimated from the FR-EVHOE and IR-GFS7gSweptArea surveys, in recent years the French survey estimates have been far higher than those of the Irish survey. Because of these reasons the geometric mean is used.

Natural mortality: That used in the assessment

Maturity: Maturity ogive used in the assessment

F and M before spawning: Those used in the assessment method

Weight-at-age in the stock: Unscaled 3 year arithmetic mean

Weight-at-age in the catch: Unscaled 3 year arithmetic mean

Exploitation pattern: Unscaled 3 year arithmetic mean (though alternative options may be used depending on recent F trajectories and the Working Group's perception of the fishery).

Intermediate year assumptions: *Status quo* F

Stock–recruitment model used: Geometric mean of full time-series (1982 to present-1) for age 0 recruitment

F_{bar}: That used in the assessment

E. Medium-term projections

None.

F. Long-term projections

Model used: Multi Fleet Yield-per-recruit

Software used: MFYPR2a

Yield-per-recruit calculations are conducted using the same input values as those used for the short-term forecasts.

G. Biological reference points

A summary of reference point proposals to date, their technical basis and currently adopted reference points is given in the text Table below:

	WG 1998	ACFM 1998	WG 2000	ACFM 2000
F_{lim}	No Proposal	No Proposal	1.18 (F_{lim}=F_{loss})	No Proposal
F_{pa}	No Proposal	No Proposal	0.72 (F_{pa}=F_{lim} x $e^{-1.645 \times 0.3}$)	No Proposal
B_{lim}	15,000 t	15,000 t	15 000 t (B_{lim}=B_{loss})	15,000 t (B_{lim}=B_{loss})
B_{pa}	18,000 t	21,000 t	21 000 t (B_{pa}=B_{loss} x 1.4)	21,000 t (B_{pa}=B_{loss} x 1.4)

The technical basis of ACFM's 1998 B_{pa} proposal is given below (1999 WG text):

B_{pa} = B_{lim} x 1.4 = 21 000 t. In the past the WG have selected MBAL as 18 000 t based on evidence of reduced recruitment at SSBs <18 000 t. However this MBAL is driven by a period of low recruitments at low SSB in the earlier years of the time-series (1982–1985) when the data are probably not reliable. Examination of the stock–recruit plot provides no compelling evidence of reduced recruitment below SSB of 18 000 t.

The technical basis of the WG's 2000 F_{lim} and F_{PA} proposals are given below:

On the basis of results obtained from a LOWESS fitted non-parametric stock and recruitment relationship and the derived equilibrium SSB and yield curves with the original data trajectories the 2000 Working Group considered that F_{PA} and F_{lim} could be defined because F_{loss} appeared reasonably estimated. However, taking into account the uncertainties in the data the 2000 Working Group decided to use 0.3 as the SE in calculation of F_{PA} from F_{loss}. The technical basis for the proposed reference points are defined below:

$F_{lim} = F_{loss}$ (1.18 in this year's assessment)
$F_{PA} = F_{lim} \times e^{-1.645*0.3} = 0.72$

The currently adopted reference points are as follows:

	Current Reference Points	
F_{lim}	No Proposal	
F_{pa}	No Proposal	
B_{lim}	15,000 t	($B_{LIM} = B_{LOSS\ 1983}$, $ACFM_{1998}$)
B_{pa}	21,000 t	($B_{PA} = B_{LOSS\ 1983} \times 1.4$)

H. Other issues

No other issues.

I. References

Table 1. Model settings/Input data/Tuning data.

		1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Catch date range:	***Years***	82-98	82-99	82-00	82-01	82-02	82-03	82-04	82-05	82-06	82-07	82-08
	Ages	1-7+	0-7+	0-7+	0-7+	0-7+	0-7+	0-7+	0-7+	0-7+	0-7+	0-7+
Assmnt Method:		XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA
Fbar Age Range:		2-5	2-5	2-5	2-5	2-5	2-5	2-5	2-5	2-5	2-5	2-5
Time taper:		No	No	No	No	No	No	No	No	No	No	No
Q plateau age:		4	4	4	4	4	4	4	4	5	5	5
F shrinkage S.E:		0.8	2.5	1.5	1.5	1.5	1.5	1.5	1.5	1	1	1
	Num yrs	5	5	5	5	5	5	5	5	5	5	5
	Num ages	3	3	3	3	3	3	3	3	3	3	3
Fleet S.E:		0.2	0.2	0.2	0.2	0.2	0.2	0.5	0.5	0.5	0.5	0.5
Commercial Tuning Fleets:												
FR-Gadoid	*Yrs*	89-98	90-99	93-00	82-92	82-92	82-92	83-92	83-05			
	Ages	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-6			
FR-Gadoid Late	*Yrs*				93-01	93-02	93-03	93-04		93-06	93-07	93-08
	Ages				3-6	3-6	3-6	3-6		3-6	3-6	3-6
FR-Nephrops	*Yrs*	89-98	90-98	93-00	93-01	87-02	87-03	87-04	87-05	93-06	93-07	93-08
	Ages	2-6	4-6	2-6	2-6	2-6	2-6	2-6	3-6	3-6	3-6	3-6
IR-7g&j-OT	*Yrs*			95-00	95-01	95-02	95-03	95-04	95-05			
	Ages			1-6	1-4	1-4	1-4	1-4	3-4			
Survey Tuning series:												
FR-EVHOE	*Yrs*			97-00	97-01	97-02	97-03	97-04	97-05	97-06	97-07	97-08
	Ages			0-4	0-4	0-4	0-4	0-4	0-4	0-4	0-4	0-4
UK-WCGFS	*Yrs*	92-98	92-99	93-00	92-01	92-02	92-03	92-04	92-04	87-01	87-01	87-01
	Ages	1-6	1-6	2-6	2-4	2-4	2-4	2-4	1-6	1-6	1-6	1-6
UK-BCCSBTS	*Yrs*	89-98	90-99	89-00	89-01	89-02	89-03	89-04	89-05			
	Ages	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1			
IR WCGFS	*Yrs*			93-00								
	Ages			1-1								
IR-IGFS Swept area	*Yrs*								99-05	99-06	99-07	99-08
	Ages								0-6	0-6	0-6	0-6

8.2 Stock Annex Western Channel Plaice VIIe

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Western Channel Plaice (VIIe)
Date	4th March 2010 (last revised at WKFLAT 2010) updated time-series I. Holmes May 2011
Revised by	I. Holmes, S. Kupschus and C. Lynam (Cefas Lowestoft).

A. General

A.1. Stock definition

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

Between 1965 and 1976, more than 5500 plaice were tagged and released around Start Point. Previous analysis of the recaptures from plaice tagged while spawning in the Channel (eastern and western areas) during January and February showed that 20% spent summer in the western Channel, 24% in the eastern Channel, and approximately 56% migrated to the North Sea after spawning (Pawson, 1995). Few of the plaice tagged in the western Channel during April and May were recaptured outside the Channel however, suggesting that there is a resident stock that does not migrate to the North Sea after spawning in the Channel.

The main spawning areas are south of Start Point and south of Portland Bill. Spawning takes place between December and March with a peak in January and February. Figure A shows the spawning areas for VIIe plaice.

The spawning habitat in VIIe is much smaller than that in VIId and tagging studies have estimated that 87% of the recruits to the western Channel (VIIe) come from outside the area (34% from the eastern Channel VIId and 53% from the North Sea, Pawson 1995). Similarly, 38% of recruits to the eastern Channel are estimated to have come from the North Sea. The historic tagging data on which these studies were based also show that there is substantial mixing of adult plaice between the western and eastern Channel and between the English Channel and the North Sea, but very limited exchange between the Channel and the Celtic and Irish Seas (Burt *et al*., 2006).

The stocks of plaice in the Channel and North Sea are known to mix greatly during the spawning season (January–February). At this time many western Channel and North Sea plaice may be found in the eastern Channel (Pawson, 1995). The comparable lack of spawning habitat in the western Channel alone suggests that this migration from VIIe to VIId during the first quarter may be of considerable importance. North Sea (IV) plaice have been shown to spawn in VIId during January–February and subsequently return to the North Sea (Hunter *et al*., 2004). This migration is tracked by the international fleets fishing in the area: landings peak in January over the spawning grounds, when migrant fish are present, and track the movement towards the North Sea in February and March. A similar migration of plaice from the smaller VIIe stock into VIId during quarter 1 is believed to take place. Once fish have moved into VIId to spawn they are then subject to fishing, largely by the Belgian and French trawlers that take the majority of their annual catch in January and February.

Conventional tags inform the recapture position and date of a tagged fish (with known release point) and such data has been investigated to estimate the likely movement rates of fish from VIId in quarter 1 into VIIe and IV. The movement rates can then be used to determine the proportion of the catch in VIId during quarter 1 that is due to immigrant spawning fish. The resulting estimates of the catch of fish from VIIe and IV that are caught in VIId can then be reallocated to the appropriate catch-at-age matrix.

WKFLAT reanalysed data from historical tagging experiments on plaice, which were archived in the Cefas 'Tagfish' database (Burt *et al*., 2006). The tags were captured through the fisheries and most are returned to Cefas within a few months of release; however these fish have had little chance to migrate. Therefore data from tagged fish with <6 months at liberty were excluded from further analysis. In order to focus on movement rates of fish that are available to the fishery only fish greater than the minimum landing size were considered for further analysis. Since tags are returned via the fishery the probability that a tag will be caught depends on the catch of plaice in an area: the greater the catch taken the more likely the tag to be caught. However, the more fish that are present within an area the less likely a tag is to be caught. Therefore the probability that a tag is caught in an area (Number recaptured/Number released) in a particular period must be weighted by the ratio of biomass/catch in that area and year so that probabilities can be comparable between areas and years. The resulting weighted proportions of tags returned from each area provide estimates of the movement probabilities between areas (Table below).

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

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

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

WKFLAT 2010 adopted a 15% movement of catches from VIId into VIIe in Q1 and similarly an additional 50% movement in Q1 from VIId to IV.

A.2. Fishery

In the western Channel, plaice are taken largely as a bycatch in beam trawls directed at sole and anglerfish. The main plaice fishery is concentrated to the south and west of Start Point. Although plaice are taken throughout the year, landings are usually heaviest during February/March and October/November. The fisheries taking plaice in the western Channel mainly involve vessels from the bordering countries: UK, France and Belgium

Main métiers

There are ten main métiers that exploit important fish and shellfish stocks in the Channel. Otter trawling accounts for a wide range of target species in season - cuttlefish, anglerfish, gurnard, rays, cod, whiting, plaice, sole, squid and lemon sole - and involves boats from France (600), England (470), Belgium (15) and the Channel Islands (11). Beam trawling is also important for boats from the three former nations (26, 83 and 65 respectively), targeting sole, anglerfish and plaice, with up to 25 of the Belgian boats extending this fishery into the Bay of Biscay. Many boats from France (626) and England (80) join two Channel Islands vessels dredging for scallops and taking a valuable bycatch of sole and anglerfish. The other main towed gear is midwater trawls, used either for the small pelagic species - mackerel, sprat, pilchard and herring - or for bass and black bream with a bycatch of gadoids by French (40) and English (25) boats. Purse-seines are used by eight UK vessels to take mainly mackerel and pilchard in the western Channel.

The fixed netting métier in the Channel is really composed of several métiers using specific net gears and mesh sizes depending on target species, the most important being with gillnets and trammelnets (580 French and 380 English boats) for sole, cod, ling, pollock, hake, plaice, bass and spider crab. Rays, anglerfish, turbot, crabs, lobster and crawfish are also taken in tanglenets (305 French, 300 English and seven Channel Islands).

Similarly, potting (960 French, 275 English and 560 Channel Islands) uses several distinct gears to catch brown (edible) crabs, spider crabs, cuttlefish, lobsters and whelk, both inshore and offshore, and there are zones in the western Channel partitioning potting and towed gears for alternating periods. Longlining has been replaced by fixed net in many cases, but conger eel, sharks, rays and bass are still taken (260 French, 60 English and 13 Channel Islands). Handlines are used for mackerel, bass, pollock and ling by small boats working along both the English (390) and French (120

French and 90 Channel Islands) coasts of the Channel. This information is accurate as at WG07.

A.3. Ecosystem aspects

Other than statistical correlations between recruitment and temperature (Fox *et al.*, 2000), little is known about the effects of the environment on the stock dynamics of VIIe plaice. Environment influences were considered by WKFLAT by incorporating sea surface temperature into the XSA model as a tuning fleet for age 1 catch numbers i.e. as an index of recruitment (ICES Working Document 4.3). Although the large recruitment signal in the late 1980s was partly tracked by the temperature time-series little information was gained, other than a mean recruitment level, for the recent period.

There is some anecdotal evidence of changes in the range of some species such as langoustine, triggerfish, and black sea bream from warmer parts of the Atlantic.

B. Data

B.1. Commercial catch

Landings

The fisheries that take plaice in the western Channel mainly involve vessels from the bordering countries: UK vessels report about 68%, France 24% and Belgium 8% of the total plaice landings from ICES Division VIIe (based on 2007/2008). Although plaice are taken throughout the year, landings are usually heaviest during February/March and October /November. Landings reached a peak of around 2600 tonnes in 1990 after a series of good recruitments in the late 1980s. Landing levels then declined rapidly once recruitment levels returned to average levels. Since 1994, landings have been stable at around 1200 tonnes; however, in 2007 and 2008 landings have been below this level.

Most of the landings are made by beam trawlers with around 70% of the UK landings being reported by these vessels and another 25% being landed by otter trawlers. The unallocated landings reported in the WG landings table in recent years are generally additional French landings derived from sales note information.

Sampling and data raising

Quarterly age compositions were available only from UK(England and Wales) landings for the years 1995–2010 (and 1989), which accounted for approximately 68% of total international landings. The total international age composition was obtained by raising the combined gears quarterly UK(England and Wales) age compositions to include the landings of the Channel Isles, France and Belgium, and summing to give an annual total.

For the earlier years of 1990–1994, French age compositions were also available. For these years, the UK(England and Wales) age compositions were raised to UK(Total) by including landings from the Channel Islands. Finally, UK(Total) and French age compositions were combined and raised to include Belgian landings. For the years 1981–1988 Prior to this, the stock data were aggregated for area of VIId+VIIe. For these years, Belgium also provided age compositions data and this was combined with UK(Total) and French age compositions. French age compositions were based on age data provided by the UK.

WKFLAT 2010 recommended a 'migration' model; this model reassigns 15% of the first quarter Belgian, French and UK catch in VIId to the VIIe catch-at-age matrix and similarly raises the landings by including 15% of the first quarter landings in VIId for each country. During the meeting, quarterly data for Belgium and France were available back to 1998 and UK data to 1997. In order to extend the time-series back to 1980 the first quarter landings and catch-at-age matrix for each country were inferred from the total annual international landings and catch-at-age data (which begin in 1980 for VIId). Total annual international catch-at-age at-age data (1980–1997 for France and Belgium and 1980–1996 for UK) were down-raised using the average proportion of catch at each age in the first quarter by each country over the period in which quarterly data were available. Similarly, SOP corrected Q1 landings for each country were calculated back to 1980 using the mean (calculated over the period in which quarterly data were available) proportion of the annual landings that were landed in Q1.

Age data representing French landings were available for 2002 and 2003, but were not used in the assessment.

Table A shows the national data availability for VIIe plaice stock for the time period 1981–2010.

Table B shows a time-series of CV's of numbers-at-age for sampling UK(E+W) all fleets combined.

Weights-at-age

Total international catch and stock weights-at-age were calculated as the weighted mean of the annual weight-at-age data supplied (weighted by landed numbers), and smoothed using a quadratic fit:

[e.g.: $Wt = (0.1109*Age) - (0.0004*(Age^2)) - 0.008$; $R^2 = 0.98$]

where catch weights-at-age are mid-year values (age = 1.5, 2.5, etc.), and stock weights-at-age are 1st January values (age = 1.0, 2.0, etc.). Catch weights-at-age have been scaled to give a SOP of 100%, and the same scaling has been applied to stock weights-at-age.

This technique has been used for many years (at least since stock has been assessed by the Southern Shelf Demersal WG. In early years in the time-series, weights-at-age were averaged over a period of years, and derived from separate-sex mean weights-at-age.

WKFLAT 2010 recommended a 'migration' model that alters the catch-at-age data. However, this model does not alter the weight-at-age matrix since it is not possible to distinguish which weight measurements in VIId are from VIIe migratory spawners.

B.2. Biological

The main spawning areas for plaice in the western Channel are south of Start Point and Portland Bill. Spawning takes place from December to March, with a peak in January and February.

On average, about a quarter of plaice in the western Channel are mature at age 2, half are mature at age 3 and all are mature at age 5. The majority of plaice landed in the western Channel in 2001, for example, were at ages 2–5, and therefore 73% of those landed were mature.

Natural mortality and maturity ogives

Initial estimates of natural mortality (0.12 ^{yr} all years and all ages) and maturity were based on values estimated for Irish Sea plaice (Siddeek, 1981). A new maturity ogive based on UK(E&W) VIIfg survey data for March 1993 and March 1994 (Pawson and Harley, 1997) was produced in 1997 and is applied to all years in the assessment.

Age	1	2	3	4	5+
Old maturity	0	0.15	0.53	0.96	1.00
New maturity	0	0.26	0.52	0.86	1.00

The proportion of mortality before spawning was originally set at 0.2 since approximately 20% of the total catch was taken prior to late February–early March, considered to be the time of peak spawning activity. The proportion of F and M before spawning was changed to zero prior to the 1994 Southern Shelf Demersal Working Group as it was considered that these settings were more robust to seasonal changes in fishing patterns, especially with respect to the medium-term projections.

B.3. Surveys and survey tuning data

An annual 4 m beam trawl survey has taken place in the Lyme Bay area of the western Channel since 1984, initially aboard chartered fishing Vessels (MV Bogey 1 and latterly MV Carhelmar) and more recently aboard the Cefas research vessel Corystes, coming back to MV Carhelmar in 2005.

Appendix 1 provides a history of the survey and details the survey methodology and objectives.

The western Channel beam trawl survey data are used to calculate assessment tuning data for both VIIe plaice and sole. Indices of abundance-at-age for years 1986 to the present, and for ages 1–5 have been used. Since 2007, this age range has been extended to include data for ages 1–8. Appendix 1 also describes how these indices of abundance-at-age are derived.

Since 2003 a 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. The survey covers a substantially larger area than the current survey (UK-WECBTS) and is thought to be more representative of the stock in UK waters. This dataset was first included in the 2007 assessment, and the exploratory analysis can be seen in that report (ICES, 2007; Section 3.2.5). However, recently the vessel(s) used for the survey have changed from the FV Nellie and the FV Lady T, to the FV Carhelmar. In 2008, in addition to the vessel changes there have been other sample protocol changes, notably the change to using 4m 'survey' beam trawls from the commercial 12 m beam trawls previously used by the other vessels. The working group, WGCSE 2009, decided to leave out the 2008 data from the FSP survey since it had an undue influence on estimates of SSB and F.

B.4. Commercial lpue

The UK(E+W) commercial lpue data are calculated for two gear groups (beam trawl, and otter trawlers both over 40 ft) and for three sectors within VIIe (VIIe north, VII south and VIIe west) made up of 'collections' of ICES rectangles. The lpue values are corrected for fishing power using a given relationship between fishing power and gross tonnage and are calculated using the total effort for a month/sector not species-directed effort. This relationship is FP=0.0072*GRT+0.6017 and this is standardized fit to pass through the mean GRT of Irish Sea trawlers in 1979 (Brander, unpublished).

Beam trawl lpue in the North of VIIe reached a peak in 1990, fell sharply to 1994 and is now fluctuates at low levels. The south and west sectors both peaked in the early 1990s but have steadily declined since. Otter trawl lpue in north of VIIe peaked in 1988 before falling sharply until 1995. Since then it has remained at these much lower levels. Lpue in the south is generally lower, but fluctuates to high peaks throughout the time-series, whereas in the west it has remained stable at a lower level for the duration of the time-series.

UK beam trawl effort has increased rapidly over the time-series, reaching record high levels in 2003 and has remained at this high level since. UK trawl effort has slowly decreased over the time-series, reaching a record low level in 2008. Effort is calculated as fishing power corrected using GRT.

Figures B and C show plots of UK effort for 1998–2008 by ICES rectangle for otter trawl and beam trawl gears, respectively.

Commercial tuning data

Commercial tuning information for this stock comprises of the UK(E&W) otter trawl fleet and the UK(E+W) beam trawl fleet. These fleets have been used by Working Groups for a number of years, and initially contained data for years back to 1976 (otter) and 1978 (beam). However in the most recent assessments carried out for this stock, otter trawl fleet data are currently used only for years 1988 to the present and for ages 3–9 and beam trawl fleet is currently used for years 1989 to the present, and ages 3–9. Since 2004, an historic otter trawl fleet (1976–1987) has been reintroduced using ages 2–9 only and this is calculated differently from the later data.

WKFLAT proposed a ‘migration’ model for western Channel plaice. If this is not acceptable and the ‘truncated’ model is taken forward then the commercial beam trawl and commercial otter trawl fleets should be truncated so that the first year of the time-series is 1998 and the last year is the most recent year. The ‘truncated’ model does not use the historic commercial otter trawl fleet, but has F-shrinkage increased from 2.5 to 1.0 to compensate for the increased variability in estimates of F.

B.5. Other relevant data

Discarding

Discard length summary data from the UK(E+W) and French discard sampling programmes has been made available to ICES working groups for the period 2002–2010. In addition, in 2010, Belgian quarterly discard length compositions were also available. All data indicate that discarding is at its highest in quarters 1 and 2 in this fishery, but is still low compared to other plaice stocks. No attempt has previously been made to raise these estimates to total landings.

For the 2010 benchmark meeting (WKFLAT), an analysis was carried out to determine the true level of discarding including trends in sampling effort, discarding patterns and an attempt to raise the sampling to an estimate of total discards. This work was presented to the meeting as ICES WKFLAT 2010, Working Document 4.4 ‘western Channel (VIIe) plaice discard data availability, trends and raising estimates to total landings, and comparisons with the trends of adjacent plaice stocks. The summary points made were as follows:

- Previous assumptions made by the Working Group that discarding is small compared to other plaice stocks, and that most discarding takes place in Quarter 1 and 2 appear robust. VIIe discard rates range from 9% in 2003 to 24% in 2008 with an average of 16%. Discarding is at its heaviest in quarters 1 and 2 with 26% and 19% discarded in these quarters and around 5% discarded in the remainder of the year.
- The discard rates appear to be increasing over time but are still at relatively low levels. Discard rates for VIIe plaice stock (16%) are much less than those for adjacent plaice stocks in VIId (57%) and VIIfg (73%).
- Sampling effort on discards is very good for the VIIe plaice stock and discard sampling effort is increasing. Most of the sampling effort has been carried out on beam and otter trawlers.
- Most discard sampling was carried out on vessels of length 10<20 m and with engine power between 100<300 Kw.
- Around 10% by weight, are discarded and this measure is increasing. The proportion discarded by weight has increased steadily from 5% in 2002 to around 13% in 2008. This compares favourably with the adjacent stocks that have rates of around 40% in VIId and around 60% in VIIfg (in 2008).
- There is no evidence of seasonal differences in the proportions discarded at length. The proportions of fish discarded at length for this stock show good levels of consistency over the time period and in addition the L50 values for each year are very close. This is not the case for the VIId and VIIfg stocks but for these stocks, the inconsistencies may be a feature of lower sample numbers.
- Around 60–70% of fish discarded are regarded as immature.
- Raising the discard sample data is possible by using either landings or effort but neither method is perfect. The main problem encountered was the limited availability of age data at the smaller/larger lengths.
- Most discards are at age 2 and age 3, where an estimated 28% and 5% respectively would be added to the landings age composition. For 2008, the resulting age compositions from both raising methods were almost identical although this may not be the case for other years.
- The total weight of the discarded catch in 2008 was estimated to be approximately 55 t amounting to around 6% of the commercial landings.

On reflection, the workshop considered the possible effects of the lack of discards included in this assessment and recommended that further investigations are conducted to include discard information in future assessments, but not to include the preliminary information available as it may reduce the management of the exploited portion of the stock. The data suggests discarding is minor in the years it has been raised to the fleet level. It was therefore concluded that the effect of including these data in the assessment would at best change the level of F and SSB over the whole time-series and at worst obscure the trends now seen because of the short and variable time-series of discard data available.

Potential discard raising methods

Two methods were used to raise the discard sample data to total discards.

1) Using landings. Sample data for the two main gear groups of beam trawl (gear 1) and otter trawl (gears 2,3,7) and the remaining gears (other) were

extracted by quarter. For each gear group and quarter, the weight of the total catch from the sampled trips was calculated by quarter using the formula (W=aL^b * N) where 'a' and 'b were quarterly condition factors for the stock in use within Cefas stock processing. The discarded Length Distributions (LD's) were then raised to total catches using the ratio of total reported catch/weight of discard trip catches.

An Age–Length Key (ALK) was applied to each raised quarterly LD to produce quarterly Age Compositions (AC) for each gear group/quarter. The ALK data used was taken from the age samples from the discard programme. Due to the small quantity of discard age data available, the ALK used was at the annual level. However even the ALK at this level only had small numbers of fish and did not cover the full length range of the discard LDs. In these instances, the discard ALK was supplemented by supplements by annual ALK data from the relevant commercial landings samples. At the smallest lengths without age data, an assumption about the age structure was made, but these were generally considered to be age 1.

These discarded ACs were then combined across gears then across quarters to give an annual estimate of discarded catches.

2) Using effort data. Given the recognized difficulties is assessing the 'true' effort levels of gears such as gillnetters and longlines, discard sample data only for the two main gear groups of beam trawl (gear 1) and otter trawl (gears 2,3,7) were extracted by quarter. The discarded LDs were raised to total catches using the ratio total reported effort (hours fished) catch/hours fished on sampled trips.

The same ALK as constructed above was applied to the quarterly raised LDs to give quarterly age compositions by gear/quarter. At the quarterly level, the two age compositions were combined then raised to include the catches form the 'other' gears. These ACs were then combined across gears then across quarters to give an annual estimate of discarded catches.

C. Historical stock development

This stock was assessed by ICES Southern Shelf Demersal WG from 1992 to 2008. For years 2009–present, this stock was assessed at ICES Celtic Seas Ecoregion Working Group. The stock has been managed by a TAC since 1984. The TAC is applicable to VIId (Eastern Channel) and VIIe combined, although in 1997 there was a separate limit for landings from VIIe. This was unpopular with the industry due to the national split being based on VIId+VIIe combined reported landings for the reference period, and has not been repeated since.

Benchmark 2010

This stock was 'benchmarked' at the WKFLAT 2010 meeting where the main issue under review was to overcome the problematic retrospective pattern that meant that forecasts had not been possible for some years. Solutions explored included making an 'allowance' for migration patterns between the two channel plaice stocks, termed the 'migration model'; this clearly had a knock-on effect on the eastern channel stock and the North Sea where there was also migration issues. Another option considered (the 'truncate model') involves truncating the commercial otter and commercial beam fleets back to 1998 but this was thought to only temporarily hide the underlying problem. Additionally, the 'truncate' model excludes the commercial historic otter trawl time-series and increases F-shrinkage from 2.5 to 1.0. WKFLAT 2010 recommends that the F_{bar} range is altered to 3–6 since very few age 7 fish are caught by the fishery (<4% of the catch numbers). The age range of the FSP survey was reduced to 2–8 since very few age 9 are caught by the survey and that age created positive residuals in catchability for every year.

Outcome: The workshop considered making an allowance for migration between the two channel plaice stocks. Having further examined tagging evidence available it was agreed that an 'allowance' of 15% of quarter 1 catches (both landings and the catch numbers-at-age) from VIId needed to be added into quarter 1 of the VIIe. This was required from all contributing nations.

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

The issue of including discard estimates was also considered, but based on the short time-series of data available and the 'limited' impact on the assessment outcome, this inclusion was deferred until a longer time-series of data was available.

Technical measures in force

Technical measures currently in force in the western Channel are a minimum mesh size of 80 mm for otter and beam trawlers and 70 mm for *Nephrops* trawlers. Panels of 75 mm square mesh are compulsory in all *Nephrops* fisheries in ICES Subarea VII.

There is also a minimum landing size (MLS) on 27 cm in force.

Model used: XSA

Software used: Lowestoft VPA suite

Model Options chosen: Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1976–2008	-	Yes
Canum	Catch-at-age in numbers	1976–2008	1–15	Yes
Weca	Weight at-age in the commercial catch	1976–2008	1–15	Yes
West	Weight at-age of the spawning stock at spawning time.	1976–2008	1–15	Yes
Mprop	Proportion of natural mortality before spawning	1976–2008	1–15	No
Fprop	Proportion of fishing mortality before spawning	1976–2008	1–15	No
Matprop	Proportion mature at-age	1976–2008	Age 1-0%; Age 2-26% Age 3-52%, Age 4-86% Age 5+-100%	No
Natmor	Natural mortality	1976–2008	1–15 (0.12)	No

Tuning data: 'migration model'

Type	Name	Year range	Age range
Survey fleet 1	UK Western beam trawl survey (UK-WEC-OT)	1986–2008	1–8
Commercial fleet 1	UK Western Channel Otter Trawl (UK-WECOT)	1988–2008	3–9
Commercial fleet 2	UK Western Channel Beam Trawl (UK-WECBT)	1989–2008	3–9
Commercial fleet 3	UK Western Channel Otter Trawl - Historic (UK-WECOT historic)	1980–1987	2–9
Survey fleet 2	UK FSP Survey (UK(E+W) FSP)	2003–2007	2–8

Tuning data: 'truncated model'

Type	Name	Year range	Age range
Survey fleet 1	UK Western beam trawl survey (UK-WEC-OT)	1986–2008	1–8
Commercial fleet 1	UK Western Channel Otter Trawl (UK-WECOT)	1998–2008	3–9
Commercial fleet 2	UK Western Channel Beam Trawl (UK-WECBT)	1998–2008	3–9
Commercial fleet 3	UK Western Channel Otter Trawl - Historic (UK-WECOT historic)	Excluded	
Survey fleet 2	UK FSP Survey (UK(E+W) FSP)	2003–2007	2–8

History of assessment methods and settings investigations

The standard settings for a catch data screening run using a separable VPA are reference age of 4; F set to 0.7 and S set to 0.8.

In 1991 the stock was assessed using a Laurec–Shepherd tuned VPA. Concerns about deteriorating data quality prompted the use in 1992 of XSA.

Trial runs have, over the years, explored most of the options with regards XSA settings:

- The effect of the power model on the younger ages was explored in 1994; 1995; 1996; 1998, 2004 and 2010.
- The use of P shrinkage was investigated in 2001; 2004.
- Different levels of F shrinkage were explored in 1994; 1995; 2000; 2002; 2004 and 2010.
- The level of the + group was examined in 1995, 2004 and 2010.
- The effect of different time tapers was investigated in 1996.
- The S.E. threshold on fleets was examined in 1996; 2001 and 2007.
- The level of the catchability plateau was investigated in 1994; 1995; 2002; 2004 and 2010.

Table C shows the history of VIIe plaice assessments and details the parameters used.

D. Short-term projection

Standard ICES software is used for the short-term projections – MFDP.

No short-term forecast has been provided since 2006 as the review group deemed it unhelpful in the management of the stock given the strong retrospective bias in F.

However WKFLAT was able to carry out a forecast following the removal of the strong retrospective bias in F.

The diagnostics suggest that estimation of the recruiting year class (age 1) is poorly estimated in the assessment, both because catchability is very low in the commercial fisheries and because the surveys are very noisy at this age. Consequently, estimation of survivors from the recruiting age is poorly estimated and should not be used in the forecast. It was deemed more appropriate to estimate survivors at age 2 on the basis of the geometric mean abundance of historic recruitment. The time period chosen should be consistent with that chosen for estimating future recruitment. Currently this could be formulated as.

The short-term forecast uses:

1) the survivors at age 3 and greater from the XSA assessment
2) N at age 2 = mean(ln(recruitment (1998 – current year-1))*exp –(0.12 + mean(F(age 1)))
3) Stock and Catch weights = average stock and catch weights over the preceding three years, unless there is an indication that there are strong trends in these, in which case they will be need to be dealt with appropriately by WGCSE.
4) The F vector used will be the average F-at-age in the last three years, unless there is strong indication of a significant trend in F. In the latter case the average selectivity pattern will be rescaled to the final F in the series.

This procedure is in line with the convention used at WGCSE and the historic treatment of the short-term forecast for this stock.

E. Medium-term projections

F. Yield and biomass-per-recruit/long-term projections

Standard ICES software is used for the long-term projections – MFYPR.

As with most plaice stocks, there is no clear stock–recruitment relationship evident.

Not carried for this stock between 2006–2009. YPR projections run for 2010–2011.

G. Biological reference points

WGCSE 2010; F_{MSY} evaluation

To derive an F_{MSY} estimate the SRMSYMC package was employed and F_{MSY} was calculated based on the three common stock–recruit relationships; Ricker, Beverton–Holt and smooth Hockey stick. Models were fitted using 1000 MCMC resamples. For all three stock–recruit relationships (SRR), all resamples allowed F_{MSY} and F_{crash} values to be determined. All three models show that there is little evidence of a stock–recruitment relationship with only limited information as to the trends at extreme levels of SSB.

The smooth hockey-stick model showed a 'break-off' point in the SRR that was inconsistent with the data and as such was rejected. The yield-per-recruit estimates were highly uncertain with high CV's. Therefore these estimates were also rejected. The two SRR models have very different levels of estimated F_{MSY}. Full diagnostics for all model fits can be found in the WGCSE 2010 report.

Stock–recruit relationship Model	F_{MSY}	F_{Crash}
Ricker	0.312	0.750
Beverton–Holt	0.143	0.781

Therefore, the suggested level of F_{MSY} for this stock is F's within the range of 0.14 and 0.31.

F_{MSY} (and PA) reference points in use after the WGCSE 2010

	Type	Value	Technical basis
MSY Approach	MSY $B_{trigger}$	2500 t	B_{PA}
	F_{MSY}	0.19	Provisional proxy by analogy with plaice in the Celtic Sea. Fishing mortalities in the range 0.14–0.31are consistent with F_{MSY}
Precautionary Approach	B_{lim}	1300 t	B_{lim}=B_{loss} The lowest observed spawning–stock biomass.
	B_{PA}	2500 t	MBAL, biomass above this affords a high probability of maintaining SSB above B_{lim}, taking into account the uncertainty in assessments.
	F_{lim}	Not defined.	
	F_{PA}	0.45	This F affords low probability that (SSBMT<B_{PA}).

However the Working Groups since 2004 had considered the precautionary reference points for this stock as unreliable for the following reasons:

- The stock–recruitment relation shows no evidence of reduced recruitment at low stock levels;
- The basis for B_{PA} is weak, and heavily dependent on two consecutive points (1985 and 1986);
- F_{PA} is based on B_{PA}, then this reference point is also rejected.

In 2010, WKFLAT examined the stock dynamics provided by the new preferred XSA model based on migration at length to determine appropriate biological reference points for this stock on the basis of the new assessment. It concluded that the historic reference points for this stock were no longer appropriate as the new assessment indicated significant changes to the historical perspective of the stock caused by the inclusion of catches from VIId in the VIIe plaice stock.

In the event that alternate assessment models be used, these reference point discussions will need to be repeated on the basis of the alternative model, as our understanding of stock dynamics are likely to be different for such a model.

Examination of the Biomass reference points indicated with some certainty that recruitment to the stock was not negatively impacted by SSB levels greater than 2200 t (B_{loss} (1996) following which a significant recovery in SSB of the stock had been observed, MBAL.), but there was little or no evidence of stock collapse at lower SSB levels Consequently, the group had difficulty in deciding whether this should be considered a limit reference point or a precautionary reference point. Dependent on this choice B_{PA} would either be 2200 t (with a commensurate B_{lim} set at 1600 t), or 3100 t (B_{lim} = 2200 t) on the basis that there should be a 40% buffer between the two reference points (procedure consistent with the development of reference points in WGCSE).

F reference points consistent with these biomass reference points based on a short-term recruitment series were calculated on the basis of the yield-per-recruit calculations and shown in the table below as option 1 and 2. Bold numbers indicate the basis of the reference points for each option.

	Option 1	Option 2	Option 3
B_{lim}	1600	2200	2100
B_{PA}	2200	3100	3000
F_{lim}	0.55	0.7	0.60
F_{PA}	0.40	0.55	0.42

Option 1 indicates that B_{lim} is lower than the observed spawning–stock biomass for this stock, while option 2 suggests that F_{lim} is higher than levels of F observed in the stock, therefore both sets of reference points would move to areas of stock dynamics not previously observed which the group considered risky. The new assessment indicates that the trend in F has been relatively flat since the late 1980s at levels around 0.6. Over this period SSB has increased and declined in response to recruitment, but without causing a collapse in the stock. It might therefore be considered as a limit reference point (F_{lim}), option (3).

The problem with this stock is that we have an insufficient understanding of the stock dynamics outside the relatively small range of Fs and little or no response in recruitment to the range of SSBs observed. Consequently, each of the choices made in considering the calculation of the other reference points is also precautionary so that the final set of reference points invariably is ultra precautionary. The group could not come to a consensus with regards to suitable precautionary reference points but clearly stated that Fsq is currently too high and should be reduced, while biomass dynamics below the reasonably well estimated SSB levels of 2200 t are poorly understood.

The group felt more confident in using the 2200 t as a $B_{trigger}$ in the new advisory framework based on MSY based management targets, provided that the management intervention at this level of SSB was sufficient to move the stock away from this level of SSB with considerable certainty. It is deemed unlikely that low levels of SSB near $B_{trigger}$ would be reached if long-term management aimed to attain F levels near an appropriate proxy of F_{MSY}.

No appropriate proxy was developed for F_{MSY} given the current uncertainty over the basis for such advice, however the WKFLAT 2010 commented that because plaice are taken largely in conjunction with sole in Area VIIe it is important that the target levels between the stocks are consistent especially because a management plan has been agreed for sole VIIe.

Previous biological reference points proposed for this stock by the 1998 working group have been in use until 2009 (as below).

F_{lim}	Not defined	F_{pa}	0.45	(low probability that SSB_{MT}<B_{pa})
B_{lim}	1300 t; (equal to B_{loss})	B_{pa}	2500 t	(equal to MBAL)

The recent Working Groups view of these reference points had been that they were considered unreliable.

H. Other issues

I. References

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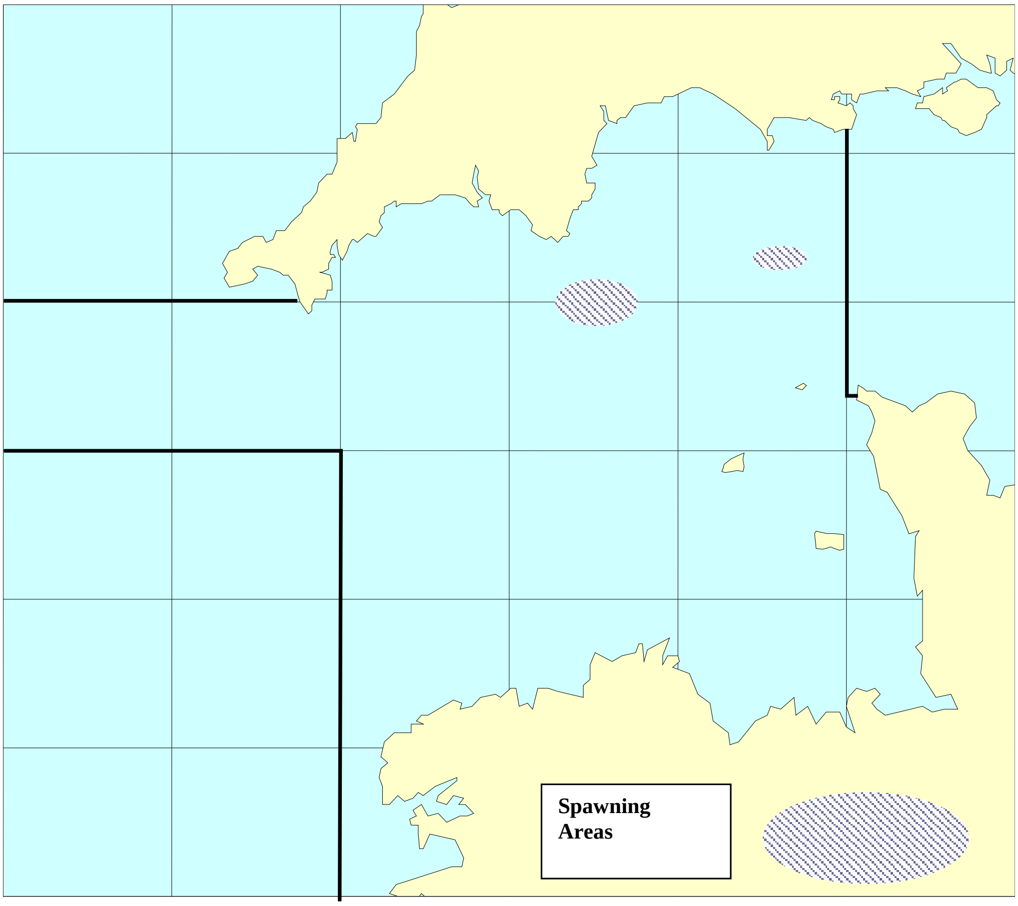


Figure A. Map of spawning areas for VIIe plaice.

Table A. VIIe plaice. Catch Derivation table for assessment years 1981–2008.

		source				
Year of WG	Data	UK	Belgium	France	derivation of international landings	% sampled
1981*	length composition	quarterly	quarterly	quarterly	UK ALK used with French LDs	100
	ALK	quarterly	quarterly	-	UK+Belgium+France combined to total international	
	Age composition	quarterly	quarterly	-	No analytical assessment carried out	
1982*		As for 1981	As for 1981	As for 1981	As for 1981	100
1983*		As for 1981	As for 1981	As for 1981	As for 1981	100
1984*		As for 1981	As for 1981	As for 1981	As for 1981	100
1985*		As for 1981	As for 1981	As for 1981	As for 1981	100
1986*		As for 1981	As for 1981	As for 1981	As for 1981	100
1987*		As for 1981	As for 1981	As for 1981	As for 1981	100
1988*		As for 1981	As for 1981	As for 1981	As for 1981	100
1989*	length composition	quarterly	-	-	UK raised to total international	70
	ALK	quarterly	-	-		
	Age composition	quarterly	-	-		
1990	length composition	quarterly	-	quarterly	UK+France raised to total international	96
	ALK	quarterly	-	quarterly		
	Age composition	quarterly	-	quarterly		
1991		As for 1990	-	As for 1990	As for 1990	97
1992		As for 1990	-	As for 1990	As for 1990	97
1993		As for 1990	-	As for 1990	As for 1990	98
1994	length composition	quarterly	-	quarterly	UK ALKs applied to French LDs	96
	ALK	quarterly	-	-	UK+France raised to total international	
	Age composition	quarterly	-	-		
1995		As for 1989	-	-	As for 1989	83
1996		As for 1989	-	-	As for 1989	82

	source				
1997	As for 1989	-	-	As for 1989	78
1998	As for 1989	-	-	As for 1989	79
1999	As for 1989	-	-	As for 1989	75
2000	As for 1989	-	-	As for 1989	72
2001	As for 1989	-	-	As for 1989	72
2002	As for 1989	-	-	As for 1989	78
2003	As for 1989	-	-	As for 1989	81
2004	As for 1989	-	-	As for 1989	79
2005	As for 1989	-	-	As for 1989	74
2006	As for 1989	-	-	As for 1989	74
2007	As for 1989	-	-	As for 1989	68
2008	As for 1989	-	-	As for 1989	70
2009	As for 1989	-	-	Migration correction added equal to 15% of Q1 VIId	78
				Landings from UK, Belgium and France. In addition, 15%	
				Of Q1 Age comps added to the VIIe international AC.	
				Also –back calculated for years 1985-2008.	
2010	As for 1989	-	-	As 2009 – with Netherlands VIId Q1 component added	78

*** stock assessed as VIId,e plaice.**

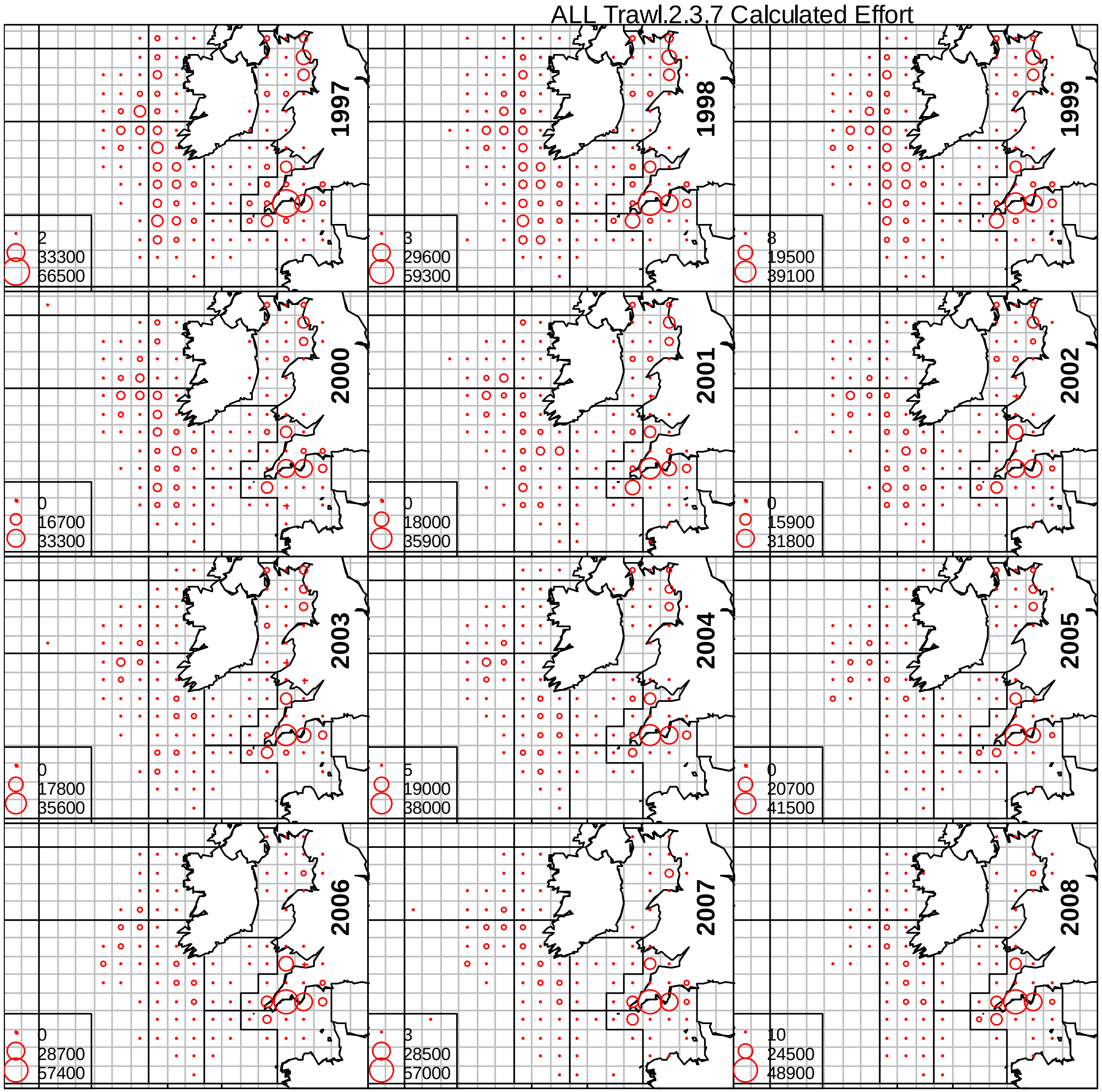


Figure B. UK(E+W) Otter trawl fleet effort (hours fished) – based on demersal landings.

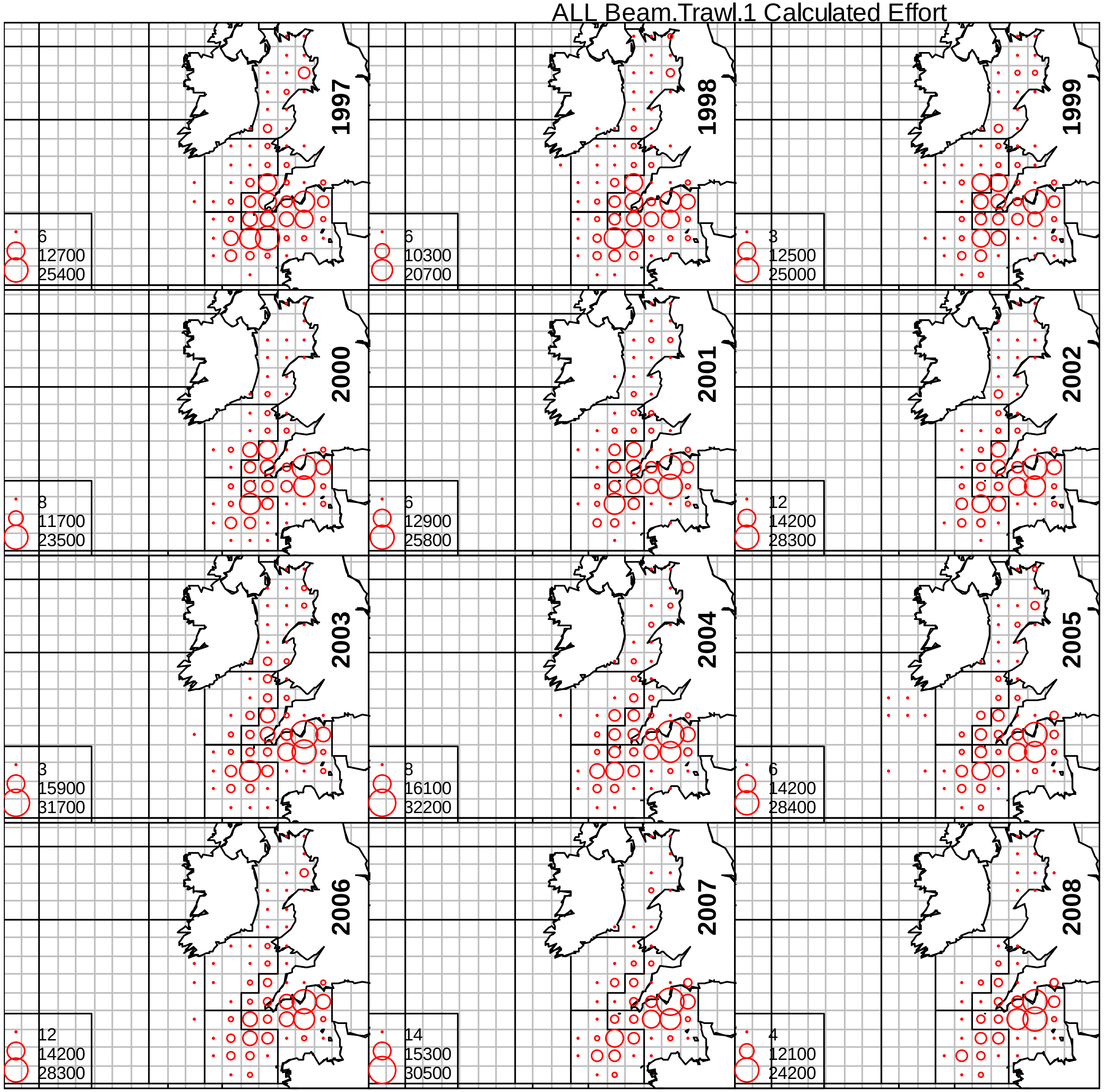


Figure C. UK(E+W) Beam trawl fleet effort (hours fished) – based on demersal landings.

Table B. CV of numbers at-age for commercial sampling

		CV by AGE								
YEAR	COUNTRY	1	2	3	4	5	6	7	8	9
2005	UK(E+W)	18%	3%	3%	3%	6%	7%	11%	10%	9%
2006	UK(E+W)	21%	4%	3%	5%	5%	8%	10%	15%	14%
2007	UK(E+W)	42%	5%	3%	4%	6%	6%	9%	13%	20%
2008	UK(E+W)	42%	4%	4%	5%	6%	8%	8%	10%	14%
2009	UK(E+W)	39%	5%	3%	6%	7%	9%	11%	11%	16%
2010	UK(E+W)	17%	4%	3%	3%	7%	9%	14%	26%	23%

Table C. History of VIIe plaice assessments.

VIIe plaice – Assessment parameters used (1991–2010)																			Benchmark		
	1991*	1992*	1993*	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2010	2011
Assessment Age Range	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+
Fbar Age Range	3-8	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-6	3-6	3-6
Assessment Method	LS/Trad VPA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA
Tuning Fleets :																						
UK trawl yrs	76-90	76-91	76-92	84-93	84-94	86-95	87-96	88-97	88-98	88-99	88-00	88-01	88-02	88-03	88-04	88-05	88-06	88-07	88-08	88-09	88-09	88-10
Ages	1-9	1-9	1-9	2-9	2-9	2-9	2-9	2-9	2-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9
UK trawl (historic) yrs														76-87	76-87	76-87	76-87	76-87	76-87	80-87	80-87	80-87
Ages														2-9	2-9	2-9	2-9	2-9	2-9	2-9	2-9	2-9
UK beam yrs	78-90	78-91	78-92	84-93	84-94	86-95	87-96	89-97	89-98	89-99	89-00	89-01	89-02	89-03	89-04	89-05	89-06	89-07	89-08	89-09	89-09	89-10
Ages	1-9	1-9	1-9	2-9	2-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9
UK b/trawl survey yrs		86-91	86-92	86-93	86-94	86-95	87-96	88-97	86-98	86-99	86-00	86-01	86-02	86-03	86-04	86-05	86-06	86-07	86-08	86-09	86-09	86-10
Ages		1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-8	1-8	1-8	1-8	1-8	1-8
UK FSP survey yrs																	03-06	03-07	03-07	03-09	03-09	03-10
Ages																	1-8	1-8	1-8	1-8	1-8	1-8
Time taper		20yr tri	20yr tri	20yr tri	20yr tri	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Power model ages		1	1	1	1-3	1-3	1-3	0	1	1-5	1-5	1-5	1-5	0	0	0	0	0	0	0	0	0
P shrinkage		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Q plateau age		8	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
F shrinkage S.E		0.3	0.3	0.3	0.8	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Num yrs		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Num ages		5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Fleet S.E.		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	0.3	0.3	0.3	0.3	0.5	0.5	0.5

*** Early version of XSA/VPA and tuning fleet age/year ranges used not specified. Assumed all years used but age range used uncertain.**

VIIe plaice - Assessment parameters used (1991-2010)

	1991*	1992*	1993*	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Benchmark 2010	2010	2011
Assessment Age Range	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+
Fbar Age Range	3-8	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-7	3-6	3-6	3-6
Assessment Method	LS/Trad VPA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA
Tuning Fleets :																						
UK trawl yrs	76-90	76-91	76-92	84-93	84-94	86-95	87-96	88-97	88-98	88-99	88-00	88-01	88-02	88-03	88-04	88-05	88-06	88-07	88-08	88-09	88-09	88-10
Ages	1-9	1-9	1-9	2-9	2-9	2-9	2-9	2-9	2-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9
UK trawl (historic) yrs														76-87	76-87	76-87	76-87	76-87	76-87	80-87	80-87	80-87
Ages														2-9	2-9	2-9	2-9	2-9	2-9	2-9	2-9	2-9
UK beam yrs	78-90	78-91	78-92	84-93	84-94	86-95	87-96	89-97	89-98	89-99	89-00	89-01	89-02	89-03	89-04	89-05	89-06	89-07	89-08	89-09	89-09	89-10
Ages	1-9	1-9	1-9	2-9	2-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9
UK b/trawl survey yrs		86-91	86-92	86-93	86-94	86-95	87-96	88-97	86-98	86-99	86-00	86-01	86-02	86-03	86-04	86-05	86-06	86-07	86-08	86-09	86-09	86-10
Ages		1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-8	1-8	1-8	1-8	1-8	1-8
UK FSP survey yrs																	03-06	03-07	03-07	03-09	03-09	03-10
Ages																	1-8	1-8	1-8	1-8	1-8	1-8
Time taper		20yr tri	20yr tri	20yr tri	20yr tri	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Power model ages		1	1	1	1-3	1-3	1-3	0	1	1-5	1-5	1-5	1-5	0	0	0	0	0	0	0	0	0
P shrinkage		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Q plateau age		8	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
F shrinkage S.E		0.3	0.3	0.3	0.8	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Num yrs		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Num ages		5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Fleet S.E.		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	0.3	0.3	0.3	0.3	0.5	0.5	0.5

* Early version of XSA/VPA and tuning fleet age/year ranges used not specified. Assumed all years used but age

Appendix A – Beam trawl surveys in the western Channel (VIIe)

1. History of the survey

Complaints from the fishing industry in the southwest about the lack of scientific investigation and knowledge of the local sole stock provided the catalyst for the survey in VIIe. Following enquiries of the local fishery officers and normal tendering procedures, a skipper-owned 300-hp beam trawler, the Bogey 1, was selected. The first year (1984) the survey consisted of a collection of tows on the main sole grounds. In 1989 the Bogey 1 was replaced with the Carhelmar and the survey continued unchanged until 2002 when R.V. Corystes took over the survey as an extension to its 'near-west groundfish survey'.

Due to the changes occurring through the time-series, the surveys completed on R.V. Corystes (2002 onwards) will be described separately to the 'previous' surveys (pre 2002).

2.a. Survey objectives (1984 to 2001, and 2005 onwards)

To provide independent (of commercial) indices of abundance of all age groups of sole and plaice on the west channel grounds, and an index of recruitment of young (1–3 year old) sole prior to full recruitment to the fishery.

2.b. Survey objectives (2002 to 2004)

The primary objectives of the Irish Sea beam trawl survey are to (a) carry out a 4 m beam trawl survey of groundfish to i) obtain fisheries-independent data on the distribution and abundance of commercial flatfish species, and ii) derive age compositions of sole and plaice for use in the assessment of stock size; and (b) to collect biological data, including maturity and weight-at-age, for sole, plaice, lemon sole and other commercially important species. The epibenthic bycatch from these catches has been quantified, and these surveys are also used to collect biological samples in support of other Cefas projects and training courses.

3.a. Survey methods (1984 to 2001, and 2005 onwards)

For the years 1984–1988 the vessel was unchanged and was equipped with two 6 m chain mat beam trawls with 75 mm codends. For the survey hauls one of the codends was fitted with a 60 mm liner. In 1989 the Bogey 1 was replaced by the latest design 24 m 300 hp(220 kw) beam trawler Carhelmar. In 1988 two commercial chain mat 4 m beam trawls (measured inside the shoe plates) were purchased by MAFF as dedicated survey gear. Both beams were fitted with the standard flip-up ropes and 75 mm codend. For years 1989 and 1990 only one codend was fished with a 40 mm liner but from 1991 with the introduction of 80 mm codends both were fitted with 40 mm liners. The vessel and gear has remained unchanged since 1991.

Between 1989 and 2001 the survey remained relatively unchanged apart from small adjustments to the position of individual hauls to provide an improved spacing. In 1995 two inshore tows in shallow water (8–15 m) were introduced. The survey now consists of 58 tows of 30 minutes duration, with a towing speed of 4 knots in an area within 35 miles radius of Start Point. The survey design is stratified by 'distance from the coast' bands, in contrast to the VIIa, f+g survey that is stratified by depth bands. The reason for this is that the coastal shelf with a depth of water less than 40 m is relatively narrow and in addition is often fished with fixed gear. The survey bands (in miles) are 0–3, 3–6, 6–12, 12+ inshore, and 12+offshore.

3.b. Survey methods (2002 to 2004)

The standard gear used is a single 4 m beam trawl with chain mat, flip-up rope, and a 40 mm codend liner to retain small fish. The gear is towed at 4 knots (over the ground) for 30 minutes, averaging 2 nautical miles per tow. Fishing is only carried out in daylight, shooting after sunrise and hauling no later than sunset, as the distribution of some species is known to vary diurnally.

Once on board the catch is sorted to species level, with the exception of small gobies and sandeels, which are identified to genus. Plaice, sole, dab, and elasmobranchs are sorted by sex, all fish categories weighed, and total lengths are measured to the full centimetre below, or half centimetre if the species is pelagic. Area stratified samples of selected species are sampled for weight, length, sex, maturity, and otoliths or scales removed for ageing.

The standard grid of 58 stations was fished in 2002 and 2003 (see map), and although other stations have been fished in this period, they were for exploratory purposes and were not included in the assessment.

4. Abundance index calculation

Plaice and sole abundance indices are calculated by allocating the appropriate ages to the fish that are caught. This gives the age composition (AC) of the catch, and this is used in the appropriate working group analysis.

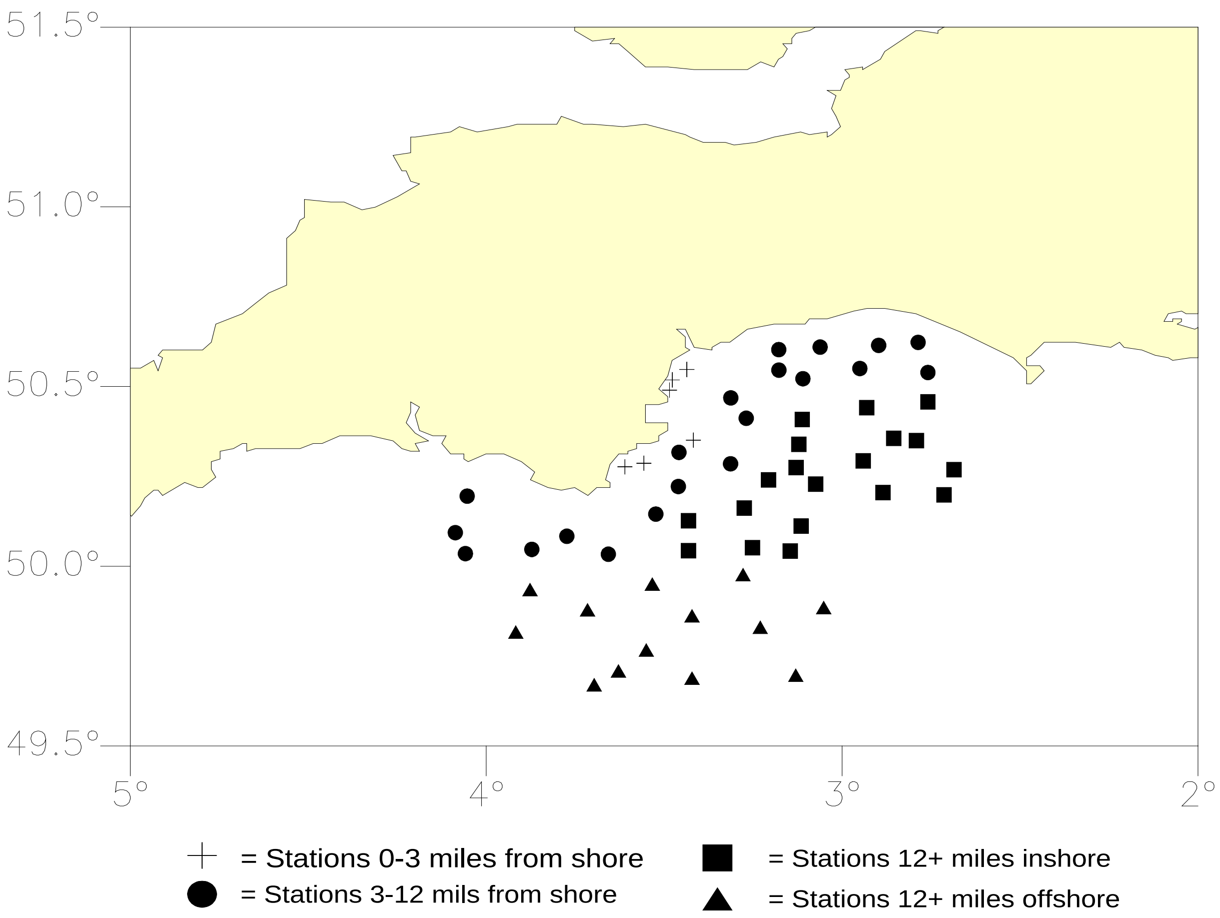
The AC's are calculated by proportioning a length distribution (LD) to an appropriate age–length key (ALK). To account for possible population differences within ICES Division VIIe, biological samples are taken from sectors stratified by distance from shore (see map). The survey bands (in miles) are 0–3, 3–12, 12+ inshore, and 12+ offshore. Where appropriate the ALK's are separated by sex, and this allows a particular 'sector, depth-band and sex' ALK to be raised to the corresponding LD to give an accurate AC for that particular habitat. The AC's can then be combined as required to give results in the form of 'numbers at-age, per distance or time'.

Between 1984 and 1990 a total survey age–length key was applied to the 'grid' length distribution, but from 1990 onwards stratum stratified age–length keys were used.

The table below show the stratifications currently used to calculate the 'near-west groundfish survey' abundance indices.

5. Map of survey grid

Additional stations have been fished throughout the time period, but as these stations are not consistently fished, they are excluded from this map.



6. Summary

Area covered	ICES Division VIIe
Target species	Flatfish, particularly prerecruit plaice and sole
Time period	September-October. 1988 to present.
Gear used	1984–1988 - 2 * 6m beam trawls
	1989–2001 - 2 * 4m beam trawls
	- 1* 4m beam trawl
	2005–Present - 2 * 4m beam trawls
Mean towing speed	4 knots over the ground
Tow duration	30 minutes
Vessel used	1984–1988 - F.V. Bogey 1
	1989–2001 - F.V. Carhelmar
	2002–2004 - R.V. Corystes
	2005–Present - F.V. Carhelmar

8.3 Sole in Division VIIe

Stock	Sole in Division VIIe (Western Channel)
Date	13/03/2009
Revised by	Sven Kupschus (revised at WKFLAT 2012. ICES, 2012)

A. General

A.1. Stock definition

The management area for this stock is strictly that for Division VIIe. Biologically speaking however the picture is much less clear. Sole in general are relatively sedentary, once settled they perform a seasonal inshore offshore movements during their spawning migration with a random longshore component. Therefore the management unit of the stock is well defined for mature fish. There is good evidence to suggest that the stock is split into two biological stocks on either side of the Hurd Deep. If this prevents complete mixing of the stock it an assessment methodology capable of taking account of this should be applied. This could explain differences in the trends representative of stock dynamics in the different fisheries. The two main fisheries on the UK coast around Lyme Bay and the Start as well as the fishery on the coast in the eastern part of the management area are clearly separated by the deeper waters of the channel, so that the fishery covers only about half of the management area so that incomplete mixing may be a problem in this stock.

With respect to the stock as observed by the fishery there seem to relatively few issues regarding stock identity and once recruited the stock appears to represent a closed population. Spawning migrations by sole tend to be in a seasonal onshore offshore pattern with a small random movement alongshore described for the species in other areas. Given the layout of the stock and the apparent breaks in the distribution of sole at the edges of the management unit there appears to be little concern for significant leakage across stocks. However the biological stock unit for Division VIIe is much less certain at the larval and prerecruit stage. The proportion of the area that represents nursery grounds is much smaller than those for other sole stocks of equal size, with only two small regions (the inner part of Lyme Bay and the Bay de Mount St Michelle) known to regularly produce 1-groups sole.

Tagging information of juvenile sole, mostly 1–3 year olds show that there is significant ingress of recruits from the adjacent stock in ICES Division VIId from both the French and the UK coast that appear in the region of out Lyme Bay. Unfortunately, very little tagging data are available to examine if there is an equal or greater reciprocal movement in the opposite direction, but given the limited nursery habitat and the abundance of sole recruits in Division VIIe it seems reasonable to assume that there is a net inwards migration of prerecruits that remain in the area following maturation.

Spawning is known to occur in the division from survey evidence in a relatively small concentration on the ‘Bank de Langustine’ and intermittently in very low concentrations in the western part of the UK coastal region and around the edges of the Hurd Deep. Little is known about the fate of the spawning products, but given the relatively long egg and larval stage as well as the significant net eastward movement of waters in the channel it is plausible that the stock utilizes nursery habitat in the eastern half of the channel. The degree of stock isolation in terms of these recruits has not been investigated, as it is possible that the recruits contribute to a common pool of recruits with the eastern stock.

Isolation from the Celtic Sea (both the Bristol Channel and the Bay of Biscay) appears to be more rigorous according to tagging information, with few individual traversing the strong environmental and habitat gradients found in the rocky areas around lands end. However, the 1998 year class is indicated to be above average from all tuning information with the exception of the UK-BTS survey. The fact that this cohort is not well represented in what is thought to be the best indicator of recruitment, yet is readily observed in information from the more westerly and offshore parts of the stock area may indicate that there are other, as yet poorly understood recruit sources within the region.

From a stock assessment point of view and in the absence of a modelled stock–recruitment relationship there appears then relatively little concern over a lack of a closed population given the low movement rates post maturation. The low movement and its seasonality in conjunction with the high concentration of fishing effort around Start Point may produce effects of local depletion that may imply higher rates of fishing mortality for the UK-CBT fleet when compared to mortality rates from other indices covering a wider area. Such conjecture is potentially supported by the fact that when the new Q1SWBeam survey is viewed as an absolute index of abundance it produces higher estimates of stock size than the assessment. While stock size remains relatively stable and the behaviour of the fishery remains stable this is likely to have little impact on the assessment as the difference is absorbed in the estimates of catchability. If the fishery expands spatially with a commensurate reduction in the per-unit-area effort, or as migration rates change in response to stock size such affects may become more apparent in the assessment so that it is important to consider/examine such changes in future.

The assessment method agreed by WKFLAT 2012 (ICES, 2012), and described in this "Stock Annex", does not specifically deal with the uncertainty regarding stock boundaries, nor the issue of incomplete mixing and spatial dynamics in the stock and fishers. However, for advisory purposes the assessment methodology agreed at WKFLAT 2012 is able to provide robust advice despite these slight omissions. Part of the problem is that such process error is apparent in this stock only because of the high degree of precision and certainty in the data. Spatial issues are known to occur in other stocks, but the results of this process error are not apparent from the assessments because overall variability is much greater.

A.2. Fishery

The principal gears used for sole in the Western Channel are beam and otter trawls, for the UK fleet and entangling nets and otter trawls for the French fleet. In recent years, UK vessels have accounted for around three quarters of the total international landings, with France taking approximately a quarter and Belgian vessels the remainder. UK landings were low and stable between 1950 and the mid-1970s, but increased rapidly after 1978 as a consequence of the replacement of otter trawlers by beam trawlers. Because the UK fleet is the major component of the international landings, they follow a similar trend. Sole is the target species of an offshore beam trawl fleet, which is concentrated off the south Devon and Cornish coasts, and also catches plaice and anglerfish. In recent years a winter fishery targeting cuttlefish has developed for the English beam trawl fleet in the Western Channel, lasting from November till the end of March. This has taken some of the reliance of the fleet away from sole, but sole still represents a substantial portion of the catch during this time so it is not clear to what degree the switch to cuttle-fishing has reduced fishing mortality on sole.

Discarding of sole in this fishery is thought to be minor, supported by the time-series (2002–2008) of discard information for the UK fleet shown in Figure A.2.1. Landings of sole reached a high level above 1400 t in the 1980s, boosted initially by high recruitment in the late 1970s, followed by an increase in exploitation. Landings declined between 1988 and 1991, following the recruitment of three below-average year classes (1986–1988); since 1991 they have fluctuated between 800 t and 1100 t. Substantial quantities of sole caught in VIIe have been reported to two rectangles in VIId in order to avoid quota restrictions. Corrections for this misreporting were first made during the 2002 WG, but misreporting to other areas has been more difficult to identify. In addition, black landings are likely to have occurred to various degrees since quotas became restrictive in the late 1980s. No estimates of the scale of the problem exist so that this uncertainty has not been incorporated into the assessment process.

Since the development of the beam trawl fleet in the Western Channel in the early 1980s there has been a consolidation to larger more powerful vessels, particularly in the late 1990s and early 2000s. However, the severe quota restrictions at that time have lead to a reversal of this trend and a lesser emphasis on sole as the major income for the fleet. Undoubtedly sole still form the back bone of this fishery due to the steady availability over the ground. However in recent years the fishery has adapted with smaller more flexible vessels and an overall reduction in kWH as well as a further small decrease in the number of boats due to a decommissioning scheme, to make the most of other resources such as scallops, cuttlefish, gurnards, etc. foregoing possible higher catch rates of sole. This is reflected in the offshore movement of the fishery around Start Point.

At the lower catch rates described above the fleet is at an appropriate capacity to take the available quota and appears to have sufficient financial stability and certainty to allow for continued investment in the fishery. Were the industry to return to previous patterns of exploitation targeting the younger and more abundant sole in Lyme Bay it would almost certainly be able to increase the fishing mortality to levels greater than that assumed to be sustainable. The current enforcement regulations with a change in the attitude of the industry have meant that the TAC is an appropriate management tool in at least the UK fishery. Limiting days at sea further will have a perverse tendency to reverse this trend and focus effort grounds in Lyme Bay because of their proximity and the higher catch rates.

A.3. Ecosystem aspects

Little is known with regards of the effect of the environment on the stock dynamics of VIIe sole. Certainly the division is on the convergence between the Celtic Sea proper and the Channel/North Sea ecosystem. If predicted increases in temperature were to materialize changes to the stock dynamics of this and other species in the Division would be expected. To date there is good evidence of a sizeable increase in the abundance of bass in the area, a species with a similar pan European distribution as sole. In addition there is some anecdotal evidence of changes in the range of some species such as langoustine, triggerfish, and black sea bream from warmer parts of the Atlantic. In the North Sea it has also been suggested that cold periods immediately prior to spawning have a tendency to increase year-class strength and there is some indication of this for this stock, but no statistical analysis has been carried out to date.

Beam trawling is known to have a significant impact on the seabed. It is understood though that those areas affected continue to be productive in terms of the target species. After the initial degradation of the habitat usually associated with the loss of sessile macro fauna, continued use of beam trawls seems to have few further impacts.

B. Data

B.1. Commercial catch

UK (>60%) and France (>30%) together provide almost all the catches for this stock. UK Landings data are based on EU logbook data for VIIe catches. In 2002 the UK industry indicated that there had been substantial misreporting of landings to two rectangles in Division VIId. It was possible to identify the misreported landings spatially and by reported lpue. Having identified misreported landings, data were corrected back to 1985 by the 2002 WG. This method of correction is ongoing. French official landings statistics have been poor since 1997, but since 1997 landings data have been calculated much more accurately using buyer and sellers notes. France has provided corrected landings information to the Working Group since 2002.

Numbers-at-age prior to 1994 are calculated by raising the UK age composition to UK and Channel Island Catches, adding the French age composition data, and finally raising the resulting age composition to the total international landings. From 1995 WG to 2005 WG the international landings for the stock were based entirely on English quarterly sampling effort then raised to quarterly international landings. Since 2006 WG French age data from 2003 onwards have been included.

Numbers-at-age 1 in the catch are low or zero in most years and most likely reflect variation in the sampling, rather than variation in the stock itself. Therefore, these were not considered to add useful information and are replaced by zeros.

Table A demonstrates the history of the derivation of catch numbers-at-age.

B.2. Biological

Weights-at-age

Total international catch and stock weights-at-age for each year's catch data are calculated as the weighted mean of the annual weight-at-age data (weighted by catch numbers), and smoothed in-year using a quadratic fit so that:

$$Wt = a + b*Age + c*Age^2$$

where catch weights-at-age are mid-year values, and stock weights-at-age are 1 January values. Following the estimation of the weights-at-age catch-numbers are adjusted to so that the sum of products of the weights and catches sum to the estimated Landings (SOP correction). Catch numbers-at-age 1 are replaced by zeros, but the catch weights-at-age 1 were retained because they are part of the smoothing procedure and do not affect the assessment. They are also essential if a medium-term forecast is performed.

A smoother is applied to sampled catch weights-at-age to adjust for variation in the weight-at-age that may result from low levels of sampling rather than differences in growth rate between cohorts. It also allows estimation of the stock weights-at-age by extrapolation of the curve rather than by using quarter 1 samples, which may be sparse. However this smoother is applied through the plus group and the age range in the plus group is such that this will tend to overestimate the weights at the younger ages. This needs to be corrected as soon as possible.

Natural mortality and maturity-at-age

Natural mortality is assumed constant over ages and years at 0.1. This is consistent with the natural mortality estimates used for sole by other ICES working groups (WGNSSK: IV, VIId, WGCSE: VIIa, VIIfg, VIIIa,b) and consistent with estimates of M reported in Horwood, 1993 for VIIfg sole as well as other stocks and papers cited therein.

Assessments prior to 1997 had use knife edge maturity-at-age 3. This was changed in 1997 to a maturity ogive from area VIIf and g according to Pawson and Harley (WD presented to WGSSDS in 1997), which is applied in all years, 1969 to present, since the 1997 WG.

Age	1	2	3	4	5	6,7, ...12+
Prop. Mature	0.00	0.14	0.45	0.88	0.98	1.00

Proportions of F and M before spawning are both set to zero to reflect the SSB calculation date of 1 January.

B.3. Surveys

UK-BTS

The longest survey time-series available for this stock is the Western Channel Beam Trawl Survey conducted by the UK in late September, early October (UK-BTS). The survey covers a relatively small area of VIIe from Start Point through to the middle of Lyme Bay and out to the edges of the Hurd Deep covering the immediate area of fishing for the Brixham and Plymouth fleets. Sampling started originally in 1984 on the chartered commercial fishing vessel 'Bogey One', replaced in 1988 by the 'Carhelmar' and moved to the research vessel 'Corystes' in 2002 to 2004. Concerns were raised regarding differences in catchability between the Carhelmar and Corystes, and in 2003 the survey was carried out on both vessels. The results of the comparison convinced Cefas to return the survey to the long-serving Carhelmar and to replace the 2003 data with the data from the comparison trials in order to improve consistency. Consequently, the time-series has been largely recovered, with only 2002 and 2004 data coming from the RV Corystes.

The survey cpue demonstrates a decline from 1986 to 1995 in line with the commercial data, after which SSB seems to have largely stabilized at lower levels. The abundance indices at-ages 1 and 2 demonstrate little overall trend, but ages 3 to 6 indicate a decline over the middle part of the series, despite intermittent peaks and troughs. More recently survey cpue has increased to the highest level over the consistent time-series (starting in 1988 as used in the assessment) with the majority of the increase coming from the younger ages and only a marginal increase at the older ages. The age information is internally consistent to the survey, with 1989 year class is indicated to be strong at all ages and this year class can also be traced through the catch-at-age matrix. More recently the 1998 year class can be tracked reasonably consistently.

UK-FSP

A shorter, but more spatially extensive survey-series has been developed and managed by Cefas since 2003 in the UK in conjunction with the industry. Age sampling issues preclude the use of the data in the first year and the time-series is used here since 2004. The survey vessels (two separate trips are carried out annually see Annex 1 of this Stock Annex) are subject to a three yearly tendering procedure and vessels characteristics and gears used have changed over the time period, which is why the index has been standardized by meter beam and hour fished. The survey covers the extent of the UK fishery for the species including the less frequently exploited western part of the stock, which is why it is principally to be preferred over the more limited UK-BTS survey but is expected to be more variable due to the inconsistency of vessels used. Age information from this survey has shows evidence of some internal consistency in the medium age range but the series is too short to evaluate this at the older or younger ages at present. However the survey appears to show consistency with other survey indices and is therefore included in the present assessment for the entire age range available (ages 2–11). Data from this survey has been used in the plaice assessment since 2008.

Q1SWBeam

This survey was included in the assessment for the first time in WKFLAT 2012. The survey-series starts in 2006. Important considerations for WKFLAT 2012 (ICES, 2012) were that the survey is based on a stratified random survey approach and covers the entire region of the management area and some adjacent waters which may not fully conform to the delineation. The survey shows strong gradients in species composition within the western channel (justifying the stratification approach), although there is some indication that more appropriate post stratification could provide an increase in precision of single species abundance estimates.

Given sampling effort, fundamentally this survey is more variable than fixed stations survey designs of equal effort, but also inherently is less biased when there are potential changes in the distribution of the species within the area. Although estimates of survey variance of the limited dataseries are available, these are unlikely to reflect the full range of the variance that would be encountered in a longer time-series as variance estimates are unlikely to have reached their asymptote, particularly since the range of SSBs observed by the survey is very restricted.

The survey-series was started in 2006 and surveys have been conducted consistently since then. To include as much information as is available at the time of the assessment working group the survey that is conducted in the first quarter has been shifted to back by one year and one age. This practical, because it adds further available information on the abundance of recruitment into the assessment, particularly important since there is uncertainty regarding the estimation of recruits from the UK-BTS which otherwise is the sole source of information of this parameter. The benefits of shifting the series were thought to out-weight the potential error that may be introduced by this procedure if the seasonal pattern of true F were to change in future.

Age information provides estimates of abundance for all ages in the assessment, despite the fact that the survey only catches between 250 and 300 sole in a given year. Theoretically this removes the necessity of retaining the commercial lpue (at-age) series required as the UK-BTS survey does not cover the full age range in the assessment. 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 FSP survey.

Given these uncertainties regarding true survey variance and concerns regarding future funding for the survey it seemed unreasonable to put the entire weight on this survey, so at this stage it is not sensible to remove the commercial fleets from the assessment as they provide a high degree of precision at the cost of introducing some bias into the assessment.

B.4. Commercial cpue

The commercial tuning-series available for the assessment are the same as in previous assessments. Two historic surveys had been included in previous versions of the assessment because historically reference points in the stock had been based on historic development of the fishery and variance in the early time-series indicated considerable uncertainty with respect to these historic estimates as a response to the choice of plus group in the assessment. The new assessment is less susceptible to these variable estimates of catch-at-age, and the group decided to not base reference points on the historic development of the stock so that the historic indices are no longer required in the assessment and are not discussed further here.

UK-COT

The UK otter trawl index is the same as presented in previous assessments. As previously observed the index suffers from two distinct negative year effects in 1991–1992 and 2004. These inconsistencies were observed in previous assessments and the WG concluded that given the length of the period the effects of these in the historic period were minor on the current estimates of F and SSB as they are modelled mainly as residuals in the XSA model. For the new assessment there were no indications to presume that these effects were detrimental to the accuracy of the assessment so that the information is included as in previous years.

Currently this fleet contributes only a small proportion of the overall landings, but it is sampled much more heavily than its representation in the landings so continues to provide a good independent time-series from the main commercial catches. It is uncertain whether the new DFC sampling will continue to provide such accurate data as the intent is to sample catches more proportional to landings.

Despite the year effects the series is characterized by high internal consistency and is also consistent with other series in identifying strong cohorts.

UK-CBT

The time-series of commercial beam trawl information has always formed the backbone of this assessment, but investigations at WKFLAT 2009 (ICES, 2009) indicated that this series showed declining lpue, particularly at the younger ages, in contrast to other information in the surveys and to a lesser degree to the catch-at-age despite the fact that the fleet accounts for around 60% of the landings in the stock. It was assumed that it was largely this fleet that was responsible for the persistent bias in the assessment. Historic area misreporting by the fleet prior to 2010 had been an issue, but after discussions with the industry in 2002 landings information and lpue data have been corrected for this, and the incidence of this practice had been decreasing. Increased scrutiny by enforcement, and lpue limits imposed by the producer organization contributed to the reduction.

The operation of the fleet was examined at this WK using VMS data from 2006–2011. The conclusions from this analysis were that since 2006 the fleet has been increasingly shifting its effort southwards more into the central regions of the channel. Effort in

Lyme Bay, the region where catch data and survey information indicate the majority of younger fish are found are now much lower than previously and have ceased almost entirely in 2010 and 2011. This shift in the selectivity towards older ages is very apparent also from the catch-at-age information for the fleet from market sampling records suggesting that it would be appropriate to split the fleet on the basis of inconsistent operation.

It was not possible from independent information to discern when the majority of the contrast in this information occurred, and hence to decide on appropriate time to split the series, because VMS data are not available prior to 2006. Information from the industry also confirmed that there had been changes in the operation of the fleet, but again suggested that these changes had been gradual, rather than abrupt making the choice of the year for a split of this fleet difficult. The WK determined that 2002, the period when the area misreporting was officially acknowledged, would be an appropriate point for splitting and would also be suitable for the assessment, as this would retain a sufficiently long time-series over which to estimate the new catchabilities for the fleet. This new methodology was adapted and the UK-CBT fleet is used in the assessment as two fleets UK-CBT-early (1989–2002) and UK-BTS-late (2003–2010).

B.5. Other relevant data

None.

C. Assessment: data and method

Model used: extended survivor analysis.

Software used: FLXSA (version 1.4-2)

Model Options chosen:

	2012	2013 and after
Assmnt Age Range	1–12+	1–12+
Fbar Age Range	F(3–9)	F(3–9)
Assmnt Method	XSA	XSA
Tuning Fleets		
Q1SWBeam (offset by 1y 1a)	2006–11 2–12	2006–11 2–12
UK-FSP	2004–11 2–11	2004–11 2–11
UK combined beam Ages (early)	1988–02 3–11	1988–02 3–11
UK combined beam Ages (late)	2003–11 3–11	2003–11 3–11
UK otter trawl Ages	1988–11 3–11	1988–11 3–11
UK BTS yrs Ages	1988–11 1–9	1988–11 1–9
Time taper	No	No
Power model ages	No	No
P shrinkage	No	No
Q plateau age	6	6
F shrinkage S.E	0.5	1.5 or 0.5*
Num yrs	3	3
Num ages	5	5
Fleet S.E.	0.6	0.6

***Final decision on F shrinkage S.E will be made in 2013 at the WGCSE based on retrospective pattern.**

D. Short-term projection

ICES has provided advice for this stock on the basis of a short-term forecast with the exception of 2009 when the advice was based on a trends only assessment. The assessment methodology developed at this benchmark meeting is determined to be appropriate to such projections and advice. This conclusion is largely based on the diagnostics of the assessment. The forecast methodology described below has not been specifically been evaluated at the benchmark, but given the biology of the species, the understanding of fleet dynamics and the similarity to previous assessment the previous procedure as described below is considered suitable.

Input data

Short-term forecasts require the input of a selection pattern, which is taken from the average of the last three years. In cases where a Fsq forecast is appropriate (i.e. where there is no documented trend in the level of F in the final three years) the selection pattern is scaled to the average F over the final three years. When there are significant changes in F over the last three years the selectivity pattern is rescaled to the final year to estimate catches in the 'interim year'. When catches have been constrained at the level of the TAC a TAC constraint is implemented and the selectivity pattern is rescaled by the value of F that produces landings equal to the TAC for the 'interim year'.

Survivor estimates for fish greater than age three in the interim year are used in the projections. Recruits, including the last cohort in the assessment (age one, given as survivors at age 2) are not thought to be particularly reliably estimated as they are poorly selected even in the inshore survey so their values is replaced by geometric mean recruitment determined as in the paragraph below depreciated for natural mortality.

Recruitment in subsequent years is determined as geometric mean recruitment over the appropriate time-series. For this stock in recent year this is currently the entire time-series excluding the last two years (i.e. 1969–2008 for the 2011 assessment). Historically there have been periods where recruitment was thought to be lower or higher, in which case GM is calculated over a shorter recruitment-series, minus one year).

E. Medium-term projections

No longer applicable.

F. Long-term projections

Long-term projections are no longer carried out as part of the stock assessment procedure at working groups. However, STECF (SGMOS 9-02, SGMOS 10-06a) carried out long-term simulations as part of the management plan evaluations. The methodology examined the effects of different types of biases and uncertainty on the management of the stock running stochastic simulations under similar assumptions to the short-term forecast. This method was also employed to derive the level of MSY $B_{trigger}$ by WKFLAT 2012 (ICES, 2012).

G. Biological reference points

Biological reference points in this stock were originally set in 1998 as described in the Table below along with the reasoning and amended in 2001 to take account of a change to the assessment methodology.

	WG(1998)/ACFM(1998)	since WG(2001)/ACFM (2001)
		Age range extended from 1–10+ to 1–12+
F_{lim}	0.36 (F_{loss} WG98)	0.28 (F_{loss} WG01)
F_{pa}	0.26 (F_{lim}*0.72)	0.20 (F_{lim}*0.72)
B_{lim}	1800 t (B_{loss}= B73 WG98)	2000 t (B_{loss}= B_{00} WG01)
B_{pa}	2500 t (B_{lim}*1.4)	2800 t (Historical development)

The assessment methodology that formed the basis for these precautionary reference points was rejected by WKFLAT 2009 (ICES, 2009) and resulted in rejection of the reference points. ICES has adopted a provisional MSY $B_{trigger}$ based on the former B_{pa} as the technical basis. Having developed a new assessment methodology during WKFLAT 2012 (ICES, 2012) appropriate values for the assessment, given a sound technical basis, were determined as shown below.

	Type	Value	Technical basis
Precautionary approach	B_{lim}	1300 t	WKFRAME 2 meta-analysis (ICES, 2011)
	B_{pa}	1800 t	WKFRAME 2 meta-analysis (ICES, 2011)
	F_{lim}	Undefined	
	F_{pa}	Undefined	
MSY approach	F_{MSY}	0.27	Based on a suitably defined F_{max} and stochastic LT simulations
	MSY $B_{trigger}$	2800 t	Based on the lower 95% confidence limits of exploitation at F_{max} from LT simulations.

(unchanged since 2012)

H. Other issues

H.1. Sole in Division VIIe management plan

A management plan was agreed for VIIe sole in 2007:

> Council Regulation (EC) No 509/2007 establishes a multi-annual plan for the sustainable exploitation of sole in Division VIIe. Years 2007–2009 were deemed a recovery plan, with subsequent years being deemed management plan. For 2007–2009 the TAC was required to be at a value whose application will result in a 20% reduction in F compared with F_{bar} (03–05). If this value exceeded a 15% change in TAC, a 15% change in TAC was to be implemented. Fishing mortality <0.27 was reached in 2009, although the average fishing mortality over three years as prescribed by the management plan was only reached in 2010. After reaching F_{MSY}=0.27 the stock is to be maintained at this level of fishing mortality.

H.2. Historical overview of previous assessment methods

Although this stock has been exploited historically for a long time at low levels, official landing statistics and catch-at-age data are available from 1969 onwards. At this time landings were 353 t mainly attributable to otter trawlers and netters. The development of a beam trawl fleet in UK waters lead to rapid increases in landings from the stock in the late 1970s which resulted in a commensurate decline in SSB after an initial increase in stock size to its maximum in 1980 as a consequence of particularly good recruitment in 1976. The decline as assessed by XSA occurred despite some subsequent good recruitment in 1980, 1984, 1986 until 1990 where the SSB appears to have level out near 3,000t. More recent estimates of recruitment are estimated to be high again and SSB has started to increase in response to this recruitment and reduced fishing mortality since the introduction of the single area licence since the end of 2009. Fishing mortality appears to have been stable in the fishery since the early 1980s at around 0.3 before declining to near F_{max} since 2010.

Key uncertainties with regards to the data quality/assessment quality of this stock are the uncertainty regarding the degree of mixing between this and adjacent stock, particularly with regards to recruitments, the fact that the survey covers only a small portion of the stock the lack of a discernible stock–recruit relationship which does not allow us to determine reference points with any certainty.

Table B demonstrates the history of Division VIIe sole assessments and details the assessment model used (XSA) and the parameters and settings used in each year's assessment until 2008.

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Table A. VIIe Sole. Catch derivation table for assessment years 1981–2007.

		source			
Year of WG	Data	UK	France	derivation of international landings	% sampled
1981	length composition	quarterly	quarterly	UK ALKs applied to French LDs	95
	ALK	quarterly	-	UK+France raised to total international	
	Age composition	quarterly	-		
1982		As for 1981	As for 1981	As for 1981	99
1983		As for 1981	As for 1981	As for 1981	92
1984		As for 1981	As for 1981	As for 1981	96
1985		As for 1981	As for 1981	As for 1981	96
1986		As for 1981	As for 1981	As for 1981	96
1987	length composition	quarterly	quarterly	UK+France raised to total international	95
	ALK	quarterly	quarterly		
	Age composition	quarterly	quarterly		
1988		As for 1987	As for 1987	As for 1987	96
1989		As for 1987	As for 1987	As for 1987	95
1990		As for 1987	As for 1987	As for 1987	94
1991		As for 1987	As for 1987	As for 1987	96
1992		As for 1987	As for 1987	As for 1987	97
1993		As for 1987	As for 1987	As for 1987	94
1994	length composition	quarterly	quarterly	UK ALKs applied to French LDs	92

		source			
Year of WG	Data	UK	France	derivation of international landings	% sampled
	ALK	quarterly	-	UK+France raised to total international	
	Age composition	quarterly	-		
1995	length composition	quarterly	-	UK raised to total international	81
	ALK	quarterly	-		
	Age composition	quarterly	-		
1996		As for 1995	-	As for 1995	78
1997		As for 1995	-	As for 1995	73
1998		As for 1995	-	As for 1995	64
1999		As for 1995	-	As for 1995	57
2000		As for 1995	-	As for 1995	56
2001		As for 1995	-	As for 1995	59
2002		As for 1995	-	As for 1995	60
2003	length composition	As for 1995	quarterly	UK and French raised to total international	~95%
	ALK	As for 1995	biannually		~95%
2004		As for 1995	As for 2003	As for 2003	~95%
2005		As for 1995	As for 2003	As for 2003	~95%
2006		As for 1995	As for 2003	As for 2003	~95%
2007		As for 1995	As for 2003	As for 2003	~95%
2008		As for 1995	As for 2003	As for 2003	~95%
2009		As for 1995	As for 2003	As for 2003	~95%
2010		As for 1995	As for 2003	As for 2003	~95%

Table B. History of VIIe sole assessments.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Assmnt Age Range	1-9+	1-9+	1-9+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-10+	1-12+	1-12+	1-12+	1-12+	1-12+	1-12+	1-12+	1-12+
Fbar Age Range	F(3-8)	F(3-7)	F(3-7)	F(3-7)	F(3-7)	F(3-7)	F(3-7)	F(3-7)	F(3-7)	F(3-7)	F(3-7)	F(3-7)	F(3-7)	F(3-7)	F(3-7)	F(3-7)	F(3-7)	F(3-7)
Assmnt Method	L.S.	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA
Tuning Fleets																		
UK Inshore beam	1983-92	1973-92	1973-92	1973-93	1973-93	1986-95	1987-96	1983-97	1984-98	1986-99	1986-00			1973-87	1973-87	1973-87	1973-87	1973-87
Ages	2-9	2-9	2-9	2-9	2-9	2-9	2-9	2-9	2-9	2-9	2-11			2-11	2-11	2-11	2-11	2-11
UK Offshore beam	1983-92	1973-92	1973-92	1973-93	1973-93	1986-95	1987-96	1983-97	1984-98	1986-99	1986-00			1973-87	1973-87	1973-87	1973-87	1973-87
Ages	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-9	3-11			3-11	3-11	3-11	3-11	3-11
UK < 24m beamtr												1989-01						
Ages												2-11						
UK > 24m beamtr												1988-01						
Ages												2-11						
UK combined beam													1988-02	1988-03	1988-04	1988-05	1988-06	1988-07
Ages													3-11	3-11	3-11	3-11	3-11	3-11
UK otter trawl												1988-01	1988-02	1988-03	1988-04	1988-05	1988-06	1988-07
Ages												3-11	3-11	3-11	3-11	3-11	3-11	3-11
UK BTS yrs		1984-91	1984-92	1984-93	1984-94	1986-95	1987-96	1983-97	1984-98	1984-99	1984-00	1984-01	1988-02	1988-03	1988-04	1988-05	1984-06	1988-07
Ages		2-6	2-6	1-6	1-6	1-6	1-6	1-6	1-6	1-6	1-6	1-6	1-6	1-9	1-9	1-9	1-9	1-9
Time taper		20yr tri	20yr tri	20yr tri	20yr tri	No	No	No	No	No	No	No	No	No	No	No	No	No
Power model ages		1	1-2	1-4	1-6	1-6	1-6	1-6	1-6	1-6	1-6	1-6	1-6	1-6	No	No	No	No
P shrinkage		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Q plateau age		8	5	6	7	7	7	7	7	7	9	9	9	9	9	8	8	8
F shrinkage S.E		0.3	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0
Num yrs		5	5	5	5	5	5	5	5	5	5	5	5	5	3	4	5	5
Num ages		5	3	5	3	3	3	3	3	3	5	5	5	5	5	5	5	5
Fleet S.E.		0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5

	2009	2010	2011	2012
Assmnt Age Range		1-12+	1-12+	1-12+
Fbar Age Range		F(3-9)	F(3-9)	F(3-9)
Assmnt Method	Trends	XSA	XSA	XSA
Tuning Fleets				
UK Inshore beam Ages		1973-87 2-11	1973-87 2-11	
UK Offshore beam Ages		1973-87 3-11	1973-87 3-11	
Q1SWBeam (offset by 1y 1a)				2006-11 2-12
UK-FSP				2004-11 2-11
UK combined beam Ages (early)		1988-09 3-11	1988-10 3-11	1988-02 3-11
UK combined beam Ages (late)				2003-11 3-11
UK otter trawl Ages		1988-09 3-11	1988-10 3-11	1988-11 3-11
UK BTS yrs Ages		1988-09 1-9	1988-10 1-9	1988-11 1-9
Time taper		No	No	No
Power model ages		No	No	No
P shrinkage		No	No	No
Q plateau age		8	8	6
F shrinkage S.E		1.0	1.0	0.5
Num yrs		10	10	3
Num ages		5	5	5
Fleet S.E.		0.5	0.5	0.6

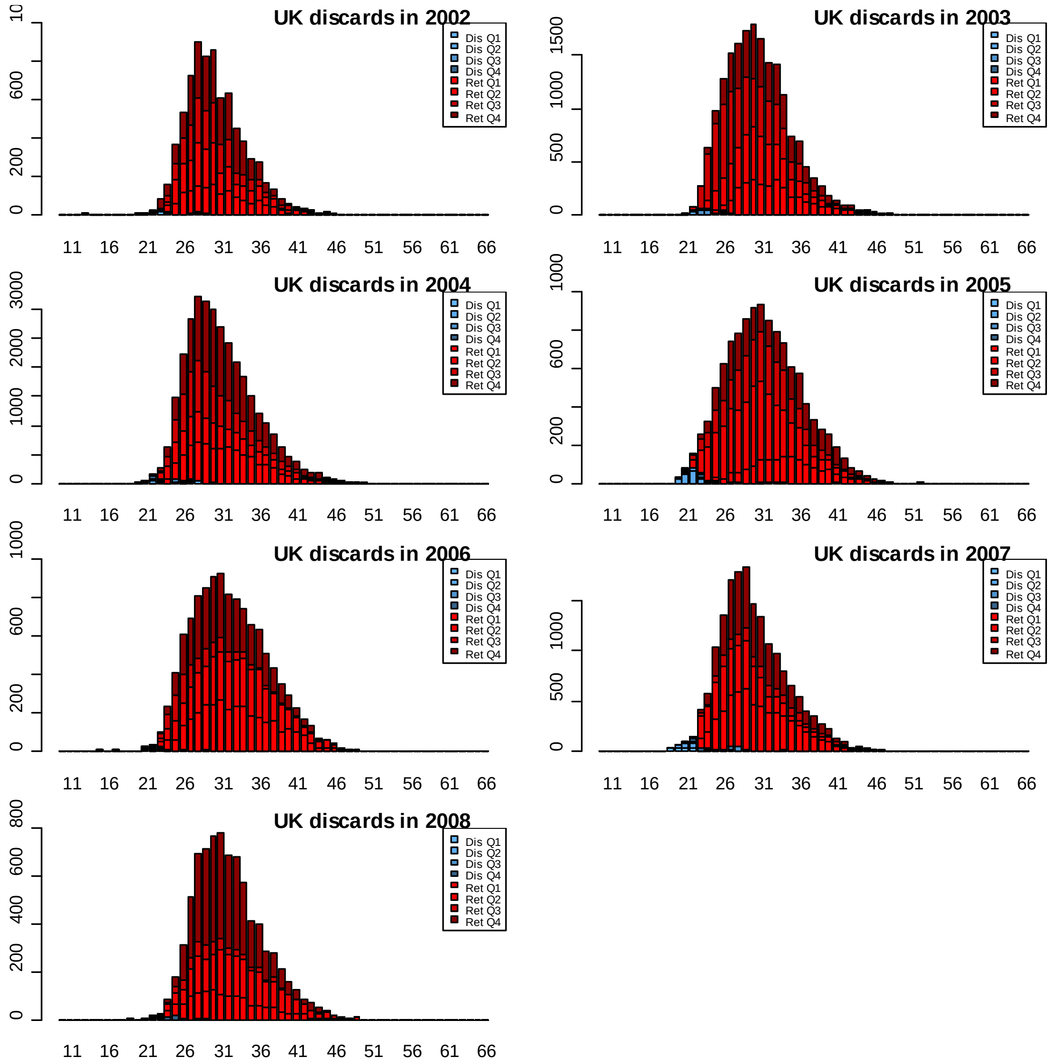


Figure A2.1. Time-series of UK discard data raised to trip information.

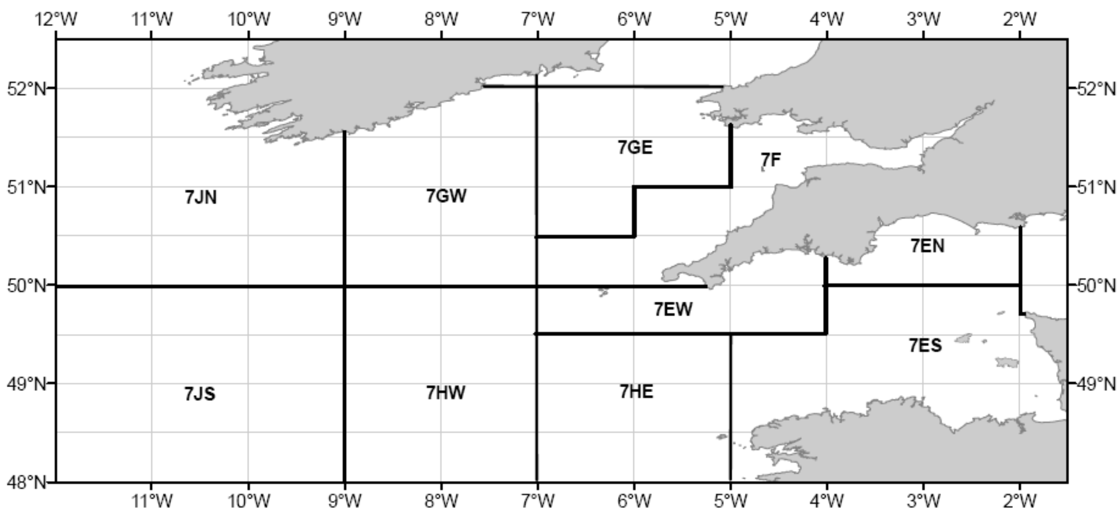


Figure B4.1. Areas used for the calculation of lpue time-series exploring temporal changes in the distribution of stock and effort.

Annex 3: Summary of WGCSE 2012 Working Documents

WD01 Fisheries Science Partnership 2011. Final report Programme 8: Western Channel Sole and Plaice

Robert Bush and Rob Phillips, Cefas, UK

During August and September 2011, the beam trawler *Carhelmar* carried out the ninth in a series of FSP surveys of Western Channel sole and plaice. Similar FSP surveys were carried out during the months August–October of 2003–2010. The surveys are aimed at showing trends in distribution, abundance and age composition of sole and plaice, and providing information on bycatch species.

The survey design followed that of the 2010 survey caried out by *Carhelmar*, using

2 × 4 m beam trawls to survey both the western and eastern 'legs' of the survey area. The survey differed from those of 2003–2007, when a larger beam trawler, fishing 2 × 12 m beams, carried out the eastern part of the survey. The western area has been surveyed with a 2 × 4 m beam trawler throughout 2003–2011. The survey covered exclusively 45 western and 45 eastern 'core' stations, for which consistent data were available for all previous years.

The catch rates of Western Channel sole as indexed by the survey saw a modest increase again, as was first seen in 2010. This may be because the moderate, long-term decline of this stock from 2003 to 2007 previously observed may now have ceased, and/or the stocks may be improving. However, catch rates of plaice were significantly higher again this year, surpassing values witnessed in the 2010 survey, (Bush *et al.*, 2010). The amount of plaice being caught is now at its highest level since the survey commenced in 2003, so indications are that the stock is really on a recovery trajectory. The catch rates of lemon sole and monkfish were all comparable with last year's survey results, with minor change. However, after concerns were raised over the megrim catches of 2010 it would appear that that stock too has bounced back, 2011 numbers being at their highest since the time-series started. Cod were encountered scarcely over the survey, just four fish being caught, although the gear is not appropriate for catching cod and hence the survey is not representative for monitoring purposes of that species.

As in previous surveys, the age distribution for sole was broad, with ages of fish >15 years recorded in both survey legs; one sole 26 years old was caught on the eastern leg. As usual, plaice age distribution was much narrower than sole; the oldest recorded being 14 years on the eastern leg. The trends in sole spawning–stock biomass (SSB) from the FSP surveys show similarities with the recent, steadily increasing or static trends shown by the ICES assessment (ICES, 2009, 2010). The story for plaice, however, is different, that species having shown a significant jump in SSB to a level not seen in the nine years of the survey thus far. The sudden reduction of SSB in 2008 for both stocks was followed by higher estimates in 2009, but overall interpretation of that dip requires caution because of the poor weather conditions and survey delay during that year's survey.

WD02 A potential assessment method for Northern Shelf megrim (*Lepidorhombus whiffiagonis*) ICES Divisions VIa-IVa using a Bayesian state-space biomass dynamic model-post review

Norman Graham, Marine Institute, Ireland

Megrim (*Lepidorhombus whiffiagonis*) is distributed from the Iberian peninsula, along the shelf break to the Northern North Sea. ICES consider the megrim in VIa and IVa as a single stock, with other separate stocks: VIb (Rockall) and Celtic Sea and Bay of Biscay (VII and VIIIa,b,d,e). Exploratory analytical age based assessments for VI were presented by ICES in 1999 and again in 2003. In neither case were the assessments considered as the basis of advice, largely due to lack of commercial or survey tuning fleets. The advice basis for this stock is limited. Recent advice has been based on relative trends in fishery lpues and survey cpue trends. During a recent benchmark meeting (ICES, 2011) attempts were made to reconstruct the commercial catch (landings and discards) at age data for megrim in both VIa and IVa. However, due to imprecise (low and/or spatially biased sampling levels) and missing age data, particularly in Divison IVa, this was not possible. It is thought that some of the imprecision is due to the length-at-age exhibiting a significant depth-dependency (Gerritsen, 2010), where the mean length-at-age decreases with depth such that a 3 year old inhabiting shallow water (<50 m) can be larger than a 4 year old in deeper water (>200 m). This together with low agreement (57%) between age readers with fish greater than 6 years old, low sampling sizes relative to historic levels, all combine to inhibit the production of an age based assessment (ICES, 2011). Attempts have been made to assign port based sampling events to particular fishing trips via VMS to explore the possibility of obtaining depth data associated with particular samples, but this has proved difficult due to depth variability within a fishing trip.

As a consequence, for management purposes the EU classify the megrim stocks in Subarea VI and IVa as "data poor" and in 2011 subject to automatic TAC deductions due to the absence of an analytical assessment and basis to set future TAC. While classified as "data poor", there a number of data streams that could be utilised to provide the desired level of detail including five fishery-independent survey cpue series and commercial landings and effort data. As an alternative to the age based approach, ASPIC (Prager, 2005), a non-equilibrium surplus production model was investigated (WKFLAT, 2011), but the results were inconclusive and estimates of K (carrying capacity) was strongly influenced by the initial starting K estimate. While commonly referred to as surplus production models, here we use the term biomass dynamic models as surplus production can also be estimated from full age disaggregated data and the approach taken here is unique in that the dynamics of the stock is described in terms of biomass rather than numbers-at-age (Hilborn and Walters, 1992).

Following on from WKFLAT (2011) exploratory analysis with a Bayesian implementation of a state–space model biomass dynamic model was presented at WGCSE (2011). In this working document we describe the results from further work with the Bayesian approach and present this as the possible basis for providing advice on Megrim in ICES Divisions VIa and IVa. Note that this work does not include megrim in Division VIb (Rockall) due to more limited survey indices. In the first instance we are able to provide quantitative assessments of biomass and provide estimates on the level of exploitation relative to F_{MSY} and assess the biomass and exploitation of megrim within a precautionary framework with biomass and exploitation reference points. This addresses the need to provide population estimates and the level of exploitation. Secondly, we provide catch forecasts based on projecting a range of fixed TACs within the ICES F_{MSY} framework.

WD03 Maturity-at-age estimates for Irish Demersal Stocks in VIa and VIIabgj 2004–2011

Hans Gerritsen (Marine Institute, Ireland)

This document provides maturity-at-age estimates for stocks assessed by the WGCSE and WGHMM. All data are obtained on surveys and commercial sampling carried out by the Marine Institute.

WD04 Western Irish Sea *Nephrops* Grounds (FU15) 2011 UWTV Survey Report

Colm Lordan, Matthew Service, Jennifer Doyle (Marine Institute, Ireland) and Ross Fiztgerald (AFBI, N Ireland)

The Norway lobster, *Nephrops norvegicus*, is exploited throughout its geographic range, from Icelandic waters to the Mediterranean and the Moroccan coast. The western Irish Sea stock (FU15) is by far the most productive of all the *Nephrops* stocks currently fished yielding landings of between 7000–10 000 tonnes annually from a relatively small geographic area (ICES, 2011). *Nephrops* spend a great deal of time in their burrows and their emergence behaviour is influenced by many factors; time of year, light intensity and tidal strength. Underwater television surveys and assessment methodologies have been developed to provide a fishery-independent estimate of stock size, exploitation status and catch advice (ICES, 2009; 2011).

This is the ninth in a time series of UWTV surveys in the western Irish Sea carried out jointly by the Marine Institute, Ireland and the Agri-Food and Biosciences Institute (AFBI), Northern Ireland. The 2011 survey was multidisciplinary in nature; the specific objectives are listed below:

1) To complete randomised fixed survey grid of ~150 UWTV with 3.5 nautical mile (Nmi) spacing stations on the western Irish Sea *Nephrops* ground (FU15).
2) To obtain 2011 quality assured estimates of *Nephrops* burrow distribution and abundance on the western Irish Sea *Nephrops* ground (FU15). These will be compared with those collected previously.
3) To collect ancillary information from the UWTV footage at each station such as the occurrence of seapens, other macrobenthos and fish species and trawl marks on the seabed.
4) To collect oceanographic data using a sledge mounted CTD.
5) Technology and protocol transfer between Marine Institute and AFBI.

This report details the final UWTV results of the 2011 survey and also documents other data collected during the survey.

WD05 Aran, Galway Bay and Slyne Head *Nephrops* Grounds (FU17) 2011 UWTV Survey Report

Colm Lordan, Jennifer Doyle, Robert Bunn, Dermot Fee, and Chris Allsop (Marine Institute, Ireland)

This report provides the main results and findings of the tenth annual underwater television on the 'Aran grounds' ICES assessment area; Functional Unit 17. The survey was multidisciplinary in nature collecting UWTV, fishing, CTD and other ecosystem data. In total 76, ten and seven UWTV stations were successfully completed on the Aran, Galway Bay and Slyne Head *Nephrops* Grounds. The observed abundance estimate for the main Aran ground has declined by 23% relative to 2010. Abundance estimates have fluctuated over the time-series. The 2011 abundance is the third lowest in the ten year history of the survey. This is not a cause for immediate concern about the stocks sustainability. Raised abundance estimates for Galway Bay and Slyne Head are provided for the first time based on improved knowledge of the boundaries of those areas. *Nephrops* accounted for 26% of the catch weight from ten beam trawl tows. The observed length–frequency and maturity of female *Nephops* caught was similar to previous years. Various further investigations needed before the next ICES benchmark are discussed.

WD06 Celtic Sea *Nephrops* Grounds 2011 UWTV Survey Report

Jennifer Doyle, Colm Lordan, Ross Fitzgerald, Sean O'Connor, Dermot Fee, Cormac Nolan and Joan Hayes (Marine Institute, Ireland)

The prawn (*Nephrops norvegicus*) are common in the Celtic Sea occurring in geographically distinct sandy/muddy areas were the sediment is suitable for them to construct their burrows (Figure 1). The Celtic Sea area (Functional Units 19–22) supports a large multinational targeted *Nephrops* fishery mainly using otter trawls and yielding landings in the region of ~6000 t annually over the last decade (ICES, 2011). *Nephrops* spend a great deal of time in their burrows and their emergence behaviour is influenced by many factors; time of year, light intensity and tidal strength. Underwater television surveys and assessment methodologies have been developed to provide a fishery-independent estimate of stock size, exploitation status and catch advice (ICES, 2009; 2011).

This is the sixth in a time-series of UWTV surveys in the Celtic Sea carried out by the Marine Institute, Ireland. The 2011 survey was multi disciplinary in nature; the specific objectives are listed below:

1) To complete randomised fixed survey grid of ~100 UWTV with 3 nautical mile (Nmi) spacing stations on the "Smalls" *Nephrops* ground (FU22).
2) To carry out ~20 UWTV indicator stations in the wider Celtic Sea if time allows.
3) To obtain 2011 quality assured estimates of *Nephrops* burrow distribution and abundance on the "Smalls" *Nephrops* ground (FU22). These will be compared with those collected previously.
4) To collect ancillary information from the UWTV footage collected at each station such as the occurrence of seapens, other macro benthos and fish species and trawl marks on the sea bed.
5) To collect oceanographic data using a sledge mounted CTD.
6) To collect sediment samples.

7) To sample *Nephrops* and macro benthos using a 4 m beam trawl deployed at ~ten stations.

This report details the final UWTV results of the 2011 survey and also documents other data collected during the survey.

WD07 Re-examination of the Western Channel Plaice Reference Points following a change in the perceived stock-recruitment relationships

Sven Kupschus, Ian Holmes, Cefas, UK

The 2011 assessment of Plaice in the western channel indicated that the 2009 year class was large, but its absolute size was uncertain. The 2012 WG estimate of recruitment for this cohort confirms that this is the largest year class observed in the current assessment going back to 1980. Furthermore the previous and subsequent year classes are also indicated to be above average. These improved recruitments have all come from some of the lowest observed biomasses. Although the 2011 recruitment is still considered to be too unreliable for inclusion in reference point estimation, even the inclusion of the 2008 and 2009 year classes in the stock–recruit plot considerably change the estimation of F_{MSY} reference points (see working group report). Both Ricker and Beverton & Holt stock–recruit relationships produce unrealistic results. For the smoothed hockey stick the SSB at which recruitment becomes impaired has moved down to the lowest level of observed SSB in the time-series. This suggests that the current data do not contain any information on the level of SSB at which recruitment becomes impaired and that F_{MAX} is the most appropriate proxy of F_{MSY} available. F_{MAX}, though stable in its estimate over the last three years is relatively flat topped, but it is unclear whether the spawning stock will likely remain in the area of known stock dynamics if exploited at the level of F_{MAX} and where to set an appropriate MSY $B_{trigger}$ other than the lowest observed SSB from which a recovery of the stock has been observed (1612 t).

This working document sets out to explore some of the uncertainties using a stochastic evaluation framework incorporating uncertainty in the assessment and TAC implementation (both variability and bias), temporal auto correlation in recruitment and the risk of potential effects of SSB on recruitment. The framework was developed for the evaluation of the western channel sole management plan (STECF 2010, ICES 2012) and setting with respect to recruitment and TAC implementation have been refined to more closely match the observed time-series for plaice.

WD08 Trawl survey based assessment of haddock (*Melanogrammus aeglefinus*) at Rockall

Khlivnoy V.N., Gavrilik T.N. (PINRO, Russia)

Extensive datapool has been created by now through trawl surveys of haddock at Rockall. The Aberdeen Marine Laboratory has been carrying out the Scottish trawl surveys in the area for a long time. Cpue data obtained from surveys are used to assess haddock stock with analytical tools. Trawl survey assessment was conducted only once in 2005 and was based on the data of the Russian R/V 'Fridtjof Nansen' survey. The Scottish survey methodology was modified in 2011 which resulted in expansion of survey area to deep-water areas.

This paper aims to assess stock through trawl surveys, analyze survey methodology modification and influence of abundance indices determination methods on outcomes of analytical assessment of the stock.

WD09 FU19 *Nephrops* Grounds 2011 UWTV Survey Report

Colm Lordan, Matthew Service, Jennifer Doyle (Marine Institute, Ireland) and Ross Fiztgerald (AFBI, N Ireland)

This report provides the main results and findings of the second underwater television survey of the various *Nephrops* grounds in Functional Unit 19. The survey was multidisciplinary in nature collecting UWTV, CTD and other ecosystem data. In total 35 UWTV stations were successfully completed on the following *Nephrops* grounds: Bantry Bay, Galley, Cork Channels and Helvick. Raised abundance estimates for these grounds are provided for the first time based on improved knowledge of the boundaries of those areas.

Annex 4: Technical minutes from the Celtic Sea Review Group

- RGCSE
- 29 May–8 June 2012
- Participants: Daniel Goethel (Chair), Steve Cadrin (Chair), Sally Roman, Greg DeCelles, Cate O'Keefe, Adam Barkley, Piera Carpi, Emily Keiley, Judith Rosellon Druker
- Working Group: WGCSE (Chairs Helen Dobby and Joël); ICES Secretariat: Michala Ovens and Barbara Schoute

Review process

The ICES advisory service quality assurance program requested that a team of graduate and post-doctoral students and their professor serve as a review group, as specified in Guidelines for Review Groups (ACOM 2009). The group initially met on 29 May to review the ICES advisory process, RG guidelines, and to assign several WG report sections to each reviewer. Additionally, the various assessment models used by ICES (e.g., XSA, ICA, SURBA, TSA, SAM, and UWTV) were discussed in order to familiarize reviewers with common assessment techniques and resolve any outstanding questions. Members reviewed WG report sections independently, and presented their summaries and reviews to the group in a series of daily meetings from 30 May–1 June. At these meetings reviewers provided a summary of their report, while focus was placed on any WG report discrepancies or apparent modelling issues. At the close of each presentation the review group discussed and finalized recommendations for each stock. Reviews were collated and finalized 2–8 June by the chairs, which included verifying the data provided in each review and resolving any outstanding questions raised by reviewers.

Stock assessment reports for 44 stocks were reviewed (Table 1). Two WG report sections contained two stocks in a single document: *Nephrops* in FU20–22 was split into FU20–21 and FU22, while Megrim in Divisions IVa and VIa also contained information on Megrim in VIb. The WG reports were generally informative, and WG decisions about data, model choice, and specification were clearly explained and justified. The data poor nature of some stocks did not allow any type of analytical assessment to be carried out, so the RG could not make recommendations. In general, the RG concludes that most reports are technically correct, and agrees with the WG interpretations and recommendations, with only a few exceptions.

Table 1. List of stocks reviewed by the RGCSE.

Code	Species	EG	Assessment	Assessment Model	WKLIFE Category	RG Suggestion
ANG-78AB	Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Divisions VIIb–k and VIIIa,b,d	WGHMM	Trends Based on lpue and Survey	None	Cat-6	Acceptable
MGW-78	Megrim (*Lepidorhombus whiffiagonis*) in Divisions VIIb–k and VIIIa,b,d	WGHMM	Trends Based on Model	Bayesian SCAA	Cat-2	Insufficient Data
HER-IRLS	Herring in Division VIIa South of 52°30′N and VIIg,h,j,k (Celtic Sea and South of Ireland)	HAWG	Analytical	FLICA	None	Acceptable
HER-VIAN	Herring in Division VIa (North)	HAWG	Analytical	FLICA	None	Acceptable
HER-IRLW	Herring in Divisions VIa (South) and VIIb,c	HAWG	Trends Based on Model	Exploratory Separable VPA	Cat-2	Acceptable
HER-NIRS	Herring in Division VIIa North of 52°30′N (Irish Sea)	HAWG	Analytical	SAM	None	Acceptable
SPR-CELT	Sprat in Divisions VI and VII (the Celtic Sea Ecoregion)	HAWG	Catch only	None	Cat-6	Insufficient Data
COD-SCOW	Cod in Division VIa (West of Scotland)	WGCSE	Analytical	TSA	None	Acceptable
HAD-SCOW	Haddock in Division VIa (West of Scotland)	WGCSE	Analytical	TSA	None	Acceptable with Caveats
WHG-SCOW	Whiting in Division VIa (West of Scotland)	WGCSE	Analytical	TSA	None	No
NEP-11	*Nephrops* in Division VIa (North Minch, FU 11)	WGCSE	Survey-based Abundance	UWTV	None	Acceptable

Code	Species	EG	Assessment	Assessment Model	WKLIFE Category	RG Suggestion
NEP-12	*Nephrops* in Division VIa (South Minch, FU 12)	WGCSE	Survey-based Abundance	UWTV	None	Acceptable
NEP-13	*Nephrops* in Division VIa (the Firth of Clyde and Sound of Jura, FU 13)	WGCSE	Survey-based Abundance	UWTV	None	Acceptable
COD-ROCK	Cod in Division VIb (Rockall)	WGCSE	Catch Only	None	Cat-6	Insufficient Data
HAD-ROCK	Haddock in Division VIb (Rockall)	WGCSE	Analytical	XSA	None	Acceptable with Caveats
WHG-ROCK	Whiting in Division VIb (Rockall)	WGCSE	Catch only	None	Cat-6	Insufficient Data
ANG-IVVI	Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Divisions IIa, IIIa, Subarea IV and VI	WGCSE	Trends Based on Surveys	None	Cat-3	Insufficient Data
MEG-4A6A	Megrim (*Lepidorhombus* spp) in Divisions IVa and VIa	WGCSE	Analytical	Bayesian Surplus-Production	None	Acceptable
MEG-ROCK	Megrim (*Lepidorhombus* spp) in Division VIb	WGCSE	Trends Based on lpue and Survey	None	Cat-3	Insufficient Data
COD-IRIS	Cod in Division VIIa (Irish Sea)	WGCSE	Analytical	SAM	None	Acceptable with Caveats
HAD-IRIS	Haddock in Division VIIa (Irish Sea)	WGCSE	Trends Based on Survey	SURBA	Cat-3	Acceptable
NEP-14	*Nephrops* in Division VIIa (Irish Sea East, FU 14)	WGCSE	Survey-based Abundance	UWTV	None	Acceptable
NEP-15	*Nephrops* in Division VIIa (Irish Sea West, FU 15)	WGCSE	Survey-based Abundance	UWTV	None	Acceptable
WHG-IRIS	Whiting in Division VIIa (Irish Sea)	WGCSE	Trends Based on Surveys	SURBA	Cat-3	Acceptable

Code	Species	EG	Assessment	Assessment Model	WKLIFE Category	RG Suggestion
PLE-IRIS	Plaice in Division VIIa (Irish Sea)	WGCSE	Trends Based on Model	AP	Cat-2	Acceptable
SOL-IRIS	Sole in Division VIIa (Irish Sea)	WGCSE	Analytical	XSA	None	Acceptable
COD-7E-K	Cod in Divisions VIIe–k (Celtic Sea cod)	WGCSE	Analytical	XSA	None	Acceptable
HAD-7B-K	Haddock in Divisions VIIb–k	WGCSE	Analytical	ASAP	None	Acceptable with Caveats
NEP-17	*Nephrops* in Division VIIb (Aran Grounds, FU 17)	WGCSE	Survey-based Abundance	UWTV	None	Acceptable
NEP-16	*Nephrops* in Division VIIb,c,j,k (Porcupine Bank, FU 16)	WGCSE	Trends Based on lpue and Survey	None	Cat-3	Insufficient Data
NEP-2021	*Nephrops* in Division VIIf,g,h (Celtic Sea, FU 20–21)	WGCSE	Trends Based on lpue	None	Cat-4	Insufficient Data
NEP-22	*Nephrops* in Division VIIf,g,h (Celtic Sea, FU 22)	WGCSE	Survey-based Abundance	UWTV	None	Acceptable
NEP-19	*Nephrops* in Division VIIa,g,j (South East and West of IRL, FU 19)	WGCSE	Survey-based Abundance	UWTV	Cat-4	Acceptable
PLE-7B-C	Plaice in Division VIIb,c (West of Ireland)	WGCSE	Catch Only	DCAC	Cat-6	No
PLE-CELT	Plaice in Divisions VIIf,g (Celtic Sea)	WGCSE	Trends Based on Model	AP	Cat-2	Acceptable
PLE-7H-K	Plaice in Divisions VIIh–k (Southwest of Ireland)	WGCSE	Trends Based on Model	Exploratory Separable VPA	Cat-4	No
SOL-7B-C	Sole in Division VIIb, c (West of Ireland)	WGCSE	Catch Only	DCAC	Cat-6	Acceptable
SOL-CELT	Sole in Divisions VIIf, g (Celtic Sea)	WGCSE	Analytical	XSA	None	Acceptable

Code	Species	EG	Assessment	Assessment Model	WKLIFE Category	RG Suggestion
SOL-7H-K	Sole in Divisions VIIh–k (Southwest of Ireland)	WGCSE	Trends Based on Catch Curves	None	Cat-4	Insufficient Data
WHG-7E-K	Whiting in Division VIIe–k	WGCSE	Analytical	XSA	Cat-2	Acceptable with Caveats
PLE-ECHW	Plaice in Division VIIe (Western Channel)	WGCSE	Analytical	XSA	None	Acceptable
SOL-ECHW	Sole in Division VIIe (Western Channel)	WGCSE	Analytical	XSA	None	Acceptable with Caveats
POL-CELT	Pollack in Subareas VI and VII (Celtic Sea and West of Scotland)	WGCSE + WGNEW	Catch only	DCAC	Cat-5	Acceptable with Caveats
GUG-CELT	Grey Gurnard in Subarea VI and Divisions VIIa–c and e–k (Celtic Sea and West of Scotland)	WGCSE + WGNEW	None	None	Cat-3 or 6	Insufficient Data

Some of the major issues identified by the RG were:

- The RG was unable to provide detailed recommendations for a handful of species due to insufficient data, including:
    - Sprat in Divisions VI and VII
    - Megrim in Divisions VIIb–k and VIIIa,b,d
    - Cod in Division VIb
    - Whiting in VIb
    - Anglerfish in Divisions IIa, IIIa, IV, and VI
    - Megrim in VIb
    - *Nephrops* in FU16
    - *Nephrops* in FU20–21
    - Sole in Division VIIh–k
    - Grey Gurnard in Divisions VI and VIIa-c,e–k
- Furthermore, the RG feels that the XSA for Haddock in VIb and the TSA for Whiting in VIa are too uncertain to be used as full analytical assessments for the estimate of stock status. The RG suggests that these stocks be moved to the ‘trends only’ category and the trends from the assessments be used as the basis for management advice instead of the terminal year point estimates.

- For Plaice in Division VIIb–c, the RG does not believe the DCAC was accurately applied and does not support the use of these results for management advice.
- For Plaice in VIIh–k, the RG does not support the use of the exploratory VPA as it is un-calibrated and highly uncertain.
- Finally, a number of models were deemed appropriate for management advice, but with caveats. The RG noted that caution should be taken when using terminal year point estimates from these models as high levels of uncertainty and the potential for large levels of bias exist. These models included:
    - TSA for Haddock in VIa
    - SAM for Cod in Division VIIa
    - ASAP for Haddock in Division VIIb–k
    - XSA for Whiting in Division VIIe–k
    - XSA for Sole in Division VIIe
    - DCAC for Pollack in Divisions VI and VII

Some general issues were raised relating to discards, standardized methods (especially for data poor species and UWTV models for *Nephrops*), and lack of documentation for lesser known assessment models. These issues are discussed further in the general comments section and should be considered for the next round of benchmark reviews for these stocks.

The WG appropriately applied the procedures specified in the stock annexes for nearly all stocks. However, annexes were not provided for some stocks, making determination of the consistency of the assessment with the agreed upon model specifications nearly impossible. The lack of stock annexes also made it difficult for the RG to assess the appropriateness of the model choice, because the RGs familiarity with the stock dynamics and data are limited, and the established benchmark procedures are often relied upon as a determination of the best practices for each stock. Additionally, a lack of finalized reports for a quarter of the species resulted in draft reports being reviewed. These assessments were particularly difficult to review and gauge for quality. In a few instances, changes were made to the final assessment that the RG may not have been able to review due to time constraints. Draft advice for 2013 was not finalized while the RG was meeting and so these reports were not analyzed by the RG.

General Comments

Most of the stocks that were reviewed are caught in mixed stock fisheries. Many assessments include mixed stock considerations, estimate discards, and include them in the stock assessment. However, the treatment of discards varies widely among assessments. The RG recommends that all information on discarded catch should be reported, the magnitude of discards should be estimated or approximated for all fleets, and if the proportion of discards is substantial, discards should be included as a component of catch for the entire assessment series for exploratory analyses and possibly as the basis for fishery management advice. The RG recognizes that estimates of discards for some fleets and in historical periods will be highly uncertain. However, many of the stocks in this group have substantial discards, and retrospective patterns suggest underreported catch. The RG concludes that including discard approximations may improve the accuracy and consistency of assessments. Additionally, for cases where discards are known to be substantial, but estimates are highly uncertain, the RG suggests the application of statistical catch-at-age models. In such instances, VPA-based models are often not robust to uncertainty in catch data. Although the WGCSE appears to be applying more flexible models, there are still some stocks that may benefit from new approaches.

As mentioned above, bycatch and discards appear to be an enormous problem for many Celtic Sea fisheries, especially within the growing *Nephrops* fishery. Some stocks of haddock, whiting, and plaice no longer have directed fisheries, but are discarded as unwanted bycatch in such large quantities that it has hindered rebuilding. The RG supports the recent ICES advice for many stocks in this region that TAC management may not be appropriate since it does not limit discards. Alternative measures such as bycatch limits and gear modification are likely necessary to protect species undergoing high discards. Although certain fisheries have begun to adopt such measures (e.g. the Swedish grate in certain *Nephrops* fisheries), it appears that continued development of technical measures to limit bycatch is needed.

Approximately half of the stocks in the Celtic Sea region are listed as data limited, and nine stocks that were reviewed had no models applied. The RG understands that RGLIFE and WGCSE were held simultaneously, so the guidance in RGLIFE could not be fully considered. The RG suggests that WKLIFE and RGLIFE guidance be considered in the next assessment.

Despite developing proper protocols that have led to informative estimates of stock status for many *Nephrops* stocks monitored by UWTV surveys, the WK*NEPH* 2009 report appears to have some discrepancies. There appear to be different suggestions in terms of how mean weight and discard rates should be applied for catch forecasts. The body of the WK*NEPH* 2009 document suggests one protocol, while the annexes for individual stocks do not necessarily follow this recommendation. The document suggests that an agreed upon rate of discards for each stock should be used until the next benchmark. However, many stock annexes indicate that a three year running average is more appropriate and should be used. The RG suggests that the methods for UWTV analysis should be clarified in the WK*NEPH* 2009 document and addressed at the WK*NEPH* 2013 benchmark.

The RG also suggests that at the next *Nephrops* benchmark in 2013 a method to objectively estimate bias in UWTV surveys be attempted. The WG notes that bias estimates from the UWTV surveys are largely based on expert opinion without precision estimates of the bias. However, the management decisions would be greatly improved if estimates of precision were included, especially for the catch forecast inputs. The RG acknowledges that this may not be possible, but estimates of precision would greatly enhance model outputs.

As a suggestion for future data collection, the RG notes that the addition of a trawl survey in coordination with the UWTV survey would greatly increase the data for *Nephrops*. Detailed information regarding the population structure (e.g. size composition, weight, sex ratio, and maturity) would improve the ability to assess stock status. However, the RG realizes that the cost may be prohibitive to implementing these measures.

In general, the RG feels that more in-depth stock annexes would be extremely helpful for reviewers. Although the annexes are generally quite detailed regarding data availability and species-specific information, they lack information on model techniques. The specification of model inputs is thorough, but more detailed descriptions of the models themselves are warranted. Such descriptions should outline the main facets of the model and provide a brief description of important formulas and calculations. Often the model is simply listed without any description of the fundamental workings of the model itself. For well-established models that reviewers are familiar with this is not a problem. However, for some of the lesser known models used by ICES (e.g. Aarts and Poos, SURBA, UWTV, TSA, and SAM) a brief description of the model properties would be extremely helpful for those reviewing the stock and analyzing consistency.

The WG reports were well written and justified most of the modelling choices that were made. Despite some reports not being finalized at the time of the review, the RG commends the working groups for developing excellent documentation and thorough assessments. As mentioned previously, only a few assessments were deemed inappropriate for management by the RG. For the most part, the RG felt that the models that were rejected were too uncertain to provide point estimates due to lack of or uncertainty in important input data. The assessment scientists did an excellent job given the data that was available, and RG recommendations to not accept an assessment should not be viewed as a suggestion to not attempt an assessment in the future. However, data limitations for many stocks in the Celtic Sea region have hampered the ability to apply stock assessment models, and future work to improve data quality and monitoring is urged.

Review of the Working Group on the Celtic Seas Ecosystem (WGSCE) Report

COD-SCOW [WGSCE Section 3.2: Cod in Division VIa (West of Scotland)]

Assessment Type: Update with additional year of landings and discards through 2011 (benchmarked in 2012).

Assessment: Analytical.

Forecast: A short-term projection was presented.

Assessment method: Time-series analysis (TSA) tuned to ScoGFS-WIBTS-Q1 survey from 1985–2010.

Consistency:

- The assessment is consistent with the annex.
- Limited retrospective patterns exist, but they appear small and relatively balanced.
- The 2011 assessment was not accepted (due to changes in the survey index).
- Assessments prior to 2011 did not use commercial catch data due to poor model fit. The 2012 assessment reintroduces this data and provides slightly improved fits to the data.
- Compared to the 2010 assessment 2009 SSB was reduced from 5166 t to 2727 t, F remains around 0.88, and recruitment was revised down to 5.39 mil from 10.4 mil.

Stock status:

- SSB has been increasing slightly since 2006, while F and recruitment have remained relatively stable.

- SSB in 2011 (3865 t) is well below BLIM (14 000 t), and mean F (ages 2–5) in 2011 (0.951) is more than four times the provisional proxy for FMSY (0.19; based on FMAX for North Sea cod) and above FLIM (0.8).

Management plan:

- The fishery is managed by a combination of a TAC limit, area closures, technical measures and effort restrictions.
- In 2012 council regulation (EU) No. 43/2012 made the stock a bycatch species and the TAC was set to zero. Bycatch 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.
- In 2011 landings were 496 t, with discard estimated of 2302 t.
- TSA projections for landings in 2012 assuming three year average F (.924) is 764 t with discards of 1901 t, which results in a 2012 SSB of 3707 t.
- Even under zero catch scenarios this stock cannot rebuild to greater than BLIM in 2014.

General Comments

Data inputs and assessment methods are consistent with the stock annex.

The WG observed that the mean weight in the catch-at-age exhibited an increasing trend for age 2 and age 3 in recent years, but the decreasing trend in mean weight observed for the older ages is not discussed (see Figure 3.2.2 below). The RG suggests that this should be further examined in the future.

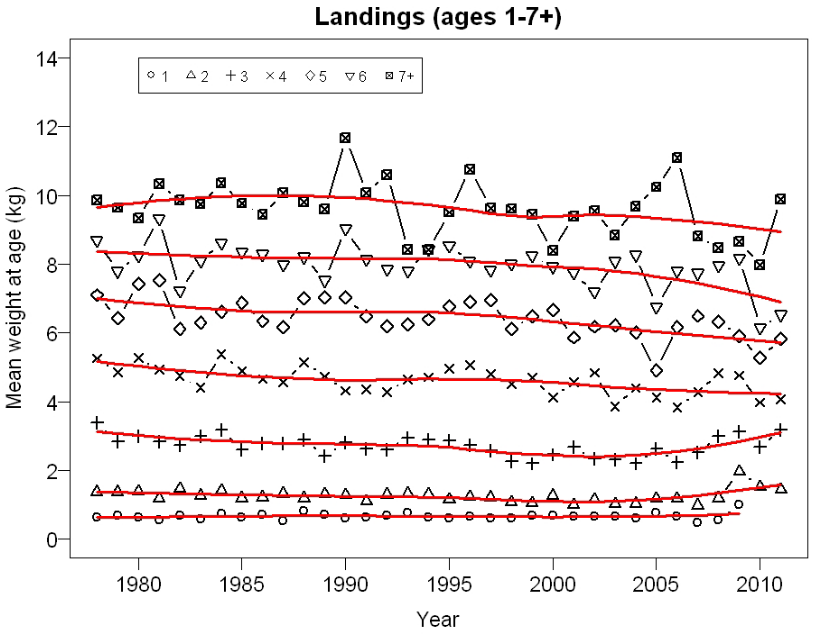


Figure 3.2.2. Cod in Division VIa. Mean weights-at-age in landings. A loess smooth has been fitted to the data at each age, with a span including three quarters of the datapoints.

The diagnostic plots from the TSA model demonstrate strong residual patterns in the fit to landings data. The RG understands that large issues exist in this data due to misreporting of landings and discards, but suggests that these results should be further explored in future analysis.

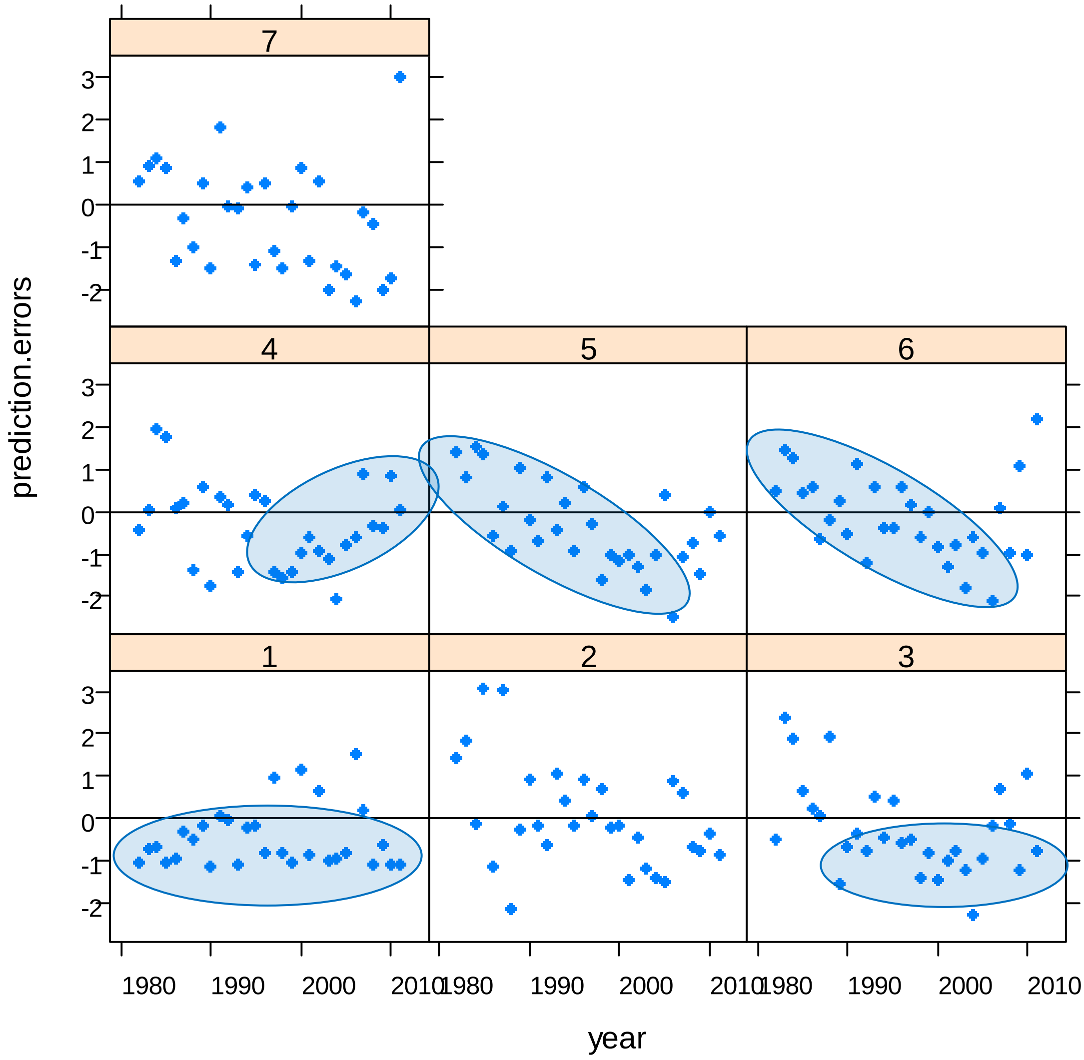


Figure 3.2.10. Cod in Division VIa. TSA final run. Standardised prediction errors at age plots for landings.

Technical Comments

The tables embedded in the text of the report often lack labels making them difficult to interpret.

Figures 3.2.5 and 3.2.6 are not clear (perhaps a multipanel xyplot in R would be more readable?).

A table (besides the figure) for the M-at-age would be useful.

Section 3, which should provide an overview of the fisheries and the management, could not be found.

Conclusions

The RG suggests that this model is an acceptable basis for management, but cautions that there is a fair degree of uncertainty in model point estimates. The assessment results are different from the last accepted assessment (2010), showing a lower SSB and recruitment, while the F has remained virtually unchanged. The stock is still in a situation of reduced reproductive capacity, and unsustainable removals continue to occur. Despite the TAC being set at 0, management measures appear ineffective due to high discards and misreporting. The RG is aware that addressing this problem is complicated. Due to the high uncertainty in the catch-at-age data, the RG suggests that an exploratory biomass dynamics model might be useful for future investigations into stock status. The RG agrees that further study of seal predation should be carried out.

HAD-SCOW [WGCSE Section 3.3: Haddock in Division VIa (West of Scotland)]

Assessment type: Update with catch data through 2011 (changes to survey protocol did not allow survey data to be updated for 2011).

Assessment: Analytical.

Forecast: Short-term forecasts were provided as specified in the stock annex (MFDP method), and an alternative forecast from TSA was also provided.

Assessment model: Time-series analysis (TSA) model that uses catch data from 1978 to 1994 and from 2006 to 2011. In the missing years only survey data is used. Two surveys were included in the analysis, but not updated because of changes in survey methods (Sco-GFS-Q1 from 1985–2010 and Sco-GFS-Q4 from 1996–2009).

Consistency:

- The assessment methods were consistent with those in the stock annex.
- Changes in survey methods precluded the use of updated (2011) survey data in the assessment.
- There is a slight retrospective pattern of overestimating SSB and underestimating F. Diagnostic plots indicate some time trends in residual patterns.
- SSB in 2010 has been revised down by ~12% while recruitment has been decreased by about 15% compared to the 2011 assessment. F was comparable between the two assessments.

Stock status:

- The stock is at risk of reduced reproductive capacity, but is being harvested sustainably.
- The stock has been decreasing since 2000 with near time-series lows in SSB. However, there was a slight recovery of the stock in the last year coincident with a decline in F, which is at the lowest level seen.
- Recruitment has been improving since 2010, but is still well below average.
- In 2011 the F (0.22) was less that F_{PA} (0.38).
- The 2012 SSB (23 600 t) was greater than B_{LIM} (22 000 t), but less than B_{PA} (30 000 t).
- There is no estimate of MSY reference points.

Management plan:

- No management plan is available.
- A long-term management plan was evaluated by ICES in 2010 and is waiting to be approved. This plan was not described in the assessment report.
- The TAC was 2005 t in 2011 and 6015 t in 2012 based on transition to an F_{MSY} proxy (F less than 0.33 and 0.3 in 2011 and 2012, respectively).

- Management by TAC may not be appropriate for this fishery as ~50% if total catch has been discards in recent years mostly from the *Nephrops* fisheries.
- *Status quo* F (average over last three years; 0.279) implies removals of 11 000 t in 2012 and 12 400 t in 2013. This results in a SSB of 24 804 t in 2012, 32 130 t in 2013, and 36 000 t in 2014. However, due to the variability of haddock recruitment, these estimates are considered highly uncertain.

General comments

The document was well written and was consistent with the stock annex.

The RG agrees with the WG decision to not update survey data in the assessment due to changes in survey methods, and to consider recent surveys as a new series in the next benchmark.

Technical comments

While the justification of using only survey data from 1995–2005 is well described in the report, the stock annex does not provide a clear explanation of the data used in the model. The RG suggests that the stock annex should be updated (last version from 2009).

Conclusions:

The RG suggests that this assessment is appropriate for the basis of advice, but notes that the assessment is essentially un-calibrated because of the lack of updated survey data consistent with the earlier part of the time-series. The RG suggests that this additional uncertainty, especially in point estimates in recent years, should be considered in future advice.

Table 1. Data used in the TSA model over time.

Data	2007 assessment	2008 assessment	2009 assessment	2010 assessment	2011 assessment	2012 assessment
Catch data	Years: 1978–1994 Ages: 1–8+	Years: 1978–1994 Ages: 1–8+	Years: 1978–1994 Ages: 1–8+	Years: 1978–1994 and 2006-2009 Ages: 1–8+	Years: 1978–1994 and 2006-2010 Ages: 1–8+	Years: 1978–1994 and 2006-2011 Ages: 1–8+
Survey: ScoGFS Q1	Years: 1985–2007 Ages 1–7	Years: 1985–2008 Ages 1–7	Years: 1985–2009 Ages 1–7	Years: 1985–2010 Ages 1–7	Years: 1985–2010 Ages 1–7	Years: 1985–2010 Ages 1–7
Survey: ScoGFS Q4	Years: 1996–2006 Ages 1–7	Years: 1996–2007 Ages 1–7	Years: 1996–2008 Ages 1–7	Years: 1996–2009 Ages 1–7	Years: 1996–2009 Ages 1–7	Years: 1996–2009 Ages 1–7
Survey: IGFS	Not used	Not used	Not used	Not used	Not used	Not used

WHG-SCOW [WGCSE Section 3.4: Whiting in Division VIa (West of Scotland)]

Assessment type: Update to include 2011 landings, discard, and survey data. This stock was subject to a benchmark in 2012 (WKROUND).

Assessment: Analytical (but RG suggests consideration as a trends-only assessment).

Forecast: A short-term forecast was presented with a catch option table.

Assessment model: TSA tuned with three survey indices (ScoGFS-WIBTS-Q1from 1985–2010; ScoGFS-WIBTS-Q4 from 1996–2009; and IRGFS-WIBTS-Q4 from 2003–2011).

Consistency:

- TSA and exploratory SURBA runs were performed on this stock in 2011, but the assessments were unable to determine the status of the stock relative to biological reference points.
- The 2012 assessment methods followed those defined at the 2012 WKROUND benchmark.
- The TSA model performed reasonably well in 2012 without any major retrospective patterns.

Stock status:

- SSB has been in gradual decline from the beginning of the time-series, but appears to have stabilized at all time low levels over the last decade. A slight upturn over the last year appears to have occurred.
- F has been declining for the last decade from a time-series high in 2000 to time-series lows in the last two years.
- Recruitment has been low since 2000, but a stronger than average 2009 year class is expected to lead to a small increase in SSB in the next few years. Initial indications show that the 2011 year class may be the strongest seen since the late-1990s.
- SSB in 2012 (10 000 t) is less than B_{LIM} (16 000 t). F in 2011 (0.07) is much lower than F_{PA} (0.6).
- MSY-based reference points and proxy calculations were attempted, but were deemed too uncertain to be applied.

Man. plan:

- There are no specific management objectives or a management plan for this stock, but a plan is under development.
- A TAC of 307 t has been set for 2012, which covers Divisions VI, XII, XIV, and international waters of Vb. 230 t of this TAC came from Division VIa, but 569 t were caught (339 t of discards).
- Due to extreme discarding (50–60% of total catch in recent years), TAC management is deemed ineffective for limiting mortality in this stock.
- ICES advice in 2012 was to reduce catches to the lowest possible levels. This stock is listed as category 10 (catches should be reduced to the lowest possible level) in the EU policy paper on fisheries management, which implies a 25% TAC decrease leading to a suggestion of a 242 t TAC for 2012.
- Assuming F in 2012 is equal to the mean $F_{2009-2011}$ (0.07), SSB is expected to increase slightly in 2013 to 15 600 t (below B_{LIM}) with total catch of 675 t in 2012 and 837 t in 2013. SSB in 2014 is expected to then decrease slightly to 14 960 t.

General comments

The methods are well explained and data inputs and assessment methods are consistent with the stock annex. The model fits and diagnostics are well documented in the assessment.

The WG tried to define MSY reference points for this stock using the SRMSYMC package, but parameter estimates were too uncertain to allow the reference points to be calculated.

The WG notes that changes in catchability for the survey time-series are troubling and require further investigation (Figure 3.4.14). Changes in catchability could be aliasing a number of unknown issues within the model. As the WG mentions, these issues could be related to: bias in catch estimates, actual changes in catchability of the surveys, changes in natural mortality, or climate regime shifts. However, the RG notes that without *a priori* reasons for believing the survey protocols have changed, it may not be appropriate to allow catchability to vary. It is possible that by holding catchability constant, the time-series estimate of catchability would be lower and result in higher estimates of abundance. The RG recommends a sensitivity analysis that does not allow time varying catchability, because it is difficult to assess the uncertainty in this model without knowing how changes in catchability affect model outputs. The RG recommends that the survey catchability problems should be explored at the next benchmark for this stock. Additionally, the RG notes that until these issues are resolved, it is difficult to recommend this as a full analytical assessment for use in assessing stock status and setting management advice.

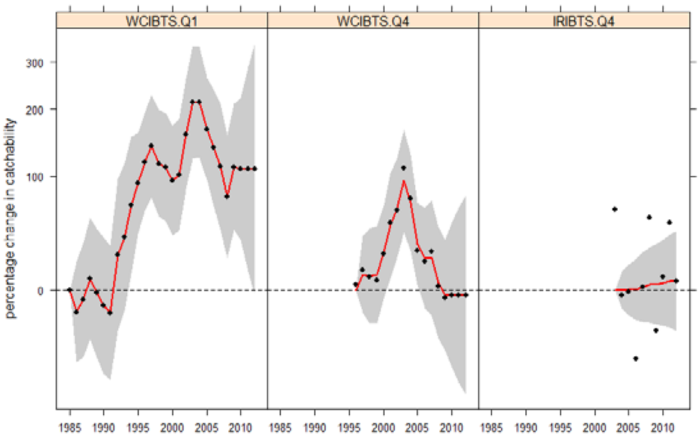


Figure 3.4.14. Whiting in Division VIa. Percentage change in catchability from the final TSA run. Transient changes (points) and the persistent change (solid line) with uncertainty bounds.

The RG recommends that due to possible issues indicated by increasing catchability trends, advice should be based on data limited guidance from RGLIFE (e.g. catch projections at $F_{0.1}$). This model appears to be applied as specified in the stock annex, but potential bias could be high. Until these issues have been investigated further, it may not be appropriate to use point estimates from model outputs as the basis for management advice. Additionally, without any MSY reference points or proxy estimates, it is difficult to assess stock status regardless of model performance. This model may be better suited as an exploratory model to assess stock trends as opposed to a full analytical assessment.

Technical comments

The RG recommends that future assessments explore the use of a commercial index (or indices) of the directed fishery for inclusion in the TSA model. The survey data are particularly noisy, and do not always track age classes well. The WG noted that the reliability of commercial landings data has increased markedly since 2005, which may facilitate the development of a commercial effort and lpue index for this stock.

In the stock development section it is stated that "*some points in the time-series that were identified as outliers were downweighted to improve the fit*". The RG feels that this statement should have been clarified in the assessment report to explain what data were down-weighted in the assessment, and why those steps were taken.

The short-term forecast was presented with a very small range of F values for 2012 and 2013 (0 to 0.08). Given the high exploitation of this stock in the recent past, the RG feels that the short-term forecast should have been provided with a wider range of F (e.g. 0 to 0.5).

Conclusions

The assessment was performed as prescribed in the stock annex, and the RG feels that the assessment trends provide a good basis for management advice. However, due to increasing estimates of catchability in the surveys, which may be aliasing unknown model issues, and uncertainty in estimating reference points, the RG suggests that this model be treated as an exploratory model for assessing trends and not as a full analytical assessment for estimating stock status. Given the status of this stock, the RG agrees with the ICES advice to reduce catches of this stock to the lowest possible levels. The RG also feels that additional technical measures (e.g. mesh changes or sorting grids) are needed to help reduce discarding of this stock, particularly for small whiting. Until such measures are enacted, particularly within the expanding *Nephrops* fishery, it is unlikely that any substantial increases in biomass will occur for this stock.

NEP-11 [WGCSE Section 3.5: *Nephrops* in Division FU11 (North Minch)]

Assessment Type: Update with 2011 UWTV survey and commercial catch data (benchmarked at WK*NEPH* 2009, next benchmark in 2013).

Assessment: Analytical (essentially a survey-based abundance assessment).

Forecast: A short-term projection was completed to produce a catch-option table.

Assessment model: Underwater television (UWTV).

Consistency:

- There are inconsistencies between the WG report methods and those described in the stock annex.
- There are inconsistencies within the WK*NEPH* 2009 report between the body of the text and the annexes on whether discard rates should be a fixed value or a time-varying value.
- Confidence intervals around the biomass estimate are similar to those of the last assessment.

Stock status:

- Abundance has been increasing since 2008 and is approaching time-series highs.
- Lpue trends have been relatively stable across the time-series as have total landings, which have fluctuated around 3000 t.
- There was a 33% increase in estimated abundance in 2011 from 1115 million in 2010 to 1488 million (bias adjusted numbers; unadjusted biomass in

2011 was 1979 million), which is well above $B_{TRIGGER}$ (465 million individuals).

- This is considered an underestimate because the survey excludes sea loch areas.
- The calculated harvest ratio in 2011 (7.3%; dead removals/TV abundance) is at a time-series low and is below the F_{MSY} proxy ($F_{35\%}$=12.5%).

Man. plan:

- No management plan exists for this stock.
- ICES suggests management at the FU level rather than the division level and that the MSY proxies should be used for the basis of management advice.
- The total VIa 2012 TAC=14 100 t.
- In 2011 2696 t were landed, which is less than the suggested landings of 3100 t.
- In 2012 3200 t were suggested for FU11.
- Using the MSY proxy suggests landings of 4160 t in 2013.
- Sea loch areas support a significant, but unknown portion of the creel fishery, and these areas are also not included in UWTV abundance estimates.
- Discarding of bycatch species remains a concern in the *Nephrops* fishery (mostly haddock and whiting), and technical measures may be needed to limit future discards.

General comments

This report was well written. However, the report makes multiple references to 'Section 2', which is used to describe the assessment and landings projections. This Section cannot be located and it is unclear if it is supposed to be located in the annex or the assessment document. It is difficult to determine if the methods described in the report are consistent with this section because it cannot be located.

Values for $F_{0.1}$ (8.7%) and F_{MAX} (16.6%) are not the same values listed in the annex for $F_{0.1}$ (8.8%) and F_{MAX} (15.4%). According to WK*NEPH* 2009, the values for both were calculated at the Workshop by FU, and put in the stock annex to be used for catch-option calculations. There is no explanation of why this change occurred. The RG notes that F_{MAX} catch projections may be overestimated.

There are inconsistencies within the WK*NEPH* 2009 report between the body of the text and the annexes on whether discard rates should be a fixed value or a time-varying value.

The dead discard rate used in the assessment is not consistent with what is reported in the annex. According to WK*NEPH* 2009, the dead discard rate "*should be fixed at the value calculated at the benchmark assessment.*" The discard rate in the annex is 19.9%. The report stated that "*The discard rate adjusted for survivorship which is used in the provision of landings options for 2013 was 12.2 % based on a 3-year average.*" There is no explanation of why this change occurred. The WG method assumes that the low discard rate will continue.

The mean weight in the landings calculation differs from that outlined in the annex. The report stated that "The mean weight in the landings (Figure 3.5.6 and Table 3.5.9) shows a clear increase in the last three years. This has a strong effect in the catch forecast and therefore it was considered more appropriate to use a full-time average, from 1999 (first year with creel and trawl length distributions combined) until 2011." The annex states that the report should "Check the time-series of mean landing weights for evidence of a trend in the most recent period. If there is no firm evidence of a recent trend in mean weight use the average of the three most recent years. If, however, there is strong evidence of a recent trend then apply most recent value (don't attempt to extrapolate the trend further in the future)." The statement indicating why the choice was made to use the average of the entire time-series is not in agreement with the annex. The RG feels that the evidence of a trend in mean weight is weak.

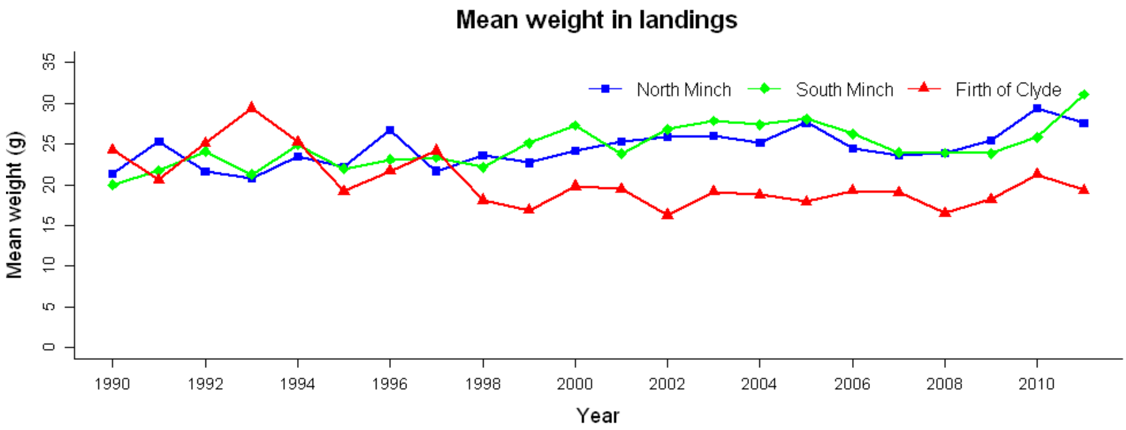


Figure 3.5.5. *Nephrops*, North Minch (FU11), Catch length–frequency distribution and mean sizes (red line) for *Nephrops* in the North Minch, 1979–2011.

The RG suggests that the addition of a trawl survey that tows behind the UWTV survey would greatly increase the data for *Nephrops*. Detailed information regarding the population structure (e.g. size composition, weight, sex ratio, and maturity) would improve the ability to assess stock status. However, the RG realizes that the cost may be prohibitive to implementing these measures.

The WG notes that bias estimates from the UWTV survey are largely based on expert opinion without precision estimates of the bias. Further, the method to derive landings for the catch options is sensitive to the input estimates of discard rate and mean weight in landings, both with unknown levels of uncertainty. The RG agrees with the WG suggestion that precision estimates are need for the forecast inputs.

Technical comments

Table 3.5.10 does not fit on the page. The last 1.5 columns are cut off.

There are two tables in Table 3.5.2. The tables look similar, but have different data and are not labelled separately. It is unclear if both tables are supposed to be in the report.

The report states that "*An overview of the data provided and used by the WG is shown in Table 2.1.*" Table 2.1 was not included.

Conclusions

Overall, the assessment appears appropriate for the basis of management advice. However, the results of the short-term forecasts may be biased and need to be reanalyzed before being used for 2013 landings advice. It appears that the input parameters used to calculate the harvest ratios for the catch option table were not used in a consistent manner to the method in the annex, and the change was not justified. It is unclear if the method is similar to that of the previous assessment. The landings predictions for 2013 may be biased as a result. The RG feels that the catch option table should be recalculated using the method in the annex because, as the report states, *"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."* The RG suggests that sensitivity analyses would help to quantify the effect of the decision on catch advice.

NEP-12 [WGSCE Section 3.6: *Nephrops* in FU12 (South Minch)]

Assessment type: Update including one additional year of survey and catch data (benchmarked at WK*NEPH* 2009, next benchmark in 2013).

Assessment: Analytical (essentially a survey-based abundance assessment).

Forecast: A short-term projection was completed to produce a catch option table.

Assessment model: Underwater television (UWTV).

Consistency:

- The 2012 Assessment is consistent with the 2011 assessment and with the methods described at the 2009 benchmark assessment.
- There are inconsistencies within the WK*NEPH* 2009 report between the body of the text and the annexes on whether discard rates should be a fixed value or a time-varying value.

Stock status:

- The bias-adjusted survey estimate of population abundance declined from a record high in 2004 (2558 million) to a record low in 2007 (1016 million=$B_{TRIGGER}$), but has since doubled (2076 million in 2010 and 1945 million in 2011).
- This is considered an underestimate because the survey excludes sea loch areas.
- The 2011 harvest ratio (6.5%; dead removals/TV abundance) is below the F_{MSY} proxy harvest rate ($F_{35\%}$=12.3%).

Man. plan:

- No management plan exists for this stock.
- ICES advises that management should be at the FU level rather than division level and the MSY proxy should be used for management advice.
- The total VIa 2012 TAC=14 100 t.
- In 2011 3703 t were landed, which was in line with ICES suggestions of 3800 t.
- Landings of 5500 t were suggested by ICES for 2012 based on the MSY proxy.
- The landings prediction for 2013 at the F_{MSY} proxy harvest ratio (i.e., 12.3%) is 5821 t.
- Sea loch areas support a significant, but unknown portion of the creel fishery, and these areas are also not included in UWTV abundance estimates.

- Discarding of bycatch species remains a concern in the *Nephrops* fishery (mostly haddock and whiting), and technical measures may be needed to limit future discards.

General comments

This report was well written. However, the report makes multiple references to 'Section 2', which is used to describe the assessment and landings projections. This section cannot be located and it is unclear if it is supposed to be located in the annex or the assessment document. It is difficult to determine if the methods described in the report are consistent with this section because it cannot be located.

There are inconsistencies within the WK*NEPH* 2009 report between the body of the text and the annexes on whether discard rates should be a fixed value or a time-varying value.

The discard rate applied in the assessment (three year average of 2009–2011) complies with the annex. The WG noted that discard rates in 2010 and 2011 were substantially lower than rates from 1999–2009. This could be the result of an increase in mean size of smaller animals or market fluctuations. The RG is concerned about the assumption that low discard rates will continue, and the influence of the low discard rates in 2010 and 2011 on the landings predictions.

Discarding has been historically high in FU12 and reasons for the decline in discards in 2010–2011 were not well documented. Similar to the 2011 RG conclusions, the RG notes that the catch forecast depends on the recent low discard rates continuing.

The RG suggests that the addition of a trawl survey that tows behind the UWTV survey would greatly increase the data for *Nephrops*. Detailed information regarding the population structure (e.g. size composition, weight, sex ratio, and maturity) would improve the ability to assess stock status. However, the RG realizes that the cost may be prohibitive to implementing these measures.

The WG notes that bias estimates from the UWTV survey are largely based on expert opinion without precision estimates of the bias. Further, the method to derive landings for the catch options is sensitive to the input estimates of discard rate and mean weight in landings, both with unknown levels of uncertainty. The RG agrees with the WG suggestion that precision estimates are need for the forecast inputs.

Technical comments

Labels and captions would be helpful for the tables in the body of the report text.

Conclusions

Overall, the assessment appears appropriate for the basis of management advice. The assessment results are consistent with previous updates, and the stock appears to be relatively stable with low fishing mortality. The RG agrees that the MSY proxy is a solid basis for setting management advice, but the results of the forecasts may be biased if discarding rates increase.

NEP-13 [WGCSE Section 3.7: *Nephrops* in FU13 (Firth of Clyde and Sound of Jura)]

Assessment type: Update including one additional year of survey data (benchmarked at WK*NEPH* 2009, next benchmark in 2013).

Assessment: Analytical (essentially a survey-based abundance assessment).

Forecast: A short-term projection was completed to produce a catch option table.

Assessment model: Underwater television (UWTV).

Consistency:

- The 2012 assessment is consistent with the 2011 assessment and with methods described at the 2009 benchmark.
- There are inconsistencies within the WK*NEPH* 2009 report between the main sections and annexes on whether discard rates should be a fixed value or a time-varying value.

Stock status:

- Firth of Clyde component:
  - Abundance has been increasing since 2009 and has reached record high levels for the time-series.
  - The 2011 harvest ratio (17.6%) >F_{MSY} proxy (F_{MAX}=16.4%).
  - Bias-adjusted survey estimate of abundance in 2011 (2165 million individuals) > $B_{TRIGGER}$ (579 million individuals).
- Sound of Jura component:
  - Trends for this component are difficult to assess due to an incomplete survey time-series, but abundance appears relatively stable.
  - The 2011 harvest ratio (1.2%) <F_{MSY} proxy ($F_{35\%}$=14.5%).
  - Bias-adjusted survey estimate of abundance in 2011 was 312 million, but no biomass reference points are defined for this component.

Man. plan:

- No management plan exists.
- ICES suggests management at the FU level rather than the division level and that the MSY proxies should be used for the basis of management advice.
- The total VIa 2012 TAC=14 100 t.
- Landings in 2011 for all of FU13 were 6431 t, which is above the suggested landings of 4600 t.
- The 2012 suggested landings for the Firth of Clyde were 4200 t and for the Sound of Jura were 900 t.
- The 2013 advice for the Firth of Clyde is 5600 t and 800 t for the Sound of Jura.
- Sea loch areas support a significant, but unknown portion of the creel fishery, and these areas are also not included in UWTV abundance estimates.
- Discarding of bycatch species remains a concern in the *Nephrops* fishery (mostly haddock and whiting), and technical measures may be needed to limit future discards.

General comments

The assessment was well-written and explanations were thorough. The WG report states that methods to derive F_{MSY} and landings predictions did not deviate from the benchmark process.

There are inconsistencies within the WK*NEPH* 2009 report between the body of the text and the annexes on whether discard rates should be a fixed value or a time-varying value.

The discard rate applied in the assessment (three year average of 2009–2011) complies with the annex. The WG noted that discard rates in 2010 and 2011 were substantially lower than rates from 1999–2009. This could be the result of an increase in mean size of smaller animals or market fluctuations. The RG is concerned about the assumption that low discard rates will continue, and the influence of the low discard rates in 2010 and 2011 on the landings predictions.

F_{MSY} proxies were determined as outlined in the benchmark. $B_{TRIGGER}$ is determined by calculating the number of animals associated with the bias-adjusted lowest observed UWTV abundance. F_{MSY} proxies were calculated for both the Firth of Clyde and Sound of Jura stock components, but only the Firth of Clyde has a calculated $B_{TRIGGER}$ point. However, it is unclear why different reference point proxies were used for the two stocks (F_{MAX} for the Firth of Clyde and $F_{35\%}$ for the Sound of Jura). Considering that other stocks in the area (FU11–FU12) also use $F_{35\%}$, the RG notes that the proxy for the Firth of Clyde may not be as precautionary as the advice for adjacent stock areas.

The RG suggests that the addition of a trawl survey that tows behind the UWTV survey would greatly increase the data for *Nephrops*. Detailed information regarding the population structure (e.g. size composition, weight, sex ratio, and maturity) would improve the ability to assess stock status. However, the RG realizes that the cost may be prohibitive to implementing these measures.

The WG notes that bias estimates from the UWTV survey are largely based on expert opinion without precision estimates of the bias. Further, the method to derive landings for the catch options is sensitive to the input estimates of discard rate and mean weight in landings, both with unknown levels of uncertainty. The RG agrees with the WG suggestion that precision estimates are need for the forecast inputs.

Technical comments

The text under the "Final Assessment" heading references the wrong years for Table 3.7.4. The table years include 2009 and 2010, not 2008 and 2009.

Conclusions

Overall, the assessment appears appropriate for the basis of management advice. The assessment results are consistent with previous updates, and the stock appears to be stable or increasing in biomass. Harvest ratios have been reduced in recent years with transition to the F_{MSY} approach. Discarding has been historically high in FU13 and reasons for the decline in discards in 2010–2011 were not well documented. Similar to the 2011 RG conclusions, the RG notes that the catch forecast depends on the recent low discard rates continuing.

COD-ROCK [WGCSE Section 4.2: Cod in Division VIb (Rockall)]

Assessment Type: None (no stock annex is available for this stock).

Assessment: Catch only (analysis of lpue trends).

Forecast: None.

Assessment method: None.

Consistency: None.

Stock status:

- Total landings and the Irish otter trawl fleet lpue have been at relatively stable, but extremely low (approximately 1/10th of the time-series high) levels for the last decade.
- Landings and lpue in 2011 have increased slightly from 2010.

Management Plan: None.

General comments

No analytical assessment has been carried out. This stock is extremely data poor, but the assessment document did not provide any information regarding reasons for the lack of data (it was only one paragraph in total length). The RG suggests that a better job of describing this stock should be done in the future. Any information, even qualitative data, should be provided including any known evidence of stock structure, TAC management, etc... A brief description explaining the reasons for lack of data on this stock would be helpful for future review.

Based on WKLIFE and RGLIFE guidance, life-history information and estimates of selectivity should be used to estimate data-limited reference points (e.g. $F_{0.1}$) to determine exploitation status.

Technical comments

None.

Conclusions

Despite the lack of an assessment or fishery-independent data for this stock, the overall landings data as well as the lpue indices are at near time-series lows over the last decade. Additionally, current catches are less than 1/10th of historic levels. It is suggested that landings should not be allowed to increase for this stock and increased data collection be initiated for cod in Division VIb.

HAD-ROCK [WGCSE Section 4.3: Haddock in Division VIb (Rockall)]

Assessment type: Update with 2011 catch data.

Assessment: Analytic.

Forecast: Short-term and medium-term projections were provided.

Assessment model: XSA tuned with one survey index (Scottish Rock-IBTS-Q3 from 1991–2009). An exploratory statistical catch-at-age (SCAA) model (STAT-CAM) was also presented.

Consistency:

- The assessment methods are consistent with the stock annex, except that the updated (2010–2011) Scottish Rock-IBTS-Q3 survey was not included due to changes in methodology (i.e. area sampled).
- There is a slight to moderate retrospective pattern of underestimating F and overestimating recruitment, but no retrospective pattern for estimates of SSB.

- Perceptions of the stock for 2010 have not changed since the 2011 assessment.
- The XSA and exploratory STAT-CAM generally agree, especially regarding stock trends.

Stock status:

- SSB has shown a moderate decline over the last four years, but remains at intermediate levels for the time-series. F continues to decline to near all time lows, while recruitment remains severely depressed.
- The 2011 F (0.21) $<F_{PA}$ (0.4; analogy to other haddock stocks, but also consistent with F_{MAX}), but above $F_{0.1}$ (.11).
- The 2011 SSB (11 000 t) $>B_{PA}$ (9000 t).
- However, recruitment is extremely weak (each of the last five year-classes were a new record low).
- The stock annex does not report MSY reference points, but MSY reference points are referred to in the WG report (F_{MAX}=0.40; $F_{0.1}$=0.11).

Management plan:

- A management plan is currently under consideration, but has not been accepted and was not presented in this report.
- The EU TAC for VIb, XII and XIV was set at 3300 t in 2012 (a 12% reduction compared to TAC for 2011).
- Landings in 2011 totalled 1903 t from Division VIb.
- Discards have been an issue in this fishery (around 52–87% historically), but have been to some extent in the recent period.
- There is a high probability (98%) that SSB will fall below B_{PA} and $B_{TRIGGER}$ (92%) by 2014 under status quo conditions, mainly as a result of extremely poor recruitment in recent years.

General comments

The WG report was reviewed in draft form (downloaded 30/05/2012). Any changes made after this date were not reviewed (another version was uploaded on 04/06/2012, but could not be checked for consistency). Due to the unfinished nature of the document that was available for review, many sections were incomplete and detracted from the ability of the RG to confirm consistency. Despite the problems in production of the WG report, there appear to be major uncertainties in the assessment (e.g. no survey data available in the last two years). It is unknown how assessment uncertainty impacts stock status.

The WG documented the uncertainties and biases in the assessment and projections. Based on these uncertainties the WG considers the trends in the XSA assessment and survey biomass indices indicative of the general stock trends. However, F is considered to be poorly estimated.

MSY estimates were evaluated in 2010 (WGCSE 2010) and 2011 using the SRMSYSC ADMB package. The number of stock and recruit pairs for this stock is fairly limited and show a relatively wide range. Given the high CVs on all F parameters the WG concluded that the underlying data did not support the estimation of absolute estimates of F_{MSY}. However, the WG believes that current F is close to that which is expected to deliver long-term equilibrium yield.

Without tuning indices for 2010 and 2011 the assessment is essentially an uncalibrated VPA, and should be considered as an exploratory assessment rather than a full analytical assessment. Therefore, the RG recommends that advice should be based on data limited guidance from RGLIFE (e.g. catch projections at $F_{0.1}$).

Technical comments

The RG suggests that for future assessments attempts should be made to standardize the available lpue time-series. Developing an lpue dataset that covers the entire time-series will improve the assessment by providing tuning data for 2010–2011, which is not available from the only survey for haddock in VIb (i.e. the Scottish Rock-IBTS-Q3 survey, which also does not cover the entire stock area).

Conclusions

The RG does not believe that the XSA model is a reliable source for the basis of management advice. There are a number of uncertainties that affect the performance of the XSA, including: poor information on total catch (i.e. discards); and lack of tuning data for the final two years of the time-series. Despite these uncertainties, recruitment appears to be extremely weak, and the stock is projected to decrease to below biomass reference points. The RG recommends that advice should be based on data limited guidance from RGLIFE (e.g. catch projections at $F_{0.1}$), because of the considerable uncertainties in the assessment and the perception of weak recruitment.

WHG-ROCK [WGSCE Section 4.4: Whiting in Division VIb (Rockall)]

Assessment type: Update of landings data through 2011 (there was no annex, but methods were developed by WKLIFE).

Assessment: Catch only.

Forecast: None.

Assessment model: The utilization of DCAC (Depletion Corrected Average Catch) was explored, but not accepted by the WG for advice.

Consistency:

- There is an inconsistency in the categorization of the stock.
- WKLIFE considered VIb whiting to be a category 6 stock: data limited (including stocks for which only landings data are available).
- The WGCSE reviewed the categorization and concluded that VIb whiting should be considered a category 7 stock: a bycatch species in other fisheries caught in minor amounts (category 7).

Stock status:

- The state of the stock is unknown.

Man. plan:

- A total allowable catch limit (TAC) is applied for the combined areas of VIa and VIb.
- There is nothing that specifically limits catch of whiting in Area VIb.
- Whiting in VIb is primarily a bycatch species in the haddock and anglerfish fisheries, but there is no monitoring reported or a constraint on bycatch.

General comments

In general, the document is clear, concise, and well organized.

The state of the stock is unknown, thus there is limited information to inform management advice. Therefore, based on precautionary considerations, ICES advised in 2011 that no increase of the catch should take place unless there is evidence that it would be sustainable. Without information on total catch and size or age structure, quantitative catch advice is not possible at this time.

Whiting in Area VIb may be part of the adjacent stock in Area VIa; however, there is no information on stock structure. Stock identity needs to be determined to develop an assessment for this species.

The WG recommended that when a time-series of catch data is available, the use of DCAC should be explored. In this case, only landings data were available. However, the WG did explore the use of DCAC. The results suggest that catch is sustainable in the range of 53.4 to 71.2 tons. Given the uncertainties associated with landings and stock definitions, DCAC results were not recommended for advice. The decision to reject the DCAC results for the purpose of advice is supported by the RG.

Landings of whiting were relatively high in the beginning of the time-series, specifically from 1990 to 1997 (range of 62–488 t). It is not clear if the decrease in landings (recent landings are less than 20 t) is a reflection of stock status or a product of regulatory or fishery changes. It may be useful to explore changes in fishing effort both spatially and temporally.

The report states that "landings of whiting from Division VIb are considered negligible," but there is little data to support this statement since there is no way to estimate biomass. This statement may not be true if whiting in Division VIb are a distinct stock, or a relatively small subpopulation.

Based on WKLIFE and RGLIFE guidance, life-history information and estimates of selectivity should be used to estimate data limited reference points (e.g. $F_{0.1}$) to determine exploitation status.

Technical comments

There was no stock annex available, so no statement can be made regarding the consistency of the document.

In Figure 4.4.1 there are no units on the y-axis, or in the figure legend.

Conclusions

There is limited data on whiting in Division VIb. Additional information on life history, stock structure and catch are necessary before more robust assessments can be applied. It appears that catches should be maintained at current low levels. More importantly, monitoring of discards should be improved and technical measures may be necessary to reduce bycatch.

ANG-IVVI [WGSCE Section 5.1: Anglerfish in Division IIa, IIIa, Subarea IV and VI (Northern Shelf)]

Assessment type: Update including data through 2011 from the joint science/industry survey and nominal commercial catch, effort, and age composition.

Assessment: Survey trends based on abundance estimates from the Sco-IV-VI-AMISS-Q2 joint industry/science survey from 2005–2011.

Forecast: No forecasts were presented.

Assessment model: None (the last analytical assessment was a modified CASA length based analysis in 2004).

Consistency:

- No assessment model was undertaken in this update.
- Survey trends appear to support results from the 2004 assessment.

Stock status:

- Minimum estimates of biomass from the survey indicate that average biomass over the last two years has decreased by 20% compared to the three years previous.
- Catch-curve analysis averaged over ages 6–8 gives a total mortality over the course of the survey (2005–2011) of 0.44. The sustainability of this harvest rate depends on the F_{MSY} proxy being used (Table 5.2.10).
- The annex supports the use of $F_{35\%SPR}$ =0.30 as F_{PA}, and considers it an approximation of F_{MSY}.

Table 5.2.10. Status of the northern shelf anglerfish stock (F) according to various assumptions about natural mortality (M) and sustainable fishing mortality (F_{MSY}). a) M used in previous assessment (ICES, 2004); b) M used for Southern anglerfish stock assessment (ICES, 2012a); c) M based on relationship to mean weight-at-age in the Northern Shelf stock (Lorenzen, 1996); d) F_{MSY} based on F_{MAX} from previous assessment (ICES, 2004); e) F_{MSY} based on F_{MAX} from Southern anglerfish stock assessment (ICES, 2012a). Status is indicated by the red circle and white cross where F>F_{MSY}; or a green circle and white tick where F<F_{MSY}. In one case, both are included because F is close to F_{MSY}.

M	F	Fmsy	Status
0.15a	0.29	0.19d	✗
0.20b	0.24	0.19d	✗
0.28c	0.16	0.19d	✓
0.15a	0.29	0.28e	✗ ✓
0.20b	0.24	0.28e	✓
0.28c	0.16	0.28e	✓

Man. plan:

- There is no management plan.
- The ICES advice for 2011 in Subdivisions IIIa, IV, and VI was that effort should be reduced because catch is unknown, and in 2012 it was suggested that catches should be reduced.
- The ICES advice for 2011 in Subdivision IIa was that effort in fisheries that catch anglerfish should not be allowed to increase, while the advice for 2012 was that catches should be reduced.

General comments

The document was well written and is consistent with the stock annex.

Two management units are described in Section 5.2 and the stock annex (anglerfish in IIIa, IV and VI; and anglerfish in IIa). The RG agrees with the WGNSDS decision to treat IIa separately, because it found no conclusive evidence to indicate an extension of the stock area northwards to include Division IIa.

The RG agrees with the WG conclusion that an analytical assessment of anglerfish is not possible, because of unreliable commercial data (misreported landings and uncertain effort data) and poor catchability of anglerfish in traditional research vessel surveys. This is not a 'data poor' assessment; it's a 'poor data' assessment. Based on WKLIFE and RGLIFE guidance, life history and fishery selectivity information should be used to estimate data limited reference points (e.g. $F_{0.1}$) to determine exploitation status.

The annual science–industry partnership survey is promising, but the WG reports that problems remain in using survey results for assessment. Further investment is needed to improve the basis for management advice.

Technical comments

None.

Conclusions

The RG agrees that catch and effort need to be reliably monitored to provide even qualitative advice. More quantitative advice would require a reliable time-series of catch and indices of stock size.

MEG-4A6A [WGCSE Section 5.3.1: Megrim in Division IVa and VIa (Northern North Sea and West of Scotland)]

Assessment type: This stock was subject to an inter-benchmark in 2012 (IBP_MEG 2012). The assessment was updated to include 2011 catch and survey data.

Assessment: Analytical (previously a trends only assessment was used based on survey indices and landings).

Forecast: A risk-based approach was used to carry out short-term projections for a range of catch options. A traditional catch forecast could not be done because there is no index of recruitment for this stock.

Assessment model: A Bayesian state–space surplus production model is used that includes catch and six survey indices. The survey indices are:

- Sco-IBTS-Q3 in Area IVa (1987–2011)
- Sco-IBTS-Q1 in Area IVa (1987–2011)
- ScoGFS-WIBTS-Q1 in Area VIa (1986–2010)
- ScoGFS-WIBTS-Q4 in Area VIa (1986–2010)
- SAMISS-Q2 in Area IVa and VIa (2005–2011)
- IAMISS-Q1 in Area VIa (2005–2011)

Consistency:

- A trends assessment was performed for this stock in 2011, and the stock status was not estimated relative to biomass reference points.
- The surplus production model performed reasonably well in 2012 without any major diagnostic problems.

Stock status:

- Biomass in 2012 (26 214 t) >B_{MSY} (19 180 t) and $B_{TRIGGER}$ (9590 t). F in 2011 (0.13) <F_{MSY} (0.3).
- Biomass has been above $B_{Trigger}$ and F has been less than F_{MSY} for nearly the entire time-series.
- Estimates of recruitment are not currently available for this stock.

Man. plan:

- Megrim in IVa are managed under a TAC that also includes Area IIa, and 77% of the TAC (1845 t) was caught in 2011.
- Megrim in VIa are managed under a separate TAC that also includes Areas Vb, XII and XIV, and 44% of the TAC (3387 t) was caught in 2011.
- The RG did not find evidence of a specific management plan for Megrim in Areas IVa and VIa.
- The 2012 advice was that catch should not be allowed to increase.
- Catches between 3000–6000 t over the next few years carry a low risk (0.1–8.8%) that F will exceed F_{LIM}. Similarly, these catches indicate similar risk of falling below $B_{TRIGGER}$ (1.7–2.1%). However, discrepancies exist in the catch option table, which need to be examined before these values are used for management.

General comments

The methods are well explained and data inputs and assessment methods are consistent with the stock annex.

Spanish landings data in Area VI were not presented to the WG for 2011. Therefore, the WG used the Spanish landings from 2010 (288 t) as an estimate of catch for 2011. This deviated from the procedures specified in the stock annex, but the RG feels that the WG decision was justified given the lack of available data.

There appears to be a problem with the catch option table (Table 5.3.6.). The probability of biomass decreasing below $B_{TRIGGER}$ or B_{LIM} does not match well with the catch levels that were explored. The RG feels that this table should be recalculated to provide accurate projections for managers.

Table 5.3.6. Time-series of biomass and fishing mortlaity estimates and ratios of B/B_{MSY} and F/F_{MSY}.

	Total catch option 2013 (tonnes)			
Management Risks	3000	4000	5000	6000
Probability of falling below $B_{MSY\ trigger}$)	1.7%	0.4%	1.5%	2.1%
Probability of falling below B_{lim}	0.3%	0.1%	0.7%	0.5%
Probability of exceeding F_{lim}	0.1%	0.7%	4.2%	8.8%
Stock Size (B/B_{MSY})	1.441	1.404	1.325	1.29
Fishing Mortality (F/F_{MSY})	0.429	0.589	0.825	1.04

Technical comments

Figure 5.3.7 was not updated for this assessment.

Conclusions

The assessment was performed as prescribed in the stock annex and the RG feels that the assessment provides a solid basis for management advice. The stock appears to be healthy, and the RG agrees that *status quo* catches (e.g. 1500 t for Area VI and 1400 t for Area IV) should allow biomass to remain above $B_{TRIGGER}$ in the future. The RG feels that the technical measures introduced under Cod Long-Term Management Plan will be beneficial for the health of this megrim stock in the long term. The increase in MLS (from 28 to 42 cm) and the decrease in discards in recent years are positive steps that will help sustain this stock in the long term.

MEG-ROCK [WGCSE Section 5.3.2: Megrim in Division VIb (Rockall)]

Assessment type: Update from 2011 including additional year of survey, landings, and lpue data.

Assessment: Trends only based on survey indices and commercial lpue.

Forecast: None.

Assessment model: No assessment was performed. Trends in survey indices and biomass estimates from the SAMISS-Q2 and IAMISS-Q2 surveys were presented. Trends in commercial lpue from the IRE-OTB fleet were also analyzed.

Consistency:

- No analytical assessment has been performed for this stock since 1999.

Stock status:

- The status of this stock is unknown relative to MSY reference points.
- Biomass estimates derived from the SAMISS and IAMISS surveys indicate that harvest rates have been 3–6% of the stock biomass since 2008.
- Survey indices suggest that the biomass of the stock increased between 2005 and 2009, but has declined by 7% over the last two years, while abundance has increased by 4%.

Man. plan:

- Megrim in VIb are managed under a TAC that also manages Areas VIa, Vb, XII and XIV.
- The RG did not find evidence of a specific management plan for Megrim in Areas VIb.
- The 2012 advice was that there should be no increases in catch for megrim in VIb.

General comments

The WG report adequately described the current data deficiencies for this stock. The RG agrees that the available data is not sufficient to carry out an analytical assessment. The RG agrees that the collection of age data for this stock during the anglerfish survey starting in 2012 as well as developing improved estimates of landings and discards will help facilitate the use of an analytical assessment in the future.

Based on WKLIFE and RGLIFE guidance, life-history information and estimates of selectivity should be used to estimate data limited reference points (e.g. $F_{0.1}$) to determine exploitation status.

Technical comments

Table 5.3.10 is incomplete and a column for the year (2005–2011) is missing.

Conclusions

Given the uncertainty of the stock status, the RG agrees with the ICES advice that there should be no increase in catches for this stock.

Cod-IRIS [WGCSE Section 6.2: Cod in Division VIIa (Irish Sea)]

Assessment Type: Update of benchmark assessment in 2012 with 2011 fishery landings and survey data.

Assessment: Analytical.

Forecast: Medium-term projections are presented.

Assessment model: State–space assessment model (SAM) tuned to nine surveys (NIGFS-MAR from 1993–2011, ScoGFS-Q1 from 1996–2006, the ScoGFS-Q4 from 1997–2007, the E/W FSPw and E/W FSPe from 2005 to 2011, the NIGFS-OCT from 1992–2011, the E/W BTS-SEPT from 1994–2011, the NIMIK 0-gp from 1995 to 2011, and the AEPM-SSB for 1995, 2000, 2006, 2008 and 2010). However, the SAM model is considered a work in progress.

Consistency:

- The assessment did not deviate from the procedures developed at WKROUND2.
- The assessment is consistent with the previous benchmark assessment.
- Advice on catch from ICES has been consistent for 2011 and 2012.
- WKROUND2 considered the SAM a work in progress rather than a final model structure. As such it should be used to give advice on the status of the stock and total mortality rate, but the actual causes of that high mortality rate are still undetermined.
- No retrospective analysis is provided.

Stock status:

- SSB has been at reduced reproductive capacity since the mid 1990s with SSB (2033 t for 2011, 2394 t in 2012) $<B_{LIM}$ (6000 t).
- F (1.187 in 2011) remains above F_{LIM} (1.0) and the stock is being harvest unsustainable.
- Recruitment has been below average for the past 18 years.
- F_{MSY} is estimated to be between 0.25 and 0.54.

Man. plan:

- There is an Irish Sea cod management plan, but that was deemed to be inconsistent with the ICES Precautionary Approach in 2009.
- The long-term target for the plan is an F=0.4.

- A TAC (380 t in 2012), days-at-sea limits, and technical measures (spawning closures and vessel decommissioning) are associated with the cod recovery plan.
- ICES advice in 2012 was to not allow any directed fishing on this stock, limit bycatch as much as possible, and introduce further technical measures to reduce discards.
- Substantial underreporting of landings continues to be an issue for this stock.
- Due to bias in removal estimates within the model and an unknown relationship between TACs and total removals, short-term forecasts were deemed too uncertain to provide for this stock.

General comments

The report was well written and documented issues associated with the assessment, although a few portions were not complete.

F_{MSY} work was completed in 2010 by WGCSE and not revisited in this assessment. F_{MSY} estimated values were 0.25–0.54.

The concern regarding the bias estimate used in the SAM model is valid. The report addresses this concern by running the model with and without the bias estimate. Results were similar, although the biased SAM results indicated slightly higher SSB. However, confidence intervals from the two models do not overlap for 2010. The RG notes that since biomass is extremely low this may not be of concern at the moment, but if the stock recovers it will need to be addressed.

Technical comments

None.

Conclusions

The RG reiterates the concerns of the WKROUND benchmark that this model is appropriate for the basis of management, but caution should be taken in analyzing point estimates as unknown levels of bias exist. Based on the stock status and catch recommendations from ICES for the last two years, catch should be set to the lowest value possible. ICES advice for 2012 states: *"ICES has evaluated the long-term management plan and found it not precautionary..... Given the low SSB and low recruitment it is not possible to identify any non zero catch which would be compatible with the MSY transition scheme. This implies no targeted fishing should take place on cod in Division VIIa. Bycatches including discards of cod in all fisheries in Division VIIa should be reduced to the lowest possible level and uptake of further technical measures to reduce discards"*. The RG agrees with this recommendation. The TAC may need to be reduced again by 25% to decrease mortality and discarding while other issues associated with this stock are addressed.

HAD-IRIS [WGCSE Section 6.3: Haddock in Division VIIa (Irish Sea)]

Assessment type: Update from 2011 including one additional year of catch and survey data (through 2011). A benchmark is scheduled for 2013.

Assessment: Trends only based on the NIGFS-WIBTS-Q1 survey.

Forecast: A new short-term forecast was developed for this assessment, which was not outlined in the annex.

Assessment model: SURBA (v. 3.0) tuned to the NIGFS-WIBTS-Q1 survey from 1992–2012.

Consistency:

- The same method is used as last year and as outlined in the stock annex.
- Retrospective trends in the SURBA analysis appear to be limited with some slight patterns of overestimating SSB and underestimating total mortality in the early 2000s.
- The general trends are the same as in the previous assessment.

Stock status:

- No official stock status is provided.
- SSB has been increasing over the last two years.
- Recruitment is highly variable, but recent recruitment appears above average.
- Relative total mortality is stable, but absolute values are difficult to assess.
- Landings have been at intermediate levels, while discards (mainly of juvenile fish) remain comparatively large (up to 50% of total catch).
- No absolute estimates of biomass or F are available to compare to PA reference points. F_{PA} is set at 0.5, which comes from other haddock stocks in ICES waters, but no other reference points exist.
- No F_{MSY} or per-recruit reference points are estimated, but previous working groups did attempt to estimate these. No stock–recruit relation was estimable to determine F_{MSY}, while old XSA outputs have been used to calculate per-recruit values but were deemed too uncertain.
- F is believed to be above F_{MSY} based on high juvenile discards and a lack of rebuilding of a truncated age structure following large recruitment events in the mid-2000s.

Man. plan:

- No management plan exists for this stock.
- The 2011 TAC was 1317 t, but only 813 t were landed. The 2012 TAC was reduced to 1251 t.
- Haddock in the Irish Sea has a strong directed fishery, but discards of juvenile fish make up a large proportion of total catch (up to 50%).
- TACs are non-restrictive and deemed inappropriate for this species as they do not limit discards. The WG advice for 2012 is to decrease catch and especially discards, and implement further technical measures to reduce discards and maximize the contribution of small haddock to future yield and SSB.
- Short-term forecasts indicate the possibility of slight declines in SSB under *status quo* conditions.

General comments

The SURBA analysis was well done and provides numerous diagnostic plots that help the reviewer assess performance. The SURBA model was applied exactly as described in the index. In addition, the raw survey indices for a number of other surveys were presented for comparison. Alternative analyses were also presented, such as DCAC and a new short-term forecast, which verified SURBA results and current levels of removals. The RG was impressed with the thoroughness of this review and the presentation of multiple analyses considering the relatively data poor situation for Irish Sea haddock. There was also ample justification given for most modelling decisions.

Although the raw survey indices were presented, and mostly appeared consistent with the NIGFS-WIBTS-Q1 survey used for the SURBA analysis, it would be useful to run the SURBA model on a number of survey indices in order to verify the consistency of results. The RG also suggests that justification for choosing this survey be presented in the annex.

As the WG reports, the estimates of discards are highly imprecise due to lack of coverage and samples. Considering discards are around 20–50% of total catch in weight, it is important that better estimates of discard rates are obtained if this stock is to be reliably monitored, managed, and eventually analytically assessed.

The short-term forecast was well done and the RG appreciates its inclusion despite not being developed in the annex. It is extremely useful for managers considering the lack of information on stock status.

Based on WKLIFE and RGLIFE guidance, life-history information and estimates of selectivity should be used to estimate data limited reference points (e.g. $F_{0.1}$) to determine exploitation status.

Technical comments

Future assessments may consider the use of a biomass dynamics model for this stock. The RG agrees with the WG that in order to develop an age based analytical assessment for this stock better data on catch numbers and age composition must be collected. It is also necessary to improve discard estimates. However, it may be useful to develop an age independent assessment as an exploratory model that could be used to justify the SURBA results. Although surplus-production models are not ideal for assessing stock status, in such a data poor case this may be a beneficial approach and would also provide estimates of F_{MSY}.

On page 455 of the report the text refers to Figure 6.3.11, but should read 6.3.10.

Conclusions

The RG agrees with the WG that the status of the haddock stock in VIIa appears to be increasing based on recent survey trends. However, high discards of juveniles remains problematic and is hindering rebuilding. Mortality estimates are unknown, while reference points are currently unable to be calculated for this stock. Short-term forecasts indicate that SSB will decrease slightly in 2013 under average mortality conditions over the last three years, while DCAC analysis suggests that current TACs around 1200 t–1350 t are appropriate for this stock. Similarly, according to WKLIFE protocol for survey based stocks, the SSB in the last two years has decreased by only 18% compared to the SSB in the three years previous so that no change in TAC is necessary. Overall, the RG agrees that a more precautionary approach should be taken due to the highly variable nature of this stock and the extreme levels of discarding of juveniles. This warrants decreases in catch and more technical measures to attempt to reduce discard rates.

NEP-14 [WGCSE Section 6.4: *Nephrops* in Division FU14 (Irish Sea East)]

Assessment type: Update with one additional year of survey and catch data, but length composition data was not updated (benchmarked at WK*NEPH* 2009, next benchmark in 2013).

Assessment: Analytical (essentially a survey-based abundance assessment).

Forecast: A short-term projection was completed to produce a catch option table.

Assessment model: Underwater television (UWTV).

Consistency:

- The 2012 assessment is consistent with the 2011 assessment and with methods described at the 2009 benchmark.
- There are inconsistencies within the WK*NEPH* 2009 report between the main sections and annexes on whether discard rates should be a fixed value or a time-varying value.
- The WG reviewed and recalculated UWTV estimates for 2008–2011 using a more accurate field of view (0.75m) and a bias of 1.2. The new estimate shows a decrease of abundance around 10% compared with the 2011 estimations.

Stock status:

- The 2011 harvest ratio (6.25%) and $F_{2009-2011}$ (7.52%) <F_{MSY} proxy ($F_{0.1}$=9.8%).
- Abundance in 2011 was 431 million individuals, but there are no $B_{TRIGGER}$ reference points presented for this stock.
- The time-series for this stock is extremely short (four years), thus it is difficult to assess whether any trends exist or how current stock status compares to historical levels.
- Lpue trends tend to indicate increasing catch rates, but insufficient sampling has not allowed all of the datasets to be updated in recent years.

Man. plan:

- No management plan exists.
- ICES suggests management at the FU level rather than the division level and that the MSY proxies should be used for the basis of management advice.
- The total VII 2012 TAC = 21 759 t.
- Landings in 2011 were 561 t, which is less than the 680 t suggested by ICES.
- The 2012 FU14 suggested landings are 960 t.
- The suggested landings for 2013 based on the MSY proxy are 881 t.

General comments

The assessment was well-written and explanations were thorough. Descriptions of data quality and assessment uncertainty added justification to decisions made about data exclusion. Methods to derive F_{MSY} and landings predictions did not deviate from the benchmark process.

There are inconsistencies within the WK*NEPH* 2009 report between the body of the text and the annexes on whether discard rates should be a fixed value or a time-varying value.

The discard rate applied in the assessment (three year average of 2006–2008) complies with the annex. However, the WG noted that reduced sampling in 2009–2011 precluded use of more recent discard rates. The RG agrees with the WG decision to exclude the 2009–2011 discard rates and agrees with the WG suggestion that sampling needs to be intensified to improve discard estimates.

The WG reviewed and recalculated UWTV estimates for 2008–2011 using a more accurate field of view (0.75m) and a bias of 1.2. The new estimate shows a decrease of abundance around 10% compared with the 2011 estimations of the dataseries. The RG agrees with the WG updated abundance calculations.

F_{MSY} proxies have been developed for FU14. However, MSY $B_{TRIGGER}$ is not defined. The current sampling levels are considered too low for reliable length–frequency determination and the time-series of abundance estimates is too short. The RG again suggests that sampling needs to be intensified for this stock to improve assessment and management advice.

The RG suggests that the addition of a trawl survey that tows behind the UWTV survey would greatly increase the data for *Nephrops*. Detailed information regarding the population structure (e.g. size composition, weight, sex ratio, and maturity) would improve the ability to assess stock status. However, the RG realizes that the cost may be prohibitive to implementing these measures.

The WG notes that bias estimates from the UWTV survey are largely based on expert opinion without precision estimates of the bias. Further, the method to derive landings for the catch options is sensitive to the input estimates of discard rate and mean weight in landings, both with unknown levels of uncertainty. The RG agrees with the WG suggestion that precision estimates are need for the forecast inputs.

Technical comments

The legend in Figure 6.4.8 has the second sentence repeated from the previous figure (6.4.7), which should be deleted.

Conclusions

Overall, the assessment appears appropriate for the basis of management advice. The assessment results are consistent with previous updates, and the assessment methods include improvements to the abundance estimates. The crash of the *Nephrops* catch sampling programme in 2010–2011 has impacted the quality of the assessment due to exclusion of length composition data. Additionally, reduced sampling levels in 2009 resulted in the WG decision to exclude 2009 discard data from the assessment. Increased sampling of the FU14 stock is needed to improve the quality of the assessment.

NEP-VII: NEP-15 [WGSCE Section 6.5: *Nephrops* in FU15 (Irish Sea West)]

Assessment type: Update including an additional year of survey and catch data (benchmarked at WK*NEPH* 2009, next benchmark in 2013).

Assessment: Analytical (essentially a survey based abundance assessment).

Forecast: A short-term projection was completed to produce a catch option table.

Assessment model: Underwater television (UWTV).

Consistency:

- The assessment is consistent with the Stock Annex.
- Last year the mean size and discard rates were derived from two years data. A reanalysis was performed using three years data (2008–2010), and the results were consistent with this year's assessment (which also used three years data, 2009–2011).
- There are inconsistencies within the WK*NEPH* 2009 report between the main sections and annexes on whether discard rates should be a fixed value or a time-varying value.

Stock status:

- The stock abundance has been relatively stable for the entire time-series of the UWTV survey.
- Abundance in 2011 (4.9 billion) is above $B_{TRIGGER}$ (3.0 billion).
- Recent harvest rates have fluctuated around the F_{MSY} proxy (F_{MAX}=17.1%), but F in 2011 (19%) is above the proxy.

Management plan:

- No management plan exists.
- ICES suggests management at the FU level rather than the division level and that the MSY proxies should be used for the basis of management advice.
- The total Division VII TAC for 2012 was 21 759 t.
- In 2011 10 162 t were landed, which is slightly above the suggested landings of 9800 t.
- The suggested landings for 2012 are 9800 t.
- The short-term forecast based on MSY proxies suggests landings for 2013 of 9336 t.
- Discarding of bycatch species remains a concern in the *Nephrops* fishery (mostly haddock and whiting), and technical measures may be needed to limit future discards.

General comments

The WG report was reviewed in draft form (downloaded 30/05/2012). Any changes made after this date were not reviewed.

The WG report was well written. The assessment did a good job of documenting any possible sources of uncertainty and bias. The WG also did an excellent job of documenting management considerations.

The RG notes that bycatch limits for could have a significant impact on the directed *Nephrops* fishery, and tools to limit discards of species such as haddock and whiting should be explored.

The RG notes that in 2011 the harvest rate (19%) in FU15 exceeded the 17.1% harvest ratio implied by the MSY framework (Figure 6.5.10). It also exceeded the transitional recommendation of 18.6%. It is unclear if the regional TAC will be effective at restricting harvest rates within individual functional units.

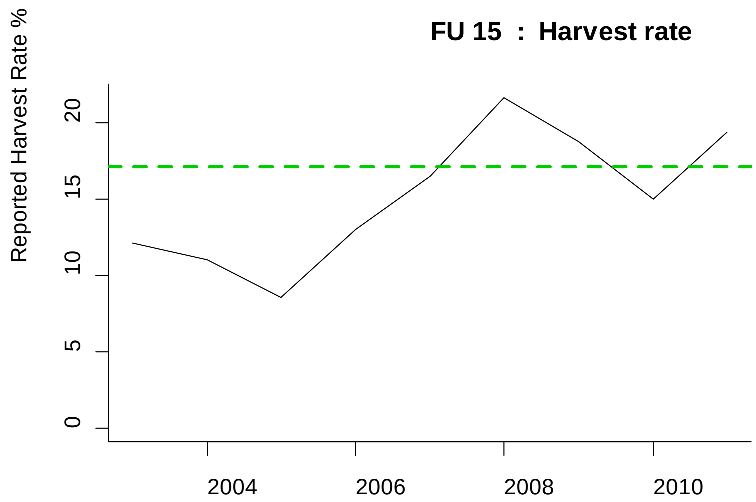


Figure 6.5.10. Irish Sea West (FU15): Stock summary plot of landings (tonnes), UWTV abundance and harvest rate (ratio).

There are inconsistencies within the WK*NEPH* 2009 report between the body of the text and the annexes on whether discard rates should be a fixed value or a time-varying value.

The RG suggests that the addition of a trawl survey that tows behind the UWTV survey would greatly increase the data for *Nephrops*. Detailed information regarding the population structure (e.g. size composition, weight, sex ratio, and maturity) would improve the ability to assess stock status. However, the RG realizes that the cost may be prohibitive to implementing these measures.

The WG notes that bias estimates from the UWTV survey are largely based on expert opinion without precision estimates of the bias. Further, the method to derive landings for the catch options is sensitive to the input estimates of discard rate and mean weight in landings, both with unknown levels of uncertainty. The RG agrees with the WG suggestion that precision estimates are need for the forecast inputs.

Technical comments

None.

Conclusions

Overall, the assessment appears appropriate for the basis of management advice. The assessment results are consistent with previous updates, and the stock appears to be. Catch limits based on the ICES MSY framework seem suitable for management. Reducing the scale of catch limits to be consistent with functional units should be a management priority.

WHG-IRIS [WGCSE Section 6.6: Whiting in Division VIIa (Irish Sea)]

Assessment type: Update from 2011 including one additional year of catch and survey data (through 2011).

Assessment: Trends only based on analysis of two bottom trawl surveys.

Forecast: None.

Assessment model: Two independent SURBA (v. 2.2) runs tuned to the NIGFS-WIBTS-Q1 survey and the NIGFS-WIBTS-Q4 survey from 1992–2011.

Consistency:

- The stock annex does not outline the SURBA method or identify which of the surveys are deemed appropriate as a basis of analysis of stock status.
- Retrospective trends in the SURBA analysis appear to be limited.
- Both SURBA runs showed similar trends.
- The declining trend in stock size is consistent with previous outlooks.

Stock status:

- No official stock status is provided.
- SSB continues to decline and is at all time lows for the time-series.
- Mortality is variable, but remains high.
- Landings have been extremely low compared to those seen in the early 1980s, while discards remain comparatively large.
- No estimates of biomass or F are available to compare to PA reference points of B_{LIM} = 5000 t, B_{PA} = 7000 t, F_{LIM} = .95, and F_{PA} = .65.
- No F_{MSY} or per-recruit reference points are estimated, but the WG believes that the data suggests F_{2011}>F_{MSY}.

Man. plan:

- No management plan exists for this stock.
- The 2011 TAC was 118 t, but only 74 t were landed. The 2012 TAC was reduced to 89 t.
- However, whiting in the Irish Sea is now mainly a bycatch species within the *Nephrops* fishery.
- TACs are non-restrictive and deemed inappropriate for this species as they do not limit discards.
- In 2011 total catch was estimated at 1246 tons, but only 74 t were landed and applied against the 118 t TAC.
- The 2012 advice is to decrease catch to the lowest possible levels and implement further technical measures to reduce discards.

General comments

The SURBA analysis appears well done and provides numerous diagnostic plots that help the reviewer assess performance. However, no information was provided in the annex regarding SURBA or describing which surveys should be used to assess trends. The RG suggests that the annex should be updated to reflect the details of the SURBA analysis. Otherwise, evaluating consistency from year to year is almost impossible, especially without a pre-designated set of surveys to analyze.

Considering the plethora of surveys available for this stock, it might be useful to run the SURBA model on a wider number of datasets in order to assess general consistency in trends. The RG agrees that the WG likely chose the two best survey time-series, but analyzing a wider array of surveys would help to instil more confidence in the trends. This is especially true considering the rather noisy fit to data contained in the two surveys that were analyzed.

The estimates of discards are highly imprecise due to lack of coverage and samples. Considering discards appear to be about ten times the TAC, it is important that better estimates of discard rates are obtained if this stock is to be reliably monitored, managed, and eventually analytically assessed.

Although the model options were laid out in the annex for previous XSA runs along with those for short-term projections and per-recruit analysis, none of these were carried out in the 2012 report. The only mention in either document is that the last assessment was a 'survey-based assessment in 2007'. This wording is confusing as SURBA has been carried out on this stock since 2005, which is considered a survey-based assessment. It is unknown if it is meant that the last XSA assessment was carried out in 2007.

More importantly, justification should be given for why per-recruit calculations were not provided. Even though data is uncertain for this stock, it would be useful to provide calculations of per-recruit reference points no matter the level of uncertainty in them. This would require an estimate of selectivity, but this should be obtainable from the length–frequency of discards (considering discards are a majority of total catch using this selectivity should not bias reference points to a great extent). Catch curve analysis from the surveys could then be used to estimate total mortality, and this can be compared to reference points to obtain some indication of stock status. Again these estimates would be uncertain, but the RG suggests that this would help verify stock trends from the SURBA analysis and help managers to determine the general status of the resource. Alternatively, the RG suggests that survey catch-curve analysis should be undertaken even without estimates of per-recruit reference points as this stock already has established PA reference points. Estimates from catch curve analysis could then be compared to the PA values. Any alternative analysis that would help managers determine relative stock status, and verify the results of the SURBA models, would greatly enhance the current assessment.

Based on WKLIFE and RGLIFE guidance, life-history information and estimates of selectivity should be used to estimate data limited reference points (e.g. $F_{0.1}$) to determine exploitation status.

Technical comments

Future assessments may consider the use of a surplus production model for this stock. The RG agrees with the WG that in order to develop a benchmark for this stock better data on catch numbers and age composition must be collected. It is also necessary to improve discard estimates. However, it may be useful to develop an age independent assessment as an exploratory model that could be used to justify the SURBA results. Although surplus production models are not ideal for assessing stock status, in such a data poor case this may be a beneficial approach and would also provide estimates of F_{MSY}.

Conclusions

The RG agrees with the WG that the status of the whiting stock in VIIa appears to be declining due to reduced catches and declining survey trends. The directed fishery should be limited as much as is feasible and better monitoring of bycatch needs to occur. The RG also agrees that continued development of technical measures such as the Swedish grid, which appears to reduce whiting bycatch in the *Nephrops* fishery by up to 60%, are crucial for reducing mortality of whiting. TAC management approaches are not effective due to the lack of a directed fishery and the high level of discards. In the future, alternative analysis such as survey catch curve and per-recruit analysis would enhance and justify results of the current SURBA model, while providing managers with a more direct estimate of stock status.

PLE-IRIS [WGCSE Section 6.7: Plaice in Division VIIa (Irish Sea)]

Assessment type: Update including 2011 landings, discards, and survey data (benchmarked in 2011, but current AP model is considered a provisional assessment).

Assessment: Survey and catch trends based on a provisional AP analytical model.

Forecast: None.

Assessment model: An Aarts and Poos (AP) analytic assessment model tuned to three surveys (Extended UK(E&W)-BTS-Q3, NIGFS-WIBTS-Q1, and NIGFS-WIMTS-Q4 from 1993–2011) was utilized to derive relative trends.

Consistency:

- The update AP assessment follows the same procedure as in the WKFLAT 2011 benchmark assessment and the stock annex.
- The 2011 and 2012 AP assessment models perform similarly in terms of temporal trends in SSB, recruitment (other than the initial year), and F_{BAR}.
- No retrospective analysis is possible for this assessment.
- "*WKFLAT (2011) agreed that the [AP] model will be used as a temporary basis for the assessment and provision of advice for the Irish Sea plaice. 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 data sets which include recent discards estimates but for which historic discard information is not available.*"

Stock status:

- The update assessment estimates that fishing mortality declined from high levels in the early 1990s to very low levels since 2000 with a slight upturn in 2011.
- SSB increased between 1995 and 2005 and has since been stable around time-series highs.
- Recruitment is variable, but near time-series highs.
- No MSY reference points are available.
- Estimates of PA reference points were carried out before discards were included in the catch data and are now considered inappropriate, but have not been re-estimated.

Management plan:

- Management of plaice in Division VIIa is by TAC and there is a minimum landing size (MLS) of 27 cm.
- The TAC was 1627 t in 2011 and 2012.
- TAC management may not be appropriate for this species due to lack of quota uptake and targeting of plaice, but especially due to high discard rates (between 50–75% of total catch in the last five years) in bycatch fisheries such as those targeting *Nephrops*.
- The ICES advice for 2012 is that effort should be consistent with no increase in catches.

- No short-term forecasts are available for this stock.

General comments

The WG report was reviewed in draft form (downloaded 30/05/2012; **note:** the final report was made available 31/05/2012). Any changes made after the download date were not reviewed. It does not appear that changes were made to the assessment model, outputs, or stock status between the report versions reviewed.

There seemed to be outstanding issues regarding inconsistencies in several of the surveys used to tune the model. The RG suggests that these inconsistencies be addressed.

There are a number of issues, particularly with discard data, that the WG addresses in-depth.

The TAC in 2011 was 1627 tonnes and the working group estimate of landings in 2011 was 594 t, which is only 37% of the TAC. The RG notes that when discards are included the total catch is 1198 t, which is 70% of the TAC. The shortfall in landings relative to the TAC has occurred in previous years and was suggested by the WG to be a consequence of limited consumer demand and relatively low value of plaice.

High levels of discarding occur in all fisheries that catch plaice in the Irish Sea. The RG notes that in recent years discards have been greater than landings. For Irish Sea plaice, management by TAC is ineffective for constraining total catch and F.

The WG report states: "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. Any measures that effect a reduction in discards will result in increased future yield. However, decreasing the mesh size may not have the desired result since the market demand for plaice is poor and small plaice are particularly undesirable". The RG is unsure why reduced mesh size would be considered as a measure to reduce discards. Based on the WG report and stock annex a significant proportion of plaice is discarded in fisheries targeting other species. Reduction of discards will likely need to rely on incentives to avoid the stock (such as limitations on the amount that can be discarded) or gear modification, which allow target species to be caught while reducing plaice bycatch.

Based on WKLIFE and RGLIFE guidance, life-history information and estimates of selectivity from the AP analysis should be used to estimate data limited reference points (e.g. $F_{0.1}$) to determine exploitation status.

Technical comments

There are no units on the y-axis of Figure 6.7.2.1.

The WG notes that there may be significant substock structure within Division VIIa. The RG encourages additional analysis of the stock structure.

There is an inaccuracy in the WG report: "However, discarding in 2011 has drop markedly and was lower than landings". While discards did decrease significantly, they were still greater than landings.

The final AP output and diagnostics were difficult to assess due to formatting in the draft document.

Conclusions

The RG suggests that the trends from the AP model are appropriate for the basis of management advice. The WG concludes that, while F_{BAR} and SSB are considered poorly estimated, the overall state of the stock is 'acceptable' with consistently low fishing mortality and high spawning biomass. Therefore, the stock is considered to be within safe biological limits. The RG agrees with this conclusion. The RG cautions that current management measures do not constrain discards. Discards should be monitored carefully and the WG should continue to pursue the development of analytical models that include discards. The WG states that effort by the UK(E&W) *Nephrops* fleet has increased, and the *Nephrops* grounds in the western Irish Sea overlap with the distribution of small plaice. The RG supports the development and expansion of programs that reduce plaice bycatch, especially of young plaice, such as using sorting grates in the *Nephrops* fishery.

SOL-IRIS [WGSCE Section 6.8: Sole in Division VIIa (Irish Sea)]

Assessment type: Update with survey (UK-BTS-Q3) and commercial data through 2011.

Assessment: Analytical.

Forecast: Short-term and long-term projections (YPR and SPR) are provided as specified in the annex.

Assessment model: XSA with tuning from one survey (UK beam trawl survey, UK-BTS-Q3 1988–2011). Other surveys and lpue indices are available but not used in the assessment as per the stock annex.

Consistency:

- The assessment methods are consistent with the stock annex and the 2011 assessment.
- There is no retrospective pattern.
- There is no change in the perceived stock status.

Stock status:

- The 2011 F (0.32) >F_{MSY} (0.16).
- The 2011 SSB (1137 t; the lowest in the time-series) <MSY $B_{TRIGGER}$ (2200 t).
- Recruitment has been well below average since 2001, and the estimate of the most recent recruitment (the 2009 year class) is the lowest in the series.

Man. plan:

- There is no management plan.
- ICES advice for 2011 was a TAC of 390 t, based on F=0.24, which was a transition to F_{MSY}.
- ICES advice for 2012 was a TAC of 80 t, based on F=0.07, which was less than F_{MSY} to promote rebuilding according to the ICES MSY framework.
- The transition plan to F_{MSY} suggested a 2012 TAC of 200 t based on F=0.19.
- *Status quo* F (three year average) of 0.3156 results in 2012 catches of 279 t and 2013 catches of 298 t. This should lead to an SSB of 1113 t in 2013 and 1225 t in 2014.

General comments

The document was well written and followed the annex.

The RG agrees with the WG conclusion that discards appear to be a small portion of the recent catch (0–8%). However, the RG recommends that discards should be considered for inclusion in the assessment, particularly if they increase due to TAC restrictions.

The long-term projection method specified in the stock annex is a yield- and spawning biomass-per-recruit analysis (MFYPR). However, the RG notes that the stock–recruit relationship is informative (Figure 6.8.10) and recommends that the stock–recruit relationship used to derive F_{MSY} should be considered for evaluating rebuilding plans.

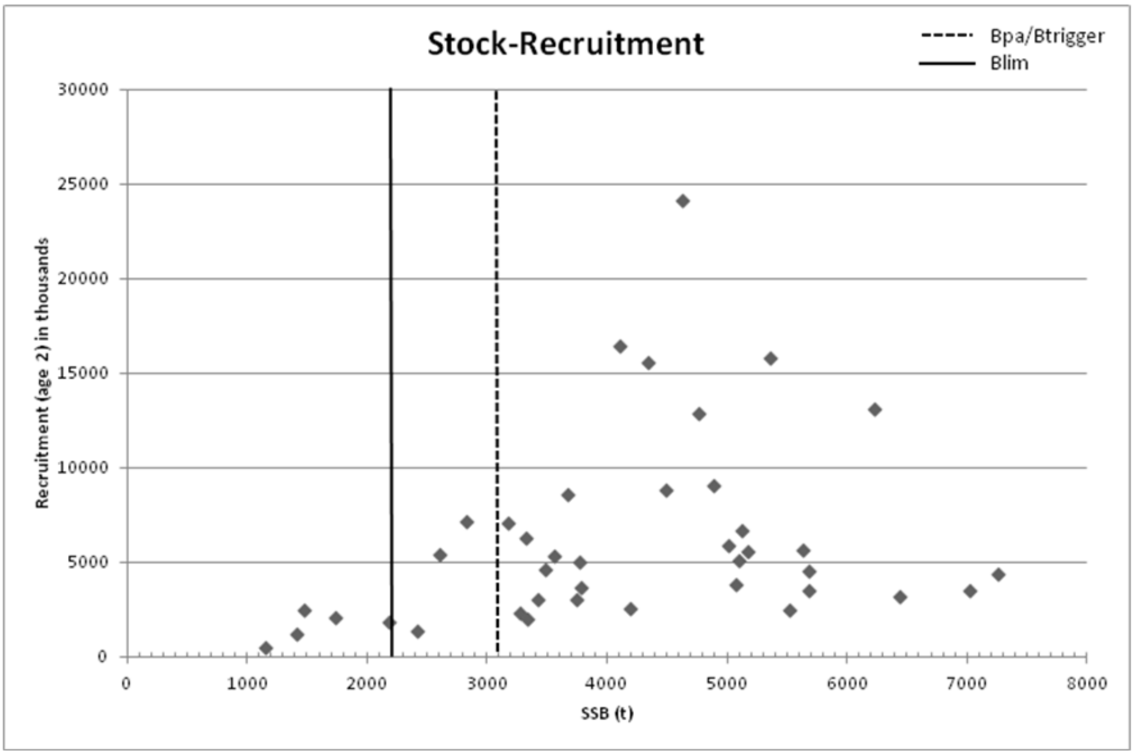


Figure 6.8.10. Sole VIIa- Stock–recruitment plot.

Technical comments

The legend for Figure 6.8.9 should define 'X' in the Y-axis label ('Probability of SSB(2014)<X'). Presumably this is MSY $B_{TRIGGER}$.

Conclusions

The quality of landings-at-age sampling appears to be good, and the survey tracks cohorts well. The assessment appears to be a reliable basis to inform a rebuilding plan. However, discards should continue to be sampled, and considered in future assessments.

COD-7E-K [WGCSE Section 7.2: Cod in Divisions VIIe-k (Celtic Sea cod)]

Assessment type: This stock was subject to a benchmark in 2012 (WKROUND). The assessment was updated to include 2011 catch and survey data.

Assessment: Analytical.

Forecast: A short-term forecast was presented, but the forecast was not completed as prescribed in the Annex. No medium-term forecast was presented.

Assessment model: XSA tuned by one survey-series (combined FR-IBTS-Q4 and IR-GFS-Q4) and one commercial series (FR-OTDEF-Q2-Q4).

Consistency:

- An exploratory XSA was used in 2011 and F was considered to be decreasing. However, stock status could not be determined.
- The inputs to the XSA model were changed substantially at the 2012 benchmark.
- The XSA model performed well in 2012 without any retrospective patterns.

Stock status:

- In 2011 F (0.387) was slightly lower than the F_{MSY} proxy (F_{MAX}) of 0.4.
- The 2011 SSB (11 450) > MSY $B_{TRIGGER}$ (10 300 t).
- Recruitment was strong in 2010 and 2011, and the strong recruitment is expected to lead to an increase in SSB in the next few years.

Man. plan:

- The stock is managed under a TAC based on MSY, but there is no formal management plan in place for this stock.
- A long-term management plan is under discussion for this stock and an effort based management system in the Celtic Sea (VIIf,g) is being discussed by member states and the EC.
- Assuming the full 2012 TAC (10 059 t) is taken implies that F in 2012 is equal to 0.405, which is approximately equal to F_{MAX}.
- This should lead to an SSB in 2013 of 27 567 t, which is much greater than MSY $B_{TRIGGER}$ (10 300 t).
- The MSY framework suggests an F in 2013 of 0.4 (based on F_{MAX}), which leads to a projection of a 2013 TAC of 10 240 t and a 2014 SSB of 26 530 t.

General comments

The report was well written, and any deviations from the stock annex were well explained.

Estimates of discards (including highgrading) were included in the assessment for 2011, but not for other years. The WG felt that the magnitude of discards in 2011 was large enough to warrant inclusion in the assessment. Discarding (and highgrading) rates in 2011 were high due to a restrictive TAC and a strong 2010 year class. Discards in 2011 were estimated to be 35% of the total catch for this stock in 2011. The RG agrees with the WG decision to include 2011 discards in the updated assessment. However, the RG is concerned that discarding of small cod may be a serious problem in the fishery.

A commercial tuning index (FR-OTDEF) is used in the assessment. In the benchmark, it is stated that a French trawl vessel that lands 40% or more of gadoids per trip should be included in the index. The large 2009 and 2010 year classes of cod led to an increase in the number of vessels that landed at least 40% of gadoids per trip in 2011. As a result, the apparent effort on this stock increased 170%. The WG explored this apparent increase in effort by looking at four effort indicators, including the number of trips and number of days at sea by French trawlers in 2011. The analysis showed that actual fishing effort by French trawlers changed very little (-3% to 1%) from 2010 to 2011. In the assessment, the effort for the FR-OTDEF fleet was increased by 1% to reflect the results of the reanalysis. An exploratory XSA was performed to examine the sensitivity of the XSA results to the effort assumption that is applied to the FR-OTDEF fleet (Figure 7.2.7). The results showed that the assessment results are sensitive to the assumed effort for the FR-OTDEF fleet. Stock status is robust to the decision about effort, but catch projections are sensitive to the decision. The RG believes that the 40% gadoid criterion may need to be reconsidered to derive a consistent index of effort so that the method does not need to be revised each year.

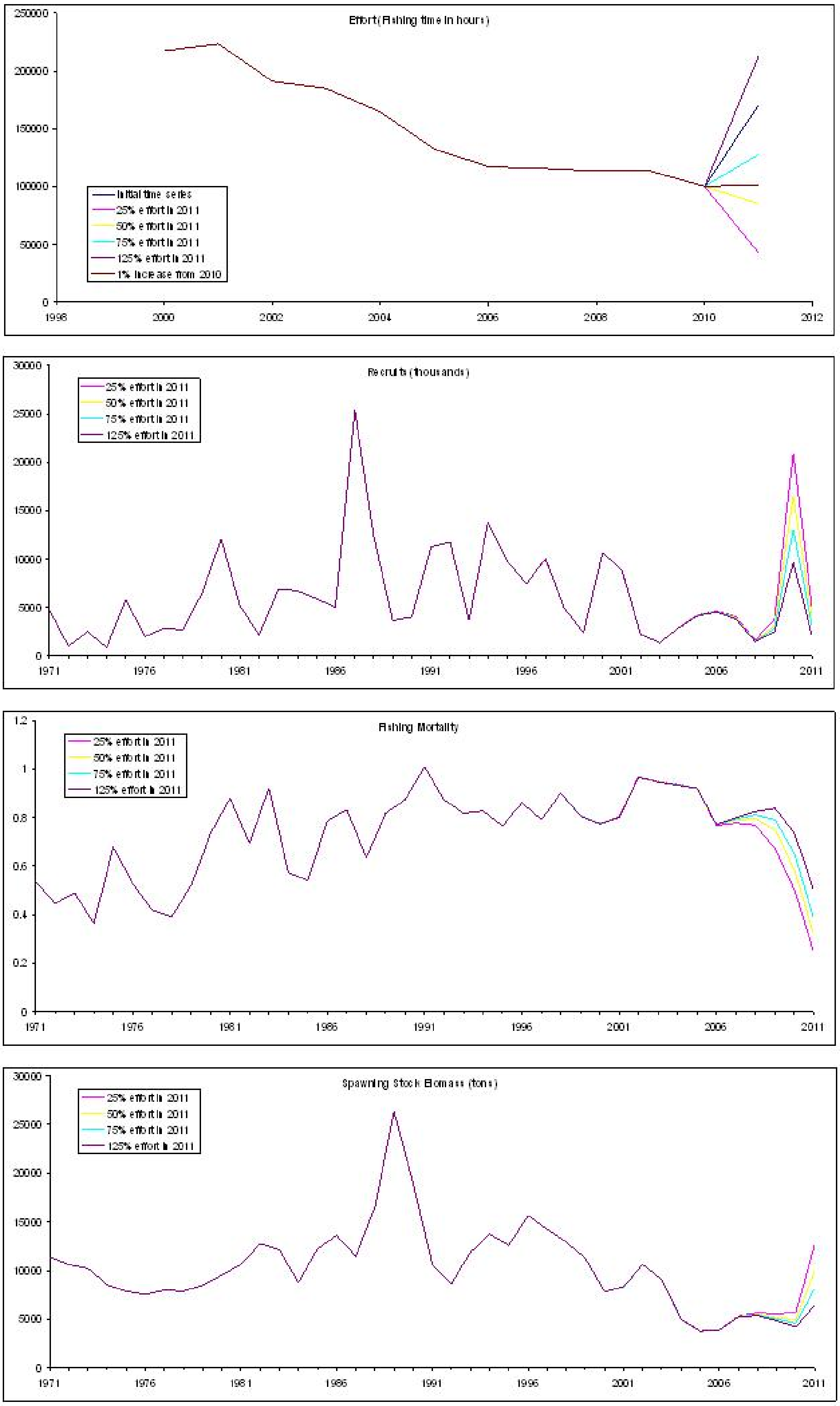


Figure 7.2.7. Celtic Sea cod in Division VIIe–k. Exploratory XSA.

The short-term forecast was not performed according the specifications in the stock annex. In the annex, it is stated that the mean F for the last three years should be used. However, the WG assumed that F in 2012–2014 would be constrained by a TAC of 10 059 t, and that no discarding or highgrading would occur in those years. The F used in the short-term projections (0.405) is much lower than the mean $F_{2009–2011}$

(0.543). The short-term forecast with management options (Table 7.2.16) indicates that even with F near the mean $F_{2009–2011}$ (e.g. 0.54) the SSB is expected to remain above MSY $B_{TRIGGER}$ in 2013. The RG agrees with the decision to revise the F assumption if the fishery will be effectively constrained by the TAC in the next few years. However, due to high discard rates in recent years, the RG is not sure if the fishery will strictly adhere to the TAC in the future. The RG cautions that the forecast may be too optimistic if the TAC is exceeded in future years.

The WG also changed the biomass reference points, and the reference points in the assessment do not match those provided in the stock annex. B_{LIM} was changed from 6300 t to 7300 t. B_{PA} was changed from 8800 t to 10 300 t, and MSY $B_{TRIGGER}$ (10 300 t) was provisionally set to be the same as B_{PA}. F_{MSY} was provisionally set at 0.4 based on F_{MAX}. F_{LIM} (0.9) and F_{PA} (0.68) were specified in the stock annex. The RG notes that the change in biomass reference points does not affect the perception of the stock, which would be considered acceptable under both sets of biomass reference points. The RG agrees with the WG that these reference points should be considered as provisional, and more work is needed to derive MSY reference points.

Technical comments

The RG is concerned that there is a lack of contrast in the survey index and the commercial index that are used in the assessment. The survey index is fairly recent (1997–present) and the commercial index only includes data from 2000–present. However, the SSB and the landings were substantially greater during the 1980s. Future assessments could be improved by exploring alternative XSA models that include a longer time-series of commercial fisheries indices.

The exploratory XSA analysis showed that the assessment results are sensitive to the assumed effort for the FR-OTDEF fleet. Given the uncertainty in the magnitude of effort for the French fleet in recent years, the RG is concerned that the French fleet is the only commercial tuning index used in the assessment. The annex states that numerous commercial indices are available, and these indices have been used in past assessments. The RG suggests that future assessments should try to include effort and lpue data from some of these other fleets as tuning indices.

The French self reporting programme is a major source of discard information for this fishery, but examination of landings and discards (Figure 7.2.2.) leads the RG to believe that discarding is not being estimated accurately. In particular, in fisheries where samples are obtained by at sea observers, discarding of small cod appears to be much more widespread (Figure 7.2.3a).

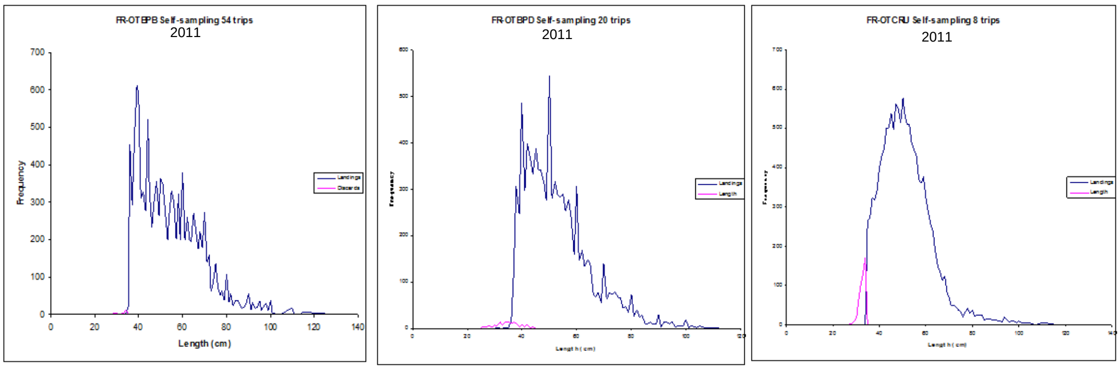


Figure 7.2.2. Annual length compositions of sampling and discards from the French self sampling programme.

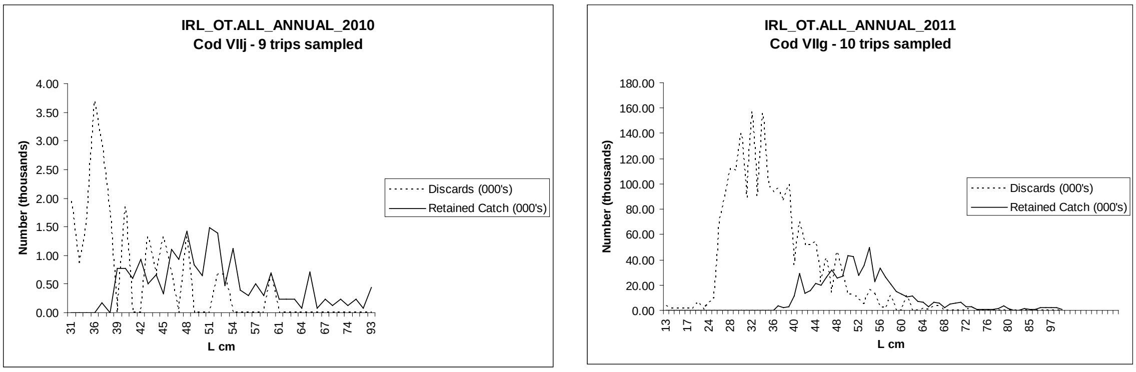


Figure 7.2.3a. Cod in Divisions VIIe–k. 2011 quarterly or annual length compositions of UK, Irish discards raised using effort ratio for Irish data, from hauls sampled for UK.

Conclusions

The assessment provides a strong basis for management. Although the WG deviated from the stock annex in several ways, the RG feels that the changes made to the assessment were well justified. The changes did not change the perception of the stock, but catch forecasts are sensitive to these changes, especially in regards to adjustments in effort for the French FR-OTDEF fleet. The biomass of this stock appears to be 'acceptable' and F is close to F_{MSY} assuming that the TAC effectively constrains the fishery and discards are accurately monitored.

HAD-7B-K [WGCSE Section 7.4: Haddock in Divisions VIIb-k]

Assessment type: This stock was subject to a benchmark in 2012 (WKROUND) and updated with catch and survey data through 2011. No annex was provided for this stock, but the assessment procedures are laid out in WKROUND 2012.

Assessment: Analytical (previously used XSA trends, but ASAP was deemed robust enough to provide point estimates).

Forecast: A short-term forecast was presented, but there were no medium- or long-term forecasts.

Assessment method: ASAP tuned to one survey (FR-IRL-IBTS) and one commercial lpue index (IR-GAD).

Consistency:

- The stock was previously assessed using XSA.
- The ASAP model estimates are in general agreement with the 2011 XSA results with the exception of F_{BAR} (ages 3–5) in the early part of the time-series.
- Retrospective trends are exhibited in the ASAP model. SSB was consistently underestimated, while F was overestimated.

Stock status:

- No formal stock status was presented.
- SSB has doubled since 2010 and F_{BAR} (ages 3–5) has been decreasing over the last four years.
- However, SSB increases are due to an extremely high 2009 year class, while recent recruitments have been below average.

- It is expected that as the 2009 year class is fished out the SSB will decrease dramatically.
- F_{MAX} (0.28) is suggested as an F_{MSY} proxy. The only B_{PA} reference point available is the lowest SSB in the time-series (7500 t).
- F_{BAR} 2011 (0.526) is well above F_{MAX}, but around time-series lows. SSB 2011 (76 541 t) is ten times the suggested B_{PA}, but is expected to decline rapidly.

Management plan:

- No management plan has been agreed upon or proposed for this stock.
- The TAC is set for combined Areas VIIb–k, VII, IX, X, and EU waters of CECAF 34.1.1. 98% of the TAC comes from division from haddock in VIIb–k.
- The 2011 and 2012 TAC was 13 316 t. Landings in 2011 were 12 524 t, but discards were 14 275 t.
- TAC management is deemed inappropriate for this stock due high discards of small fish and legal size fish in recent years due to restrictive quotas. Discarding has averaged 81% of the catch over the last ten years. Introducing technical measures to decrease discards is suggested.
- *Status quo* F leads to 2012 SSB of 58 128 t, landings of 19 708 t, and a SSB of 2013 SSB of 34 233 t.
- The 2014 forecast is highly uncertain due to recruitment variability. *Status quo* F for 2013 leads to landings of 12 393 t and a 2014 SSB of 29 622 t, while F_{MAX} suggests landings of 4462 t and an SSB of 41 501 t.

General comments

The report was well written, and WG decisions were well explained.

Report mentions that 2012 French lpue data was omitted due to increased availability of cod, so trips were classified as OT_DEF resulting in unrepresentative lpue data, but the French landings data historically account for 58% of the landings. The RG recognizes the change in targeting and the effect on using the index in the assessment. However, no sensitivity analysis was provided on including or excluding the series. Given the importance of the French fleet, the RG recommends that the effort criterion be reconsidered for future assessment, similar to the approach used for cod VIIe–k.

Stock weights-at-age are fairly noisy and the WG used a 3-year running average of stock weights-at-age as per the Annex.

The RG is concerned that knifed edged maturity at age 2 was used, but WD 03 suggests that neither males nor females are fully mature at age 2, and only females are fully mature at age 3 (males-94%). This may have considerable implications if discard mortality is high because 56% of the catch in numbers was discarded age 2 fish in 2011, some of which have yet to mature.

Both tuning indices are extremely variable. The survey indicates a flat trend, but covers most of the stock area. The Irish Gadoid commercial fleet data indicates an increasing trend, but only covers "selected rectangles of VIIg,j". The RG is concerned that the fleet index may give a false representation of increasing SSB.

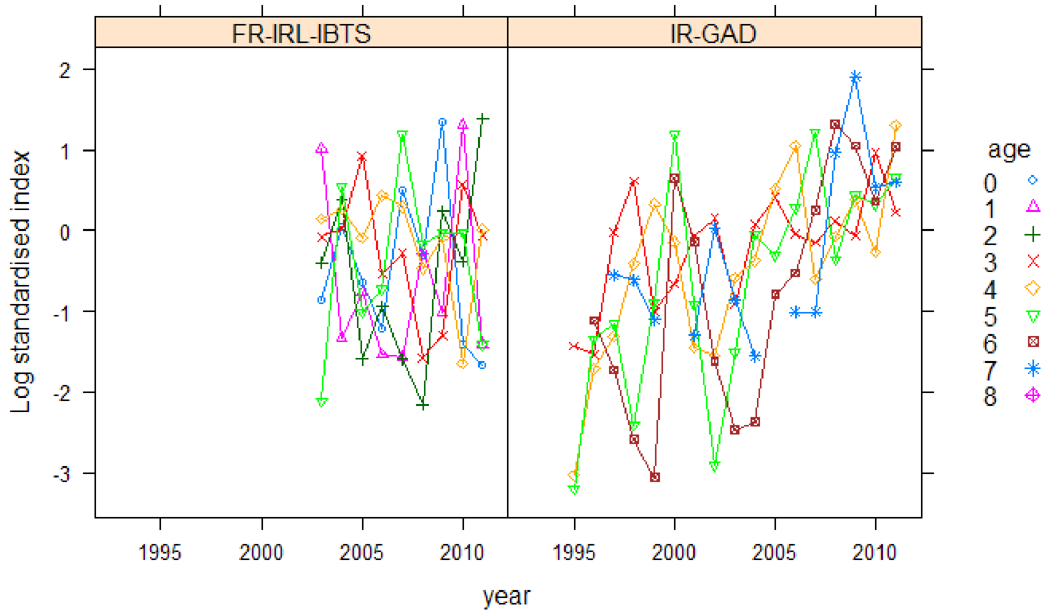


Figure 7.4.9. Log standardized indices of tuning fleets by year. The FR-IRL-IBTS survey is the combined French EVHOE Q4 WIBTS and Irish IGFS Q4 WIBTS survey. The IR-GAD commercial tuning fleet is the Irish gadoid fleet in VIIg,j.

No stock–recruitment relationship was defined due to erratic recruitment. Assuming recruitment is independent of stock size leads to $F_{MSY} = F_{MAX} = 0.28$. The RG agrees with using this proxy until a stock–recruitment relationship can be determined.

Technical comments

Age 8 stock weights are extremely erratic. Even with the three year average, the 2011 age 8 weight is lower than ages 6 and 7. The RG is concerned that the results indicate poor sampling, and a younger plus group should be considered.

The WG report mentions that discards are high in this fishery (53% of catch in 2011), with the majority of discards being below minimum landings size. The WG report recommends that separating discards from landings would be desirable, but this was not done because the WKROUND (2012) concluded that doing so would result in undesirable residual patterns. The RG notes that retrospective patterns remain in the current assessment (SSB is underestimated and the F is overestimated consistently), and that a mistreatment of fishery selectivity caused by lumping landings and discards into a single fleet may be one possible cause of this retrospective trend.

The RG did not understand the description of the reasons for discarding fish. The WG report mentions that half the discarded fish from the French fleet are above minimum landing size due to restrictive quotas. However, the French have the largest quota of any country and has yet to exceed their TAC. If this is an issue of highgrading at sea, careful attention needs to be paid to monitoring so that estimates of discards can be accurately measured.

(b)	Landings used by WG (Quota in brackets)					
Year	Belgium	France	Ireland	UK	Others	Total
2002	134 (103)	3878 (6200)	2070 (2067)	301 (930)	21	6403 (9300)
2003	116 (91)	5960 (5456)	1667 (1819)	362 (819)	41	8146 (8185)
2004	137 (107)	6336 (6400)	1732 (2133)	303 (960)	73	8581 (9600)
2005	165 (128)	4096 (7680)	1991 (2560)	282 (1152)	20	6555 (11520)
2006	98 (128)	3151 (7680)	1857 (2560)	262 (1152)	14	5383 (11520)
2007	118 (128)	4073 (7680)	1925 (2560)	383 (1152)	10	6510 (11520)
2008	109 (129)	4587 (7719)	1794 (2573)	545 (1158)	14	7049 (11579)
2009	131 (129)	5455 (7719)	2986 (2573)	703 (1158)	2	9276 (11579)
2010	170 (129)	6267 (7719)	2609 (2573)	789 (1158)	34	9868 (11579)
2011	212 (148)	7365 (8877)	3323 (2959)	1510 (1332)	114	12524 (13316)

The report notes that ASAP "does not accommodate the inclusion of age 0 in the model" and explains that the first age in the ASAP input and output is always age 0. The RG does not understand if this means age 0 is labelled as age 1 or not.

Figure 7.4.13 was mislabelled on page 5 paragraph 2 as 7.4.12.

Figure 7.4.14 was mislabelled on page 5 paragraph 2 as 7.4.13.

Section 7.4.7 cited Table 2.1, but there was no corresponding table.

Conclusions

The RG agrees with the 2011 advice that, despite the apparent increase in SSB, there should be no increase in catch. Retrospective trends and extremely high discard rates make estimates of stock status uncertain, while extreme and unpredictable variability in future recruitment make forecasts unreliable Thus, catch should not be allowed to increase, and, given that current F appears to be almost twice that of F_{MAX}, the PA and MSY approaches indicate that catches may need to be severely reduced . The RG also notes that technical measures to mitigate the discarding of recruiting year classes may be necessary in future.

NEP-17 [WGCSE Section 7.5: *Nephrops* in FU17 (Aran Grounds)]

Assessment type: Update from 2011 including one additional year of UWTV survey and catch data. This stock was benchmarked in 2009 (WK*NEPH* 2009) and is scheduled for another benchmark in 2013.

Assessment: Analytical (essentially a survey-based abundance assessment).

Forecast: A short-term landings prediction forecast was presented. The MSY proxy projections from the previous assessment were presented, which was not documented in the annex.

Assessment model: Underwater television (UWTV) abundance estimates and harvest rate estimates based on fraction of dead removals to UWTV abundance.

Consistency:

- The 2012 assessment is the same as the 2011 assessment and generally follows the annex, although some aspects are missing from the annex (e.g. short-term forecast discard calculations and MSY projection methods).
- There are inconsistencies within the WK*NEPH* 2009 report between the main sections and annexes on whether discard rates should be a fixed value or a time-varying value.

- No retrospective plots are given for this stock.

Stock status:

- SSB has declined below the time-series average, but the harvest rate has also decreased slightly due to a 40% decrease in landings from 1000 t in 2010 to 600 t in 2011.
- $F_{35\%}$ (harvest rate of 10.5%) is used as the MSY proxy, which suggests that F in 2011 (7.7%) is below this level.
- No PA or biomass based reference points are available for this stock.

Man. plan:

- No management plan exists for this stock.
- ICES suggests management at the FU level rather than the division level and that the MSY proxies should be used for the basis of management advice.
- The 2011 total TAC for Area VII (FUs 14–22) is set at 21 759 t for 2011 and 2012.
- Landings in 2011 for FU17 were 600 t, which are below ICES suggestions of 900 t.
- The 2012 advice was to use the F_{MSY} proxy of 10.5%, which suggested landings of 1100 t.
- Assuming *status quo* F (7.7%) results in projected landings of 653.7 t for 2013. This is below F_{MSY} proxy (10.5%) levels of 894 t.
- The WG noted that there has been past uncertainty in landings data due to restrictive quotas and misreporting from the Irish fleet, which could bias harvest rate estimates (e.g., no catch statistics are available for 2006–2007 due to industry noncompliance).

General comments

The UWTV assessment was generally well done, but the assessment document (uploaded 17/5/12; downloaded 31/5/12) was still in draft form and contained many 'Track Change' comments, which indicated that some of the numbers presented in the document were incorrect. The RG had no way to verify these comments or numbers. Additionally, both the assessment and annex were lacking justification for major modelling decisions such as reasons for borrowing key model biological parameters from other *Nephrops* stocks.

The annex appears to have copied the general procedure for performing UWTV assessments and short-term forecasts from the WK*NEPH* 2009 benchmark. However, stock-specific parameters and decisions were not provided (e.g. what the rate of assumed discards should be for FU17). It would help the RG if the annex had a more thorough description of UWTV methods, while also providing stock-specific decisions where applicable.

There are inconsistencies within the WK*NEPH* 2009 report between the body of the text and the annexes on whether discard rates should be a fixed value or a time-varying value.

Bias correction factors for the UWTV survey are given in both documents, but little justification or impact of these biases is given. The RG suggests that a more thorough justification of bias corrections should be provided. The WG notes that bias estimates from the UWTV survey are largely based on expert opinion from different stock areas without precision estimates of the bias. The RG agrees with the WG suggestion that precision estimates are needed.

The MSY proxy projections were not described in the annex. The RG agrees with the WG that the method used seems appropriate, but, due to problems with fit within the SCA model used, proxy values may be uncertain. Additionally, the full procedure used should be explained in the annex.

Although estimates of abundance in the Slyne Head and Galway Bay subareas were provided for the first time, these values were not included in overall estimates of abundance or catch projections. The RG suggests that justification should be given for this decision, and unless there is a reason not to include these estimates then they should be used in future assessments.

A number of key biological parameters are borrowed from other stocks without justification. Attempts should be made in the future to estimate all parameters from the FU17 stock. Similarly, the assumed discard rate for catch projections should be documented. The WG also states that weight-at-age parameters are from a study carried out in 1955. As the WG mentions, future work should investigate the possibility of time-varying weight parameters.

The RG suggests that the addition of a trawl survey that tows behind the UWTV survey would greatly increase the data for *Nephrops*. Detailed information regarding the population structure (e.g. size composition, weight, sex ratio, and maturity) would improve the ability to assess stock status. However, the RG realizes that the cost may be prohibitive to implementing these measures.

Technical comments

On page 774 the reference to Table 7.5.7 should read Table 7.5.8.

The units for landings in Table 7.5.9 are mislabelled.

Conclusions

The RG agrees that the FU17 *Nephrops* stock appears to be in ‘acceptable’ shape. However, uncertainty exists in MSY proxy values and in harvest rate estimates due to the possibility of misreporting in the fishery. The RG suggests that the *status quo* F (7.7%) should be maintained indicating 2013 landings of 653.7 t. Due to the observed 30% decline in burrow density since 2010, this stock should be closely monitored. Future reductions in catch and a re-evaluation of reference points may be warranted if the stock decline continues. Additionally, the RG suggests that FU-specific TACs be enacted, as opposed to division based management, for *Nephrops* in order to avoid sudden displacement of effort from year to year.

NEP-16 [WGCSE Section 7.6: *Nephrops* in FU16 (Porcupine Bank)]

Assessment type: Update including catch, lpue, and survey data trough 2011 (a benchmark is planned for 2013).

Assessment: Trends only based on several indicators such as lpue, landings, sex ratio, length distribution, Spanish Porcupine Bank survey (SpPGFS-WIBTS-Q4; 2001–2011), IFSRP survey (2010–2011), and DCAC analysis.

Forecast: No forecast was provided.

Assessment model: No model was implemented. Depletion corrected average catch (DCAC) was used to estimate sustainable yield. Also, the '*Nephrops* data limited approach' was applied.

Consistency:

- The WG explored two new methods for data limited stocks: DCAC analysis and the '*Nephrops* data limited approach'.
- Trends from the main data sources used for previous indication of stock health were coherent from 2011 to 2012.

Stock status:

- No official status was provided.
- The main indicators suggested that the recruitment was very low from 2004–2008, but has recovered to the historical average in 2009.
- The exploitation proxy appears to show that mortality has declined compared to the early 2000s.
- Lpue has been increasing over the last two years.
- Total landings increased by 30% in 2011 to 1186 t.
- The stock is classified as data limited (category 6).
- Productivity of deep-water *Nephrops* stocks is generally lower than in shelf waters with more sporadic recruitment events, which indicates that this stock may be more prone to overexploitation than those in adjacent FUs.

Management plan:

- There is no formal management plan in place for this stock.
- ICES suggests management at the FU level rather than the division level and that catches should not be allowed to increase for FU16.
- The total TAC for Area VII in 2012 is 21 759 t, but FU16 is the only FU given a sub TAC which was 1260 t in 2011 and 2012.
- Landings in 2011 were 1186 t, which are below the sub TAC of 1260 t.
- The estimate of sustainable harvest levels from the DCAC (1240 t) is similar to the sub-TAC regulation in FU16 (1260 t), which may indicated that current harvest rates are sustainable.
- The sub TAC has appeared to increase both misreporting and highgrading in this fishery.
- Discarding of bycatch species remains a concern in the *Nephrops* fishery (mostly haddock and whiting), and technical measures may be needed to limit future discards.

General comments

The report is concise and clearly written. There are no inconsistencies between the annex and the WG report.

Current sampling intensity, commercial landings information, and discard data are insufficient for the accurate assessment of this stock. The main issues in terms of available information are: misreported catches, unknown discard levels, and lack of survey coverage.

The survey with the longest time-series (the Spanish Porcupine Bank survey; SpPGFS-WIBTS-Q4) covers only eleven years and is carried out in September when

Nephrops catchability is low. If this survey is to be used as the main indicator of FU16 abundance then survey protocols will need to be altered in the future.

A data limited approach for *Nephrops* was carried out using a single UWTV station. This analysis indicated a burrow density of ~0.06/m^2 inside FU16. This approach obviously needs further development (e.g. more stations). A dedicated UWTV survey on Porcupine Bank would greatly enhance the ability to assess this stock, which is done for most of the adjacent FUs.

Based on WKLIFE and RGLIFE guidance, life-history information and estimates of selectivity should be used to estimate data limited reference points (e.g. $F_{0.1}$) to determine exploitation status.

Technical comments

A closed area was implemented in 2010. However, the information on the effects of this area on stock size is not yet available. The only information described in the report about the differences between closed and open areas is related to survey cpue trends. The RG suggests alternative information such as possible differences in carapace length between areas would be useful in determining the benefit of the closed area. Such information would provide indicators of differences in mortality rates and recruitment in open and closed areas.

The annex has an error on the ICES statistical rectangles that comprise FU16. It should be "**31-35** D5-D6 32-35 D7-D8" instead of "**31-36** D5-D6 32-35 D7-D8."

Figure 7.6.13 is duplicated in the report.

The axes in Figures 7.6.6, 7.6.7, and 7.6.8 are not clear.

The DCAC model assumed the following parameters: M was set equal to 0.15 (reduced natural mortality because this is a deep-water stock), F_{MSY} to M ratio was 0.5, depletion delta was 0.75, and B_{MSY}/B_0 was set equal to 0.4. The RG suggests that more justification is needed for decisions regarding the choices of: F_{MSY}/M, depletion delta, and B_{MSY}/B_0 values.

Conclusions

The FU16 stock of *Nephrops* is severely data limited. The only data available are limited samples from the commercial landings and surveys with insufficient data collection protocols to be informative. Additionally, misreporting and highgrading appear to be an issue in FU16 making commercial data unreliable. Until a dedicated UWTV survey can be implemented in this area, it does not seem likely that this stock can be accurately assessed. Based on DCAC analysis it appears that current harvest rates are sustainable, but due to misreporting it is unknown how reliable such results are or if the sub TAC is effectively constraining catch. The RG agrees with previous ICES advice that catch should not be allowed to increase and the fishery should be closely monitored.

NEP-2022: [WGCSE Section 7.7: *Nephrops* in FU20-22 (Celtic Sea)]

Assessment type:

- FU 20–21: Update with commercial landings and lpue from France and the Republic of Ireland through 2011.
- FU 22: Update with 2011 estimates of catch and survey indices.

Assessment:

- FU 20–21: Trends only based on lpue data and length–frequencies.
- FU 22: Analytical (essentially a survey-based abundance assessment).

Forecast:

- FU 20–21: None.
- FU 22: A short-term forecast was presented.

Assessment model:

- FU 20–21: None.
- FU 22: Underwater television (UWTV).

Consistency:

- FU 20–21:
    - This unit is a new advisory FU, which was previously combined with FU22.
- FU 22:
    - The UWTV survey methods have not been benchmarked, but appear to follow the protocols outlined by WK*NEPH* 2009.
    - There are inconsistencies within the WK*NEPH* 2009 report between the main sections and annexes on whether discard rates should be a fixed value or a time-varying value.

Stock status:

- FU 20–22: The combined stock has been considered stable or increasing based on lpue, mean size, and UWTV data. There were indications of strong recruitment in 2006 and 2009.
- FU 20–21: Lpue from French trawlers has declined slightly since 2009. Lpue is reported for all three FUs as a group. Lpue from Irish trawlers has also declined since 2008. Lpue is reported separately for FU 20–21. There are no reference points for FU 20–21.
- FU 22: The mean density in 2011 (1256 million individuals) has increased by 10% compared to 2010 and is slightly above the average for the time-series. The harvest rate in 2011 (5.3%) suggest the stock is harvested below the F_{MSY} proxy ($F_{35\%}$ = 10.9%).

Man. plan:

- There is no specific management plan for the FU 20–22 stock.
- ICES recommended that FU 20–21 and FU 22 should be separated for advice and assessments, and that catches should be reduced for FU20–21 and MSY proxies should be used to calculate the harvest rate for FU22.
- The Division VII TAC is 21 759 t in 2012.
- In 2011 2854 t were landed in the combined FU20–22 area, which is a decline of 38% from 2010.
- 1617 t were landed in FU22 in 2011, while 1237 t were landed in FU20–21.
- The suggested landings for 2012 in FU22 are 2300 t.
- The short-term forecast based on MSY proxies suggests landings for 2013 of 2830 t in FU22.

General comments

The WG report was reviewed in draft form (the version dated 06/05/2012 was reviewed). Any changes made after this date were not reviewed.

The report stated that the back calculation approach used to estimate discards for FU 20–22 had been discontinued until the stock is benchmarked. The reason given is that there has been a change in discarding practices, especially by the French fleet, which is related to tailing of *Nephrops*. The RG aggress with this decision. Using the back calculation described in the annex would result in a biased discard number.

FU 22

There was a decision made to use the time-series average (2003–2011) mean weight calculations for catch table calculations in order to account for variability in mean weights that are linked to recent recruitment. This is in opposition to the method described in WK*NEPH* 2009. There is no figure of mean weight of landings to assess if there are any recent trends to justify this decision. The time-series is short so it may be appropriate to include the entire series.

There are inconsistencies within the WK*NEPH* 2009 report between the body of the text and the annexes on whether discard rates should be a fixed value or a time-varying value.

The RG suggests that the addition of a trawl survey that tows behind the UWTV survey would greatly increase the data for *Nephrops*. Detailed information regarding the population structure (e.g. size composition, weight, sex ratio, and maturity) would improve the ability to assess stock status. However, the RG realizes that the cost may be prohibitive to implementing these measures.

The WG notes that bias estimates from the UWTV survey are largely based on expert opinion without precision estimates of the bias. Further, the method to derive landings for the catch options is sensitive to the input estimates of discard rate and mean weight in landings, both with unknown levels of uncertainty. The RG agrees with the WG suggestion that precision estimates are need for the forecast inputs.

FU20–21

Based on WKLIFE and RGLIFE guidance, life-history information and estimates of selectivity should be used to estimate data limited reference points (e.g. $F_{0.1}$) to determine exploitation status.

Considering the data limited nature of this stock it is suggested that alternative analysis such as DCAC analysis should be carried out to determine estimates of sustainable levels of harvest.

The RG suggests that attempts should be made in the future to include FU20–21 in the UWTV survey carried out in other FUs in this region. Without a survey for this stock it will be difficult to develop an analytical estimate of abundance.

Technical comments

There is no Table 7.7.12. It may be Table 7.7.11.

Conclusions

The UWTV method used to assess FU22 appears to be appropriate as the basis of management advice. Catch limits based on the ICES MSY framework seem suitable for management. On the other hand, the stock in FU20–21 is extremely data poor and it is difficult to determine stock health. The RG agrees with the ICES advice for 2012 that catches should be decreased in this area. Additionally, attempts should be made to extend the UWTV survey over the entire FU20–22 area so that abundance estimates and harvest rates can be calculated for FU20–21 as well as FU22.

NEP-19 [WGCSE Section 7.8: *Nephrops* in FU19 (South and Southwest of Ireland)]

Assessment type: This is the first assessment for this stock based on the UWTV survey. Formally this stock was based on lpue and size trends. This stock has never been benchmarked, but a benchmark is scheduled for 2013.

Assessment: Analytical (essentially a survey based abundance assessment).

Forecast: A short-term projection was completed to produce a catch option table.

Assessment model: Underwater television (UWTV).

Consistency:

- Previous assessments (1993, 2003 and 2005) attempted to use an age structured assessment for this stock, but in each case the model was considered to be inadequate.
- Previous assessments were based on trends in catch data.
- This was the first assessment for this stock based on the UWTV survey based on methods from WK*NEPH* 2009, but the methods for this particular stock were not benchmarked.

Stock status:

- Due to the short time-series of the UWTV survey no trends in abundance or F are available and no abundance based reference points have been developed to assess stock status.
- Landings have been decreasing and were below the time-series average in 2011.
- Trends in lpue have been fairly stable in recent years.
- Abundance is 2011 is estimated to be 557 million individuals.
- $F_{0.1}$ (7.5%) has been suggested as a provisional proxy for F_{MSY} and 2011 F (7%) is below this level. The harvest rate is below that for stocks in adjacent FUs.

Man. plan:

- No specific management plan exists for this stock.
- ICES suggests management at the FU level rather than the division level and that the catches for FU19 for 2012 should be reduced from 2011 levels.
- A TAC has been established at 21 759 t for *Nephrops* in Area VII for 2012.
- In 2011 608 t were landed, which was a decrease from the 722 t landed in 2010.
- Fishing at the MSY proxy level would imply landings of 817 t in 2013.
- Discarding of bycatch species remains a concern in the *Nephrops* fishery, and technical measures may be needed to limit future discards. The *Nephrops* grounds in FU19 coincide with an important nursery area for juvenile hake and anglerfish among other species.

General comments

The report was well documented and was easy to follow.

The UWTV survey was not conducted in the Galley Grounds 4 in 2011. Instead, the density values observed in Galley Grounds 4 during the 2006 UWTV survey were used in the assessment. This is particularly important because the Galley Grounds 4 encompasses 39% of the area that is included in the UWTV survey footprint. The WG had the option to omit Galley Grounds 4 from the abundance estimate, which would have resulted in an abundance estimate of 850 million individuals. The WG felt that using the 2006 survey values for Galley Grounds 4 was a more conservative approach. When the 2006 estimate for Galley Grounds 4 was included in the assessment, the abundance estimate was revised downwards to 724 million individuals. There is no guidance in the annex on how to treat this situation. The RG questions the decision to include density estimates from the 2006 UWTV survey, because it is possible that the abundance may have changed substantially over the five years since the survey was conducted. The 2006 estimate of density in Galley Grounds 4 is substantially lower than the 2011 density estimate for Galley Grounds 1–3 (see Figure 7.8.6. below). The RG recommends that a directed effort be made to survey Galley Grounds 4 during the 2012 UWTV survey.

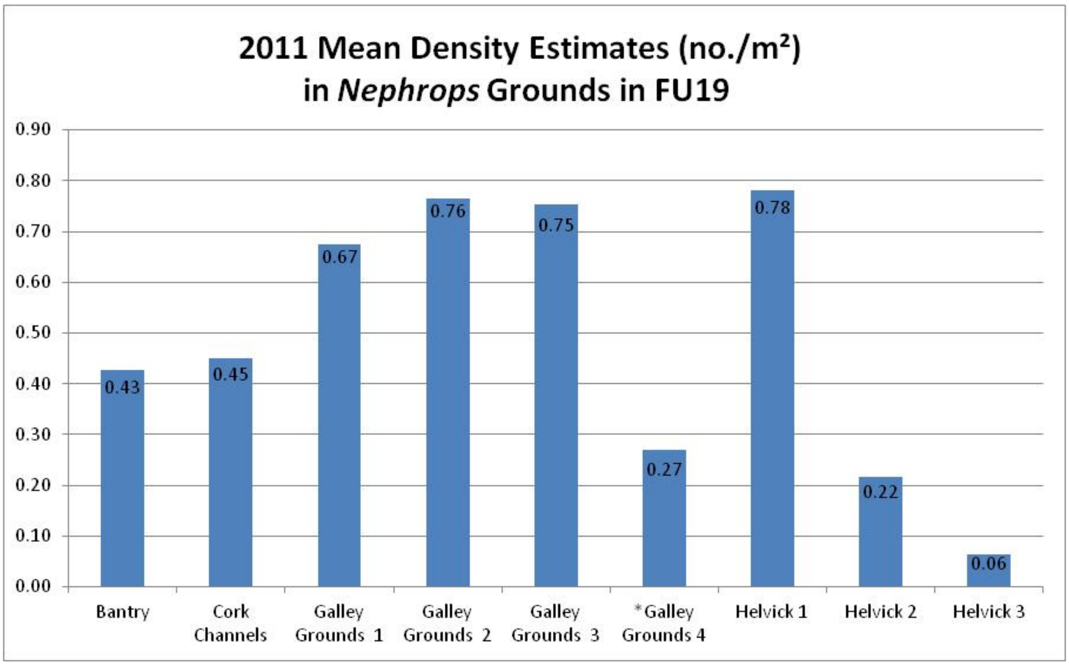


Figure 7.8.6. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). 2011 Mean density estimates for the various** ***Nephrops*** **grounds in FU19. * Galley ground 4 estimate is from 2006 TV survey.**

The report mentions that the standard errors and 95% confidence intervals associated with the biomass estimates from the UWTV survey were calculated for each survey area, but these estimates of precision and error were not provided in the assessment. The RG suggests estimates of standard error and confidence intervals be provided in future WG reports.

Since no benchmark was carried for this stock, it is impossible to assess the consistency. Although it appears that the modelling approach follows the general procedure laid out in WK*NEPH* 2009 for UWTV based assessments, it should be noted that this report contained inconsistencies between the body of the text and the annexes on whether discard rates should be a fixed value or a time-varying value.

The RG suggests that the addition of a trawl survey that tows behind the UWTV survey would greatly increase the data for *Nephrops*. Detailed information regarding the population structure (e.g. size composition, weight, sex ratio, and maturity) would improve the ability to assess stock status. However, the RG realizes that the cost may be prohibitive to implementing these measures.

The WG notes that bias estimates from the UWTV survey are largely based on expert opinion without precision estimates of the bias. Further, the method to derive landings for the catch options is sensitive to the input estimates of discard rate and mean weight in landings, both with unknown levels of uncertainty. The RG agrees with the WG suggestion that precision estimates are need for the forecast inputs.

Technical comments

The WG states that more work is needed to develop life-history parameters that are specific to the FU 19 *Nephrops* stock and to establish F_{MSY} proxies. The RG agrees with this suggestion and encourages future research and sampling programmes that will better characterize the biological structure and catch of *Nephrops* in this area. The 2013 benchmark will provide a good opportunity to accomplish this task.

The WG notes that the current survey footprint may underestimate the extent of the *Nephrops* stock. The video survey areas are based on VMS observations of fishing locations. However, roughly 50% of the vessels in the *Nephrops* fleet do not have VMS. The RG encourages the WG to cooperate with *Nephrops* fishermen to determine if the current survey footprint is missing any of the major fishing grounds for this stock.

Conclusions

The assessment appears appropriate for the basis of management advice. The assessment was performed as prescribed in the stock annex. Based on recent trends in landings and lpue, and the estimated 2011 harvest rate (7%), the RG agrees with the WG that the biomass of the stock appears to be stable. Additionally, the MSY proxy appears to be a solid basis for prescribing future management advice. As the UWTV survey is continued in FU 19, it may become possible to estimate biomass reference points for this stock, and to assess stock status with more certainty.

PLE-7B-C [WGCSE Section 7.9: Plaice in Division VIIb,c (West of Ireland)]

Assessment type: Update including one additional year of catch data (no annex is available for this stock).

Assessment: Catch only, but DCAC was attempted.

Forecast: No forecasts were presented.

Assessment model: No assessment is available for this stock.

Consistency:

- The 2012 assessment is the only one available through WGCSE 2009–2012 reports.
- No stock annex is provided for this stock.

Stock status:

- No stock status is available for this stock.
- Landings are near time-series lows.

Man. plan:

- No management plan is provided.
- The 2012 advice is consistent with that from 2011 that no increases in catch should be allowed for this stock.
- The most conservative estimate of DCAC suggests sustainable harvest rates of 74.6 t per year, which is well above current landings. The RG does not believe the DCAC estimates are robust enough to be used as management advice.

General comments

The Stock Annex was absent, so comparison to previous assessment and advice could not be conducted. The assessment was concise and described the applied DCAC methods appropriately. The assessment gave an explanation for the choice of the two year ranges chosen for DCAC analysis. However, the report did not explain why the entire time-series was not analyzed.

The WG describes the stock identity of plaice in VIIb,c from off the Aran Grounds in VIIb and in the north of VIIb extending into VIa (Stags Grounds). A large portion of landings in recent years has come from the VIa Stags Grounds region. The WG notes that plaice in this area of VIIb are more linked with VIa populations than populations further south. It is currently unknown how much exchange occurs between plaice on the Aran and Stags Grounds. The RG is concerned that stock mixing and changes in fishing practices could confound landings data specific to plaice in Division VIIb,c.

The stock was examined with Depletion-Corrected Average Catch (DCAC) analysis. A range of depletion parameters (10%, 50%, 90%) were analyzed and two sets of year ranges were tested (1950–2011 and 1995–2011). The depletion parameter had little influence on estimated catch levels. However, the year range had a major influence (Table 7.9.2). The RG notes that the 1995–2011 estimate of DCAC is somewhat sensitive to the depletion assumption.

Table 7.9.2. Settings and results from DCAC.

Year range	Sum Catch (landings)	CV	Nyears	M	StDev	Fmsy/M	StDev[1]	Bmsy/B0	StDev[2]	Delta	StDev[2]	Avg Catch	Avg DCAC
1950–2011	12 264	0.2	62	0.12	0.5	0.8	0.2	0.25	0.1	0.1	0.1	197.8	196.1
1950–2011	12 264	0.2	62	0.12	0.5	0.8	0.2	0.25	0.1	0.5	0.1	197.8	187.6
1950–2011	12 264	0.2	62	0.12	0.5	0.8	0.2	0.25	0.1	0.9	0.1	197.8	181.4
1995–2011	1661	0.2	17	0.12	0.5	0.8	0.2	0.25	0.1	0.1	0.1	97.7	94.4
1995–2011	1661	0.2	17	0.12	0.5	0.8	0.2	0.25	0.1	0.5	0.1	97.7	82.9
1995–2011	1661	0.2	17	0.12	0.5	0.8	0.2	0.25	0.1	0.9	0.1	97.7	74.6

[1] Assuming lognormal distribution.

[2] Assuming bounded (1-0) beta distribution.

The time-series of landings data dates to 1908, however, the 1908–1949 data were not included in the DCAC analysis. Due to the major influence of year ranges on the estimates from the DCAC model, the RG recommends further analysis to include year ranges dating from the start of the time-series. Alternatively, the exclusion of early years needs to be justified.

Based on WKLIFE and RGLIFE guidance, life-history information and estimates of selectivity should be used to estimate data limited reference points (e.g. $F_{0.1}$) in order to determine exploitation status.

Technical comments

Future assessment work should consider stock mixing between VIIb north and VIa (Stags Grounds) and potential influences on DCAC analysis. Combined landings data for the regions may provide a more accurate measure to determine year ranges for DCAC analysis.

No surveys are used in the assessment. Therefore, no tuning indices are available.

Figure 7.9.1 is not referenced in text.

Conclusions

The assessment does not provide biological reference points or stock status. It is unclear from the choice of year ranges in the DCAC analysis whether landings are currently at low values compared to the entire time-series. Due to the data poor nature of the stock and the limited analysis of year ranges, the RG does not recommend accepting the DCAC estimate of 74.6 t as the basis for management advice for 2013 catch levels. This is mainly because of severe sensitivity of DCAC estimates to model input assumptions.

PLE-CELT [WGCSE Section 7.10: Plaice in Division VIIf,g (Celtic Sea)]

Assessment Type: Update with 2011 survey and commercial data. This stock was benchmarked at WKFLAT 2011, but the AP model was accepted only as a temporary basis for the assessment and provision of advice for Celtic Sea plaice.

Assessment: Trends only based on output of the AP analytic assessment model.

Forecast: None.

Assessment method: An Aarts and Poos (AP) analytic model was fitted to one survey index (UK(E&W)-BTS from 1990–2011) and two commercial lpue time-series (UK commercial beam and otter trawl fleets from 1990–2011).

Consistency:

- The model was applied as per the stock annex, but the differences between the three exploratory runs were unclear.
- All three exploratory AP runs indicated similar trends.
- Only a 1-year retrospective pattern was presented.
- Retrospective analysis indicates that R is overestimated and F is underestimated, while no trend in SSB is apparent.
- Comparisons of the AP model and the 2010 XSA, which did not include discards, indicated similar trends, but the XSA severely underestimated F and recruitment.
- The estimate of F increased substantially from 2010 to 2011.

Stock status:

- No formal status determination was presented.
- SSB has been increasing since 2004 towards time-series highs, although the 2011 SSB (1867 t) showed a slight decrease from previous years.
- F has been increasing since 2008 and appears to be at an all-time high level in 2011 (0.676).
- The assessment indicates increasing recruitment trends and possibly the strongest recruitment year class in the time-series in 2011. However, the survey data suggests that this year class is not as strong as the assessment predicts.
- Lpue appears to be consistently low since the early 1990s.
- There are no MSY reference points.

Management plan:

- No Management plan is in place for this stock.
- The 2011 TAC was set at 410 t and reduced to 369 t in 2012.
- Approximately 75% of total catch has been discards in recent years, which indicates that TAC management of plaice is inappropriate for reducing fishing mortality.
- In 2011 421 t of plaice were landed, while 1107 t were estimated to be discarded.
- The advice for 2012 noted that the stock was below any biomass-based reference points, while mortality was too high to allow for rebuilding. It was suggested that catches of plaice be decreased and measures introduced to reduce discards.

General comments

This report appeared to follow the guidance of the stock annex. However, both the report and stock annex were vague when differentiating between the exploratory AP model runs.

The level of F increased substantially in 2011, which the WG explained was due to an increase in discarding (72% of the catch in 2011). The WG also indicated that the majority of discarded fish were below the minimum landing size. The RG agrees that this may be indicative of a "*mismatch between the mesh size employed in the fishery and the size of the fish being landed*," and an increase in the mesh size would lower the level of discarding leading to lower levels of F.

No reference points are estimated for this stock. Although the RG agrees with the WG that due to recent changes in modelling approaches previous estimates of reference points are inappropriate, attempts should be made in the near future to determine MSY proxies as outlined by WKLIFE and RGLIFE guidance.

Technical comments

Section 7.10.3 cites Section 1.4.1, but no such section exists.

Section 7.10.8 cites a Table X.X.X, which does not exist.

Figure 7.10.4 does not have a legend denoting what the coloured bars represent.

Conclusions

The RG suggests that the trends from the AP model are appropriate for use as a basis of management. The RG agrees with the advice that catches should be reduced and technical measures introduced to reduce discards in the fishery. This is supported by the WG estimates that the total international landings for 2011 (421 t) exceeded the TAC (410 t), and discards substantially outnumbered landings (1107 t). Additionally, attempts should be made in future assessments to estimate reference points.

PLE-7H-K [WGCSE Section 7.11: Plaice in Divisions VIIh-k (Southwest of Ireland)]

Assessment type: Update including one additional year of catch data (no annex was provided and it is unknown when or if this stock was benchmarked).

Assessment: Trends only based on catch curves and an untuned exploratory separable VPA (no surveys are available for this stock).

Forecast: No forecasts were presented.

Assessment model: A yield-per-recruit model was used to estimate data limited reference points based on biological data from plaice in VIIf,g, while catch curve analysis and an exploratory separable VPA were used to estimate current harvest levels and SSB trends.

Consistency:

- No annex was provided.
- The catch curve analysis indicated similar F levels as those estimated in the separable VPA.
- Trends similar in 2011 were similar to those seen in 2012.

Stock status:

- No official stock status was provided.
- Exploratory VPA analysis indicates SSB and R have been stable at depressed levels around time-series lows for the last decade. F had been decreasing over this period to time-series lows.
- However, estimates of 2011 F from VPA runs (0.35) and catch curve analysis (0.43–1.08) are above potential F_{MSY} proxies ($F_{0.1}$=0.135 and $F_{35\%}$=0.144).

Man. plan:

- No management plan was presented.
- The draft advice for 2012 indicates that plaice are mainly a bycatch species in VIIj with discard rates above 60% by weight in recent years.
- No information on TACs or previous ICES management advice was provided.
- In 2011 it was estimated that 176 t of plaice were landed.
- No landings of plaice in VIIh are reported.
- Based on WKLIFE and RGLIFE guidance, $F_{0.1}$ should be used to advise catch for 2013.

General comments

The RG encourages the development of an analytical assessment for this stock. However, the stock annex was absent. Therefore, justification for the choice of the exploratory separable VPA was not provided. The assessment was concise and mostly verbatim from the 2011 assessment.

The assessment examines plaice in ICES Divisions VIIh–k, however, the WG states that VIIh is included for assessment purposes without evidence that it is the same stock as VIIj–k. The 2009–2012 assessments make the same statement without justification for including VIIh with VIIj–k. Data for the assessment are solely based on age data from Irish landings from VIIj–k, without information from VIIh. The RG is concerned that extrapolation of data from VIIj–k to VIIh may confound stock status determination and management advice. The ICES draft advice for 2013 states that VIIh plaice may be more connected to ICES Divisions VIIe–g. Further work is needed to determine the accuracy of stock definitions for plaice in Division VII.

The WG describes the high numbers of small plaice (<20 cm) in the 1994 and 1995 landings length distribution samples as misclassified discards and made the decision to remove the samples from the assessment. Further, the WG states that "*there are no distinct modes of strong year classes discernible*". The RG is concerned that the removal of two consecutive years of data showing potential strong cohorts confounds the choice of selectivity (S) in the separable VPA by biasing a lower selectivity-at-age when large year classes enter the fishery. Terminal S was set at 0.8 (age 6+), resulting in S at age two (<20 cm) of 0.1589. The separable VPA results indicated either a potentially increasing S on younger ages in the most recent years or evidence for stronger year classes. The RG encourages further analysis to determine the effect of the selected terminal S value.

The assessment examines landings data only and does not address discards. Separable VPA method results indicate stable SSB and recruitment levels and reduced F since 1995. The ICES draft advice for 2013 indicates that more than 60% by weight of plaice catch in VIIh–k is discarded. The RG is concerned that the population dynamics as estimated in the separable VPA may be misleading due to the exclusion of discard data.

The assessment does not define $B_{TRIGGER}$, B_{PA} or B_{LIM} reference points, and the F_{MSY} proxy is not clearly defined. Based on WKLIFE and RGLIFE guidance, $F_{0.1}$ should be used to advise catch for 2013.

Technical comments

Future assessment work should consider redefining VIIh as part of the VIIe–g stock complex.

No surveys are used in the assessment, therefore no tuning indices are provided.

Discards are not accounted for in the assessment despite more than 60% by weight of total catch is discarded in the fishery. A plan to account for discards in the fishery and incorporation of this data in the assessment should be developed.

Conclusions

The assessment results are consistent with previous updates. Inclusion of the VIIh Division is not justified for this assessment, and potential removal of this component could strengthen assessment results. The lack of discard data confounds the assessment results of stable trends for SSB and recruitment and reduced F. The RG does not feel that the current exploratory VPA model is appropriate for basing management advice as it is an uncalibrated VPA lacking information on upwards of 60% of the total catch. Additionally, no fishery-independent data is available to assess biomass trends, which further complicates assessment of stock status. A comprehensive plan for monitoring discards and inclusion of discard data in the assessment is needed, while alternative sources of data on the health of this plaice stock will be necessary to develop a reliable analytical assessment. Based on WKLIFE and RGLIFE guidance, $F_{0.1}$ should be used to advise catch for 2013.

SOL-7B-C [WGSCE Section 7.12: Sole in Division VIIb, c (West of Ireland)]

Assessment type: Update including 2011 nominal landings and logbook effort.

Assessment: Catch only (DCAC analysis).

Forecast: No forecast was presented.

Assessment model: Depletion Corrected Average Catch (DCAC).

Consistency:

- There was no stock annex, and no assessment model was presented in 2011.
- The DCAC is based on guidance from WKLIFE, providing the first estimate of sustainable yield.

Stock status:

- The most conservative estimate of DCAC is 41 t, which is similar to recent catch (27 t in 2011, 40 t annual average 2009–2011).
- Lpue has been generally stable since 1995.

Man. plan:

- There is no management plan.
- ICES advice for 2011 was that there should be no increase in catch unless there is evidence that it will be sustainable.
- DCAC suggests that current catches are sustainable.

General comments

The document was well written and provided useful information that is consistent with WKLIFE guidance.

The DCAC was estimated assuming a range of depletion values (10%, 50% and 90%) and starting years (1950–present, i.e. after WWII when the stock was heavily exploited; and 1995–present, i.e. when the landings showed a declining trend). The estimate of DCAC is more sensitive to the starting year. The RG agrees that the method was applied according to WKLIFE guidance.

Technical comments

The document reports landings from 1908 to 2011, but there is no justification provided for excluding 1908–1949 from the DCAC.

Conclusions

The RG agrees with the conclusion of the WG that the limited information available (lpue and DCAC) suggest that the stock is being harvested sustainably.

SOL-CELT [WGCSE Section 7.13: Sole in Divisions VIIf,g (Celtic Sea)]

Assessment Type: Update with 2011 survey and landings data.

Assessment: Analytical.

Forecast: Short-term forecasts and long-term MSY calculations were presented.

Assessment model: XSA with tuning from one survey (UK(E&W)-BTS-Q3 from 1988–2011) and two commercial lpue series (UK(E&W)-CBT from 1991–2011 and BEL-CBT from 1971–2003).

Consistency:

- 2010 estimates of F (increased by 14%), SSB (decreased by 4%) and recruitment (increased by 5%) were slightly revised from the 2011 assessment, but the trends are similar.
- There were minor retrospective patterns in the last few years for all three metrics, but they are generally balanced across the time-series.

Stock status:

- SSB has been relatively stable over the last decade around the time-series average.
- Recruitment had been decreasing, but shows an upturn in 2011.
- F has been stable at low levels and is well below the high rates seen in the late 1990s.
- F in 2011 (0.24) $<F_{MSY}$ (0.31), SSB in 2011 (3715 t) is above $B_{TRIGGER}$ (2200 t), and incoming recruitment is estimated to be above average.

Man. plan:

- There is no explicit management plan.
- The TAC in 2011 was 1241 t about 1029 t of which was landed, while the 2012 TAC is set at 1060 t.
- Management advice for 2011 and 2012 was to fish at F_{MSY}, which indicated sustainable landings of 1400 t and 1060 t, respectively. TACs were at or below the values determined by the MSY approach and observed catches were further below the TAC.
- Discards of sole appear to be minor based on current data.
- Assuming *status quo* F (0.263) implies a catch of 1010 t in 2012 and 970 t in 2013. This suggests an SSB of 4212 t in 2012, 4050 t in 2013, and 4170 t in 2014.
- Sensitivity analysis for the catch forecast indicate less than 5% probability that *status quo* F will reduce SSB below $B_{TRIGGER}$.

General comments

The report document was well written and followed the stock annex. The report also thoroughly discussed issues raised by the last RG. Uncertainties and bias in the assessment and forecasts were analyzed sufficiently. Finally, the report provides a list of recommendations to improve the assessment for future benchmarks.

Technical comments

In Figure 7.13.14 'probability' is misspelled.

Under the 'data screening' section '20110' should be changed to read '2010'.

Conclusions

The RG agrees that this assessment is appropriate for the basis of management. The report is well documented and provides justifications for most modelling decisions. Most importantly, it thoroughly analyses uncertainties and potential bias. The projected catch of 970 t in 2013 is acceptable to use as a guideline for setting a TAC and is consistent with the pattern of previous TACs. The fact that F has been underestimated and SSB has been slightly overestimated in the last three years indicates that some caution should be used in setting catch limits, even though the stock biomass is above $B_{TRIGGER}$.

SOL-7H-K [WGCSE Section 7.14: Sole in Divisions VIIh-k (Southwest of Ireland)]

Assessment type: Update with catch provided through 2011. No annex was available for this stock.

Assessment: Trends only based on catch-at-age data (catch-curve analysis).

Forecast: No forecasts were presented.

Assessment Model: No assessment was performed. Irish catch numbers and catch weights were used to estimate mortality from catch curve analysis and reference points were calculated using yield-per-recruit analysis for Areas VIIj,k.

Consistency:

- There was no stock annex provided, so the RG cannot determine if the 2012 assessment is consistent with past years.

Stock status:

- Uncertain.
- Estimates of total mortality from catch curves suggest that F in recent years is likely between 0.05 and 0.35.
- F_{MAX} is estimated to be 0.34 and $F_{0.1}$ is estimated to be 0.16. However, the YPR analysis does not include Area VIIh.

Man. plan:

- The management plan was not discussed in the assessment.
- Recent landings have been near time-series lows and are less than a quarter of the landings in the early 1990s.

General comments

The assessment was brief, and made no mention of the management plan for this stock. No advice was provided for this stock, and the annex was not provided to the RG.

The WG notes that sole in Area VIIh are likely part of a separate stock, and sole from VIIh were not included in the analysis. The RG encourages that the stock structure of sole be explored in future benchmarks, as it appears that the current assessment boundaries do not accurately reflect the stock structure of the species.

Based on WKLIFE and RGLIFE guidance, life-history information and estimates of selectivity should be used to estimate data limited reference points (e.g. $F_{0.1}$) to determine exploitation status.

Technical comments

None.

Conclusions

The RG cannot determine if this assessment was performed according to the stock annex. The stock structure of sole in this region needs to be explored further, and the RG suggests that future benchmarks should consider removing sole in Area VIIh from this assessment. The WG report concedes that sole in VIIh are likely distinct from sole in VIIg and VIIk.

WHG-7E-K [WGCSE Section 7.15: Whiting in Divisions VIIe-k]

Assessment type: Update from 2011 including one additional year of survey and catch data (lpue time-series have not been updated since 2009) and a data correction for the 2010 IR-IGFS Swept-area index. No benchmark has been attempted and none is scheduled.

Assessment: Analytical (listed as trends only, but it is a full analytic assessment).

Forecast: Deterministic short-term projection (MFDP1a software) and per-recruit analysis (MFYPR2a software) were provided. The short-term forecast differs from that presented stock annex. It uses XSA estimates of recruitment and not the geometric mean.

Assessment model: XSA tuned with two commercial lpue datasets (FR-Gadoid Late and FR-*Nephrops*) from 1993–2008 and three survey abundance indices (FR-EVHOE from 1997–2011, IR-IGFS Swept-area from 1999–2011, and UK-WCGFS from 1987–2001).

Consistency:

- The update follows the annex (except for minor changes to the short-term forecast), but the annex is lacking important details and justifications.
- Changes to the 2010 IR-IFGS Swept-area index led to relatively large changes to model outputs from 2011, which lead to a more optimistic stock outlook.
- The general trends of increasing SSB, decreasing F, and low recruitment continue.
- There appear to be no retrospective trends in recent years. However, large retrospective trends plagued this assessment in the early to mid-2000s, especially for estimates of recruitment and SSB.

Stock status:

- SSB has been increasing rapidly in recent years and is near historically high levels, while F continues to decrease and is at the lowest level ever observed for this stock.
- Recent recruitment has been weak, but the 2008 and 2009 year classes appear to be above average.
- SSB in 2012 (64 640 t) is well above PA reference points of B_{LIM} = 15 000 t, and B_{PA}=21 000 t (no F_{PA} are available).
- $F_{0.1}$ (0.19) was deemed too low for such a highly productive stock, while $F_{35\%}$ = 0.361 compares favourably to the current F of 0.2416.

- No F_{MSY} reference points are estimated due to the inability to determine a stock–recruit relationship.

Man. plan:

- No management plan exists for this stock.
- The 2011 total TAC for Areas VIIb–h,k was 16 658 t, which was increased to 19 053 t in 2012. VIIe–k landings were 8555 t in 2012.
- However, whiting discards remain high (upwards of 50% in some areas and fleets) and are unaccounted for within the assessment, which may lead to an extreme underestimate of mortality.
- TACs are non-restrictive and deemed inappropriate for this species as they do not limit discards.
- The 2012 advice was to avoid increases in catch levels and implement further technical measures to reduce discards.
- Assuming *status quo* F (i.e. average over the last three years; 0.35) leads to landings estimates of 19 000 t in 2012 (very close to the total TAC for Areas VIIb–h,k) and 17 000 t in 2013. This corresponds to an SSB of 67 492 t in 2012, 59 047 t in 2013, and 54 074 t in 2014.

General comments

The XSA was well done, but both the annex and assessment documents were lacking key information. This assessment was still in draft form (uploaded 29/5/12, viewed 1/6/12) and was clearly not complete. It was especially difficult to view some of the figures due to low resolution images in the document.

There was a general lack of justification regarding why certain survey and lpue indices were chosen for inclusion in the model. The RG would suggest that full justification be presented for all XSA modelling decisions.

No information was provided regarding lpue standardization. Also, without a more detailed description of the lpue series, it was difficult for the RG to determine if the decision to use the FR-*Nephrops* series in the assessment was appropriate considering whiting is clearly a bycatch species in this fishery.

The RG agrees with the WG decision to alter the short-term forecasts from the description laid out in the annex. Using the 2011 recruitment estimate (18 mil. fish) instead of the geometric mean estimate (71 mil.) seems appropriate. Recruitment appears to be extremely low, which is supported by the 2011 surveys.

As the WG notes, the lack of discard information is a huge uncertainty for this stock assessment. Limited discard data is available, but it does not extend to the whole fishery or the entire time-series. However, evidence suggests that discards can reach up to 50% for some fleets, while other whiting stocks in the Celtic Sea region (e.g. whiting in Division VIIa) exhibit discards over 1000 t. Despite issues of discarding, it appears that this stock remains healthy, but mortality may be severely underestimated.

The RG reiterates that an agreed upon method to raise discard estimates across the entire fishery must be developed. Similarly, a time-series of discard values must be calculated. Monitoring of discards should be made a priority for this stock.

Due to uncertainties in discards, the RG suggests that a Statistical Catch-at-Age (SCAA) model be explored for this stock. This type of model is better suited to deal with missing catch data compared with the current VPA approach, and will be able to make use of what discard information is currently available.

Although the RG agrees that the retrospective patterns have decreased, until discards are formally incorporated into this assessment the results should be treated cautiously. The retrospective patterns may return suddenly, especially if a large year class moves through the fishery as discards will likely be large and unaccounted for in the assessment.

Sensitivity runs of the XSA model should be provided that explore the effect of discards on model outputs. For instance, a fleet-wide approximate discard rate or range of discard rates (e.g. 0–50%) could be applied so that managers can view the impact that discarding might be having on estimates of mortality and biomass.

Technical comments

The annex was incomplete and lacked key descriptions (e.g. information on discards of whiting) that were included in the assessment report.

A number of tables were poorly formatted and many of the figures were extremely low resolution. Both of these factors made review of this document difficult.

The reference to a table and figure for the per-recruit analysis is mislabelled on page 1013. No table is given in the assessment for the per-recruit analysis, while the figure should be 7.15.17.

The annex explains that F_{PA} reference points were calculated at the 2000 WG meeting, but both the assessment and annex claim that no F_{PA} reference points exist. It is unclear whether these were rejected or why they are not currently being used.

It is unclear if any F-based reference points are accepted for this stock. It is briefly mentioned in the assessment that $F_{35\%}$ is deemed more appropriate than $F_{0.1}$, but is not mentioned as an MSY proxy reference point anywhere else or compared to current F-levels. The RG suggests that a formal adoption of an F-based reference point should be made in the future and included in the description of the status of the stock.

Considering the high level of cannibalism exhibited by whiting, it may be appropriate to investigate an age varying natural mortality rate for future assessments. Time-varying M may also be worth investigating. However, the RG acknowledges the difficulty in assessing these issues, and the relatively low level of importance compared with assessing discards for this stock.

Conclusions

The RG suggests that this model provides a solid basis for management advice, but cautions that without inclusion of discards in catch data there may be bias in point estimates. The RG agrees that the Division VIIe–k whiting stocks appear to be in 'acceptable' shape with high levels of SSB and time-series low F estimates. However, recruitment has been extremely weak in recent years and mortality estimates are likely biased low due to lack of discard information. The RG agrees with the 2012 advice that catches not be allowed to increase and technical measures should be actively sought to reduce bycatch and discards. Monitoring of discards must be made a priority as the lack of discards in the XSA model makes outputs extremely uncertain. It is suggested that an SCAA model be explored so that the information that is known on discards can be incorporated. Otherwise, exploratory XSA sensitivity runs should be included that apply an approximate fleet-wide discard estimate so managers can be given an idea of how discards may affect the state of the stock.

PLE-ECHW [WGCSE Section 8.2: Plaice in Division VIIe (Western Channel)]

Assessment Type: Update including 2011 survey and catch data (benchmarked at WKFLAT 2010).

Assessment: Analytical.

Forecast: Short-term only, no medium- or long-term projections were presented.

Assessment method: XSA tuned to two survey time-series (UK-WECBTS from 1986–2011 and FSP-7e (UK(E+W)) from 2003–2011, excluding 2008) and three commercial fleet survey time-series (UK-WECOT-historic from 1980–1987, UK-WECOT-recent from 1988–2011, and UK-WECBT from 1989–2011).

Consistency:

- The model was applied as per the stock annex and the 2010 benchmark.
- No retrospective trend in SSB or F was present, but a slight pattern of underestimating R was apparent.
- Since the 2011 assessment the 2010 F has been revised upwards by 22%, while SSB has been decreased by 14%.

Stock status:

- SSB 2011 (3271 t) >$B_{TRIGGER}$ (1650 t). $B_{TRIGGER}$ is based on the lowest SSB at which the stock has recovered.
- F_{BAR} 2011 (0.43) >F_{MAX} (0.24).
- F has been declining strongly since 2007 and is now near historic lows. Likewise, SSB has been increasing since 2008 and is more than halfway to time-series highs. Recent recruitment has been at historically high levels.
- No MSY-based reference points are available for this stock due to lack of evidence for a stock–recruit relationship. F_{MAX} is used as a proxy for F_{MSY}.
- PA reference points were previously available, but rejected by WKFLAT in 2010.

Management plan:

- No Management plan is in place for this stock.
- Assessment and management units do not overlap for this stock (TACs cover both Areas VIIe and VIId).
- Following the MSY transition framework ICES recommended decreasing F to 0.39 (landings of 950 t) for 2011 and 0.35 (landings of 1440 t) for 2012.
- The TAC for Area VIIe,d for 2010 was 4665 t and 5062 t for 2011. Only 25% of the TAC came from VIIe in 2010, while this stock represented 28% of the TAC in 2011. Total landings in 2011 for VIIe plaice was 1505 t.
- *Status quo* F (0.48) implies landings of 2997 t in 2012 and 2910 t in 2013. SSB is predicted to increase to 5070 t in 2012 and 5805 t in 2013 before declining slightly in 2014 to 5390 t.

General comments

This report was thorough and easy to read. Additionally, all of the methods were clearly explained and justified.

The WG deviated from the annex with the derivation of MSY reference points, but the RG agrees with the method for estimating provisional reference points. The F_{MSY} proxy falls within the acceptable range given in the annex.

The WG mentions that the stock units (VIIe and VIId separated) do not correspond to the combined management unit (VIIe and VIId combined). The lack of overlap between management and assessment units hampers effective management. The RG agrees that steps should be taken to remedy this problem in order to provide more effective management advice.

Fishing mortality since 1980 has been roughly double F_{MAX}, while SSB has only been less than $B_{TRIGGER}$ once during this period (following a historically low recruitment event). The RG questions if the proxy for F_{MSY} and $B_{TRIGGER}$ are consistent with one another. Future work should be undertaken to reanalyze reference points for this stock.

The short-term projection uses the geometric mean of R between 1980 and 2009 for 2011 recruitment. However, the 2011 recruitment was the highest in the time-series. The same approach was used in the last assessment for 2010 recruitment, which was also the highest level in the time-series up until the recent assessment. This high value was subsequently confirmed in the current assessment and revised upwards from the 2011 assessment. The RG suggests two forecasts should be run using the GM recruitment and the assessment estimate, which would provide managers a portfolio of options on which to base catch advice.

Technical comments

Page 4 of the report cites Table 2.1, but no table exists.

Conclusions

The XSA analysis appears well done for this stock showing no strong retrospective trends or diagnostic problems. The RG feels that because the XSA estimates large recruitment in 2010 and 2011, SSB >$B_{TRIGGER}$, and since no directed fishery exists, that *status quo* F may be a reasonable method for setting the TAC. However, this approach may not correspond to the MSY framework considering F in 2011 was almost twice F_{MAX}. Re-evaluation of reference points for this stock should be a priority for future work.

SOL-ECHW [WGSCE Section 8.3: Sole in Division VIIe (Western Channel)]

Assessment type: Update assessment with 2011 catch and survey data (benchmark WKFLAT 2012).

Assessment: Analytical.

Forecast: A short-term forecast was presented.

Assessment method: XSA (FLXSA) tuned to three surveys (Q1SWBeam from 2006–2012, UK-FSP from 2004–2012, and UK-BTS from 1988–2011) and three lpue time-series (UK combined beam late from 1988–2002, UK combined beam early from 2003–2011, and UK otter trawl from 1988–2011).

Consistency:

- The 2012 assessment trends agree with the 2011 assessment, but 2010 F was adjusted down, while SSB and recruitment were adjusted upwards.

- Minor retrospective patterns exist for SSB and F, but are generally not very large. However, there has been a severe overestimation of recruitment in the last two years of the retrospective analysis.
- Trends from exploratory single fleet XSA runs demonstrate similar trends and agree with the final model.

Stock status:

- The SSB is at intermediate levels for the time-series and has been increasing slowly since 2009.
- F has been stable for the last few years at intermediate rates, but has decreased from 2007 levels.
- Recruitment is highly variable, but appears to be sharply declining in recent years and is below average.
- In 2011 SSB was 3190 t, which is well above B_{LIM} (1300 t) and B_{PA} (1800 t).
- F in 2011 was 0.235, which corresponds well to the long-term management target F_{MSY} proxy (F_{MAX}) of 0.27.

Management plan:

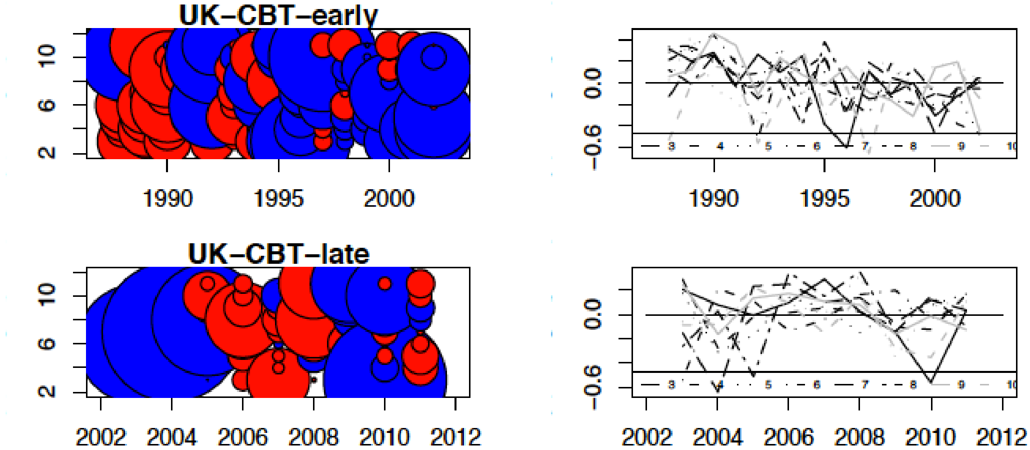
- A multiannual management plan was established for plaice in 2007 (Council Regulation No. 509/2007), which sets the TAC at the highest level resulting from either a 15% reduction in F or F = 0.27 (F_{MSY} proxy).
- This plan led to a TAC of 710 t for 2011 and 777 t for 2012.
- Landings in 2011 were estimated at 740 t.
- Discarding appears to be minor given the current data.
- *Status quo* F (0.227) will result in 2012 yield of 787 t and SSB of 3339 t with increases to 821 t and 3450 t in 2013.
- Using the current management plan results in a 2013 TAC of 894 t resulting in an F = 0.25 (due to a 15% constraint on yearly deviation in TAC levels), which should result in a 2014 SSB of 3530 t.

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 show a strong decreasing trend and a dome shaped trend, respectively (Figure 8.3.7). Although the value of the residuals is relatively small, the trend is problematic.

Figure 8.3.7 Sole VIIE Single Fleet log catchability Residuals



The RG suggests that the WG perform an exploratory run that does not include the UK-CBT index.

The RG agrees that discard data should be more widely collected. Additionally, a sensitivity analysis that includes an approximate discard percentage, which is added to the landings, should be provided to help guide management advice and better estimate total fishing mortality.

Technical comments

On page 1, '20010' should read 2010.

The second paragraph on page 11 in Section 8.3.8 should be revised to improve clarity.

The residual plots provided in this assessment are difficult to interpret. They are too small and the scaling of the bubble plots is atrocious. The RG found it difficult to assess diagnostics for this stock due to the lack of interpretable residual plots.

Conclusions

The RG recommends that this model is appropriate for the basis of management, but notes that the lack of discards in the catch data may cause bias in point estimates. The assessment results are consistent with previous updates and suggest that the stock is improving since 2009. However, it is still far below the high biomasses observed in the 1980s. The recruitment is quite variable and suggests that a precautionary approach is necessary to prevent overfishing. The long-term management target based on the F_{MSY} proxy of 0.27 appears to be sufficient to maintain biomass above PA reference points as long as the TAC is able to effectively control effort. The discards must be kept under control and should be more closely monitored. Inclusion of discard estimates in future assessments would help improve mortality estimates if they can be reliably estimated.

POL-CELT [WGCSE Section 9.2: Pollack in Divisions VI and VII (Celtic Sea eco-region)]

Assessment type: New assessment with catch data available through 2011 (no annex was available, but this stock was considered by WGNEW 2012).

Assessment: Catch only (DCAC).

Forecast: No forecast was provided.

Assessment model: Depletion corrected average catch (DCAC) was used to estimate sustainable yield.

Consistency:

- This was the first time ICES analyzed Pollack in the Celtic Sea and west of Scotland.

Stock status:

- No formal stock status was presented and no indicators are available to assess stock status.

Management plan:

- There is no management plan for this stock.
- The average DCAC was 162 t for Subarea VI and 4008 t for Subarea VII, which are well below the TACs set for 2012 (397 t for Subarea VI and 13 495 t for Subarea VII).
- DCAC analyses are hampered by the lack of recreational catch in the landings data, which are believed to represent a significant portion of removals from the stock.
- Catches in 2012 were 45 t in Division VI and 4072 in Division VII, which are in line with sustainable estimates from DCAC analysis.
- ICES advice for 2012 was to not allow catches to increase due to the extremely data poor nature of this stock.

General comments

This report follows the documentation provided in WGNEW 2012, which appears to be an appropriate replacement of the stock annex.

The current survey information is extremely variable due to low Pollack catches, and thus not informative. The landings information is erratic and incomplete, while by-catch information is not available. It is clear that establishing a monitoring programme for this stock should be a priority so that an analytical assessment can be developed in future. This will necessitate better collection of landings, discards, size or age distributions, maturity, and recreational catch.

The WG mentions that the magnitude of recreational fisheries may be similar to commercial fisheries. The RG suggests that it should be a main priority to obtain data on recreational fishing activity. Only two years (2006–2008) of recreational fisheries data from France were available and this information is not described in the report.

WKLIFE recommendations are that DCAC should only be applied when catch information is complete. The RG is concerned that DCAC estimates for Pollack may underestimate MSY due to the lack of recreational landings data.

Technical comments

The inputs for the DCAC model were as follows: M was set equal to 0.2, F_{MSY} to M ratio was tested at 0.6, 0.7 and 0.8, depletion delta was tested at 0.8, 0.9 and 1 for Subarea VI and 0.5, 0.6 and 0.7 for Subarea VII, and B_{MSY}/B_0 was set equal to 0.5. Justification for model settings (e.g. why different ranges of depletion for the two areas were tested) was not justified.

Conclusions

Due to lack of data on landings, discards, stock structure, and recreational fisheries, it is difficult to develop advice for this species or determine if recent TAC advice is appropriate. The RG concludes that the DCAC estimate of MSY is an underestimate and should be used cautiously for TAC advice.

GUG-CELT [WGSCE Section 9.3: Grey gurnard in Subarea VI and Divisions VIIa-c and e-k (Celtic Sea and West of Scotland)]

Assessment Type: None (no annex was available, but this stock was considered by WGNEW 2012).

Assessment: None.

Forecast: None.

Assessment model: None.

Consistency: None.

Stock status:

- There is no TAC.
- Stock status is unknown.
- This is the first time ICES is providing advice for the species.

Man. plan:

- None.
- The 2013 advice is to not allow catches to increase.

General comments

No information is provided because there is no assessment, and this is the first time ICES is providing advice.

Technical comments

None.

Conclusions

No assessment was performed and there is no annex for the stock. Since this is the first time ICES is providing advice, and there is very limited information regarding stock structure or total catch, advice is to not allow catches to increase. The RG agrees that quantitative advice cannot be provided at this time.

Appendix 2

Checklist for review process

General aspects

- Has the WG 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?
- Has the group carried out evaluations of management plans?
- Has the group collected and analyzed mixed fisheries data?

For stocks where management plans or recovery plans have been agreed

- Has the management plan been evaluated in earlier reports?
- If the management plans has been evaluated during this WG:
    - Is the evaluation credible and understandable?
    - Are the basic assumptions, the data and the methods (software) appropriate and available?

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?

For overview sections

- Are the main conclusions in accordance with the WG report?
- Verify that tables and figures been updated and are correct (except for the advice table).

Amendment 1

HAD-ROCK [WGCSE Section 4.3: Haddock in Division VIb (Rockall)]

Assessment type: Update with 2011 catch and survey data (no survey was carried out in 2010).

Assessment: Analytic.

Forecast: Short-term and medium-term projections were provided.

Assessment model: XSA tuned with one survey index (Scottish Rock-IBTS-Q3 from 1991–2011, excluding 1998, 2000, 2004, and 2010 when the survey was not conducted). An exploratory statistical catch-at-age (SCAA) model (STAT-CAM) was also presented.

Consistency:

- The assessment methods are consistent with the stock annex.
- There is a slight to moderate retrospective pattern of underestimating F and overestimating recruitment, but no retrospective pattern for estimates of SSB.
- Perceptions of the stock for 2010 have not changed since the 2011 assessment.
- The XSA and exploratory STAT-CAM generally agree, especially regarding stock trends.

Stock status:

- SSB has shown a moderate decline over the last four years, but remains at intermediate levels for the time-series. F continues to decline to near all time lows, while recruitment remains severely depressed.
- The 2011 F (0.21) $<F_{PA}$ (0.4; analogy to other haddock stocks, but also consistent with F_{MAX}), but above $F_{0.1}$ (.11).
- The 2011 SSB (11 000 t) $>B_{PA}$ (9000 t).
- However, recruitment is extremely weak (each of the last five year classes were a new record low).
- The stock annex does not report MSY reference points, but MSY reference points are referred to in the WG report ($F_{MAX} = 0.40$; $F_{0.1} = 0.11$).

Management plan:

- A management plan is currently under consideration, but has not been accepted and was not presented in this report.
- The EU TAC for VIb, XII and XIV was set at 3300 t in 2012 (a 12% reduction compared to TAC for 2011).
- Landings in 2011 totalled 1903 t from Division VIb.
- Discards have been an issue in this fishery (around 52–87% historically), but have been to some extent in the recent period.
- There is a high probability (98%) that SSB will fall below B_{PA} and $B_{TRIGGER}$ (92%) by 2014 under *status quo* conditions, mainly as a result of extremely poor recruitment in recent years.

General comments

The WG report was reviewed in draft form (downloaded 30/05/2012). Any changes made after this date were not reviewed (another version was uploaded on 04/06/2012, but could not be checked for consistency). Due to the unfinished nature of the document that was available for review, many sections were incomplete and detracted from the ability of the RG to confirm consistency.

The WG documented the uncertainties and biases in the assessment and projections.

MSY estimates were evaluated in 2010 (WGCSE, 2010) and 2011 using the SRMSYSC ADMB package. The number of stock and recruit pairs for this stock is fairly limited and show a relatively wide range. Given the high CVs on all F parameters the WG concluded that the underlying data did not support the estimation of absolute estimates of F_{MSY}. However, the WG believes that current F is close to that which is expected to deliver long-term equilibrium yield.

The RG incorrectly reported that no tuning indices were available for 2010 **and** 2011. Based on this assumption it was concluded that this assessment was essentially an uncalibrated VPA, and should be considered as an exploratory assessment rather than a full analytical assessment. However, this was a mistake by the RG as survey data was available for 2011 and used in the assessment. Therefore, the RG rescinds its previous conclusion considering that the VPA is calibrated in the terminal year. The sparse discard data were also a consideration in the decision of the RG to not accept the XSA model as a full analytical assessment. Although discard estimates are still uncertain, recent discarding appears relatively low. Since the model is tuned to survey data in 2011, the uncertainty in discard data has a much smaller impact on the reliability of the assessment. Without a tuning index, the uncertainty in discards was deemed important because the model estimates in the final two years were based solely on total catch. The RG now concludes that the current XSA is a reliable basis for management as a full analytical assessment.

Technical comments

The RG suggests that for future assessments attempts should be made to standardize the available lpue time-series. Developing an lpue dataset that covers the entire time-series will improve the assessment by providing tuning data for 2010–2011, which is not available from the only survey for haddock in VIb (i.e. the Scottish Rock-IBTS-Q3 survey, which also does not cover the entire stock area).

Conclusions

The RG suggests that the XSA model is a reliable source for the basis of management advice. However, uncertainties still remain in the assessment that may affect the performance of the XSA, including: poor information on total catch (i.e. sparse data on discards); possible changes in survey catchability due to new gear being used in 2011; and holes in the tuning data time-series (particularly the 2010 datapoint, which impacts assessment estimates for terminal years). Despite these uncertainties the RG concludes that, due to limited retrospective patterns and no major diagnostic issues, this assessment is indeed appropriate to use as a full analytical assessment. The RG believes that the point estimates from the model should be treated with caution, but believes that they are still appropriate for use in management. The previous conclusion was based on incorrect knowledge of the input data (i.e. that no 2011 survey data were used to calibrate model estimates in the final year). The RG no longer agrees with its previous recommendation. Recruitment in the stock appears to be extremely weak and the stock is projected to decrease below biomass reference points under *status quo* harvest rates.