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

11–19 May 2011

Copenhagen, Denmark

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CIEM Conseil International pour l'Exploration de la Mer

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Executive summary

ICES Working Group on the Assessment of Celtic Seas Ecoregions stocks (WGCSE) met at ICES headquarters in Copenhagen (Denmark) from 11 to 19 May 2011. 35 stocks distributed in ICES Subareas VI and VII (excluding VIId), with anglerfish (*Lophius piscatorius* and *L. budegassa*) extending its distribution to ICES Divisions IIa, IIIa and Subarea IV, and megrim (*Lepidorhombus whiffiagonis*) extending to ICES Division IVa, were assessed. In total, WGCSE assesses four stocks of cod (*Gadus morhua*), four stocks of haddock (*Melanogrammus aeglefinus*), one stock of anglerfish ((*Lophius piscatorius and L. budegassa*), two stocks of megrim (*Lepidorhombus whiffiagonis*), four stocks of whiting (*Merlangius merlangius*), five stocks of sole (*Solea solea*), five stocks of plaice (*Pleuronectes platessa*), and nine stocks of *Nephrops* (*Nephrops norvegicus*) distributed in eleven functional units (FU), upon which one stock was added this year, pollock (*Pollachius pollachius*) in Subareas VI and VII. There were 22 participants from six countries (Belgium, France, Ireland, Norway, Russia and UK), and some supportive help by correspondence in various institutes. The meeting was chaired by Pieter-Jan Schön (UK) and Joël Vigneau (France).

The meeting was tasked with carrying out stock assessments and providing catch forecasts and a first draft of ICES Advice for 2012 for all stocks in its remit. Particular attention was given this year to provide an advice for all the stocks where this was possible, following ICES guidelines. In accordance with the advisory framework, all assessments conducted by WGCSE in 2011 were update analyses, and were conducted on the basis of the stock annex, for those stocks having an agreed assessment method. In 2011, four stocks in the remit of WGCSE were subject to benchmark analysis, and only sole in VIIa received an agreed assessment. Plaice in VIIa and plaice in VIIfg were recommended to use trends only assessment for the provision of management advice but could not be used as a basis for predicting future catch options, and the benchmark was inconclusive for megrim IV, VI. During the meeting:

- eight stocks were assessed with an age-based model: haddock in VIb, plaice in VIIe, sole in VIIe, in VIIfg and in VIIa, (XSA), cod and haddock in VIa (TSA) and cod in VIIa (B-ADAPT);
- five stocks were assessed with an age-based assessment considered for trends only: haddock in VIIb–k, cod in VIIe–k, plaice in VIIfg and in VIIa and whiting in VIIe–k;
- seven *Nephrops* stocks were assessed with information from underwater TV surveys : FU11, 12, 13, 14, 15, 17 and the FU22 part of the FU20–22 stock;
- nine stocks were assessed for trends only: anglerfish in IV and VI, haddock in VIIa, megrim in IVa and VIa and megrim in VIb, *Nephrops* FU16, plaice in VIIh–k, sole VIIh–k, Whiting VIIa and whiting VIa. *Nephrops* FU20–21 part of the FU20–22 stock can also be added to this list.
- six stocks could not be assessed: cod and whiting in Vb, sole and plaice in VIIbc, pollock in Celtic Seas and *Nephrops* FU19.

Some difficulties were encountered preventing from applying strictly an update assessment, and solutions had to be accommodated during the WG. The major difficulties were the absence of one survey in 2010 for technical reasons, and the modification of one survey design. No special data deficiencies were reported this year, although all data poor stocks remained in the same situation.

The WG discussed the preparatory work for the benchmarks in 2012, and proposed seven stocks to be reviewed next year. These are cod in Division VIa, in Division VIIa and in Divisions VIIe–k, Haddock in Division VIa, Whiting in Division VIa, Anglerfish in Division IIa, IIIa, Subarea IV and VI and Sole in Division VIIe. In the longer run, plaice in Division VIIa, haddock in Divisions VIIb–k and in Division VIIa were put on the list to be subject to a benchmark in 2013 and sole in Divisions VIIfg in 2014. Another set of six stocks were said to be prone to benchmark without a proposed date.

1 General

1.1 Terms of reference

2010/2/ACOM12 The **Working Group for the Celtic Seas Ecoregion** (WGCSE), chaired by Pieter-Jan Schon (UK) and Joel Vigneau (France) will meet at ICES Headquarters, 11–19 May 2011 to:

- Address generic ToRs for Fish Stock Assessment Working Groups (see table below);
- Assess the progress on the benchmark preparation of Anglerfish (*Lophius budegassa* and *L. piscatorius*) in Divisions IIa, IIIa, Subarea IV, VI, VIIb–k and VIIIa,b, Cod in Division VIa, VIIa, VIIe–k; Sole in Divisions VIIf,g, and Sole in Division VIIe.

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 to the meeting must be available to the group no later than 14 days prior to the starting date.

WGCSE will report by 23 May 2011 for the attention of ACOM.

Fish Stock	Stock Name	Stock Coord.	Assessment Coord. 1	Assessment Coord. 2	Perform assessment	Advice
ang-ivvi	Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Division IIa, IIIa, Subarea IV and VI	UK (Scotland)	UK (Scotland)	Denmark, Norway	Y	Update
cod-iris	Cod in Division VIIa (Irish Sea)	UK (England)	UK (England)		Y	Update
cod-rock	Cod in Division VIb (Rockall)	UK (Scotland)	UK (Scotland)		N	Catch statistics only
cod-scow	Cod in Division VIa (West of Scotland)	UK (Scotland)	UK (Scotland)		Y	Update
cod VIIe–k	Cod in Division VIIe–k (Celtic Sea)	France	France	Ireland	Y	Update
had-7b–k	Haddock in Divisions VIIb–k	Ireland	Ireland	France	Y	Update
had-iris	Haddock in Division VIIa (Irish Sea)	UK (Scotland)	UK (Scotland)		Y	Update
had-rock	Haddock in Division VIb (Rockall)	Russia	Russia	UK (Scotland)	Y	Update
had-scow	Haddock in Division VIa (West of Scotland)	UK (Scotland)	UK (Scotland)		Y	Update

Fish Stock	Stock Name	Stock Coord.	Assessment Coord. 1	Assessment Coord. 2	Perform assessment	Advice
meg-scrk	Megrim (*Lepidorhombus* spp) in Subarea VI (West of Scotland and Rockall) and Subarea IV (North Sea)	Ireland	Ireland	UK (Scotland)	Y	Update
nep-11	*Nephrops* in Division VIa (North Minch)	UK (Scotland)	UK (Scotland)		Y	Update
nep-12	*Nephrops* in Division VIa (South Minch)	UK (Scotland)	UK (Scotland)		Y	Update
nep-13	*Nephrops* in Division VIa (Firth of Clyde)	UK (Scotland)	UK (Scotland)		Y	Update
nep-14	*Nephrops* in Division VIIa (Irish Sea East)	UK (England)			Y	Update
nep-15	*Nephrops* in Division VIIa (Irish Sea West)	UK (Northern Ireland)	UK (Northern Ireland)	Ireland	Y	Update
nep-7bcj	*Nephrops* in Division VIIb,c,j,k (Porcupine Bank)	Ireland	Ireland		Y	Update
nep-17	*Nephrops* in Division VIIb (Aran Grounds, FU17)	Ireland	Ireland		Y	Update
nep-19	*Nephrops* in Division VIIa,g,j (Southeast and West of IRL, FU19)	Ireland	Ireland		Y	Update
nep-20–22	*Nephrops* in Divisions VIIfgh (Celtic Sea, FU20–22	France	France	Ireland	Y	Update
ple-7b–c	Plaice in Division VIIb,c (West of Ireland)	Ireland			Y	Update
ple-7h–k	Plaice in Divisions VIIh,k (Southwest of Ireland)	Ireland	Ireland	Belgium	Y	Same advice as last year
ple-celt	Plaice in Divisions VIIf,g (Celtic Sea)	UK (England)	UK (England)	Belgium	Y	Update

Fish Stock	Stock Name	Stock Coord.	Assessment Coord. 1	Assessment Coord. 2	Perform assessment	Advice
ple-echw	Plaice in Division VIIe (Western Channel)	UK (England)	UK (England)	France	Y	Update
ple-iris	Plaice in Division VIIa (Irish Sea)	UK (England)	UK (England)		Y	Update
sol-7b–c	Sole in Division VIIb, c (West of Ireland)	Ireland			N	Catch statistics only
sol-7h–k	Sole in Divisions VIIh–k (Southwest of Ireland)	Ireland			Y	Same advice as last year
sol-celt	Sole in Divisions VIIf,g (Celtic Sea)	Belgium	Belgium	UK (England)	Y	Update
sol-echw	Sole in Division VIIe (Western Channel)	UK (England)	UK (England)	France	Y	Update
sol-iris	Sole in Division VIIa (Irish Sea)	Belgium	Belgium		Y	Update
whg-7e–k	Whiting in Divisions VIIe–k	Ireland	Ireland	France	Y	Update
whg-iris	Whiting in Division VIIa (Irish Sea)	Ireland	Ireland	UK (Northern Ireland)	Y	Update
whg-rock	Whiting in Division VIb (Rockall)	Ireland			N	Catch statistics only
whg-scow	Whiting in Division VIa (West of Scotland)	UK (Scotland)	UK (Scotland)		Y	Update
Pol-celt	Pollock in the Celtic Seas					Collate data

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 2011 SharePoint site, under the "Data Tables" folder. It seems clear to WG members that these tables have been used recently by the European Commission to check whether collected data under the DCF were being transmitted to ICES assessment WGs.

The WG members would like to highlight that the categories provided in the drop down boxes to fill these tables are not appropriate to all situations. To try to avoid possible confusions, WG stock coordinators have made extensive use of the comments box to make the situation as clear as possible. Therefore, the WG urges any potential users of these tables to read those comments carefully and to take them into consideration.

2.1.1 Data section

From the WGCSE 2010 report, a data section has been collated and provided as a Working Document to ICES WKDDRAC 2011. This initiative could not be repeated during the meeting due to time pressure, but is planned to be done during intersession to serve the needs for action planning (ICES PGCCDBS) and coordination (Regional Coordination Meeting). Moreover, a supplementary objective of such a work will be the setting of a template in order to ease its inclusion in future WGCSE reports.

For the moment, a data section is available in each of the stock sections.

2.1.2 Biological sampling

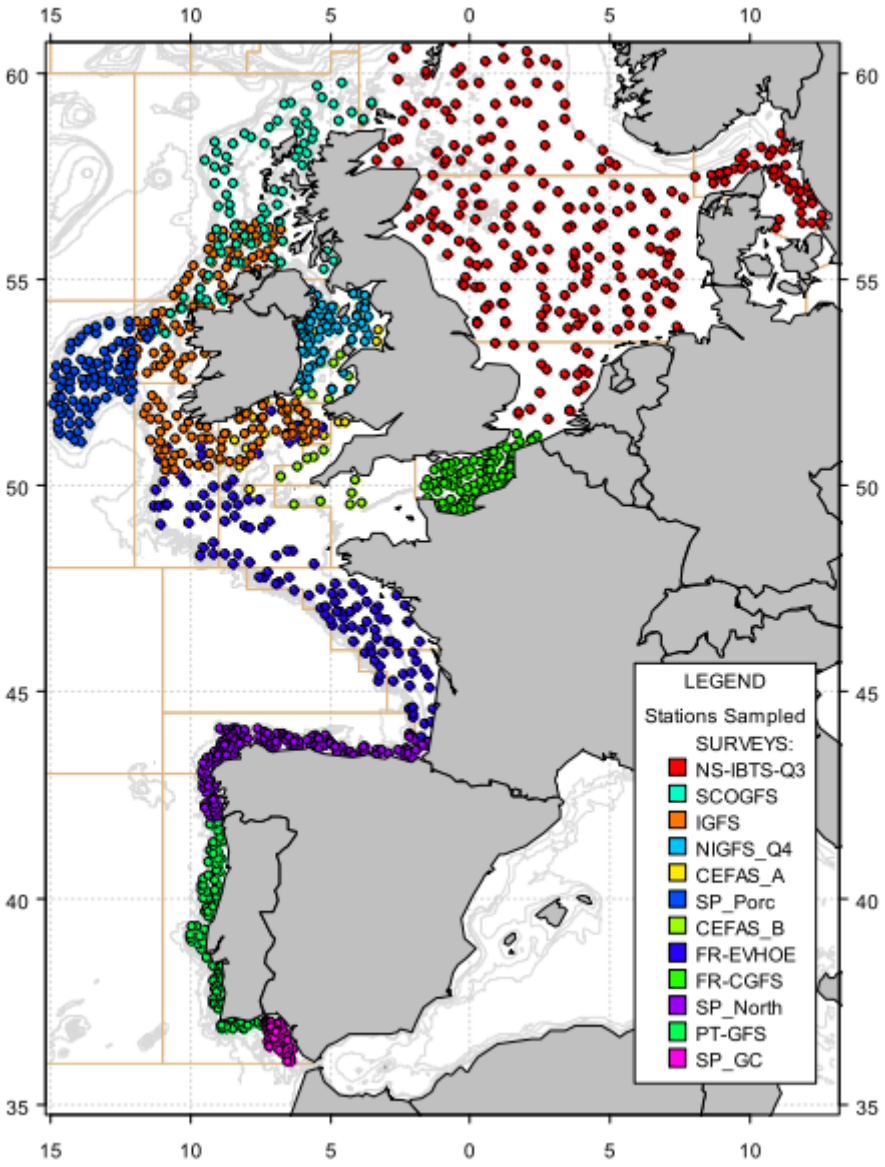
Table 2.1 Biological sampling levels by stock and country		Cod					Whiting				Nephrops										Plaice					Sole				Haddock				Megrim		Anglerfish			
		VIa	VIb	VIIa	VIIb,c	VIIe-k	VIIb,c	VIIe-k	VIIa	VIIa	FU11	FU12	FU13	FU14	FU15	FU16	FU17	FU19	FU20-22	VIIa	VIIb,c	VIIe	VIIfg	VIIhjk	VIIa	VIIb,c	VIIe	VIIfg	VIIhjk	VIIb-k	VIIa	VIIb	VIIa	VIIb	VIIa	VIIb	Ia	IVa & IIIa	VIa	VIb
Belgium	No. lengths [landings]			237		213		3,238		887										33,730		413	8,543		17,388		1,933	28,388		3,232			3,013							
	No. ages n [landings]			210		178		835		218										528		0	638		1,884		0	259		876			301							
	No. samples [landings]*			3		16		35		7										31		4	31		11		4	31		35			7							
	No. lengths [discards]			1,373		1,326		21,797		11,337										38,630		21	13,093		4,896		41	1,413		41,348			2,706							
	No. ages n [discards]			340		413		761		427										648		29	543		313		39	280		118			449							
	No. samples [discards]**			3		16		35		7										8		4	21		8		4	13		35			7							
UK (W [IIIa])	No. lengths [landings]			1,315		4,131		1,818		0										1,532		20,878	1,738	571	288		15,118	1,813	3,072	1,817			0			0				
	No. ages n [landings]			288		1,138		311		0										931		1,852	845	1	687		1,810	1,870	488	213			0			0				
	No. samples [landings]*			3		205		28		0										31		286	48	0	16		157	20	25	35			0			0				
	No. lengths [discards]			23		2,771		14,388		1,328										9,133		4,386	2,731	0	5		446	103	18	12,284			0			190				
	No. ages n [discards]			3		128		287		0										91		334	48	0	1		9	20	0	179			0			2				
	No. samples [discards]*			28		130		138		28										28		289	178	116	28		148	108	116	1,084			28			413				
Northern Ireland	No. lengths [landings]																																						
	No. ages n [landings]																																						
	No. samples [landings]*																																						
	No. lengths [discards]																																						
	No. ages n [discards]																																						
	No. samples [discards]*																																						
France	No. lengths [landings]					12,883		8,615											30,389			481	2,157				957	2,154	972	13,615										
	No. ages n [landings]					1,907		701											0			0	0				648	0	0	382										
	No. samples [landings]*					121		101											48			69	38				80	32	33	383										
	No. lengths [discards]					1,128		1,484											2,967			55	148				28	0	4	5,897										
	No. ages n [discards]					0		0											0			0	0				0	0		0										
	No. samples [discards]*					48		45											28			45	6				78	0	1	252										
Spain	No. lengths [landings]																																						
	No. ages n [landings]																																						
	No. samples [landings]*																																						
	No. lengths [discards]																																						
	No. ages n [discards]																																						
	No. samples [discards]*																																						
Ireland	No. lengths [landings]	3,257	1,257	2,211	252	6,561	1,221	13,551	2,819	488						14,650				2,649	1,356		6,215	1,355	1,650	113		1,951	1,959	19,884	1,673	278	1,673	6,558				2,538	
	No. ages n [landings]	25	25	57	14	158	22	221	29	9										52	17		62	17	54	21		63	25	357	29	2	25	25				29	
	No. samples [landings]*	112	151	1,276	11	1,151	149	1,524	171	125						5				141	110		149	110	101	118		121	107	1,186	1,018	141	145	172				199	
	No. lengths [discards]	25		170	25	1,121	1,111	1,529	115	11,611			14,113			7,125			11,799	1,118	101		1,116	161	91	29		11	1	11,171	116		1,115	111				117	
	No. ages n [discards]			14	1	101	118	171	14	115										111	118		117	110	11			1	1	1,179	19		117	91				91	
	No. samples [discards]*	11		115	115	117	111	117	11	115			11			17			11	115	111		119	118	115	115		119	111	161	11		115	11				11	
	No. lengths [catches]												11,111			11,119	7,111	1	11,111																				
	No. ages n [catches]																																						
	No. samples [catches]												11			11	11	1	11																				
UK (other)	No. lengths [landings]																																						
	No. ages n [landings]																																						
	No. samples [landings]*																																						
	No. lengths [discards]																																						
	No. ages n [discards]																																						
	No. samples [discards]*																																						
Norway	No. lengths [landings]																															2,111				1,111	1,111		111
	No. ages n [landings]																															111							
	No. samples [landings]*																															11				111	111		11
	No. lengths [discards]																																	1,111					
	No. ages n [discards]																																						
	No. samples [discards]*																																	11					
Russian Federation	No. lengths [landings]																																						
	No. ages n [landings]																																						
	No. samples [landings]*																																						
	No. lengths [discards]																																						
	No. ages n [discards]																																						
	No. samples [discards]*																																						
Denmark	No. lengths [landings]																																						
	No. ages n [landings]																																						
	No. samples [landings]*																																						
	No. lengths [discards]																																						
	No. ages n [discards]																																						
	No. samples [discards]*																																						
* Number of vessels sampled ** Number of hauls sampled																																							

2.1.3 Survey information

This Section lists the surveys used in the assessment of stocks by this WG:

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	SCO-IV-VI-AMISS-Q2	
Joint science/industry survey Irish anglefish survey	IRL-IV-VI-AMISS-Q2	
Rockall haddock survey	ROCK-IBTS-Q3	
Scottish west coast groundfish survey - 1Q	ScoGFS-WIBTS-Q1	IBTS Q1
Scottish west coast groundfish survey - 4Q	ScoGFS-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 (FU11–13)	UWTV (FU11–13)
Underwater TV survey	UWTV (FU14 & 15)	UWTV (FU15)
Underwater TV survey	UWTV (FU17)	UWTV (FU17)
Underwater TV survey	UWTV (FU20–22)	UWTV (FU20–22
Western Channel Fisheries Science Partnership	FSP-7e	
Western English Channel beam trawl survey	UK-WEC-BTS	VIIe BTS

The following figure, from the ICES IBTSWG 2010 report, shows the station positions for the IBTS surveys carried out in the Western and North Sea Area in autumn/winter of 2009. Many of the surveys used by WGCSE can be identified in the figure.



It is to be noted that the Scottish west coast groundfish survey - 4Q (ScoGFS-WIBTS-Q4) was not carried out in 2010 due to an engine breakdown of the research vessel, and the Scottish survey design and gears have been modified in 2011. Consequences for the assessment are discussed in the sections on cod, whiting and haddock in VIa.

2.1.4 Ecosystem information

A presentation by ICES was made on the ecosystem approach to fisheries, in the frame of the Marine Strategy Framework Directive (MSFD). ICES has established a Joint ACOM/SCICOM MSFD Steering Group to support Member States and Regional Conventions' implementation of the MSFD.

ICES has decided to develop Descriptor 3 on Commercially Exploited Fish and Shellfish and a Core Group has been established. The descriptor 3 proposes criteria to evaluate if *Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock*.

These criteria are:

- level of pressure of the fishing activity: the indicators are fishing mortality in relation to F_{msy}, or ratio catch/biomass if not available;
- reproductive capacity: the indicators are spawning–stock biomass in relation to SSB_{msy}, or biomass indices if not available;
- age and size composition: the indicators are proportion of fish larger than size of first maturity, mean maximum length across all species found in research vessel surveys, 95% percentile of fish length distribution observed in research vessel surveys, and size at first sexual maturation.

This year the Expert Groups were tasked to:

1) Identify elements of the EGs work that may help determine status for the eleven descriptors set out in the Commission Decision;

2) Provide views on what good environmental status (GES) might be for those descriptors, including methods that could be used to determine status.

During the discussion, it was agreed that information on the three criteria for descriptor 3 were available in the report of the EG for the stocks subject to an assessment. It was also agreed that it was premature for the EG to go further and that the MSFD SG should propose guidance on how EG should address this issue in the coming years.

2.1.5 Intercatch

The InterCatch database has historically not been widely used by the WGCSE. During the 2011 meeting, a specific effort was made to try improving the coverage of the data uploaded in InterCatch. It has though not been possible to spend much time actually uploading new data during the meeting itself because of time pressure, but it is expected that further follow-up will take place intersessionally and improvements will be achieved in future. The actual level of InterCatch use by stock is described below.

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	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.
Sol-iris	In parallel with another tool	InterCatch was used, however it is not possible to make a combined age distribution from the raw data. There is also no option to upload a combined age distribution as "international" because an international code is not available. Therefore the country code "BE" is used for the moment.	Non or insignificant	Can be used, although further adaptations to InterCatch are needed.
Had-7b–k	In parallel with another tool	The current system of aggregating international data is fairly complicated and involves data that are supplied for combined divisions	Small and presumably acceptable	The differences will have to be investigated in more detail before intercatch can be used as only tool.
Sol-Echw	Not used	Not all 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

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	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.
Ple-Echw	Not used	Not all 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	Not all 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	Not all 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	Not all national datasets were uploaded to Intercatch by stock coordinators.	Comparison not made– but 2009 and earlier years were Non or insignificant	Can be used
Sol-Celt	In parallel with another tool	Compared at the WG as not all national datasets were uploaded to intercatch before the meeting	Non or insignificant	Can be used

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	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.
Ple-7bc Ple-7h–k Sol-7bc Sol-7h–k	Not used	No assessment	NA	NA
Cod-scow	In parallel with another tool		Non or insignificant	Can be used
Had-scow	In parallel with another tool		Non or insignificant	Can be used
Whg-scow	In parallel with another tool		Non or insignificant	Can be used
Nep-11	Not used	Trials to upload sex specific length structured data successful for 2009 data. No reason why it cannot be used in future.	Comparison not made	Not tested
Nep-12	Not used	Trials to upload sex specific length structured data successful for 2009 data. No reason why it cannot be used in future.	Comparison not made	Not tested
Nep-13	Not used	Trials to upload sex specific length structured data successful for 2009 data. No reason why it cannot be used in future.	Comparison not made	Not tested

2.1.6 Celtic Seas Stocks and Mixed Fisheries Forecasts

Starting in 2010 the ICES working group WGMIXFISH has performed mixed fisheries short-term forecasts specific to stocks in the North Sea and Kattegat. A broad outline of the method involved and the types of basic scenarios considered to date was presented.

At the 2011 meeting of WGCHAIRS it was clear ICES would like the sort of projections performed at WGMIXFISH extended to other regions. Three criteria are required for mixed fisheries considerations to be worthwhile. First, there must be potential (or known) inconsistencies between TAC advice for stocks in a region because of technical interactions between those stocks. Second, all major stocks prosecuted by the fisheries in an area need an accepted fishing mortality or harvest rate. Third, landings (preferably catches) and effort data needs to be available by all main fleet-métier combinations.

The current situation in ICES Division VIa did not make it an obvious candidate for WGMIXFISH style considerations. All three main gadoid stocks-cod, haddock and whiting-have been considered at dangerously low biomass levels with advice for low or zero catch, although this may change with the latest haddock assessment (see Section 3.3). For VIa cod there is also currently no accepted value for fishing mortality.

Celtic Sea stocks (ICES VIIb–k) were considered a more appropriate choice. There is an opportunity to develop management plans for all major stocks in the region that are consistent in the mixed fisheries context after making use of mixed fisheries forecasts. A lack of accepted stock assessments or complete datasets might be obstacles to overcome but it was agreed in principle that WGMIXFISH could consider Celtic Sea stocks in 2012.

The ICES MICC report 2010 concluded that mixed fisheries considerations at this stage should not be considered formal advice but information and that WGMIXFISH output should be presented in this context. It is not clear whether long term the current WGMIXFISH will assume responsibility to conduct mixed fisheries forecasts for additional areas or whether new area specific working groups will be formed.

Because of the fleet-métier nature of the data required for WGMIXFISH and the desire by ACOM to make reporting of the mixed fishery projections before or coincident with single-species advice in June, WGMIXFISBH has begun a consultation with data providers around the possibility of data submissions to ICES that would fulfil the needs of WGNSSK and WGMIXFISH and still conform to sound sampling practice (the current métier definitions are not considered ideal). Similar considerations to do with fleet-métier definitions that are consistent with national sampling schemes would be necessary if mixed fisheries projections were adopted for stocks from the Celtic Seas. Métier definitions need not be the same as for the North Sea region.

The WGCSE considered that work needs to be done in the definition of métier for raising procedures in preparation of the benchmarks 2012. The recent availability of the final report of the EU study on the development of tools for logbook and VMS data analysis (Study 2008–2010 lot 2) could serve as a basis for revisiting the métiers used for sampling and raising in the different countries operating in the Celtic Seas.

2.1.7 Summary of benchmark 2011

Plaice in VIIa (Irish Sea) and Plaice in VIIfg (Celtic Sea): Several alternative methods were investigated to explore options for incorporating a short time-series of discard

observations into the assessment. None of the approaches examined proved to be entirely satisfactory. The group concluded that the Aarts and Poos (2009) method, developed initially for North Sea plaice, could be used as a trends only assessment for the provision of management advice but could not be used as a basis for predicting future catch options.

Sole in VIIa (Irish Sea): Alternative methods for raising the international catch-at-age matrix were investigated in order to reduce the impact of recent changes in sampling levels that have occurred at the national level. The existing assessment method (XSA) was retained with only minor modifications to the parameter settings.

Megrim in VI and IV: Only very limited data were available to WKFLAT. The group considered the basis for the stock definition and concluded that there was little evidence that megrim in Subdivisions VI and IV comprise separate stocks. WKFLAT applied several assessment methods to the data but was unable to recommend a preferred assessment for this stock.

2.1.8 Proposal for benchmark 2012

Seven stocks within the remit of WGCSE are scheduled to be benchmarked in 2012. These stocks are:

- Cod (*Gadus morhua*) in Division VIa;
- Cod (*Gadus morhua*) in Division VIIa;
- Cod (*Gadus morhua*) in Divisions VIIe–k;
- Haddock (*Melanogramus aeglefinus*) in Division VIa;
- Whiting (*Merlangius merlangus*) in Division VIa;
- Anglerfish (*Lophius piscatorius* and *Lophius budegassa*) in Division IIa, IIIa, Subarea IV and VI;
- Sole (*Solea solea*) in Division VIIe.

The rationale for benchmarking all cod stocks together is detailed in the reasoning for cod VIIa. Additionally, a number of stocks were listed as candidates for benchmarking, but not included in the 2012 list. The reasons vary from further analysis to be carried out to further data and/or longer time-series to be collected. All details can be found in the relevant stock sections.

The proposed benchmarks for 2013 and 2014 are the following:

- Plaice (*Pleuronectes platessa*) in Division VIIa (in 2013);
- Haddock (*Melanogramus aeglefinus*) in Divisions VIIb–k (in 2013);
- Haddock (*Melanogramus aeglefinus*) in Division VIIa (in 2013);
- Sole (*Solea solea*) in Divisions VIIfg (in 2014).

The following stocks are considering the need for a benchmark, without proposed date and pending the resolution of current known issues :

- Megrim (*Lepidorhombus spp*) in Subarea IV and VI;
- Haddock (*Melanogramus aeglefinus*) in Division VIb;
- Whiting (*Merlangius merlangus*) in Division VIIa;
- Whiting (*Merlangius merlangus*) in Division VIIe–k;
- *Nephrops* (*Nephrops novegicus*) FU16;

- *Nephrops* (*Nephrops novegicus*) FU20–22.

2.1.8.1 Planning future benchmarks

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

	Ass status	Last benchmark	Planning Year +1	Planning Year +2	Year +3	Comments
cod-iris	Update		2012			See Section 6.2
cod-7e–k	Update for trends only	2009	2012			See Section 7.2
had-iris	Survey trends			2013		Along with had 7b–k. See Section 6.3
had-7b–k	Update for trends only			2013		See Section 7.4
whg-iris	Survey trends					Benchmark pending construction of catch numbers/ weights-at-length and age. See Section 6.6.
whg-7e–k	Update for trends only					Demand for a future benchmark. See Section 7.15
ple-iris	Update for trends only	2011		2013		See Section 6.7
ple-celt	Update for trends only	2011				
ple-echw	Update	2010				
ple-7h–k	Catch curve					
ple-7b–c	No assessment					
sol-iris	Update	2011				
sol-celt	Update				2014	See Section 7.13
sol-echw	Update	2009	2012			See Section 8.3
cod-scow	Update		2012			See Section 3.2
cod-rock	No assessment					
had-scow	Update		2012			See Section 3.3
had-rock	Update					Benchmark pending improvement in model input data. See Section 4.3
whg-scow	Update for trends only		2012			See Section 3.4
whg-rock	No assessment					

	Ass status	Last benchmark	Planning Year +1	Planning Year +2	Year +3	Comments
meg-ivvi	Update for trends only	2011				Benchmark pending complete landings-at-age information. See Section 5.3
meg-rock	Survey trends	2011				
ang-ivvi	Survey trends		2012			See Section 5.2
nep-11	Update	2009				
nep-12	Update	2009				
nep-13	Update	2009				
nep-14	Update	2009				
nep-15	Update	2009				
nep-16	Trends only					Benchmark pending better growth information and improvement in sampling of catches. See Section 7.6
nep-17	Update	2009				
nep-19	No assessment					
nep-2022	Update(FU22) Trends only(FU20–21)					Demand for a future benchmark. See Section 7.7
sol-7h–k	Catch curve					
sol-7b–c	No assessment					
Ecosystem issues that need generic work						

2.1.8.2 Issue lists for stocks or ecosystem issues with upcoming benchmarks

Cod VIa		
Benchmark	Year: 2012	
(Stock) coordinator	Name:	E-mail:
(Stock) assessor	Name:	E-mail:
Data contact	Name:	E-mail:

problem	solution	expertise necessary	suggested time
Misreporting of landings. Unknown level prevents adjustment of reported catch and inclusion in assessment.	To estimate misreporting due to area misreporting; analysis of VMS data compared with landings declarations to estimate the degree of area misreporting.	Requires someone familiar with VMS analysis (plus provision of trip specific landings declarations).	Uncertain. Suitable expert needs to be identified.
Bias in discard estimates	New discard raising methodology has been developed at Marine Scotland Science.		
Inappropriate modelling of discards within TSA model	Revision of TSA to allow fitting of discards at higher ages.	Requires someone familiar TSA routines.	New model available.

problem	solution	expertise necessary	suggested time
Variance and bias in survey index	1 -Adoption of new aggregation methods to form final indices from haul by haul data, (combinations of new post stratification, weighting of strata and/or adoption of statistical approaches such as fitting of GAM or delta distribution models). 2 - Inclusion of additional surveys (ScoGFS-4Q and IRGFS-WIBTS-Q4). ScoGFS-WIBTS-Q4 indices to be formed in same manner as ScoGFS-WIBTS-Q1 after conclusion of above project. 3 - Addition of new survey effort and/or revision of survey design.	Work being undertaken as a Marine Scotland Science research project.	1 - Project due for completion in 2011. 2 -Comparison with existing assessment setup (single survey) possible in 2011 (after conclusion of above project). 3 - Anglerfish survey records cod numbers at length, now has 5 years of data and cpue indices can be formed. Data from charter surveys in 2009 available. A random stratified design for the Scottish surveys was implemented in 2011.
Uncertainty in natural mortality (level and trend) because of unquantified predation from large and increasing seal population.	Revision of TSA to allow inclusion of different fleets, (this in turn allows estimates of age specific consumption of cod by seals to be input as if from an additional fleet).	Requires someone familiar with TSA routines.	Method for estimating age specific consumption of cod by seals presented at 2008 ICES ASC. Work to adjust TSA scheduled for 2011.
Possible trend in mean weight-at-age in landings	Compare mean weights-at-age with that from survey data. Apply F test to determine if fitted smooth significantly different from straight line with zero gradient.		Work possible in 2011.

Cod VIIa		
Benchmark	Year: 2012	
(Stock) coordinator	Name:	E-mail:
(Stock) assessor	Name:	E-mail:
Data contact	Name:	E-mail:

Candidate stocks	Supporting justification and comment(s)	Indicated expertise necessary at the benchmark meeting
Western waters cod stocks (Area VI and VII excl. VIId).	Cod stocks in Divisions VI and VII comprise an assemblage of metapopulations with varying degrees of mixing. Fishing effort, predation and other environmental drivers including climate change impact the populations in different ways across the range of the stocks. The stocks have proven difficult to assess due to data deficiencies and an inability to demonstrate responses to changes in fishing effort and other management controls. Improved management advice may benefit more from quantifying the spatial dynamics of cod in relation to spatial variations in fishing and other pressures than by trying to refine the current modelling approaches applied to the current stock definitions and management units. To make progress towards this, an initial Data Workshop is proposed to collate and interpret existing and new data on cod stock structure and mixing, distribution patterns, spatial variations in size/age structure and biological characteristics as well as pressures including predation, fishing and climate. Such analyses will be facilitated by high-resolution spatial data on fishery catches and effort by métier using VMS, rectangle data, employing GIS methods. It will be necessary to develop an international database holding spatially resolved datasets (landings, discards, effort, size/age/biological data, surveys, environmental variables) and data manipulation routines to allow evaluation of the effect on the assessments of altering the stock unit definition. Data on cod movement parameters will be required to allow development of operating models for testing assessment and management procedures and ultimately developing and testing spatially disaggregated assessment models. New datasets e.g. on discarding, biology, predation, surveys and fishing effort/cpue would be evaluated. The Data Workshop would build on and review the outcomes of a major UK collaborative programme on cod stock structure and spatial dynamics, which will be completed in 2011. The ensuing Benchmark Assessment workshop would evaluate the appropriateness of current assessment methods in the light of the Data Workshop outcomes, and explore alternative approaches as candidates for providing management advice. This could potentially include changes to the spatial units for assessment or the development of spatially disaggregated assessment models including mixing coefficients.	

Cod VIIe-k		
Benchmark	Year: 2012	
(Stock) coordinator	Name:	E-mail:
(Stock) assessor	Name:	E-mail:
Data contact	Name:	E-mail:

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
Discards	WKROUND 2009 concluded that more work is required before Celtic Sea cod can be benchmarked successfully	WGCSE 2011 reviewed the available information and several improvements have occurred since WKROUND. There is now a time-series of self-sampling highgrading estimates. Discard and misreporting rates appear to have changed between years and fleets. Historical time-series of discards are required in order to include discards into the assessment.		Expert group members
Biological parameters	There is evidence from sampling on the Irish "biological survey" that maturity has changed for this stock	If new information is available for the next benchmark (e.g from the Irish Celtic Sea cod survey), the use of new ogive should be investigated There is a growing body of new tagging information (e.g. Irish tagging studies) that may prove useful to assess stock structure and possible mortality rate.		Tagging experts
Surveys		There is a new dedicated survey for the stock that need to be considered and the two other IBTS survey-series should be examined to see if a combined index might be possible		Survey experts

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
Assessment method	WKROUND 2009 considered the use of other models than XSA (B-Adapt, SAMS). Due to time constraints and lack of data, analysis have been preliminary during WKROUND	Further work is needed to investigate the suitability of those models and to identify the proper settings to use for assessment.		Modelling experts
Advice		the Benchmark should aim to develop an assessment and advice framework for the provision of MSY and precautionary advice form the information available		

Haddock VIa		
Benchmark	Year: 2012	
(Stock) coordinator	Name:	E-mail:
(Stock) assessor	Name:	E-mail:
Data contact	Name:	E-mail:

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	commercial cpue or lpue data cannot be used in the assessment	A VMS-based analysis of lpue could help to address the concern. With the increased requirement for vessels to operate with VMS it is likely that the quality of effort data will improve. This will lead to an improved time-series of effort data in future but still leaves the uncertainties regarding the earlier years in the time-series.	VMS data	
Discards	There should be a full analysis of the precision and bias of catch-at-age data. Although catch data between 2006–2010 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		
Biological Parameters	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.		

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
Surveys	Despite of not being currently used in the assessment, IGFS-WIBTS-Q4 survey was used as an index to corroborate the strength of the 2009 year class. Also due to the lack of the ScoGFS-WIBTS Q4 2010 survey it would assume a great importance the introduction of the IGFS survey into the assessment.	There are now seven years of data from the IGFS-WIBTS-Q4 and should be evaluated at the next benchmark for this stock Figure 3.1.16 shows the indices of all three surveys in a comparison plot. These seem to agree but further investigation is necessary before its introduction in the assessment.		
Assessment method		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).		
Forecast method		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.		

Whiting VIa		
Benchmark	Year: 2012	
(Stock) coordinator	Name:	E-mail:
(Stock) assessor	Name:	E-mail:
Data contact	Name:	E-mail:

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
Discards		A landings and discards disaggregated assessment may potentially be a reliable basis for determining the status of the whiting stock in Via		
Surveys	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 location of sampling stations may be reconsidered to better match the distribution of commercial landings and maximize coordinated survey effort in the area.		
Assessment method	Currently, the main problem is the discrepancy between survey and catch data prior to 1995	Unless this discrepancy can be resolved, truncating the catch data from 1995 may be an option, which proved satisfactory in previous exploratory XSA runs carried out at this working group. Given the new legislation on reporting landings, the quality of landings data is likely to continue to improve.		

Anglerfish in in Division IIa, IIIa, Subarea IV and VI		
Benchmark	Year: 2012	
(Stock) coordinator	Name:	E-mail:
(Stock) assessor	Name:	E-mail:
Data contact	Name:	E-mail:

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
Input data	ICES has previously advised a two-stage approach for management of the anglerfish fishery. The first stage was to substantially improve the quality and quantity of data collected in the fishery while maintaining exploitation at its current level. It has stated that this was expected to take at least five years to establish useable time-series. The second stage would then be to use these data to examine alternative management approaches and harvest control rules	The data collection stage of this process is ongoing and an assessment approach is in preparation. WGCSE 2010 considers that significant progress towards assessment has been made for this stock		
Discards				
Biological Parameters	There are still uncertainties about the validity of age readings of anglerfish.	1 - : this will be addressed by an age determination exchange. Depending on the outcome of this exchange, the catch-at-age data should then be evaluated for use in any assessment 2 - The biological data associated with the anglerfish surveys should be evaluated and compared with existing estimates (e.g. maturity-at-age, growth rates, length distributions, sex ratios and species compositions).		

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
Surveys	1 - Irrespective of any ageing concerns, the survey estimates have underestimated the younger ages. This is despite the recent incorporation of a correction to account for escapes of small fish under the footrope of the survey trawl, which clearly has not accounted for all small fish. 2 - A number of recommendations were made at ICES WKAGME for the improvement of the anglerfish surveys. 3 - efforts to extrapolate estimates of abundance into areas that have not been surveyed (southern North Sea and Subarea IIIa) have not proved particularly successful	1 - Some developments of the latter bias correction are still possible; however, it seems likely that a survey based assessment model could also be developed to determine the absolute abundance of the total population. 2 - Some of these have been addressed and other will be addressed in the coming year in advance of the Benchmark. These include: improving the survey design in the light of previous estimates of density (allocation of samples to strata); providing estimates for the two species separately so that they may be incorporated separately in any assessment model (for cohort tracking for example); accounting for areas not surveyed in the North Sea using IBTS data; and improving the estimates of footrope escapes. 3 - Additional participation of nations with an interest in this fishery should be encouraged before the next Benchmark. In 2009 only Scotland and Ireland participated in this survey and in 2010 and 2011 only Scotland was able to conduct a survey.		
Assessment method		See the point above		
Forecast method				

Sole VIIe		
Benchmark	Year: 2012	
(Stock) coordinator	Name:	E-mail:
(Stock) assessor	Name:	E-mail:
Data contact	Name:	E-mail:

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**
Surveys and tuning series	WKFLAT 2009 could not recommend an appropriate assessment procedure for this stock for the following reasons: Closed population and complete mixing assumptions of the assessment are violated. Tuning data indicate differences in trends in F and recruitment resulting in a serious retrospective pattern in the assessment. Survey information only partially covers the stock area	Effort correction parameters / methodologies may require updating as the main beam trawl fleet has restructured substantially recently. This effort would be greatly enhanced by an internationally coordinated survey that more appropriately covers the management area and is able to assess recruitment dynamics irrespective of the sources of recruitment and environmental drivers		Experts with expertise in spatial modelling of stock dynamics and survey specialist to help evaluate the new stratified random survey in the area
Assessment method		.		

2.2 Methodology and software; MSY estimation for *Nephrops* stocks

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

If there is clear peak at low F in the YPR analysis and no evidence of recruitment dependence on biomass, then F_{max} may be an appropriate proxy.

Where $F_{max,}$ is undefined then $F_{0.1}$ might be considered as a 'lower bound' to the range of F suitable for F_{msy}, as it is assumed to be low risk.

Spawning biomass per recruit analysis should be routinely evaluated in addition to YPR. There is not a single level of % SPR that is optimal for all stocks and the proposal for F_{msy} should include some consideration of life history. 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 three categories, those with TV surveys, those monitored by lpue/mean size and those with only landing information. Only for those stocks with TV surveys is the catch advice determined by an exploitation rate, advice for the other stocks is based on changes to landings. For those stocks with a TV survey, the Harvest Rates (removals divided by abundance as estimated by the TV survey) associated with fishing at $F_{0.1}$ and F_{max}

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

The remaining challenge is determining which F_{msy} proxy is appropriate 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 the sexes of a typical *Nephrops* stock (FU8 in this example), the Harvest Rates which correspond to those F multipliers and the resulting level of spawner-per-recruit expressed as a percentage of the virgin level.

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

The yield-per-recruit and spawner-per-recriut 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 (100's of metres) and therefore very low densities of males could result in sperm limitation. Ensuring that the fishing mortality target on males is not exceeded will usually result in an 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 per m^2), medium (i.e. 1.0–0.2 per 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, the Harvest Rates they correspond to along with the implied %spawner-per-recruit for males and females.

Following changes to UK legislation in 2006 the reliability of UK landings data is considered to have significantly improved (representing ~80% of the landings). Provided that this is both true and continues into the future, assessment scientists will eventually have data which could be used to 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.

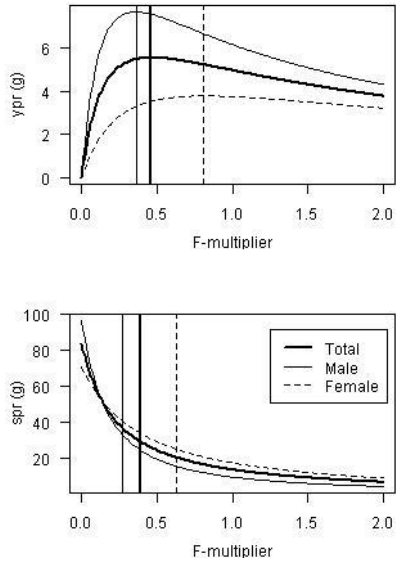


Figure 2.1. Yield-per-recruit and spawning–stock biomass-per recruit for males, females (dotted line) and combined (bold) with F_{max} and $F_{35\%spr}$ reference points.

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). An update assessment was conducted this year by the WG.

ICES advice applicable to 2010

Single-stock exploitation boundaries

ICES evaluated the long-term management plan and has not yet been able to confirm that it is precautionary. Considering the options below, ICES advises on the basis of exploitation boundaries in relation to precautionary considerations that no fishing should take place on cod in Division VIa.

Exploitation boundaries in relation to existing management plans

Due to the uncertainty in the level of fishing mortality, ICES is not in a position to give quantitative forecasts. Given the stock status it is likely that the stock will fall into the category defined in Article 9.a of the plan which implies a 25% TAC reduction.

Exploitation boundaries in relation to precautionary considerations

Given the low SSB and low recruitments in recent years, it is not possible to identify any non-zero catch which would be compatible with the precautionary approach.

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

MSY approach

Estimates of F_{MSY} for this stock are uncertain due to the absence of fisheries data in the assessment since 1994. However, the estimates are consistent with the proposed F_{MSY} for the neighbouring North Sea cod stock. There is no estimate for current fishing mortality for this stock. However, it is likely that current F is above F_{MSY}. SSB has declined to a very low level. Therefore, catches (mainly discards) of cod should be reduced to the lowest possible level.

PA Considerations

Given the low SSB and low recruitments in recent years, it is not possible to identify any non-zero catch which would be compatible with the precautionary approach. No targeted fishing should take place on cod in Division VIa. Bycatches including discards of cod in all fisheries in Division VIa should be reduced to the lowest possible level.

The 2008 year class is estimated to be more abundant and consequently additional measures (such as real-time closures) to protect it are essential to ensure that it contributes to the rebuilding of the stock. It will be necessary to reduce all sources of fishing mortality on cod to as close to zero as possible if the stock is to recover above B_{pa} as quickly as possible

Management plan

The stock is considered data poor. Following the cod long-term management plan (EC 1342/2008) article 9(a) implies a TAC and associated effort reduction of 25%. This translates to a TAC of less than 180 t. ICES considers that article 10(2) may also apply. Because it is not possible at present to assess unaccounted mortality accurately, ICES cannot yet evaluate if the management plan is in accordance with the precautionary approach.

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 a TAC is set for ICES Areas VIa and Vb (EC waters). The 2010 and 2011 TACs for cod in the management unit were 240 t and 182 t respectively.

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 for VIa and Vb1 was given.

TAC for 2010

Species:	Cod *Gadus morhua*	Zone:	VIa; EU and international waters of Vb east of 12° 00′ W (COD/5B6A-C)
Belgium	0		
Germany	4		
France	38		
Ireland	53		
United Kingdom	145		
EU	240		
TAC	240		Analytical TAC

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

Technical measures applicable to the West of Scotland, including those associated with the cod recovery plan in force in 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 2010

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 2010.

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). Area misreporting, however, is still believed to take place in the UK. 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 3.2.1). Discard numbers as a percentage of catch numbers-at-age for 2009 and 2010 are shown in the following text table.

Age year	1	2	3	4	5	6	7+
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

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). There are indications a similar pattern is emerging with respect to the 2008 year class.

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				Survey Data			
	Landings		Discards		Cpue at age			
	No.-at-age	Wght.-at-age	No.-at-age	Wght.-at-age	ScoGFS-WIBTS-Q1	ScoGFS-WIBTS-Q4	IreGFS	IRGFS-WIBTS-Q4
Available	1978–2010 Ages : 1–7+	1978–2010 Ages : 1–7+	1978–2010 Ages : 1–7+	1978–2010 Ages : 1–7+	1985–2011 Ages : 1–7	1996–2009 Ages : 0–8	1993–2002 Ages : 0–3	2003–2010 Ages : 0–3
Used	1978–1994 Ages : 1–7+	1978–2010 Ages : 1–7+	1978–1994 Ages : 1–7+	1978–2010 Ages : 1–7+	1985–2011 Ages : 1–6	NOT USED	NOT USED	NOT USED

A plot of log catch curve gradient derived from commercial catch data (landings plus discards) is shown in Figure 3.2.2. 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 2005 and 2006 cohorts. The final value (estimated over age range 2–5) is as high as any in the time-series. Landings and discard data numbers-at-age are, however, only included in the assessment up to 1994 because of concerns over deteriorating quality of landings data.

Annual mean weights-at-age in landings, discards and catch are given in Tables 3.2.5, 3.2.7 and 3.2.9. Weights-at-age for the stock are still required to obtain biomass estimates and so the full series of stock weights are used. Figure 3.2.1 shows the mean weights-at-age in the landings and discards. There is no evidence of a trend in weight-at-age for ages 1 and 2 for VIa cod landings, but some evidence of a gradual long-term decline at age 3 and above. Mean weight-at-age of discarded fish at age 2 has increased in recent years.

Raised discard numbers-at-age are given in Table 3.2.6. Discard data were supplied by Scotland and Ireland. Discard rates at age for the Irish fleet were very low and considerably different from those of the Scottish fleet. Applying combined Scottish-Irish discard rates to the international fleets resulted in significantly lower international discard totals. With no evidence other nations had achieved the low discards of the Irish fleet discards for the international fleet (except Ireland) were raised from Scottish observations. Observer coverage 2008–2010 (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

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. A consequence of the current assessment model configuration is that the change in discarding practices from 2006 as shown in Tables 3.2.2 and 3.2.6 have no influence on the final assessment.

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 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 spe-

cific 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 if Figure 3.2.3. 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.

The ScoGFS-WIBTS-Q4 did not take place in 2010. Figure 3.2.4 shows cpue by survey haul from 2010 for the IRGFS-WIBTS-Q4 survey and from 2011 for the ScoGFS-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). In a pattern relatively consistent between 2007–2009 the quarter four surveys have shown catches of cod in the northern part of the region (north Minches and north of 58.5 degrees N) and in the southern part of the region (off the north coast of Ireland and along the shelf edge south of 56 degree N) but mostly zero returns in the intervening latitudes. The 2010 IRGFS-WIBTS-Q4 demonstrates the same pattern as in previous years with the exception of one large haul at 56 degrees N.

Since 2000 the ScoQ1 survey has caught very few cod in the southern region (south of 56 degrees N) especially west of 7 degrees west (see also Figure A9.3 in the stock annex). In 2011 however two hauls caught 10–20 fish in the Clyde area. The ScoGFS-WIBTS-Q4 and IRGFS-WIBTS-Q4 are not currently used in the VIa cod assessment but their suitability as tuning indices will be considered in preparation for the benchmark meeting in 2012.

Figures 3.2.5 and 3.2.6 show the log mean standardized 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. The extent to which this occurs seems little affected by the 2011 data points coming from a revised survey.

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.

Values for natural mortality (0.2 for all ages and years) and the 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 over and above values assumed in the assessment. A working document looking at the significance of seal predation to perceptions of the VIa cod stock was submitted to WGNSDS_08 and work is ongoing for incorporation into the VIa cod benchmark. Any increase in predation mortality would be incorporated into estimates of total mortality by the stock assessment model.

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.

3.2.3 Historical stock development

This update 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, alongside final run estimates for VIa cod from previous WGs. Standardized prediction errors at age from the update assessment run (which can be interpreted as residuals) are shown in Figure 3.2.9 (landings), Figure 3.2.10 (discards) and Figure 3.2.11 (ScoGFS-WIBTS-Q1). Errors within ±2 are considered reasonable. The prediction error for age 2 from the 2011 survey data initially fell significantly outside of ±2 and the data point was downweighted. Table 3.2.11 shows final parameter estimates have remained very consistent over the last five assessments.

It is important to note that the assessment is based on survey estimates of mortality with corresponding population abundance. Whereas the assumed natural mortality rate (M=0.2) is excluded from the estimates of 'fishing mortality', unallocated removals from the stock due to the fishery or other sources are not and are therefore also included in the estimates of 'fishing mortality' used in the forecast. The WG consider the mortality outputs from TSA not to represent F at age but rather estimated total mortality that cannot be accounted for by the standard value used for natural mortality. These mortality estimates are here referred to as 'Z-0.2'. For management purposes, however, this combined mortality would still need to fall below the level of F_{lim}, as higher levels of mortality over and above M are considered to have led to stock decline in the early 1980s.

Table 3.2.12 gives the TSA population numbers-at-age and Table 3.2.13 gives their associated standard errors. Estimated Z-0.2 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 3.2.12. The disparity between the estimated removals compared to the supplied commercial catch data is clear. Figure 3.2.13 shows the ratio between the estimated removals and observed catch. The disparity has reduced since the largest values in 2004 and 2005 but the lower limit of the confidence intervals on the estimated removals are still above the line showing a 1:1 ratio.

From Figure 3.2.12 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 1996 year class. The value for the 2009 year class is also higher than many since 2000. There has been a modest increase in SSB since 2007 and the estimate for 2011 is the highest since 2001. The value is still well below B_{lim} however. Despite a drop in the final year, mean Z-0.2 is above F_{lim} and comparable to values since 1995.

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 the runs terminating in 2006 and 2009 sit below the lower confidence limit. Higher levels of Z-0.2 from the run terminating in 2006 appear untypically high and fall outside the confidence limits for this metric. The confidence interval for mean Z-0.2 is wide, reflecting uncertainty in estimation of mean Z-0.2 when that estimation is based on the age structure present in survey data.

The TSA estimated stock–recruit relationship is shown in Figure 3.2.15. It includes the data point of the 1986 year class which from inspection of Figure 3.2.11 appears an

outlier.

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 (substituting Z-0.2 for F) unsustainable removals.

Comparison with last year's assessment

Compared to last year's assessment SSB in 2009 has been revised down from 5166 t to 5028 t while the estimate of mean Z-0.2 has remained constant at 0.89. The estimate of recruitment in 2009 is revised up from 10.4 million to 12.4 million. The estimate of SSB in 2010 from this update assessment is 6581 t with a s.e. of 838 t. The short-term forecast from last year's assessment predicted SSB in 2010 at 6230 t which is less than one s.e. difference from the update assessment. Figure 3.2.14 shows these revisions represent comparatively small retrospective adjustments.

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
2011	4122 (ScoGFS-WIBTS-Q1)	4122 (ScoGFS-WIBTS-Q1)
2012	7697 (Ricker)	5032 (GM 00-09)
2013		5032 (GM 00-09)

Three-year means of the Z-0.2 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 the Z-0.2 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 for two of the main trawl gear fleets in Area VIa are again 25% in 2011 compared to 2010. Consistent with last year the *status quo* Z-0.2 was reduced by 25% for the intermediate year in the forecast (2011). The management options table from this first run showed SSB to be below B_{lim} at the start of 2012. Following article 6, paragraph 2(a) of the cod management plan *status quo* Z-0.2 was reduced by a further 25% for 2012 with the aim of producing more representative detailed tables. This was again consistent with the procedure adopted last year.

Input data to the short-term projection is 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 3.2.17. Results from sensitivity analysis from this forecast are shown in Figure 3.2.18 and probability profiles in Figure 3.2.19. It is emphasized again that the outputs from the forecasting software include figures labelled as "H-cons" do not refer to the human consumption fishery but in the present application refer to all removals over and above the losses due to the assumed natural mortality rate of M=0.2. These values will include estimates of unallocated fishery removals that may be due to misreporting, or additional natural mortality not encompassed by the standard value of M=0.2. The WG recommends that these forecasts are not used to determine a future TAC using the procedure specified

in Article 7 of the long-term management plan for cod, as it is not possible to determine figures for unallocated fishery removals to deduct from the forecasted total removals to calculate the TAC for 2011.

Estimates of SSB corresponding to the different levels of the Z-0.2 mortality should, however, remain appropriate. From Table 3.2.18 it can be seen that an assumption of zero removals in 2012 give an estimate of SSB in 2013 between B_{lim} and B_{pa}. From Figure 3.2.19 the probability of SSB in 2013 being above Blim is approximately 0.15.

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.

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 Z-02 is higher than the median F_{crash} value for all three stock–recruit relationships tested.

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 3.2.## 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 3.2.## to 3.2.## 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 data points 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 3.2.27 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 3.2.24–26) 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}.

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 are discussed in Section 9.

3.2.7 Uncertainties and bias in assessment and forecast

Figure 3.2.20 shows a comparison of SSB, recruitment-at-age one and mean Z-0.2 (ages2–5) estimates produced by final run assessments between this year's assessment and assessments going back to 2001.

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.

Effort

Commercial effort data for Division VIa from the Scottish fleets is considered very uncertain and was not used in the assessment.

Discards

The current assessment model removes discard information for the same years for which landings data are removed. The increase in discards at ages one and two and additional ages of cod discarded since 2006 are not therefore able to influence the assessment. A new version of the model is now capable of fitting discard proportions across more ages and can be considered at the planned benchmark in 2012. To consider discards from 2006 requires commercial data (landings and discards) to be reintroduced from 2006.

Available discard estimates are calculated mainly from the Scottish sampling programme. The method used is to sample on a stratified basis then raise by some auxiliary variable to, initially, total strata discards, and ultimately international discards. These estimates are prone to bias. An alternative method of raising discard data using the same raw data, and which reduces estimation bias, is being applied and tested on data from both the Northern Shelf and North Sea regions before the resulting revised data are released to assessment working groups. Data using the new method was not available for this year's assessment.

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 current spatial aggregation of the 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 the ScoGFS-WIBTS-Q1 in 2008). This in turn can cause a 'noisy' set of indices that can lead to high prediction errors from TSA (residuals from other models) and downweighting of data points. The current weighting of strata (weighting by number of valid hauls) is also not consistent between years leading to further increase in the overall estimation of survey variance. Ways of compiling the historical survey data that can better incorporate extreme values, including new post stratification and strata weightings, are currently under investigation and are proposed for consideration at a scheduled benchmark in 2012.

The survey gear changed in 2011 to bring it in line with other surveys in the area so that these can be combined in future to provide a more robust and precise survey index. The opportunity was also taken to improve the survey design at this time: it is now random stratified with strata weighted by surface area. This only effects our perception of stock metrics in 2011 and does not influence the basis for the advice.

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 localized species to high exploitation and low population numbers are so far unknown to the working group. Estimates of high predation consumption of cod relative to total-stock biomass have raised concerns that natural mortality of cod at younger ages may be significantly greater than the standard value of 0.2. Also that it will have changed significantly over the period of the historical assessment.

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 or wholly based on survey data are poorly estimated and therefore noisy and sensitive to survey catchability. In addition, for VIa cod only one survey-series has been considered sufficiently long and self-consistent for use in assessment.

Natural mortality on cod at some or all ages is considered to have become greater than can be accommodated by the standard natural mortality figure of M=0.2. It is also possibly subject to a persistent upward trend. As a consequence, mortality outputs from TSA (or any model reliant on survey data) are not considered to represent a fishing mortality F at age for recent years in the time-series but rather estimates, (referred to here as 'Z-0.2'), of total mortality that cannot be accounted for by the standard value used for natural mortality. It is not possible to determine the proportion of the mortality caused by fishing and therefore not possible to partition F into landings and discard F. Until a better estimate of natural mortality can be determined short-term forecasts are only appropriate to considering the SSB corresponding to the different levels of the Z-0.2 mortality.

3.2.8 Recommendation for next benchmark

problem	solution	expertise necessary	suggested time
Misreporting of landings. Unknown level prevents adjustment of reported catch and inclusion in assessment.	To estimate misreporting due to area misreporting; analysis of VMS data in comparison to landings declarations to estimate the degree of area misreporting.	Requires someone familiar with VMS analysis (plus provision of trip specific landings declarations).	Uncertain. Suitable expert needs to be identified.
Bias in discard estimates	New discard raising methodology has been developed at Marine Scotland Science.		
Inappropriate modelling of discards within TSA model	Revision of TSA to allow fitting of discards at higher ages.	Requires someone familiar TSA routines.	New model available.

problem	solution	expertise necessary	suggested time
Variance and bias in survey index	Adoption of new aggregation methods to form final indices from haul by haul data, (combinations of new post stratification, weighting of strata and/or adoption of statistical approaches such as fitting of GAM or delta distribution models).	Work being undertaken as a Marine Scotland Science research project.	Project due for completion in 2011.
	Inclusion of additional surveys (ScoGFS-4Q and IRGFS-WIBTS-Q4). ScoGFS-WIBTS-Q4 indices to be formed in same manner as ScoGFS-WIBTS-Q1 after conclusion of above project.		Comparison with existing assessment setup (single survey) possible in 2011 (after conclusion of above project).
	Addition of new survey effort and/or revision of survey design.		Anglerfish survey records cod numbers at length, now has 5 years of data and cpue indices can be formed. Data from charter surveys in 2009 available. A random stratified design for the Scottish surveys was implemented in 2011.
Uncertainty in natural mortality (level and trend) because of unquantified predation from large and increasing seal population.	Revision of TSA to allow inclusion of different fleets, (this in turn allows estimates of age specific consumption of cod by seals to be input as if from an additional fleet).	Requires someone familiar with TSA routines.	Method for estimating age specific consumption of cod by seals presented at 2008 ICES ASC. Work to adjust TSA scheduled for 2011.
Possible trend in mean weight-at-age in landings	Compare mean weights-at-age with that from survey data. Apply F test to determine if fitted smooth significantly different from straight line with zero gradient.		Work possible in 2011.

3.2.9 Management considerations

The fishery is managed by a combination of TAC, 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 2010 has not been reflected in the latest estimate of Z-0.2.

Although the UK 'Buyers and Sellers' and Irish 'Sales Notes' legislation is considered to have reduced underreporting from 2006, discard data shows 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 were four in 2008, 17 in 2009 and 17 in 2010, representing 27, 12 and 10% of total RTCs in each year. RTCs are determined by lpue, based on fine scale VMS data and daily logbook records and also by on-board inspections. The small number of RTCs west of Scotland result from few instances of high lpue in the area. Early indications are that the scheme has not so far been as effective as in the North Sea with discard rates remaining high in Area VIa. In 2010 discards as a percentage of catch were 100% for age 1 and 97% and 75% for ages 2 and 3 (although discards-at-age 4 fell to 42% compared to over 80% in 2009). There are also anecdotal reports of continued area misreporting.

Mortality estimates arising from an assessment heavily or wholly based on survey data are poorly estimated and therefore noisy and sensitive to survey catchability. In contrast, historical trends in spawning biomass and recruitment appear to be robust measures of stock dynamics.

Population estimates using the ScoGFS-WIBTS-Q1 survey data indicated 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 and that work is done to estimate area misreporting (comparing declared landings to VMS data).

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-SGMOS-10-05) assessing effort and catch of fishing regimes subject to fishing effort limitations shows trawl gear vessels targeting finfish (TR1 gear) to take roughly 80–85%% of cod catch and the *Nephrops* fleet (TR2 gear) to take 15–20% 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 3.2.21 effort is restricted to a lesser degree. Figure 3.2.21 also shows locations of fishing activity using TR1 gear (from VMS data) linked to cod landings. It can be seen a large proportion of the effort falls outside the cod management area. The landings composition restrictions do not restrict discards.

Article 7 (paragraph 1) of the current management plan requires TACs to be calculated after removal of quantities of discards and fish corresponding to other sources of cod mortality caused by fishing. The current assessment of VIa cod is considered to estimate a mortality that is a combination of mortality from fishing and natural mortality not accounted for by the standard long-term input value (termed Z-0.2). As such mortality from landings, discards and other causes due to fishing cannot be defined. For management purposes this combined Z-0.2 mortality would still need to fall below the level of F_{lim}, as higher levels of mortality over and above M are considered to have led to stock decline.

A report by the Sea Mammal Research unit (SMRU, 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 greater than can be accommodated by the standard value of natural mortality used for gadoid species in ICES Division VIa. It has not been possible using an update assessment to quantify the level of mortality caused by seal predation. This is proposed for a benchmark assessment, (see Section 3.2.9).

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*
Belgium								0
Denmark								
Faroe Islands		2	0	0.8	12	1		0.2
France	172	91	107	100.7	92	82	74	60.3
Germany	+			2	2	1	0	0
Ireland	120	34	27.9	18	70	58.2	24.4	48.7
Netherlands	-						0	
Norway	45	10	17	30	30	65	18	20.7
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
Total landings	1,298	596	419.9	483.6	487	445.2	234.4	248.5

*** Preliminary.**

Table 3.2.2. Cod in Division VIa. Landings, discards and catch estimates 1978–2009, as used by the WG. Values are totals for fish over the ages 1 to 7+.

Year	Landings	Discards	Catch
1978	13521	3678	17199
1979	16087	54	16141
1980	17879	996	18875
1981	23866	520	24386
1982	21510	1652	23162
1983	21305	2026	23331
1984	21271	635	21906
1985	18608	8812	27420
1986	11820	1201	13022
1987	18975	8767	27742
1988	20413	1217	21629
1989	17171	2833	20004
1990	12176	326	12503
1991	10926	917	11843
1992	9086	2897	11983
1993	10315	192	10507
1994	8929	186	9115
1995	9438	257	9696
1996	9425	87	9513
1997	7033	354	7387
1998	5714	423	6137
1999	4201	98	4298
2000	2977	607	3584
2001	2347	224	2571
2002	2242	169	2412
2003	1241	49	1291
2004	540	75	615
2005	479	57	535
2006	463	478	940
2007	525	2104	2629
2008	451	909	1360
2009	222	1401	1623
2010	239	1183	1422

Table 3.2.3. Cod in Division VIa. Survey data made available to the WG. Data used in update run are highlighted in bold. For ScoGFS-WIBTS-Q1, numbers are standardized to catch-rate per 10 hours.

ScoGFS-WIBTS-Q1	Scottish west coast groundfish survey							
1985	2011							
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
10	0.6	33.9	20.8	0.9	1.0	1.0	0	2011

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. For ScoGFS-WIBTS-Q4, numbers are standardized to catch-rate per 10 hours. "+" indicates value less than 0.5 after standardizing.

ScoGFS–WIBTS–Q4		Quarter 4 Scottish groundfish 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. For IRGFS-WIBTS-Q4, effort is given as minutes towed, numbers are in units. Values for 2007 are revised compared to last year's assessment

IRGFS-WIBTS-Q4	Irish West Coast groundfish					
2003	2010					
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

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	17	91	72	21	13	2	1
2007	5	165	62	33	3	3	2
2008	0.07	27	88	16	10	1	2
2009	2	10	9	30	4	1	0.1
2010	0	19	33	15	13	2	0.5

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	0.656	1.169	2.236	3.822	6.172	7.796	11.1
2007	0.476	0.976	2.512	4.285	6.491	7.733	8.810
2008	0.557	1.195	2.943	4.775	6.329	7.957	8.471
2009	1.048	1.960	2.916	4.743	5.853	8.171	8.646
2010	n/a	1.385	2.284	3.797	5.029	5.605	7.974

Table 3.2.6. Cod in Division VIa. Discard dataset from Scottish and Irish sampling programmes, ages 1–7, years 1978–2008. Data from 1978–2001 raised from Scottish sampling only; later data raised from Scottish sampling and Irish sampling when available (2004 and 2005 to date).

A. Discards–at–age (thousands).

	Age						
Year	1	2	3	4	5	6	7
1978	8904	1203	0	0	0	0	0
1979	11	119	0	0	0	0	0
1980	2758	0	0	0	0	0	0
1981	289	1475	0	0	0	0	0
1982	5264	2	0	0	0	0	0
1983	7371	1005	0	0	0	0	0
1984	2117	10	0	0	0	0	0
1985	43508	3122	0	0	0	0	0
1986	4483	10	0	0	0	0	0
1987	52582	159	0	0	0	0	0
1988	714	3256	0	0	0	0	0
1989	8443	25	0	0	0	0	0
1990	1835	158	0	0	0	0	0
1991	3255	319	0	0	0	0	0
1992	12498	143	2	0	0	0	0
1993	595	51	0	0	0	0	0
1994	773	2	0	0	0	0	0
1995	1111	126	0	0	0	0	0
1996	233	86	0	0	0	0	0
1997	1074	27	0	0	0	0	0
1998	472	837	3	0	0	0	0
1999	283	16	0	0	0	0	0
2000	2081	53	0	0	0	0	0
2001	216	373	0	0	0	0	0
2002	508	32	0	0	0	0	0
2003	77	38	8	0	0	0	0
2004	232	21	0	0	0	0	0
2005	108	20	0	0	0	0	0
2006	1242	48	25	2	3	1	0.1
2007	627	1651	56	42	3	3	0
2008	89	133	368	1	0	0	0
2009	883	219	160	138	0	7	0
2010	531	592	99	11	5	0	0

Table 3.2.7. Cod in Division VIa. Discard dataset from Scottish and Irish sampling programmes, ages 1–7, years 1978–2006. Data from 1978–2001 raised from Scottish sampling only; later data raised from Scottish sampling and Irish sampling when available (2004 and 2005 to date).

B. 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	0.259	1.291	2.649	3.499	6.24	5.581	11.122
2007	0.198	0.940	3.016	4.453	5.018	10.627	0
2008	0.220	0.976	2.046	4.047	7.937	0	0
2009	0.261	1.312	2.248	3.324	0	6.448	0
2010	0.252	1.312	2.268	3.218	3.245	0	0

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

	Age						
Year	1	2	3	4	5	6	7+
1978	9627	2965	999	695	286	97	75
1979	940	1731	2125	682	342	134	69
1980	3953	3294	2001	796	191	77	37
1981	749	8491	3220	904	182	29	20
1982	7091	1676	3206	1189	367	111	33
1983	9706	5520	1118	1400	468	148	60
1984	4260	2371	2564	448	555	185	59
1985	44863	8191	1269	1091	140	167	79
1986	5275	1495	2055	411	191	40	30
1987	60456	4996	988	905	137	56	26
1988	1722	11592	2193	278	210	39	20
1989	10459	1107	3858	709	113	69	33
1990	2348	4182	432	924	170	23	11
1991	4773	2047	1805	188	266	70	23
1992	13905	2011	577	720	69	58	24
1993	923	3647	1050	131	183	24	36
1994	1715	1209	1545	280	56	51	20
1995	1864	2877	700	630	70	15	11
1996	574	2417	1210	247	204	31	13
1997	2488	1094	989	281	66	62	7
1998	783	4155	296	174	57	16	9
1999	415	900	1047	64	48	24	9
2000	2846	585	211	231	15	12	13
2001	312	1614	155	63	52	3	4
2002	845	372	522	41	13	14	4
2003	139	554	93	107	6	2	1
2004	267	113	85	11	26	2	1
2005	139	141	43	37	7	6	0.5
2006	1259	139	97	23	15	2	1
2007	632	1816	118	75	5	7	2
2008	89	160	456	18	10	1	2
2009	885	229	168	168	4	8	0.1
2010	531	611	131	26	18	2	0.5

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	0.390	1.020	2.839	4.923	7.518	9.314	10.328
1982	0.411	1.467	2.737	4.749	6.113	7.227	9.856
1983	0.310	1.103	2.995	4.398	6.305	8.084	9.744
1984	0.518	1.398	3.168	5.375	6.601	8.606	10.350
1985	0.191	0.864	2.597	4.892	6.872	8.344	9.766
1986	0.334	1.205	2.785	4.655	6.336	8.283	9.441
1987	0.213	1.282	2.783	4.574	6.161	7.989	10.062
1988	0.595	0.929	2.886	5.145	6.993	8.204	9.803
1989	0.404	1.282	2.425	4.737	7.027	7.520	9.594
1990	0.237	1.244	2.815	4.314	7.021	9.027	11.671
1991	0.371	0.979	2.618	4.346	6.475	8.134	10.076
1992	0.267	1.274	2.606	4.268	6.190	7.844	10.598
1993	0.430	1.309	2.940	4.646	6.244	7.802	8.409
1994	0.462	1.291	2.899	4.710	6.389	8.423	8.409
1995	0.365	1.109	2.857	4.956	6.771	8.539	9.505
1996	0.487	1.191	2.738	5.056	6.892	8.088	10.759
1997	0.477	1.188	2.571	4.805	6.952	7.821	9.630
1998	0.379	0.921	2.248	4.506	6.104	8.017	9.612
1999	0.420	1.025	2.194	4.688	6.486	8.252	9.439
2000	0.390	1.186	2.457	4.126	6.666	7.917	8.392
2001	0.372	0.856	2.679	4.568	5.860	7.741	9.386
2002	0.424	1.130	2.330	4.841	6.175	7.192	9.548
2003	0.450	0.986	2.15	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	0.264	1.211	2.341	3.797	6.184	7.031	11.103
2007	0.200	0.943	2.752	4.380	5.729	9.166	8.810
2008	0.220	1.013	2.219	4.731	6.371	7.957	8.471
2009	0.262	1.340	2.283	3.577	5.853	6.654	8.646
2010	0.252	1.314	2.272	3.555	4.582	5.605	7.974

Table 3.2.10. Cod 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 runs.
Multipliers on variance matrices of measurements.	Blandings(a) = 2 for ages 6, 7+ Bsurvey(a) = 2 for age 1, 5, 6	Allows extra measurement variability for poorly sampled ages.
Multipliers on variances for fishing mortality estimates.	H(1) = 4	Allows for more variable fishing mortalities for age 1 fish.
Downweighting of particular data points (implemented by multiplying the relevant q by 9)	Landings: age 2 in 1981 and 1987, age 7 in 1989. Discards: age 1 in 1985 and 1992, age 2 in 1998. Survey: age 1 in 2000, age 2 in 1993 and 2011, age 3 in 2008 (large haul near 4W line), age 4 in 2001, age 5 in 2001, age 6 in 1995 and 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 and 2 are modelled independently.	
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 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	Φ(1)	Survey selectivity at age a	0.83	0.33	0.47	0.6275	0.5425	0.4746	0.4809	0.4791	0.4530
	Φ(2)		4.41	1.98	3.19	3.5857	3.7292	3.2855	3.3317	3.3463	3.3290
	Φ(4)		18.28	10.65	14.92	15.9096	14.1997	14.0472	13.7891	13.6507	13.9381
Fishing mortality standard deviations	σF	Transitory changes in overall fishing mortality	0.10	0.04	0.07	0.0947	0.0741	0.0846	0.0850	0.0834	0.0819
	σU	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
	σV	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
	σY	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	σΩ	Transitory changes in survey catchability	0.24	0.00	0.00	0.1224	0.2374	0.2276	0.2498	0.2275	0.1990
	σβ	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)

Parameter	Notation	Description	2002 WG	2003 WG	2004 WG Run 3	2006 WG	2007 WG	2008 WG	2009 WG	2010 WG	2011 WG
Measurement standard deviations	σlandings	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
	σdiscards	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
	σsurvey	Standard error of survey data	0.36	0.56	0.35	0.3887	0.364	0.3875	0.3930	0.3926	0.3999
Discards	σlogit p	Transitory trends in discarding	n/a	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	σpersistent	Persistent trends in discarding	n/a	0.16	0.68	0.5735	0.6742	0.7032	0.6959	0.7112	0.7429
Recruitment	η1	Ricker parameter (slope at the origin)	0.82	0.62	0.80	0.6584	0.7882	0.9634	0.8913	1.0233	1.0986
	η2	Ricker parameter (curve dome occurs at 1/η2)	0.03	0.003	0.01	0.0049	0.0124	0.0203	0.0177	0.0223	0.0251
	cvrec	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	21.2379	9.5054	2.5814	1.4206	0.5313	0.1631	0.1316
1979	28.8208	10.2923	4.2324	1.1283	0.5317	0.1890	0.1031
1980	31.3080	13.7790	4.3650	1.3568	0.2825	0.1227	0.0634
1981	10.6823	16.2539	6.1773	1.8109	0.4963	0.0996	0.0667
1982	26.0569	5.1030	6.8296	2.3944	0.6771	0.1895	0.0594
1983	15.5670	12.0287	2.1643	2.5968	0.8559	0.2382	0.0879
1984	24.2650	6.0582	4.5391	0.7583	0.8458	0.2773	0.1012
1985	12.5220	12.0384	2.2196	1.4580	0.2276	0.2281	0.1094
1986	19.4670	4.2415	3.8831	0.6918	0.3265	0.0627	0.0779
1987	61.4969	9.8610	1.7572	1.3687	0.2272	0.1032	0.0460
1988	6.1191	16.7088	3.6519	0.5521	0.3565	0.0662	0.0422
1989	20.0814	2.4792	5.4715	1.1637	0.1861	0.1082	0.0346
1990	6.4821	8.7792	0.9434	1.4903	0.3408	0.0555	0.0408
1991	11.3121	2.9437	3.4386	0.3625	0.4842	0.1213	0.0349
1992	17.6739	4.5555	0.9729	1.1375	0.1237	0.1493	0.0482
1993	7.3395	8.1848	1.8327	0.3065	0.3435	0.0417	0.0671
1994	15.8467	3.3418	3.2962	0.6062	0.1097	0.1149	0.0372
1995	13.1793	7.7974	1.5014	1.2945	0.2305	0.0410	0.0574
1996	4.9971	6.0632	3.1608	0.5353	0.4525	0.0799	0.0340
1997	18.4078	2.0707	2.3605	1.0589	0.1789	0.1525	0.0379
1998	8.7956	8.1808	0.7781	0.7874	0.3420	0.0584	0.0622
1999	5.0068	3.8213	3.0777	0.2466	0.2509	0.1084	0.0384
2000	10.5275	2.1352	1.4733	1.0167	0.0791	0.0806	0.0473
2001	3.2356	4.7867	0.8535	0.5128	0.3464	0.0268	0.0433
2002	8.8398	1.3174	1.8227	0.2798	0.1649	0.1145	0.0227
2003	1.4542	3.8705	0.4900	0.5905	0.0894	0.0529	0.0440
2004	3.7698	0.4646	1.4036	0.1551	0.1817	0.0271	0.0299
2005	5.2773	1.3162	0.1266	0.4191	0.0445	0.0542	0.0170
2006	11.5938	2.2641	0.4393	0.0273	0.1260	0.0131	0.0213
2007	2.6895	5.1914	0.8979	0.1502	0.0088	0.0421	0.0115
2008	3.0811	1.2439	2.1318	0.3204	0.0514	0.0030	0.0184
2009	12.4446	1.3334	0.4748	0.6772	0.0995	0.0158	0.0067
2010	8.9661	5.5570	0.5156	0.1568	0.2149	0.0315	0.0072
2011	4.1218	4.1944	2.2893	0.1789	0.0533	0.0730	0.0131
2012	7.6974	1.8756	1.6829	0.7932	0.0593	0.0178	0.0287
GM(78–10)	10.3157	4.5652	1.7597	0.6275	0.2159	0.0709	0.0406

***2011 and 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	2.9806	0.5647	0.1235	0.0837	0.0495	0.0288	0.0211
1979	2.2027	0.5782	0.1761	0.0599	0.0432	0.0292	0.0183
1980	2.609	0.8087	0.2338	0.0977	0.0307	0.0258	0.0189
1981	1.1784	1.2426	0.3429	0.1017	0.0372	0.0134	0.0123
1982	2.2157	0.3687	0.3871	0.137	0.0373	0.0143	0.0045
1983	1.5773	0.9268	0.1152	0.1651	0.0648	0.024	0.0087
1984	1.8004	0.5459	0.2894	0.0511	0.071	0.0348	0.0133
1985	1.5175	0.8142	0.1503	0.1149	0.023	0.037	0.0185
1986	1.5104	0.3257	0.2373	0.052	0.0406	0.0111	0.0171
1987	10.6337	0.6544	0.1013	0.0963	0.0216	0.0186	0.0089
1988	1.1519	1.6205	0.1948	0.0378	0.0355	0.0107	0.0086
1989	2.1079	0.1812	0.4761	0.0763	0.0141	0.0155	0.0063
1990	1.1802	0.4893	0.0527	0.1318	0.0284	0.007	0.0066
1991	1.6492	0.221	0.1976	0.0198	0.0424	0.013	0.0039
1992	1.7576	0.3241	0.0707	0.0771	0.0088	0.0191	0.0063
1993	1.0557	0.5247	0.1269	0.0256	0.0328	0.0047	0.0083
1994	3.0578	0.3615	0.2971	0.0678	0.0115	0.0174	0.0049
1995	3.1557	1.5772	0.226	0.1916	0.0403	0.0073	0.0106
1996	2.1082	1.3872	0.6568	0.0946	0.08	0.0166	0.0068
1997	4.2723	0.8139	0.5595	0.2506	0.037	0.0323	0.0087
1998	2.6301	1.879	0.3125	0.2045	0.0939	0.015	0.016
1999	1.9422	1.1024	0.7533	0.1077	0.0746	0.0357	0.0113
2000	3.0407	0.7341	0.4297	0.268	0.0368	0.0275	0.0162
2001	1.5202	1.2523	0.2752	0.1532	0.093	0.0127	0.0139
2002	2.529	0.5224	0.4925	0.0951	0.0553	0.0342	0.0081
2003	1.3062	1.0363	0.1896	0.1752	0.0332	0.0201	0.0148
2004	1.8239	0.3726	0.3937	0.0631	0.0623	0.0121	0.0111
2005	1.2259	0.5898	0.121	0.1328	0.0216	0.0226	0.0071
2006	1.7159	0.4133	0.1992	0.036	0.0441	0.0075	0.0096
2007	0.8534	0.6993	0.1534	0.0638	0.0115	0.0151	0.0049
2008	1.0532	0.3179	0.3268	0.053	0.0213	0.0039	0.0064
2009	2.0335	0.411	0.1221	0.1375	0.0218	0.0075	0.0029
2010	2.4167	0.8552	0.1557	0.042	0.0498	0.0086	0.003
2011	2.9595	1.174	0.3752	0.0559	0.0145	0.0186	0.0039
2012	4.8677	1.3691	0.5038	0.1639	0.0199	0.0055	0.0084
GM(78–10)	1.9395	0.6323	0.2248	0.0878	0.0355	0.0156	0.0090

***2011 and 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	0.5331	0.6128	0.6291	0.7657	0.793	0.7928	0.7887
1979	0.5914	0.7171	0.8649	1.0174	1.001	0.9881	0.9722
1980	0.4746	0.6373	0.6809	0.7906	0.8144	0.794	0.7855
1981	0.49	0.6619	0.7488	0.7527	0.6852	0.7299	0.7385
1982	0.6127	0.6608	0.7602	0.8259	0.8438	0.839	0.8447
1983	0.6874	0.7491	0.8397	0.9069	0.9136	0.9492	0.9605
1984	0.5772	0.7524	0.8832	0.9634	1.0276	0.9864	0.9655
1985	0.7983	0.9064	0.9321	1.1488	1.0362	1.1147	1.0998
1986	0.5108	0.676	0.819	0.8973	0.8971	0.893	0.8683
1987	0.8048	0.8028	0.9293	1.0754	1.0088	1.0133	1.0138
1988	0.6477	0.7746	0.9294	0.887	0.964	0.9426	0.9289
1989	0.6313	0.7595	0.9749	1.0084	1.0012	1.0234	1.0086
1990	0.5734	0.7309	0.7554	0.9064	0.833	0.8172	0.8065
1991	0.688	0.855	0.8967	0.8756	0.9586	0.9669	0.9811
1992	0.5693	0.7106	0.9148	0.983	0.8885	0.8746	0.894
1993	0.5892	0.7095	0.8998	0.8272	0.892	0.8785	0.8711
1994	0.5092	0.5958	0.7332	0.7662	0.7833	0.7701	0.784
1995	0.5767	0.7026	0.831	0.8513	0.8599	0.8613	0.8621
1996	0.617	0.738	0.8857	0.8962	0.8877	0.9004	0.9013
1997	0.6099	0.7481	0.891	0.9222	0.9139	0.9116	0.9152
1998	0.6253	0.7638	0.9114	0.9342	0.9362	0.9334	0.9332
1999	0.6259	0.7515	0.9026	0.9295	0.9285	0.927	0.9261
2000	0.5888	0.7189	0.8555	0.8738	0.8818	0.8838	0.8832
2001	0.6301	0.7532	0.8992	0.9253	0.9091	0.9209	0.9216
2002	0.6206	0.7555	0.9098	0.9312	0.9297	0.9266	0.9296
2003	0.655	0.784	0.9287	0.9608	0.9628	0.9577	0.9581
2004	0.6905	0.7995	0.9664	0.9922	0.9853	0.987	0.9853
2005	0.6461	0.8072	0.9679	0.9951	0.9934	0.9883	0.988
2006	0.541	0.7129	0.8747	0.9062	0.8955	0.8978	0.8968
2007	0.5842	0.6904	0.8126	0.8733	0.8759	0.8693	0.8701
2008	0.6336	0.7669	0.9411	0.9634	0.9648	0.9623	0.9608
2009	0.5769	0.7498	0.9075	0.9483	0.9479	0.9395	0.9383
2010	0.5543	0.6811	0.8605	0.8752	0.8783	0.8803	0.8785
2011	0.5874	0.7132	0.86	0.9042	0.8978	0.899	0.8994
2012	0.5908	0.7214	0.874	0.908	0.908	0.908	0.908
GM(78–10)	0.6038	0.7317	0.8606	0.9105	0.9086	0.9093	0.9077

***Estimates for 2011 and 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+
1978	0.1982	0.1054	0.0648	0.0641	0.0768	0.0905	0.0917
1979	0.2052	0.1069	0.0591	0.0564	0.0681	0.086	0.089
1980	0.2008	0.1047	0.0636	0.0639	0.0684	0.0868	0.09
1981	0.2078	0.0918	0.0608	0.0629	0.0741	0.0895	0.0926
1982	0.202	0.0964	0.0639	0.0654	0.079	0.0903	0.0973
1983	0.1754	0.0868	0.0602	0.0625	0.0742	0.0875	0.0921
1984	0.1988	0.0967	0.0623	0.0633	0.0706	0.0869	0.0919
1985	0.1844	0.0791	0.0632	0.0593	0.0741	0.0837	0.0898
1986	0.2101	0.0917	0.0638	0.066	0.0734	0.0918	0.0901
1987	0.1796	0.0908	0.0597	0.0598	0.0778	0.0884	0.0937
1988	0.2076	0.0766	0.0581	0.0651	0.0711	0.0934	0.0947
1989	0.1896	0.0844	0.0647	0.061	0.0732	0.085	0.0955
1990	0.2035	0.071	0.0647	0.0658	0.0742	0.0901	0.092
1991	0.1971	0.069	0.0617	0.064	0.0704	0.0871	0.0944
1992	0.1951	0.0779	0.0645	0.0657	0.0797	0.0881	0.0954
1993	0.208	0.0842	0.076	0.0785	0.0879	0.1003	0.0984
1994	0.2168	0.1206	0.1135	0.1169	0.1237	0.1244	0.1248
1995	0.2339	0.1439	0.1394	0.1396	0.1403	0.141	0.1411
1996	0.2353	0.1446	0.1399	0.1401	0.1406	0.1414	0.1414
1997	0.2312	0.1474	0.1416	0.1412	0.1418	0.1426	0.1426
1998	0.2354	0.1461	0.1433	0.1418	0.1423	0.1431	0.1431
1999	0.2366	0.1492	0.1435	0.1439	0.1436	0.1444	0.1444
2000	0.2366	0.151	0.1466	0.1453	0.1459	0.1459	0.146
2001	0.2358	0.1487	0.1448	0.1431	0.1438	0.1445	0.1446
2002	0.2338	0.1505	0.1442	0.144	0.1442	0.1449	0.145
2003	0.2362	0.1487	0.1465	0.1439	0.1445	0.1452	0.1453
2004	0.2296	0.1511	0.1441	0.1439	0.1443	0.1451	0.1451
2005	0.2377	0.1524	0.1486	0.1458	0.1465	0.1471	0.1472
2006	0.2392	0.1549	0.15	0.1485	0.1482	0.1489	0.149
2007	0.2368	0.1519	0.1483	0.1475	0.1478	0.148	0.1481
2008	0.2398	0.1535	0.1455	0.1454	0.1464	0.147	0.1471
2009	0.2401	0.1548	0.1493	0.1471	0.1478	0.1487	0.1488
2010	0.2436	0.1549	0.1506	0.1499	0.1496	0.1504	0.1506
2011	0.2466	0.1599	0.1558	0.154	0.154	0.154	0.1541
2012	0.2473	0.1609	0.1568	0.155	0.155	0.155	0.155
GM(78–10)	0.2160	0.1149	0.0962	0.0966	0.1044	0.1141	0.1166

***Estimates for 2011 and 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 Z-0.2 (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
1978	13.5205	13.2804	0.5792	3.6808	3.479	0.8787	17.2013	17.5665	1.2281	0.7001	0.032	26.159	0.7598	39.9728	1.5533	21.2379	2.9806
1979	16.0887	15.8363	0.6526	0.0541	4.3856	0.7941	16.1427	27.4287	2.1024	0.9001	0.0365	28.6559	0.7861	56.6294	1.99	28.8208	2.2027
1980	17.8789	17.4229	0.7937	0.9958	3.5779	0.8554	18.8747	24.3403	1.7351	0.7308	0.0328	31.9817	1.0949	56.7011	2.0364	31.308	2.609
1981	23.8646	22.0777	1.3705	0.5198	0.9691	0.3056	24.3843	24.1054	1.469	0.7121	0.0309	37.9663	1.2613	52.5474	1.8668	10.6823	1.1784
1982	21.5108	23.3391	1.0284	1.6539	2.4482	0.7641	23.1647	26.0074	1.5518	0.7727	0.0355	37.432	1.194	54.3604	1.7277	26.0569	2.2157
1983	21.3052	20.968	0.9205	2.0195	1.6501	0.4799	23.3247	22.8087	1.2666	0.8523	0.0353	32.0726	1.0791	44.1671	1.551	15.567	1.5773
1984	21.2717	19.8097	0.9667	0.6355	2.6718	0.6762	21.9071	24.5075	1.6022	0.9067	0.0389	29.8634	1.1393	48.5059	1.828	24.265	1.8004
1985	18.6071	17.6954	0.8028	8.8246	1.3061	0.3651	27.4317	17.3967	1.0228	1.0059	0.0404	22.0341	0.8878	30.2328	1.18	12.522	1.5175
1986	11.8201	11.6098	0.6343	1.1998	1.7837	0.4298	13.0199	13.786	0.9082	0.8223	0.0363	18.5027	0.7459	28.9634	1.0749	19.467	1.5104
1987	18.9705	18.1948	0.9561	8.7876	4.0576	1.4857	27.7581	21.1777	2.2156	0.9541	0.0409	19.7267	0.7274	39.611	2.5822	61.4969	10.6337
1988	20.4133	18.572	1.2918	1.133	0.8486	0.3025	21.5462	18.6358	1.3983	0.8888	0.0354	23.4299	1.0147	35.9977	1.871	6.1191	1.1519
1989	17.1693	15.0977	1.0157	2.818	2.2638	0.696	19.9873	17.2997	1.3621	0.936	0.039	21.0287	1.106	32.519	1.5939	20.0814	2.1079
1990	12.1755	11.9297	0.6227	0.3141	0.3836	0.1383	12.4896	12.3662	0.7411	0.8064	0.0332	17.761	0.7092	24.9112	0.9558	6.4821	1.1802
1991	10.9267	10.8487	0.5208	0.9095	0.9296	0.3376	11.8362	11.7264	0.7693	0.8965	0.0349	15.2891	0.5737	22.1251	0.9319	11.3121	1.6492
1992	9.0862	8.9356	0.4241	2.9024	1.4258	0.3994	11.9886	10.0989	0.6554	0.8742	0.0386	12.5012	0.4987	20.3642	0.8276	17.6739	1.7576
1993	10.3142	10.4311	0.4552	0.1846	0.7797	0.245	10.4988	11.5943	0.657	0.8321	0.0468	14.6636	0.6293	23.7129	1.0804	7.3395	1.0557
1994	8.9279	9.1759	0.4413	0.1863	1.2052	0.4053	9.1142	11.3814	0.9003	0.7196	0.0677	15.2964	1.0868	26.0236	1.9976	15.8467	3.0578
1995	9.4385	11.2864	1.7122	0.258	0.9649	0.3568	9.6965	12.8403	1.952	0.8112	0.0946	17.0562	1.9484	26.6266	3.0126	13.1793	3.1557
1996	9.4267	11.9326	2.0208	0.086	0.4722	0.2539	9.5127	12.8761	2.2067	0.8519	0.0994	18.0363	2.3795	25.1532	3.3717	4.9971	2.1082
1997	7.0336	9.4928	1.8904	0.3537	2.1116	0.8525	7.3872	12.5115	2.3177	0.8688	0.1026	14.3873	2.2376	25.1932	3.5614	18.4078	4.2723
1998	5.7139	9.0563	1.8471	0.4175	0.8192	0.3824	6.1314	9.8199	1.8636	0.8864	0.1047	12.1244	1.9084	19.3179	2.8953	8.7956	2.6301
1999	4.201	7.9745	1.6657	0.0879	0.5649	0.3156	4.2889	8.7386	1.7753	0.878	0.1049	11.8871	2.0373	16.8186	2.7655	5.0068	1.9422
2000	2.9771	6.6439	1.528	0.6049	1.0424	0.5101	3.582	7.8642	1.5924	0.8325	0.1011	10.1864	1.7995	16.0125	2.5881	10.5275	3.0407
2001	2.347	6.2979	1.3103	0.2093	0.3501	0.2354	2.5563	6.5083	1.3165	0.8717	0.1034	9.0826	1.476	12.5743	2.0587	3.2356	1.5202
2002	2.2426	5.3044	1.3305	0.1662	0.8735	0.4461	2.4089	6.5475	1.4003	0.8816	0.1048	7.8395	1.42	12.8998	2.1908	8.8398	2.529
2003	1.2411	4.6116	1.059	0.0458	0.2148	0.2265	1.2869	4.8505	1.1256	0.9091	0.1079	6.537	1.1676	9.1697	1.7782	1.4542	1.3062
2004	0.5402	3.4653	0.9232	0.0718	0.3848	0.2734	0.612	3.8413	0.9753	0.9359	0.1104	5.163	1.0656	6.9889	1.4902	3.7698	1.8239
2005	0.5114	2.6409	0.9439	0.0406	0.5757	0.3046	0.552	3.2605	0.8544	0.9409	0.1133	3.5073	0.8567	6.3181	1.2993	5.2773	1.2259
2006	0.4545	2.7638	1.154	0.4777	1.0551	0.5226	0.9323	3.6362	0.7187	0.8473	0.1037	3.4707	0.6769	7.9956	1.0852	11.5938	1.7159
2007	0.5242	4.0093	0.7609	2.0833	0.319	0.3798	2.6076	4.3584	0.6919	0.8131	0.0978	5.8665	0.7036	9.1018	1.0237	2.6895	0.8534
2008	0.4501	5.4789	0.9145	0.9084	0.2832	0.1865	1.3585	4.7181	0.7325	0.909	0.1075	6.7466	0.8085	8.6926	1.0276	3.0811	1.0532
2009	0.222	4.993	2.1667	1.3803	1.155	0.605	1.6023	4.5546	0.7755	0.8884	0.1068	5.0282	0.7467	9.3028	1.1629	12.4446	2.0335
2010	0.239	4.922	1.0294	1.1834	0.9466	0.7285	1.4224	5.7613	0.9261	0.8238	0.1002	6.5809	0.838	12.51	1.5387	8.9661	2.4167
2011	NA	7.1687	1.4178	NA	0.4907	0.5307	NA	6.4274	1.1371	0.8438	0.1066	8.7198	1.2484	12.9142	2.077	4.1218	2.9595
2012	NA	6.2827	1.6807	NA	0.7151	0.5711	NA	5.9877	1.4149	0.8528	0.1084	8.2887	1.7131	11.8063	2.7807	7.6974	4.8677
Min	0.2220	2.6409	0.4241	0.0406	0.2148	0.1383	0.5520	3.2605	0.6554	0.7001	0.0309	3.4707	0.4987	6.3181	0.8276	1.4542	0.8534
GM	4.9184	9.3715	0.9841	0.5467	1.0386	0.4269	6.6491	10.6964	1.2015	0.8534	0.0618	13.5835	1.0391	21.5023	1.6675	10.3157	1.9395
AM	9.7398	11.0939	1.0828	1.3695	1.4030	0.4890	11.1093	12.8762	1.2973	0.8564	0.0702	16.6019	1.1323	26.1218	1.8030	13.8953	2.2368
Max	23.8646	23.3391	2.1667	8.8246	4.3856	1.4857	27.7581	27.4287	2.3177	1.0059	0.1133	37.9663	2.3795	56.7011	3.5614	61.4969	10.6337

*** Estimates for 2011 and 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. Note: Text is presented as it was output from WGFRANSW but data referred to as that for the human consumption fishery should be regarded as that for removals in addition to the assumed value of natural mortality.

Label	Value	CV	Label	Value	CV
Number-at-age			Weight in the stock		
N1	4122	0.72	WS1	0.24	0.09
N2	4194	0.28	WS2	1.22	0.15
N3	2289	0.16	WS3	2.26	0.01
N4	179	0.31	WS4	3.95	0.17
N5	53	0.27	WS5	5.60	0.16
N6	73	0.26	WS6	6.74	0.17
N7	13	0.30	WS7	8.36	0.04
H.cons selectivity			Weight in the HC catch		
sH1	0.59	0.07	WH1	0.24	0.09
sH2	0.73	0.06	WH2	1.22	0.15
sH3	0.90	0.04	WH3	2.26	0.01
sH4	0.93	0.05	WH4	3.95	0.17
sH5	0.93	0.05	WH5	5.60	0.16
sH6	0.93	0.05	WH6	6.74	0.17
sH7	0.93	0.05	WH7	8.36	0.04
Natural mortality			Proportion mature		
M1	0.20	0.10	MT1	0.00	0.10
M2	0.20	0.10	MT2	0.52	0.10
M3	0.20	0.10	MT3	0.86	0.10
M4	0.20	0.10	MT4	1.00	0.10
M5	0.20	0.10	MT5	1.00	0.00
M6	0.20	0.10	MT6	1.00	0.00
M7	0.20	0.10	MT7	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF11	0.75	0.05	K11	1.00	0.10
HF12	0.56	0.05	K12	1.00	0.10
HF13	1.00	0.05	K13	1.00	0.10
Recruitment in 2012 and 2013					
R12	5032	0.73			
R13	5032	0.73			

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

Stock numbers in 2011 are TSA survivors.

Table 3.2.18. Cod in Division VIa. Results of short-term forecasts from TSA run. Management options. Note: Text is presented as it was output from WGFRANSW but data referred to as that for the human consumption fishery should be regarded as that for removals in addition to the assumed value of natural mortality.

	Year							
	2011	2012						
Mean F Ages								
H.cons 2 to 5	0.66	0.00	0.17	0.35	0.52	0.70	0.87	1.05
Effort relative to 2010								
H.cons	0.75	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Biomass								
Total 1 January	12.91	12.97	12.97	12.97	12.97	12.97	12.97	12.97
SSB at spawning time	8.72	9.84	9.84	9.84	9.84	9.84	9.84	9.84
Catch weight (,000t)								
H.cons	5.38	0.00	1.84	3.39	4.71	5.83	6.78	7.59
Biomass in year.... 2013								
Total 1 January		21.86	18.81	16.23	14.04	12.18	10.60	9.25
SSB at spawning time		17.64	14.95	12.67	10.75	9.12	7.75	6.59

	Year							
	2011	2012						
Effort relative to 2010								
H.cons	0.75	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.15	0.21	0.21	0.21	0.21	0.21	0.21	0.21
SSB at spawning time	0.15	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Catch weight								
H.cons	0.15	0.00	0.23	0.20	0.20	0.20	0.20	0.20
Biomass in year.... 2013								
Total 1 January		0.25	0.25	0.26	0.26	0.27	0.27	0.28
SSB at spawning time		0.23	0.24	0.24	0.24	0.25	0.25	0.26

Table 3.2.19. Cod in Division VIa. Results of short-term forecasts from TSA run. Detailed tables. Note: Text is presented as it was output from WGFRANSW but data referred to as that for the human consumption fishery should be regarded as that for removals in addition to the assumed value of natural mortality.

```
    Detailed forecast tables.


Forecast for year 2011
F multiplier H.cons=0.75

      Populations     Catch number
+----+-----------+   +--------+-------+
| Age| Stock No. |   | H.Cons |  Total|
+----+-----------+   +--------+-------+
|   1|       4122|   |    1342|   1342|
|   2|       4194|   |    1622|   1622|
|   3|       2289|   |    1032|   1032|
|   4|        179|   |      82|     82|
|   5|         53|   |      24|     24|
|   6|         73|   |      34|     34|
|   7|         13|   |       6|      6|
+----+-----------+   +--------+-------+
|  Wt|         13|   |       5|      5|
+----+-----------+   +--------+-------+


Forecast for year 2012
F multiplier H.cons=0.56

      Populations     Catch number
+----+-----------+   +--------+-------+
| Age| Stock No. |   | H.Cons |  Total|
+----+-----------+   +--------+-------+
|   1|       5032|   |    1292|   1292|
|   2|       2171|   |     670|    670|
|   3|       1982|   |     722|    722|
|   4|        952|   |     355|    355|
|   5|         73|   |      27|     27|
|   6|         22|   |       8|      8|
|   7|         35|   |      13|     13|
+----+-----------+   +--------+-------+
|  Wt|         13|   |       4|      4|
+----+-----------+   +--------+-------+
```

Table 3.2.20. 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 3.2.20. (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	
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		

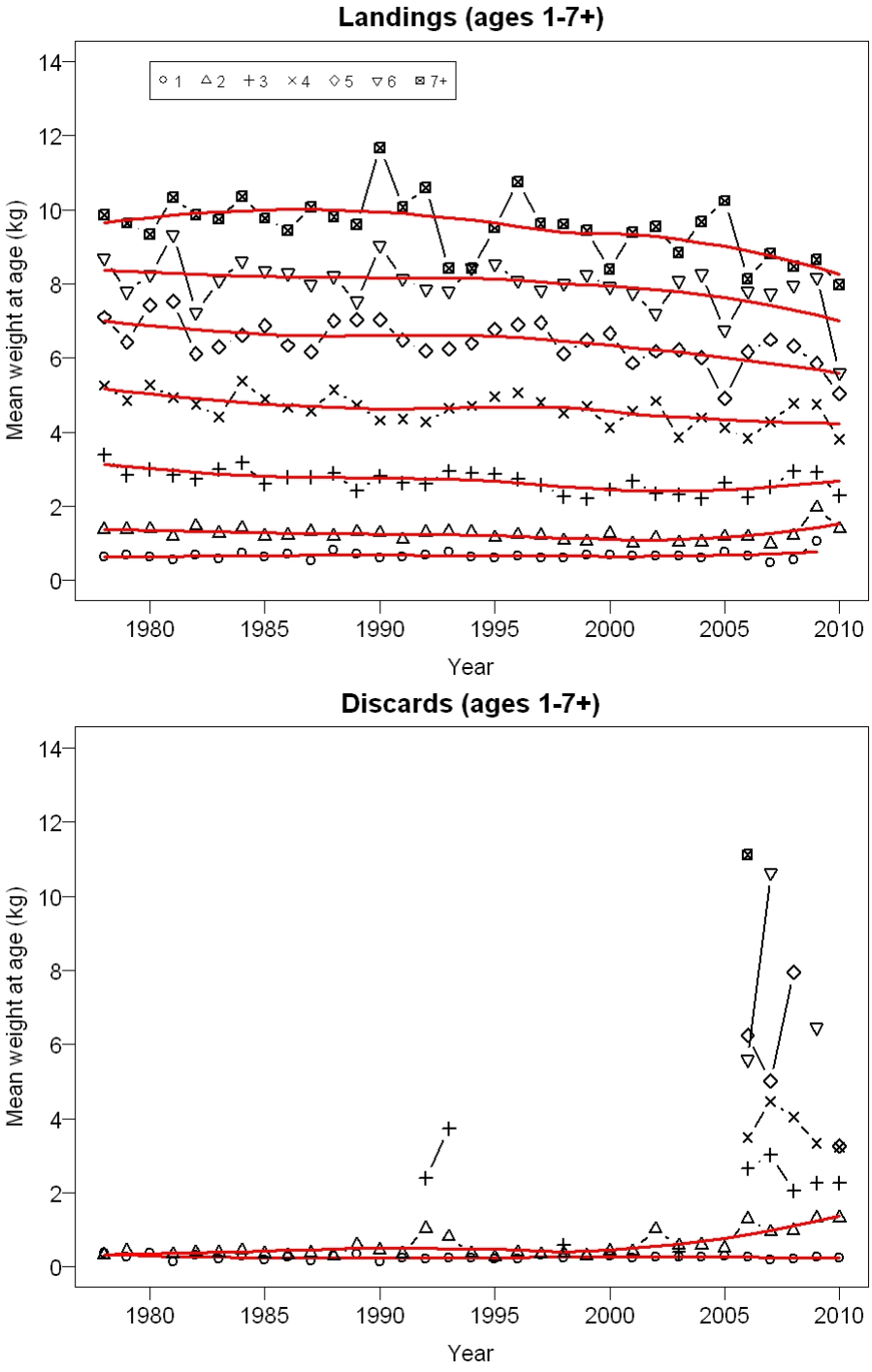


Figure 3.2.1. Cod in Division VIa. Mean weights-at-age in landings and discards. A loess smooth has been fitted to the data at each age, with a span including three quarters of the data points.

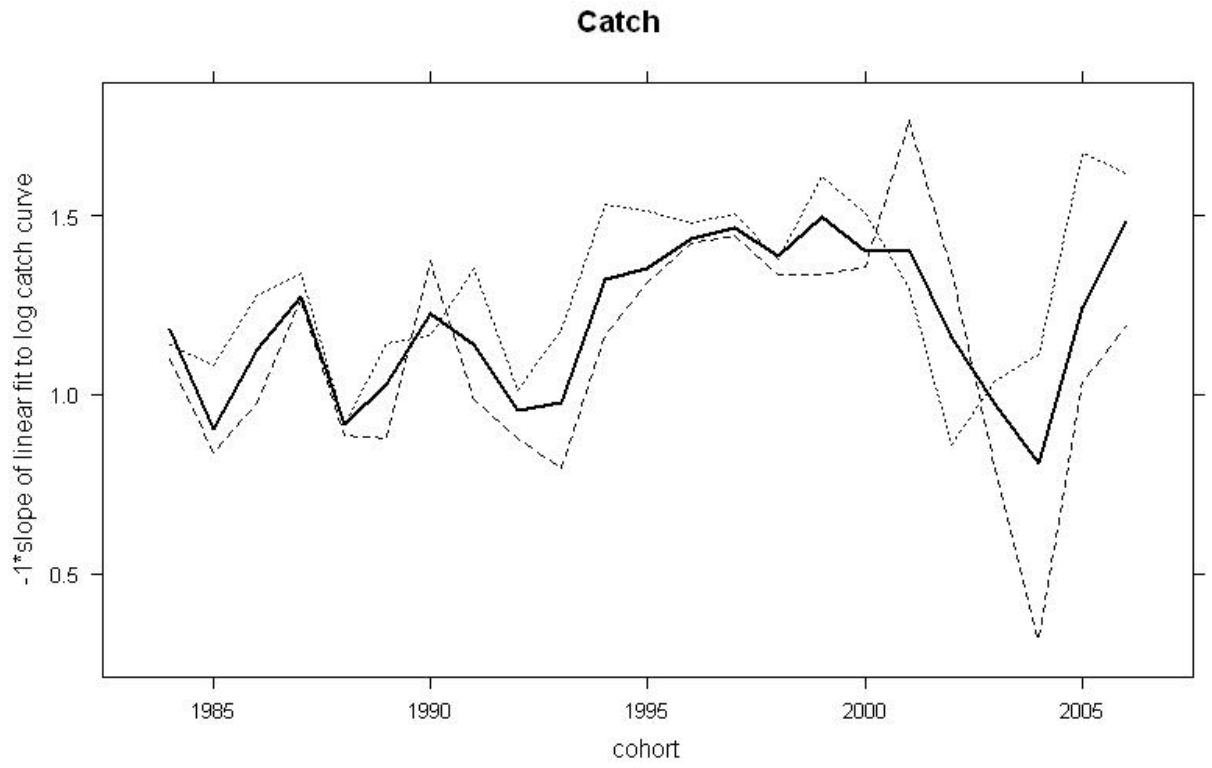


Figure 3.2.2. Cod in Division VIa. Log catch (landings + discards) curve gradient plot using WG commercial catch-at-age data. Solid line shows time-series of gradient of linear fit to curve over the age range 2–5, dashed line over the ages 2–4 and dotted line over the ages 3–5. An increasing value indicates increasing mortality.

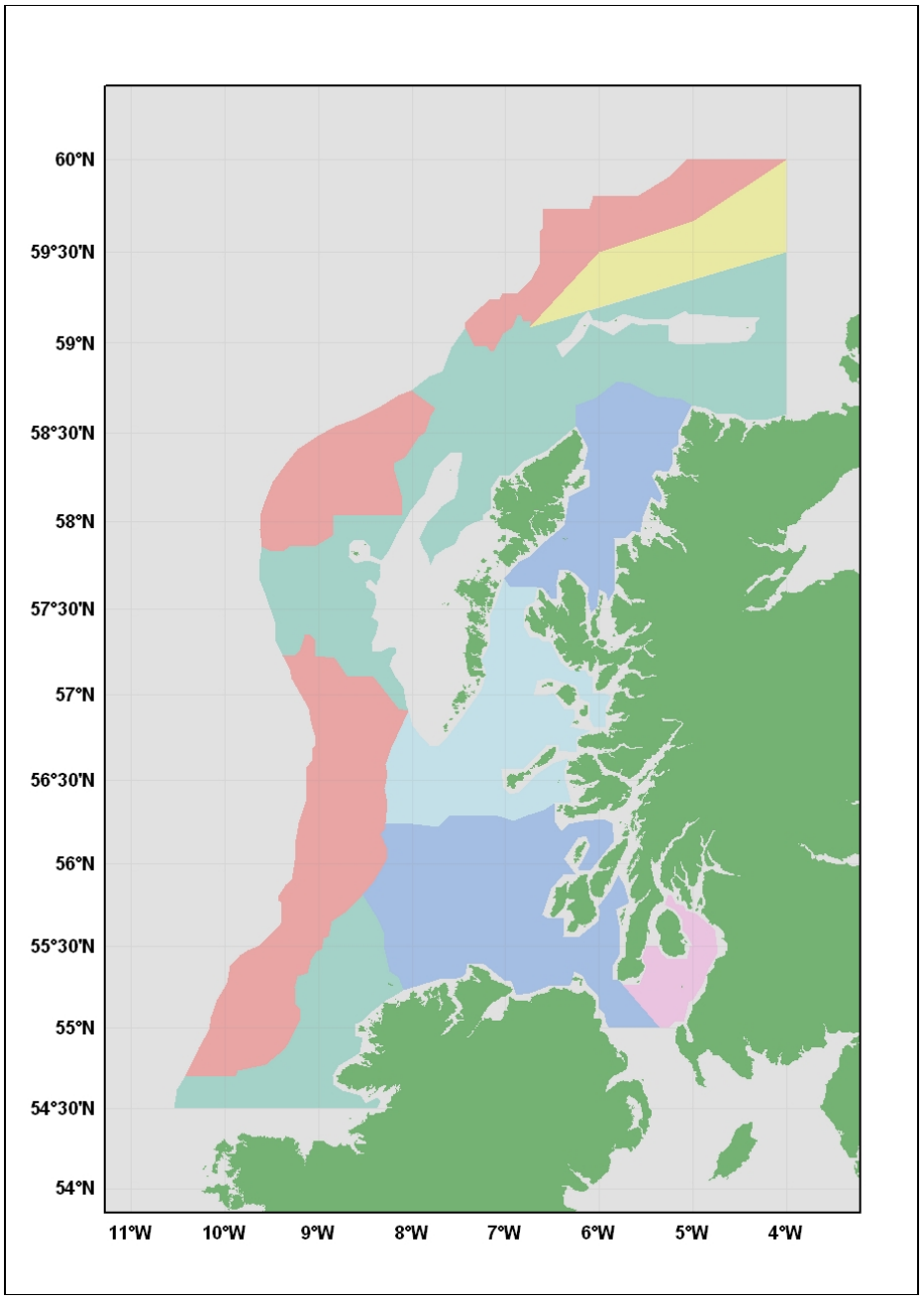


Figure 3.2.3. Cod in Division VIa. Sampling strata of revised Scottish quarter one groundfish survey (ScoGFS-WIBTS-Q1).

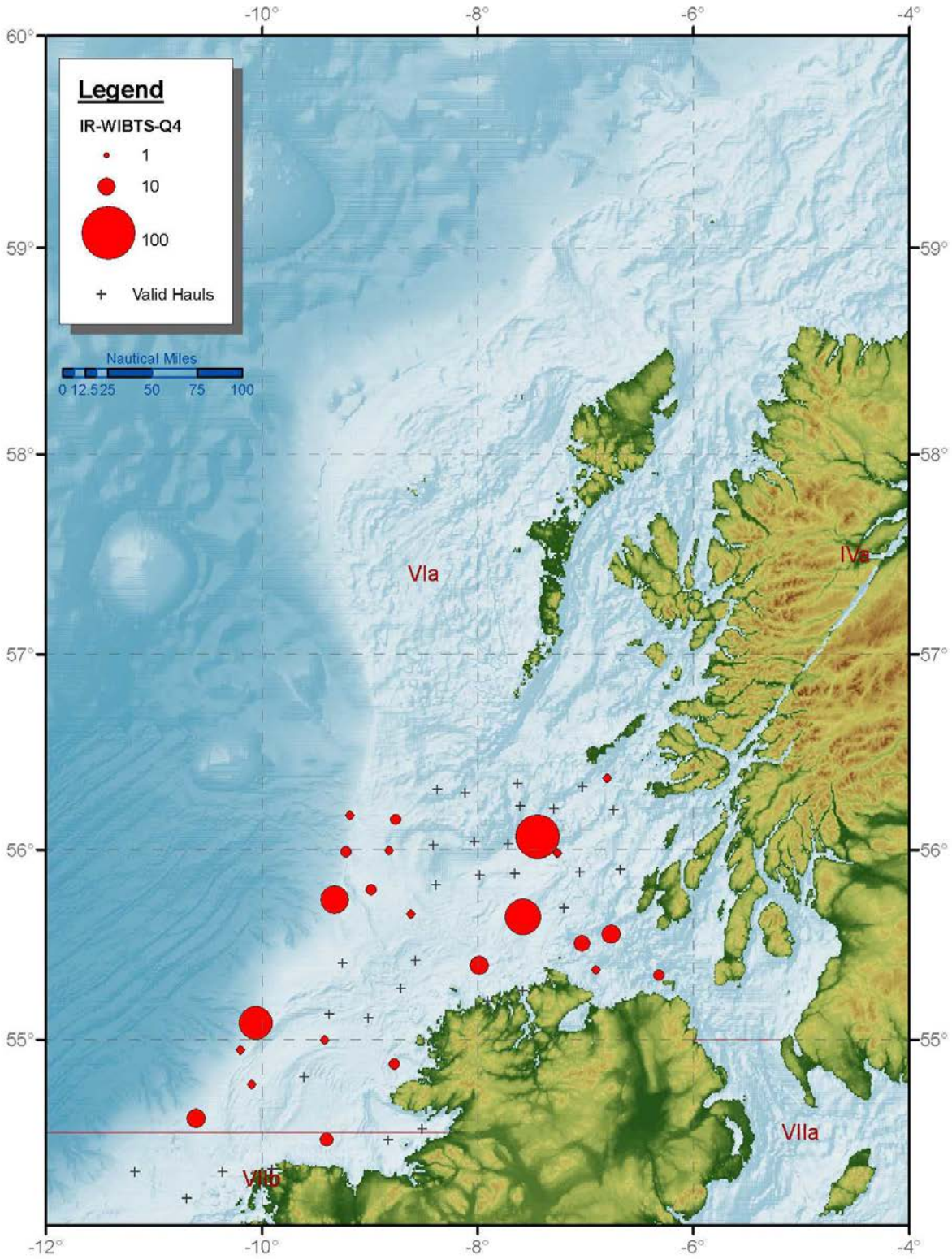


Figure 3.2.4. Cod in Division VIa. Cpue numbers for fish aged at 1+ by ICES statistical rectangle resulting from quarter four Irish groundfish survey (IRGFS-WIBTS-Q4). Irish Survey values are for fish >23 cm in length (proxy for age 1+) and numbers are standardized to 60 minutes towing. Note that no Scottish quarter four groundfish survey (ScoGFS-WIBTS-Q4) took place in 2010.

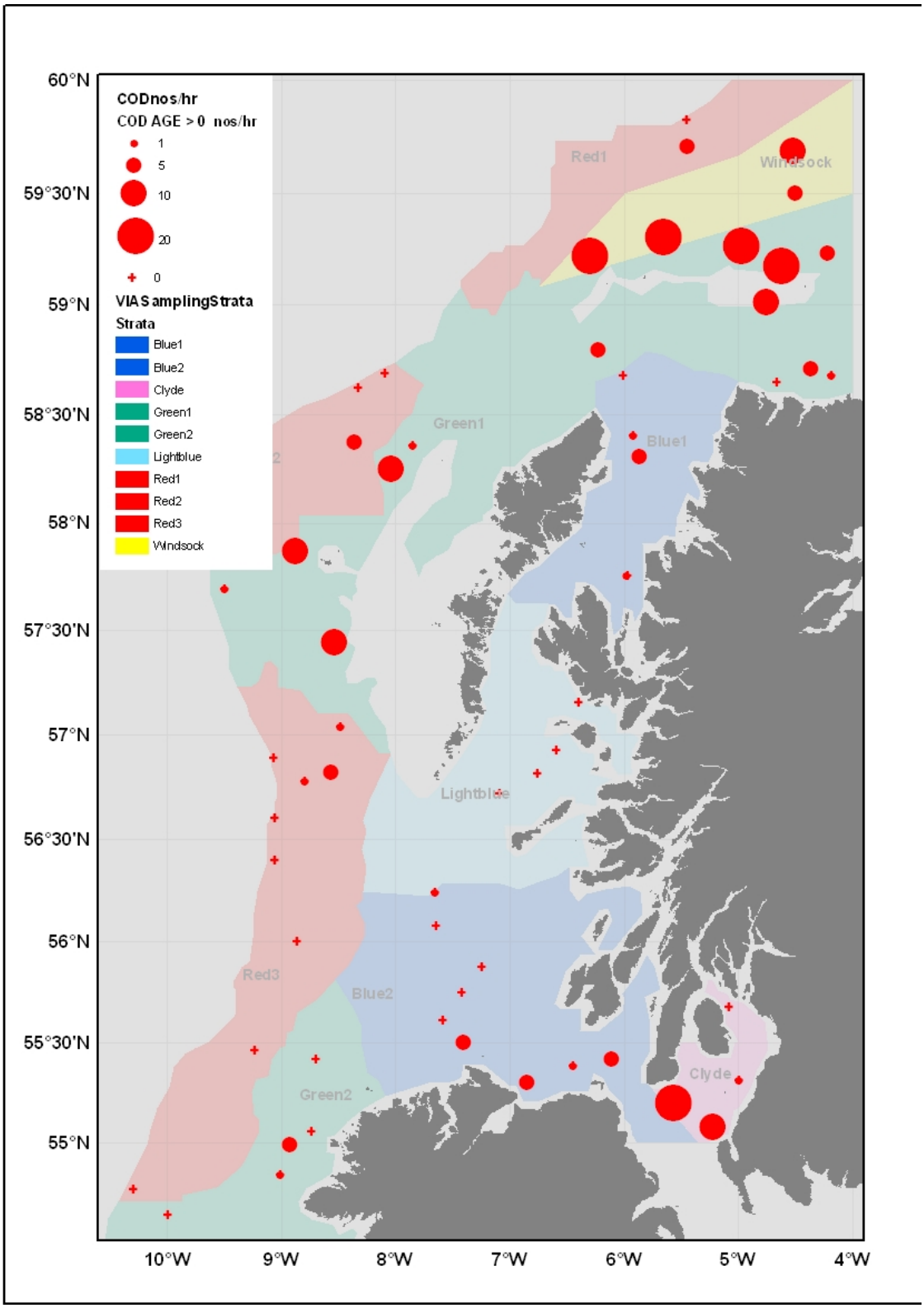


Figure 3.2.4. Cont. Cod in Division VIa. Cpue numbers for fish aged at 1+ by ICES statistical rectangle resulting from Scottish quarter one survey (ScoGFS-WIBTS-Q1). Numbers are standardized to 60 minutes towing.

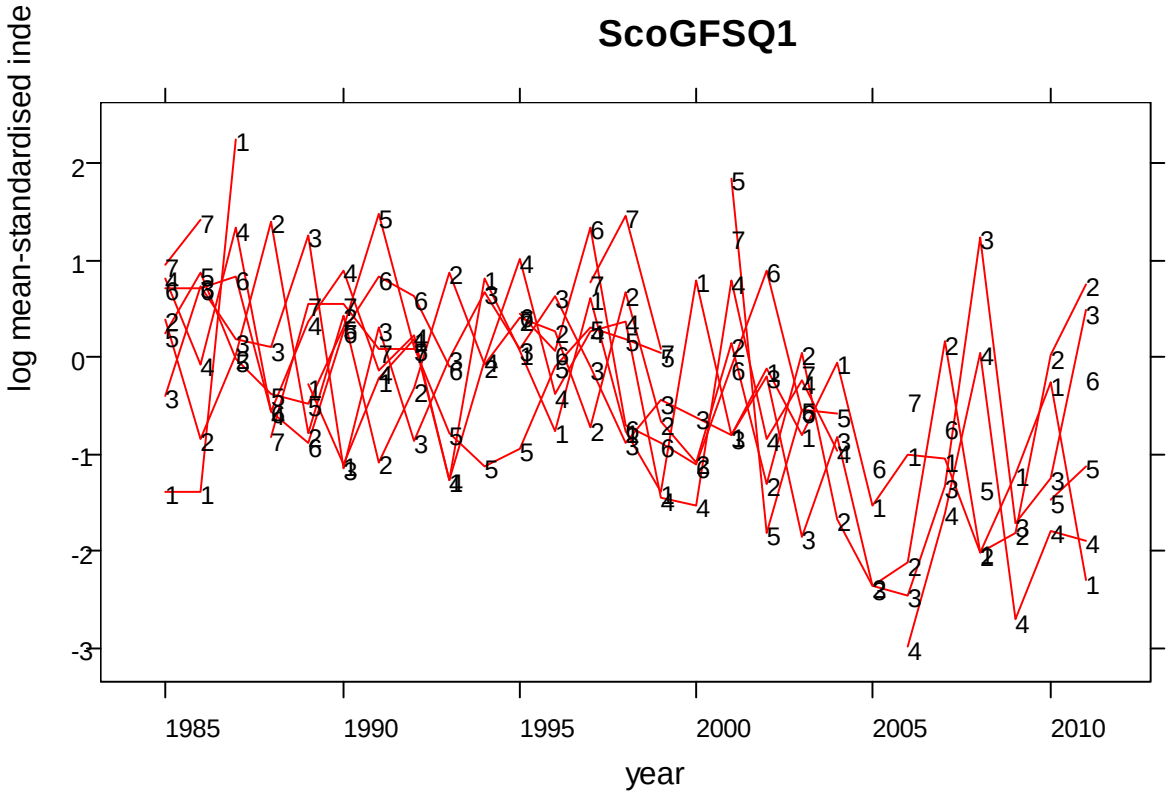


Figure 3.2.5. Cod in Division VIa. Log mean standardized index values-by year-from Scottish quarter one groundfish survey (ScoGFS-WIBTS-Q1); ages 1–6.

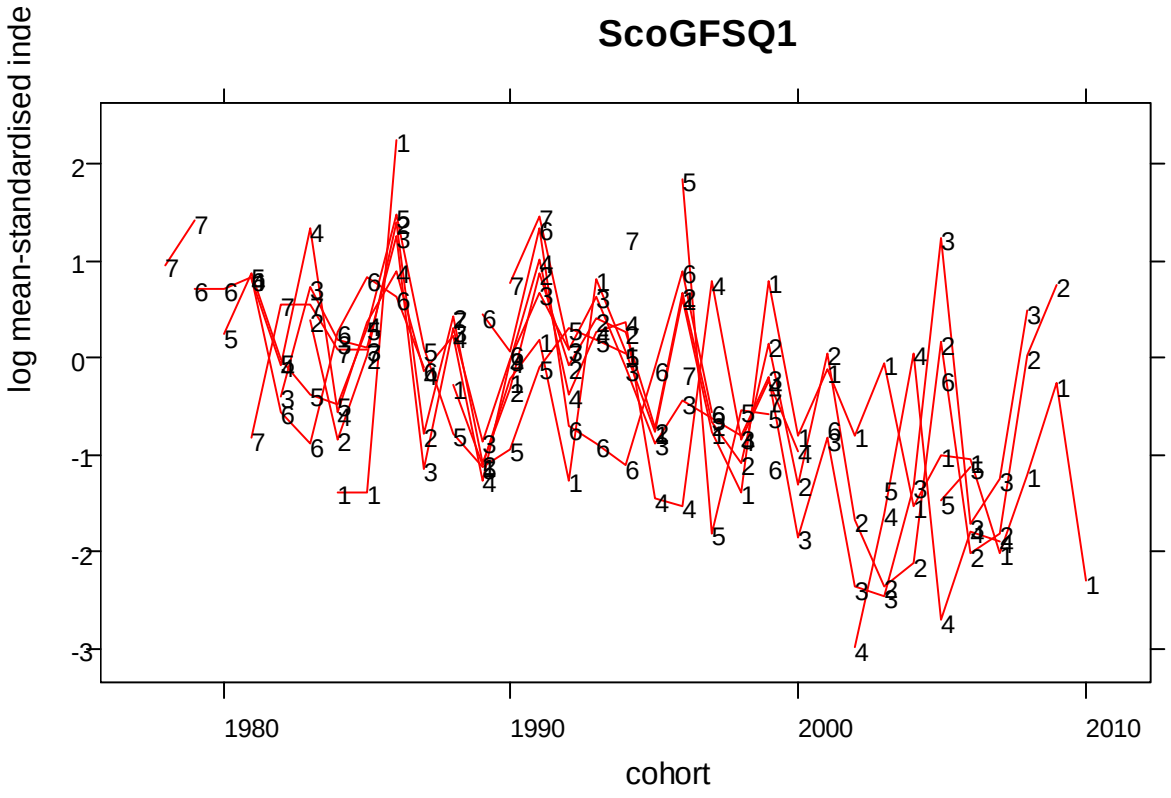


Figure 3.2.6. Cod in Division VIa. Log mean standardized index values-by cohort-from Scottish quarter one groundfish survey (ScoGFS-WIBTS-Q1); ages 1–6.

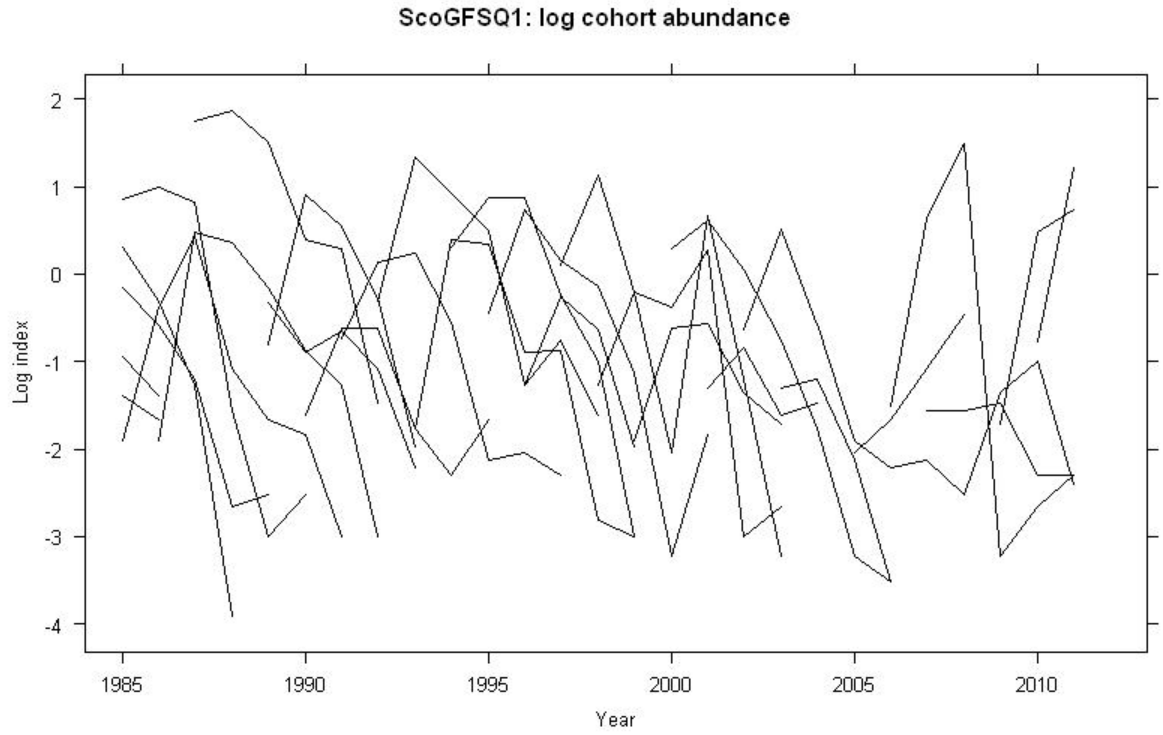


Figure 3.2.7. Cod in Division VIa. Log catch curves from Scottish quarter one groundfish survey (ScoGFS-WIBTS-Q1); ages 1–6.

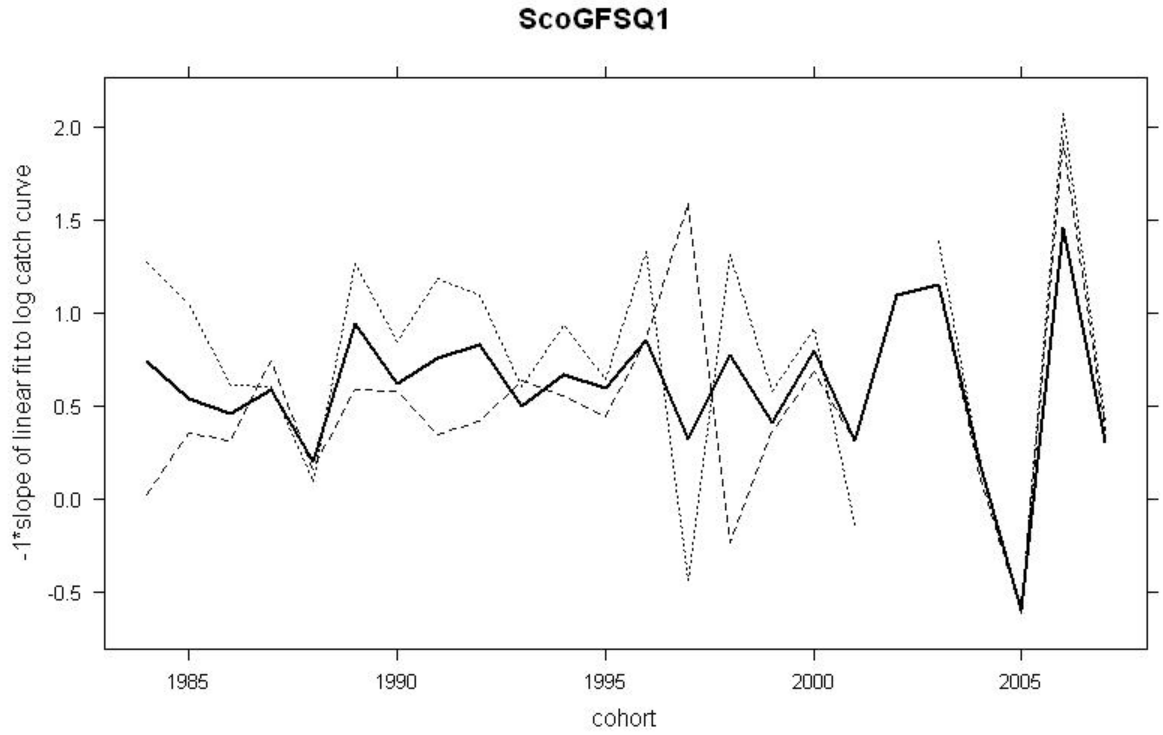


Figure 3.2.8. Cod in Division VIa. Log catch curve gradient plot using ScoGFS-WIBTS-Q1 index data. Solid line shows time-series of gradient of linear fit to curve over the age range 2–5, dashed line over the ages 2–4 and dotted line over the ages 3–5. An increasing value indicates increasing mortality.

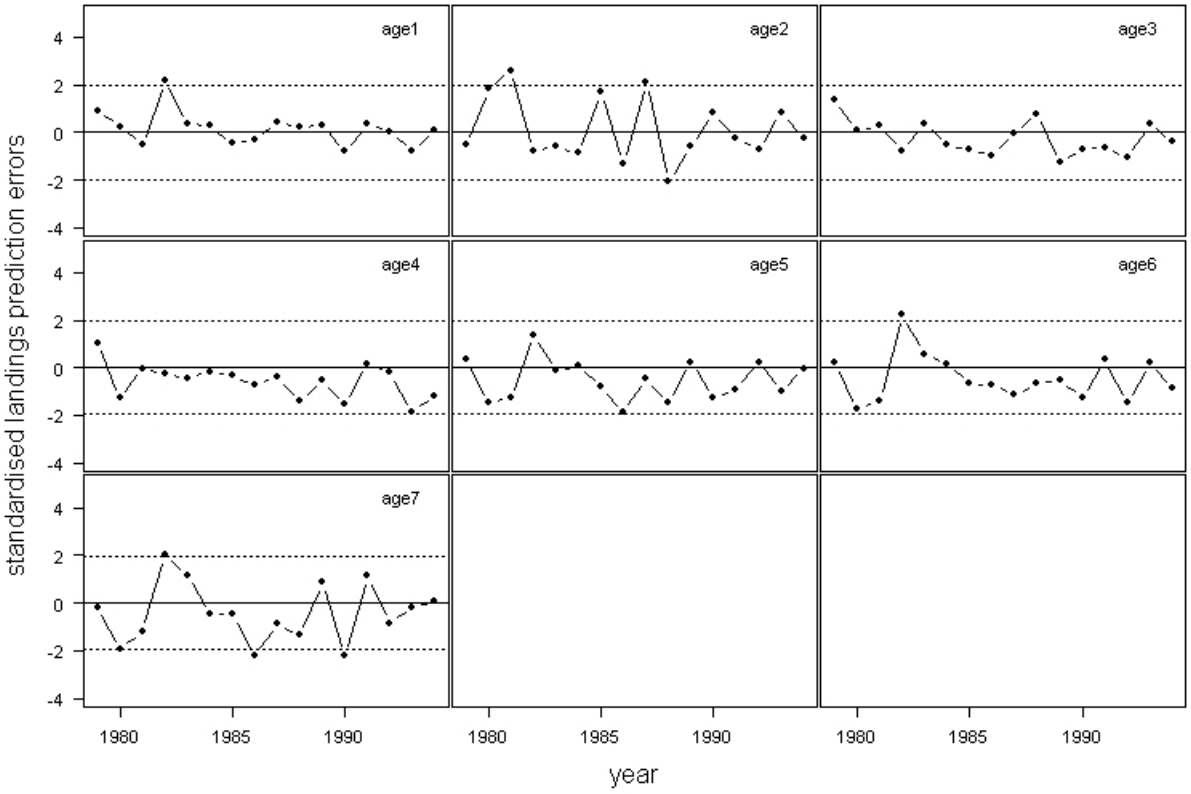


Figure 3.2.09. Cod in Division VIa. TSA final run. Standardized prediction errors at age plots for landings.

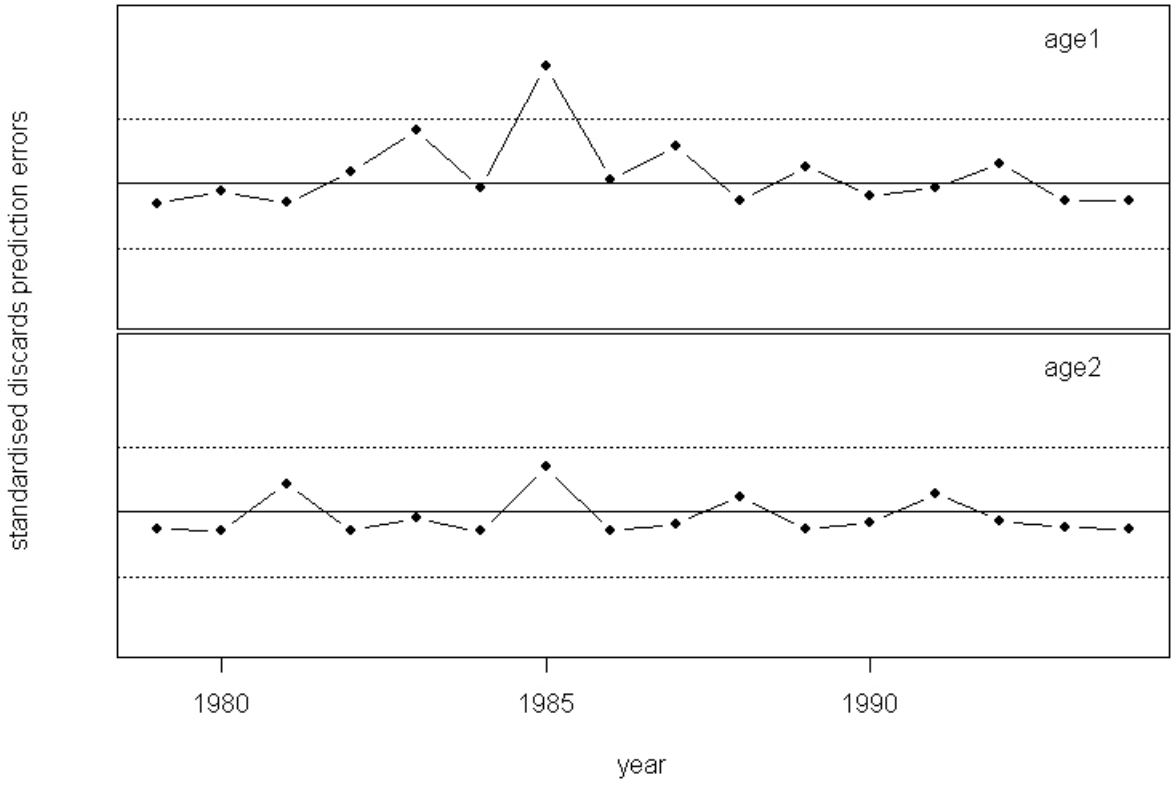


Figure 3.2.10. Cod in Division VIa. TSA final run. Standardized prediction errors at age plots for discards.

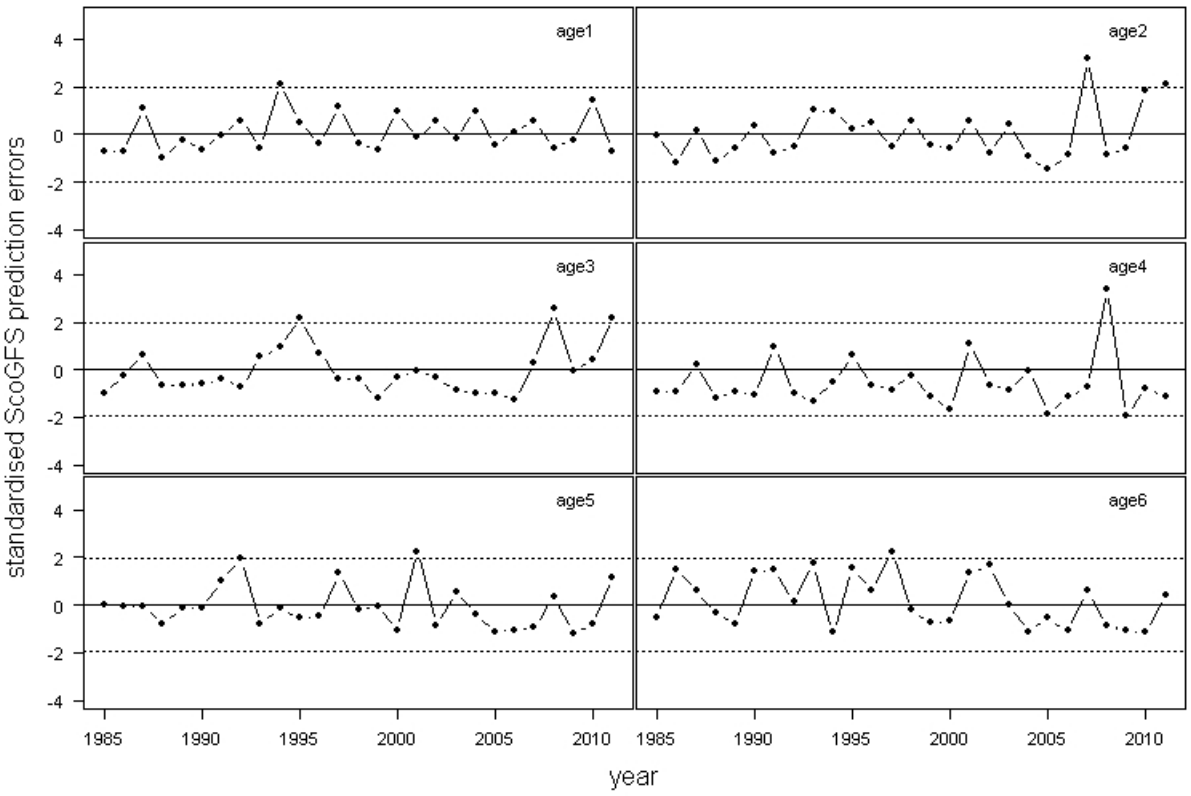


Figure 3.2.11. Cod in Division VIa. TSA run. Standardized prediction errors at age plots for ScoGFS-WIBTS-Q1.

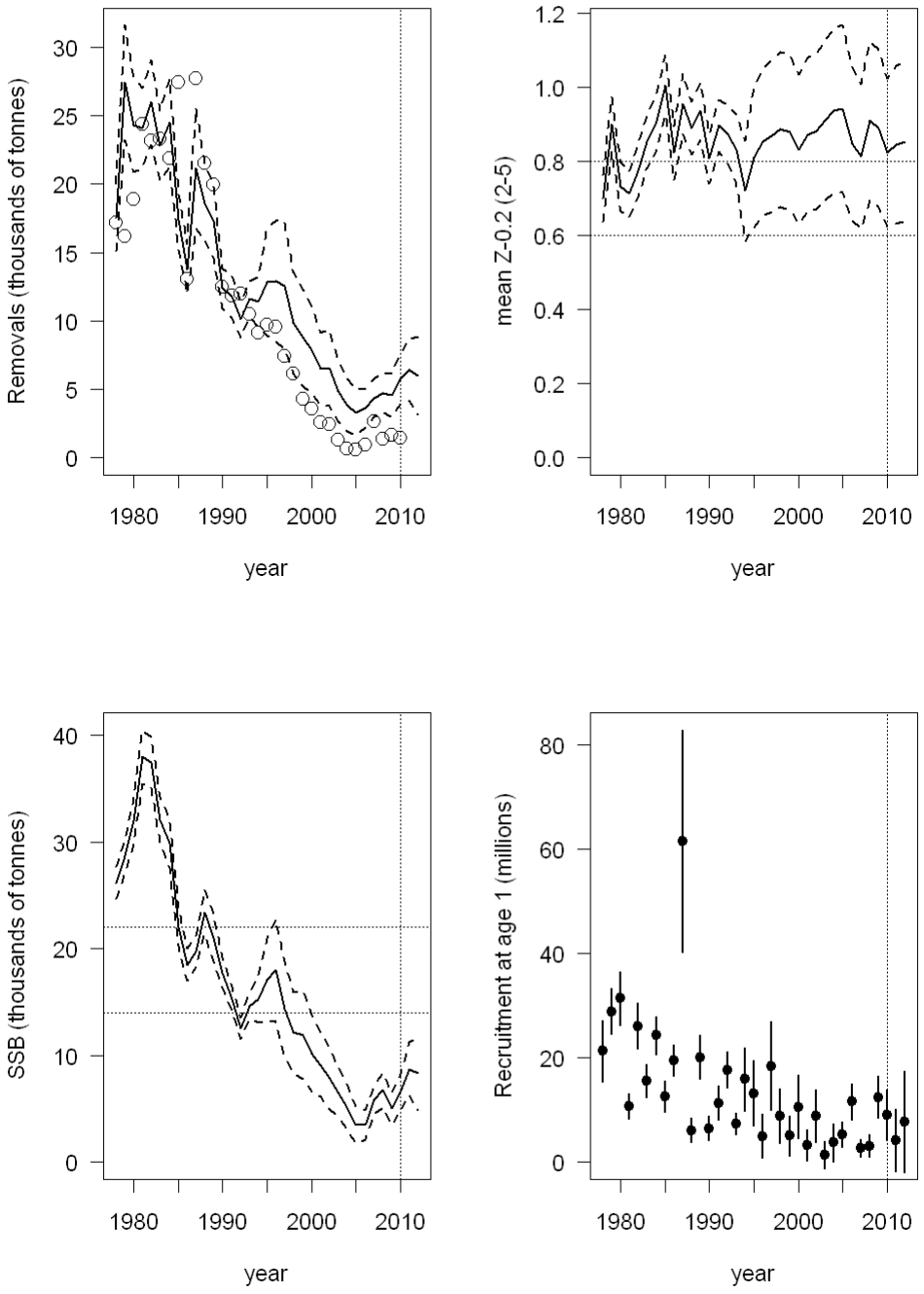


Figure 3.2.12. Cod in Division VIa. Summary plot of TSA update run. (landings and discard data excluded from 1995 onward). Solid line in top left frame indicates removals resulting from mortality over and above M=0.2; open circles represent reported catch. Solid line in top right frame indicates mortality over and above M=0.2. Dashed lines show ± 2 s.e. (approx 95% confidence interval).

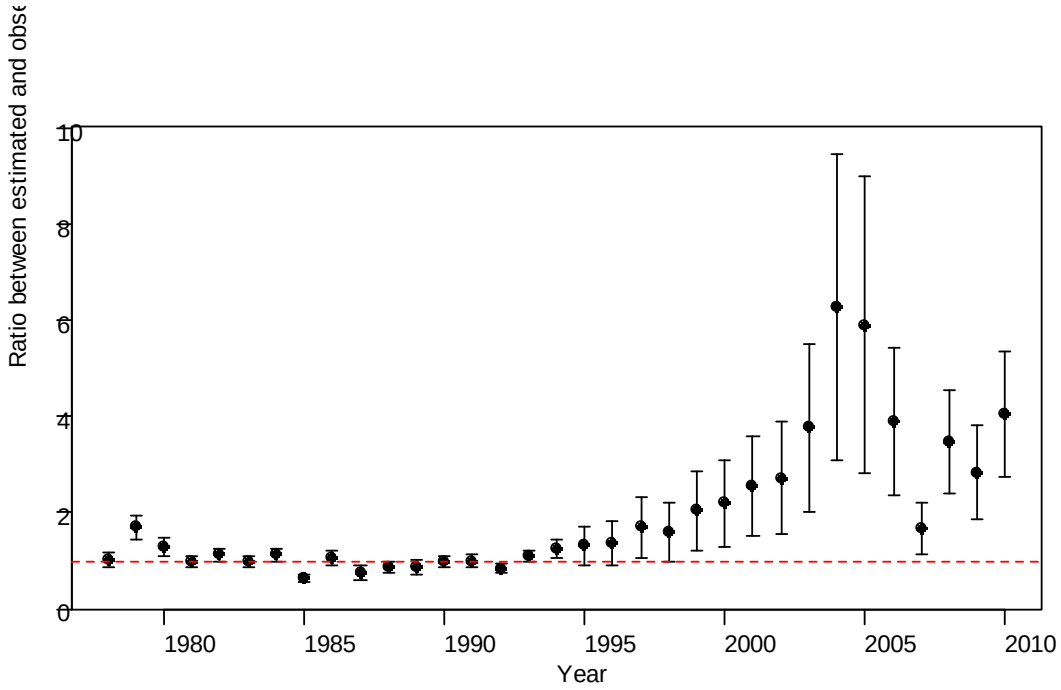


Figure 3.2.13. Cod in Division VIa. Ratio of estimated to observed catch using TSA. Bars show ± 2 s.e. TSA excludes catch data from 1995 to 2010 inclusive. The 'catch' resulting from TSA is considered removals from both fishing and natural mortality over and above M=0.2.

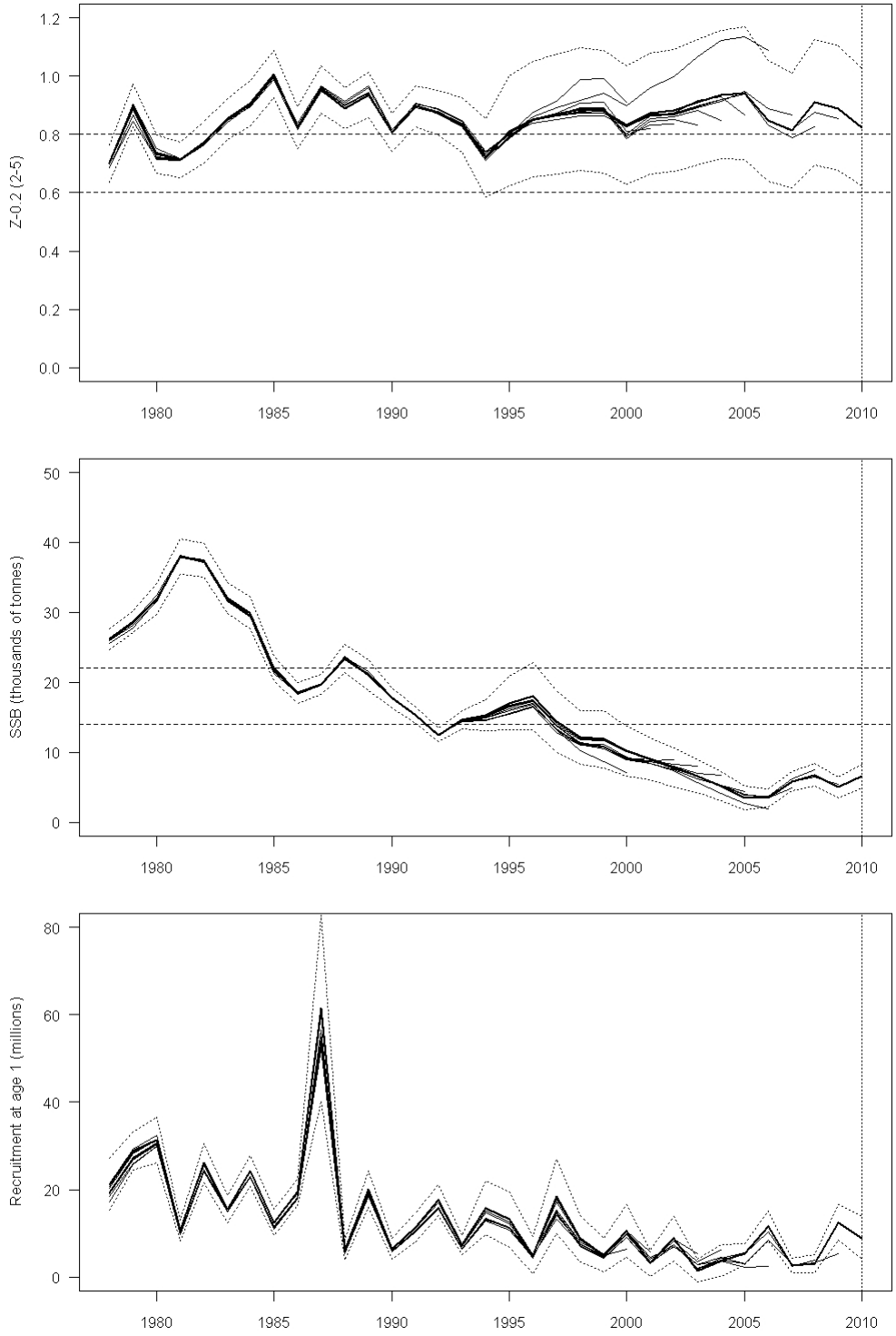


Figure 3.2.14. Cod in Division VIa. Retrospective plots of TSA run. Biological reference points are given by horizontal dashed lines. Confidence intervals for the run using all years of data are shown by dotted lines.

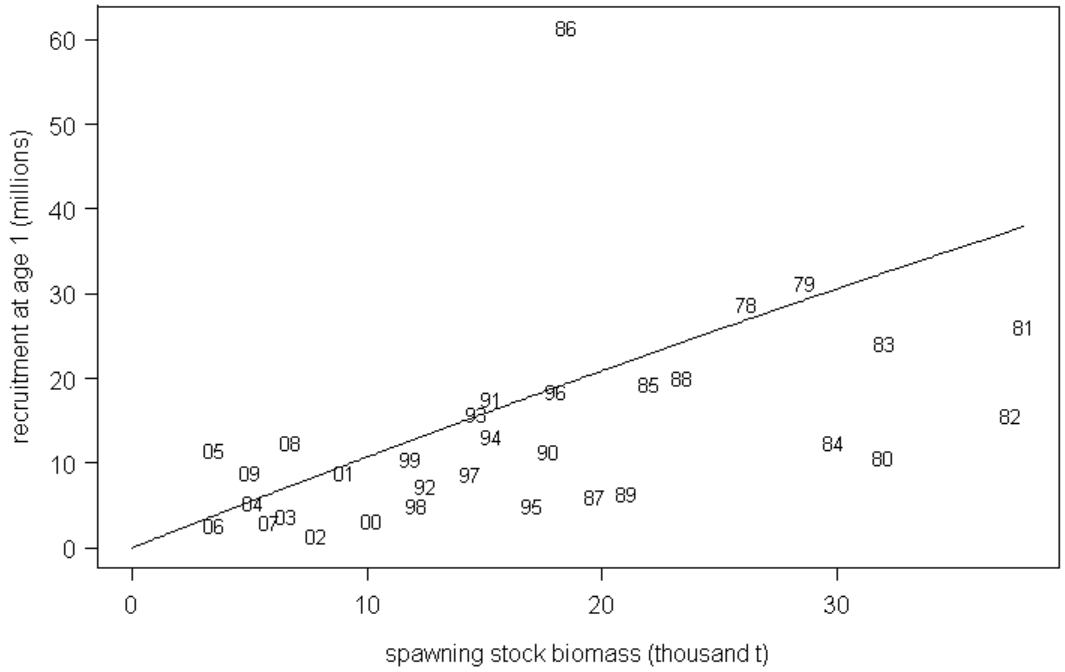


Figure 3.2.15. Cod in Division VIa. TSA final run. Stock–recruit relationship. Numbers indicate year class.

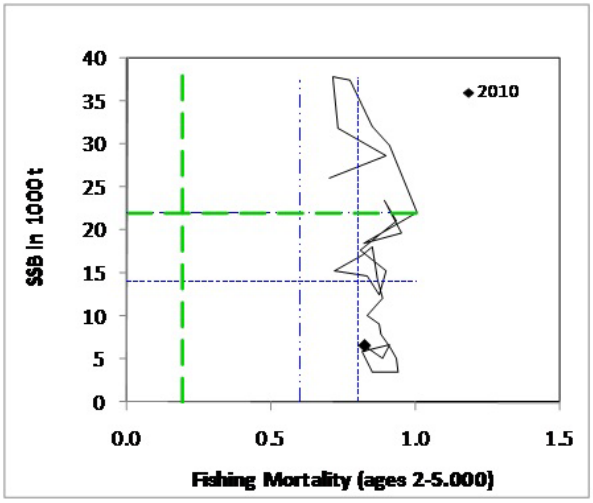
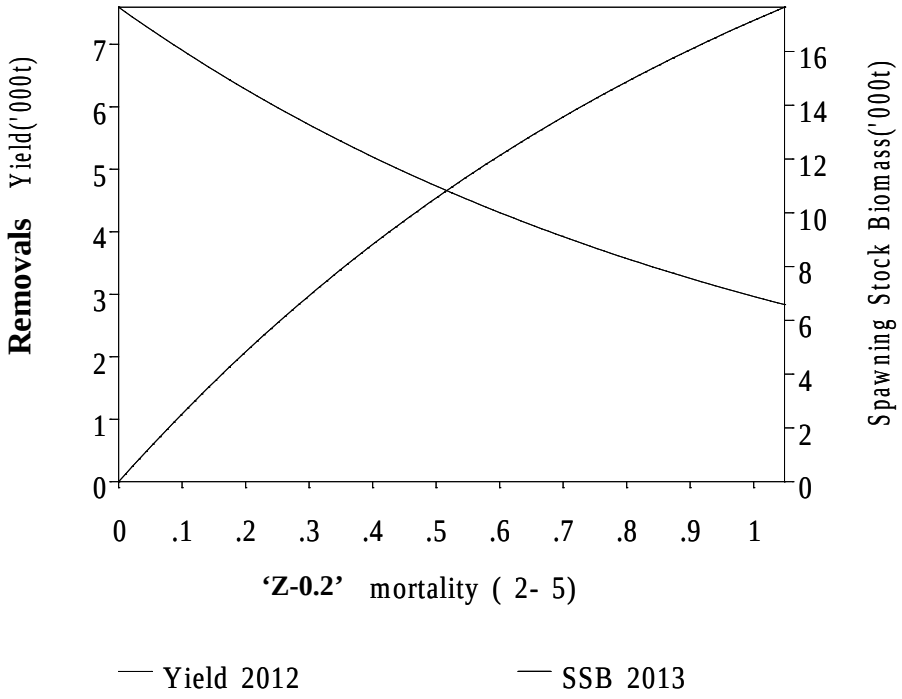


Figure 3.2.16. Cod in Division VIa. Precautionary approach plot. Mortality is all mortality over and above the fixed natural mortality value of 0.2 (referred to as 'Z-0.2').

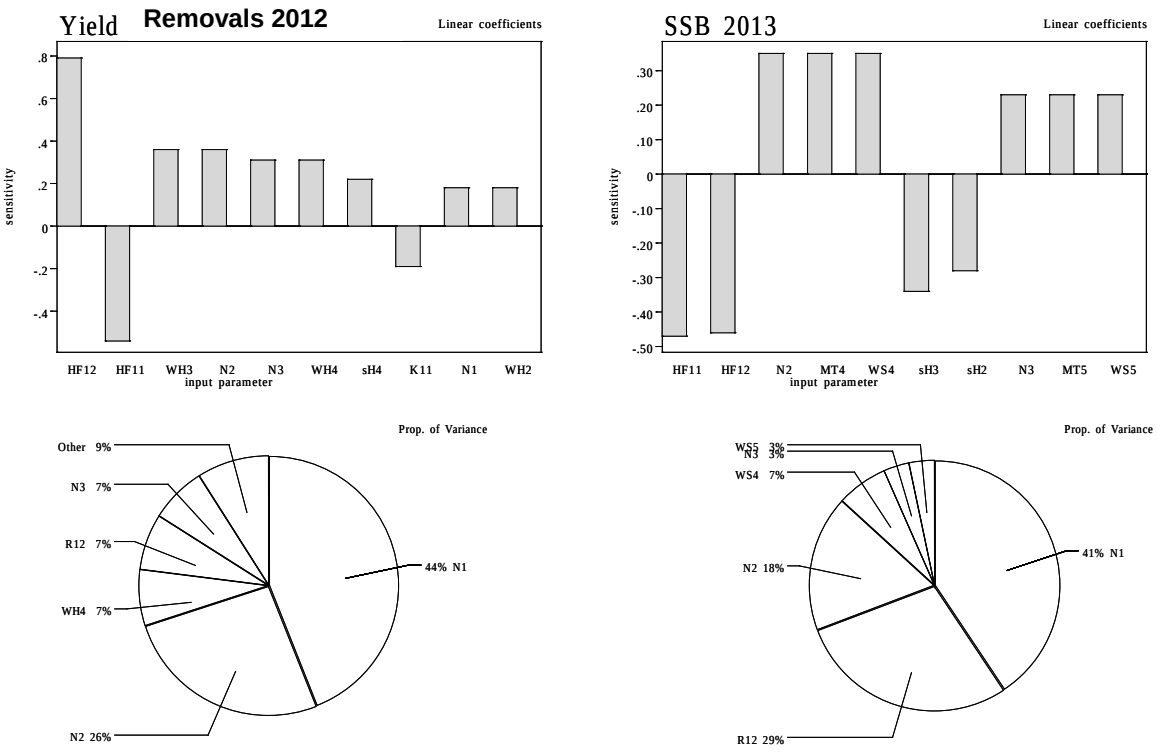
Figure Cod,,,,VIa,,,. Short term forecast



Data from file:C:\Work\WGCSE\WGCSE_11\forecasting\COD\codVIa11RunSPALYHF075HF056

Figure 3.2.17. Cod in Division VIa. Short-term forecast. Figure shows mortality from all sources that is over and above M=0.2 and associated removals.

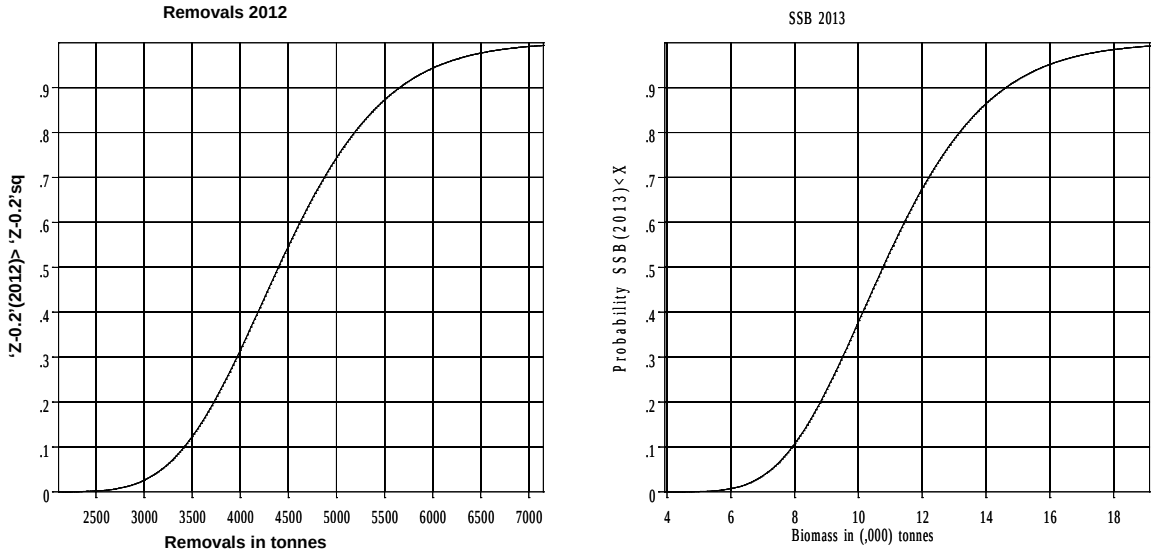
Figure Cod,,,,VIa,,,. Sensitivity analysis of short term forecast.



Data from file:C:\Work\WGCSE\WGCSE_11\forecasting\COD\codVIa11RunSPALYHF075HF056

Figure 3.2.18. Cod in Division VIa. Sensitivity analysis of short-term forecast. Removals are associated with mortality from all sources over and above M=0.2.

Figure Cod,,,,VIa,,,. Probability profiles for short term forecast.



Data from file:C:\Work\WGCSE\WGCSE_11\forecasting\COD\codVIa11RunSPALYHF075HF056

Figure 3.2.19. Cod in Division VIa. Probability profiles for short-term forecast. Removals are associated with mortality from all sources over and above M=0.2.

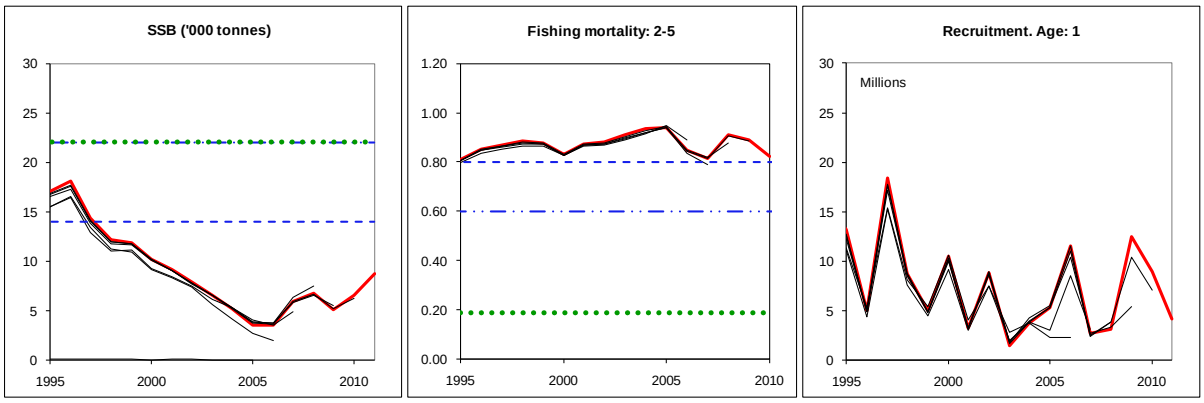


Figure 3.2.20. Cod in Division VIa. Comparison of SSB, mean F (2–5) estimates and recruitment-at-age one produced by final run assessments between this year's assessment and assessments going back to 2001.

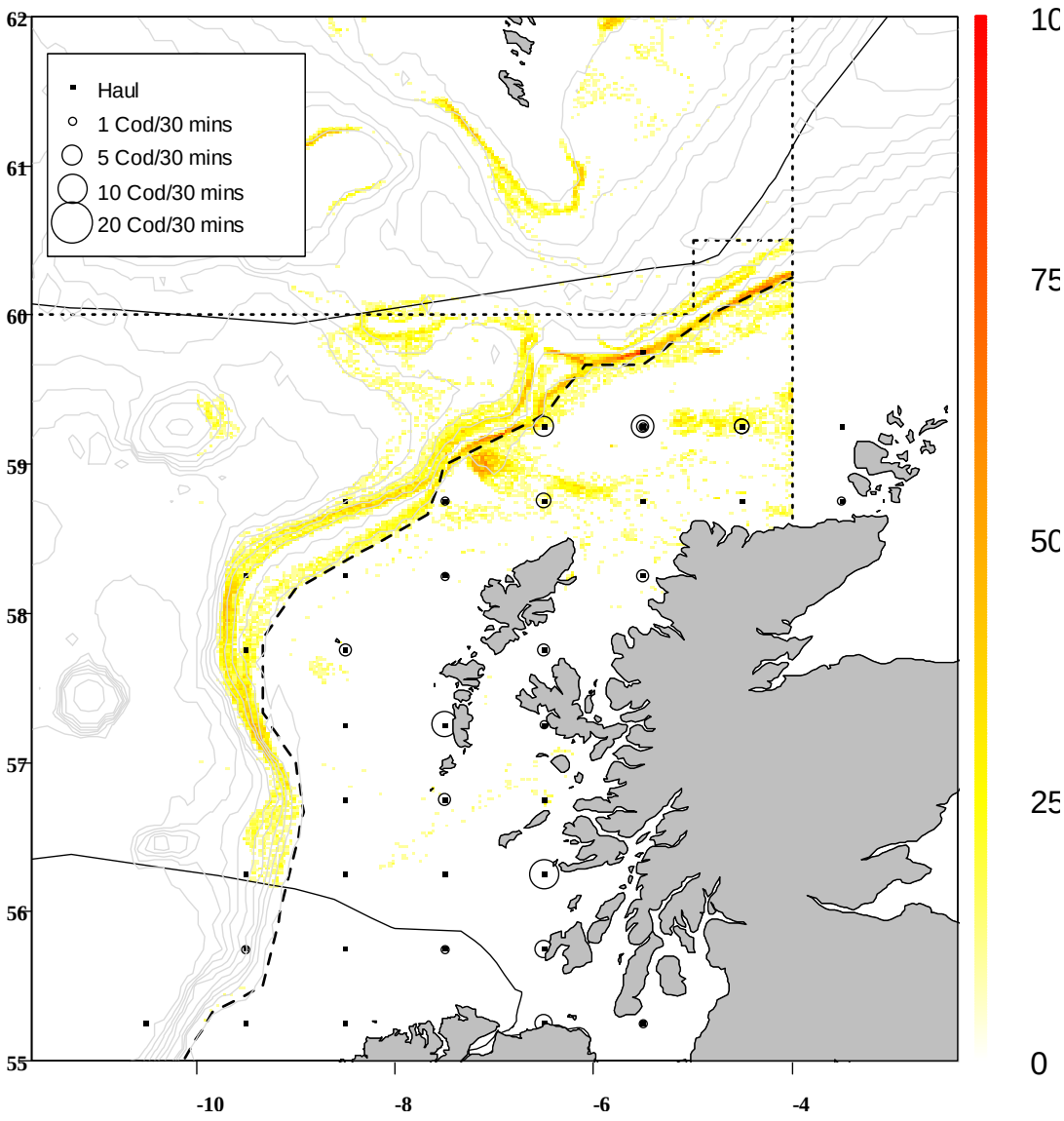


Figure 3.2.21. Scottish Q1 2010 Survey cpues of Cod plotted over Scottish (and other EU landing into Scotland) VMS data on fishing activity (annual VMS pings per square n.m.) associated with TR1 gear and trips with cod landings. Scottish survey results are centred on the statistical rectangle sampled. 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.

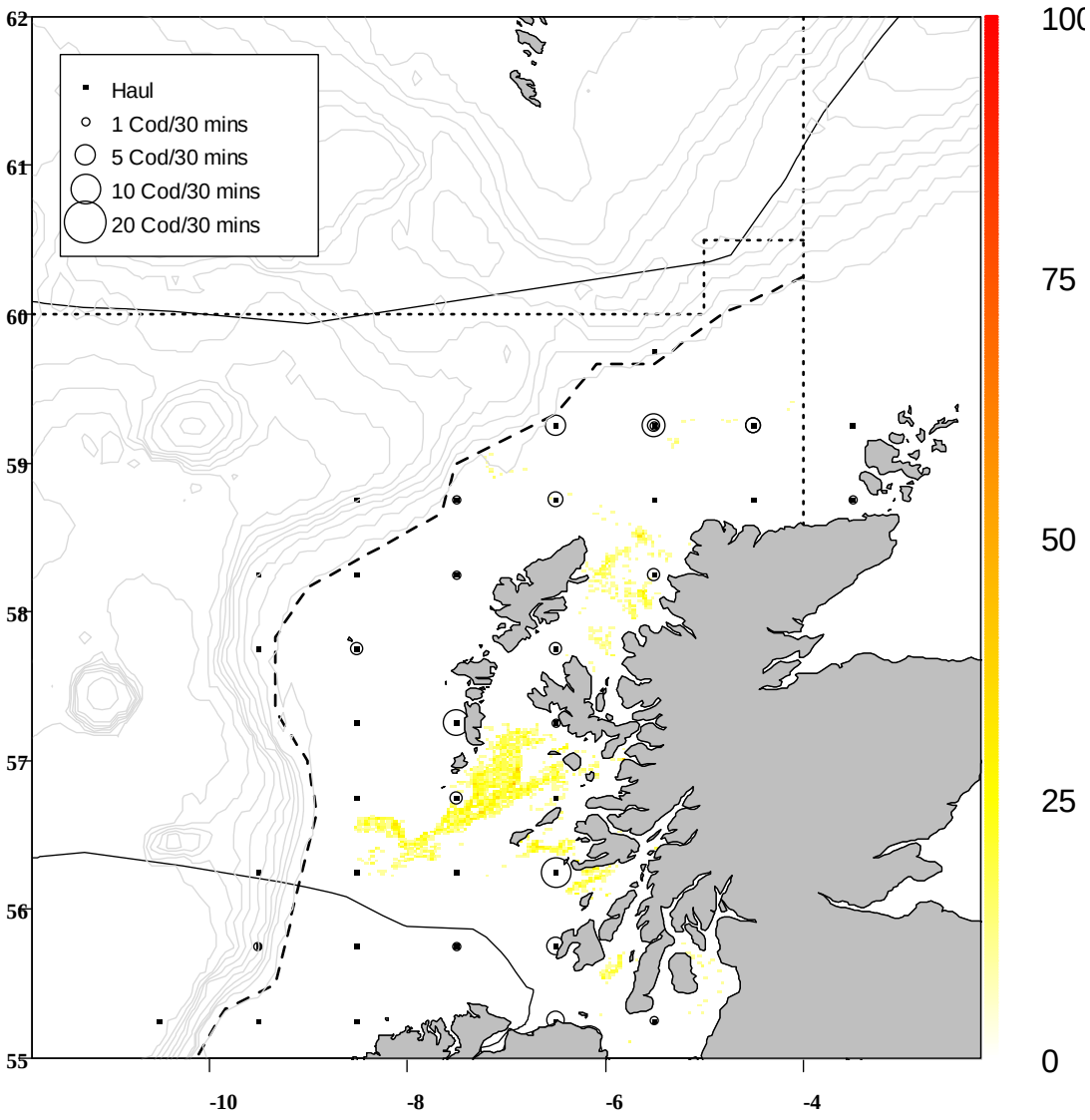


Figure 3.2.22. Scottish Q1 2010 Survey cpues of Cod plotted over Scottish (and other EU landing into Scotland) VMS data on fishing activity (annual VMS pings per square n.m.) associated with TR2 gear and trips with cod landings. Scottish survey results are centred on the statistical rectangle sampled. 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.

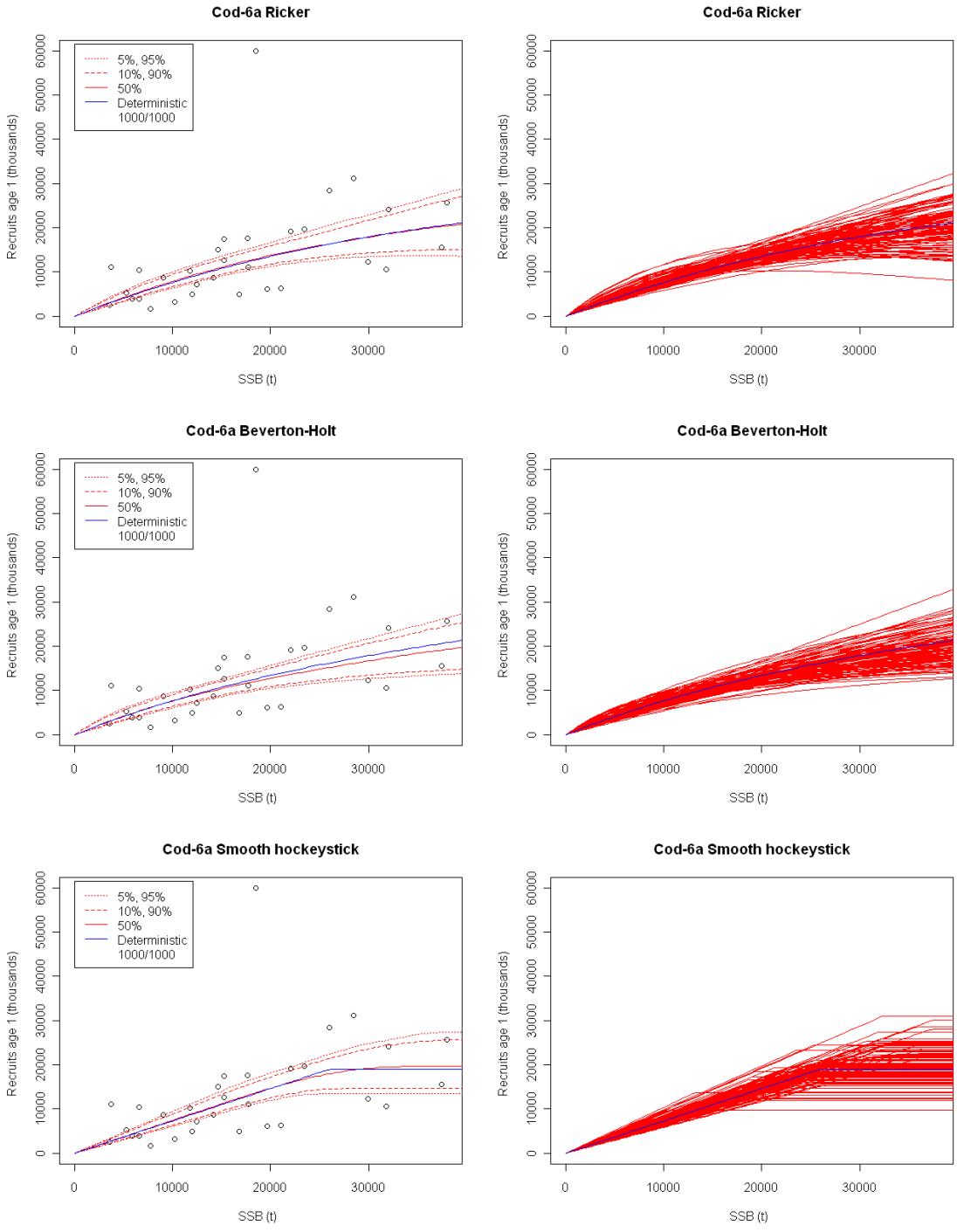


Figure 3.2.23. Cod in Division VIa. Stock–recruit relationships fitted by srmsymc package. Models were fitted using 1000 MCMC resamples. Left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a 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.

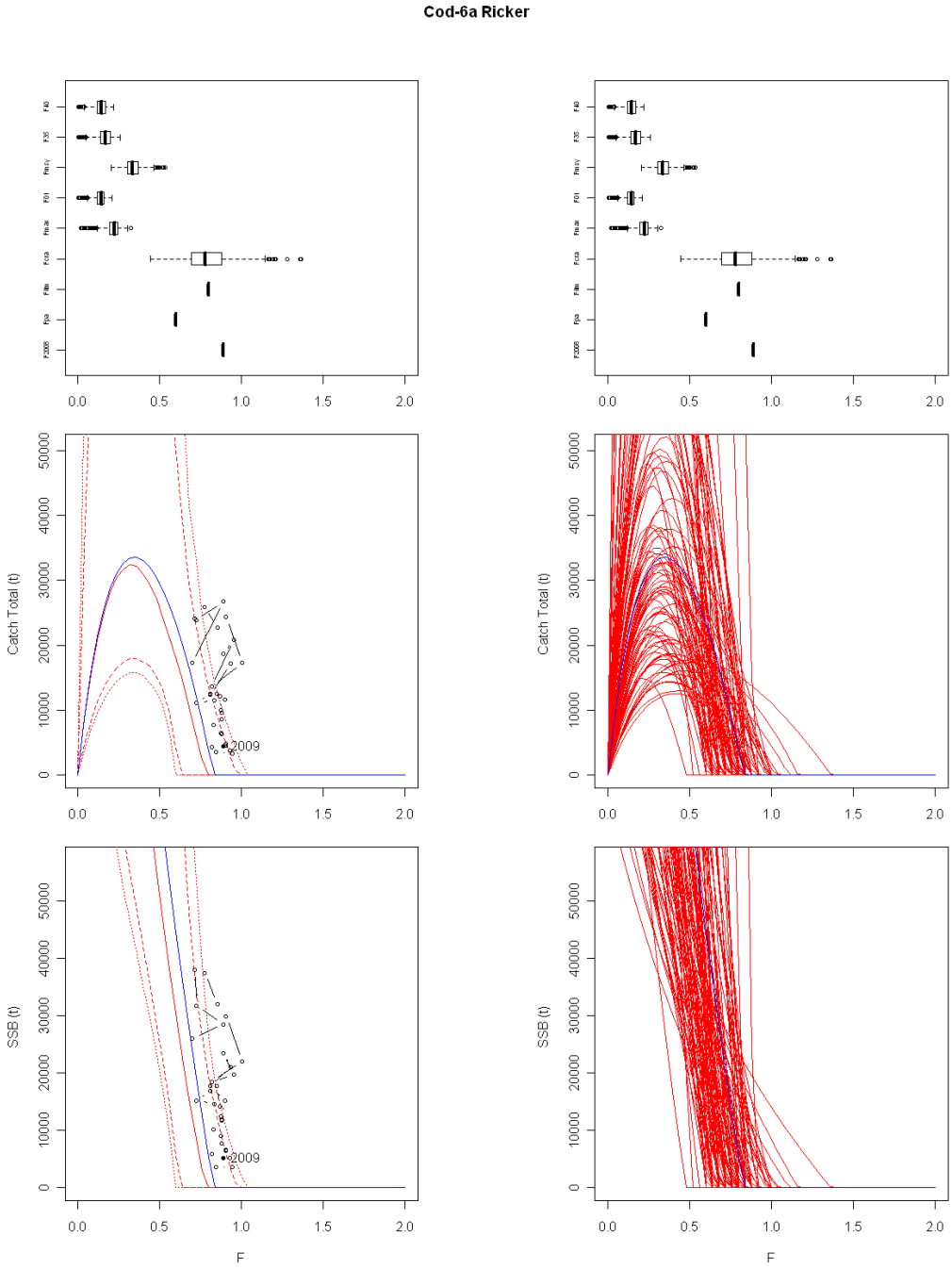


Figure 3.2.24. Cod in Division VIa. srmsymc package. Estimation of F reference points and equilibrium yield and SSB against mortality using Ricker recruitment model. For yield and SSB plots left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. Circles show data points 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.

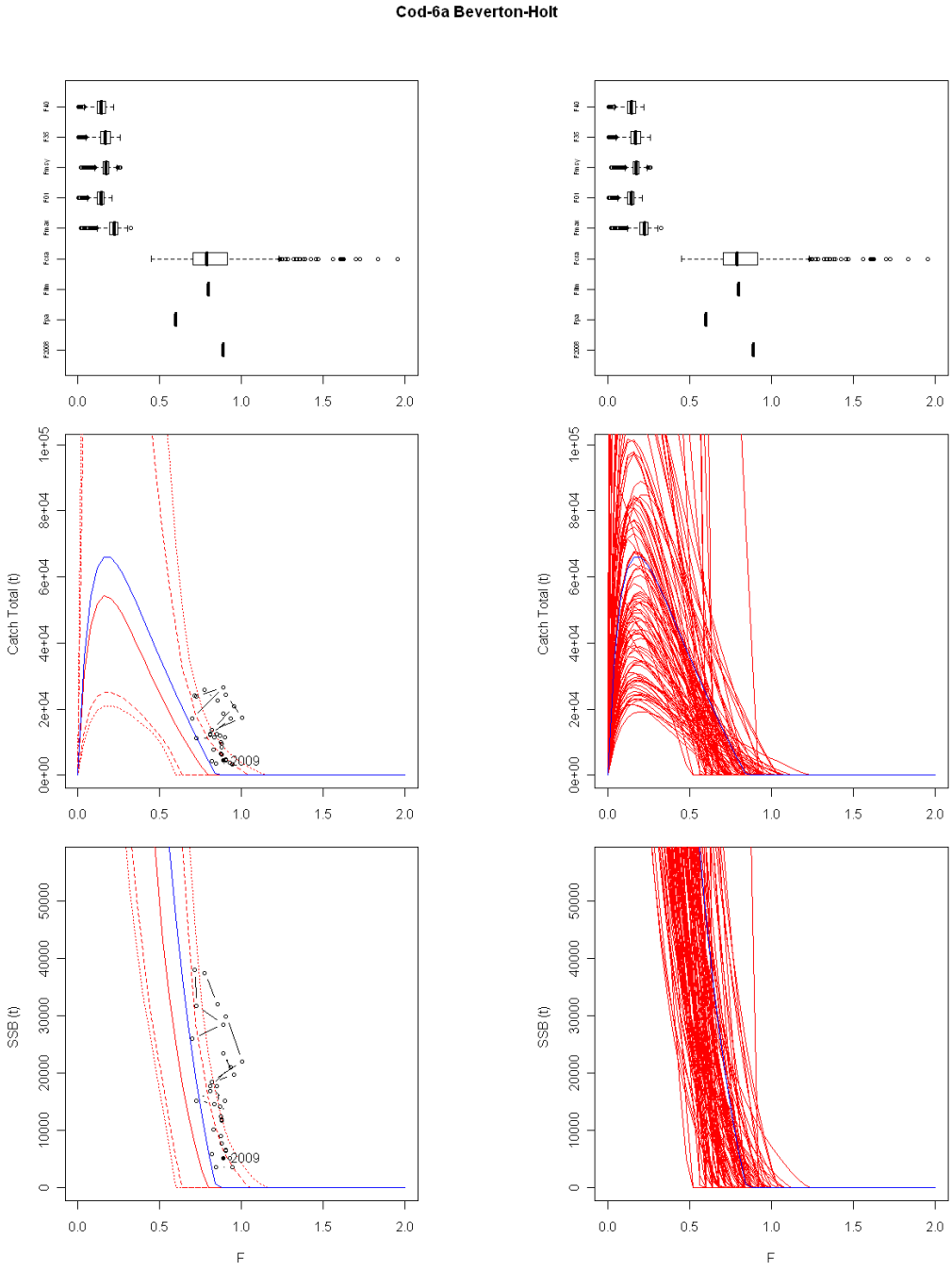


Figure 3.2.25. Cod in Division VIa. srmsymc package. Estimation of F reference points and equilibrium yield and SSB against mortality using Beverton–Holt recruitment model. For yield and SSB plots left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. Circles show data points 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.

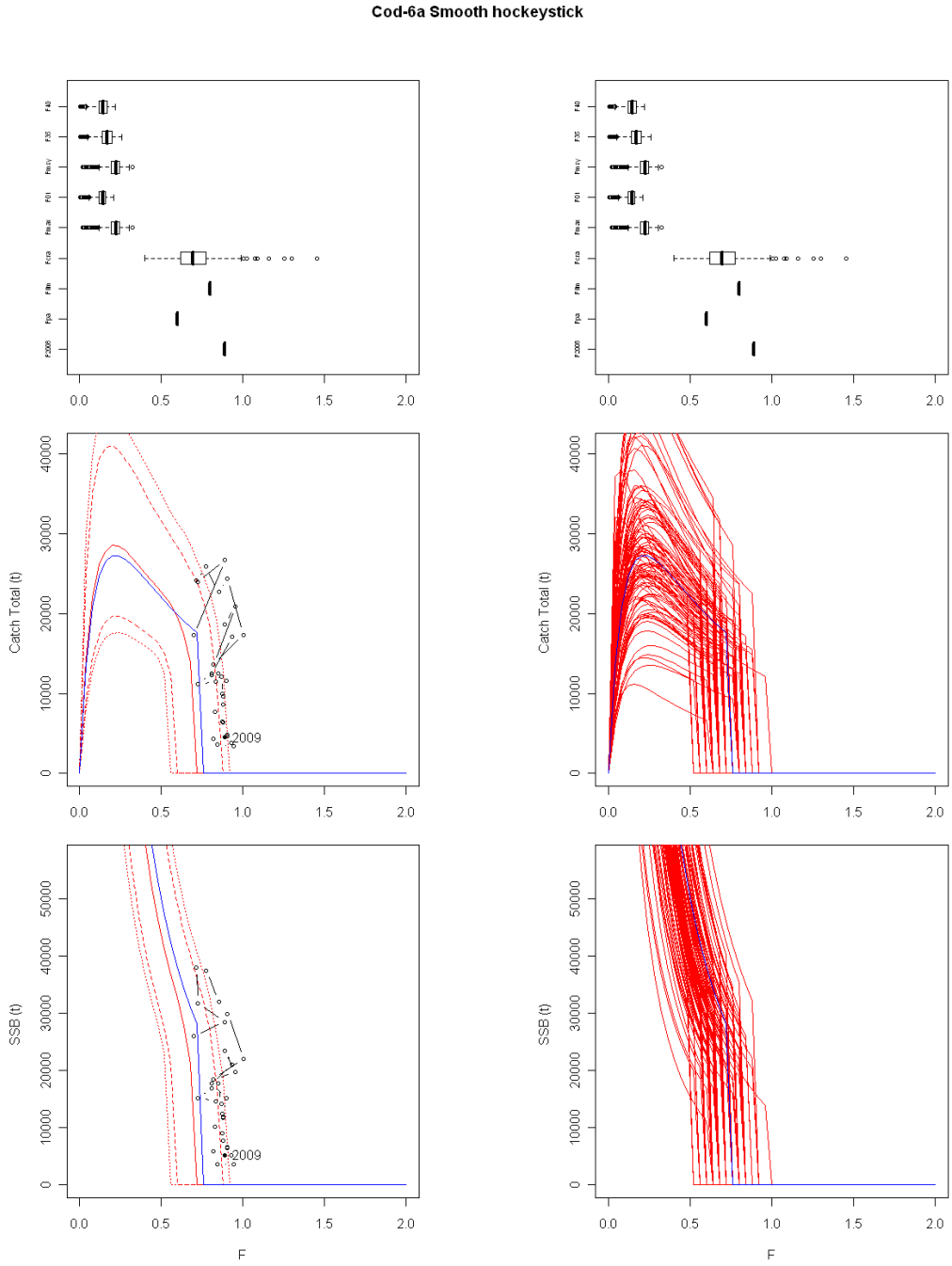


Figure 3.2.26. Cod in Division VIa. srmsymc package. Estimation of F reference points and equilibrium yield and SSB against mortality using smooth hockey-stick recruitment model. For yield and SSB plots left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. Circles show data points 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.

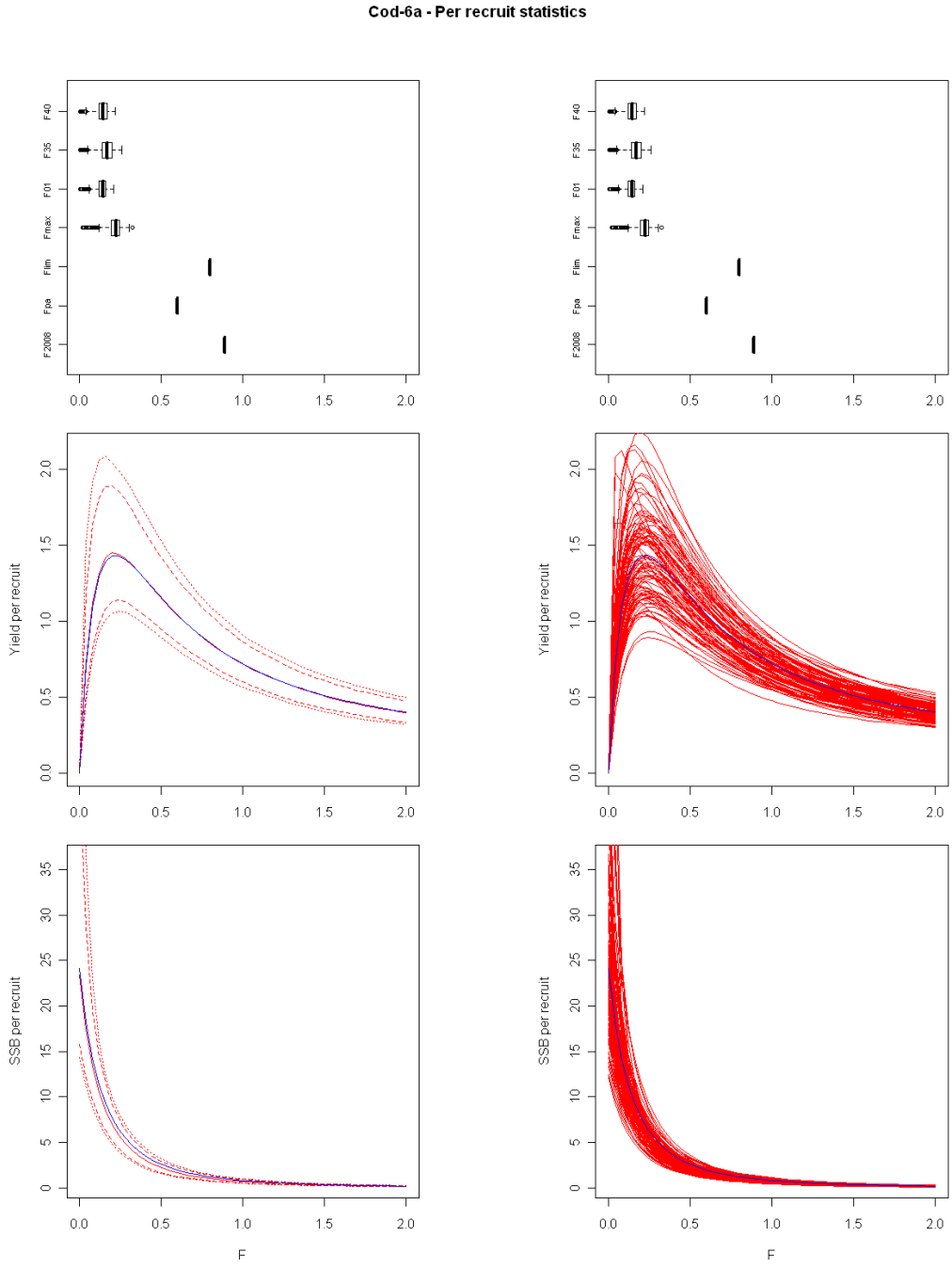


Figure 3.2.27. Cod in Division VIa. srmsymc package. F reference points and yield-per-recruit and SSB per recruit against mortality. For VIa cod the model has been run using total removals over and above natural mortality, i.e. the x-axis represents Z-0.2.

3.3 Haddock in Division VIa

Type of assessment in 2011

The stock assessment of VIa haddock in 2011 is an update of last year's assessment with the TSA model, using catch data up to 1994 and tuning data from two Scottish groundfish surveys In 2011 the ScoGFS-WIBTS Q1 was undertaken using a new survey stratification, survey trawl groundgear and adjusted sweep lengths in waters >80 m. In this year's assessment catch data were also included for the period 2006–2010 as these were thought to be recent years where sufficiently reliable catch data were available. See Section 3.3.2 for further explanation.

ICES advice applicable to 2010

The advice relating to the single-species exploitation boundary for 2010 was:

"*Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects:*

The current fishing mortality (2009) is estimated to be 0.30, which is the rate expected to lead to high long-term yields and low risk of stock depletion.

MSY approach

Following the ICES MSY framework implies fishing mortality to be reduced to 0.14, resulting in human consumption landings of less than 1300 t in 2010. This is expected to lead to an SSB of 24 100 t in 2012.

EC MSY transition approach

Following the EC MSY transition implies fishing mortality to be increased to 0.36, resulting in human consumption landings of less than 3100 t in 2010. This is expected to lead to an SSB of 20 200 t in 2012.

Policy paper approach

Following the Policy Paper implies fishing mortality to be maintained at 0.30, resulting in human consumption landings of less than 2600 t in 2010. This is expected to lead to an SSB of 21 200 t in 2012.

Exploitation boundaries in relation to precautionary limits:

In the absence of fishing, the stock is expected to be rebuilt close to B_{pa} in the short term."

Following a request to evaluate a management plan for haddock in VIa:

"*ICES advises that a harvest rule with a target fishing mortality of 0.3 and a TAC constraint of ±15% is consistent with the precautionary approach (high probability of SSB being above B_{lim} by 2015 and beyond). In addition, simulations suggest that this harvest rule has the best chance, among those tested, of producing a combination of low risk to biomass and high cumulative yield, thus it conforms with the goal of achieving long-term maximum sustainable yield from the stock.*

The harvest rule was tested for several combinations of target fishing mortality (0.2, 0.3, 0.4) and interannual variation in TAC (±15%, ±20%, ±25%)."

Note that the statement above refers to a management plan where, when SSB is below B_{lim}, the fishing mortality should be 0.1. Subsequent evaluations are being carried

out for a management plan where the TAC constraint is ±25% whether above or below B_{lim}.

ICES advice applicable to 2011

MSY approach

Following the ICES MSY framework implies fishing mortality to be increased to 0.3, resulting in human consumption landings of less than 13 300 t in 2011. This is expected to lead to an SSB of 52 300 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. Further regulations implemented for the west of Scotland, include technical measures associated with the cod recovery plan (EC regulation 1342/2008), 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 2010.

Species:	Haddock *Melanogrammus aeglefinus*	**Zone:**	EU and international waters of Vb and VIa (HAD/5BC6A.)
Belgium	3		
Germany	4		
France	147		
Ireland	438		
United Kingdom	2 081		
EU	2 673		
TAC	2 673		Analytical TAC

Values are tonnes.

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 tonnes.

Fishery in 2010

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. The UK surpassed their allocated quota by ~16% in 2010, increasing the overall uptake in relation to 2009. Uptake of quota has generally been low in recent years (e.g. ~73% in 2006; ~51% in 2007; ~45% in 2008 and ~79% in 2009) but in 2010 there was an increase to ~109%. Discards data that are reported are dealt with in the following section.

Country	TAC 2010	Official landings*	% uptake of quota
Belgium	3	0	0%
Germany	4	1	25%
France	147	88	60%
Ireland	438	396	90%
UK	2081	2414	116%
EC	2673	2911	109%

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

*** The official landings provided to the WG for 2010 are preliminary at time of writing in 2011.**

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 are likely to have reduced or largely eliminated underreported landings. Information from the Compliance section of Marine

Scotland suggests that approximately 435 tonnes of haddock were suspected of misreported out of Area VIa in 2010 (~18% of the officially reported UK(Scotland) landings). At the same time 246 tonnes were suspected of misreported in to Area VIa (~10% of the officially reported UK (Scotland) landings). The TAC in recent years was not restrictive; however this has not been the case in 2010.

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. As that was the initial year of the discard observer programme. The 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.). Discards data from Scotland were raised from ten sampled trips in 2010, spread across the year. And the Irish were raised from nine trips.

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. The weights-at-age of younger fish (age 1 and 2) have decreased in 2010. Weights-at-age in discards are relatively constant but with a decrease in weight in 2010. The supplied data for fish weights-at-age 1 in 2010 in Irish landings was 365 g. This is far from the 2009 value (460 g) but again it is higher than the Scottish 2010 value (245 g). 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^{o}C less than the Irish Sea and 2^{o}C less than Celtic Sea) being these the areas were the Irish fishing vessels are most likely to operate.

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	1985–2011	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 cpue.

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 (1985–2011) and with catch data included 1978–1994 and 2006–2010, 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 assess-

ment 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	2006 assessment	2007 assessment	2008 assessment	2009 assessment	2010 assessment	2011 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+	Years: 1978–1994 and 2006-2009 Ages: 1–8+	Years: 1978–1994 and 2006-2010 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	Years: 1985–2010 Ages 1–7	Years: 1985–2011 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	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. These are described here. A notable prediction error occurred in the ScoGFS-WIBTS Q1 in 2011 at age 6 This was due to a large index value in this survey year at that the model setting, $q_{catch}(age=6, year=2011)$ was altered (multiplied by 3.0 in the appropriate model settings) in order to decrease the influence of this extreme value (an adjustment recommended in Fryer, 2001 which has been applied previously to several age/year data points). A prediction error from the ScoGFS-WIBTS Q1 in 2009 (age 4) was also down weighted according to the same procedure. Three other points were down-weighted from the ScoGFS-WIBTS Q1 for the assessment 2011. 1993 age 2, 1995 age 7, 2002 age 3 (all of them were multiplied by 3.0).

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 2006–2010) 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 the retrospective pattern observed in F is not surprising.

Comparison with previous year's assessment

There was a minor revision of the discard and landings data for 2009 due to an update of the French data This resulted in an overall difference of an additional 8 tonnes in discards and 12 tonnes in landings.

The 2010 VIa haddock assessment estimated F in 2009 at 0.30 and SSB (January 1st 2009) at 16 818 tonnes. The current assessment has revised these figures, to a fishing mortality of 0.22 in 2009 and an SSB (January 2009) as 22 302 tonnes (33% increase). Recruitment in 2009 has been revised from 7.9 million to 21.9 million (~177% increase).

The estimate of SSB in January 2010 from this assessment is 19 004 tonnes with a standard error of 2009 tonnes (~11%). Last year's assessment put this figure at 13 377 tonnes.

The current assessment's estimate of SSB (for January 2011) is 29 508 tonnes. The short-term forecast from last year's assessment predicted SSB in 2011 to be at 13 600 tonnes. This is a difference of 15 908 tonnes (~117% increase 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 2010 are:

$F_{(2\text{-}6)}$ = 0.23

SSB = 19 004 t

Based on the most recent estimates of SSB in 2011 (29 508 tonnes, $>B_{lim,}$) ICES classifies the stock as being at full reproductive capacity.

Based on the most recent estimate of fishing mortality in 2010 (0.23, $<F_{pa}$) 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 $B_{trigger}$; ICES in relation to the MSY reference, classifies the stock as being appropriate.

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. The most recent estimate of recruitment, from the 2011 Quarter 1 Scottish Groundfish survey (the 2009 year class) is highest in the last nine years and above the long-term average.

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 survey 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 (2006–2010) the confidence intervals of the estimates are seen to reduce.

The difference between observed and predicted catch represents unaccounted removals, amounting to about 10% of the landings by 2006–2010. The reported catch in 2010 is within the bounds of error of the estimated catch. This is thought to reflect beneficial effects of management regulations and changes in fleet behaviour since 2006, and is supported by anecdotal information from the fishing industry. For example, there has been great effort reduction by the whitefish otter trawler fleet in Division VIa and the TAC does not appear to be restrictive for this fishery, diminishing the incentive to underreport landings. Information from the Compliance section of Marine Scotland put estimates of misreporting out and in of VIa at approximately 680 tonnes in 2010 (table below). The misreporting seems to occur mainly between Areas VIa and Iva but with the contribution of other areas as well.

Recorded in	IVa (EU)	VIa (EU)	VIa (EU)	VIa (EU)	VIa (EU)	VIa (EU)	VIb (EU)	VIIa (EU)
Suspected of	VIa (EU)	IVa (EU)	IVa (NEZ)	IVb (EU)	Vb (FEZ)	VIb (EU)	VIa (EU)	VIa (EU)
Tonnes	219.3	239.8	12.8	66.0	89.8	26.1	23.0	3.7

3.3.4 Short-term projections

Recruitment estimates

The TSA assessment model provides estimates of recruitment for the forecast years 2011 and 2012. The value for 2010 (that is, the 2010 year class at age 1) is based largely on the ScoGFS –WIBTS-Q1 datum for 2011 (along with a degree of time-series smoothing), and as it is based on observations it is appropriate to use it in the forecast. The value for 2012 (that is, the 2011 year class at age 1) is not generated directly by data, but rather the underlying Ricker stock–recruit model that is included by TSA (Figure 3.3.9) as part of the overall model fit. As with the assessment of last year, a

long-term (1978–2010) geometric mean is used for subsequent years (2013). The recruitment values used in the forecast are given in the following table:

Year	TSA	GM (78–10)
2011	5532 (~ ScoGFS)	
2012	116 300 (Ricker)	
2013	-	83 400

There is agreement in trends between the TSA-generated recruitment estimates, and the indices from the survey (see Figure 3.3.12).

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 procedure used instead of TSA's built in procedure is described below.

The time-series at age of fishing mortality estimate is shown in Figure 3.3.13, 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 3.3.14 compares a simple three-year mean, the most recent estimate (2010), 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 5830 tonnes; of these 51% are discards. Splitting discards by fleet shows that TR2 vessels are responsible for ~88% of all discards while landing only 21 tonnes, less than 1% of total landings (2882 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 3.3.15 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).

Short-term projections are presented here for reference only; they are not considered reliable because recruitment of haddock is characterized by sporadic events, therefore the use of geometric mean recruitment (1978–2010) for 2011–2013 provides a very uncertain estimate of future 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)
2011	5.83	29.5
2012	3.7	37.3
2013	-	46.9

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 establised (1998)
F_{pa} = 0.5	High probablity of avoiding SSB falling below B_{pa} in the long term
F_{lim}	Not defined

3.3.6 Management plans

There is no management plan currently in place for this stock. ICES has evaluated a proposed management plan, the details of which can be found at:

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

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.

Effort

Currently commercial cpue or lpue data cannot be used in the assessment with any confidence. The assessment is therefore primarily survey-based, with landings and discards data used prior to 1995.

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 the 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 2006–2010 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 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 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 a bias prone method for surveying. 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, had-

dock, 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. Also, 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 *de facto* 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 to be appropriate to re-include catch data when they become more reliable, and investigations have indicated that this has been the case in the years 2006–2010.

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. Continuing the work on management plan development is also important.

Landings and discards

There should be a full analysis of the precision and bias of catch-at-age data. Although catch data between 2006–2010 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.

Effort

A VMS-based analysis of lpue could help to address the concern that currently commercial cpue or lpue data cannot be used in the assessment. With the increased requirement for vessels to operate with VMS it is likely that the quality of effort data will improve. This will lead to an improved time-series of effort data in future but still leaves the uncertainties regarding the earlier years in the time-series.

Surveys

There are now seven years of data from the IGFS-WIBTS-Q4 and should be evaluated at the next benchmark for this stock Despite of not being currently used in the assessment, this survey was used as an index to corroborate the strength of the 2009 year class. Also due to the lack of the ScoGFS-WIBTS Q4 2010 survey it would assume a great importance the introduction of the IGFS survey into the assessment. Figure 3.1.16 shows the indices of all three surveys in a comparison plot. These seem to agree but further investigation is necessary before its introduction in the assessment.

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 and at this point is waiting to be signed off.

Discard rates, in recent years have been high, and in 2010 they represented 51% of the total catch. The majority of these discards ~88% (2592 tonnes) happen in the *Nephrops* fishery landing only 21 tonnes, 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 25 vessels in 2011 and still 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 - England & Wales	-	-	-	-	-	-	-	-	-	-	-	-
UK – (Total)	-	-	-	-	-	-	-	-	-	-	-	-
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	20101
Belgium	2	-	-	+	-	-	-	-	-	-
Denmark	-	-	+	+	-	-	-	-	-	-
Faroe Islands	-	-	-	4	-	1	2	+	-	0
France	160	151	183	173	273	291	211	151	139	88
Germany	1	-	-	-	1	7	-	1	-	-
Germany	-	-	-	-	-	-	-	-	-	1
Ireland	744	672	497	194	152	526	759	879	297	396
Netherlands	-	-	-	1	-	-	-	-	-	
Norway	32	30	23	4	21	17	16	28	18	11
Spain	4	4	5	-	47	44	5	10	21	-
UK – (E&W)3	201	237	107	93	42	19	193	32	14	-
UK - England & Wales	-	-	-	-	-	-	-	-	-	-
UK – (Total)	-	-	-	-	-	-	-	-	-	-
UK - Scotland	5886	5988	4582	2909	2025	4928	2587	1744	2366	2414
Un. Sov. Soc. Rep.	-	-	-	-	-	-	-	-	-	-
Total reported	7030	7082	5397	3378	2561	5833	3773	2845	2855	2911
WG estimates	6762	7115	5337	3874	3792	6266	3777	2848	2851	3016

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
1373	37370	1936	422	580	4633	258	158	1373	64

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

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

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

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

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

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	0.04	0.16	0.242	0.412	0.692	0.916	1.041	1.249	1.517
1966	0.04	0.162	0.251	0.555	0.572	1.041	1.125	1.325	1.522
1967	0.04	0.16	0.266	0.569	0.573	0.667	1.177	1.844	1.611
1968	0.04	0.159	0.264	0.567	0.823	0.731	0.811	1.43	1.903
1969	0.04	0.158	0.243	0.526	0.916	1.042	1.024	0.999	1.569
1970	0.04	0.161	0.23	0.368	0.812	1.283	1.262	1.043	1.342
1971	0.04	0.16	0.248	0.341	0.546	1.04	1.313	1.651	1.426
1972	0.04	0.16	0.249	0.38	0.53	0.546	0.984	1.499	1.538
1973	0.04	0.159	0.251	0.384	0.597	0.512	0.571	1.185	1.706
1974	0.04	0.159	0.248	0.368	0.527	0.764	0.685	0.798	1.142
1975	0.04	0.159	0.26	0.428	0.581	0.832	1.027	1.001	1.009
1976	0.04	0.159	0.256	0.459	0.592	0.831	1.095	1.585	1.084
1977	0.04	0.161	0.274	0.406	0.684	0.8	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	0.73	0.777	1.04	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	0.05	0.178	0.282	0.461	0.557	1.002	1.37	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	0.27	0.362	0.637	0.903	1.115	1.043	1.418
1987	0.028	0.168	0.27	0.418	0.566	0.88	1.105	1.25	1.147
1988	0.085	0.17	0.254	0.444	0.562	0.704	1.027	1.28	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	1.28	1.823
1991	0.058	0.184	0.297	0.547	0.618	0.678	0.931	1.053	1.091
1992	0.05	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	0.65	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	0.03	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	0.75	0.754	1.122
1997	0.048	0.153	0.263	0.394	0.614	0.73	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	0.84	1.067
2000	0.053	0.127	0.27	0.361	0.447	0.572	0.719	0.84	0.749
2001	0.05	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	0.81
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	0.29	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	0.043	0.067	0.180	0.388	0.409	0.459	0.725	0.755	0.852

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	1.92	1.833	0	0	0	0	0	1.713
1966	0	0	0	0	0	0	0	1.522
1967	2.355	0	0	0	0	0	0	1.786
1968	2.516	0	0	0	0	0	0	2.005
1969	2.065	0	0	0	0	0	0	1.590
1970	1.791	1.213	0	0	0	0	0	1.352
1971	1.466	2.042	0	0	0	0	0	1.506
1972	0	1.551	0	0	0	0	0	1.548
1973	2.202	1.52	0	0	0	0	0	1.581
1974	1.319	1.229	0	0.833	0.89	0	0	1.183
1975	1.19	2.523	0	0	0	0	0	1.016
1976	1.243	1.806	0	1.679	0	0	0	1.246
1977	1.394	1.339	1.593	0	0	0	0	1.325
1978	2.126	1.376	1.208	1.627	0	0	0	1.338
1979	1.735	1.569	1.781	1.119	1.59	0	0	1.754
1980	1.632	1.879	2.862	0	1.482	0	0	1.747
1981	1.366	1.314	1.785	1.587	0	1.677	0	1.379
1982	1.738	2.068	1.543	0	0	0	0	1.555
1983	1.556	1.555	1.999	0	0	0	0	1.572
1984	1.882	1.417	1.864	0	0	0	0	1.724
1985	1.695	2.014	2.152	2.741	0	0	4.141	1.694
1986	1.517	1.832	1.925	1.504	2.635	0	0	1.463
1987	1.149	1.851	2.774	3.04	2.828	2.664	0	1.182
1988	0.879	1.618	0.99	3.424	3.994	4.15	0	0.984
1989	1.357	0.949	1.388	2.807	3.008	0	0.429	1.110
1990	1.682	2.288	1.964	2.506	0	0	0	1.860
1991	1.755	3.29	2.17	1.343	0	0	2.869	1.201
1992	1.564	2.18	0	0	0	0	0	1.639
1993	1.21	1.578	2.304	1.8	2.405	0	0	1.483
1994	1.243	1.319	1.961	2.43	0	0	0	0.992
1995	0.94	1.953	1.996	2.492	0	0	0	1.020
1996	1.163	1.046	1.141	0	3.167	0	0	1.137
1997	2.024	1.63	2.252	0	3.033	0	0	1.020
1998	1.064	2.488	2.585	3.322	2.591	0	0	1.077
1999	1.465	1.465	3.246	1.993	2.954	2.829	0	1.172
2000	1.186	1.262	0	2.168	0	0	0	0.813
2001	0.975	1.089	3.361	0.597	0	0	0	1.015
2002	1.995	0.916	0	2.698	0	0	0	0.939
2003	1.232	1.393	2.682	0	0	0	0	1.086
2004	0.853	1.396	3.976	0	0	0	0	0.988
2005	1.467	2.084	3.491	2.275	0	0	0	1.018
2006	1.182	1.682	2.675	0	3.889	5.471	0	1.294
2007	0.825	2.160	2.270	0	0	0	0	0.685
2008	0.911	2.494	2.109	0	0	0	0	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

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

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

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

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

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
2011	23	3759	310	98	109	828	12	10	5139

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

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	2003	2004	2005	2006	2007	2008	2009	2010	2011
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	0.43	0.4105
	F (2, 1978)		0.67	0.5	0.51	0.50	0.56	0.71	0.70	0.81	0.6707
	F (4, 1978)		0.53	0.51	0.51	0.51	0.52	0.56	0.57	0.59	0.5971
Survey selectivities	□(1)		3.99	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	4.84	2.71	2.45	2.55	3.01	3.07	3.01	3.34	2.86
	□(4)		2.1	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	0.00	0.11	0.10	0.10	0.12	0.20	0.20	0.19	0.076
	□U	Persistent changes in selection (age effect in F)	0.05	0.04	0.01	0.00	0.09	0.03	0.03	0.05	0.08
	□V	Transitory changes in the year effect in F	0.27	0.23	0.22	0.23	0.23	0.33	0.35	0.26	0.25
	□Y	Persistent changes in the year effect in F	0.00	0.14	0.09	0.09	0.07	0.00	0.00	0.15	0.17
Survey catchability standard deviations	□	Transitory changes in ScoGFS Q1 catchability	0.00	0.08	0.18	0.30	0.19	0.12	0.12	0.27	0.23
	□	Persistent changes in ScoGFS Q1 catchability	0.14	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	0.22	0.25	0.23	0.20	0.20	0.24	0.25	0.28	0.24
	cv discards	Coefficent of variation of discards-at-age data	0.51	0.43	0.45	0.42	0.41	0.54	0.54	0.59	0.51
	cv survey	Coefficent of variation of ScoGFS Q1 survey data	0.40	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	2003	2004	2005	2006	2007	2008	2009	2010	2011
Discard curve parameters	□P	Transitory changes in overall discard proportion	0.50	0.19	0.20	0.19	0.18	0.20	0.20	0.00	0.30
	□□ 1	Transitory changes in discard-ogive intercept	0.00	0.15	0.02	0.00	0.14	0.00	0.00	0.01	0.00
	□□ 1	Persistent changes in discard-ogive intercept	0.26	0.21	0.22	0.21	0.32	0.26	0.25	0.29	0.28
	□□ 2	Transitory changes in discard-ogive slope	0.34	0.01	0.03	0.21	0.23	0.22	0.23	0.40	0.36
	□□ 2	Persistent changes in discard-ogive slope	0.02	0.61	0.43	0.23	0.002	0.000	0.000	0.00	0.0
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)	9.10	9.63	9.71	9.73	9.06	11.35	11.08	9.62	10.84
	□2	Ricker parameter (curve dome occurs at $1/\eta^2$)	0.33	0.29	0.31	0.29	0.30	0.35	0.35	0.39	0.36
	cv rec	Coefficent of variation of recruitment curve	0.52	0.89	0.89	0.90	0.62	0.60	0.61	0.69	0.55

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	69076	8047	2435	59099	4412	610	479	1045
1979	155068	41185	3905	1057	22713	1509	220	561
1980	501887	87106	17587	1513	371	7548	448	241
1981	63026	322440	44882	7215	593	151	2985	254
1982	71169	41985	191820	22592	3459	290	75	1565
1983	44787	47495	24885	103340	11666	1798	150	853
1984	336806	28409	25639	10930	47148	5308	805	469
1985	73355	200978	12036	9748	4633	19894	2214	530
1986	59617	42544	94867	5011	4044	2001	8342	1170
1987	270616	38677	23127	48080	2564	2086	1039	4891
1988	22295	146689	14890	8018	16477	860	696	2021
1989	16216	11586	61178	5493	2844	5867	311	976
1990	98947	7993	4413	22949	1916	958	1983	437
1991	126295	58734	3319	1837	9526	792	398	999
1992	180215	71060	24172	1183	701	3573	300	526
1993	184579	111886	33850	10182	524	308	1555	359
1994	57675	103697	42158	9632	3023	147	87	555
1995	207798	33973	49726	16691	3742	1205	59	254
1996	113294	121442	15410	19826	6401	1447	471	122
1997	132049	62616	51198	5507	7326	2303	529	217
1998	146197	73795	25618	17836	1993	2644	826	269
1999	31542	80334	29209	8781	6199	714	964	385
2000	508661	16945	31033	9730	3142	2058	251	472
2001	199368	262441	6103	8984	2887	960	584	213
2002	97823	120660	128097	2633	3583	1142	386	316
2003	115446	65154	70712	71262	1306	1769	574	351
2004	46052	74446	36248	37658	32041	590	797	420
2005	29476	28859	39761	18464	17194	14204	259	539
2006	104721	16680	13506	16610	6718	6367	5010	286
2007	23103	67262	8389	6844	7402	2959	2826	2317
2008	13972	14864	40984	4871	3609	3843	1550	2688
2009	24596	9341	9475	26729	2896	2163	2284	2528
2010	134971	17346	6198	6541	17191	1854	1388	3089
2011	17382	94357	11441	4224	4270	11096	1206	2913
2012	109794	12098	61313	7693	2671	2700	7017	2604

***Estimates for 2011 and 2012 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	7680.7581	713.66067	282.89319	375.24692	1044.4071	186.34319	107.50876	285.40186
1979	15059.291	3980.6091	329.16963	133.86536	1721.3997	495.44174	94.586488	156.12112
1980	41490.823	8085.3057	2033.4584	165.66072	61.472679	1012.6672	233.73317	92.155607
1981	6654.6378	26490.176	4773.8027	1034.1256	91.605527	34.758886	579.40641	138.96673
1982	7879.5052	4493.1513	16596.352	2553.1159	541.78473	54.524069	20.756808	376.11037
1983	5930.2272	5301.4998	2719.1761	8783.4684	1272.9889	288.97068	31.157739	207.21062
1984	35541.225	3333.0356	2553.07	1119.787	3432.92	496.84632	115.2341	85.335489
1985	8170.0062	19845.891	1475.278	1217.3977	448.42292	1938.8053	292.31023	79.392071
1986	6425.4495	4464.2209	9170.227	575.77142	513.51126	252.55782	1162.8688	189.29034
1987	34147.264	3923.4529	2477.3898	4627.164	284.87577	269.57087	146.39853	718.51068
1988	4091.8135	15764.112	1455.735	909.1432	1736.3719	118.58138	124.6594	346.98751
1989	3684.6073	1517.0202	6374.9505	586.22854	342.8845	739.44152	54.471433	180.00044
1990	12002.917	1558.2411	544.19818	2718.3574	234.10389	156.06351	365.28894	99.563423
1991	13233.463	6768.8043	493.36272	200.67548	1012.8211	94.94132	66.811831	174.00583
1992	18430.666	6662.2247	2595.0451	163.30142	70.478959	429.60654	43.529415	85.957254
1993	20082.854	10929.535	2855.6964	1066.1101	54.97695	29.71376	192.01416	47.441912
1994	11308.729	11640.395	4196.0058	953.25349	274.18639	13.249435	10.510903	66.540817
1995	28308.588	6841.1845	7213.707	2722.0073	598.45578	188.21762	9.7276637	44.685884
1996	19973.849	19181.761	3403.0847	3652.4585	1243.8714	281.86356	93.58631	25.939739
1997	22400.347	11183.5	9382.6976	1087.9189	1225.9712	440.08745	108.10771	45.902796
1998	22859.317	11750.603	4405.5472	3062.1764	299.74394	357.06128	138.46706	47.450485
1999	9731.3542	12759.485	4974.0646	1385.9393	1027.9695	105.3525	145.12154	66.07159
2000	101502.11	5353.7406	6147.4025	1853.1624	535.52209	441.13812	50.149917	96.534405
2001	24270.173	47902.459	1632.5661	1748.7471	522.07933	165.85059	151.5133	52.754375
2002	14415.294	13500.63	20620.75	432.27296	543.75467	162.96822	58.445121	65.533372
2003	14442.976	9398.3911	8198.4331	10455.959	205.25986	273.0398	88.064524	60.491915
2004	6197.1757	9480.1881	5206.3832	4636.9955	4607.3458	99.647874	141.42527	74.684069
2005	4278.4364	3762.3073	5591.0329	2527.6238	2137.7359	2188.6836	48.473927	99.688369
2006	8370.2525	2267.4624	1444.7327	1822.0121	739.54094	749.92949	831.71256	54.016837
2007	2836.5048	5320.5852	1211.0334	725.31779	867.9712	390.21218	425.6539	453.03156
2008	2908.9791	1712.4127	3552.5262	624.64609	417.67572	521.90423	245.46834	460.10377
2009	5609.6048	1944.9403	1091.4156	2404.2826	411.57506	289.39346	360.00954	423.10283
2010	23852.56	4054.1239	1346.5629	839.58052	1801.0605	296.73358	212.11782	491.31837
2011	33812.363	17505.255	2756.9394	941.67446	611.38282	1406.5954	217.02947	470.14959
2012	60768.184	23571.761	13097.995	1998.5183	665.02937	506.02365	1250.4611	527.52466

***Estimates for 2011 and 2012 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	0.2988685	0.4458873	0.6341248	0.7636918	0.766471	0.7579773	0.7517134	0.7548334
1979	0.3766399	0.6299629	0.7454233	0.8538543	0.870116	0.8615486	0.8666279	0.8656776
1980	0.2585282	0.4612172	0.6134899	0.6947724	0.6636843	0.6779775	0.6760237	0.6718661
1981	0.2104816	0.3372768	0.4697196	0.4964646	0.4968406	0.489848	0.4990518	0.4964275
1982	0.20192	0.3207524	0.4063326	0.4619612	0.4562779	0.4618071	0.4637395	0.4575135
1983	0.2807623	0.423583	0.4373751	0.4741334	0.4815324	0.4863003	0.4856971	0.4943724
1984	0.325025	0.6037283	0.7282339	0.6584988	0.6543647	0.6706382	0.6718816	0.6655837
1985	0.3448145	0.5516437	0.6637909	0.663027	0.6379627	0.6667289	0.6507081	0.6465875
1986	0.2262162	0.4109287	0.476569	0.4648742	0.4579504	0.4512355	0.4625107	0.4632209
1987	0.4123337	0.7496722	0.8586961	0.871231	0.8926179	0.8953901	0.884557	0.8746061
1988	0.4053304	0.6757967	0.7965007	0.8336872	0.8323018	0.8160659	0.8197768	0.8261099
1989	0.4050814	0.6965645	0.7719975	0.8363724	0.8563897	0.8603704	0.8556128	0.854311
1990	0.3227772	0.6446311	0.6784371	0.672039	0.6741911	0.662637	0.6730879	0.6717257
1991	0.3631173	0.6880489	0.8045591	0.752443	0.7807398	0.7642939	0.7762774	0.7671235
1992	0.252216	0.4849945	0.6528354	0.6089101	0.5748144	0.5977391	0.5942593	0.5887749
1993	0.3665189	0.7350086	0.9936309	0.9284949	0.9214506	0.9595969	0.939885	0.9427282
1994	0.3421254	0.5169411	0.7146191	0.7401114	0.7076728	0.7083775	0.7221441	0.7156858
1995	0.3378486	0.5825792	0.7197008	0.7548053	0.7489767	0.7384421	0.7438222	0.7442031
1996	0.3925833	0.6648649	0.82824	0.7955944	0.8210597	0.8059715	0.8034656	0.8076895
1997	0.3935855	0.6963258	0.8603952	0.8080388	0.7805034	0.824308	0.8095365	0.8083949
1998	0.4024028	0.7274882	0.8651421	0.8631002	0.8185784	0.8040871	0.843675	0.8323807
1999	0.408201	0.7477899	0.8984973	0.8454646	0.8818322	0.842924	0.8378588	0.8554247
2000	0.4587839	0.8504375	1.0375051	1.0214988	0.9912442	1.0516206	1.0153849	1.0209357
2001	0.287581	0.5308291	0.6919276	0.7230524	0.7072814	0.6951046	0.7263344	0.7135568
2002	0.2064314	0.3315148	0.4166309	0.50201	0.5029943	0.4858028	0.4842632	0.4935976
2003	0.2392339	0.3920784	0.4214175	0.5952535	0.5972565	0.5997924	0.5961619	0.5903967
2004	0.2656114	0.4251686	0.4776931	0.5839767	0.6134374	0.6227742	0.6143708	0.6112762
2005	0.3644565	0.5679953	0.6589535	0.8106179	0.7937831	0.8318731	0.823936	0.8180149
2006	0.262802	0.4498199	0.4765107	0.6003383	0.6153198	0.6082807	0.619521	0.6059282
2007	0.2320079	0.2966227	0.3594623	0.4394955	0.451298	0.4434752	0.4453908	0.4437779
2008	0.1782784	0.2480998	0.2213478	0.3175094	0.3110835	0.3187046	0.3149822	0.3148026
2009	0.1460121	0.2079865	0.1701751	0.2403887	0.2464547	0.2437485	0.2444435	0.2423229
2010	0.1507412	0.2088229	0.1765188	0.224757	0.23692	0.2296376	0.2304808	0.2292399
2011	0.1623416	0.2310901	0.1969336	0.2583396	0.2583097	0.258259	0.2584656	0.2583959
2012	0.1639251	0.2338546	0.1991835	0.2613319	0.2613319	0.2613319	0.2613319	0.2613319

***Estimates for 2011 and 2012 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	0.206453	0.148727	0.150504	0.108707	0.115775	0.122662	0.125273	0.12418
1979	0.190304	0.136666	0.126038	0.112172	0.106457	0.116014	0.12161	0.120787
1980	0.208158	0.148104	0.145012	0.119063	0.12446	0.120835	0.129743	0.130305
1981	0.209366	0.161555	0.143026	0.128513	0.131389	0.135432	0.135355	0.138316
1982	0.201553	0.153463	0.140118	0.12315	0.125167	0.129327	0.134997	0.131419
1983	0.184809	0.1416	0.149031	0.116512	0.11937	0.123065	0.128858	0.12718
1984	0.21629	0.141486	0.125516	0.122116	0.117068	0.126711	0.130847	0.131687
1985	0.190243	0.141482	0.137154	0.117076	0.119771	0.121926	0.128573	0.129561
1986	0.203079	0.148184	0.138435	0.125298	0.126471	0.129743	0.132856	0.134561
1987	0.19178	0.12471	0.121978	0.100229	0.104401	0.111435	0.11682	0.114219
1988	0.198018	0.136202	0.12154	0.106595	0.107466	0.115629	0.120396	0.119079
1989	0.202943	0.146291	0.131197	0.108204	0.110479	0.113555	0.121968	0.120986
1990	0.194262	0.144491	0.143296	0.118571	0.119718	0.123929	0.127724	0.129457
1991	0.190284	0.136179	0.138359	0.110111	0.110501	0.118149	0.123135	0.121775
1992	0.196615	0.140633	0.133626	0.118286	0.118913	0.123312	0.128944	0.128488
1993	0.191276	0.127054	0.109989	0.101333	0.102957	0.116037	0.116956	0.119794
1994	0.235951	0.198522	0.186487	0.164914	0.167563	0.173068	0.174508	0.174294
1995	0.313633	0.26698	0.251585	0.229771	0.230826	0.232599	0.234215	0.234215
1996	0.309893	0.25826	0.253674	0.228216	0.227918	0.229333	0.230655	0.231699
1997	0.294442	0.238737	0.219479	0.200516	0.200392	0.201758	0.204296	0.205411
1998	0.300334	0.238714	0.229005	0.198704	0.199751	0.201172	0.203111	0.204586
1999	0.312079	0.249444	0.237881	0.215584	0.214342	0.215604	0.216602	0.218279
2000	0.312464	0.247619	0.224117	0.207523	0.206965	0.207899	0.210009	0.211204
2001	0.317023	0.253042	0.241566	0.214318	0.215251	0.215485	0.216871	0.218404
2002	0.326674	0.265213	0.256829	0.228131	0.227145	0.227669	0.227915	0.229972
2003	0.325278	0.266759	0.250366	0.226513	0.225861	0.226795	0.228187	0.229242
2004	0.327999	0.265352	0.250926	0.230496	0.230195	0.231583	0.232418	0.233467
2005	0.298893	0.23372	0.204967	0.183508	0.183724	0.18671	0.189898	0.189999
2006	0.232325	0.169921	0.154264	0.121719	0.122623	0.125637	0.130809	0.133124
2007	0.237761	0.179961	0.172191	0.132762	0.13316	0.135659	0.140711	0.14191
2008	0.243622	0.196434	0.195269	0.145507	0.146524	0.147506	0.152729	0.153586
2009	0.252796	0.21284	0.215753	0.159105	0.159074	0.160202	0.16481	0.16558
2010	0.279207	0.243262	0.251027	0.176641	0.17748	0.178924	0.183039	0.18314
2011	0.445671	0.410543	0.412679	0.383666	0.383651	0.383678	0.383668	0.383683
2012	0.483273	0.451159	0.453215	0.426662	0.426662	0.426662	0.426662	0.426662

***Estimates for 2011 and 2012 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 2011 and 2012 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	18892	1439	2318	2438	525	19505	21308	1620	0.674	0.059	38947	1020	69076	7681
1979	14837	16285	1451	13841	9592	1947	28678	26042	2713	0.792	0.064	30683	1909	155068	15059
1980	12759	13928	1564	4715	16397	3177	17474	32034	4237	0.622	0.058	35728	2437	501887	41491
1981	18233	18946	2584	15048	14754	3133	33281	34640	4515	0.458	0.047	77463	4683	63026	6655
1982	29635	28616	4115	10063	7430	1625	39698	34693	4132	0.421	0.041	102365	6732	71169	7880
1983	29411	29903	3332	6781	5230	1008	36192	35084	3573	0.461	0.042	92449	5473	44787	5930
1984	30689	27519	2409	15666	14735	3264	46355	42614	4639	0.663	0.059	63486	3085	336806	35541
1985	24451	23728	2329	17385	16310	3270	41837	39833	4571	0.637	0.057	67393	4069	73355	8170
1986	19561	19966	2399	7153	5082	1038	26714	23972	2745	0.452	0.044	60311	4027	59617	6425
1987	27012	29271	2613	16193	15710	3530	43205	45066	4887	0.854	0.064	54488	3381	270616	34147
1988	21153	21302	2217	9519	10188	2268	30672	31567	3685	0.791	0.064	47728	3103	22295	4092
1989	16691	18809	2335	2979	3028	767	19669	21320	2546	0.804	0.068	38836	2939	16216	3685
1990	10141	10854	1374	5381	3205	709	15522	13169	1630	0.666	0.062	21962	1800	98947	12003
1991	10557	10080	1037	8691	9624	1823	19248	20258	2485	0.758	0.064	21702	1531	126295	13233
1992	11351	10105	1120	9161	9192	1542	20513	20008	2217	0.584	0.053	29703	1901	180215	18431
1993	19068	18345	1767	16803	16303	2365	35871	34667	3028	0.908	0.069	42622	2545	184579	20083
1994	14272	12130	1530	11070	11903	2173	25342	24406	2840	0.678	0.101	40773	2981	57675	11309
1995	12368	14613	3824	8552	12543	3458	20920	26819	6216	0.709	0.154	36738	4682	207798	28309

Continued on next page.

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 2011 and 2012 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	13691	4037	11351	14178	3841	24817	28210	6944	0.783	0.166	37934	5269	113294	19974
1997	12883	15163	4268	6461	13925	3674	19344	30163	6622	0.794	0.145	41243	5718	132049	22400
1998	14401	12529	3324	5535	15715	3941	19936	29464	6326	0.816	0.150	35194	4326	146197	22859
1999	10464	11114	3198	4856	10498	2884	15321	22636	5058	0.843	0.166	32270	4012	31542	9731
2000	6958	10288	3020	7893	24856	8530	14851	35652	10146	0.990	0.185	22040	3526	508661	101502
2001	6762	7957	3182	6626	23531	6854	13389	33244	9199	0.670	0.132	45318	7411	199368	24270
2002	7115	10999	4264	8862	12067	3531	15977	22412	5553	0.448	0.094	58550	7275	97823	14415
2003	5337	17543	4783	4101	9935	2814	9438	26005	5610	0.521	0.109	58965	5908	115446	14443
2004	3874	14060	3588	3705	6905	1919	7579	19504	4388	0.545	0.116	43522	4352	46052	6197
2005	3792	16289	3733	2902	5645	1601	6694	20560	4187	0.733	0.121	38990	4037	29476	4278
2006	6266	7374	908	4618	5792	1062	10884	12991	1479	0.550	0.053	22781	1461	104721	8370
2007	3777	4250	471	3968	4094	720	7745	8327	1000	0.398	0.044	22194	1342	23103	2837
2008	2848	3802	436	1229	2155	485	4077	6189	808	0.283	0.036	27295	1850	13972	2909
2009	2851	3269	484	1643	1558	356	4494	4824	560	0.222	0.031	22766	1706	24596	5610
2010	3016	3174	362	2812	1748	388	5828	5000	622	0.215	0.035	19852	1850	134971	23853
2011*	NA	3780	1234	NA	4025	1628	NA	8110	2760	0.241	0.088	31551	3696	17382	33812
2012*	NA	4488	1680	NA	3797	1921	NA	8741	3287	0.243	0.098	38156	7512	109794	60768
Min	2848	3174		1229	1558		4077	4824		0.215		19852		13972	
GM	10776	12940		6398	8138		17683	22238		0.592		39477		86793	
AM	13430	14994		7815	10190		21245	25233		0.629		43403		129112	
Max	30689	29903		17385	24856		46355	45066		0.990		102365		508661	

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
arithmetic mean	2011	0.105	0.230	0.371	0.437	0.533	0.659	0.698	0.904
linear model	2011					0.530	0.561	0.834	0.991
	year class in 2011	2010	2009	2008	2007	2006	2005	2004	2003
	CV	0.327	0.193	0.043	0.109	0.121	0.088	0.091	0.104

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	17381.77	1.95	WS1	0.105	0.33
N2	94356.51	0.19	WS2	0.230	0.19
N3	11440.96	0.24	WS3	0.371	0.04
N4	4223.859	0.22	WS4	0.437	0.11
N5	4270.216	0.14	WS5	0.530	0.12
N6	11095.72	0.13	WS6	0.561	0.09
N7	1205.718	0.18	WS7	0.834	0.09
N8	2912.888	0.16	WS8	0.991	0.10
Removals selectivity			**Removals weights**		
sH1	0.158	0.11	WH1	0.105	0.33
sH2	0.222	0.10	WH2	0.230	0.19
sH3	0.189	0.15	WH3	0.371	0.04
sH4	0.261	0.19	WH4	0.437	0.11
sH5	0.265	0.15	WH5	0.530	0.12
sH6	0.264	0.18	WH6	0.561	0.09
sH7	0.263	0.17	WH7	0.834	0.09
sH8	0.262	0.18	WH8	0.991	0.10
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**		
'HF10'	1	0.08	'K10'	1	0.1
'HF11'	1	0.08	'K11'	1	0.1
'HF12'	1	0.08	'K12'	1	0.1
Recruitment					
'R12'	109794	0.606			
'R13'	86793	1.42			
Prop. F before spawning	0				
Prop. M before spawning	0				

Stock numbers in 2011 are TSA survivors.

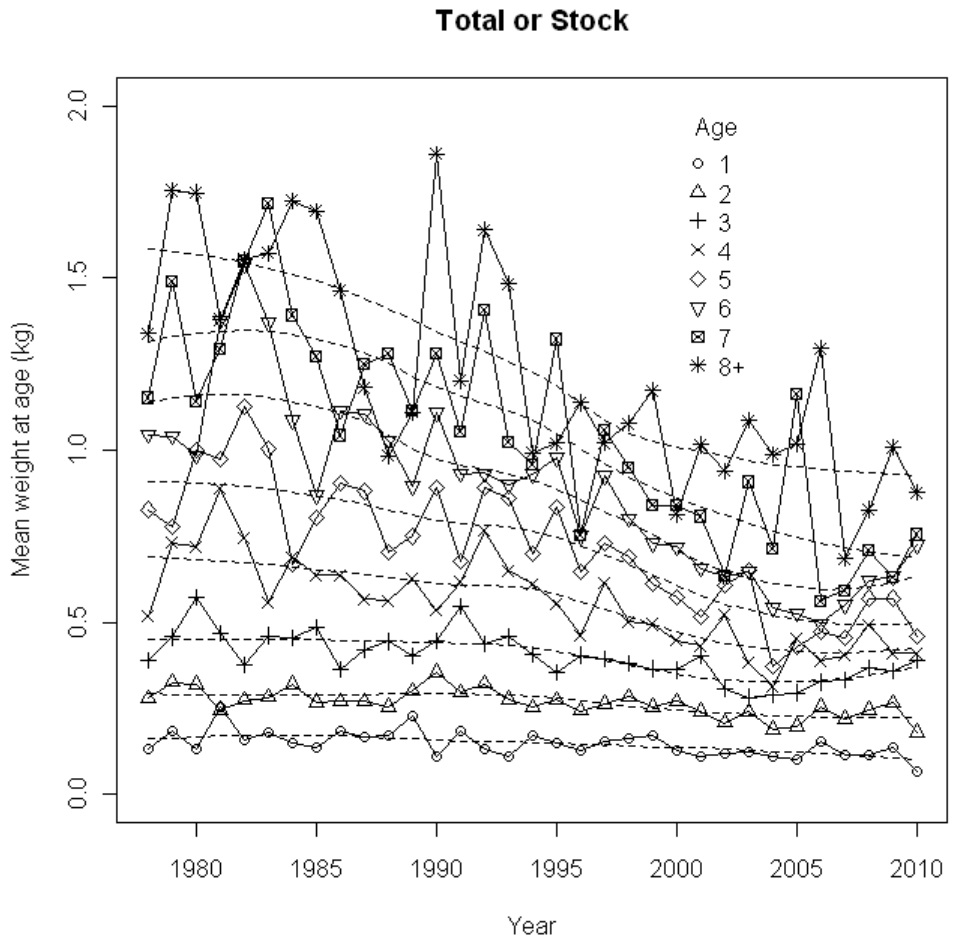


Figure 3.3.1. Haddock in Division VIa. Mean weights-at-age (kg) in total catch (also used for stock weights). Dotted lines show loess smoothers fitted through each time-series at age. For clarity, only ages 1–8+ are shown here.

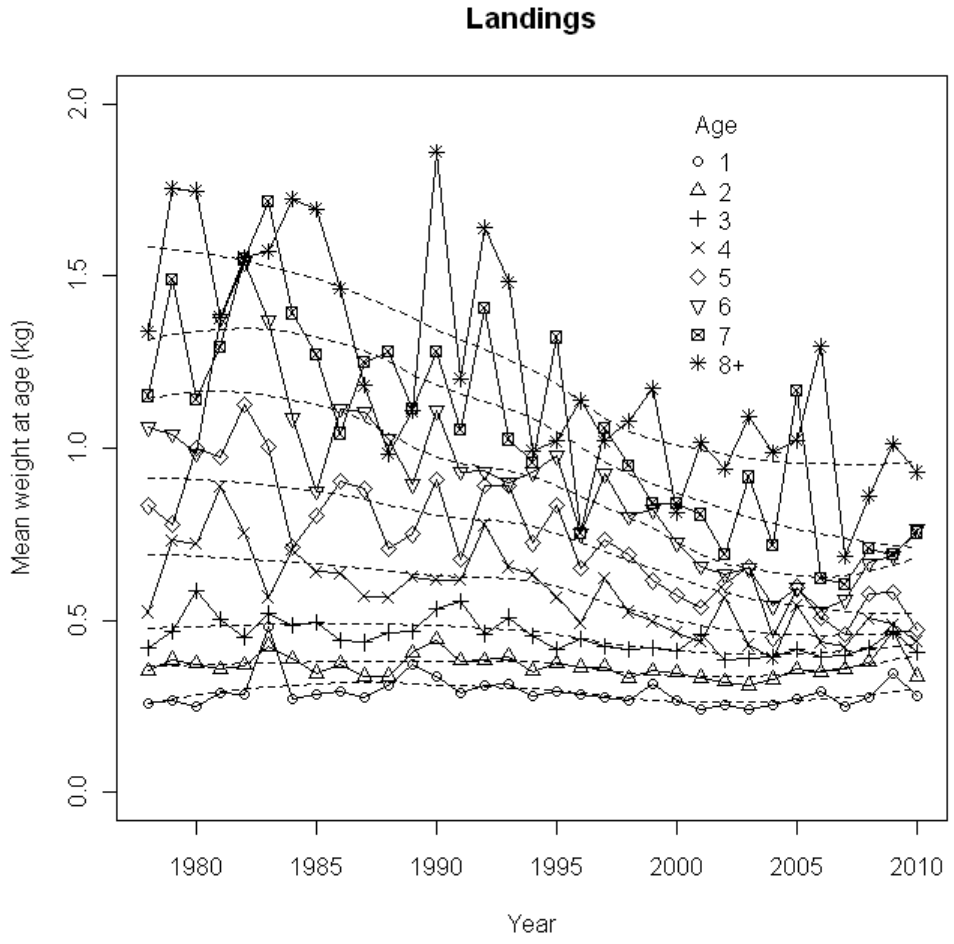


Figure 3.3.2. Haddock in Division VIa. Mean weights-at-age (kg) in landings. Dotted lines show Loess smoothers fitted through each time-series at age. For clarity, only ages 1–8+ are shown here.

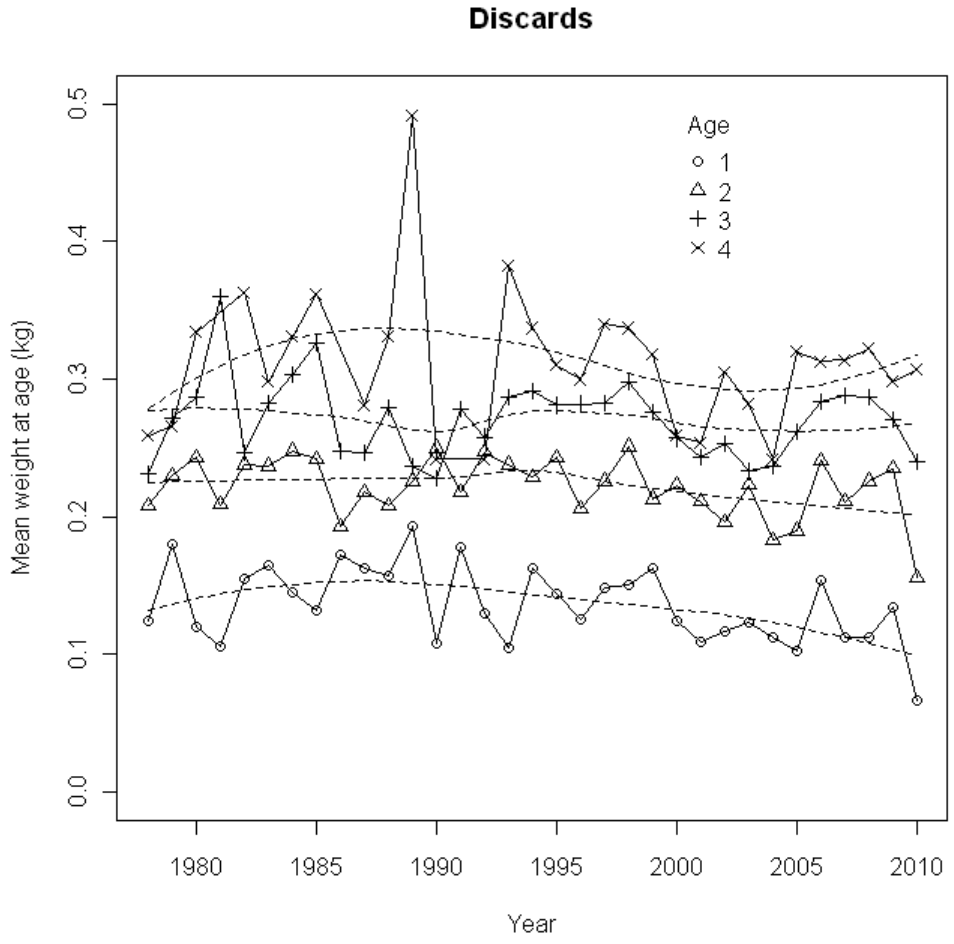


Figure 3.3.3. Haddock in Division VIa. Mean weights-at-age (kg) in discards. Dotted lines show Loess smoothers fitted through each time-series at age. For clarity, only ages 1–4 are shown here.

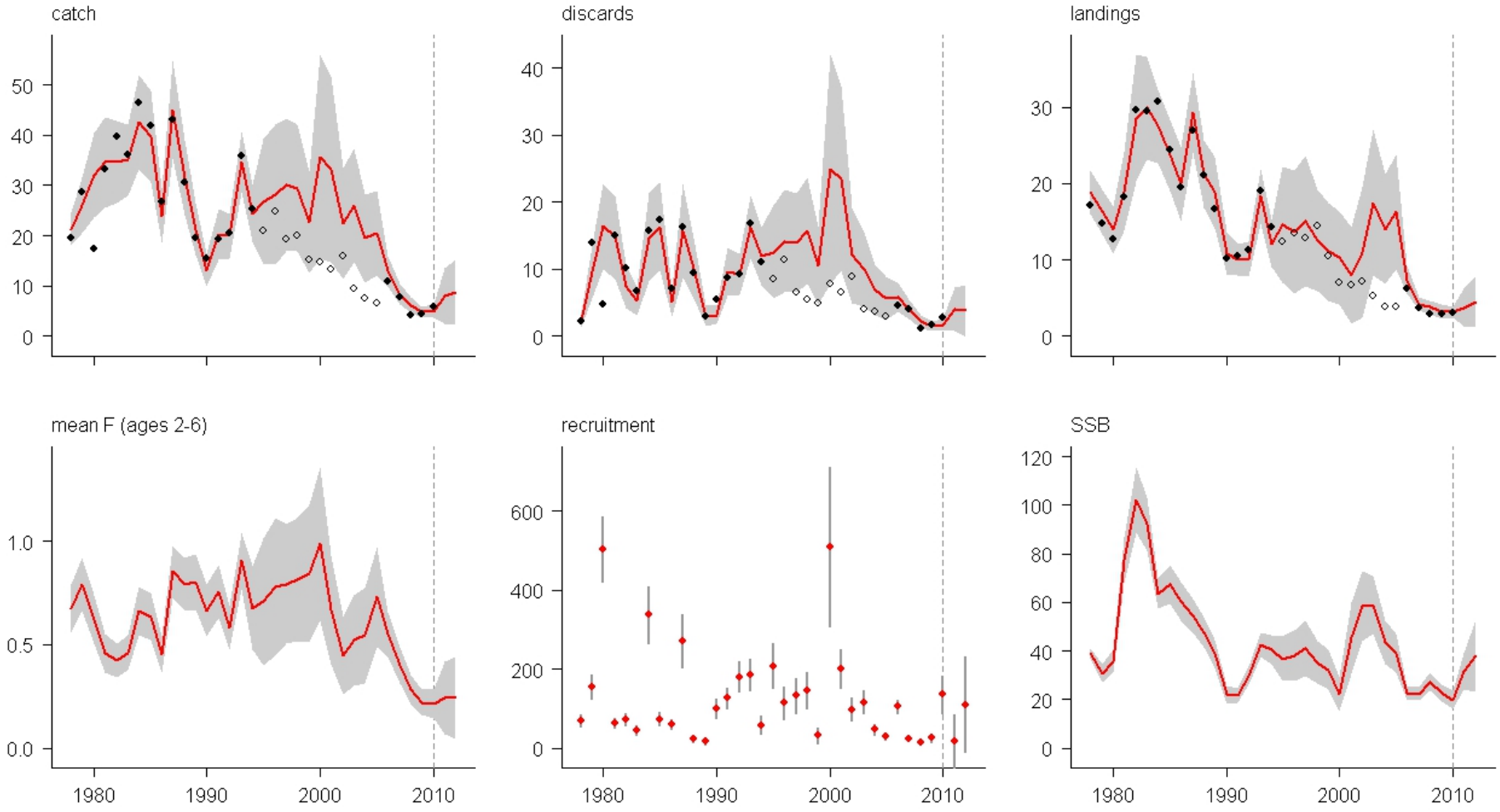


Figure 3.3.4. Haddock in Division VIa. TSA stock summaries from the final run with catch data included 1978–1994 and 2006–2010. Estimates are plotted with approximate point-wise 95% confidence bounds. Dots indicate observed values for catch, landings and discards. Values to the right of the vertical dashed line are forecasted by the model.

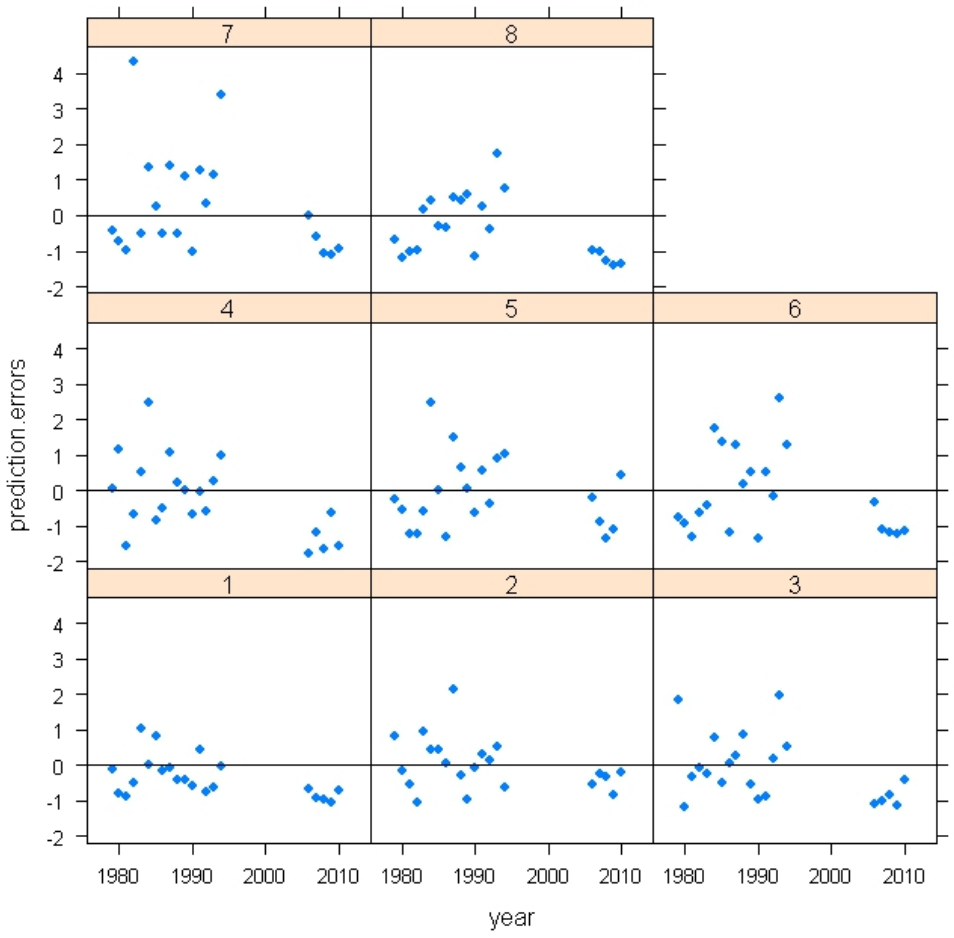


Figure 3.3.5. Haddock in Division VIa. Standardized landings prediction errors from the final TSA run.

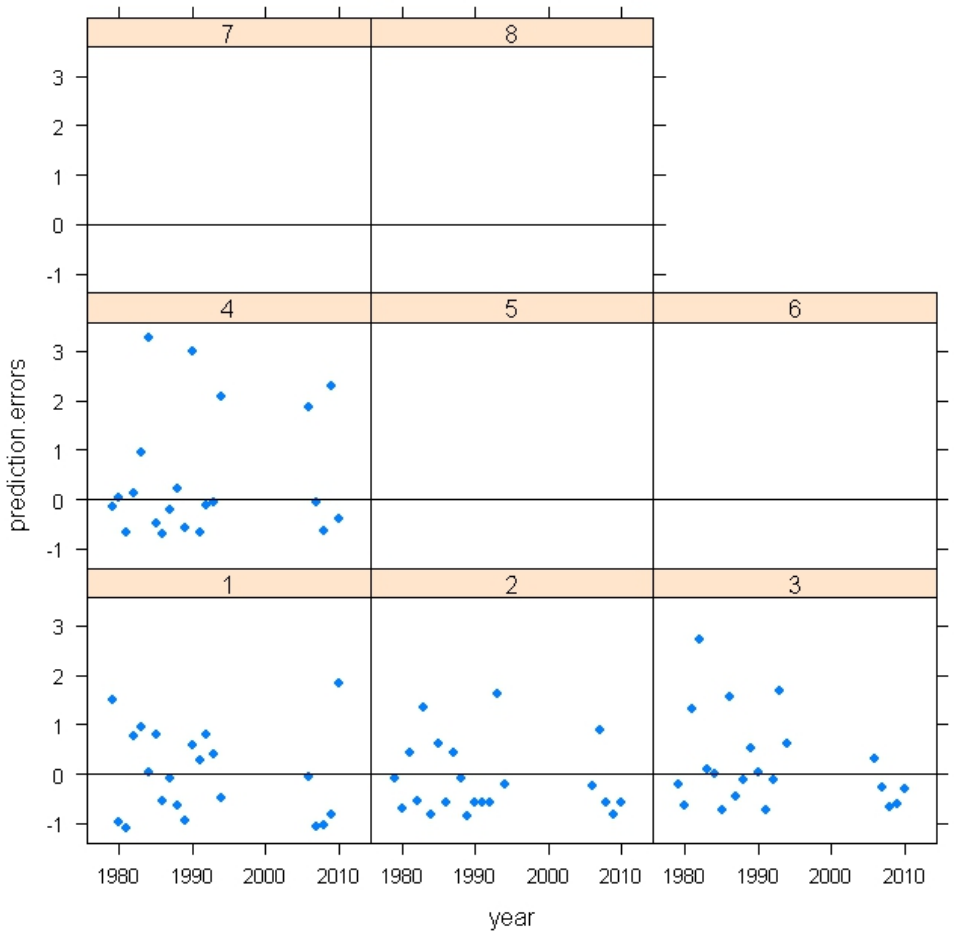


Figure 3.3.6. Haddock in Division VIa. Standardized discards prediction errors from the final TSA run.

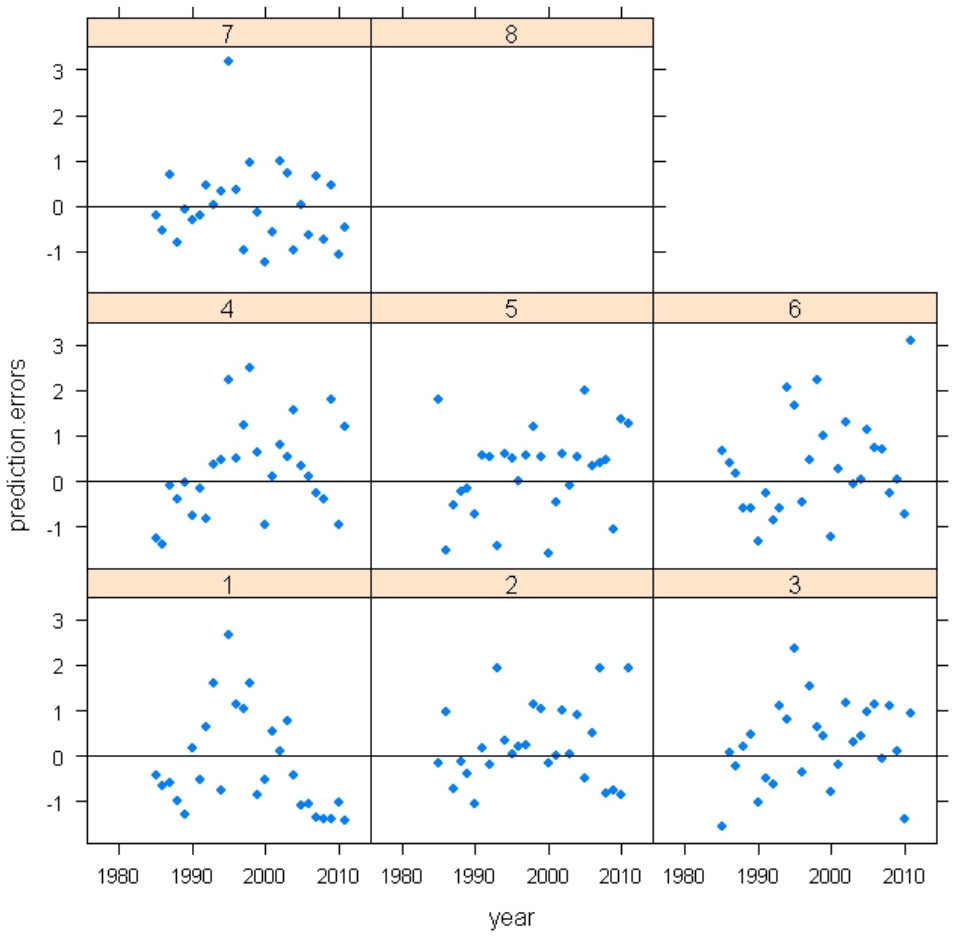


Figure 3.3.7. Haddock in Division VIa. Standardized ScoGFS Q1 prediction errors from the final TSA run.

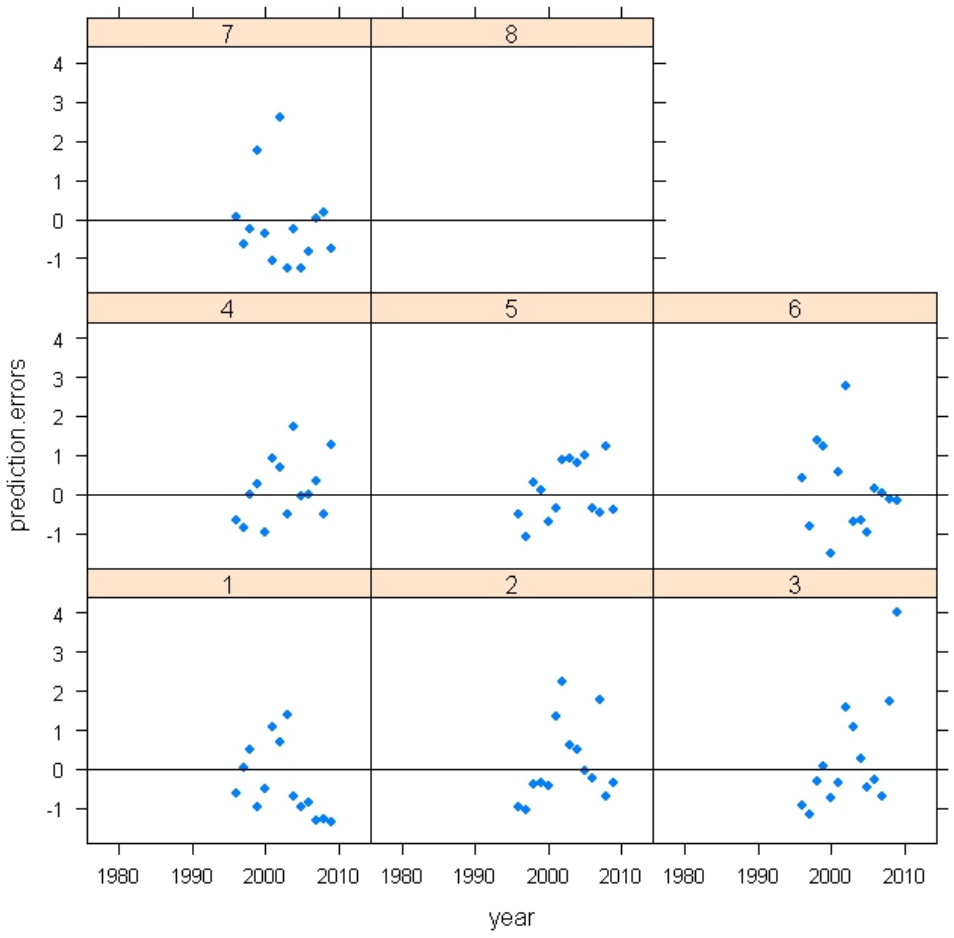


Figure 3.3.8. Haddock in Division VIa. Standardized ScoGFS Q4 prediction errors from the final TSA run.

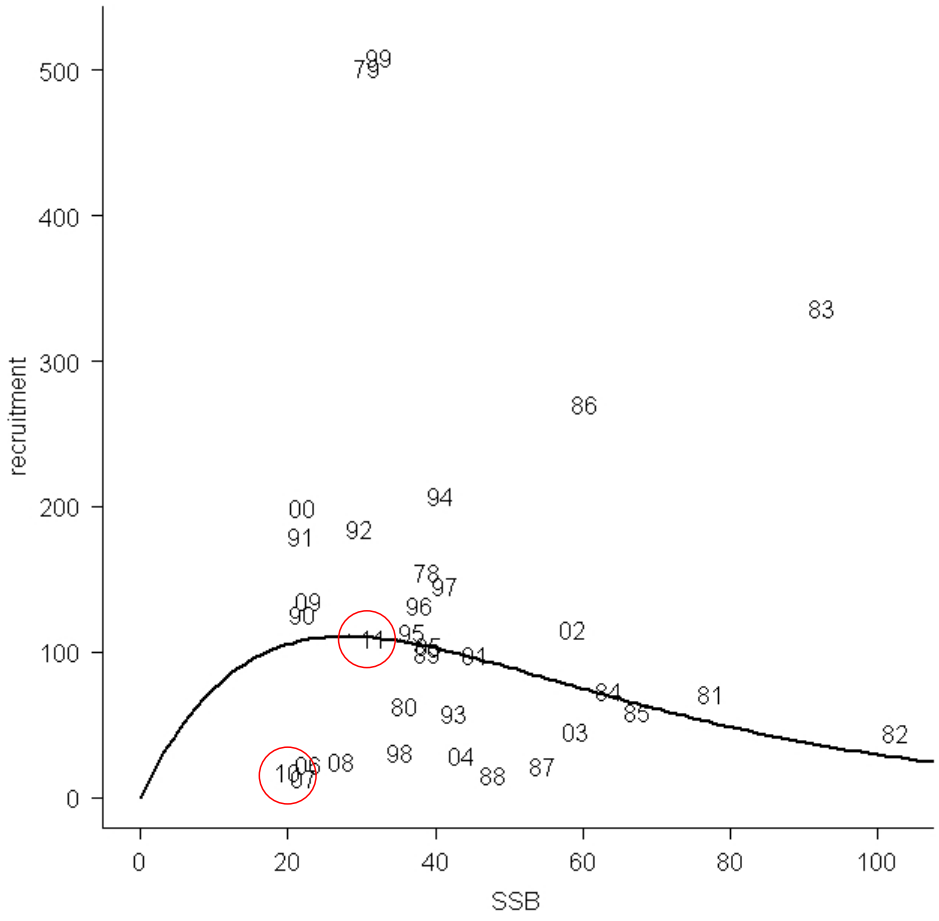


Figure 3.3.9. Haddock in Division VIa. Stock–recruit plot from the final TSA run, points labelled as year classes. Predicted recruitments are circled: for the 2009 year-class recruiting in 2010 (using ScoGFS Q1 data); and the 2010 year-class recruiting in 2011 (based on the underlying Ricker model).

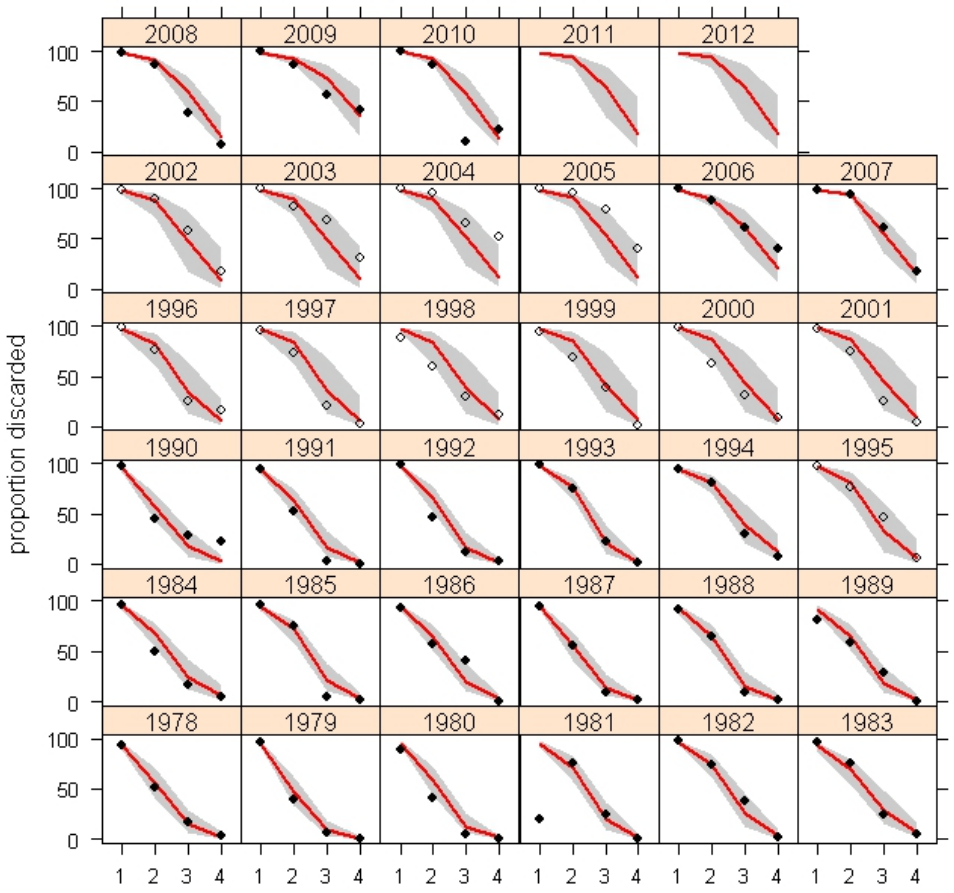


Figure 3.3.10. Haddock in Division VIa. Fitted (lines) and observed (dots) discard proportions-at-age from the final TSA run.

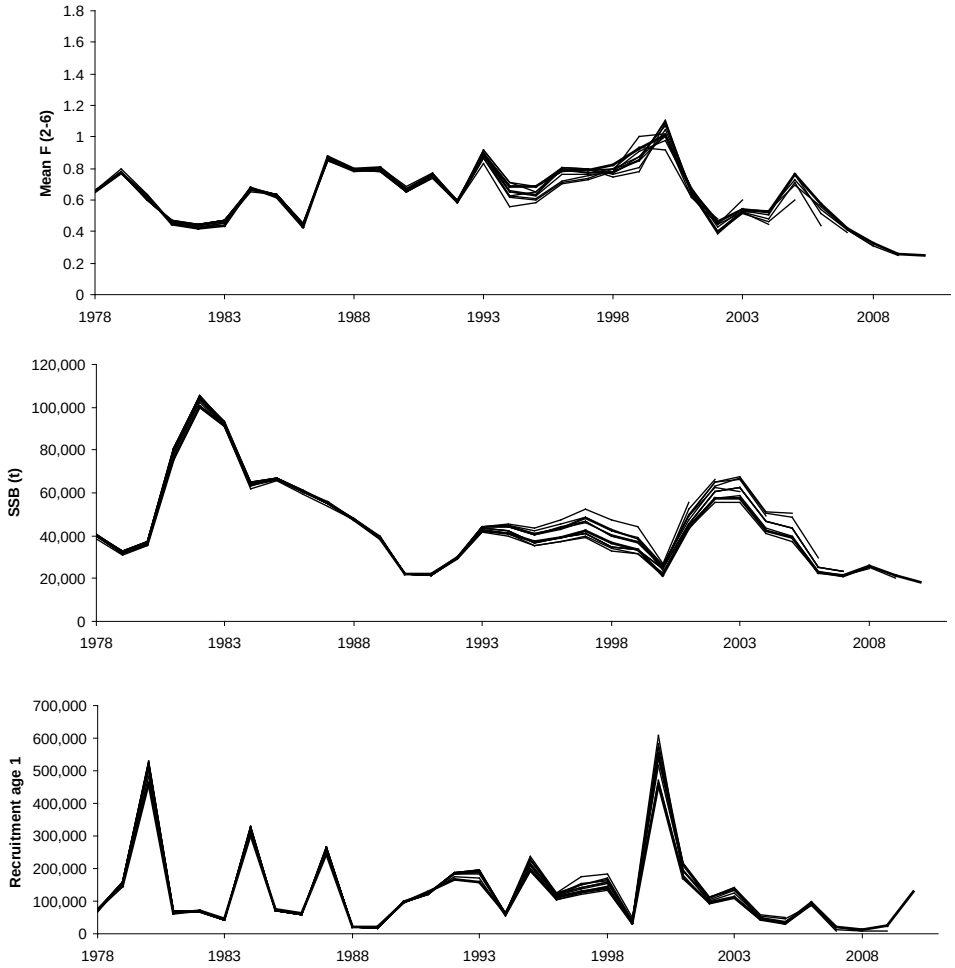


Figure 3.3.11. Haddock in Division VIa. Estimates of Mean F_{2-6}, SSB and recruitment from retrospective TSA runs.

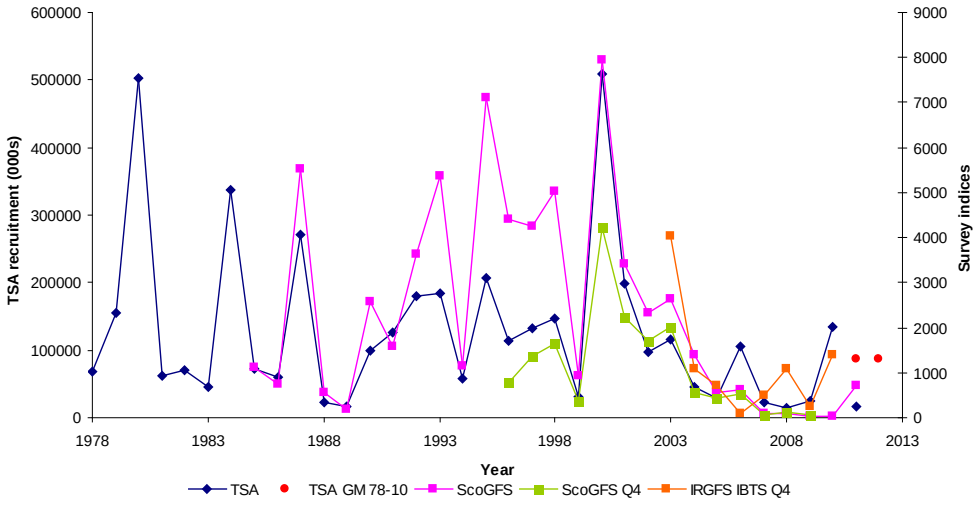


Figure 3.3.12. Haddock in Division VIa. Time-series of recruitment-at-age 1 from the final TSA assessment, along with the long-term (1978–20010) geometric mean and the age-1 indices from the Q1 and Q4 ScoGFS survey-series.

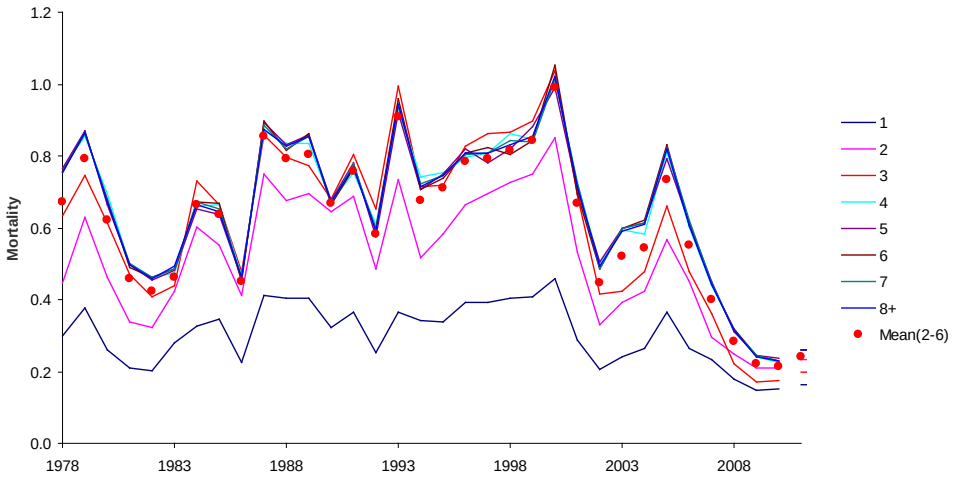


Figure 3.3.13. Haddock in Division VIa. Time-series of estimated fishing mortality-at-age, along with the mean over ages 2–6.

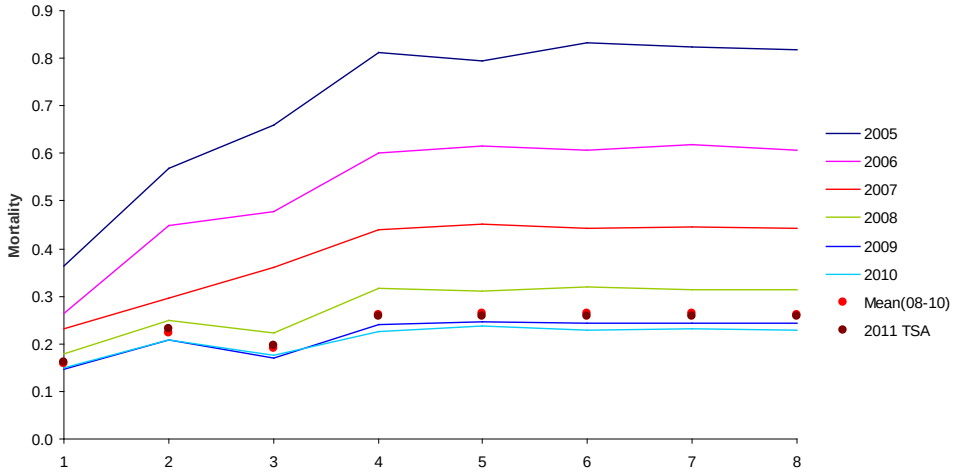


Figure 3.3.14. Haddock in Division VIa. Candidates for fishing mortality-at-age in short-term forecasts. Lines labelled 2005, 2006, 2007, 2008, 2009, 2010 indicate the TSA estimates for those years. Points marked 2010 TSA and 2011 TSA show the TSA-generated forecast values from the final assessment.

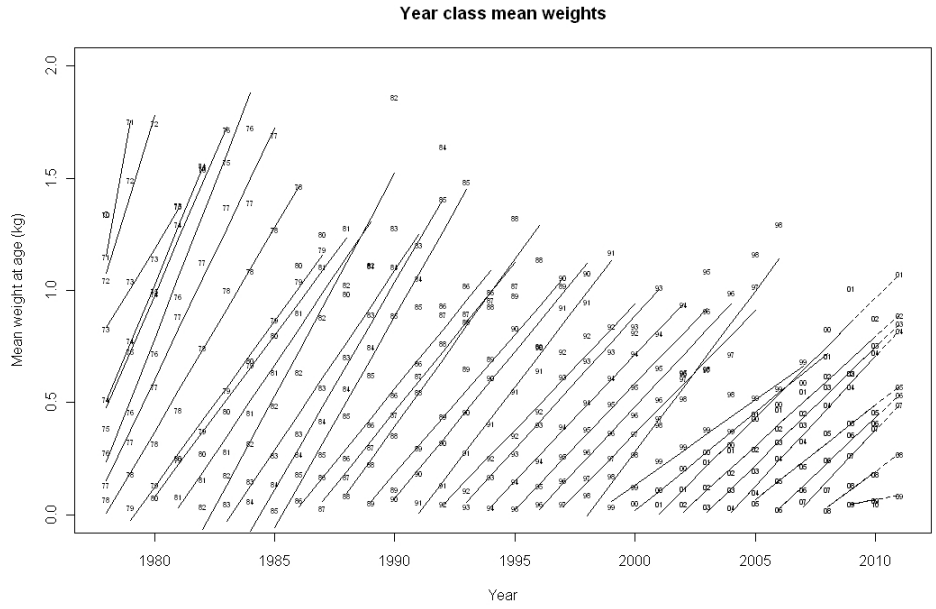


Figure 3.3.15. Haddock in Division VIa. Mean weights-at-age (kg) in total catch (or stock), tracked by year class with a linear model fit. Predicted weights in 2011 based on linear model fits indicated with the dotted lines.

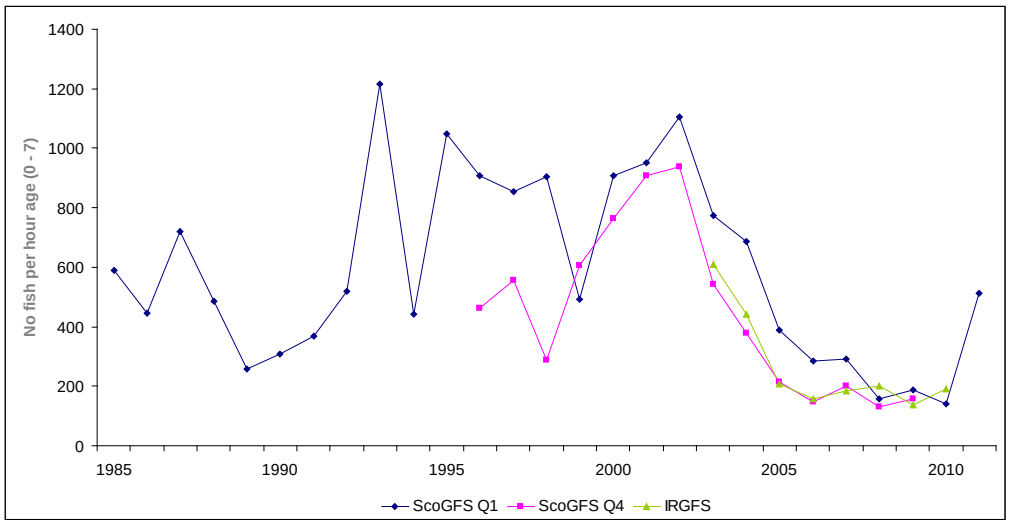


Figure 3.3.16. Survey indices for Haddock in VIa. Total number of fish ages (0–7) caught per hour. ScoGFS Q1 time-series (1985–2011), ScoGFS Q4 time-series (1996–2009), IRGFS time-series (2003–2010).

3.3.10 Other issues

After the conclusion of the stock assessment and after the review group gave its comments on the assessment; other run was made. This run as requested by the review group excluding the ScoGFS WCIBTS Q1 (2011) from the assessment due to changes both in gear and design.

The resulting figures and tables from this run are showed in the stock annex.

3.3.11 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 Subarea VIa

Type of assessment in 2011

As agreed at the 2010 meeting of ACOM, the assessment for whiting in Division VIa is being updated this year; in 2008 and 2009 no advice was provided. Earlier, ACFM review groups (RGNSDS) highlighted the various data problems associated with this stock; including noisy survey data and discard data which need to be reworked. Their conclusion in 2006 was that:

> Until revised Scottish discards are available and Irish discards included, a formal analytic assessment is not possible for this stock.

Scottish discard data are available (although not completely revised), and Irish discards from 2010 were made available. The assessment presented by the WG this year is, therefore, based on survey data which is the same approach as that adopted in the 2010 assessment, as well as an exploratory analytical assessment with the Time-Series Analysis (TSA) model using data from the catch and the Q1 survey.

ICES advice applicable to 2010 and 2011

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

> *Exploitation boundaries in relation to precautionary limits*

"*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*."

The Advice given since then has been the same (see Table with ICES Advice given in the years 2001–2011 below). Detailed advice given in 2011 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 2011.

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, recent recruitment (with the exception of the 2009 year class) has been weak catches in 2011 should be reduced to the lowest possible level.

Policy paper

In the light of the EU policy paper on fisheries management (17 May 2010, COM(2010) 241) 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 323 t.

3.4.1 General

Stock description

General information is now located in the Stock Annex.

Management applicable to 2010 and 2011

The TAC for whiting is set for ICES Subareas VI, XII and XIV and EU and international waters of ICES Subdivision Vb, and for 2011 was as shown below:

Species: Whiting *Merlangius merlangus*		**Zone:** VI; EU and international waters of Vb; international waters of XII and XIV (WHG/561214)
Germany	2	
France	39	
Ireland	97	
United Kingdom	185	
EU	323	
TAC	323	Analytical TAC

The following table summarizes ICES advice and actual management applicable for whiting in Division VIa during 2001–2011:

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)

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

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

Fishery in 2010

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

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.

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 2009 and 2010 were 96.7% and 87% respectively, with post regulation quota swaps taken into account. Total landings in 2010 were 349 t, down considerably from 2009 (Table 3.4.1). These are above the lowest recorded landings of 2005, but continue to be far below the long-term average.

The total estimated international catch of ages 1–7+ in 2010 was 1193 t of which approximately 886 t were discards (Table 3.4.2): of these 150 t were discarded by the TR1 fleet and 736 t were discarded by the TR2 (*Nephrops*) fleet. A very small amount (<1 t) of 0-gp fish were also estimated to be discarded.

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 2010. In the TR1 fleet, discarding is expected to decline in subsequent years following the mandatory increase in mesh size to 120 mm in 2009. Although the discards in 2010 were higher than those in 2007, 2008 and 2009, they are still the fourth lowest in the respective time-series. However, in terms of discard rate (discards as a proportion of catch) they represent the 2nd highest in the time-series.

3.4.2 Data

Landings

Total landings, as officially reported to ICES in 1965–2010, are shown in Figure 3.4.1. There have been concerns that the quality of landings data are 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 Re-port). 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. Work is underway to revise the time-series of Scottish discard estimates with an aim to reduce bias and increase precision. Such revisions are particularly important for the estimation of total catch for this stock which has very high discards across a wide age range. A working document set out the meth-

odology of this work at the 2004 meeting of WGNSDS (Fryer and Millar, 2004) and these methods have been developed further (Fernandes *et al*., in press).

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).

Values for natural mortality (0.2 for all ages and years) and the proportion of fish mature-at-age (knife-edged at age 2 for all years) are unchanged from the last assessment. Also as in the 2007 assessment, the proportion mature before spawning and the proportion fished before spawning are both set to be zero.

Surveys

Four research survey indices for whiting in VIa were also available:

- Scottish west coast groundfish survey (ScoGFS-WIBTS-Q1): ages 1–7, years 1985–2011.
- Irish west coast groundfish survey (IreGFS): ages 0–5, year 1993–2002.
- Scottish fourth-quarter west coast groundfish survey (ScoGFS-WIBTS-Q4): ages 0–8, years 1996–2009.
- Irish groundfish survey (IRGFS-WIBTS-Q4): ages 0–6; years 2003–2010.

The Scottish fourth-quarter west coast groundfish survey (ScoGFS-WIBTS-Q4) was not carried out in 2010 due to an engine break down of the research vessel.

For the Scottish surveys, a new vessel and gear were used from 1999. The catch rates as presented are corrected for the change in vessel and gear. The basis for the correction is comparative trawl haul data (Zuur *et al*., 2001). The Irish quarter four survey was discontinued in 2003 and has been replaced by a new survey. The replacement survey (IRGFS-WIBTS-Q4) has been running for seven years. The Scottish quarter four survey was presented for the first time to WGNSDS 2005.

The Scottish survey has been modified and presented at IBTSWG2011 and WGCSE2011. No correction applied as yet.

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. 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. Comparison trials have been conducted between the previous and new survey groundgears. The analysis from these trails was not available for this meeting but will be available in preparation for the VIa whiting benchmark scheduled for 2012.

The survey-series are described in the Report of the 2009 IBTSWG and also in the Stock Annex. For all survey-series, the oldest age given represents a true age, rather than a plus group. The survey indices are shown in Table 3.4.9 with data used in the final assessment highlighted in bold. Summing over ages 1–7, the Scottish first-quarter west coast groundfish survey indices were the 21st in the 27 year time-series. The spatial distribution of cpue from the two Scottish surveys in 2009 and 2010 have been provided in the Stock Annex.

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 CM 2001/ACFM:07), 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

Two exploratory assessments have been carried out: one based only on survey data conducted using SURBA, and one based on catch data and survey data using the Time-Series Analysis (TSA) model (Fryer, 2001) which is a state space model which allows for years with missing catch and/or survey data.

Data screening and exploratory runs

Software used: SURBA 3.0

Model Options chosen: one or two tuning series used in one run

Input data types and characteristics:

- ScoGFS-WIBTS-Q1: lambda=1, equal catchabilities at age, ages 1–6, all available years, mean Z range 2–4.

Due to a ship's engine breakdown, there was no Scottish Groundfish Survey in Quarter 4 in 2010. The results of a SURBA analysis from last year are therefore repeated here for reference.

Software used: TSA for R

Input data types and characteristics:

- Catch data, ages 1–7+, years 1965–1994 and 2006–2010;
- ScoGFS-WIBTS-Q1

Of the four survey-series available, only the two Scottish surveys were considered here.

The Irish west coast groundfish survey (IreGFS) has been discontinued and doubts about its consistency mean it is not used in stock assessments. To date the replacement IRGFS-WIBTS-Q4 has been considered too short a series to be considered. It now has seven years of data and will be considered in the VIa whiting benchmark process.

A comparison of scaled (standardized to z-scores) survey indices (from ScoGFS-WIBTS-Q1 & ScoGFS-WIBTS-Q4) at age show similar trends for most ages (up to age 5, Figure 3.4.3).

Log mean-standardized survey indices by year class and by year and scatterplots of indices within year classes are shown in Figures 3.4.4, 3.4.5 and 3.4.6. The year-class plots for both 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 ScoGFS-WIBTS-Q4 survey show very scattered data points. Age 0 in ScoGFS-WIBTS-Q4 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 3.4.7. 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.

The trawl survey data (ScoGFS-WIBTS-Q1 and ScoGFS-WIBTS-Q4) for West of Scotland whiting were extensively analysed at WGNSDS 2005–2007 using both SURBA 2.2 and SURBA 3.0 to look at consistency of output using a variety of age ranges, smoothing parameter values, relative catchabilities and weighting factors. Initial single fleet SURBA runs this year therefore used the model settings that were chosen in 2007 with the extension of the age range for ScoGFS-WIBTS-Q4 to 1–6 (as compared to ages 1–5 in the 2007 runs). This year only SURBA (version 3.0) was used to carry out the survey-based analysis; FLSURBA could not be run due to incompatibility of its available versions with the recent R versions (in 2007, both SURBA and FLSURBA were run).

The summary output of mean Z (2–4), recruitment and biomass from the SURBA run for ScoGFS-WIBTS-Q1 is shown in Figure 3.4.8 and Table 3.4.10; with the residuals illustrated in Figure 3.4.9. Model residuals are large for some age classes in some years, but with the exception of age 1, do not show any particular trends or non-randomness. Little systematic retrospective bias is apparent in the stock trends although the estimates for recruitment show some variability (Figure 3.4.10). The mean Z (2–4) estimates from this run show large fluctuations over the examined period. Choosing larger values for the smoothing parameter (lambda) smoothed out the fluctuations in mean Z, but the runs showed much worse retrospective patterns (not shown).

The SURBA analyses of the ScoGFS-WIBTS-Q4 survey from last year's WG are presented here for comparison: they do not include data from 2010 because the survey did not take place. The summary output is shown in Figure 3.4.11 and the residuals in Figure 3.4.12. Some trends are similar to those obtained with the ScoGFS-WIBTS-Q1 data. For total mortality, the trends are similar during 1996–2006 and after 2006, the trends are different. Model residuals are noisy, but show no particular trends or non-randomness. No retrospective plots could be produced as some values were ex-

tremely high. The ScoGFS-WIBTS-Q4 survey is a relatively short time-series (in comparison to ScoGFS-WIBTS-Q1), without particularly good internal consistency or strong year-class signals and this may be the reason for the poor retrospective performance.

In addition to SURBA runs, an analytical assessment using the TSA model was carried out with the ScoGFS-WIBTS-Q1 survey. Despite the lack of independent discard estimates for the pre-1978 period, catch data from a time period considered to be reliable (1965–1994 and 2006–2010) was used in the TSA run. Natural mortality was assumed to be 0.2 for all ages. The proportion mature was knife-edge at age 2 (i.e. 0 at age 1, 1 at age 2 and above). Table 3.4.11 shows the corresponding TSA parameter estimates.

Standardized prediction errors are given in Figures 3.4.13 (catch) and 3.4.14 (ScoGFS-WIBTS-Q1). None of these are large enough to invalidate the model fit and there are no obvious time-trends in recent years. Summary plots from the final assessment are given in Figure 3.4.15, while corresponding summary estimates are presented in Table 3.4.12. The TSA stock–recruit plot is presented in Figure 3.4.16 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 the survey in Figure 3.4.17. The estimates are uncertain, with wide confidence intervals, but an increase of at least 200% is indicated by this model. This will require further investigation at the benchmark.

The output from TSA was compared with the SURBA run (for ScoGFS-WIBTS-Q1) outputs, both being mean-standardized over the period 1995–2011 (Figure 3.4.18). There are some differences between the two estimates of SSB in the early period (from the mid-1980s to the early 1990s), but there is more agreement between them from the mid-1990s onwards. Both models indicate a decline in mortality to low levels from 2007 to around the lowest in the time-series.

Final assessment

In the absence of a benchmark and an official assessment to update, the TSA run using ScoGFS-WIBTS-Q1 is presented as the final assessment run given that it provides an analytical assessment. The final estimates for the stock are:

$F_{(2\text{-}4)}$ in 2010 = 0.35

SSB in 2011 = 6237 t

Mean $F_{2\text{-}4}$ is estimated to have declined below F_{pa} (0.6) since 2008, 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 2004 and contributes towards a slight increase in SSB in 2011. 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.

3.4.4 Short-term projections

No short-term predictions were made by this WG.

3.4.5 Medium-term projections

Stochastic medium-term predictions were not made at this WG because the assessment is considered only to be indicative of stock trends.

3.4.6 MSY explorations

No estimates of MSY reference points were presented at the WG this year. The general lack of consensus concerning the assessment approach prevents using the final run output as the basis for advice.

3.4.7 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.

The Working Group attempted a yield-per-recruit analysis with the output from the final TSA run (Figure 3.4.19). $F_{0.1}$ was estimated at around 0.2 and F_{max} at around 0.3, but it is unclear how stable these estimates are in the long term. The WG considers that yield-per-recruit F reference points are not applicable due to the uncertainty in historical stock trends.

3.4.8 Management plans

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

3.4.9 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 which is why it was used here as the exploratory and 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 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 (WGNSSK 2010).

Jump in SSB predicted by SURBA based on a single modified survey may have some catchability bias and benefit from a swept-area correction. Anecdotally however the trend in survey catches, particularly a significant drop in recruits, is reflected in the overlapping Irish time-series.

Long-term information on the historical yield and catch composition indicates that the present stock size is low. The current assessment indicates (as the assessment carried out in 2007 did) 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 an increase from 2008 onwards. The persistence of this trend should be verified in subsequent assessments.

3.4.10 Recommendation for next benchmark

A landings and discards disaggregated assessment may potentially be a reliable basis for determining the status of the whiting stock in VIa. Currently, the main problem is the discrepancy between survey and catch data prior to 1995. Unless this discrepancy can be resolved, truncating the catch data from 1995 may be an option, which proved satisfactory in previous exploratory XSA runs carried out at this working group. Given the new legislation on reporting landings, the quality of landings data is likely to continue to improve.

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 location of sampling stations may be reconsidered to better match the distribution of commercial landings and maximize coordinated survey effort in the area.

3.4.11 Management considerations

Recruitment during the 1990s appears to have been high while more recently, it has been below average. There are many indications that the 2009 year class is relatively strong, following historically low recruitment of 2006 to 2008 year classes.

Recent estimates of SSB to remain at a low level, but the latest estimate for 2011 indicates a potential upturn, driven by the 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, except for recruitment, 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 (Council Regulation (EC) 1342/2008). 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 2010 this fleet discarded the majority of the catch of this species: 736 t, of the total catch of 1193 t (62%), were estimated to have been discarded by the *Nephrops* fleet. 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.

References

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

3.4b Whiting in Subarea VIb

Officially reported landings are given in Table 3.4b.

Table 3.4.1. Nominal landings (t) of WHITING in Division VIa, 1989–2010, as officially reported to ICES.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010*
Belgium	1	-	+	-	+	+	+	-	1	1	+	-	-	-	-	+	-	-	-	-	-	-
Denmark	1	+	3	1	1	+	+	+	+	-	-	-	-	-	+	+	-	-	-	-	-	-
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	+
France	1991,2	180	3521,2	105	149	191	362	202	108	82	300	48	52	21	11	6	9	7	1	3	1	3
Germany	+	+	+	1	1	+	-	+	-	-	+	-	-	-	-	-	-	+	1	-	-	-
Ireland	1,315	977	1,200	1,377	1,192	1,213	1,448	1,182	977	952	1,121	793	764	577	568	356	172	196	56	69	125	99
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
Spain	-	-	-	-	-	-	1	-	1	2	+	-	2	-	-	-	-	-	-	-	-	-
UK (E, W & NI)	44	50	218	196	184	233	204	237	453	251	210	104	71	73	35	13	5	2	1	-	-	-
UK (Scot.)	6,109	4,819	5,135	4,330	5,224	4,149	4,263	5,021	4,638	3,369	3,046	2,258	1,654	1,064	751	444	103	178	424	-	-	-
UK (total)																				369	354	247
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

*** Preliminary.**

1989–2009 N. Ireland included with England and Wales.

Table 3.4.2. Whiting in Division VIa. Annual weight and numbers caught, years 1978–2010.

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
Min	617	306.843349	174	3085	601.205845	1853
GM	7741	3946	3342	42993	12677	26166
AM	11645	6862	4783	59126	23482	35645
Max	24118	17081	11784	141314	61393	100633

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

	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

Table 3.4.4. Whiting in Division VIa. Discards-at-age (thousands).

	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	1017	22014	2763	148	101	4	0
1982	17837	4577	15938	1189	55	1	0
1983	15069	8173	1964	4271	176	102	0
1984	68241	3951	1085	572	1577	59	4
1985	59783	17426	3134	663	61	446	3
1986	10459	20085	2491	117	6	2	61
1987	46876	13689	1518	180	1	0	0
1988	46421	51395	2472	292	54	0	0
1989	17778	3660	5796	401	111	11	0
1990	16406	5791	860	571	95	3	0
1991	30355	2874	4432	173	140	36	0
1992	46463	15041	2224	908	0	0	0
1993	14618	22281	5966	921	1317	0	2
1994	39697	18403	7775	1634	183	125	4
1995	28557	20921	8483	961	246	0	0
1996	28620	14617	4398	1395	18	1	18
1997	18182	9037	3431	466	93	0	0
1998	31183	7304	2418	991	184	51	64
1999	13623	7256	933	369	79	29	0
2000	63789	3556	1206	117	15	14	0
2001	5514	5861	738	208	4	0	0
2002	14166	3235	1749	130	124	8	1
2003	9331	1107	427	371	34	7	2
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

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

	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	4610	46409	14060	4758	1618	456	201
1982	20829	10360	45032	8010	2098	804	348
1983	18487	15266	10004	27029	6246	1541	540
1984	75450	16716	9306	4959	16403	2011	863
1985	63922	36946	11708	4014	2058	5210	825
1986	13133	34909	12260	2770	539	293	591
1987	53305	27624	15506	5621	839	330	259
1988	48263	71982	12110	6460	2002	290	207
1989	20307	9547	17685	5168	1377	479	71
1990	19609	13819	3252	4580	1421	208	37
1991	33648	11700	14478	1381	1531	322	51
1992	49158	24481	6697	5691	396	373	106
1993	15669	32460	12259	3594	4055	163	149
1994	40606	23292	16933	5241	896	840	73
1995	28772	25243	14999	6615	1643	377	283
1996	29611	20027	12073	6447	2479	584	175
1997	19059	12695	11946	4782	1534	338	106
1998	32023	10808	6695	4689	1626	389	352
1999	14636	13387	5479	2408	1853	384	112
2000	64273	6508	5417	1687	500	343	89
2001	5975	9132	3368	1775	405	131	17
2002	14228	4859	4767	929	351	32	13
2003	9501	1817	1538	2044	381	119	4
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

Table 3.4.6. Whiting in Division VIa. Landings weights-at-age (kg).

	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

Table 3.4.7. Whiting in Division VIa. Discard weights-at-age (kg).

	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	0.000
2010	0.038	0.124	0.269	0.375	0.376	0.401	0.964

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

	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	0.000
2010	0.038	0.124	0.269	0.375	0.376	0.401	0.964

Table 3.4.9. Whiting in Division VIa. Available survey tuning-series. Data used in final run are highlighted in bold. For ScoGFS-WIBTS-Q1 and ScoGFS-WIBTS-Q4, numbers are standardized to catch-rate per 10 hours. "+" indicates value less than 0.5 after standardizing.

SCOGFS-WIBTS-Q1: Scottish Groundfish Sruvey - 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	1526	403	68	10	9	10
1987	10	6938	1054	584	143	36	2	1
1988	10	567	3469	653	189	42	5	1
1989	10	910	505	586	237	48	3	0
1990	10	1818	572	122	216	61	4	1
1991	10	3203	277	298	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	9384	2238	635	341	135	30	5
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	0.4
2000	10	12862	471	152	34	10	11	0
2001	10	4653	1954	242	41	8	1	1
2002	10	5542	1028	964	86	15	1	1
2003	10	6934	746	436	300	32	2	4
2004	10	5888	1566	189	131	44	9	1
2005	10	1308	723	183	35	8	11	2
2006	10	1441	466	282	77	0.3	3	0.6
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
2011	10	219	1767	404	68	32	47	13

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

Table 3.4.9. (continued).

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

ScoGFS-WIBTS-Q4 : Quarter four 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	1124	149	100	20	1	0	+
1999	10	8203	2338	582	141	33	24	1	1	0
2000	10	4434	4055	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	0.9	0.7	0
2006	10	415	296	140	101	35	8	3	0.5	0
2007	10	1894	434	326	99	83	48	0.6	0	0
2008	10	2297	208	78	110	28	24	4	0	+
2009	10	4833	236	178	50	58	12	6	6	0

Table 3.4.10. Whiting in Division VIa. Summary of SURBA assessment: Relative estimates of Recruitment, Spawning–Stock Biomass (SSB) and total mortality (Z), based on data from ScoGFS-WIBTS-Q1.

Year	Rec	SSB	TSB	Mean Z(2–4)
1985	4.729	0.494	1	1.472
1986	3.79	0.399	0.812	1.048
1987	6.006	0.543	1.132	1.257
1988	1.095	0.557	0.645	1.297
1989	1.776	0.332	0.524	1.212
1990	1.495	0.262	0.472	1.27
1991	2.034	0.192	0.389	0.298
1992	6.869	0.481	1.257	0.96
1993	6.499	0.879	1.672	0.956
1994	5.462	0.959	1.445	1.082
1995	9.715	0.847	1.585	1.068
1996	7.061	1.171	1.863	1.261
1997	6.933	1.012	1.816	1.691
1998	8.415	0.582	1.432	1.853
1999	6.85	0.449	1.031	1.888
2000	13.996	0.374	1.437	1.846
2001	4.223	0.577	0.999	1.261
2002	1.914	0.575	0.716	1.11
2003	5.539	0.445	0.888	1.314
2004	5.927	0.471	0.98	1.987
2005	1.706	0.286	0.438	1.925
2006	1.33	0.146	0.208	1.038
2007	0.607	0.17	0.221	1.492
2008	0.431	0.108	0.141	0.64
2009	0.808	0.168	0.211	0.691
2010	2.838	0.161	0.269	0.385
2011	0.212	0.641	0.653	0.572

Table 3.4.11. Whiting in Division VIa. TSA parameter estimates from this year's assessment. * = fixed parameter.

Parameter	Notation	Description	2010
Initial fishing mortality	F (1, 1965)	Fishing mortality-at-age a in year y	0.37
	F (2, 1965)		0.49
	F (4, 1965)		0.75
Survey selectivities	□(1)		2.68
ScoGFS-WIBTS-Q1	□(2)		2.10
	□(3)	ScoGFS-WIBTS-Q1 survey selectivity-at-age a	1.88
	□(4)		1.56
	□(5)		1.53
	□(6)		1.43
Fishing mortality standard deviations	□F	Transitory changes in overall F	0.15
	□U	Persistent changes in selection (age effect in F)	0.07
	□V	Transitory changes in the year effect in F	0.17
	□Y	Persistent changes in the year effect in F	0.19
Survey catchability standard deviations	□	Transitory changes in ScoGFS-WIBTS-Q1 catchability	0.13
	□	Persistent changes in ScoGFS-WIBTS-Q1 catchability	0.13
Measurement coefficients of variation	cv landings	Coefficent of variation of catch-at-age data	0.20
	cv discards		0.51
	cv survey	Coefficent of variation of ScoGFS-WIBTS-Q1 survey data	0.40
Recruitment	□1	Ricker parameter (slope at the origin)	9.80
	□2	Ricker parameter (curve dome occurs at 1/η2)	0.32
	cv rec	Coefficent of variation of recruitment curve	0.40

Table 3.4.12. Whiting in Division VIa. Summary of TSA assessment: estimated catch, Recruitment-at-age 1, Spawning–Stock Biomass (SSB) and total mortality (Z).

Year	Catch (t)	Recruits ('000s)	SSB (t)	Mean F(2–4)
1965	21223	82872	45681	0.68
1966	18291	118799	36957	0.63
1967	25018	95711	36467	1.03
1968	27146	413152	28124	0.91
1969	28926	37614	66602	0.72
1970	14832	33877	40866	0.58
1971	16292	45645	28549	0.79
1972	17037	153512	18861	0.92
1973	28376	363043	25757	1.13
1974	29126	125248	51917	0.87
1975	28490	226113	44627	0.81
1976	31467	89783	49651	1.05
1977	23054	137714	29940	0.91
1978	17413	144644	26080	0.66
1979	20774	116370	33635	0.75
1980	24323	339470	33932	0.62
1981	20167	59543	61008	0.46
1982	19609	64840	50367	0.47
1983	21985	69660	39317	0.69
1984	19634	138964	28359	0.80
1985	22299	160087	26553	1.02
1986	14385	101937	24124	0.81
1987	18486	193617	26049	0.86
1988	20761	56966	30573	1.11
1989	12272	95503	15527	0.99
1990	9558	60190	16975	0.73
1991	10291	103266	15256	0.75
1992	12172	137539	17750	0.68
1993	15457	104861	26225	0.79
1994	15060	120409	23464	0.78
1995	15056	130556	22215	0.84

Table 3.4.12. contd. Whiting in Division VIa. Summary of TSA assessment: estimated catch, Recruitment-at-age 1, Spawning–Stock Biomass (SSB) and total mortality (Z).

Year	Catch (t)	Recruits ('000s)	SSB (t)	Mean F(2–4)
1996	18357	126311	23986	0.89
1997	18326	85773	21452	1.12
1998	15175	151051	10968	1.13
1999	14305	91151	13132	1.51
2000	11514	151577	6618	1.35
2001	8470	67427	9273	0.95
2002	7788	56477	9760	0.92
2003	7915	69463	6661	1.14
2004	5252	50833	3589	1.06
2005	2188	21618	1777	0.96
2006	1504	16020	2147	0.82
2007	1134	7382	1996	0.61
2008	1069	7966	1898	0.63
2009	882	13767	2234	0.35
2010	1034	33690	2422	0.31
2011			6237	

Table 3.4b. Nominal landings (t) of Whiting in Division VIb, 1989–2009, 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*
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ireland	-	-	-	-	32	10	4	23	3	1	-	-	10		2	3	3	104	16	23	4	2
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	…	…	…
UK (all)																				8	12	17
Total	34	488	460	288	128	80	62	85	117	44	44	58	14	7	13	4	4	105	17	31	16	19

*** Preliminary.**

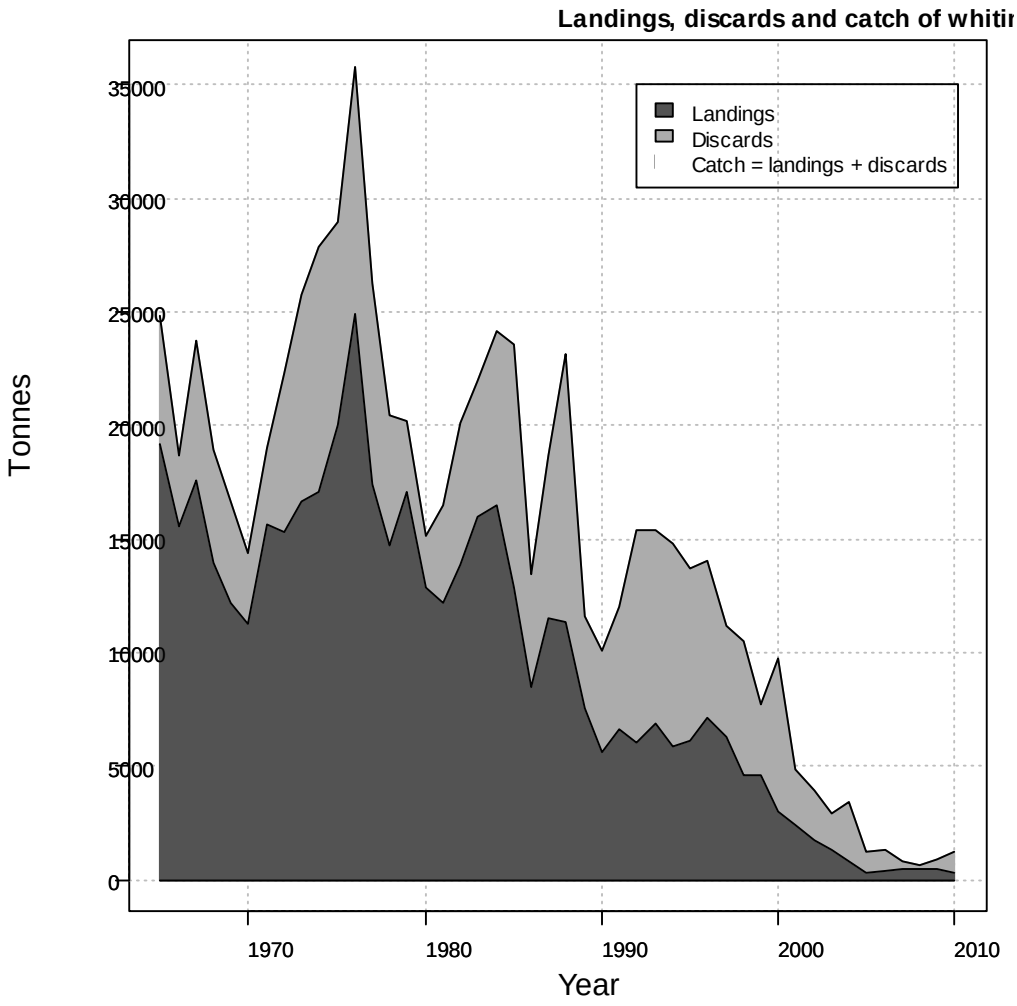


Figure 3.4.1. Landings, discards and catch (in tonnes) of whiting in Division VIa, as officially reported to ICES.

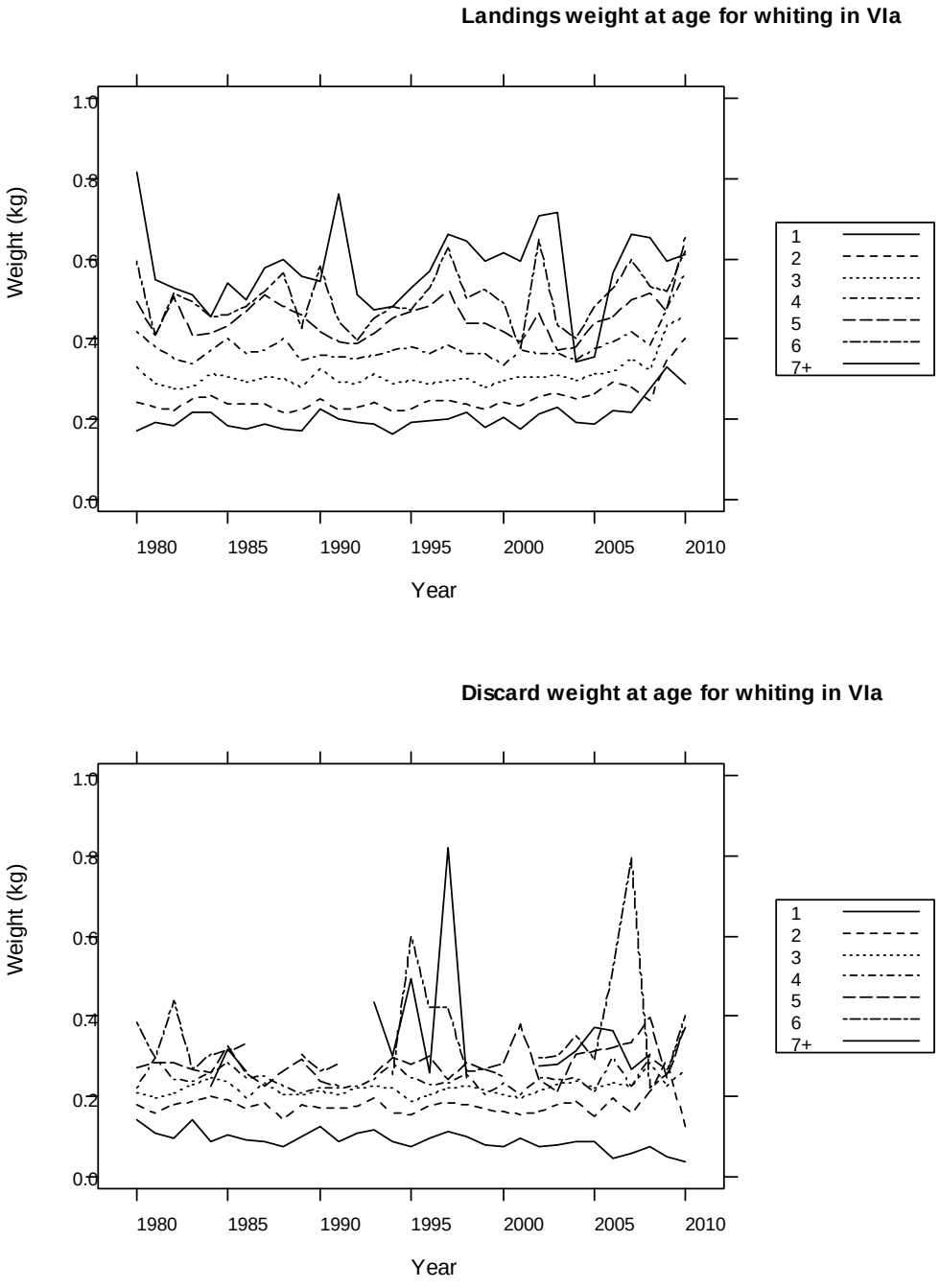


Figure 3.4.2. Whiting in Division VIa. Mean weights-at-age in the landings (upper panel) and discards (lower panel).

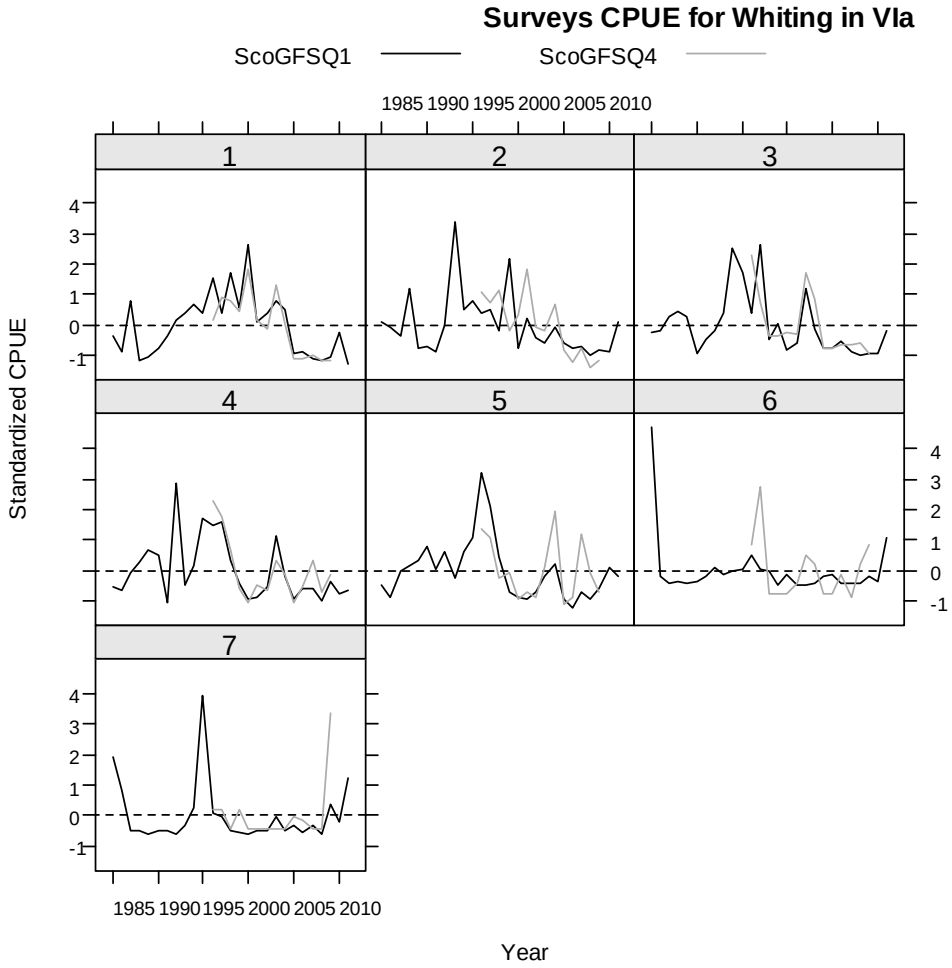


Figure 3.4.3. Whiting in Division VIa. Comparison of scaled survey indices from ScoGFS-WIBTS-Q1 and ScoGFS-WIBTS-Q4.

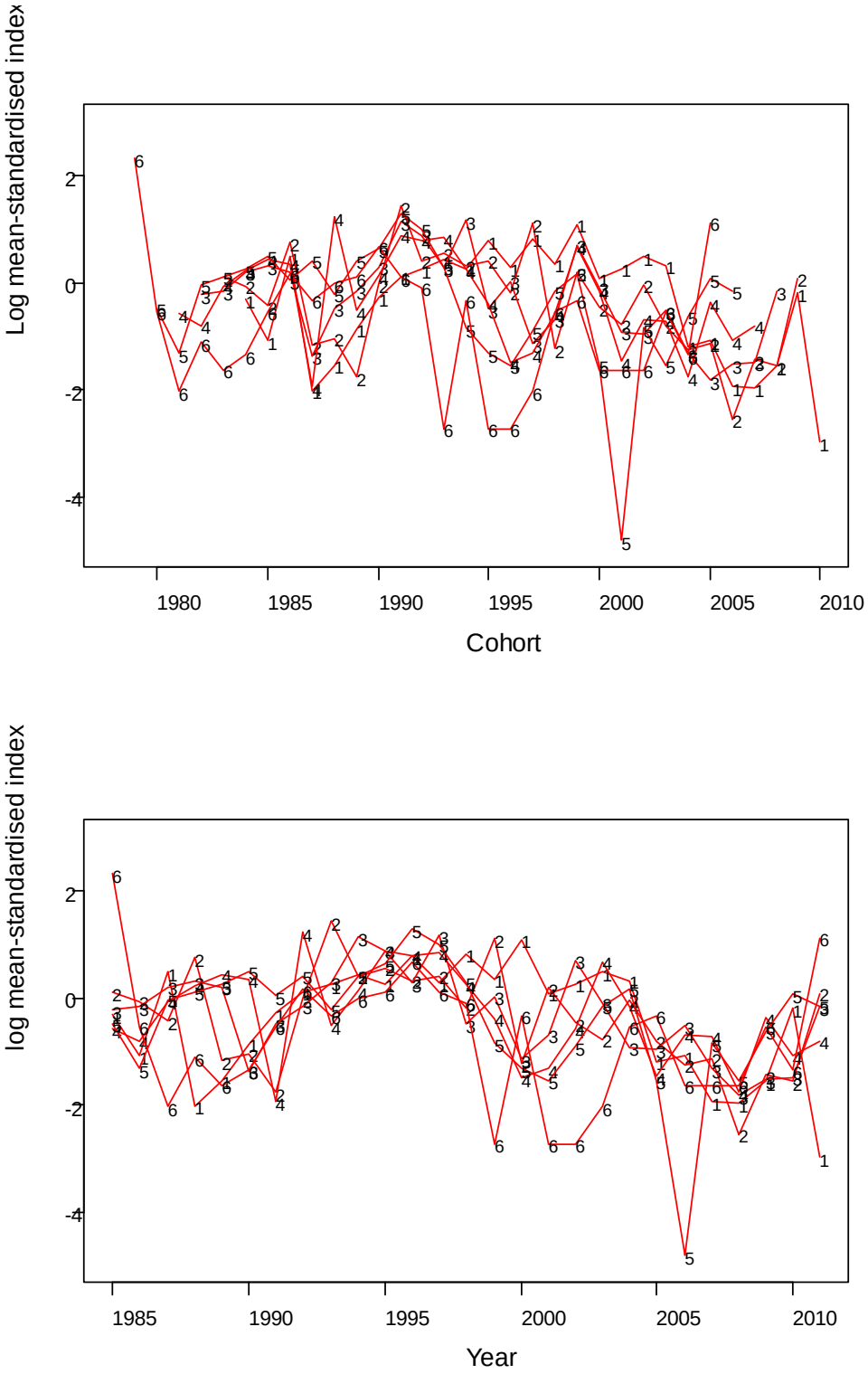


Figure 3.4.4. Whiting in Division VIa. Log mean standardized survey index for each age by cohort (upper panel) and year (lower panel) in ScoGFS-WIBTS-Q1.

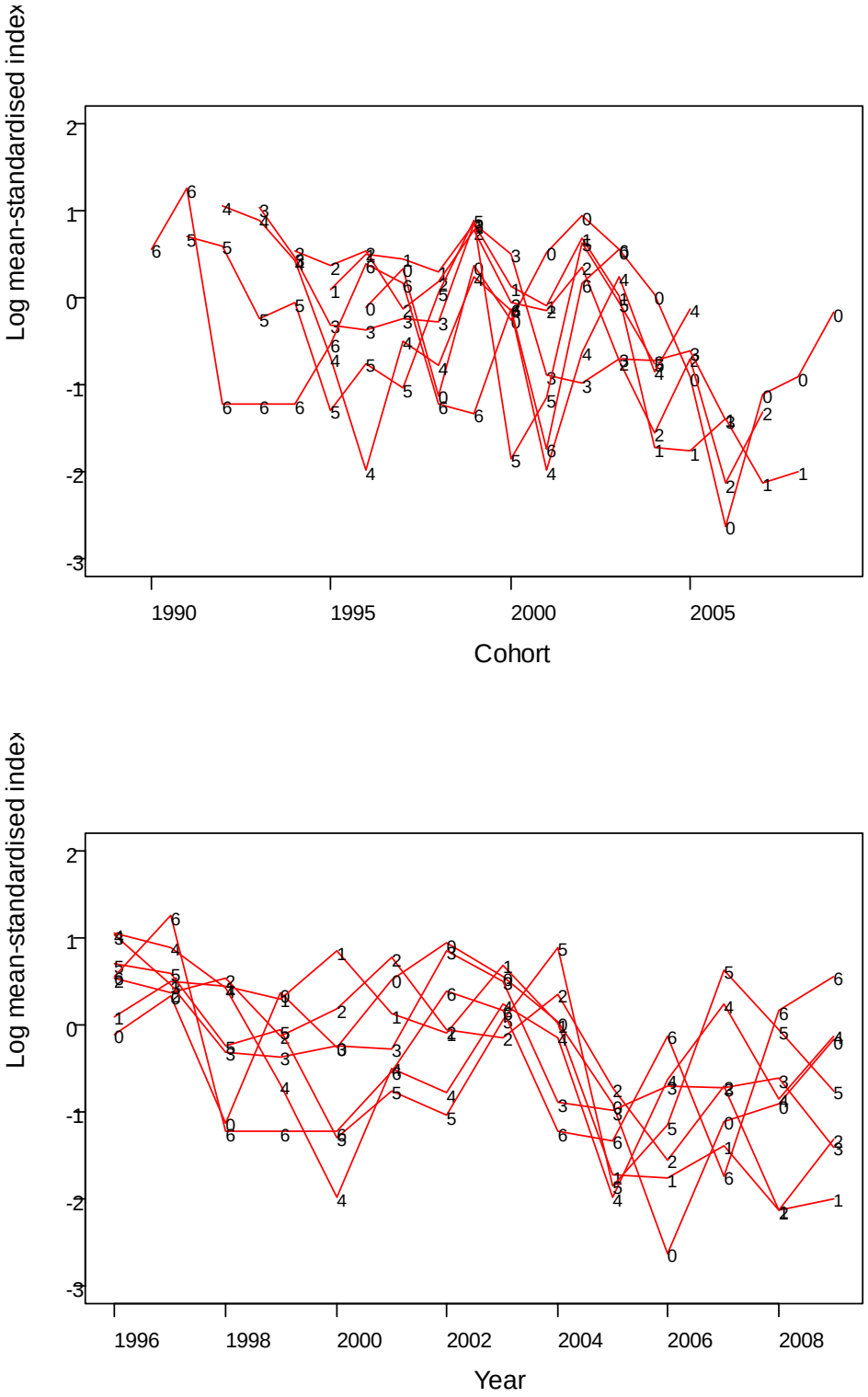


Figure 3.4.5. Whiting in Division VIa. Log mean standardized survey index for each age by cohort (upper panel) and year (lower panel) in ScoGFS-WIBTS-Q4.

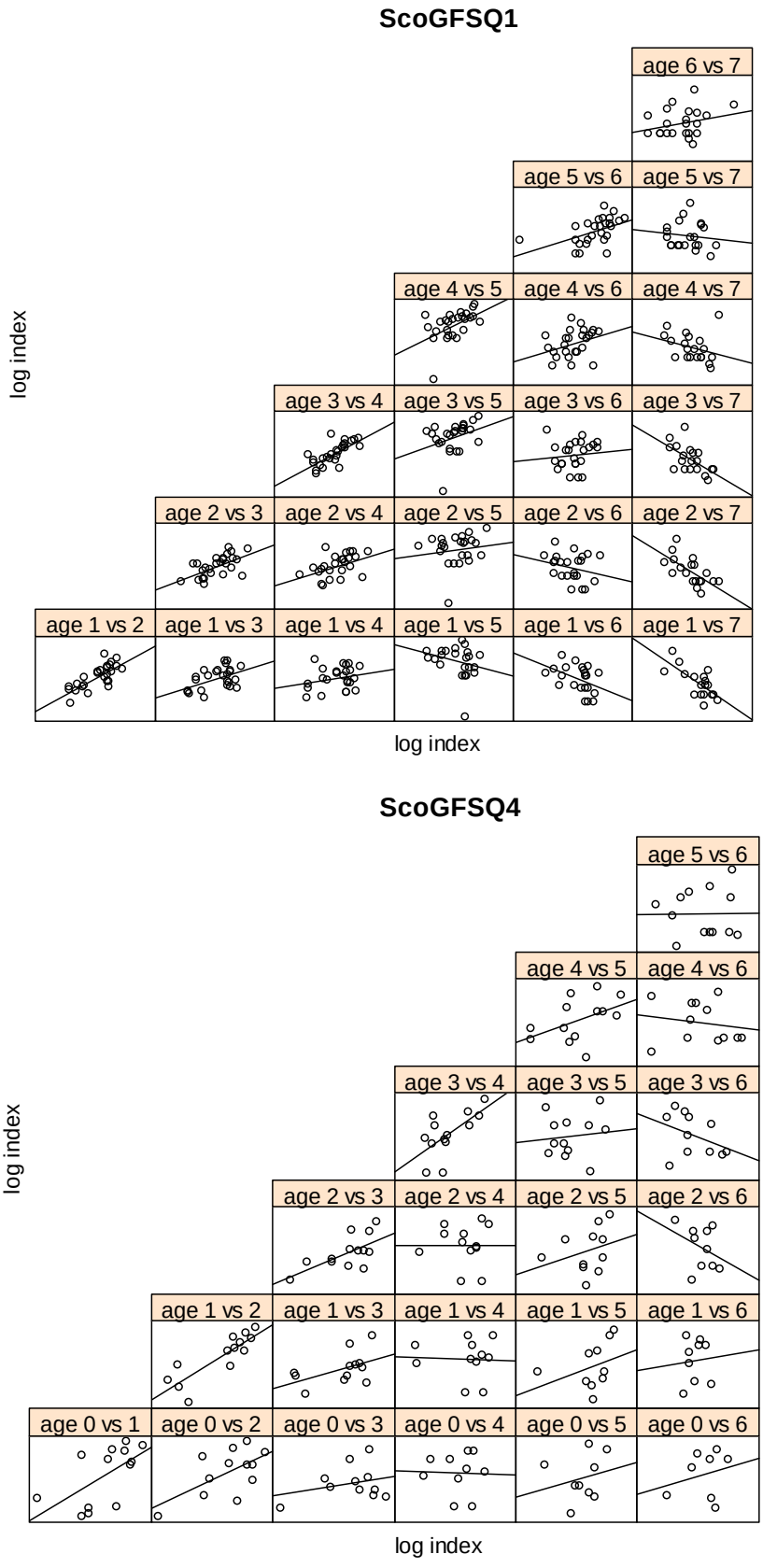


Figure 3.4.6. Whiting in Division VIa. Comparative scatterplots-at-age for Scottish groundfish surveys, ScoGFS-WIBTS-Q1 and ScoGFS-WIBTS-Q4.

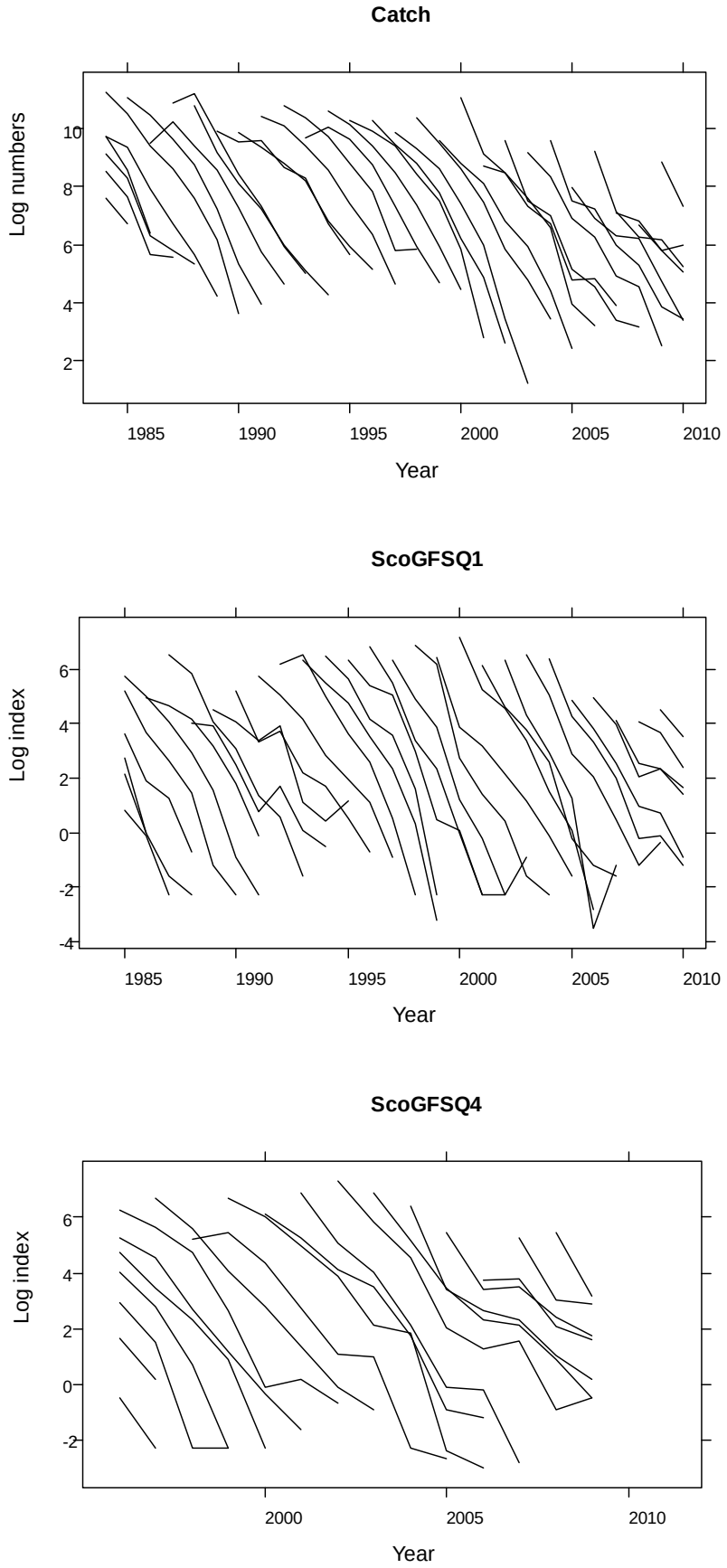


Figure 3.4.7. Whiting in Division VIa. Log catch curves from the catch (ages 1–7) and the two Scottish groundfish surveys, ScoGFS-WIBTS-Q1 (ages 1–7) and ScoGFS-WIBTS-Q4 (ages 0–7).

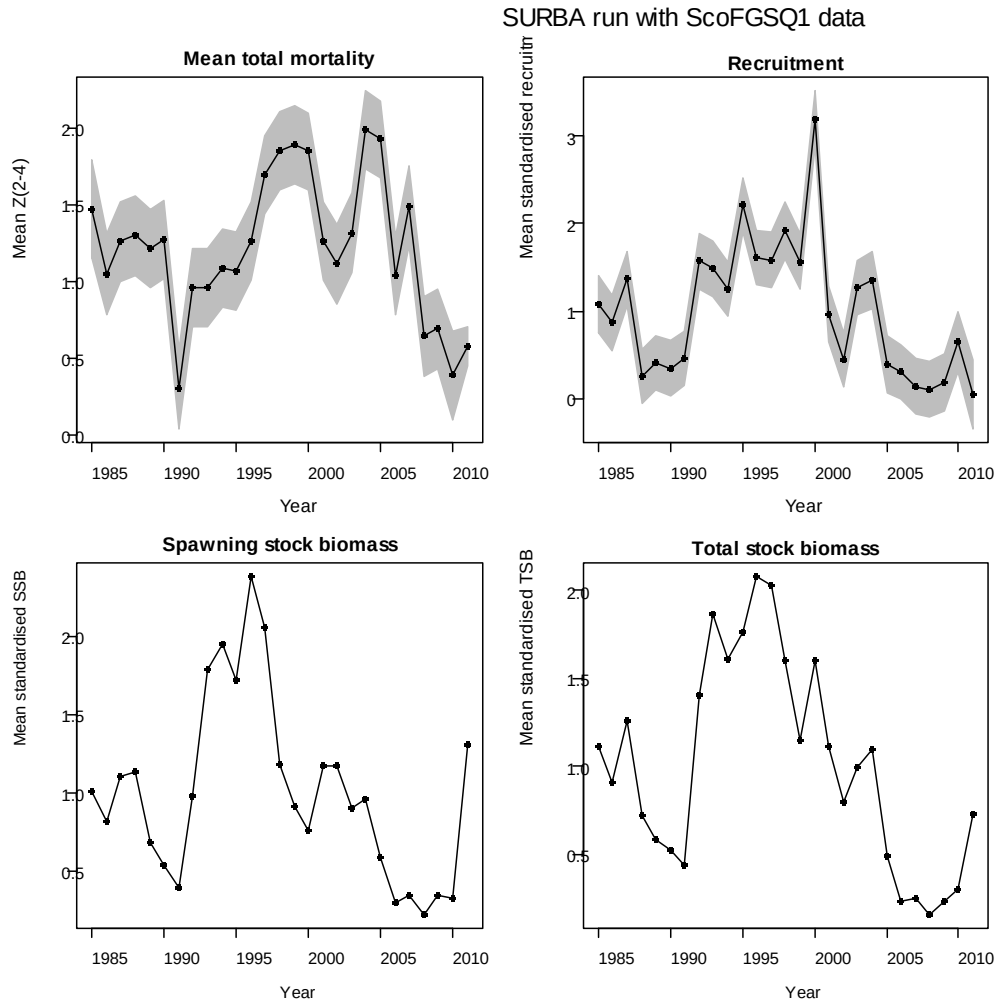


Figure 3.4.8. Whiting in Division VIa. Results of SURBA run using ScoGFS-WIBTS-Q1 data. Mean total mortality estimates are given as absolute; biomass and recruitment are mean-standardized. Mean total mortality and recruitment are shown with +/- standard errors.

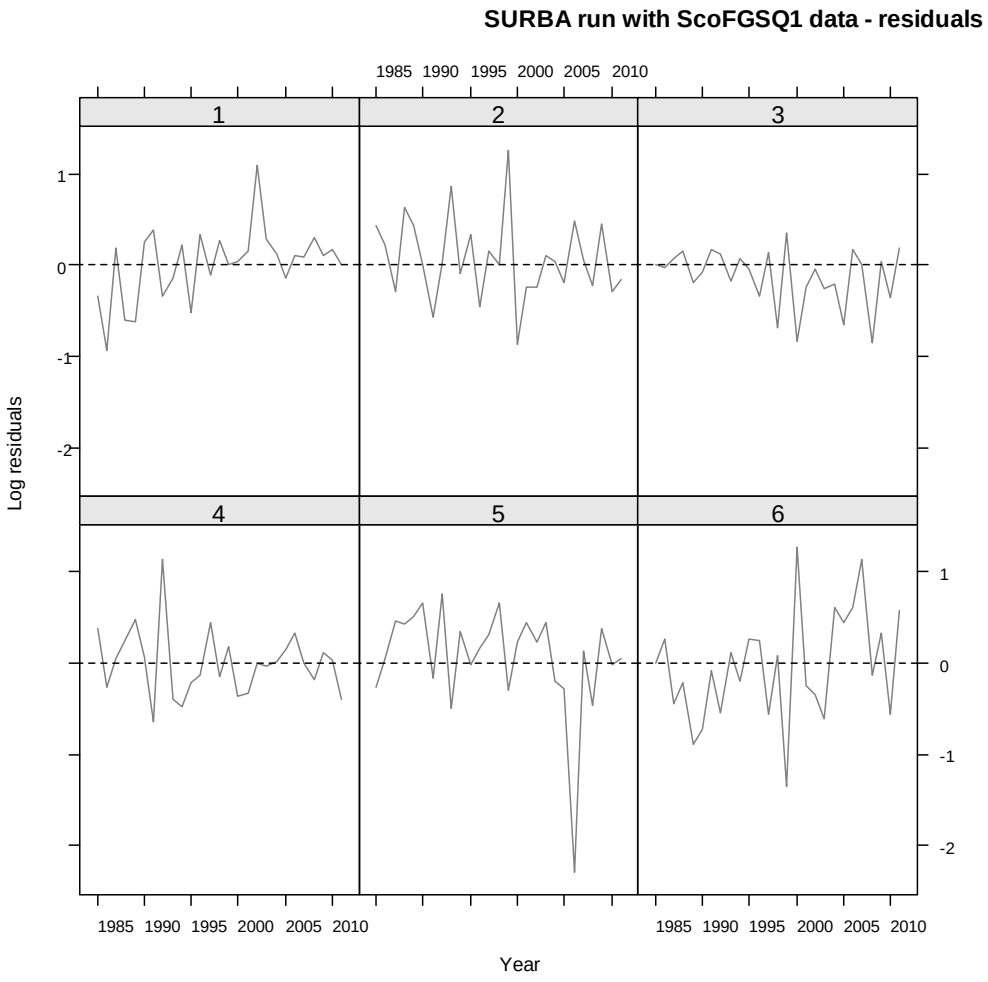


Figure 3.4.9. Whiting in Division VIa. Residuals by age from SURBA run using ScoGFS-WIBTS-Q1 data.

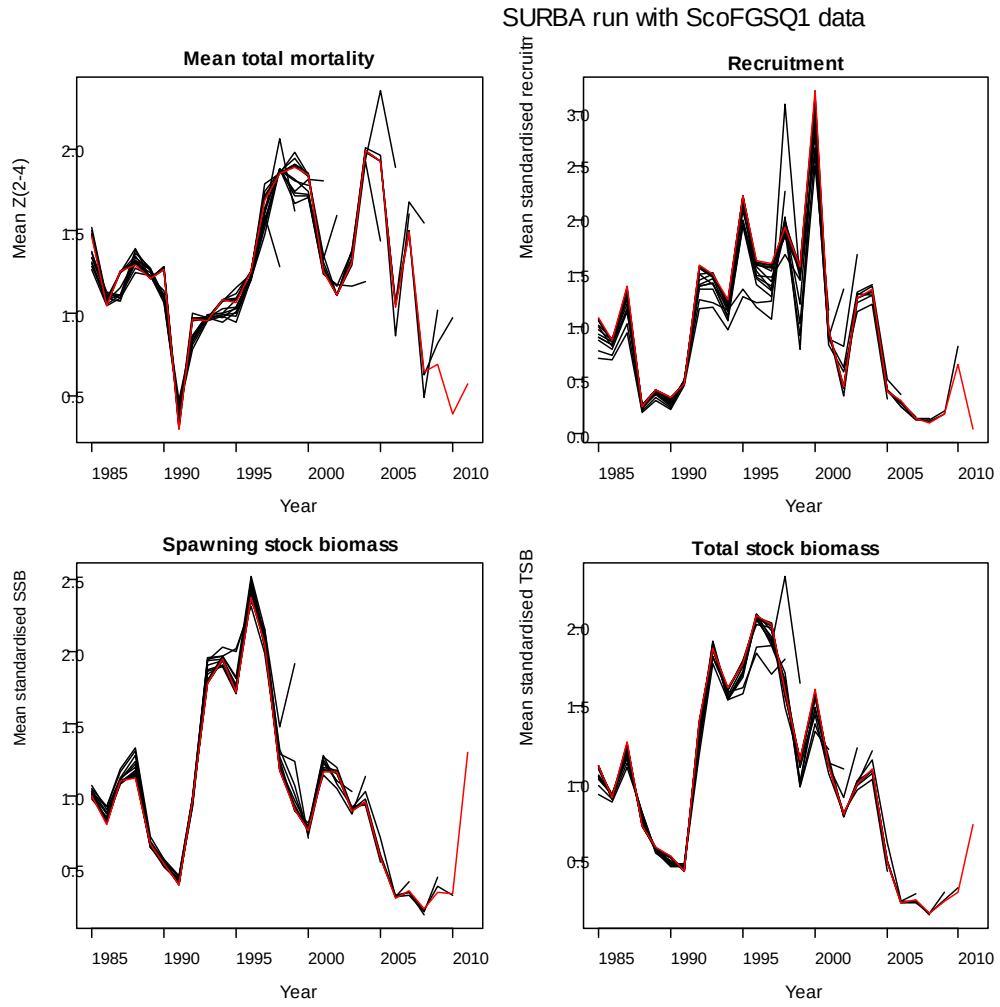


Figure 3.4.10. Whiting in Division VIa. Retrospective plots of SURBA run using ScoGFS-WIBTS-Q1 data.

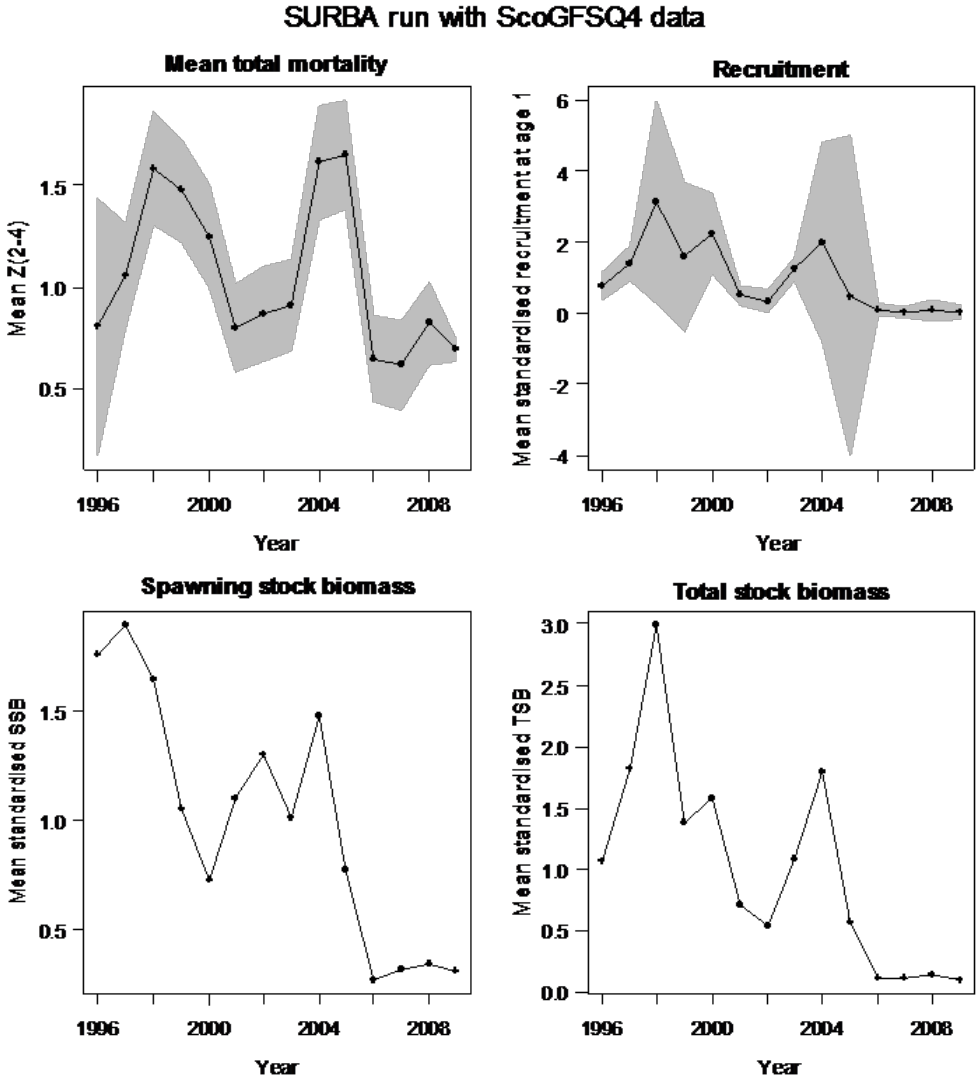


Figure 3.4.11. Whiting in Division VIa. Results of SURBA run using ScoGFS-WIBTS-Q4 data. Mean total mortality estimates are given as absolute; biomass and recruitment are mean-standardized. Mean total mortality and recruitment are shown with +/- standard errors.

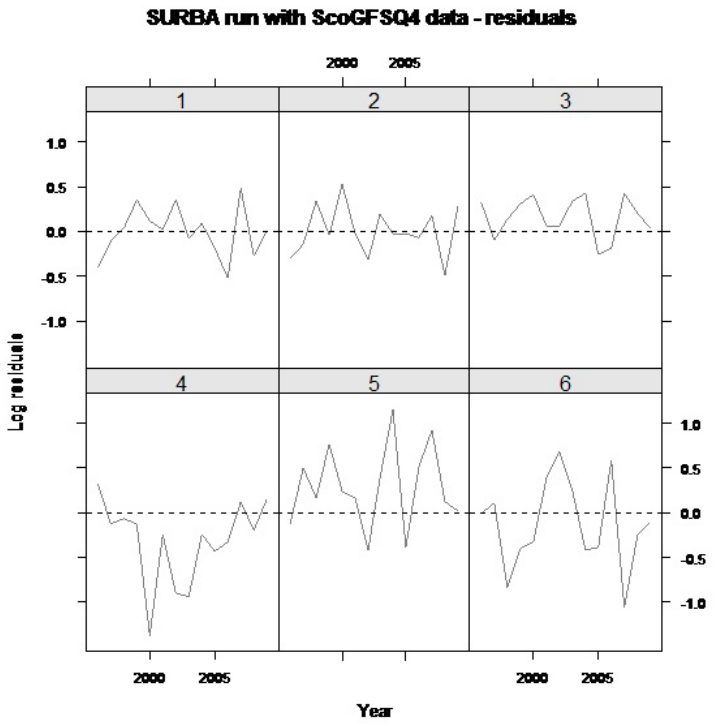


Figure 3.4.12. Whiting in Division VIa. Residuals by age from SURBA run using ScoGFS-WIBTS-Q4 data.

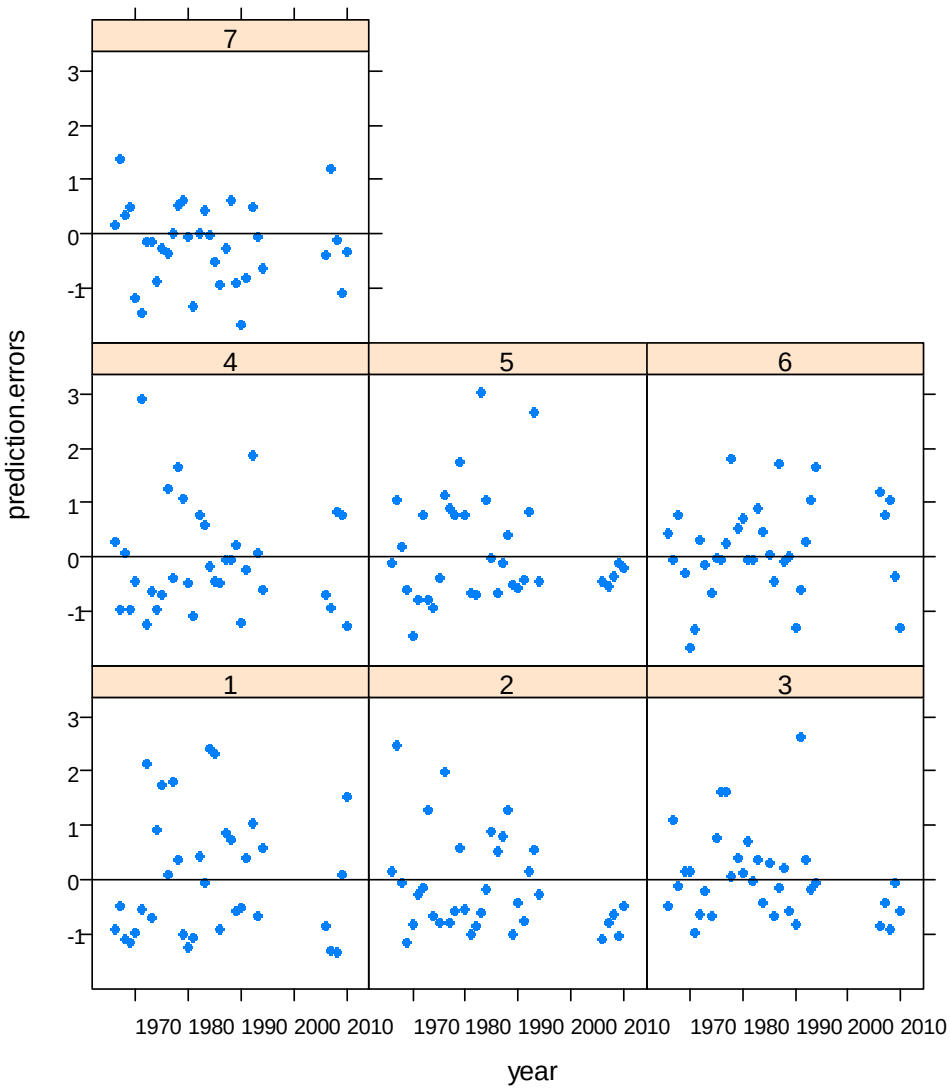


Figure 3.4.13. Whiting in Division VIa. Standardized catch prediction errors from TSA.

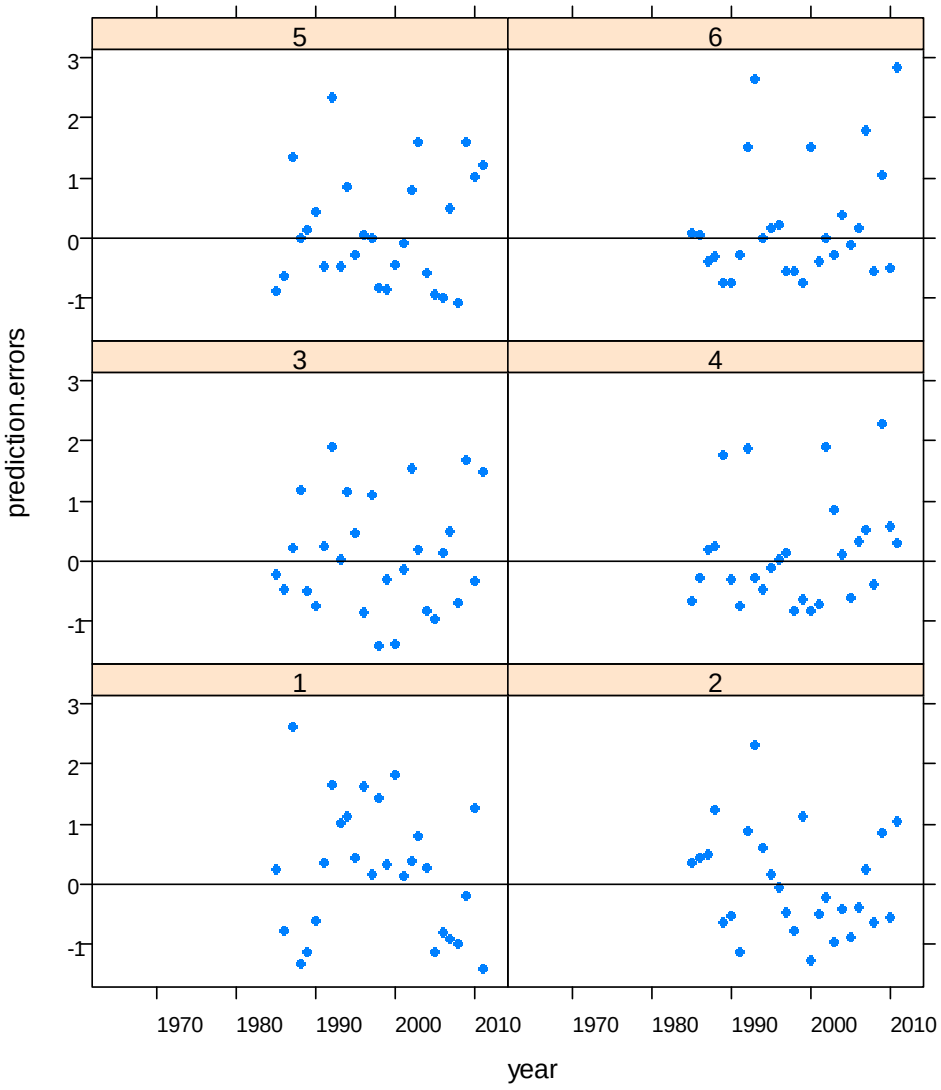


Figure 3.4.14. Whiting in Division VIa. Standardized survey prediction errors from TSA.

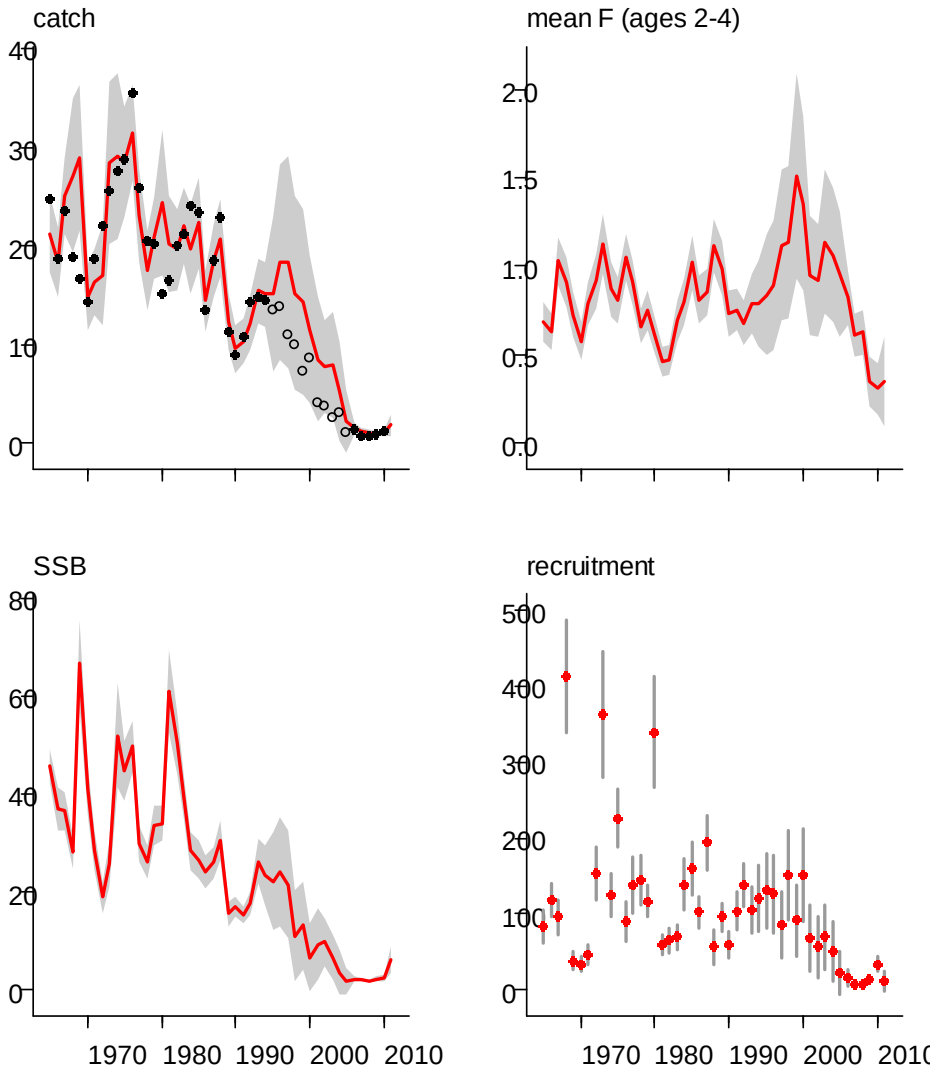


Figure 3.4.15. Whiting in Division VIa. TSA stock summaries from the TSA run with catch data included 1978–1994 and 2006–2010. Catch and SSB in tonnes, recruitment in thousands. Estimates are plotted with approximate pointwise 95% confidence bounds. Dots indicate observed values for catch, with open symbols indicating catch data that were not used in the assessment.

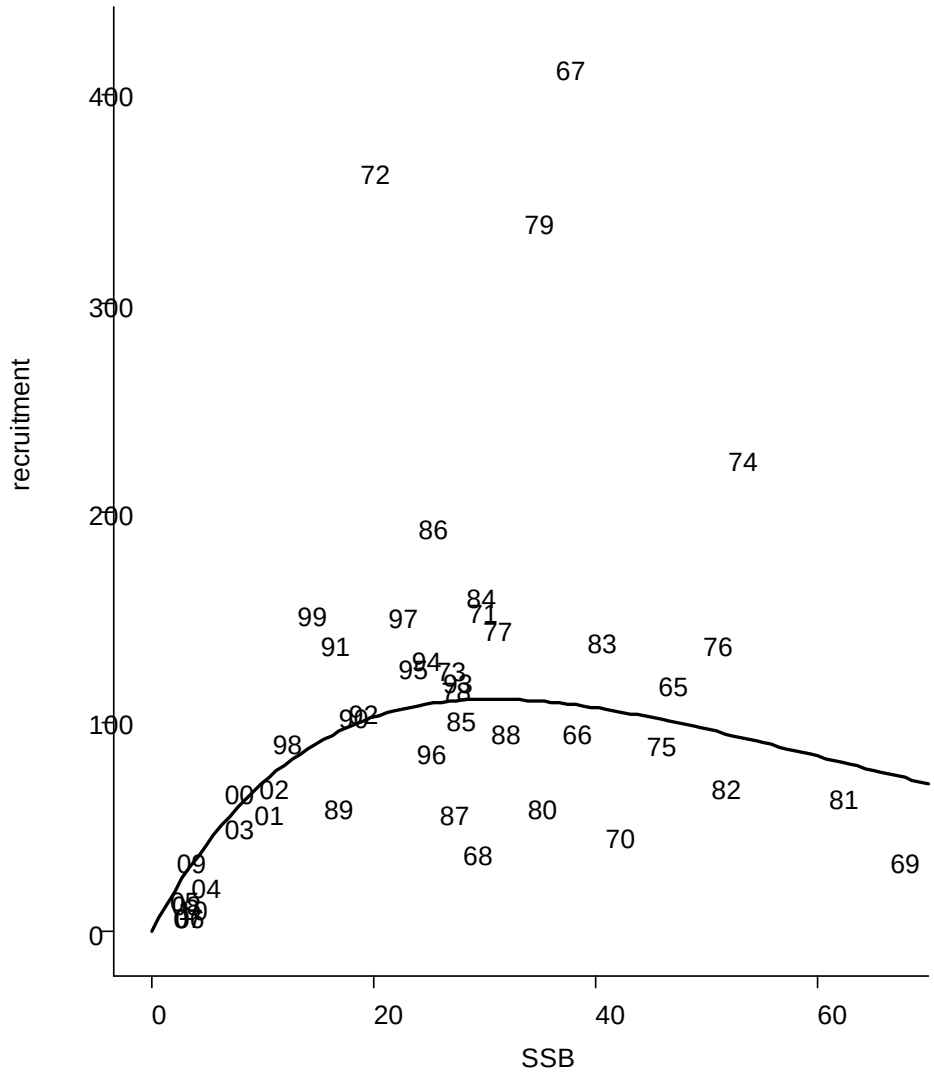


Figure 3.4.16 Whiting in Division VIa. Stock–recruitment plot from the final TSA run, with points labelled as year classes and fitted Ricker stock–recruitment function (solid line).

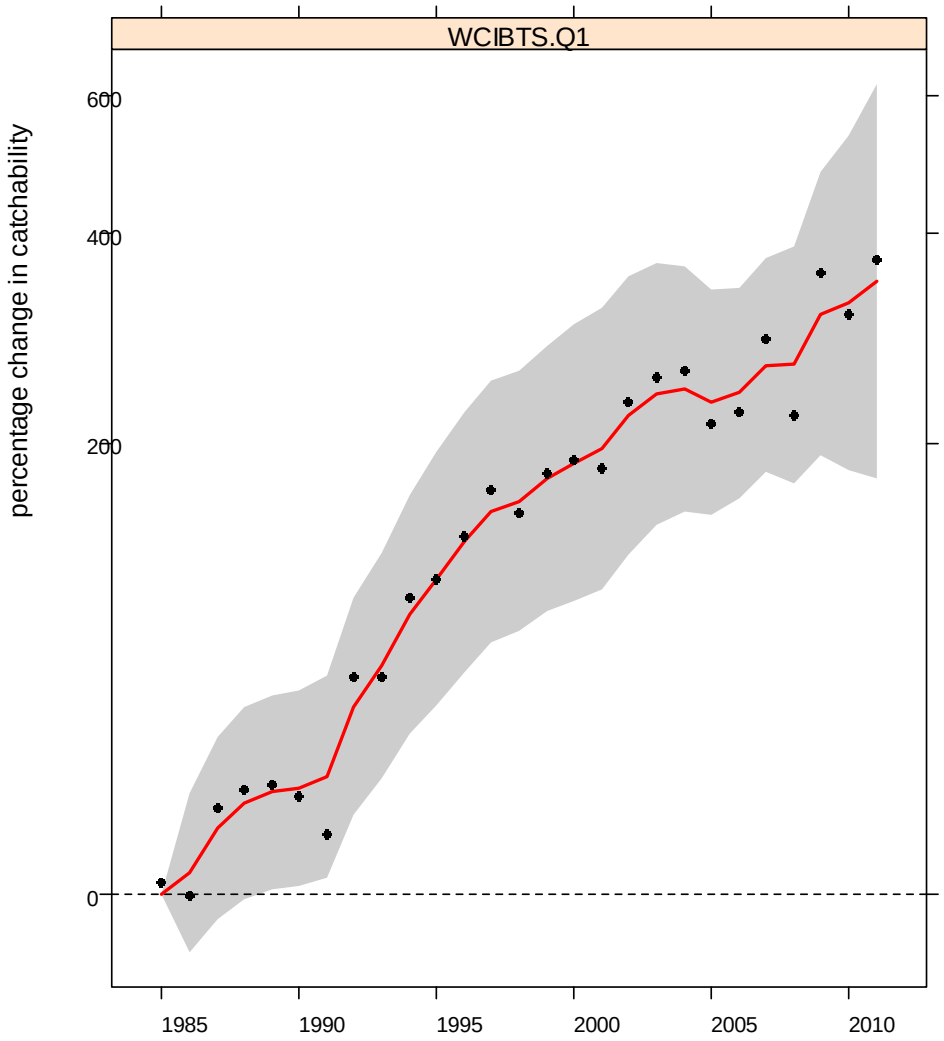


Figure 3.4.17. Whiting in Division VIa. Percentage change in catchability from the final TSA run. Transient changes are plotted as points and the persistent change is plotted as the solid red line with uncertainty represented by the grey polygon.

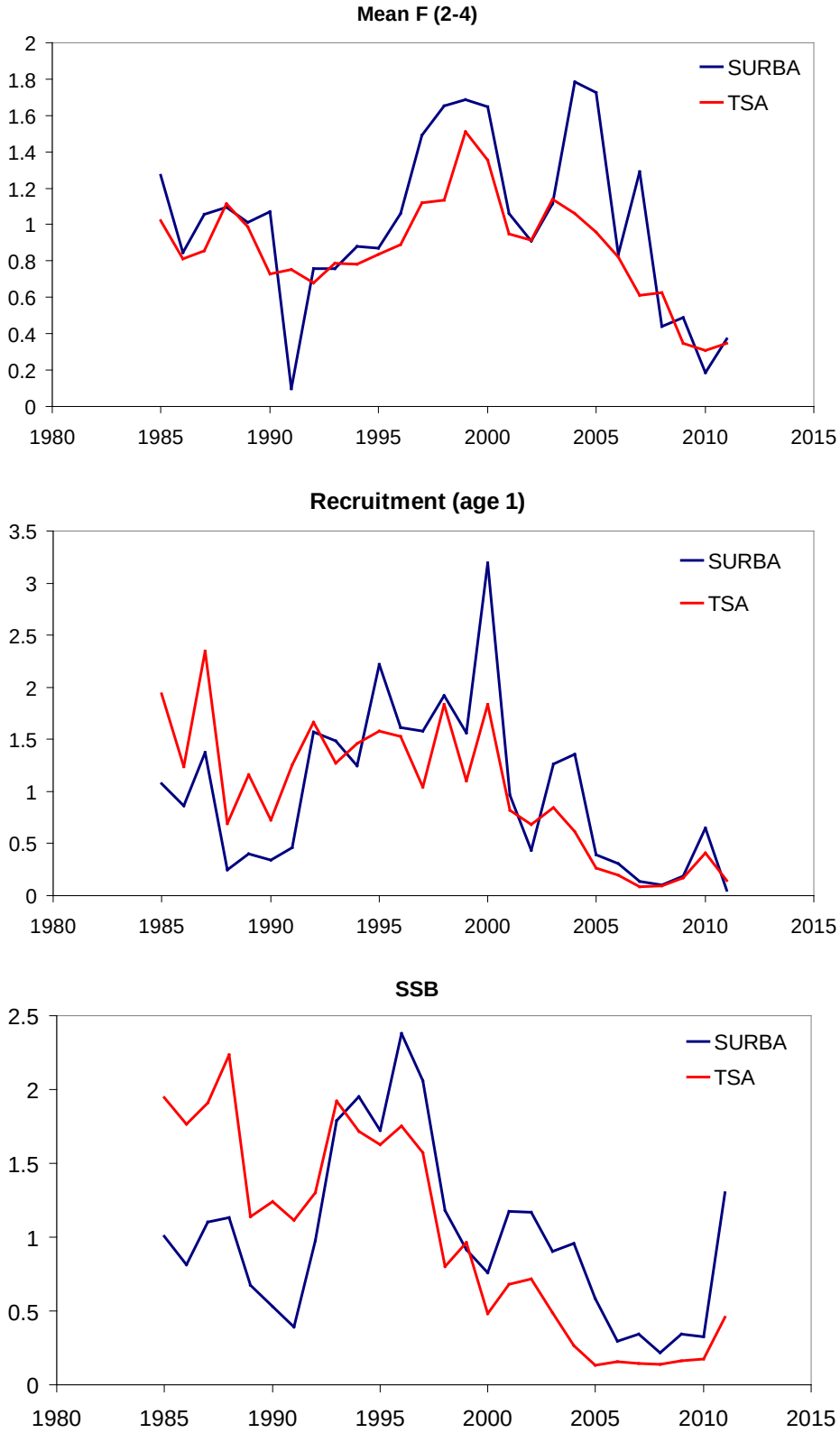


Figure 3.4.18. Whiting in Division VIa. Comparison of trends based assessment final run outputs (SURBA) with TSA final run assessment estimates. Fishing mortality, recruitment and SSB are mean-standardized over the period 1985–2010 (the length of the tuning-series used in TSA).

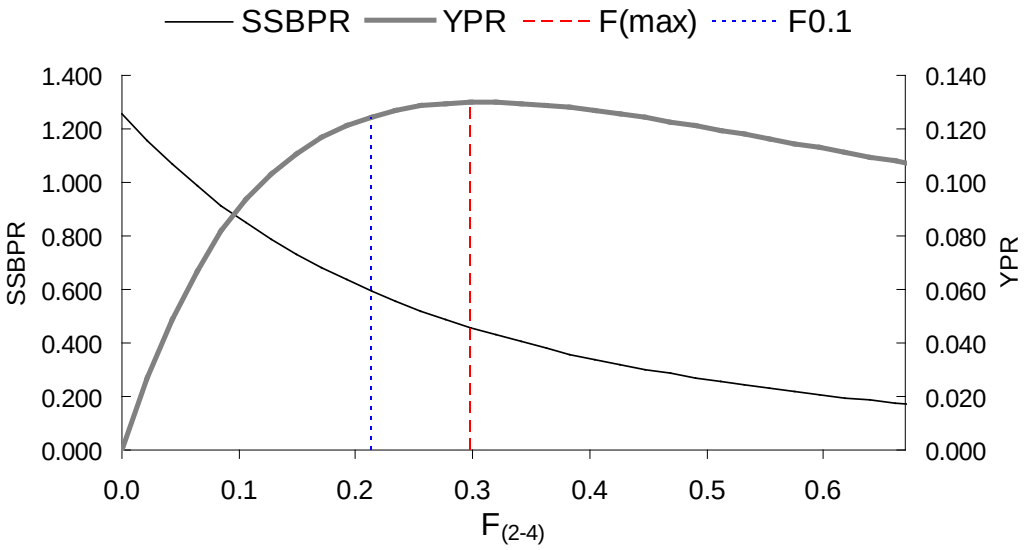


Figure 3.4.19. Whiting in Division VIa. Yield-per-recruit analysis with the output from the final TSA run.

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 2011

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 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 substrata are distributed according to prevailing hydrographic and bathymetric conditions. The area is characterized 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 among west coast FUs. Very soft sediments are found in the southeast while coarser sandy muds prevail to the north and west. Figure 3.5.7 shows the distribution of sediment in the area.

3.5.2 The fishery in 2010

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 2010 was described as being slightly better than in 2009 but generally similar to previous years with a fleet of mainly 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 smaller vessels, currently six single rigged trawlers and six muti-rigged trawlers, all but one are around 15 m length. 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. Although several vessels have been sold or left the fleet in recent years, the remainder have continued to fish the same pattern as always, most trawlers landing daily or every second day. During May 2010, several boats shifted from Lochinver, Ullapool and Gairloch towards Skye and Mallaig where the fishery was described as being better. As a consequence of bad fishing and/or poor weather, a few local boats left the North Minch to fish in 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. There are a number of creel vessels from Kylesku down to Gairloch which reported good catches during 2010.

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

3.5.3 ICES advice for 2010 and 2011

ICES advice for *2010*

Exploitation boundaries in relation to precautionary considerations was as follows:

"ICES advises on the basis of exploitation boundaries in relation to high long-term yield and low risk of depletion of production potential that the Harvest Rate for *Nephrops* fisheries should be less than $F_{0.1}$. This corresponds to landings less than 972 t for the North Minch stock."

ICES conclusions in 2010

"The evidence from the TV survey suggests that the population is stable over the last three years, but at a lower level than that evident from 2003–2006. The calculated harvest ratio in 2009 (dead removals/UWTV abundance) is above the values associated with high long-term yield and low risk depletion.

For this FU, the absolute density observed on the UWTV survey is medium (~0.55 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 expected to deliver high long-term yield with a low probability of recruitment overfishing and therefore is chosen as a proxy for F_{MSY}."

ICES advice for 2011

MSY approach was as follows:

"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."

3.5.4 Management

Management is at the ICES Subarea level as described at the beginning of Section 3.5.

3.5.5 Assessment

Conclusions of the Review of the 2010 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 $F_{35\%spr}$ (combined between sexes) is consistent with the approach adopted by the WGCSE for choosing Fmsy proxies for *Nephrops*. If ICES is to use UWTV abundance estimates as absolute, then biases due to incomplete coverage of *Nephrops* habitat need to be evaluated. The RG agrees that the relationship between fishing area (VMS) and survey area need further exploration.

The RG report contained a number of technical comments and attempts have been made to address these.

Approach in 2011

The assessment in 2011 is based on a combination of examining trends in fishery indicators and underwater TV using an extensive dataseries for the North Minch.

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 2011 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. 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 2010 were 2263 tonnes, consisting of 1717 tonnes landed by *Nephrops* trawlers and 540 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 *Nephrops* trawlers has shown a decreasing trend since 2002 (Figures 3.5.3 and 3.5.4).

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 (75% males in 2010) (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 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 average around 16% by number in the last five years (Table 3.5.10). 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 2012 was 11.2% 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 currently 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 2010. 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. Examination of the tails of the distributions above 35mm (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 Figures 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 quite stable through time.

Mean weight in the landings (Figure 3.5.6 and Table 3.5.9) show no systematic changes over the time-series although there is a slight increase in 2010.

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 of 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 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 survey and the burrow densities were raised accordingly. The VMS area to which counts were raised was calculated as the average VMS area of the last three years (2506 km^2). The numbers of valid stations used in the final analysis are shown in 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 of each of the strata adopted in the stratified random approach. For 2010 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). Figure 3.5.7 shows the distribution of stations in recent TV surveys (2004–2010), 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%.

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 2010 survey is shown in Table 3.5.7 with the 2008 and 2009 outcomes. 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 VMS calculated abundance for 2010 presented at this meeting is not directly comparable with the previous 2009 estimate used for the advice. When compared with the back-calculated VMS series, the abundance in 2010 shows a slight increase (9%) in relation to the 2009 figure.

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 Historical 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 a slight increase in 2009. The recently observed decrease (2006–2008) has left stocks at a similar abun-

dance to those seen in 2002 but not as low as previous to this. The bias adjusted abundance estimates from 1999–2010 (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 2010, the stock is estimated to now be at 1115 million individuals (bias adjusted values). Table 3.5.10 (now including comparable information to that included in the Celtic Seas WG report sections for other FUs) 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
F0.1	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
Fmax	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
F35%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

The $B_{trigger}$ point for this FU (bias adjusted lowest observed UWTV abundance) is calculated as 330 million individuals.

3.5.8 Landings forecasts

A prediction of landings in 2012 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 landings prediction for 2012 at the F_{msy} proxy harvest ratio is 3236 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 (08–10) = 26.16 g

Dead discard rate (08–10) = 11.2 %

Survey bias = 1.33

	Harvest rate	Survey Index (adjusted)	Implied fishery	
			Retained number	Landings (tonnes)
F_{msy}	12.5%	1115	124	3236
$F_{0.1(M)}$	7.4%	1115	73	1916
F_{2010}	7.6%	1115	75	1968
$F_{0.1(T)}$ / $F_{35\%SpR(M)}$	8.7%	1115	86	2253
$F_{max\ (M)}$	12.2%	1115	121	3159
$F_{35\%SpR(T)}$	12.5%	1115	124	3236
$F_{max\ (T)}$	16.6%	1115	164	4298

Note: No F_{msy} transition as F_{2010} is below F_{msy}.

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

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

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

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. However, in 2010 discard trips in quarters one and two have not been completed and as such, fill-ins from quarters four and two were applied respectively. In this assessment (as in 2010) combined trawl and creel length compositions are used to account for the fact that the creel fishery accounts for over 24% 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.

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 realized 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 (2008–2010) 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 marked decline in 2010.

The cumulative bias estimates for FU 11 are largely based on expert opinion (See Annex). The precision of these bias corrections cannot yet be characterized.

The stock are has been increased by WGCSE 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 substratum 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 utilize these data to improve estimates of mud area and *Nephrops* abundance. The current stock area can be therefore considered a minimum estimate.

3.5.11 Status of the stock

The evidence from the TV survey suggests that the population is stable, but at a lower level than that observed between 2003–2006. In 2010 an increase in abundance was observed (9% when compared with the VMS area based estimated for 2009). The calculated harvest ratio in 2010 (dead removals/TV abundance) is now 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) and real-time closures to avoid cod.

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, 1980–2010, 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	-	1226	11,462	-	12741
2010*	-	45	-	-	-	12,199	12244

*** 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

*** figures are provisional.**

Table 3.5.3. ***Nephrops*****, Total** ***Nephrops*** **landings (tonnes) by Functional Unit plus Other rectangles, 1981–2010.**

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	555	12244

*** provisional.**

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

IMS data only	2007	2008	2009*	2010*
No. *Nephrops* Samples	126	119	133	83
No. *Nephrops* measured	119 962	68 309	74 261	57 388
Discard data only	2007	2008	2009*	2010*
No. *Nephrops* Samples	22	24	25	22
No. Marketable *Nephrops* measured	NA	45 251	46 223	31 315
No. Discards Measured	14 630	15 975	13 549	8941

*** 2009 and 2010 are not directly comparable with previous years given that sampling levels shown are aggregated for all gears while sampling numbers for 2007 and 2008 include only *Nephrops* trawl and Creel fishing.**

Table 3.5.5. *Nephrops*, North Minch (FU11), Nominal Landings of *Nephrops*, 1981–2010.

	UK Scotland			
Year	*Nephrops* trawl	Other trawl	Creel	Total**
1981	2320	170	371	2861
1982	2323	105	371	2799
1983	2784	95	317	3196
1984	3449	161	534	4144
1985	3236	117	708	4061
1986	2642	203	537	3382
1987	3458	143	482	4083
1988	3449	149	437	4035
1989	2603	112	490	3205
1990	1941	134	469	2544
1991	2228	125	439	2792
1992	2978	150	432	3560
1993	2699	85	408	3192
1994	2916	246	454	3616
1995	2940	184	532	3656
1996	2355	147	369	2871
1997	2553	102	391	3046
1998	2023	67	351	2441
1999	2791	56	410	3257
2000	2695	28	523	3246
2001	2651	41	567	3259
2002	2775	79	586	3440
2003	2607	44	617	3268
2004	2400	25	710	3135
2005	2267	18	699	2984
2006	3446	17	697	4160
2007	3362	16	590	3968
2008	3230	12	557	3799
2009	2858	26	613	3497
2010*	1717	6	540	2263

*** 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, 1981–2010.

	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

*** provisional na = not available.**

Table 3.5.7. ***Nephrops*****, North Minch (FU 11): Results by stratum of the 2008–2010 TV surveys. Note that stratification was based on a series of arbitrary rectangles (U, V, W, X).**

Stratum	Area (km^2)	Number of Stations	Mean burrow density ($no./m^2$)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2008 TV survey							
U	656	13	0.36	0.05	233	1511	0.255
V	425	10	0.59	0.05	250	827	0.140
W	563	13	0.40	0.14	225	3511	0.592
X	131	5	1.07	0.02	140	78	0.013
Total	1775	41			848*	5927	1
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
2010 TV survey**							
VMS	2506	37	0.592	0.103	1483	17 494	1
Total	2506	37			1483	17 494	1

***Note: abundance estimates for these years based on figures prior to the 2009 revision of the dataseries. Differences between these figures and the revised figures shown on Table 3.5.8 are small.**

Table 3.5.8. ***Nephrops*****, North Minch (FU 11): Results of the 1994–2010 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

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	21.49	23.60	16.74	
2000	22.77	24.81	19.54	
2001	23.15	21.44	19.06	
2002	23.03	23.60	15.82	
2003	22.86	24.48	18.59	
2004	21.45	24.02	18.31	16.90
2005	23.62	23.53	17.46	15.47
2006	21.97	23.15	18.66	15.05
2007	21.68	21.43	18.53	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
Mean (08-10)	26.16	24.47	18.56	21.44

*** From 2008 onwards mean weights are shown for trawl and creels combined.**

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)	Adjusted survey (VMS)	Harvest ratio (VMS)	Harvest ratio (sediment)	Landings (tonnes)	Discard (tonnes)	Discard rate	Dead discard rate
1999	145	28	164	484	683	24.0	33.8	3257	275	16.4	12.8
2000	133	10	141	711	1003	14.1	19.9	3246	98	6.9	5.2
2001	130	17	141	666	939	15.0	21.2	3259	161	11.7	9.1
2002	132	28	153	815	1149	13.3	18.7	3440	276	17.6	13.8
2003	127	30	148	1068	1505	9.8	13.8	3268	303	19.2	15.2
2004	123	18	136	1068	1505	9.0	12.7	3135	203	13.0	10.1
2005	108	51	144	939	1324	10.9	15.3	2984	514	32.0	26.1
2006	171	74	223	1074	1515	14.7	20.7	4160	762	30.3	24.6
2007	170	12	177	735	1037	17.1	24.1	3968	216	6.5	5.0
2008	162	19	173	638	900	19.2	27.1	3799	198	10.5	8.1
2009	145	37	164	729	1027	16.0	22.5	3497	344	20.3	16.0
2010	77	11	85	-	1115	7.6	-	2263	121	12.4	9.6
Average 08–10											11.2

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

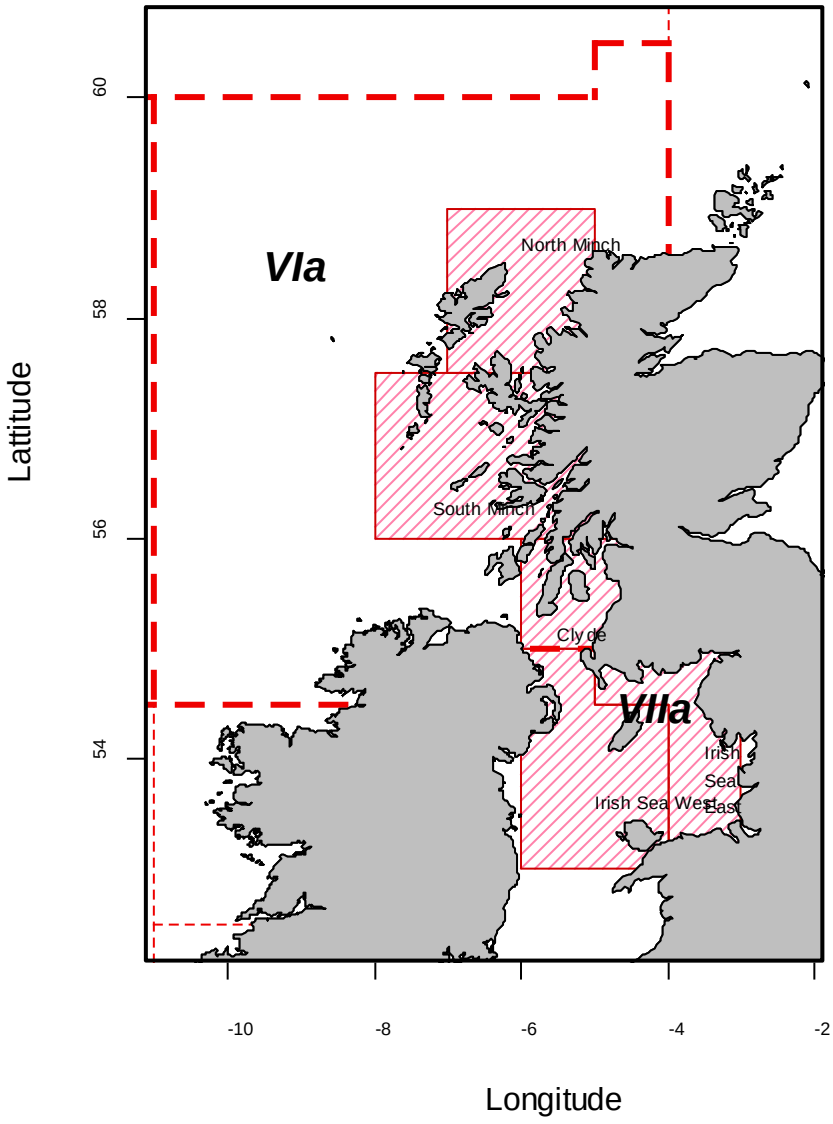


Figure 3.5.1. ***Nephrops*** **Functional Units in VIa and VIIa. North Minch (FU11), South Minch (FU12), Clyde (FU13), Irish Sea East (FU14) and Irish Sea West (FU15).**

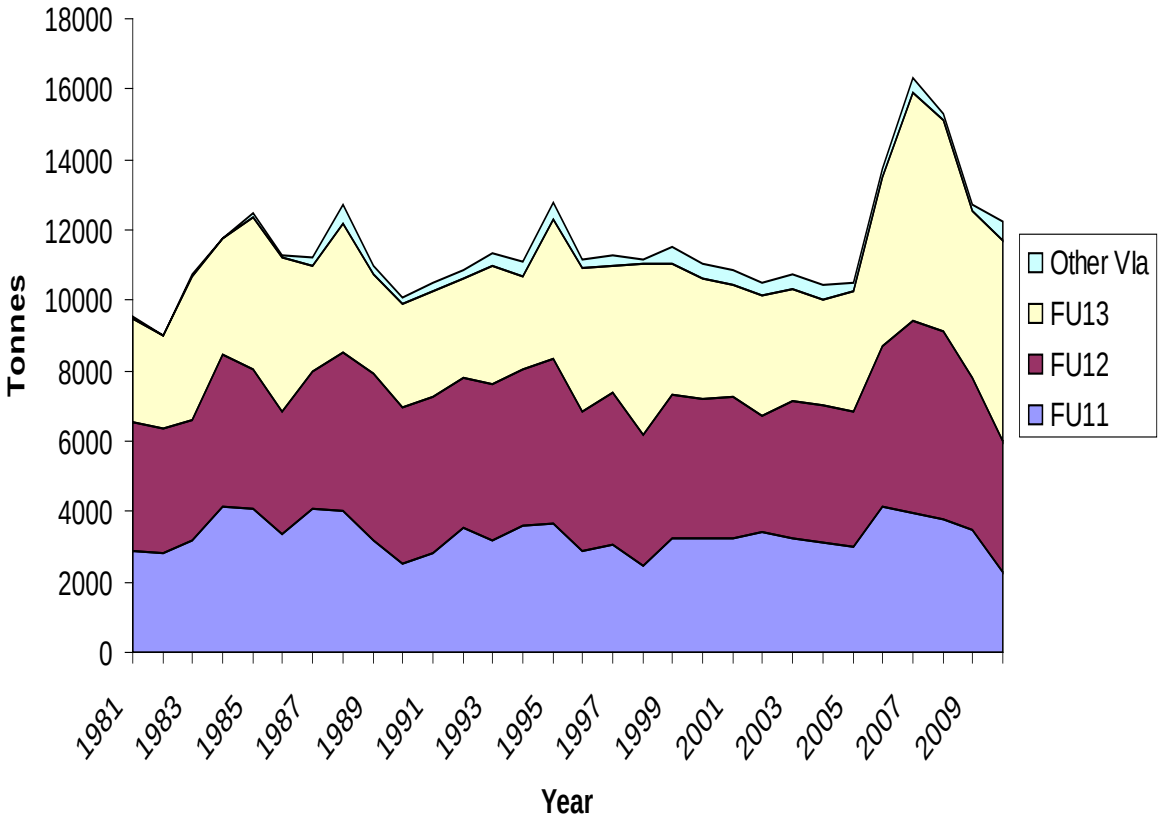


Figure 3.5.2. ***Nephrops*** **in Division VIa. Landing (thousands tonnes) by FU and Other rectangles.**

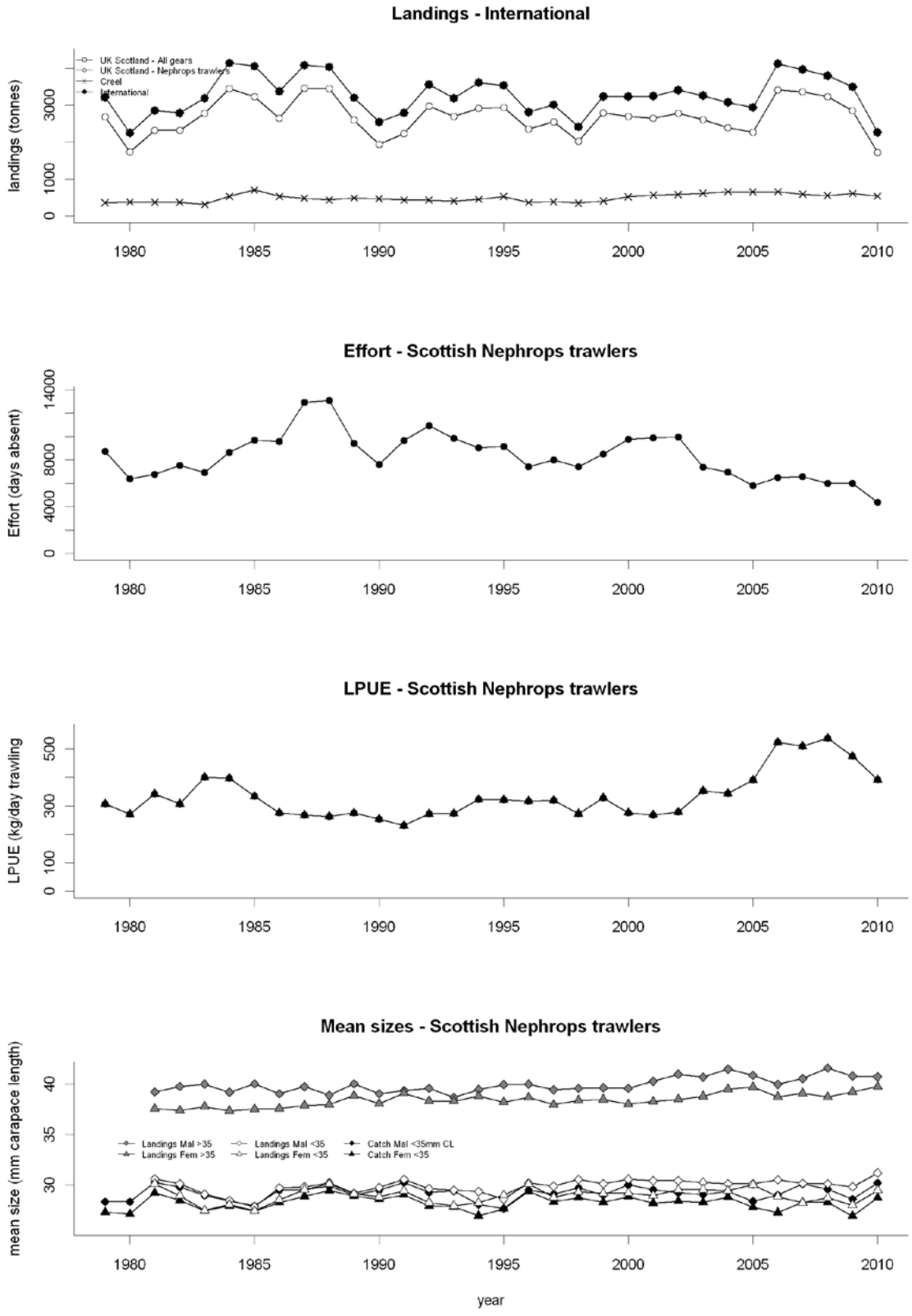


Figure 3.5.3. *Nephrops*, **North Minch (FU11), Long-term landings, effort, lpue and mean sizes. The interpretation of the lpue series is likely to be affected by the introduction of the "buyers and sellers" regulations in 2006.**

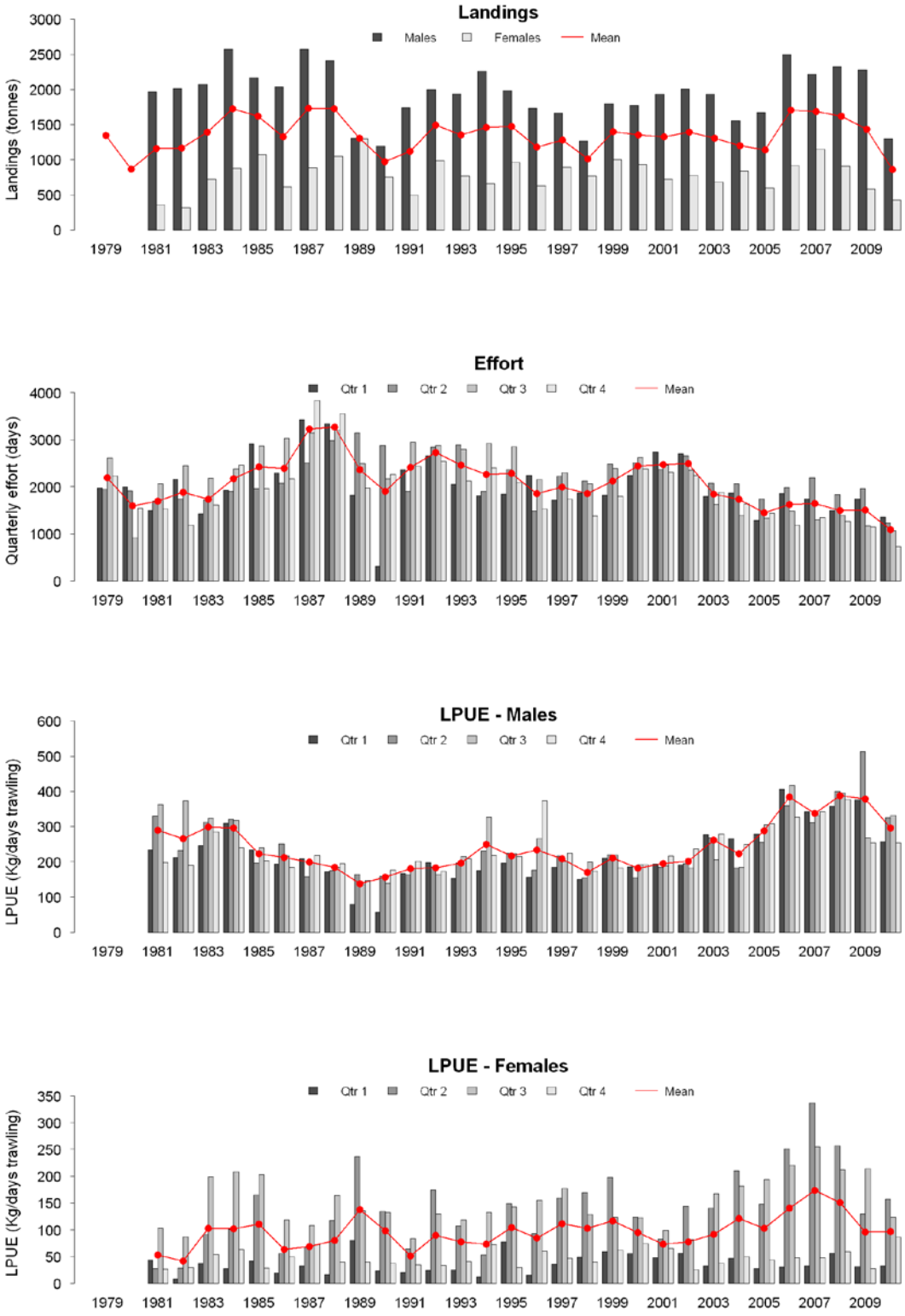


Figure 3.5.4. *Nephrops,* **North Minch (FU11), Landings, effort and lpues by quarter and sex from Scottish *Nephrops* trawlers. The interpretation of the lpue series is likely to be affected by the introduction of the "buyers and sellers" regulations in 2006.**

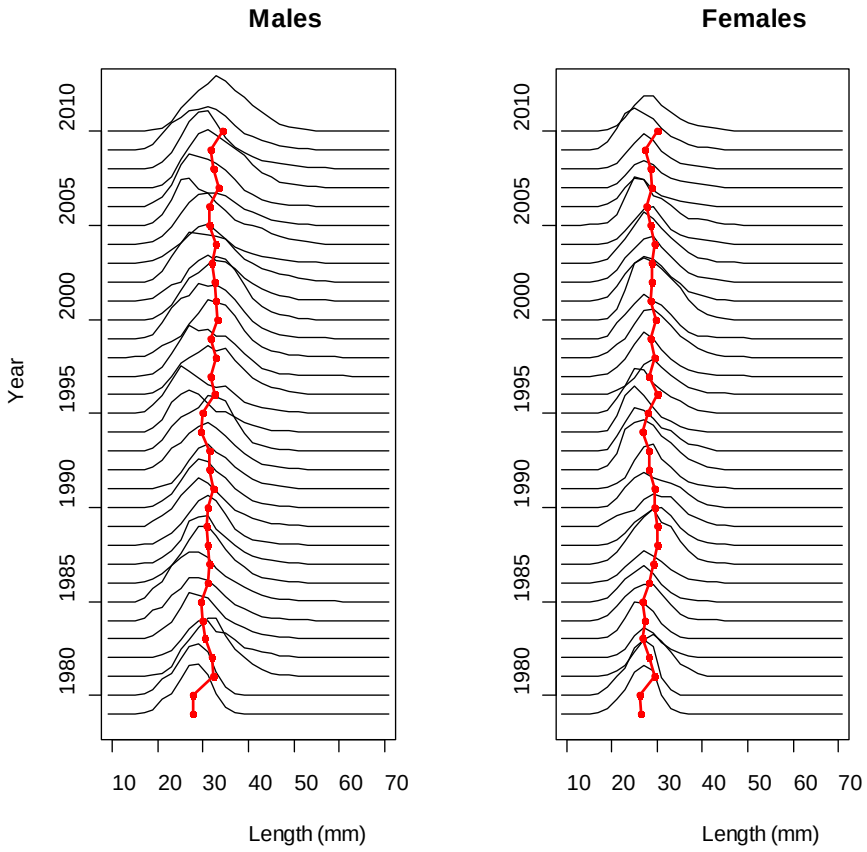


Figure 3.5.5. *Nephrops*, **North Minch (FU11), Catch length frequency distribution and mean sizes (red line) for** *Nephrops* **in the North Minch, 1979–2010.**

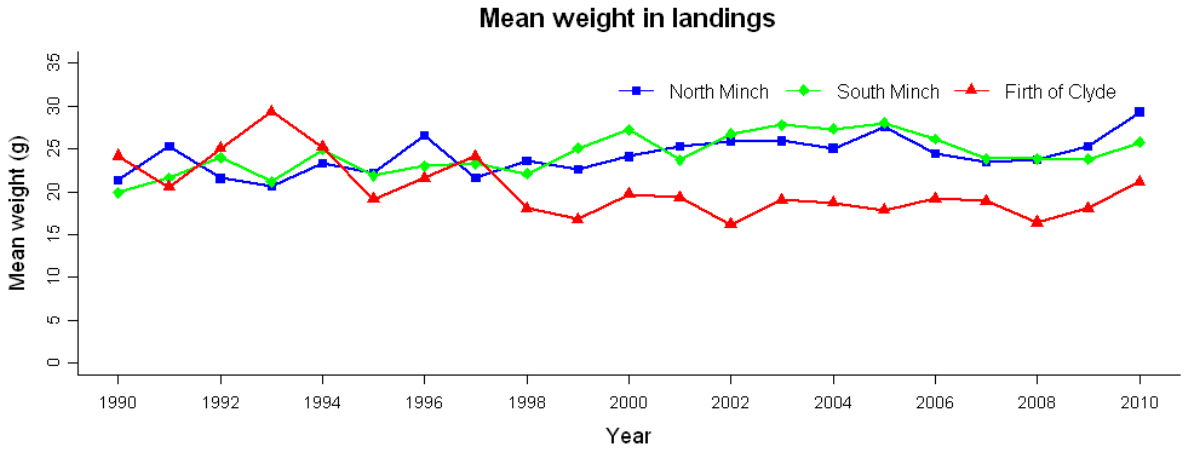


Figure 3.5.6. *Nephrops*, **(FUs 11–13), individual mean weight in the landings from 1990–2010 (from Scottish market sampling data).**

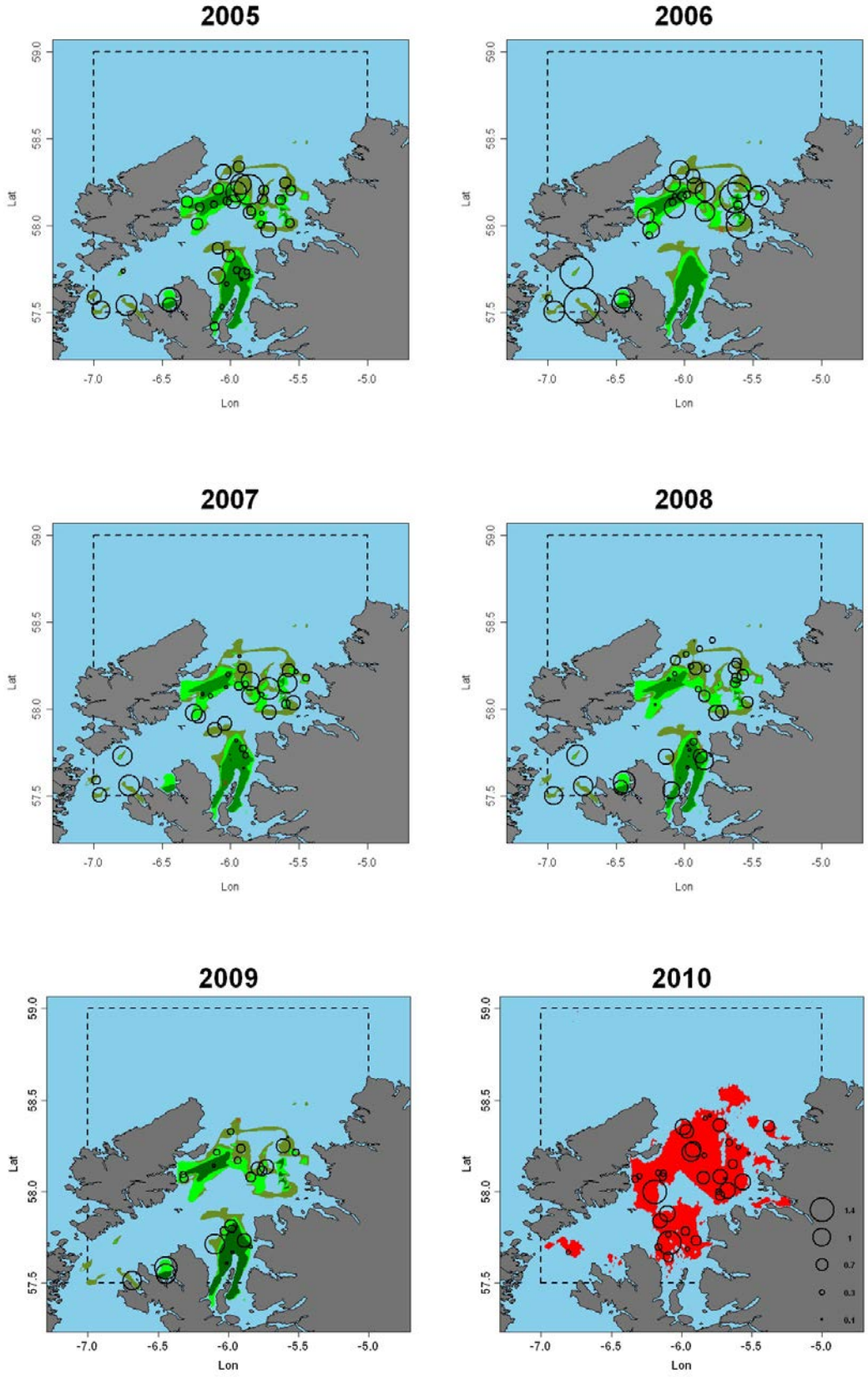


Figure 3.5.7 *Nephrops*, **North Minch (FU11), TV survey station distribution and relative density (burrows/m²), 2005–2010. Shaded green and brown areas represent areas of suitable sediment for** *Nephrops*. **Bubbles in these figures are all scaled the same. Crosses represent zero observations.**

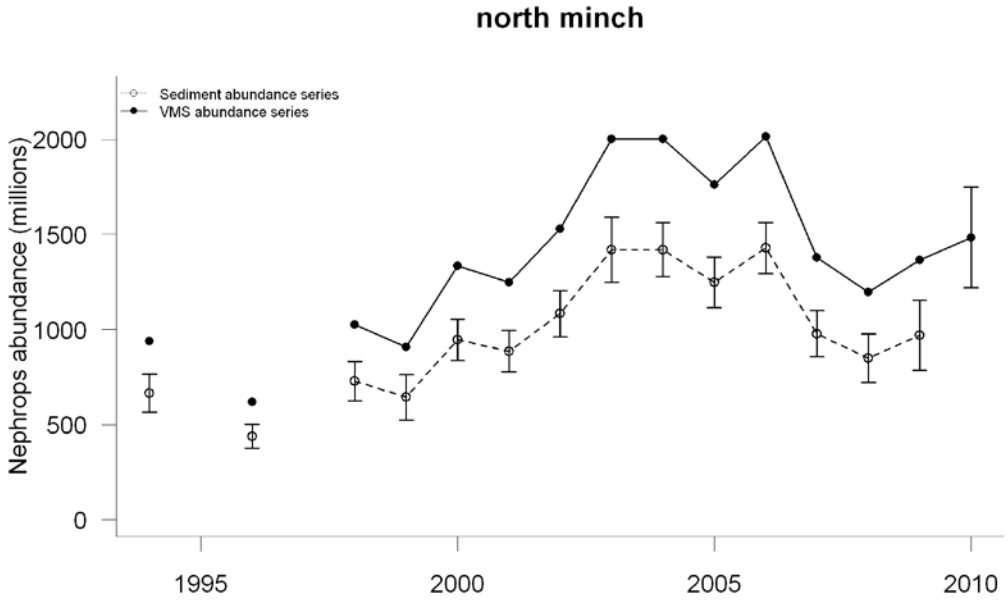


Figure 3.5.8. *Nephrops*, **North Minch (FU11), time-series of revised TV survey abundance estimates (not adjusted for bias), with 95% confidence intervals, 1994–2010 (no survey in 1995 and 1997). The dashed and solid lines are the abundance estimated raised to the sediment area and VMS area, respectively.**

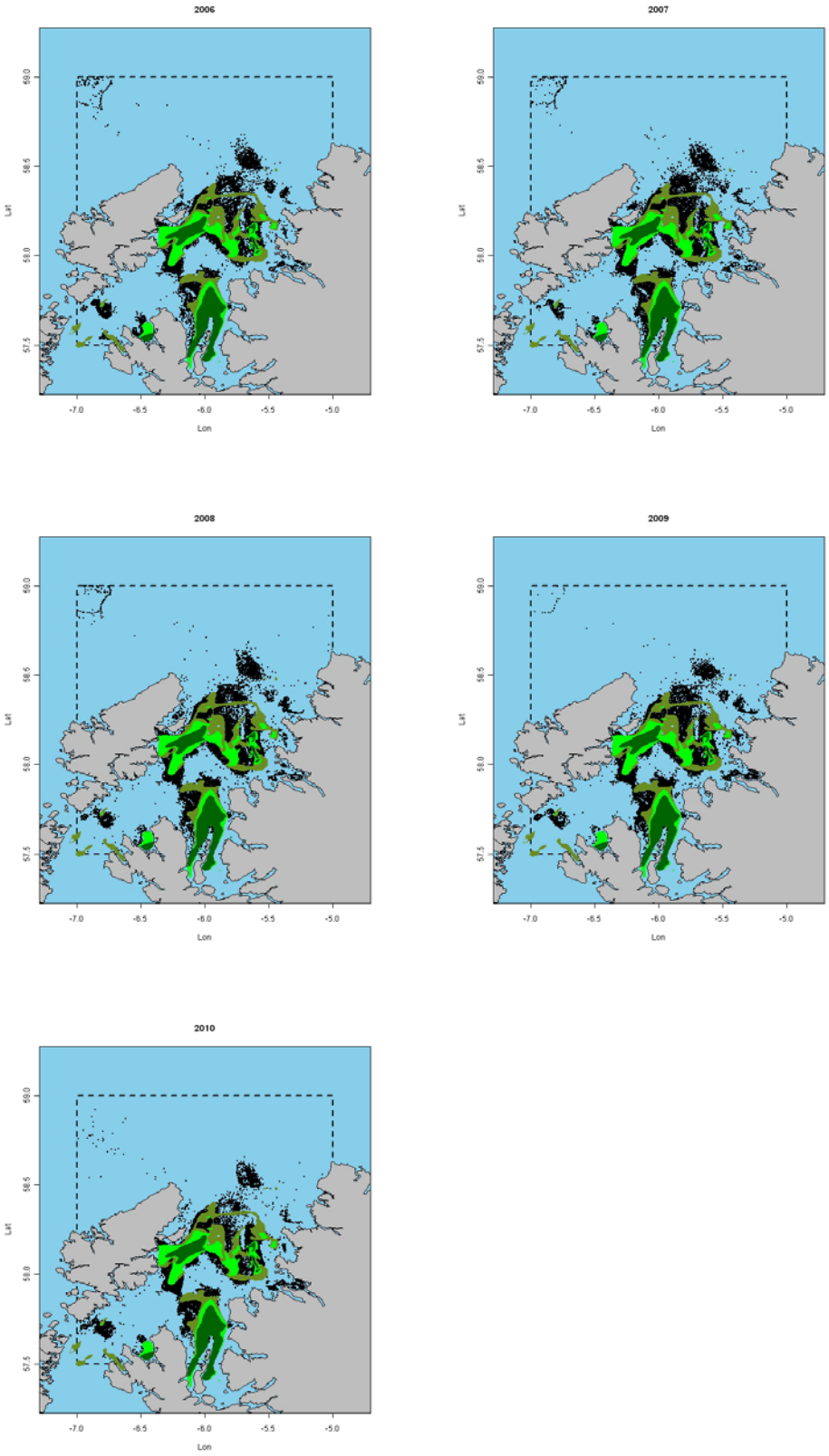


Figure 3.5.9. ***Nephrops*, North Minch (FU11), comparison of area of *Nephrops* ground defined by BGS sediment distribution (green shaded overlay) and by distribution of VMS pings (shown by black dots, underlay) recorded from *Nephrops* trawlers >15 m length for 2006-2010. VMS data filtered to exclude vessel speeds>4.5 knots.**

3.6 South Minch, FU12

Type of assessment in 2011

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 mid way 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 characterized 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 3.6.4 shows the distribution of sediment in the area.

3.6.2 The fishery in 2010

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. Two distinct fleets continued to operate in the South Minch during 2010, landing into the two main ports of Oban and Mallaig. Inshore, a fleet of smaller vessels including creel boats operated throughout the year, while some larger twin riggers fish further afield with the distance offshore increasing in 2010. 90% of boats are thought to fish for *Nephrops* at some time. The Mallaig local fleet has declined in recent years and several more vessels were decommissioned in 2010, 14 were resident during November. Traditionally east coast vessels (mainly twin riggers from Fraserburgh) visit Mallaig in March or April, but in the last few years there has been a significant reduction in effort from visiting east coast vessels, this pattern continued in 2010 as a result of high fuel prices. During May 2010, a number of vessels typically fishing the North Minch moved into the South Minch as a result of poor fishing on their regular fishing grounds.

Owing to high fuel costs and relatively poor prices for *Nephrops*, fishing practices progressively changed in 2010. Many of the boats worked longer days during slack tide periods but during stronger tides remained in harbour. Most boats landed once or twice per week. There are very few vessels (2-3) that landed on a daily basis. During winter, fishing activity is severely 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. (This is described further in the quality of assessment section to illustrate the extent of trawling by some vessels). 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 suitable for storage using 'individual tubing'. This marketing technique (previously developed in the creel fishery) was more prevalent in 2010.

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. In 2010, boats were catching small quantities of squid as bycatch with their prawns. This led to some fishermen wanting to target squid, but the ban on 40 mm mesh within west coast emergency zone meant, they were unable to do so. In November/December 2010, four smaller *Nephrops* boats diverted to pair trawling for sprats and herring.

3.6.3 ICES advice in 2010 and 2011

ICES advice for *2010*

Exploitation boundaries in relation to precautionary considerations was as follows:

"ICES advises on the basis of exploitation boundaries in relation to high long-term yield and low risk of depletion of production potential that the Harvest Rate for *Nephrops* fisheries should not exceed F_{2008}. This corresponds to landings of no more than 4126 t for the South Minch stock."

ICES advice for *2011*

"The stable mean sizes in the length compositions of catches (of individuals >35 mm CL) and recent fall in estimated harvest ratios (dead removals/TV abundance) to the equivalent of the F_{MSY} proxy suggests that the stock is now being exploited sustainably. For this FU, the absolute density observed on the UWTV survey is medium (~0.44/m^2) suggesting the stock has moderate productivity. The fishery in this area has been in existence since the 1960s and the population has been studied numerous times. Historical harvest ratios in this FU have been variable but generally around the $F_{35\%SpR}$. $F_{35\%SpR}$ (combined between sexes) is expected to deliver high long-term yield with a low probability of recruitment overfishing and therefore is chosen as a proxy for F_{MSY}."

ICES advice for 2011 based on MSY approach was as follows:

"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."

3.6.4 Management applicable in 2009 and 2010

Management applicable to this stock is included in management for Division VIa as a whole, and is described in 3.5.1.

3.6.5 Assessment

The 2010 RG concluded that the Underwater Television Survey (UWTV) and associated catch options to be an appropriate basis for management advice, The RG agreed 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 that $F_{35\%spr}$ (combined between sexes) is consistent with the approach adopted by WGCSE for choosing F_{msy} proxies for *Nephrops*. The RG recommended that if ICES is to use UWTV abundance estimates as absolute, then biases due to incomplete coverage of *Nephrops* habitat need to be evaluated. The RG agreed that the relationship between fishing area (VMS) and survey area need further exploration. An improvement suggested by the 2010 WG and endorsed by RG is improving the coverage and timing of the UWTV survey and correlating it with VMS data for best adjustment to the harvest area.

The RG report contained a number of technical comments and attempts have been made to address these.

Approach in 2011

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 2010 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 2010 were 3725 tonnes, consisting of 2814 tonnes landed by Scottish trawlers and 889 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 have remained relatively stable over the last four years, at close to 1000 tonnes, the highest level in the time-series.

Reported effort (given in days fished rather than hours since this is thought to be more reliable).by all Scottish *Nephrops* trawlers has fluctuated gently throughout the time-series reaching a peak in the early 1990s and showing a gradual decline since then (Figures 3.6.1 and 3.6.2).

Sex ratio in the South Minch shows some variation but males consistently make the largest contribution to the annual landings (63% in 2010). This occurs because males are available throughout the year whereas females on the other hand are mainly taken in 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 average around 16% by number in this FU over the most recent five years (Table 3.6.5).

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 2008–2010 and amounts to 11.8%. According to the

agreed benchmark protocol this 'dead discard' value is used in the provision of landings options for 2012.

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 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 2010. 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.

Mean weight in the landings is shown in Figure 3.5.6 and Table 3.5.9 and this also shows no systematic changes over the time-series although there is a slight increase in 2010.

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 reduce the problems associated with traditional trawl surveys that arise from variability of burrow emergence of *Nephrops*. TV surveys are targeted at known areas of mud, sandy mud and muddy sand in which *Nephrops* construct burrows.

The numbers of valid stations used in the final analysis in each year are shown in Table 3.6.4. On average, 34 stations have been considered valid each year, then raised to a stock area of 5072 km^2. In 2010 station numbers were at the average number.

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 re-working 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 of each of the strata adopted in the stratified random approach. Due to the fact only one station was surveyed in the mud sediment type in 2008, it was not possible to calculate a sample variance for this area in the usual way. Instead an average of the three previous years was taken. Results in 2010 were typical of previous years.

Figure 3.6.4 shows the distribution of stations in recent TV surveys (2005–2010), with the size of the symbol reflecting the *Nephrops* burrow density. The most recent survey suggests continued higher density in the southeast part of the functional unit and an area of high density 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 FU12 was 1.32 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 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 2010 survey is shown in Table 3.6.3 and compared with the 2008 and 2009 outcomes. 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 2010 TV survey data presented at this meeting shows that the abundance has increased to a value significantly above the 2007 low point and is in line with values recorded in 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 Historical 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. The recently observed upturn gives an abundance of 2740 which is well above the long-term average (2130 million animals) Table 3.6.4. The bias adjusted abundance estimates from 1999–2010 are shown in Table 3.6.5. Table 3.6.5 (now including comparable information to that included in the Celtic Seas WG report sections for other FUs) also shows the estimated harvest ratios over this period. Harvest rates have ranged from about 7 to 27% since 1999. The current value is relatively low at 7.4%. (It is likely that prior to 2006, the harvest ratios are underestimates of the actual harvest ratios due to underreporting of 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 (%)		
		F_{mult}	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
F_{max}	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

The $B_{trigger}$ point for this FU (bias adjusted lowest observed UWTV abundance) is calculated as 1016 million individuals.

3.6.8 Landings forecasts

A landings prediction for 2012 was made for the South Minch (FU12) using the approach agreed at the Benchmark Workshop 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 and the harvest ratio in 2010 using input parameters agreed at WKNEPH (ICES 2009) and mean weight in landings and discard rate from the average of 2008–2010 . The landings prediction for 2012 at the F_{msy} proxy harvest ratio considered appropriate to the South Minch (i.e. 12.3%) is 5514 tonnes. Since current harvest rate is below the F_{msy} proxy, the ICES MSY framework applies and would result in a landings estimate of 5514 tonnes for 2012.

The inputs to the landings forecast were as follows:

Mean weight in landings (08–10) = 24.47 g

Discard rate by number (08–10)) = 11.8%

Survey bias = 1.32

	Harvest rate	Survey Index (adjusted)	Implied fishery	
			Retained number	Landings (tonnes)
F_{msy}	12.3%	2076	225	5514
F_{2010}	7.4%	2076	136	3317
$F_{0.1(M)}$	7.8%	2076	143	3497
$F_{0.1(T)}$	8.7%	2076	159	3900
$F_{35\%SpR(M)}$	9.6%	2076	176	4304
$F_{35\%SpR(T)}$	12.3%	2076	225	5514
$F_{max\ (M)}$	13.3%	2076	244	5962
$F_{0.1(F)}$	13.8%	2076	253	6186
$F_{max\ (T)}$	16.1%	2076	295	7217

Note: No F_{msy} transition as F_{2010} is below F_{msy}.

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

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

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

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 20% 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 was introduced and the reliability began to improve. Because of this the final assessment adopted is independent of official statistics.

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 realized 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 (2008–2010) 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.

The cumulative bias estimates for FU 12 are largely based on expert opinion (See Annex). The precision of these bias corrections cannot yet be characterized.

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 some 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. On average the area estimates for the sediment maps exceed those estimated for the VMS by a factor of about 1.1 (ICES, 2010) 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 utilize 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 is now well 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 confer 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 emer-

gency measures (Council Reg. (EU) 43/2009), include the implementation of larger meshed square meshed panels (120 mm) and real-time closures to avoid cod.

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*, 1981–2010, as officially reported.

	UK Scotland						
Year	*Nephrops* trawl	Other trawl	Creel	Sub-total	Other UK	Ireland	Total
1981	2965	254	432	3651	0	0	3651
1982	2925	207	420	3552	0	0	3552
1983	2595	361	456	3412	0	0	3412
1984	3228	478	594	4300	0	0	4300
1985	3096	424	488	4008	0	0	4008
1986	2694	288	502	3484	0	0	3484
1987	2927	418	546	3891	0	0	3891
1988	3544	364	555	4463	10	0	4473
1989	3846	338	561	4745	0	0	4745
1990	3732	262	436	4430	0	0	4430
1991	3597	341	503	4441	1	0	4442
1992	3479	208	549	4236	1	0	4237
1993	3608	193	649	4450	5	0	4455
1994	3743	265	404	4412	3	0	4415
1995	3442	716	508	4666	14	0	4680
1996	3107	419	468	3994	1	0	3995
1997	3519	331	492	4342	3	1	4345
1998	2851	340	538	3729	0	0	3730
1999	3165	359	513	4037	0	14	4051
2000	2939	312	699	3950	0	2	3952
2001	2823	393	767	3983	0	9	3992
2002	2234	315	742	3291	0	14	3305
2003	2812	203	858	3873	0	6	3879
2004	2865	104	880	3849	0	19	3868
2005	2810	46	953	3809	1	31	3841
2006	3569	19	922	4510	9	35	4554
2007	4436	8	958	5402	19	30	5451
2008	4432	5	895	5332	2	13	5347
2009	3347	20	900	4267	4	11	4282
2010*	2801	13	889	3703	16	6	3725

*** provisional**

na = not available.

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, 1981–2010.

	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

*** provisional**

na = not available

Table 3.6.3. ***Nephrops*** **South Minch (FU12). Results by stratum of the 2008–2010 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
2008 TV Survey							
M	303	1	0.58	0.05	176	4593	0.037
SM	2741	18	0.45	0.19	1227	78 145	0.636
MS	2028	14	0.36	0.14	718	40 157	0.327
Total	5072	33			2123*	122 895	1
2009 TV Survey							
M	303	2	0.135	0.004	41	186	0.001
SM	2741	13	0.447	0.207	1088	109 660	0.626
MS	2028	10	0.397	0.146	906	65 406	0.373
Total	5072	25			2035	175 252	1
2010 TV Survey							
M	303	5	0.512	0.255	155	4682	0.024
SM	2741	13	0.615	0.251	1687	144 966	0.753
MS	2028	16	0.443	0.167	898	42 875	0.223
Total	5072	34			2740	192 523	1

***Note: abundance estimates for these years based on figures prior to the 2009 revision of the dataseries. Differences between these figures and the revised figures shown on Table 3.6.4 are small.**

Table 3.6.4. ***Nephrops*****, South Minch (FU 12): Results of the 1995–2010 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

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	Harvest ratio	Landings (tonnes)	Discard (tonnes)	Discard rate	Dead discard rate
1999	154	28	178	1086	16.4	4051	196	15.4	12.0
2000	140	32	168	1854	9.0	3952	275	18.7	14.7
2001	160	62	215	2037	10.6	3992	562	27.9	22.5
2002	119	25	142	1899	7.5	3305	239	17.6	13.8
2003	139	38	167	2157	7.7	3879	380	21.3	16.9
2004	138	43	173	2558	6.8	3868	443	23.8	19.0
2005	135	49	173	2208	7.8	3841	447	26.5	21.2
2006	174	29	196	1845	10.6	4554	320	14.3	11.1
2007	227	65	277	1016	27.2	5451	896	22.4	17.8
2008	224	74	279	1608	17.3	5347	605	24.7	19.8
2009	179	25	199	1542	12.9	4282	215	12.5	9.6
2010	142	12	153	2076	7.4	3725	127	7.7	5.9
Average 08–10									11.8

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

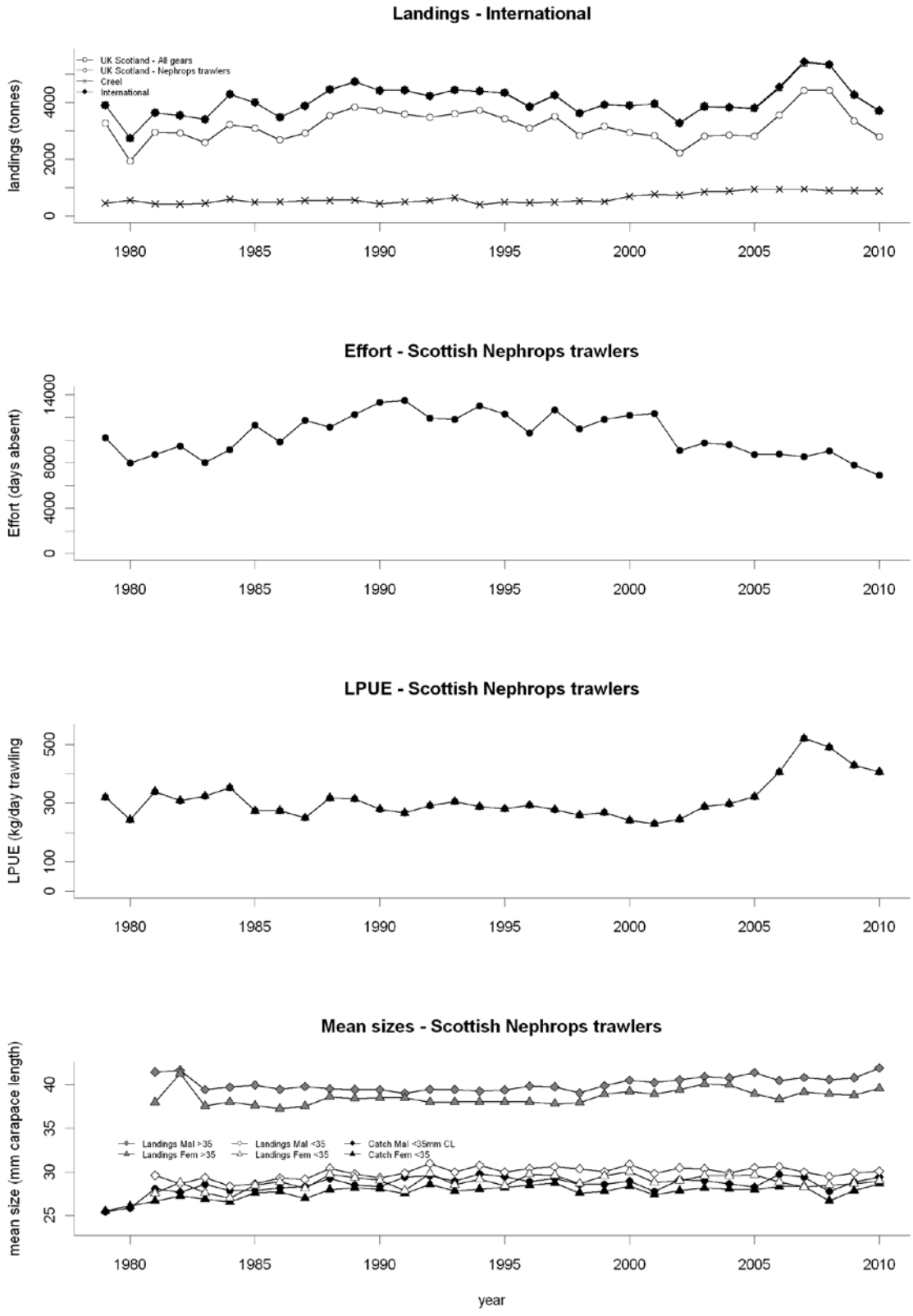


Figure 3.6.1. ***Nephrops,*** **South Minch (FU12), Long-term landings, effort, lpue and mean sizes. The interpretation of the lpue series is likely to be affected by the introduction of the "buyers and sellers" regulations in 2006.**

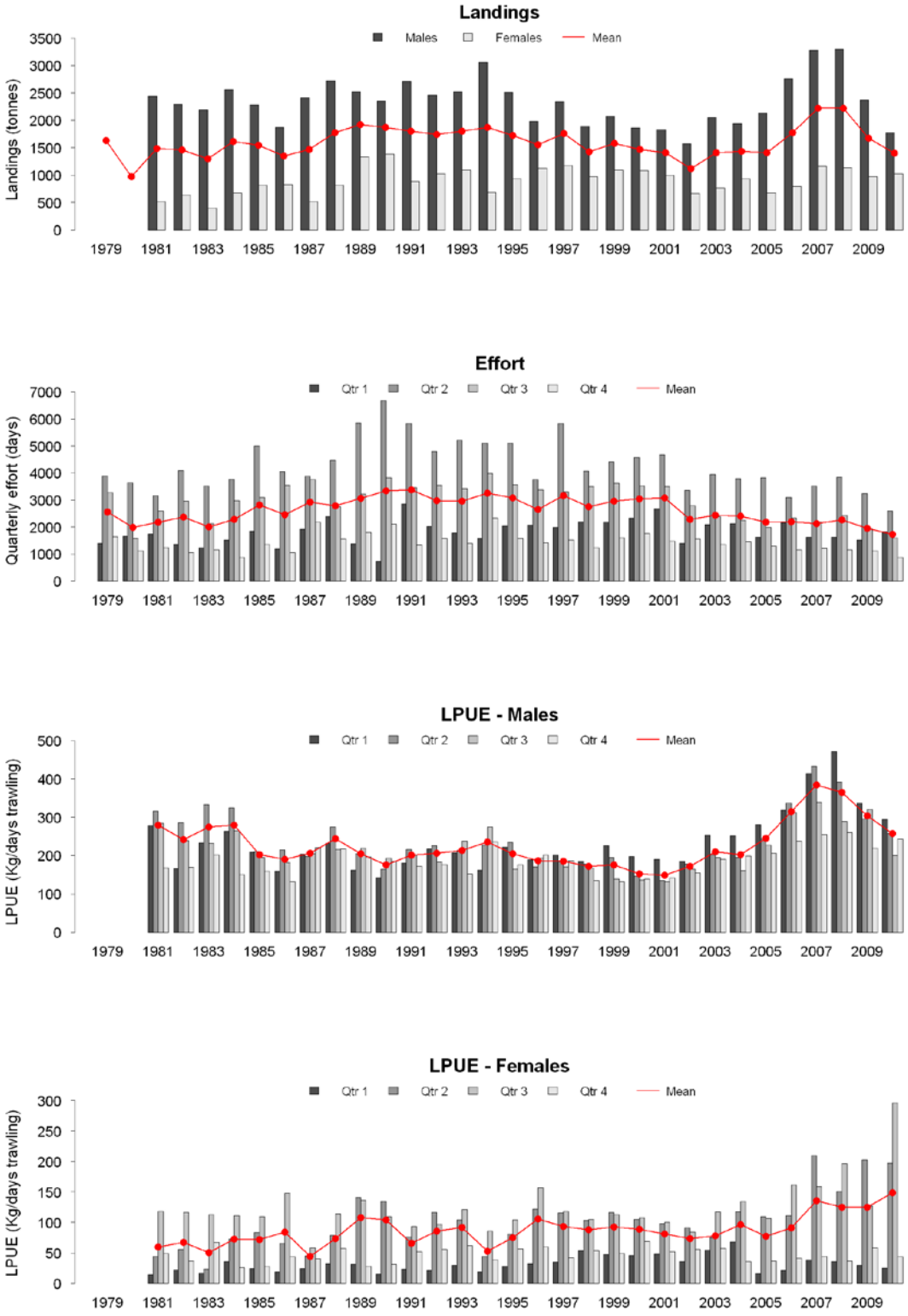


Figure 3.6.2. ***Nephrops,*** **South Minch (FU12), Landings, effort and lpues by quarter and sex from Scottish** ***Nephrops*** **trawlers. The interpretation of the lpue series is likely to be affected by the introduction of the "buyers and sellers" regulations in 2006.**

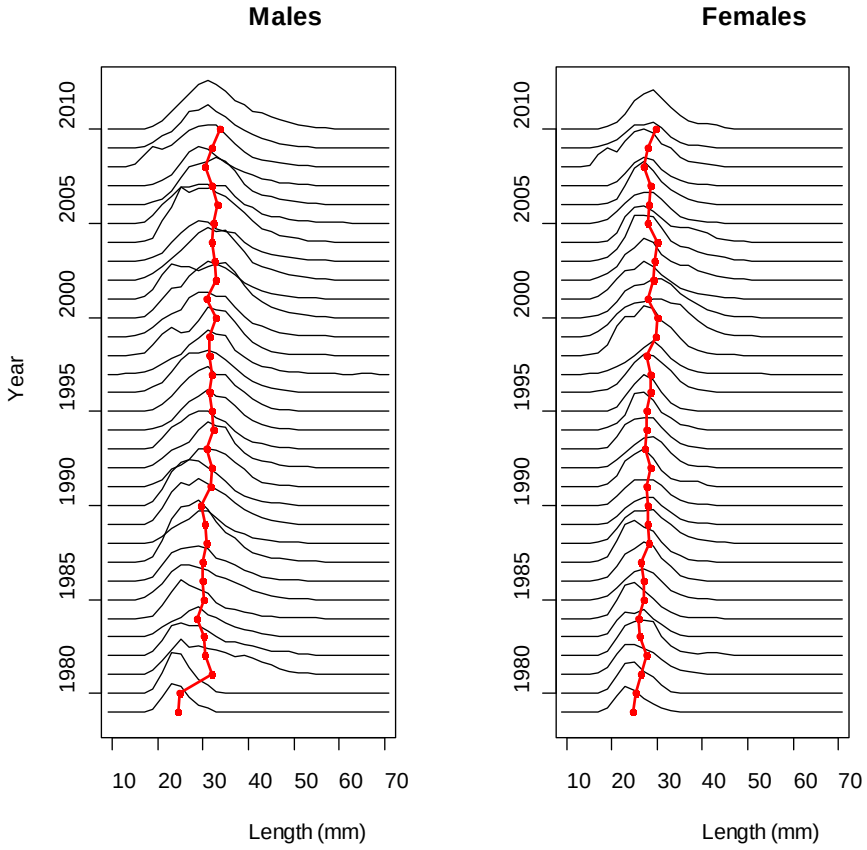


Figure 3.6.3. ***Nephrops.*** **South Minch (FU12). Catch length frequency distribution and mean sizes (red line) for** ***Nephrops*** **in the South Minch, 1979–2010.**

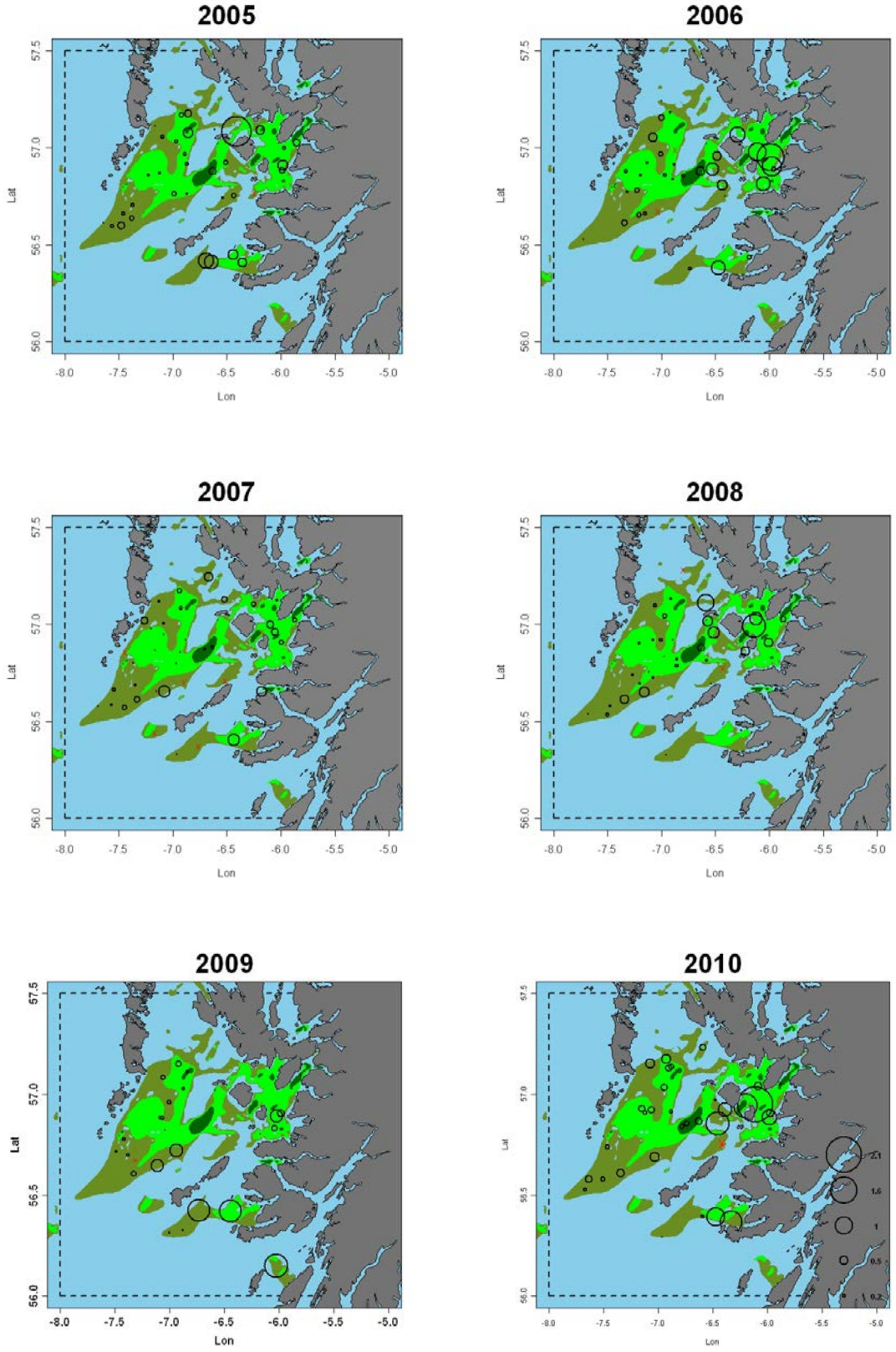


Figure 3.6.4. *Nephrops*, **South Minch (FU12), TV survey station distribution and relative density (burrows/m²), 2005–2010. Shaded green and brown areas represent areas of suitable sediment for** *Nephrops*. **Bubbles in this figure are all scaled the same. Red crosses represent zero observations.**

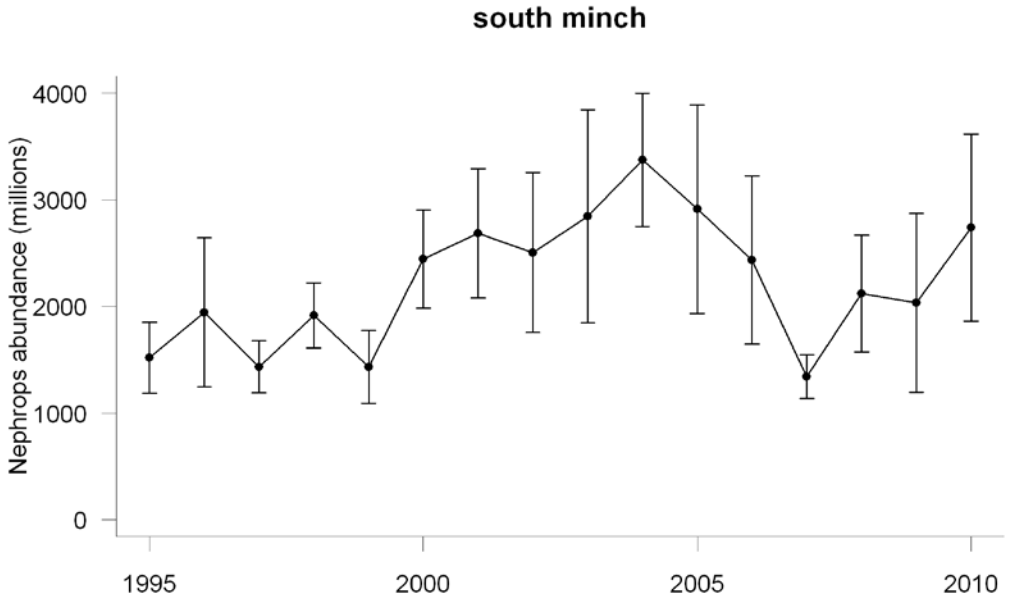


Figure 3.6.5. ***Nephrops*****, South Minch (FU12), Time-series of revised TV survey abundance estimate (not adjusted for bias), with 95% confidence intervals, 1995–2010.**

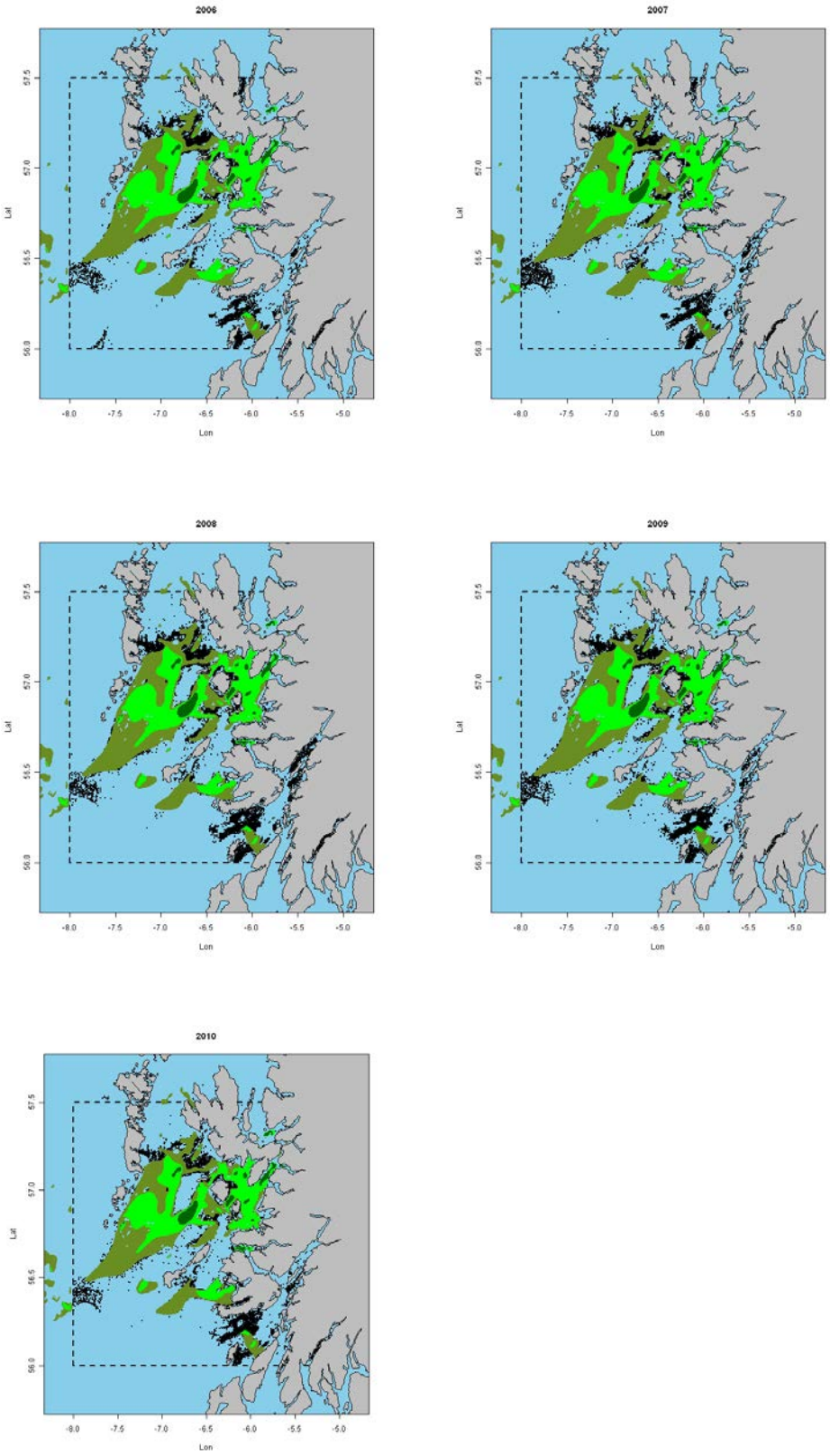


Figure 3.6.6. ***Nephrops*****, South Minch (FU12), comparison of area of** ***Nephrops*** **ground defined by BGS sediment distribution (green shaded overlay) and by distribution of VMS pings (shown by black dots, underlay) recorded from** ***Nephrops*** **trawlers >15 m length for 2006–2010. VMS data filtered to exclude vessel speeds >4.5 knots.**

3.7 Clyde, FU13

Type of assessment in 2011.

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 characterized 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 substrata 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.

3.7.2 The fishery in 2010

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. Around 35 trawlers ranging from 9.9 to 20 m operated in the Clyde during 2010. The number of vessels has not really changed from that of 2009. Some have left the fleet through decommissioning or personal reasons but they have however, been replaced by others meaning that, on the whole, the number has remained similar. Vessels were all using 80 mm codends with 120 mm minimum square mesh panels, in line with west coast emergency measures conditions (Council Reg. (EU) 43/2009). The most significant landings were made at the main Clyde landing ports of Troon, Girvan, Largs on the east side of the Clyde and Campbelltown, Tarbert, and Carradale on the west side of the Clyde. Almost all of the Clyde *Nephrops* fleet fish daily trips. 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 is not much movement of the regular vessels into other areas although in 2010 a couple of boats went to North Shields. Some went to fish to Oban and to the Irish Sea. The boats that fish in the latter two areas tend to still land into their local processor. A few Northern Irish boats fish the Clyde at varying times of the year according to weather and catch rates. In 2010, the Northern Irish fleet moved up to Clyde at the end of October for six weeks. These boats fish mainly for tails, landing into Campbeltown or Troon.

Mobile gear is banned in the Inshore Clyde from Friday night to Sunday night as are vessels greater than 21 m in length. An increasing number of creel boats operate in the Clyde. 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.

Because of the high fuel prices, poor prices for *Nephrops* and the new legislation regarding cheap labour, many of the boats have had a difficult year financially. This

has lead to 3–4 vessels diversifying into queenie and scallop fisheries; which they have been fishing for the entire year. Some of the trawlers are now tubing their prawns in order to maximize profits. The vessels that are tubing are not landing tails which means that they do not catch bulk quantities and this leads to *Nephrops* of better average size and quality suitable for storage using 'individual tubing'. This marketing technique (previously developed in the creel fishery) was more prevalent in 2010. Vessels which are landing tails are required, by the local buyers, not to land small tails (~96–100 tails per kilo). This has resulted in a larger overall size of tail being landed.

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

3.7.3 ICES advice in 2010 and 2011

ICES advice for *2010*

Based on Exploitation boundaries in relation to precautionary considerations was as follows:

"*ICES advises on the basis of exploitation boundaries in relation to high long-term yield and low risk of depletion of production potential that the Harvest Rate for Nephrops fisheries should not exceed F_{max}. This corresponds to landings of no more than 3855 t for the Firth of Clyde stock.*"

ICES conclusions in 2010

"*Harvest rates for Nephrops in the Firth of Clyde have been at or above the proposed F_{MSY} proxy in recent years. UWTV abundance remains well above the preliminary $B_{trigger}$. Harvest rates for Nephrops in the Sound of Jura have been well below the proposed F_{MSY} proxy in recent years. UWTV abundance remains higher than observed at the start of the series but the series is too short and patchy to propose a preliminary $B_{trigger}$ level.*"

ICES advice for 2011

Based on MSY approach was as follows:

"*Following the ICES MSY framework implies the harvest ratio for the Firth of Clyde subarea to be reduced to 16.4%, resulting in landings of 2800 t in 2011. Following the ICES MSY framework implies the harvest ratio for the Sound of Jura Subarea to be 14.5 %, resulting in landings of 520 t in 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".

3.7.4 Management applicable to 2009 and 2010

Management is at the ICES subarea level as described at the beginning of Section 3.5. In 2009, ICES again reiterated its advice that *Nephrops* stocks should be managed at the FU level.

3.7.5 Assessment

The RGCSE 2010 concluded as follows:

The RG considers the Underwater Television Survey (UWTV) and associated catch options to be an appropriate basis for management advice, but is concerned about the possible overestimate of landings in the forecast due to the use of a discard rate well below the recent average. 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 that F_{max} (harvest ratio 16.5% combined between sexes) is consistent with the approach adopted by WGCSE for choosing F_{msy} proxies for *Nephrops*. This is predicted to deliver an $F_{35\%spr}$ of about 20% for males. The use of the low UWTV estimates from the mid 1990s to give a $B_{trigger}$ of 579 million individuals is appropriate as a first estimate but has no basis other than being a low point in a relatively short time-series. The WG was not able to conduct a yield-per-recruit for the Sound of Jura population and has adopted the Clyde F_{MSY} calculations as an interim approach (combined sex $F_{35\%SpR}$ HR of 13%, based on low burrow density). The RG notes that the discard rates appear to be negligible which means that the F_{MSY} estimates for the Clyde (where an 18.6% discard rate was adopted) may have an additional bias. The $B_{trigger}$ point for this FU (bias adjusted lowest observed UWTV abundance) has not been defined but is expected to be below 200 million individuals. RG agrees on this provisional figure as the approach is consistent with the other VIa FUs.

Approach in 2011

The assessment in 2011 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 last year's approach, the more limited UWTV data available for the Sound of Jura subarea was also used.

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 2011 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 2010; landings from Northern Ireland form the main part of this. Total international reported landings increased by 19% in 2010 and consisted of 5050 tonnes landed by Scottish trawlers and 186 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 currently 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 characterized 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 was extracted and expressed in terms of days fished (because the logbook field for hours is not mandatory). Preliminary examination of the new 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. This will require some additional work to establish if a reliable series can be reinstated. For the present, long-term trends in effort and lpue/cpue are not reported here. It is not thought however, that the change has affected the intra-annual, quarterly patterns of effort and lpue and these have been included.

Sex ratio in the Firth of Clyde shows some variation but males consistently make the largest contribution to the annual landings (62% in 2010). 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 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 are high in this FU and average around 33% by number in this FU since 1999. In 2010, discard rates were estimated to be lower than average at 17% by number (Table 3.7.8).

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 25.3% (taking a three year average 2008–2010) and according to the agreed benchmark protocol this value is used in the provision of landings options for 2011.

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. Although assessments based on detailed catch analysis are not currently 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 2010. 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. 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 the most recent year the mean size of individuals in the landings and catch below 35 mm has increased quite markedly, which is in line with what is described in Section 3.7.2 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 3.5.9 and this also shows no systematic changes over the time-series although there is a slight increase in 2010.

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 subareas since 1995 although the Sound of Jura has been sampled more infrequently. Underwater television surveys of *Nephrops* burrow number and distribution, reduce the problems associated with traditional trawl surveys that arise from variability of burrow emergence of *Nephrops*. TV surveys are targeted at known areas of mud, sandy mud and muddy sand in which *Nephrops* construct burrows.

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, 37 stations have been considered valid each year, then raised to the estimated area of the ground available for *Nephrops*; 2080 km^2 based on contoured superficial sediment information (British Geological Surveys).

The number of valid stations in the Sound of Jura is shown in Table 3.7.6.

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 re-working 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 of 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 are similar also. Basic analysis for the Sound of Jura is shown in Table 3.7.6.

Figure 3.7.4 shows the distribution of stations in recent TV surveys (2005–2010) 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.

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 2010 Firth of Clyde survey are shown in Table 3.7.4 and compared with the 2008 and 2009 outcomes. The details of the 2009 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 2010 TV survey data presented at this meeting shows that the abundance in the Firth of Clyde has increased compared to 2009 and is in line with values recorded before the abundance drop in 2007 remaining at the upper end of the values observed throughout the time-series. The 2010 TV survey data presented at this meeting shows that the abundance in the Sound of Jura increased markedly and is around 50% higher than the previous 2009 estimate.

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

3.7.6 Historical stock trends

The TV survey estimates of abundance for *Nephrops* in the Firth of Clyde suggests 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 just prior to the maximum. The bias adjusted abundance estimates from 1999–2010 (the period over which the survey estimates have been revised) is shown in Table 3.7.8. The latest bias adjusted stock estimate is 1750 million individuals.

Table 3.7.8 (now including comparable information to that included in the Celtic Seas WG report sections for other FUs) 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 sparser and are associated with large confidence intervals particularly in 2002 and 2006. Table 3.7.9 summarizes the bias adjusted estimates of abundance and harvest rates where available.

3.7.7 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 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).

		Fbar(20–40 mm)				SPR (%)		
		Fmult	M	F	HR (%)	M	F	T
F0.1	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
Fmax	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
F35%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

The $B_{trigger}$ point for this FU (bias adjusted lowest observed UWTV abundance) is calculated as 579 million individuals.

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 0.8 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).

The $B_{trigger}$ point for this FU (bias adjusted lowest observed UWTV abundance) has not been defined but is expected to be below 200 million individuals.

3.7.8 Landings forecasts

Landings prediction for 2011 were made for the Firth of Clyde and Sound of Jura subareas of the Clyde FU13 using the approach agreed at WKNEPH 2009 and outlined in the Section 2.2. The tables below shows landings predictions at various harvest ratios, including a selection of those equivalent to the per-recruit reference points discussed in Section 2 of this report and the harvest ratio in 2010 using the input parameters agreed at WKNEPH (ICES 2009). The landings prediction for 2012 at the F_{msy} proxy harvest ratio considered appropriate to the Firth of Clyde (i.e. 16.4%) is 3980 tonnes. There is a transition stage (HR 17.1%) as the current harvest ratio is above the F_{msy} proxy in 2012 this gives landings of 4150 t.

For the Sound of Jura subarea, the landings prediction for 2012 at the F_{msy} proxy harvest ratio of 14.5% is 873 t. 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 (08-10) = 18.56 g

Mean weight in landings in Sound of Jura (08-10) = 21.44 g

Discard rate (by number) = 25.3%

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

Firth of Clyde

			Implied fishery	
	Harvest rate	**Survey Index (adjusted)**	Retained number	Landings (tonnes)
F_{msy}	16.4%	1750	214	3980
$F_{msy\ transition}$	17.1%	1750	224	4150
$F_{0.1(M)}$	8.7%	1750	114	2111
$F_{0.1(T)}$	9.7%	1750	127	2354
$F_{35\%SpR(M)}$	10.7%	1750	140	2597
$F_{max\ (M)}$	13.6%	1750	178	3301
$F_{35\%SpR(T)}$	14.5%	1750	190	3519
$F_{max\ (T)}$	16.4%	1750	214	3980
F_{2010}	17.5%	1750	229	4247

Sound of Jura

	Harvest rate	Survey Index (adjusted)	Implied fishery	
			Retained number	Landings (tonnes)
F_{msy}	14.5%	376	41	873
F_{2010}	1.1%	376	3	66
$F_{0.1(M)}$	8.7%	376	24	524
$F_{0.1(T)}$	9.7%	376	27	584
$F_{35\%SpR(M)}$	10.7%	376	30	645
$F_{max\ (M)}$	13.6%	376	38	819
$F_{35\%SpR(T)}$	14.5%	376	41	873
$F_{max\ (T)}$	16.4%	376	46	988

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

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

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

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

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

3.7.9 Biological reference points

Precautionary approach biological reference points have not been determined for *Nephrops* stocks.

3.7.10 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 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.

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 realized 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 (2008–2010) of discard rate (adjusted to account for some sur-

vival of discarded animals) has been used in the calculation of catch options. Discard rates have fluctuated over the time-series but have been stable in the last two years and there have been a significant decrease in 2010. These uncertainties are not taken into account in the forecast.

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 characterized.

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 some discrepancy 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 on the other hand, some of the sediment areas are apparently not fished. Overall the area estimates for the sediment maps exceed those estimated for the VMS by a factor of 1.2. 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.

3.7.11 Status of the stock

The perception of the state of the stock in the Firth of Clyde has not changed substantially since the assessment in 2008. The evidence from the TV survey suggests that the population is stable and the 17% increase observed in 2010 is within the confidence limits for the past two years. The calculated harvest ratio in 2010 (dead removals/TV abundance) is slightly above the values associated with high long-term yield and low risk depletion.

3.7.12 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 confer 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. There is a need to reduce discards in this FU.

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 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). 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.

3.7.13 Other *Nephrops* populations within Division VIa

Nephrops fisheries also take place outside the Functional Units in Subdivision VIa, although they represent a small 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 2012. 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.

3.7.14 Stanton Bank

Underwater TV surveys were not conducted in Stanton Bank in 2010.

3.7.15 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.

3.7.16 References

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Table 3.7.1. *Nephrops*, Clyde (FU13), Nominal Landings of *Nephrops*, 1981–2010, as officially reported.

	UK Scotland					
Year	*Nephrops* trawl	Other trawl	Creel	Sub-total	Other UK	Total
1981	2498	404	66	2968	0	2968
1982	2373	171	79	2623	0	2623
1983	3890	120	53	4063	14	4077
1984	3069	154	77	3300	10	3310
1985	3921	293	64	4278	7	4285
1986	4074	175	79	4328	13	4341
1987	2859	80	65	3004	3	3007
1988	3507	108	43	3658	7	3665
1989	2577	184	35	2796	16	2812
1990	2732	122	24	2878	34	2912
1991	2845	145	25	3015	23	3038
1992	2532	246	10	2788	17	2805
1993	3199	110	5	3314	28	3342
1994	2503	49	28	2580	49	2629
1995	3767	132	26	3925	64	3989
1996	3880	111	27	4018	42	4060
1997	3486	44	25	3555	63	3618
1998	4539	81	40	4660	183	4843
1999	3475	29	38	3542	210	3752
2000	3143	63	76	3282	137	3419
2001	2889	67	94	3050	132	3182
2002	3074	53	105	3232	151	3383
2003	2954	20	117	3091	80	3171
2004	2659	18	90	2767	258	3025
2005	3166	14	95	3275	148	3423
2006	4446	0	0	4534	244	4778
2007	6129	0	0	6129	366	6495
2008	5382	2	197	5581	416	5997
2009	4305	0	189	4494	283	4777
2010*	5050	0	186	5236	465	5701

*** provisional.**

**** Total also includes Rep. of Ireland.**

Table 3.7.2. ***Nephrops,*** **Clyde (FU13), Nominal Landings of** ***Nephrops*****, in each of the subareas (Firth of Clyde and Sound of Jura 1981–2010, 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

*** 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, 1981–2010.

	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

*** provisional.**

na = not available

Table 3.7.4. ***Nephrops,*** **Clyde (FU 13): Firth of Clyde subarea. Results by stratum of the 2008–2010 TV surveys. Note that stratification was based on a series of sediment strata (M – Mud, SM – Sandy mud, MS – Muddy sand).**

Stratum	Area (km^2)	Number of Stations	Mean burrow density (no./m^2)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2008 TV survey							
M	717	15	0.88	0.21	629	7345	0.173
SM	699	11	0.90	0.55	628	24 502	0.575
MS	665	12	1.28	0.29	848	10 732	0.252
Total	2081	38			2105*	42 579	1
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	15 575	1
2010 TV survey							
M	717	13	1.106	0.22	793	8712	0.23
SM	699	15	1.23	0.516	859	16 800	0.444
MS	665	9	0.648	0.251	431	12 324	0.326
Total	2081	37			2083	37 836	1

***Note: abundance estimates for these years based on figures prior to the 2009 revision of the dataseries. Differences between these figures and the revised figures shown in Table 3.7.5 are small.**

Table 3.7.5. *Nephrops*, **Clyde (FU 13): Firth of Clyde subarea. Results of the 1995–2010 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

Table 3.7.6. *Nephrops,* **Clyde (FU 13): Sound of Jura subarea. Results by stratum of the 2009–2010 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
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
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

Table 3.7.7. *Nephrops*, Clyde (FU 13): Sound of Jura subarea. Results of the 1995–2010 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	0.85	324	90
2002	9	1.24	474	199
2003	12	0.81	309	81
2004	no survey			
2005	11	0.94	360	100
2006	10	1.34	512	160
2007	10	0.80	304	69
2008	no survey			
2009	12	0.78	299	81
2010	12	1.173	448	46

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	Harvest ratio	Landings (tonnes)	Discard (tonnes)	Discard rate	Dead discard rate
1999	189	79	267	930	28.7	3424	481	29.6	24.0
2000	154	43	197	1411	14.0	3230	418	21.8	17.3
2001	141	71	211	1486	14.2	2980	584	33.5	27.4
2002	193	47	243	1571	15.4	3349	379	19.4	15.3
2003	161	130	264	1817	14.5	3153	1209	44.7	37.8
2004	143	152	284	1970	14.4	2975	1298	51.5	44.4
2005	179	66	240	1959	12.3	3387	580	26.9	21.6
2006	234	52	286	1851	15.4	4717	487	18.3	14.3
2007	323	357	614	1233	49.8	6397	2372	52.5	45.3
2008	332	192	513	1769	29.0	5919	1329	36.6	30.2
2009	236	152	382	1499	25.5	4686	1248	39.1	32.5
2010	236	48	306	1750	17.5	5643	460	16.8	13.1
Average 08–10									25.3

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

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	Landings in number (millions)	Removals in number (millions)	Adjusted survey	Harvest ratio	Landings (tonnes)	Discard Rate*	Dead discard Rate*
2005	0.8	3.2	303	1.1	36	26.9	21.6
2006	2	5	430	1.2	61	18.3	14.3
2007	2.1	10.8	255	4.3	98	52.5	45.3
2008	1.7	5.7	NA	NA	78	36.6	30.2
2009	0.8	5.8	251	2.3	91	39.1	32.5
2010	0.4	4.1	376	1.1	58	16.8	13.1
Average 08–10							25.3

***Discard rates assumed to be the same as in the Firth of Clyde.**

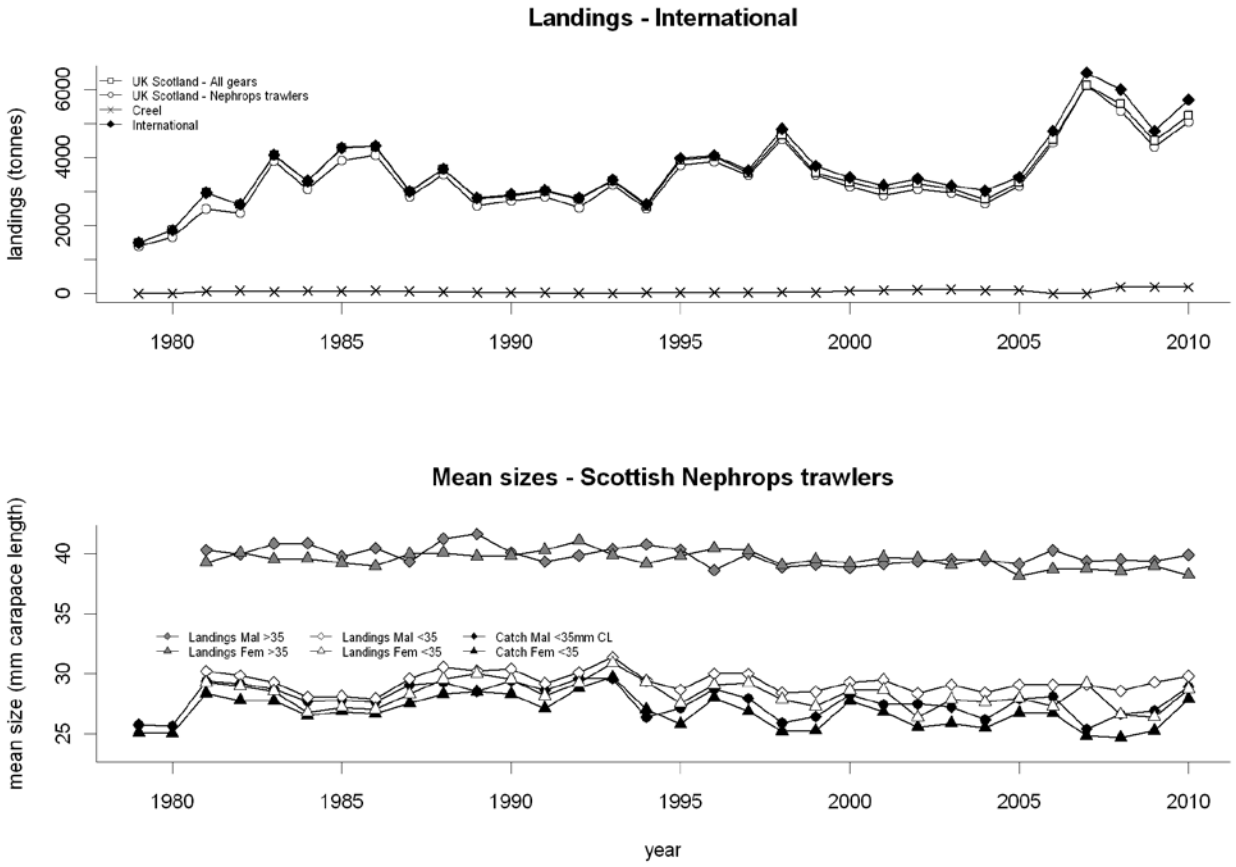


Figure 3.7.1. ***Nephrops*****, Clyde (FU13): Long-term landings, and mean sizes (Firth of Clyde subarea only).**

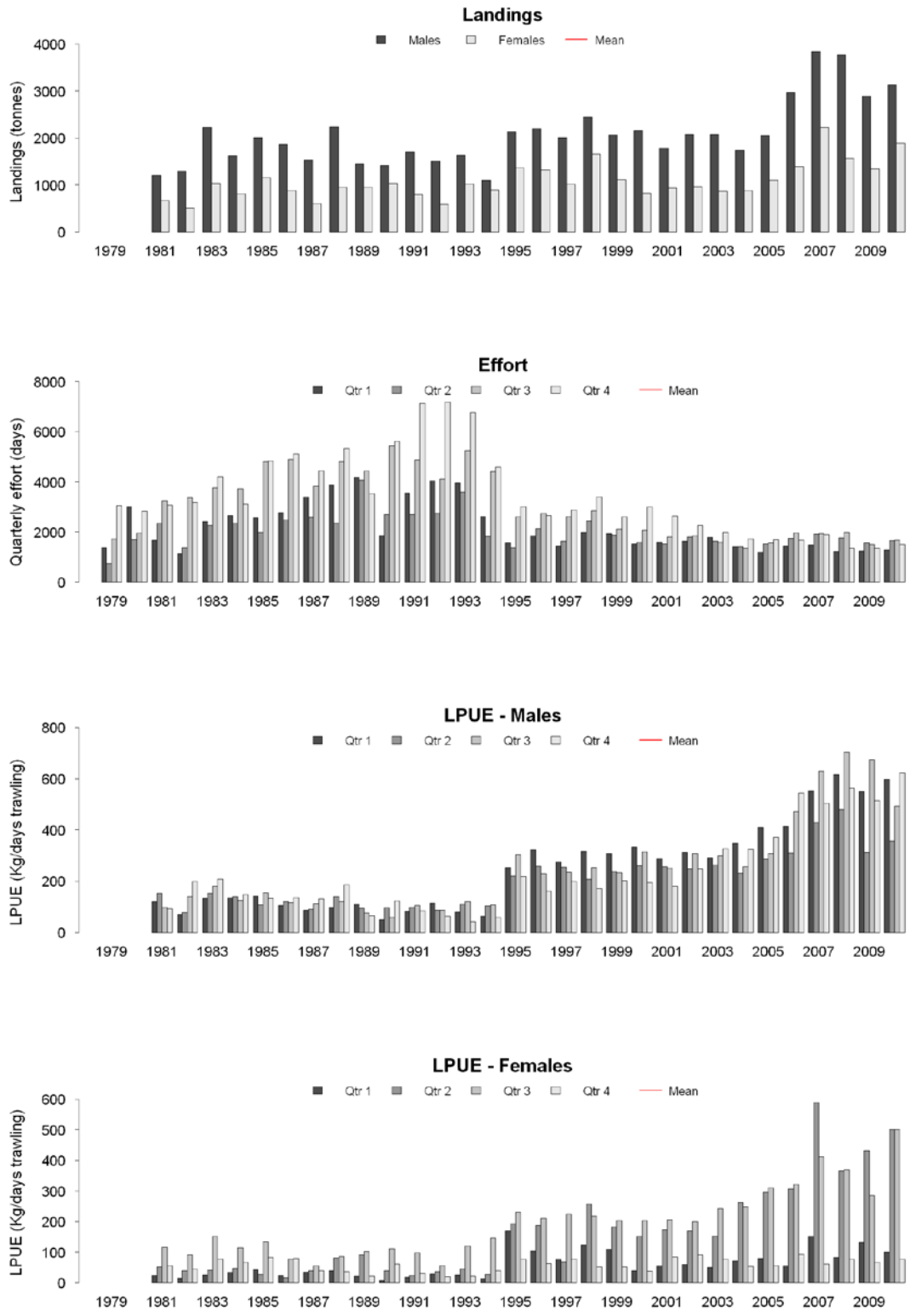


Figure 3.7.2. ***Nephrops*****, Clyde (FU13), Firth of Clyde subarea, Landings, effort and lpues by quarter and sex from Scottish** ***Nephrops*** **trawlers. The marked discontinuity in effort around 1995 is related with the process of recording days effort in the split rectangle region of the Clyde which changed at that time.**

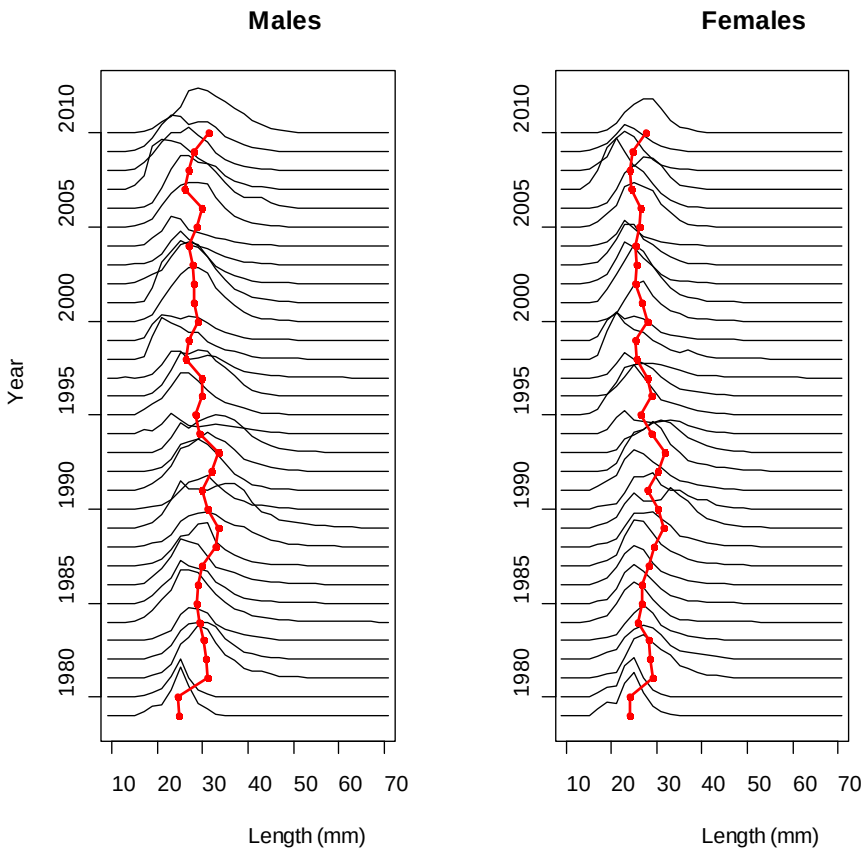


Figure 3.7.3. ***Nephrops,*** **Clyde (FU13), Catch length frequency distribution and mean sizes (red line) for** ***Nephrops*** **in the Firth of Clyde, 1979–2010.**

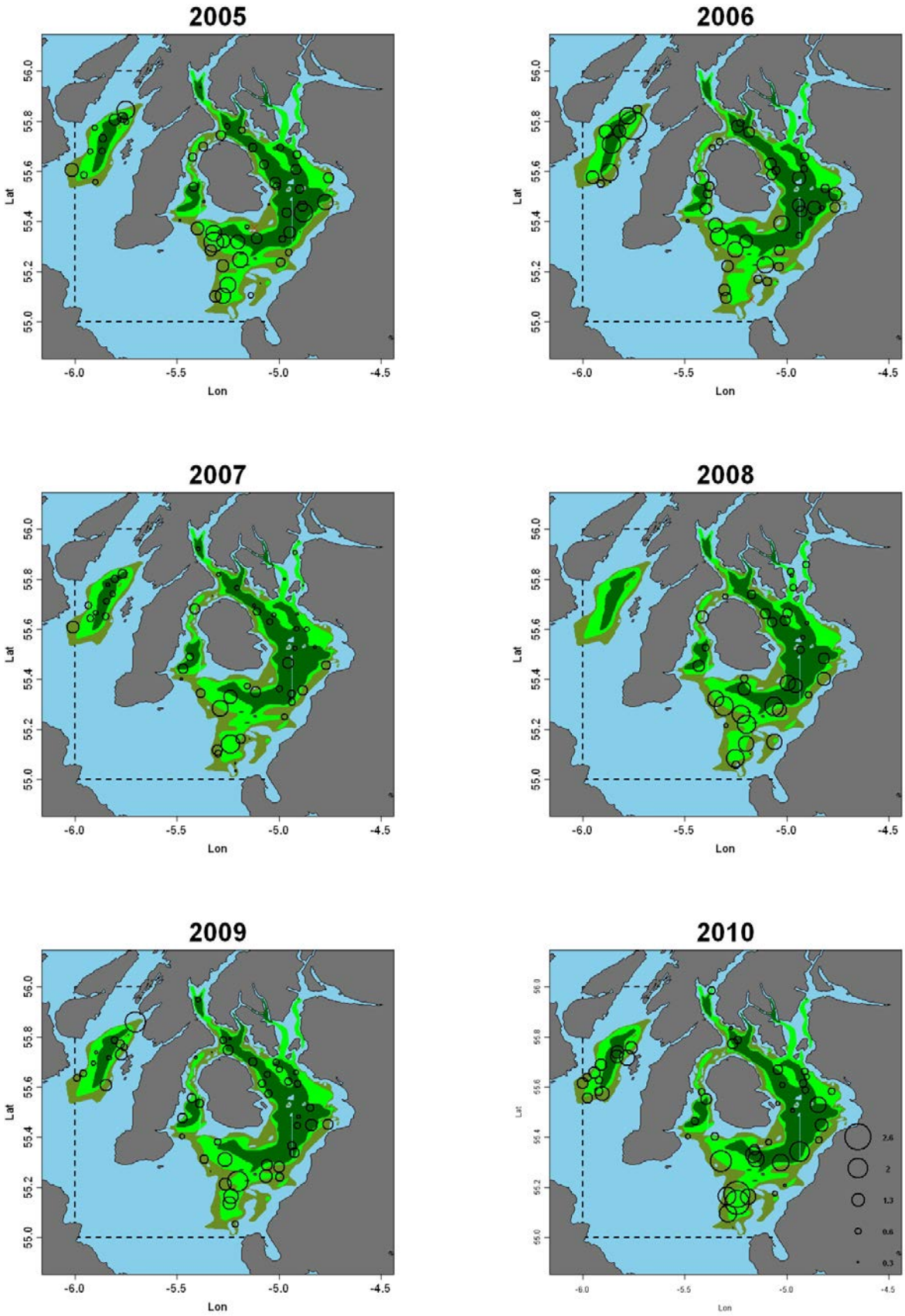


Figure 3.7.4. ***Nephrops*****, Clyde (FU13), TV survey station distribution and relative density (burrows/m²) for Firth of Clyde and Sound of Jura subareas, 2005–2010. Sound of Jura located to the east. Shaded green and brown areas represent areas of suitable sediment for** ***Nephrops*****. Bubbles scaled the same. Red crosses represent zero observations.**

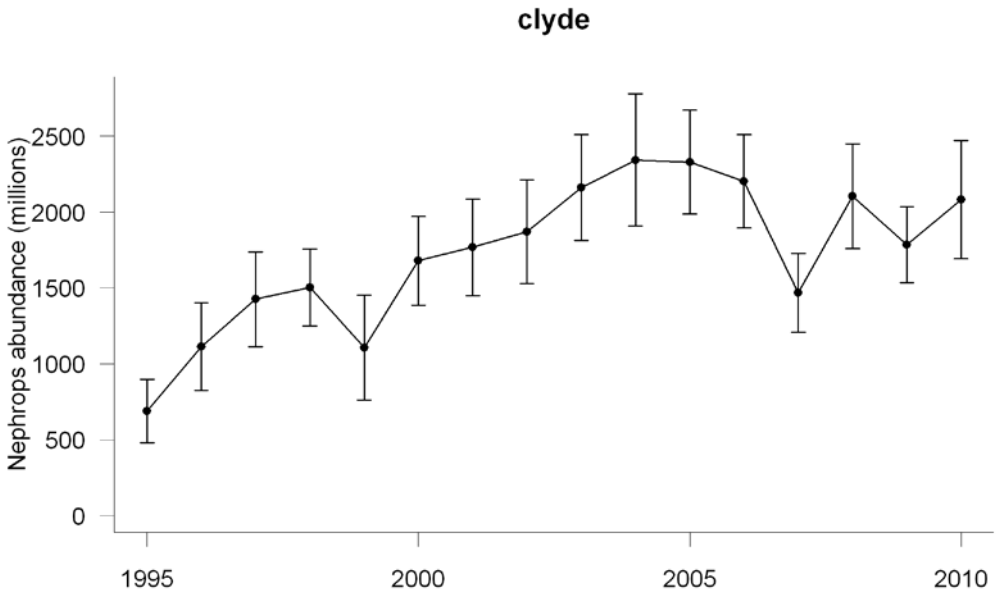


Figure 3.7.5. ***Nephrops*****, Clyde (FU13): Firth of Clyde subarea. Time-series of revised TV survey abundance estimates (not adjusted for bias), with 95% confidence intervals, 1995–2010.**

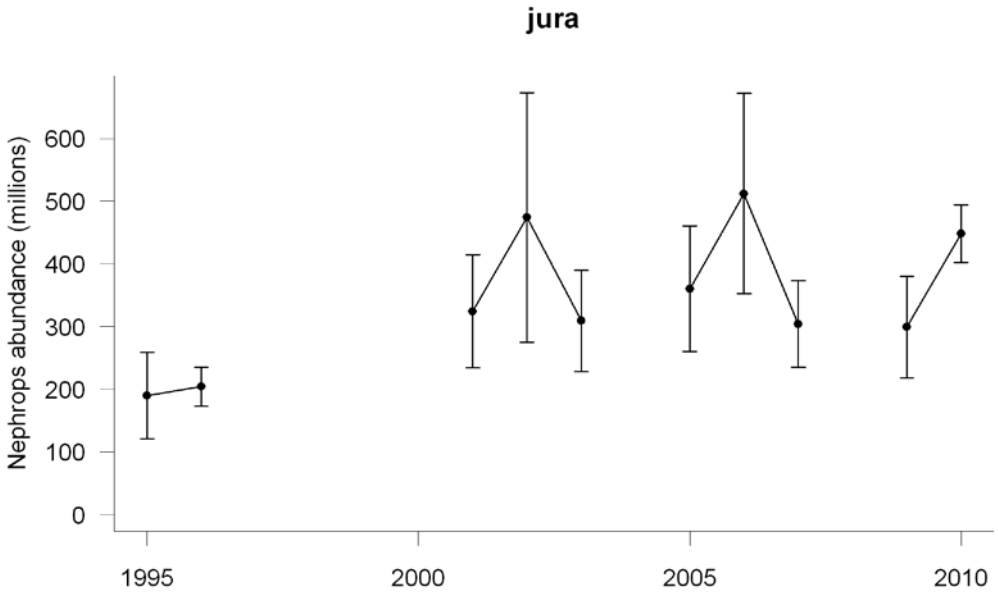


Figure 3.7.6. ***Nephrops*****, Clyde (FU13): Sound of Jura subarea, Time-series of TV survey abundance estimates with 95% confidence intervals, 1995–2010.**

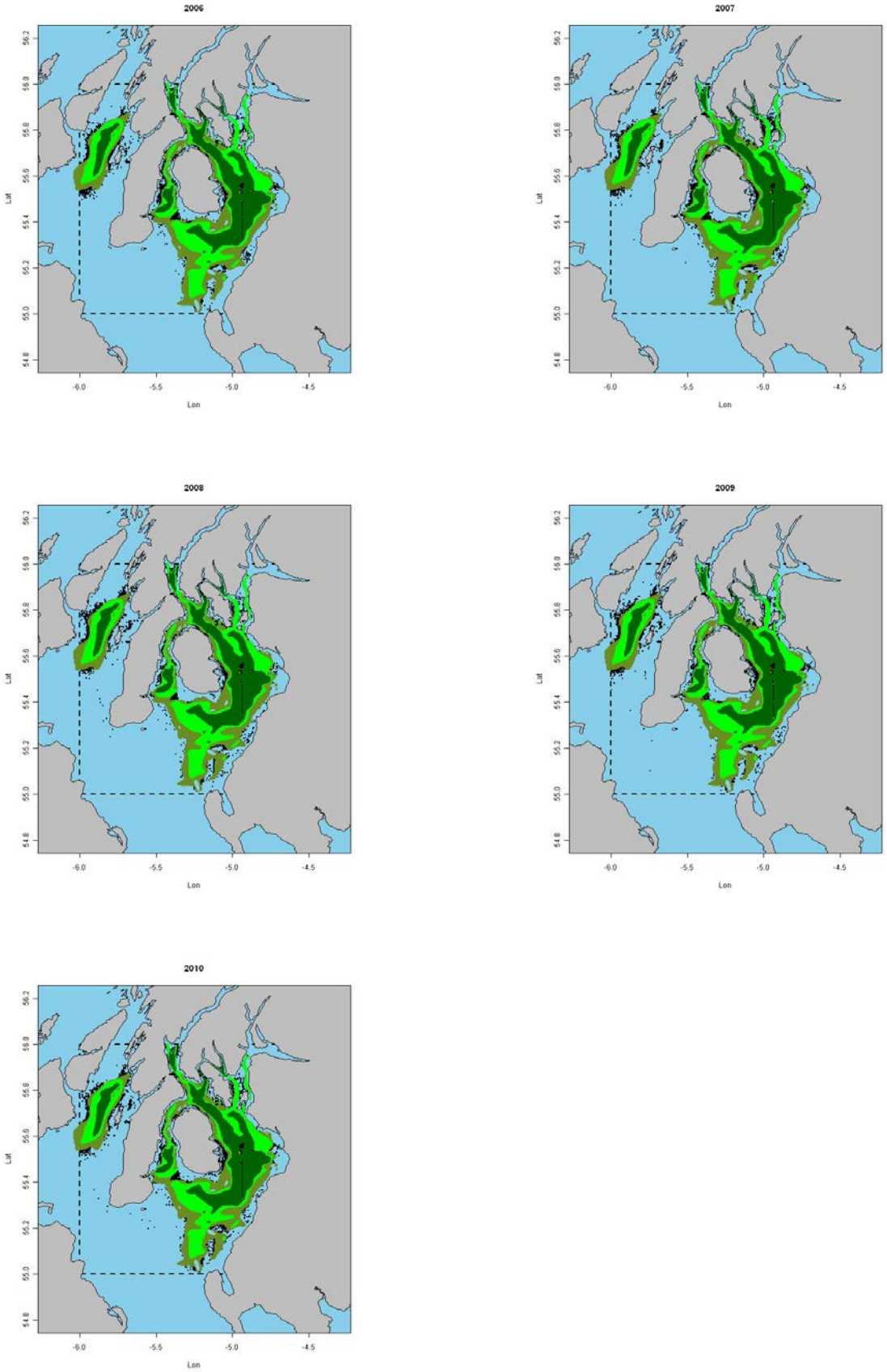


Figure 3.7.7. *Nephrops*, Clyde (FU13), comparison of area of *Nephrops* ground defined by BGS sediment distribution (green shaded overlay) and by distribution of VMS pings (shown by black dots, underlay) recorded from *Nephrops* trawlers >15 m length for 2006–2010. VMS data filtered to exclude vessel speeds >4.5 knots.

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 lpue between 1995 and 2003 followed by relatively stable values at a level much lower than at the start of the time-series. Scottish hours fished data is not mandatory and incomplete. Scottish otter trawl fleet data is therefore in units of kg/kWday. The Scottish series is too short to draw firm conclusions about trends. However, both series show a fall in lpue in 2010 relative to previous years. 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*
Faroe Islands	-		3	4.9
France	-			0
Germany	-			
Ireland	24	40.7	20.4	6.4
Norway	12	14	25	27.2
Portugal	-			
Russia	-		1	
Spain	-			
UK (E. & W. & N.I.)				
UK (Scotland)	26	41.3	47.8	
UK				22.7
Total	62	96.0	97.2	61.2

*** Preliminary**

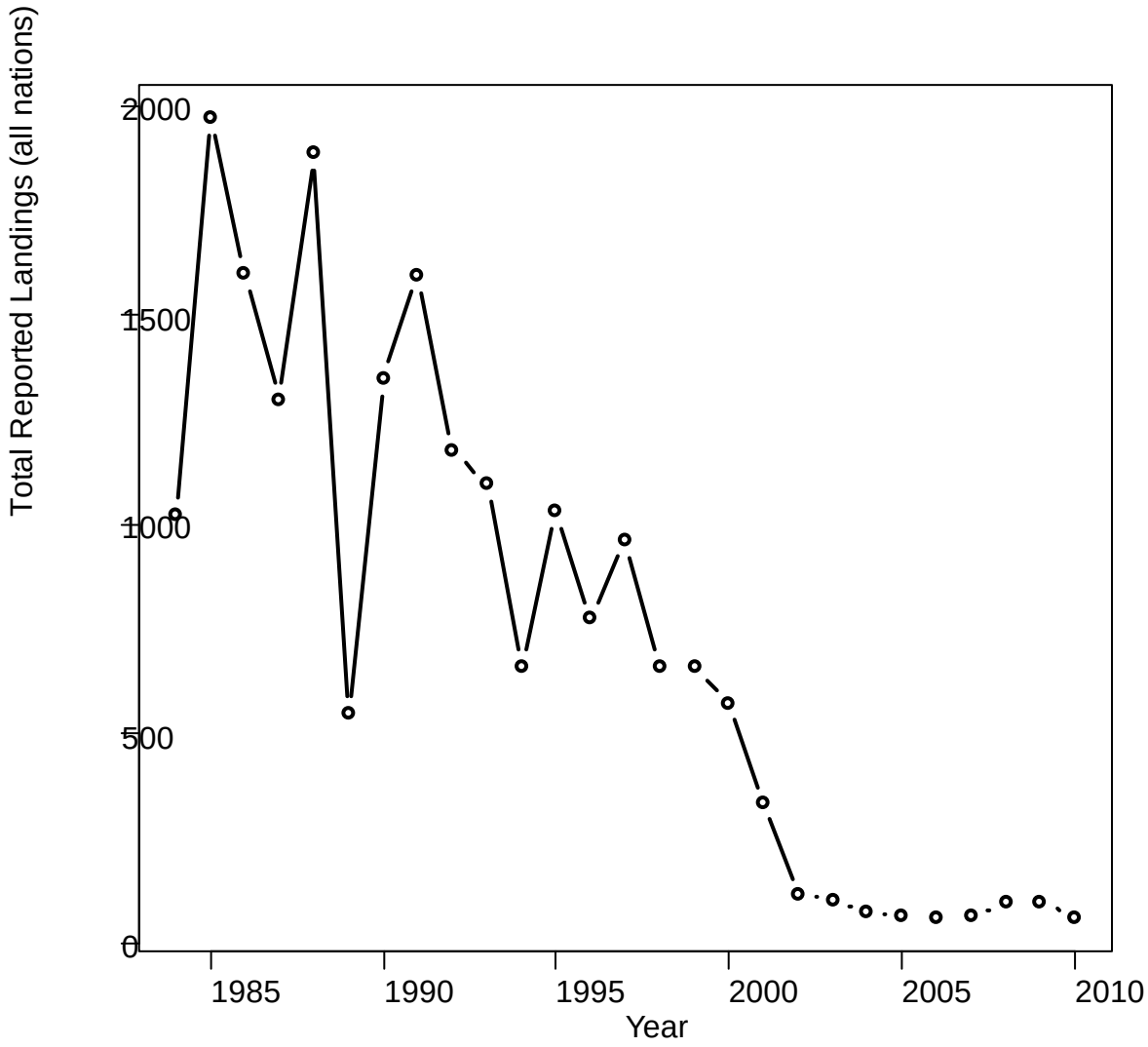


Figure 4.2.1. Cod in Division VIb. Total of official catch (all nations combined), 1984–2010. Values for 2010 are provisional.

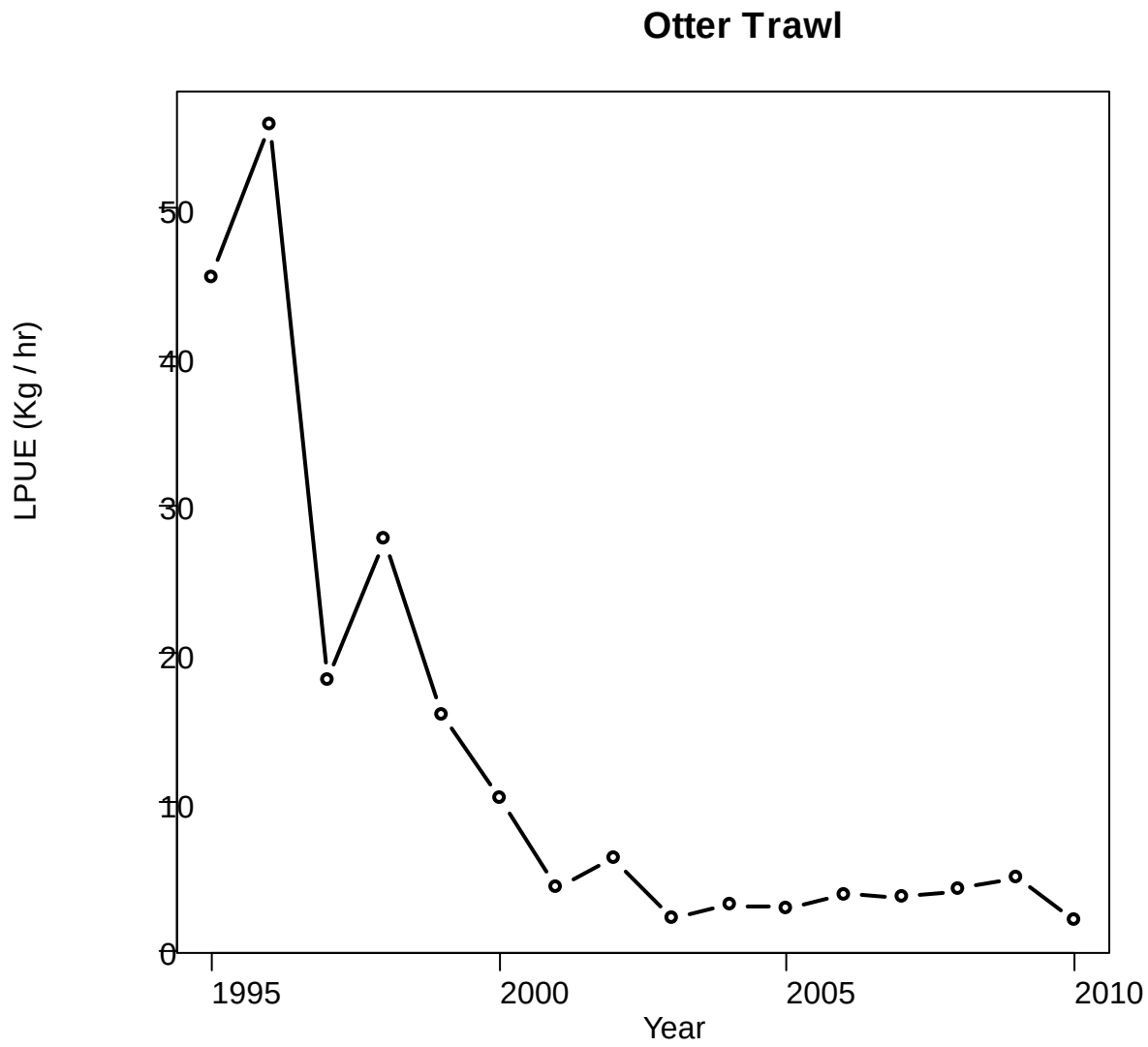


Figure 4.2.2. Cod in Division VIb. Lpue (kg/hr) from Irish Otter trawl fleet, 1995–2010.

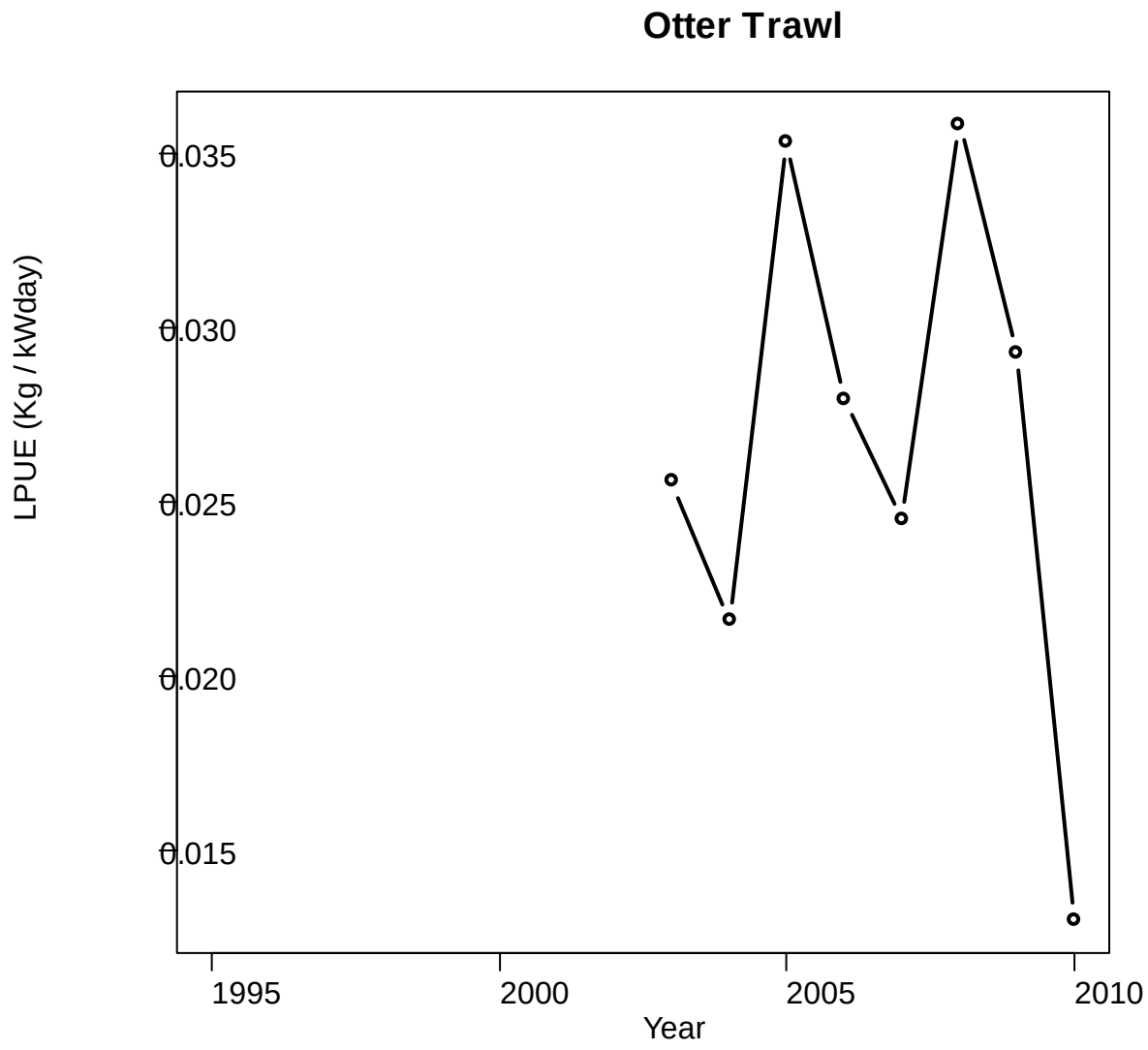


Figure 4.2.3. Cod in Division VIb. Lpue (Kg/kWday) from Scottish Otter trawl fleet, 2003–2010.

4.3 Haddock in Division VIb (Rockall)

Type of assessment in 2011: 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 2010

The ICES advice for 2010 in terms of single-stock exploitation boundaries was as follows:

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects.

"Fishing mortality around $F_{0.1}$ (0.18) can be considered as a candidate target reference point consistent with taking high long-term yields and achieving a low risk of depleting the productive potential (<5%). The present fishing mortality (0.23) is above the candidate reference point and below F_{pa}."

Exploitation boundaries in relation to precautionary limits.

"Fishing mortality should be less than F_{pa}, corresponding to total catches less than 7090 t in 2010. Assuming that current discarding practices will be continued, landings should be less than 5480 t in 2010."

Considering the option below ICES advises that there is little gain on the long-term yield by increasing fishing mortality above current levels. ICES therefore recommends limiting catches and landings in 2010 to 4280 t and 3330 t, respectively.

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."

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 2010 and 2011

The EU TAC for 2010 was set at 4997 t (a 15% reduction compared to TAC for 2009) and is shown below:

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	EU and international waters VIb, XII and XIV (HAD/6B1214)
Belgium	11		
Germany	13		
France	551		
Ireland	393		
United Kingdom	4 029		
EU	4 997		
TAC	4 997		Analytical TAC

The EU TAC for VIb, XII and XIV was set at 3748 t in 2011 (a 25% reduction compared to TAC for 2010).

The ICES advice, agreed TAC for EU waters, and WG estimates of landings during 2002–2011 are summarized below. All values are in tonnes.

YEAR	CATCHES CORRESPONDING TO ICES ADVICE (VIB)	BASIS	AGREED TAC	WG LANDINGS
2002	< 1300	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	<10 640[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	3405
2011	<2700[d]	Reduction in F is needed to keep SSB to above B_{pa} in 2012	3748	

[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 prerecruit 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 (Northwest 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 2010

Nominal landings for 2010 and previous years as reported to ICES are given in Table 4.3.1.

Russian fishery in 2010

In 2010, Russian haddock fishery on the Rockall Bank was conducted by one Russian trawler. The vessel operated in March–April during six fishing days (Table 4.3.2) (WD15, WGCSE 2011). The total Russian catch at the bottom fishery amounted to 201 t, including 198 t of haddock.

Scottish fishery in 2010

The number of Scottish vessels fishing for haddock and the number of trips made to Rockall declined substantially from 2000 onwards (WD6, 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 are estimated to be 4585 t, of which 2951 t were haddock. The landings of haddock in 2010 amounted to 2931 t (Tables 4.3.1, 4.3.3). Other important target species included anglerfish (*Lophius* spp.), saithe, ling and megrim.

The UK landings and effort data included only Scottish vessels in 2010.

Irish fishery in 2010

Landings totalling 169 t were reported from Irish otter trawlers in 2010 (over a twofold decrease from 721 t in 2008; Table 4.3.1).

Norwegian fishery in 2010

In 2010 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 2010 were 65 t. All catch of haddock was taken in March and May–November.

In 2009, Norwegian landings of haddock amounted to 71 t which was a twofold increase compared to 2008, and was within the catch range for the periods 2001–2005 and 2007–2009 (32–84 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.

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 on board 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.

Discards

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 on board and therefore, total catch is equivalent to landings.

Haddock discards on board 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 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 (Figure 4.3.1). 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 4.3.4) and up to 80–90% of catch abundance. 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 4.3.5).

Discard data were also obtained by Irish scientists from discard trips in 2007–2009. 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) (Table 4.3.6). 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.

The proportion of fish discarded from Scottish and Irish catches at different sizes may be 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).

Russian vessels retain all haddock and therefore there is no need to calculate discards (see Stock Annex).

For estimation of the discards in 2010, no on-board 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.

Biological

There was no change in biological parameters compared to the 2010 assessment (see Stock Annex).

Surveys

There is only one abundance index available for VPA assessment of this stock from the Scottish survey (Figure 4.3.2). 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 4.3.2). 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-standardized indices, i.e. same indices as last year for final run (Table 4.3.7). The indices for 2010 are missing, since the Scottish survey did not occur in 2010 due to a technical problem on the vessel.

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 five fleets are shown in Figure 4.3.3 and Table 4.3.8. Commercial cpue series for the different fleets are shown in Figure 4.3.4.

In 2005–2009, the Russian effort in bottom fishery (in hours and number of vessels/days) decreased due to economic reasons (Figure 4.3.4). 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 4.3.5).

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 restrictive 'days at sea' in other areas (VIa and IV). 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. Despite the uncertainty about the fishing effort, the lpue for the Scottish fleet increased considerably in 2007 and 2008 compared to previous years (Figure 4.3.4). The effort information for 2010 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 and 2010 (Figure 4.3.3). The lpue showed an increase in 2007–2009 (Figure 4.3.4).

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 (SCOGFS)

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: 1991–2010

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 4.3.6 and 4.3.7 and Table 4.3.9 show landings, discards and total catch by number and weight. Landings, discards and total catch-at-age by number are shown in Tables 4.3.10–4.3.12.

Mean weights-at-age in total catch, landings, discards and stock are shown in Tables 4.3.13–4.3.16. The mean weights-at-age in the stock are assumed to be the same as the catch weights. The temporal dynamics of haddock mean weights-at-age in the total catch (including discards) are shown in Figure 4.3.8. Mean weights-at-age 6 and 7+ in total catch were higher in 2010 compared to 2006–2009 (Figure 4.3.8). This increase was observed in the Scottish landings and in the Russian catches.

Mean weights-at-age 6 and 7+ for 2010 has been recalculated using linear regression by analogy with haddock VIa. The mean weights-at-age in the total catch (including discards) and in the stock are shown in Figure 4.3.9.

There were small landings of haddock aged 1 in 2010 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 4.3.10–4.3.15). Data on catches, landings and discards-at-age are given in Tables 4.3.10–4.3.12.

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 4.3.16–4.3.18.

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 4.3.19. 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 F are very noisy, but indicate a steep decline since 2000. Retrospective analysis showed consistent estimation of SSB and F (2–5) (Figure 4.3.19a).

Comparative scatterplots of log index at age are shown in Figure 4.3.19b. The survey shows relatively good internal consistency in tracking year-class strength through time.

Final update assessment

Final run

In the final run 2011, not standardized indices were used as last year final run. The diagnostics file of the final XSA run is given in Table 4.3.17. Adjusted survey cpue against XSA population estimates are shown in Figures 4.3.22-4.3.23. The analysis of residuals and retrospective analysis (Figures 4.3.20, 4.3.21, 4.3.24) shows that applying the chosen parameters for XSA (as done in 2005–2009 assessments) 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 18 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 4.3.25. The final XSA results are given in Tables 4.3.18–4.3.20. The final XSA and SURBA results are compared in Figure 4.3.26. 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 4.3.27.

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 4.3.28 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 4.3.28).

State of the stock

Spawning biomass has generally increased in recent years as a result of the 2001 and 2005 year classes. SSB has been above B_{pa} since 2003. But SSB reduced in 2009–2010. Fishing mortality was above F_{pa} throughout most of the time-series but declined in 2005 and has remained below 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.

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 4.3.29–4.3.30).

StatCam summary plots are shown in Figure 4.3.31.

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 4.3.32.

4.3.4 Short-term projections

Estimating year-class abundance

The abundance index for age 0 in the 2009 survey was low (Figure 4.3.33) and the recruitment (age 1) in 2010 by VPA was very poor (242 thousands). Given that no survey took place in 2010 and that the information on catches of age 1 in 2010 were quasi absent (Tables 4.3.10, 4.3.11 and 4.3.12), the only information on the **2009 year-class** strength available to the group was the survey estimate at age 0 in 2009. Therefore, the WG, comforted by the good correlation between VPA estimates for age 1 with age 0 indices over most of the time-series (from 1993 onwards, Figure 4.3.34), estimated year class 2009 using RCT3 regression (Shepherd, 1997) relating survey indices to stock abundance. The input and output RCT3 files are presented Tables 4.3.21 and 4.3.22..It was not considered reliable to use RCT3, as stipulated in the stock annex, for estimating the year class 2010, since the survey used in the modelling of the recruitment for the following year was not carried out in 2010. The recruitments in recent years are estimated to be extremely weak and this would not be translated with the use of geometric mean for forecasting recruitment. The recruitment estimates determined by this method would be higher than the actual total number in the stock.

For forecasting recruitment (age 1) in 2011 and thereafter, the WG recommended 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:

$$n = \frac{P}{1\ 0\ 0} * N + \frac{1}{2}$$

P being the percentile value (here P=25), and N the length of the time-series (here N=19). The rank of 25-thpercentile for the recruitment is then 5. The 5th lowest value of the time-series corresponds to a value in 2007 (18 353 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 2008–2010. Three year mean values were also used for stock weights and catch weights.

For forecasting discards and landings, the proportion of discards/landings-at-age in 1999–2009 was used, (Tables 4.3.9–4.3.12, Figure 4.3.35). The results obtained from the forecast (including discards) are given in Tables 4.3.23–4.3.25. The short-term forecast is also shown in Figure 4.3.36.

The sensitivity analysis of forecast is shown in Figures 4.3.37. The probability of SSB in 2013 being below B_{pa} is about 50% (Figure 4.3.38).

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 4.3.26.

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 with these data has been made. Particularly high discard rates result in very poor estimation of both the overall level and the interannual 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 appear on average once every 4–5 years, although the available time-series is relatively short. 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} = 0.25 there is a 60% probability of SSB falling below B_{pa} in the long term (See Figures 4.3.39–4.3.40).

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 4.3.41 shows the stock in 2009 to be above B_{pa} and below F_{pa}.

Yield-per-recruit analysis

The stock–recruitment scatterplot is shown in Figure 4.3.42. Yield-per-recruit results, long-term yield and SSB (conditional on the current exploitation pattern) are shown in Figure 4.3.43. *Status quo* F (0.25) is approximately 60% lower than F_{max} (0.40) and twice as high as $F_{0.1}$ (0.12).

MSY evaluation

MSY estimates were evaluated in 2010 (WGCSE 2010) 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.

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 minimizing 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 recognized 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, highgrading 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 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.

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) The XSA assessment shows trends in catchability, even if reduced by weak shrinkage.
6) 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 ScoGFS, 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 4.3.35) but without clear trend since 1999. Therefore, average proportions at age for 1999–2009 were used and it is assumed that these values will also apply for 2010–2012.
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 three times the average value over the period 2008–2010.

4.3.9 Recommendation for next benchmark

The main conclusion of WGCSE is that time-series of improved landings and discard data are needed before progress can be made towards the next benchmark assessment of this stock.

Because the survey covers only part of the currently known distribution area of haddock, it is necessary to use other available survey data for the assessment of this stock.

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 time frame 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}. 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. 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.

Fishing mortality levels have historically been high but have 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 2010, 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 2004–2010, 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 groundfish/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 Rock-all haddock, such as changes in landing size, changes in mesh size, use of square mesh and headline panels, licences 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, 1992–2010, as officially reported to ICES.

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009[1]	2010[1]
Faroe Islands	-	-	-	-	-	-	-	-	n/a	n/a	-	-	-	-	2	2	16	-	42
France	…[2]	…[2]	…[2]	…[2]	-	-	-		5	2	-	1	-	-	-	-	-	-	-
Iceland	-	-	-	-	-	-	-	167	-	-	-	-	-	-	-	-	-	-	-
Ireland	571	692	956	677	747	895	704	1,021	824	357	206	169	19	105	41	338	721	352	169
Norway	47	68	75	29	24	24	40	61	152	70	49	60	32	33	123	84	36	71	65
Portugal	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
Russian Federation	-	-	-	-	-	-	-	458	2,154	630	1,630	4,237	5,844	4,708	2,154	1,282	1669	55	198
Spain	51	-	-	28	1	22	21	25	47	51	7	19	-	-	5	-	-	-	-
UK (E, W & NI)	74	308	169	318	293	165	561	288	36	-	-	56	-	-	-	-	-	-	-
UK (Scotland)	3,777	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]
Total	4,520	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
Unallocated catch	800	671	1,998	-379	-543	-591	-599	-851	-357	-279	299	94	139	1	0	0	0	-192	0
WG estimate	5,320	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]Preliminary.

[2]Included in Division VIa.

[3]Includes Scotland, England, Wales and NI landings.

[4]includes the total Russian catch.

n/a = not available.

Table 4.3.2. Details of Russian fleet operations in fishery for the haddock on the Rockall Bank (Division VIb) in 2010 (preliminary data).

Month	Tonnage class	Number of vessel/days	Catch of haddock tonnes
Macrh–April	9	6	198
Total			198

Table 4.3.3. Details of UK fleet operations in fishery for the haddock on the Rockall Bank (Division VIb) in 2010 (preliminary data).

Month	Country	Gear type	Catch of haddock, tonnes
January–March	Scotland	OTT	753.1
April–June	Scotland	OTT	1773.5
July–September	Scotland	OTT	131.9
October–December	Scotland	OTT	272.2
Total			2930.7

OTT – otter twin trawl.

Table 4.3.4. 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 1985	Heavy Trawl	20	89.08	74	17.3
2	Jun 1985	Heavy Trawl	28	127.17	74	18.6
3	Jun 1999	Heavy Trawl	21	110.83	41	74.9
4	Apr 2001	Heavy Trawl	11	47.33	96	12.4
5	Jun 2001	Heavy Trawl	35	163.58	58	47.5
6	Aug 2001	Heavy Trawl	26	130.08	31	69.7

Table 4.3.5. 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 4.3.6. Discards and retained catch haddock (number per trip) by Irish discard trips in the Rockall area in 2007–2009.

Year	2007		2008		2009	
Length (cm)	Discards	Retained Catch	Discards	Retained Catch	Discards	Retained Catch
19	1.3					
22	1.6		14.8			
23	4.6		66.2			
24	7.3		183.8			
25	22.7		576.9		15.6	
26	54.2		1424.9		30.4	
27	104.6		3024.6		25.2	
28	256.9		6274.7		228.2	
29	386.5	7.9	7193.3		180.6	
30	533.4	17.6	7813.5	13.9	573.2	9.9
31	462.6	47.2	7573.7	40.6	1338.1	9.9
32	298.8	88.3	4639.0	77.8	1762.8	57.8
33	227.3	99.4	3664.7	126.8	2256.5	235.9
34	120.8	139.2	2391.8	277.4	1496.5	397.3
35	78.3	118.8	1590.1	503.6	656.6	614.8
36	27.4	187.0	871.7	580.5	423.5	567.1
37	26.1	139.8	280.3	640.9	66.9	526.8
38	24.3	142.7	78.3	581.9	57.4	421.4
39	3.4	162.5	206.6	443.0	23.1	346.9
40	8.7	119.4	37.5	535.6		281.4
41	1.3	133.8	5.2	310.7		197.9
42	4.6	133.1	5.2	334.7		155.7
43	3.2	109.3		333.5		195.1
44		118.6		291.1		201.7
45		97.9		253.6		149.9
>45 cm		574.5	0.0	1791.2	0.0	1001.7
Total	2659.9	2436.9	47916.8	7136.8	9134.4	5371.3
Discard rate, %	52.2		87.0		63.0	

Table 4.3.7. Haddock in VIb. Tuning data available from the Scottish groundfish survey conducted in September.

HADDOCK WGCSE 2011 ROCKALL
101
SCOGFS (Numbers per 10 hours fishing at Rockall)
1991 2010
1 1 0.66 0.75
0 6

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

Table 4.3.8. Details of Scottish and Irish effort (in hours) in 1985–2009 (preliminary data).

	Scottish fleet			Irish fleet
Year	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				3280

SCOTRL* – Scottish Heavy Trawl , SCOLTR* – Scottish Light Trawl , SCOSEI* – Scottish Seine, IROTB* – Irish bottom otter trawl.

Table 4.3.9. Haddock in VIb International landings, discards and total catch.

	Num (*1000)			Weight, tonnes		
Year	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

[1] **Landings and discards.**

Table 4.3.10. Haddock in VIb. International catch (landings and discards) numbers (*10³) at age.

At 05/05/2011 13:00
Terminal Fs derived using XSA (With F shrinkage)
Catch number-at-age (start of year) Numbers*10**-3

	YEAR									
AGE	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

	YEAR									
AGE	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	7667	13364	6576	932	1061	2880	1491	476	223	0.05
2	1961	11119	23606	4112	3723	1475	9829	2207	707	118
3	1815	4536	14559	10282	7420	1626	3605	11437	1237	264
4	1018	2445	2063	9212	8124	2414	1503	1291	8046	426
5	1038	898	1285	1386	753	2291	2213	507	495	4718
6	484	260	925	296	109	436	1816	964	263	308
+gp	601	444	483	474	193	151	741	930	504	310
TOTAL	14583	33066	49496	26694	21382	11273	21198	17812	11474	6144

Table 4.3.11. Haddock in VIb. International landings numbers (*10³) at age.

At 05/05/2011 13:15
Terminal Fs derived using XSA (With F shrinkage)
Landings number-at-age (start of year) Numbers*10**-3

	YEAR									
AGE	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

	YEAR									
AGE	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	399	657	920	197	887	2344	31	17	5	0.03
2	941	2983	8103	1765	2835	768	1220	749	11	71
3	1232	3998	11001	9502	6866	1290	2709	6191	244	196
4	752	2111	1846	9119	7913	2356	1074	1164	5243	352
5	988	809	1188	1364	725	2269	1539	479	460	4078
6	470	217	878	286	98	428	1623	761	261	274
+gp	579	392	475	472	182	150	740	848	486	294
TOTAL	5361	11167	24409	22705	19505	9605	8936	10209	6709	5265

Table 4.3.12. Haddock in VIb. International discards numbers (*10³) at age.

At 05/05/2011 13:30
Terminal Fs derived using XSA (With F shrinkage)
Discards number-at-age (start of year) Numbers*10**-3

	YEAR									
AGE	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

	YEAR									
AGE	2001*	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	7268	12706	5655	736	174	536	1459	458	218	0.02
2	1020	8136	15503	2346	888	707	8610	1458	696	47
3	583	539	3558	781	554	336	896	5246	993	68
4	266	334	217	93	210	58	429	128	2803	74
5	50	89	97	22	28	22	674	28	36	640
6	15	43	48	10	11	8	193	203	2	33
+gp	21	51	8	2	11	1	1	82	18	16
TOTAL	9222	21899	25087	3989	1877	1667	12261	7603	4765	878

*** data calculated using estimates from discard observer trips.**

Table 4.3.13. Haddock in VIb. International catch (landings and discards) weights-at-age (kg).

	AGE						
YEAR	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	0.926	1.401

Table 4.3.14. Haddock in VIb. International landings weights-at-age (kg).

	AGE						
YEAR	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

Table 4.3.15. Haddock in VIb. International discards weights-at-age (kg).

	AGE						
YEAR	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

Table 4.3.16. Haddock VIb. Stock weights-at-age (kg).

	AGE						
YEAR	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

Table 4.3.17. XSA diagnostics in assessment of Haddock in VIb. Final run with old survey indices.

Lowestoft VPA Version 3.1

6/06/2011 15:10

Extended Survivors Analysis

HADDOCK LANDISC 2004 ROCKALL

CPUE data from file had6b.tun

Catch data for 20 years. 1991 to 2010. Ages 1 to 7.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
SCOGFS	1991	2010	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 = .00744

Final year F values

Age	1	2	3	4	5	6
Iteration 49	0.0002	0.0416	0.068	0.0771	0.4265	0.1946
Iteration 50	0.0002	0.041	0.0673	0.0763	0.4269	0.1897

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.111	0.144	0.152	0.075	0.066	0.038	0.094	0.066	0.06	0
2	0.147	0.232	0.408	0.134	0.474	0.124	0.177	0.196	0.133	0.041
3	0.267	0.593	0.542	0.312	0.38	0.391	0.5	0.322	0.161	0.067
4	0.226	0.698	0.597	0.81	0.436	0.203	0.777	0.333	0.395	0.076
5	0.95	0.32	1.045	1.109	0.133	0.209	0.291	0.662	0.205	0.427
6	1.129	0.665	0.642	0.732	0.217	0.106	0.254	0.198	0.904	0.19

Table 4.3.17. cont.

XSA population numbers (Thousands)

YEAR \ AGE	1	2	3	4	5	6
2001	8.09E+04	1.59E+04	8.57E+03	5.55E+03	1.87E+03	7.91E+02
2002	1.10E+05	5.93E+04	1.12E+04	5.38E+03	3.63E+03	5.92E+02
2003	5.15E+04	7.79E+04	3.85E+04	5.07E+03	2.19E+03	2.16E+03
2004	1.43E+04	3.62E+04	4.24E+04	1.83E+04	2.29E+03	6.31E+02
2005	1.83E+04	1.09E+04	2.59E+04	2.54E+04	6.67E+03	6.17E+02
2006	8.49E+04	1.40E+04	5.55E+03	1.45E+04	1.34E+04	4.78E+03
2007	1.84E+04	6.69E+04	1.01E+04	3.07E+03	9.70E+03	8.94E+03
2008	8.17E+03	1.37E+04	4.59E+04	5.03E+03	1.16E+03	5.94E+03
2009	4.20E+03	6.26E+03	9.20E+03	2.72E+04	2.95E+03	4.88E+02
2010	2.43E+02	3.24E+03	4.48E+03	6.41E+03	1.50E+04	1.97E+03

Estimated population abundance at 1st Jan 2011

0.00E+00	2.03E+02	2.57E+03	3.46E+03	4.91E+03	8.02E+03

Taper weighted geometric mean of the VPA populations:

3.41E+04	3.25E+04	2.11E+04	1.09E+04	4.93E+03	1.94E+03

Standard error of the weighted Log(VPA populations) :

1.4953	0.9443	0.7457	0.6344	0.7217	0.9039

Log catchability residuals.

Fleet : SCOGFS

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.33	0.33	0.06	-0.05	0.19	0.36	-0.22	99.99	0.28	99.99
2	-0.45	0.59	0.5	0.03	0.22	0.33	-0.33	99.99	-0.27	99.99
3	-0.4	0.28	0.39	0.25	0.21	0.02	-0.58	99.99	-0.15	99.99
4	-0.16	0.62	0.41	0.49	0.83	-0.01	-1.11	99.99	-0.28	99.99
5	-0.13	0.29	0.73	-0.36	1.03	0.18	-0.56	99.99	-0.13	99.99
6	0.07	0.21	0	-0.09	0.14	-0.14	-0.35	99.99	-0.06	99.99

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	-0.61	-0.2	0.07	99.99	0.45	-0.07	0.18	-0.08	-0.36	99.99
2	-0.69	-0.75	0.23	99.99	0.31	0.66	-0.21	-0.03	-0.14	99.99
3	-0.07	-0.52	-0.27	99.99	-0.01	0.35	0.33	0.01	0.17	99.99
4	-0.78	-0.8	-0.54	99.99	0.47	0.45	0.7	-0.44	0.12	99.99
5	-0.29	-0.89	0.53	99.99	-0.36	0.98	0.18	0.04	-1.25	99.99
6	-0.33	-0.01	0.29	99.99	0.13	0.37	-0.1	0	-0.45	99.99

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	4	5	6
Mean Log q	-2.5064	-2.7677	-2.7677
S.E(Log q)	0.604	0.6346	0.2279

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	0.68	4.123	4.53	0.92	16	0.3	-1.52
2	0.78	1.642	3.92	0.8	16	0.45	-2.05
3	0.67	2.836	4.99	0.84	16	0.32	-2.49

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	0.78	1.236	3.99	0.7	16	0.46	-2.51
5	0.92	0.351	3.21	0.59	16	0.6	-2.77
6	0.93	1.186	3.12	0.95	16	0.21	-2.79

Table 4.3.17 cont.

Terminal year survivor and F summaries :

Age 1 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	1	0	0	0	0	0	0
P shrinkage mean	32472	0.94				0.529	0
F shrinkage mean	1	1				0.471	0

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
203	0.69	7.56	2	11.007	0

Age 2 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	1774	0.378	0	0	1	0.693	0.058
P shrinkage mean	21073	0.75				0.197	0.005
F shrinkage mean	621	1				0.11	0.158

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2575	0.32	0.81	3	2.548	0.041

Age 3 Catchability dependent on age and year class strength

Year class = 2007

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	3104	0.286	0.027	0.09	2	0.733	0.074
P shrinkage mean	10860	0.63				0.191	0.022
F shrinkage mean	579	1				0.077	0.346

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3464	0.25	0.41	4	1.633	0.067

1

Age 4 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	5562	0.211	0.056	0.27	3	0.939	0.067
F shrinkage mean	717	1				0.061	0.43

Table 4.3.17. cont.

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4908	0.21	0.3	4	1.422	0.076

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2005

Fleet	I S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	7749	0.2	0.057	0.28	4	0.885	0.439
F shrinkage mean	10408	1				0.115	0.344

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8017	0.21	0.07	5	0.322	0.427

1

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2004

Fleet	I S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	1371	0.202	0.333	1.65	5	0.9	0.185
F shrinkage mean	1324	1				0.1	0.191

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1366	0.21	0.28	6	1.363	0.19

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2005

Fleet	I S	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	I S	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 4.3.18. Haddock in VIb. Final runs with old survey indices. Fishing mortality-at-age.

Run title : HADDOCK LANDISC 2004 ROCKALL

At 6/06/2011 15:11

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
AGE										
1	0.2379	0.1757	0.1045	0.14	0.0507	0.2401	0.166	0.2421	0.4956	0.3847
2	0.5885	0.4824	0.3321	0.2854	0.2495	0.5697	0.3407	0.5778	0.7263	0.8448
3	0.8874	0.7708	0.644	0.5865	0.5487	0.4848	0.3128	0.6514	0.8881	1.0089
4	0.9065	0.957	0.4731	0.8797	0.7593	0.5068	0.3372	0.505	0.9319	1.2175
5	0.3644	0.9022	0.8939	0.4563	0.7277	0.634	0.5438	0.5925	0.8579	1.2074
6	0.5335	0.2394	0.6325	0.7328	0.2575	0.5081	0.8586	0.6699	1.2326	1.2973
+gp	0.5335	0.2394	0.6325	0.7328	0.2575	0.5081	0.8586	0.6699	1.2326	1.2973
FBAR 2-5	0.6867	0.7781	0.5858	0.552	0.5713	0.5488	0.3836	0.5817	0.851	1.0696

Table 8 Fishing mortality (F) at age YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	FBAR **-**
AGE											
1	0.1106	0.1444	0.1521	0.0746	0.0663	0.0382	0.094	0.0665	0.0604	0.0002	0.0424
2	0.1469	0.2323	0.4081	0.1341	0.4743	0.1238	0.1772	0.1964	0.1334	0.041	0.1236
3	0.2665	0.5929	0.5415	0.3121	0.3802	0.3912	0.4997	0.3222	0.1608	0.0673	0.1834
4	0.2262	0.6982	0.597	0.8105	0.4361	0.2031	0.7774	0.3335	0.3955	0.0763	0.2684
5	0.9505	0.3196	1.0448	1.1093	0.1331	0.2086	0.2905	0.6622	0.205	0.4269	0.4314
6	1.1287	0.6655	0.6425	0.732	0.2171	0.1062	0.2544	0.1977	0.9035	0.1897	0.4303
+gp	1.1287	0.6655	0.6425	0.732	0.2171	0.1062	0.2544	0.1977	0.9035	0.1897	
FBAR 2-5	0.3975	0.4607	0.6478	0.5915	0.3559	0.2317	0.4362	0.3786	0.2237	0.1528	

Table 4.3.19. Haddock in VIb. Final runs with old survey indices. Stock number (*10³) at age.

Run title : HADDOCK LANDISC 2004 ROCKALL

At 6/06/2011 15:11

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	110570	110317	124464	69122	61508	62627	71924	73106	48875	28455	80889
2	84093	71357	75766	91788	49200	47870	40329	49877	46984	24378	15857
3	28535	38223	36063	44501	56489	31386	22172	23486	22914	18607	8575
4	9903	9619	14479	15506	20266	26719	15824	13277	10024	7719	5555
5	6167	3275	3024	7386	5267	7765	13179	9247	6561	3232	1870
6	924	3507	1088	1013	3832	2083	3372	6264	4187	2278	791
+gp	1381	1064	837	488	382	252	390	3110	4237	3072	962
TOTAL	241571	237362	255722	229805	196944	178703	167190	178368	143782	87739	114499

Table 10 Stock number at age (start of year) Numbers*10**-3 YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	GMST 91-**	AMST 91-**
AGE												
1	109870	51500	14336	18278	84910	18353	8170	4202	243	0	50470	63737
2	59289	77862	36215	10894	14005	66913	13678	6259	3239	203	40444	48686
3	11209	38481	42389	25930	5551	10132	45889	9201	4484	2575	24047	28363
4	5378	5072	18332	25401	14516	3073	5033	27223	6415	3464	10626	12539
5	3627	2190	2286	6674	13446	9700	1156	2952	15008	4908	4769	5892
6	592	2157	631	617	4783	8936	5940	488	1969	8017	2089	2944
+gp	997	1112	995	1087	1653	3623	5703	920	1972	2702		
TOTAL	190961	178374	115183	88881	138864	120730	85569	51246	33330	21870		

Table 4.3.20. Haddock in VIb. Final run with old survey indices. Summary table.

Run title : HADDOCK LANDISC 2004 ROCKALL						
At 6/06/2011 15:11						
Table 16 Summary (without SOP correction)						
Terminal Fs derived using XSA (With F shrinkage)						
	RECI	TOTALBI	TOTSPBI	LANDIN	YIELD/SS	FBAR 2- 5
	Age 1					
1991	110570	52142	16259	5655	0.3478	0.6867
1992	110317	51635	19909	5320	0.2672	0.7781
1993	124464	55690	20607	4784	0.2321	0.5858
1994	69122	56970	25008	5733	0.2293	0.552
1995	61508	48486	30305	5587	0.1844	0.5713
1996	62627	47919	26093	7075	0.2712	0.5488
1997	71924	41898	22438	5166	0.2302	0.3836
1998	73106	44222	21444	4984	0.2324	0.5817
1999	48875	33225	16708	5221	0.3125	0.851
2000	28455	23352	11879	4558	0.3837	1.0696
2001	80889	21794	6961	1918	0.2755	0.3975
2002	109870	36347	7344	2571	0.3501	0.4607
2003	51500	37905	14220	5961	0.4192	0.6478
2004	14336	27159	17881	6400	0.3579	0.5915
2005	18278	22500	18270	5191	0.2841	0.3559
2006	84910	26882	16212	2759	0.1702	0.2317
2007	18353	28399	13861	3348	0.2415	0.4362
2008	8170	30424	25502	4205	0.1649	0.3786
2009	4202	19755	16911	3237	0.1914	0.2237
2010	243*	18273	17109	3404	0.199	0.1528
Arith.						
Mean	57586	36249	18246	4654	0.2672	0.5243
0 Units	(Thousar	(Tonnes	(Tonnes	(Tonnes)		
1						
* R is 4674 thousands by RCT3 and the total biomass in 2010 will be 18120						

Table 4.3.21. Haddock in VIb. Input RCT3 file.

Had in VIb age 1		
1 17 2		
'Y-class' 'VPA' 'Scotsr0'		
1993	69122	15220
1994	61508	23474
1995	62627	16923
1996	71924	33578
1997	73106	28897
1998	48875	-11
1999	28455	10178
2000	80889	-11
2001	109870	31813
2002	51500	11704
2003	14336	2526
2004	18278	-11
2005	84910	24452
2006	18353	3570
2007	8170	558
2008	4202	85
2009	243	132

Table 4.3.22. Haddock in VIb. Results of RCT3 runs.

Year	Weighted	Log	Int	Ext	Var	VPA	Log
Class	Average	WAP	Std	Std	Ratio	VPA	
Predictior	Error	Error					
1995	No	valid	surveys				
1996	63625	11.06	0.06	0.05	0.6	71924	11.18
1997	66531	11.11	0.07	0.03	0.18	73106	11.2
1998	No	valid	surveys				
1999	60532	11.01	0.14	0.12	0.76	28455	10.26
2000	No	valid	surveys				
2001	69804	11.15	0.27	0.22	0.65	109871	11.61
2002	48061	10.78	0.29	0.33	1.26	51501	10.85
2003	39987	10.6	0.33	0.86	6.76	14336	9.57
2004	No	valid	surveys				
2005	69433	11.15	0.28	0.17	0.39	84910	11.35
2006	20469	9.93	0.3	0.46	2.35	18354	9.82
2007	7007	8.85	0.34	1.04	9.3	8170	9.01
2008	3192	8.07	0.38	1.27	11.01	4202	8.34
2009	4674	8.45	0.37	0.72	3.83	243	5.5

Table 4.3.23. Haddock in VIb. Input data to short-term forecast.

MFDP version 1a						
Run: 20PERC						
Time and c	6	2011				
Fbar age range (Total) : 2-5						
Fbar age range Fleet 1 : 2-5						
2011						
Age	N	M	Mat	PF	PM	SWt
1	18353	0.2	0	0	0	0.182
2	3823	0.2	0	0	0	0.294
3	2575	0.2	1	0	0	0.363
4	3464	0.2	1	0	0	0.422
5	4908	0.2	1	0	0	0.6
6	8017	0.2	1	0	0	0.641
7	2702	0.2	1	0	0	0.946
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.0085	0.159	0.0339	0.203		
2	0.0413	0.324	0.0823	0.263		
3	0.1195	0.414	0.0639	0.295		
4	0.2116	0.44	0.0568	0.349		
5	0.3637	0.622	0.0677	0.357		
6	0.3779	0.641	0.0524	0.475		
7	0.4078	0.946	0.0228	0.481		
2012						
Age	N	M	Mat	PF	PM	SWt
1	18353	0.2	0	0	0	0.182
2	.	0.2	0	0	0	0.294
3	.	0.2	1	0	0	0.363
4	.	0.2	1	0	0	0.422
5	.	0.2	1	0	0	0.6
6	.	0.2	1	0	0	0.641
7	.	0.2	1	0	0	0.946
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.0085	0.159	0.0339	0.203		
2	0.0413	0.324	0.0823	0.263		
3	0.1195	0.414	0.0639	0.295		
4	0.2116	0.44	0.0568	0.349		
5	0.3637	0.622	0.0677	0.357		
6	0.3779	0.641	0.0524	0.475		
7	0.4078	0.946	0.0228	0.481		
2013						
Age	N	M	Mat	PF	PM	SWt
1	18353	0.2	0	0	0	0.182
2	.	0.2	0	0	0	0.294
3	.	0.2	1	0	0	0.363
4	.	0.2	1	0	0	0.422
5	.	0.2	1	0	0	0.6
6	.	0.2	1	0	0	0.641
7	.	0.2	1	0	0	0.946
Catch						
Age	Sel	CWt	DSel	DCWt		
1	0.0085	0.159	0.0339	0.203		
2	0.0413	0.324	0.0823	0.263		
3	0.1195	0.414	0.0639	0.295		
4	0.2116	0.44	0.0568	0.349		
5	0.3637	0.622	0.0677	0.357		
6	0.3779	0.641	0.0524	0.475		
7	0.4078	0.946	0.0228	0.481		
Input units are thousands and kg - output in tonnes						

Table 4.3.24. Haddock in VIb. Short-term forecast.

MFDP version 1a								
Run: 20PERC								
Time and (	6	2011						
Fbar age range (Total) : 2-5								
Fbar age range Fleet 1 : 2-5								
2011								
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield		
17501	13036	1	0.184	3466	0.0677	536		
2012							2013	
		Catch	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	Biomass	SSB
17692	10118	0	0	0	0	0	21436	13678
.	10118	0.1	0.0184	342	0.0068	63	21005	13266
.	10118	0.2	0.0368	670	0.0135	125	20589	12868
.	10118	0.3	0.0552	987	0.0203	186	20188	12486
.	10118	0.4	0.0736	1292	0.0271	246	19800	12117
.	10118	0.5	0.092	1585	0.0338	305	19426	11761
.	10118	0.6	0.1104	1867	0.0406	362	19065	11418
.	10118	0.7	0.1288	2139	0.0474	419	18716	11088
.	10118	0.8	0.1472	2401	0.0541	475	18380	10769
.	10118	0.9	0.1656	2653	0.0609	529	18054	10461
.	10118	1	0.184	2896	0.0677	583	17739	10165
.	10118	1.1	0.2024	3131	0.0744	636	17436	9879
.	10118	1.2	0.2208	3356	0.0812	688	17142	9603
.	10118	1.3	0.2392	3574	0.088	739	16858	9336
.	10118	1.4	0.2576	3783	0.0947	789	16583	9079
.	10118	1.5	0.276	3985	0.1015	838	16317	8831
.	10118	1.6	0.2944	4180	0.1083	887	16060	8592
.	10118	1.7	0.3128	4367	0.115	934	15811	8360
.	10118	1.8	0.3312	4548	0.1218	981	15570	8137
.	10118	1.9	0.3496	4723	0.1286	1028	15337	7921
.	10118	2	0.3681	4891	0.1354	1073	15111	7713
Input units are thousands and kg - output in tonnes								

Table 4.3.25. Haddock in VIb. Detailed short-term forecast output.

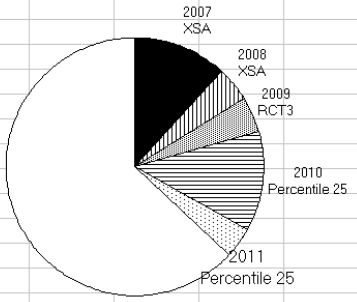
MFDP version 1a												
Run: 20PERC												
Time and d	6	2011										
Fbar age range (Total) : 2-5												
Fbar age range Fleet 1 : 2-5												
Year:	2011	F multiplier	1	Fleet1 HCR	0.184	Fleet1 DFb	0.0677					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNo	DYield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
1	0.0085	139	22	0.0339	553	112	18353	3340	0	0	0	0
2	0.0413	135	44	0.0823	269	71	3823	1124	0	0	0	0
3	0.1195	256	106	0.0639	137	40	2575	935	2575	935	2575	935
4	0.2116	585	258	0.0568	157	55	3464	1462	3464	1462	3464	1462
5	0.3637	1324	823	0.0677	246	88	4908	2945	4908	2945	4908	2945
6	0.3779	2247	1441	0.0524	312	148	8017	5139	8017	5139	8017	5139
7	0.4078	817	773	0.0228	46	22	2702	2556	2702	2556	2702	2556
Total		5503	3466		1719	536	43842	17501	21666	13036	21666	13036
Year:	2012	F multiplier	1	Fleet1 HCR	0.184	Fleet1 DFb	0.0677					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNo	DYield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
1	0.0085	139	22	0.0339	553	112	18353	3340	0	0	0	0
2	0.0413	508	165	0.0823	1013	266	14402	4234	0	0	0	0
3	0.1195	275	114	0.0639	147	43	2766	1004	2766	1004	2766	1004
4	0.2116	297	130	0.0568	80	28	1755	741	1755	741	1755	741
5	0.3637	585	364	0.0677	109	39	2168	1301	2168	1301	2168	1301
6	0.3779	732	469	0.0524	101	48	2610	1673	2610	1673	2610	1673
7	0.4078	1726	1633	0.0228	97	46	5707	5399	5707	5399	5707	5399
Total		4260	2896		2098	583	47762	17692	15007	10118	15007	10118
Year:	2013	F multiplier	1	Fleet1 HCR	0.184	Fleet1 DFb	0.0677					
	Catch											
Age	F	CatchNos	Yield	DF	DCatchNo	DYield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
1	0.0085	139	22	0.0339	553	112	18353	3340	0	0	0	0
2	0.0413	508	165	0.0823	1013	266	14402	4234	0	0	0	0
3	0.1195	1034	428	0.0639	553	163	10421	3783	10421	3783	10421	3783
4	0.2116	319	140	0.0568	85	30	1885	796	1885	796	1885	796
5	0.3637	296	184	0.0677	55	20	1099	659	1099	659	1099	659
6	0.3779	323	207	0.0524	45	21	1153	739	1153	739	1153	739
7	0.4078	1339	1267	0.0228	75	36	4427	4188	4427	4188	4427	4188
Total		3958	2413		2379	648	51741	17739	18985	10165	18985	10165
Input units are thousands and kg - output in tonnes												

Table 4.3.26. Haddock VIb. Stock numbers of recruits which were calculated by percentile 25 and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

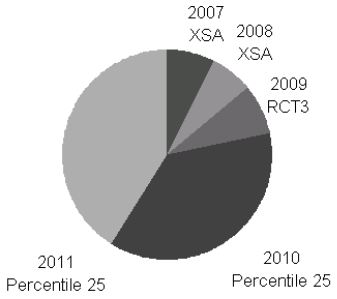
Year-class			2007	2008	2009	2010	2011
Stock No. (thousands)			8170	4202	4674	18353	18353
of	1	year-olds					
Source			XSA	XSA	RCT3	Percentile 25	Percentile 25
Status Quo F:							
% in	2011	landings	7.8	3.6	2.9	3.3	-
% in	2012	landings	11.6	4.5	4.5	12.4	3.9
% in	2011	SSB	11.2	7.2	0.0	0.0	-
% in	2012	SSB	12.9	7.3	9.9	0.0	0.0
% in	2013	SSB	7.3	6.5	7.8	37.2	0.0
GM : geometric mean recruitment							

Haddock VIb : Year-class % contribution to

a) 2012 landings



b) 2013 SSB



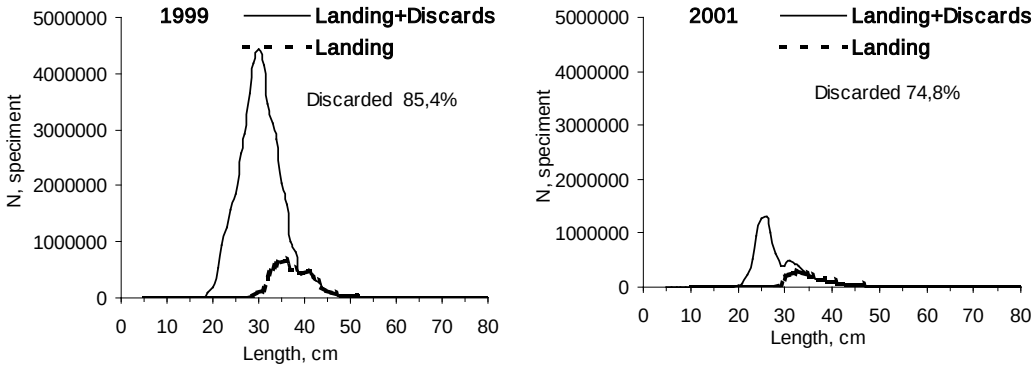


Figure 4.3.1. Length distribution and quantity of haddock lifted on board and landings by Scottish trawlers in 1999 and 2001 (unpublished data, Newton, 2004).

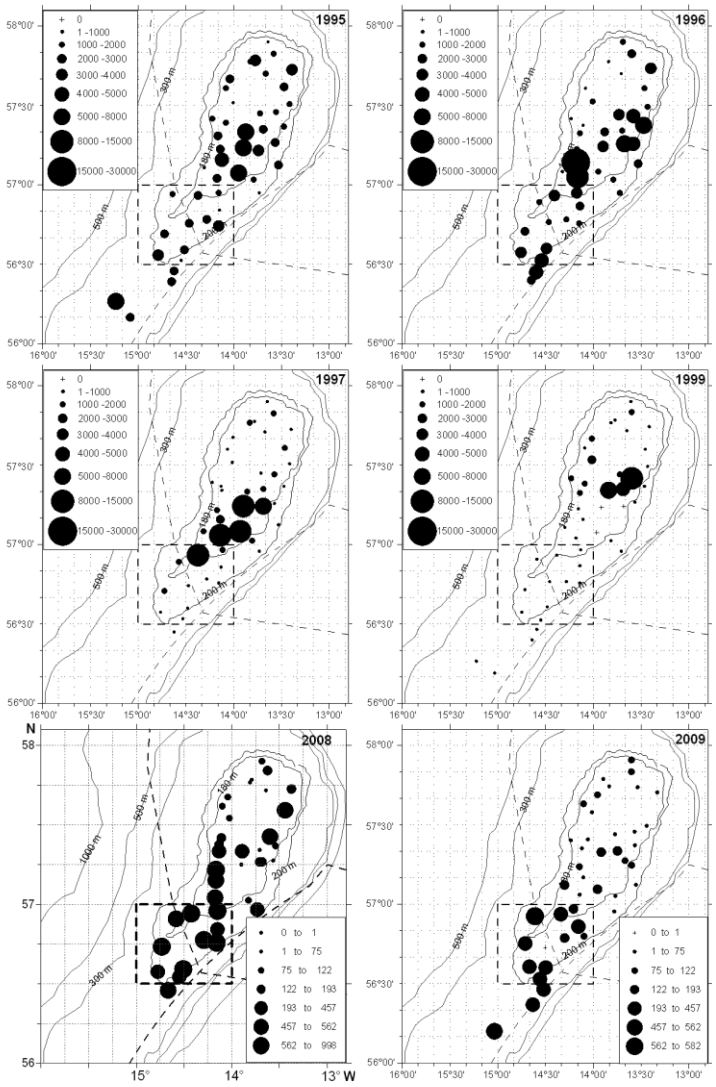


Figure 4.3.2. Distribution of haddock (catch per 30 minutes) on the Rockall Bank in 1995–1999 and 2008–2009 from the Scottish trawl survey.

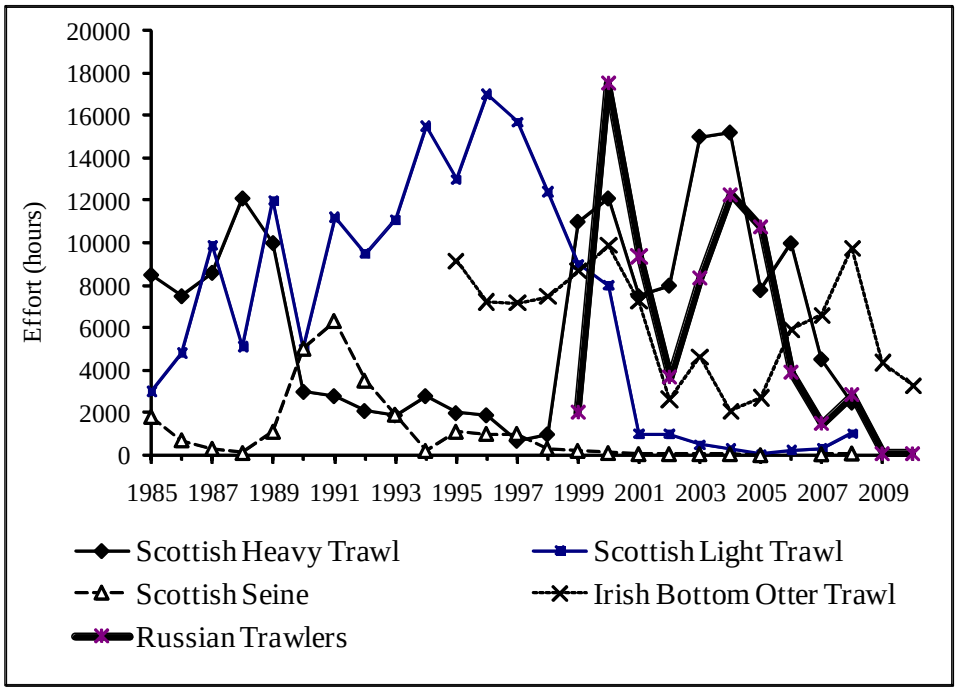


Figure 4.3.3. Rockall haddock in VIb. Scottish, Irish effort in 1985–2009 and Russian effort in 1999–2010.

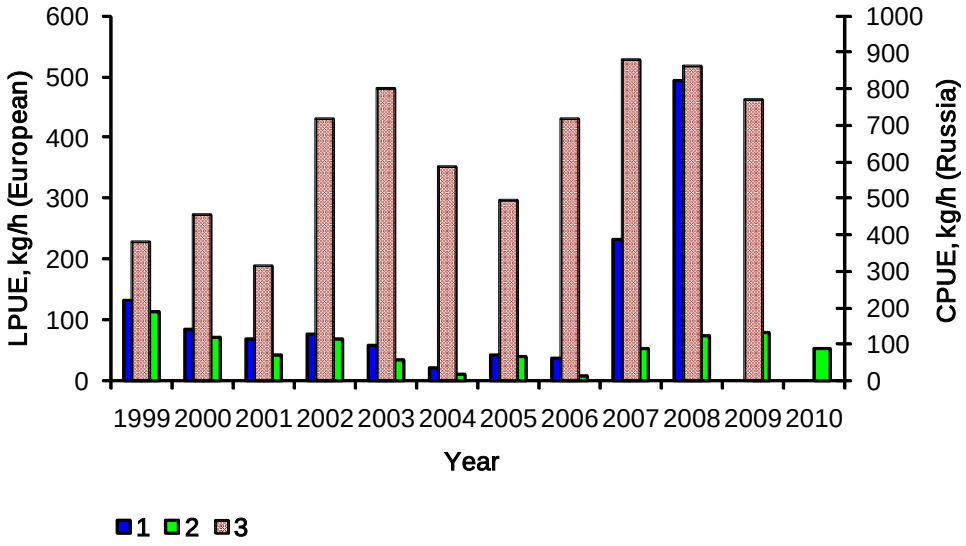


Figure 4.3.4. Lpue and cpue of the fleets fishing for Rockall haddock in 1999–2009. Note that Scottish and Irish effort data are not reliable because reporting is not mandatory.

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).

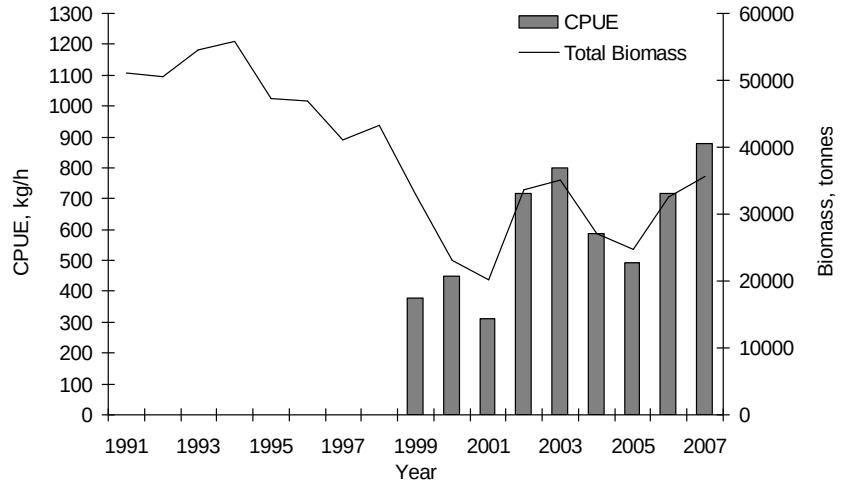


Figure 4.3.5. Dynamics of haddock total biomass (ICES, 2008a; ICES, 2008b) and directed fishing efficiency (t per a trawling hour) for tonnage class 10 vessels in 1999–2007.

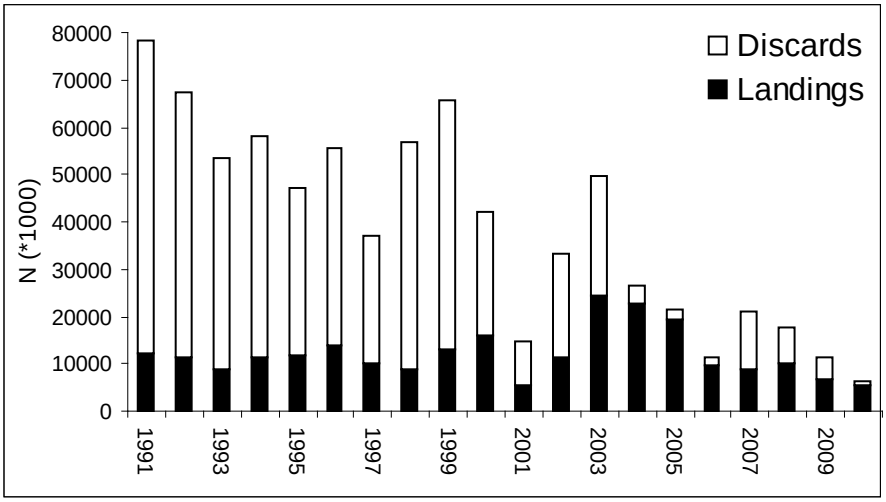


Figure 4.3.6. Total landings and discards of Rockall haddock ('000 individuals).

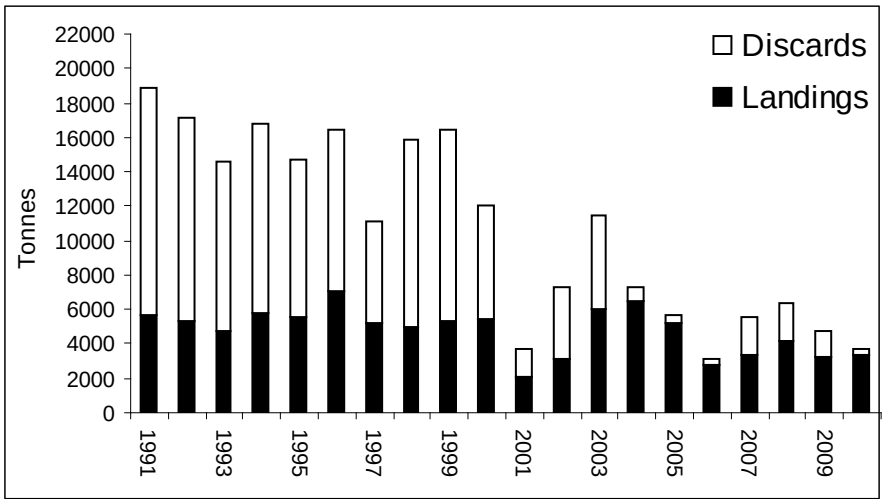


Figure 4.3.7. Total landings and discards of Rockall haddock (tonnes).

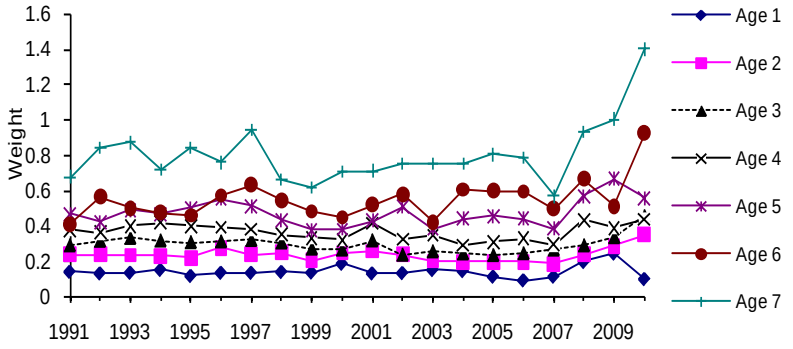


Figure 4.3.8. Haddock in VIb. Mean weights-at-age in catch by samples data.

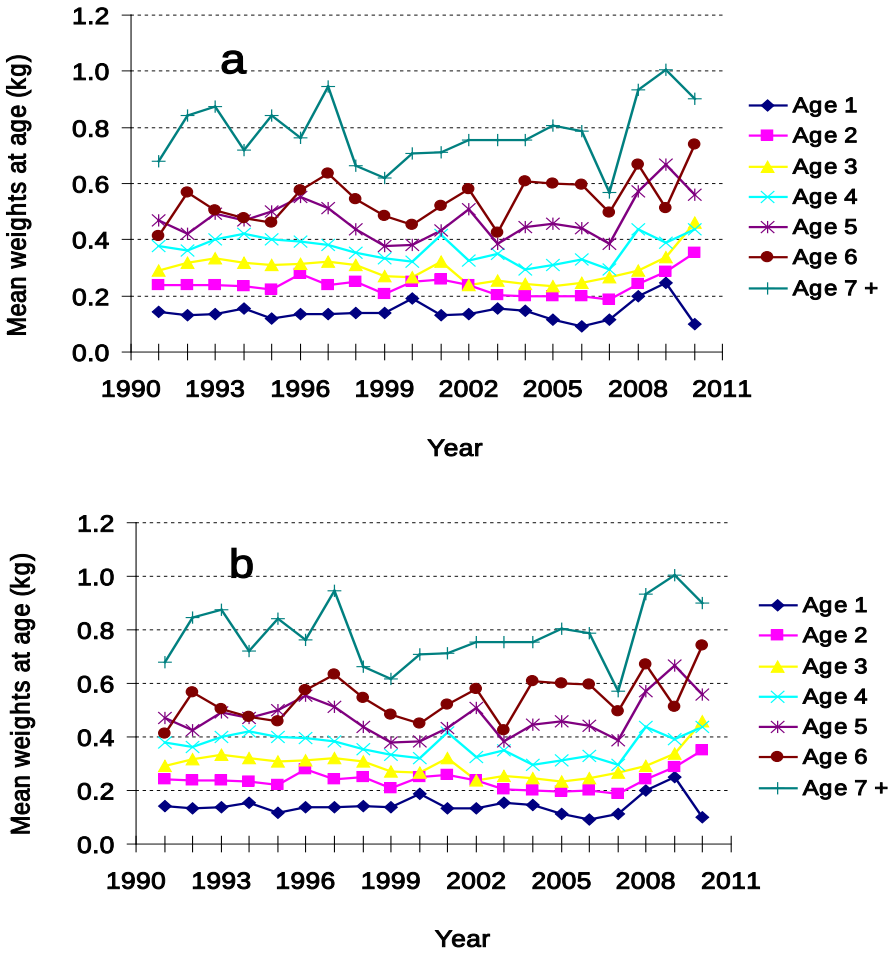


Figure 4.3.9. Haddock in VIb. Mean weights-at-age a) in catch and b) in stock.

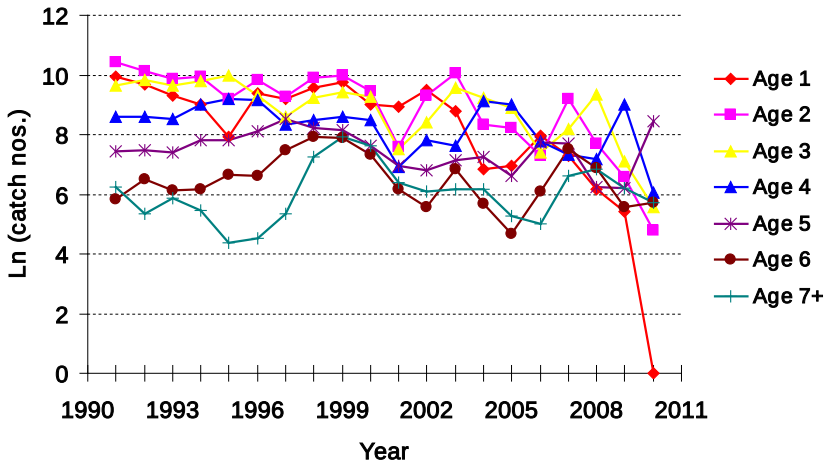


Figure 4.3.10. Haddock in VIb. Log catch (with discards in numbers) at age by year.

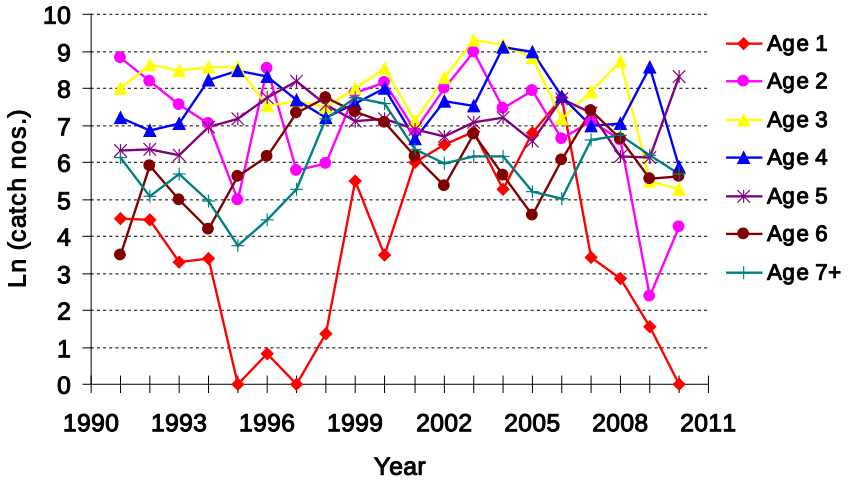


Figure 4.3.11. Haddock in VIb. Log landings (in numbers) at age by year.

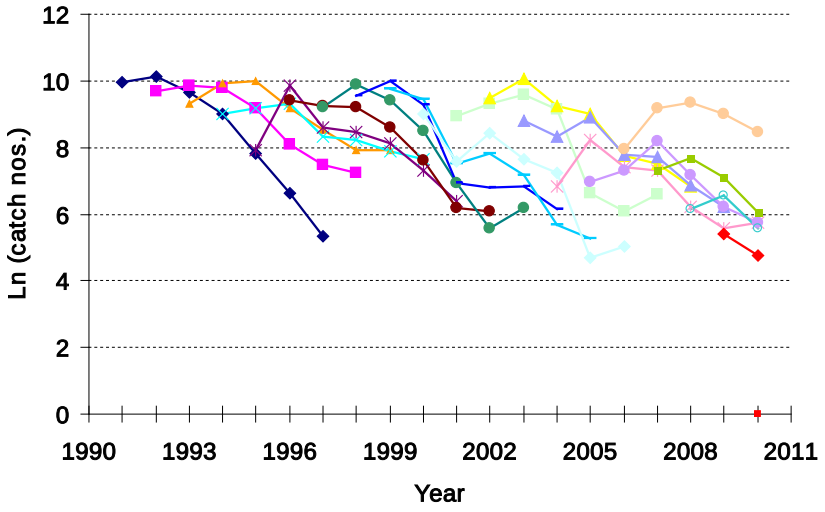


Figure 4.3.12. Haddock in VIb. Log catch (with discards, in numbers) at age by year class.

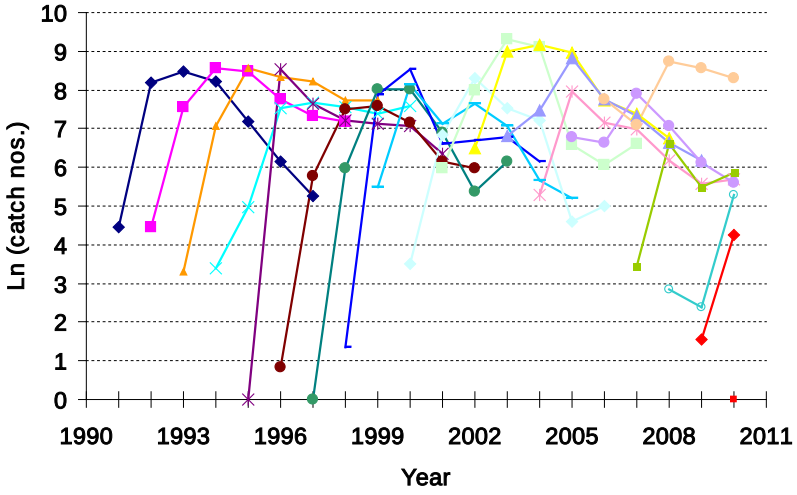


Figure 4.3.13. Haddock in VIb. Log landings (without registered discards, in numbers) at age by year class.

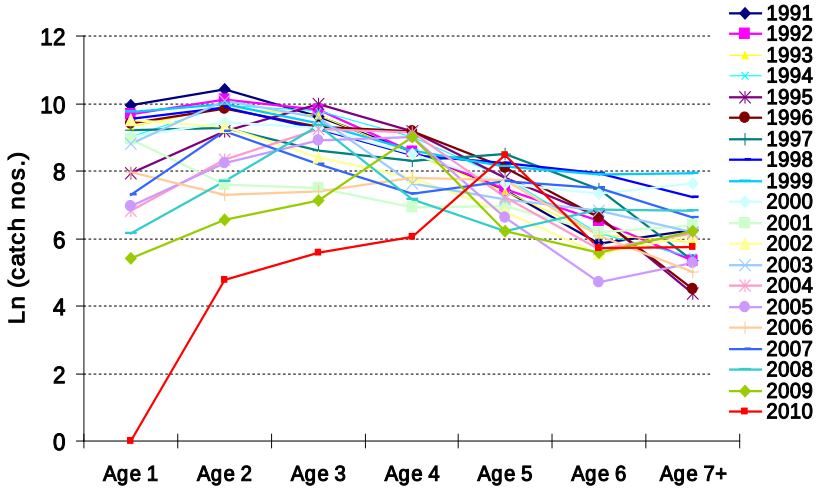


Figure 4.3.14. Haddock in VIb. Catch curves (with registered discards).

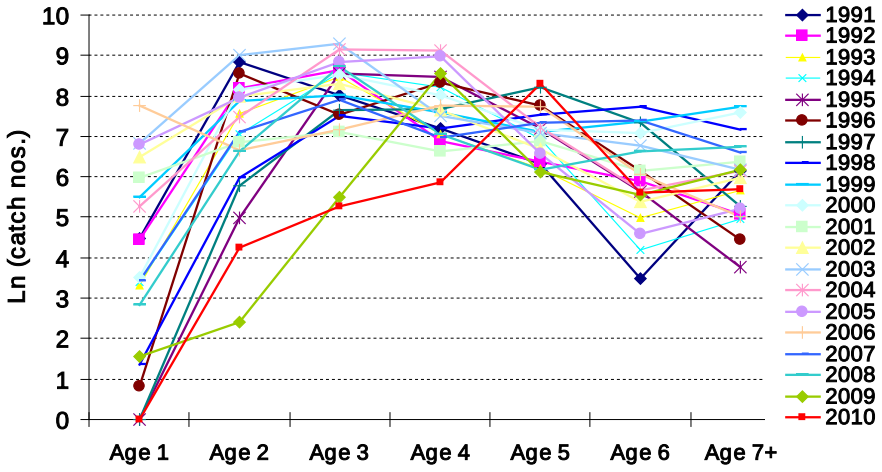


Figure 4.3.15. Haddock in VIb. Catch curves (landings without registered discards).

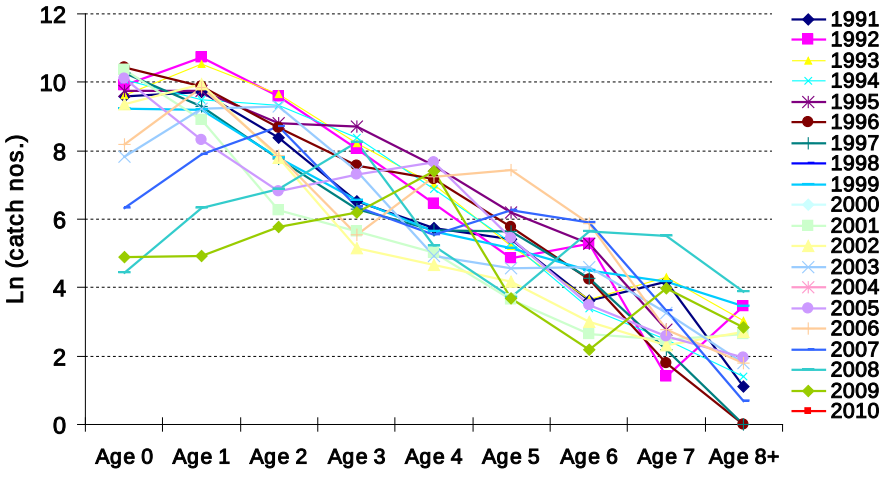


Figure 4.3.16. Haddock in VIb. Log survey cpue at age by year.

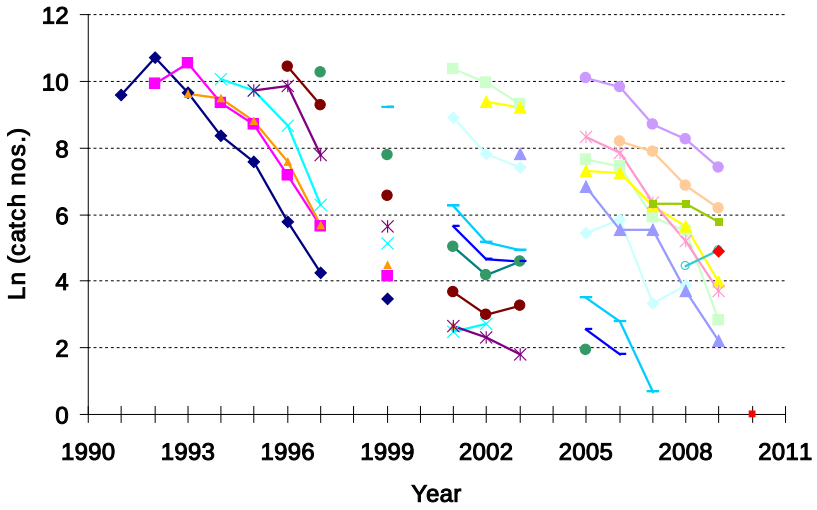


Figure 4.3.17. Haddock in VIb. Log survey cpue by year class.

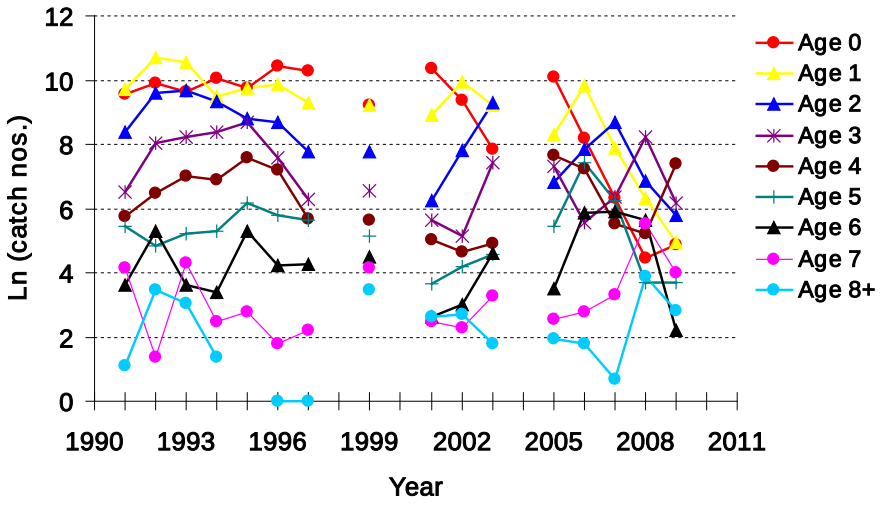


Figure 4.3.18. Haddock in VIb. Log survey cpue at age.

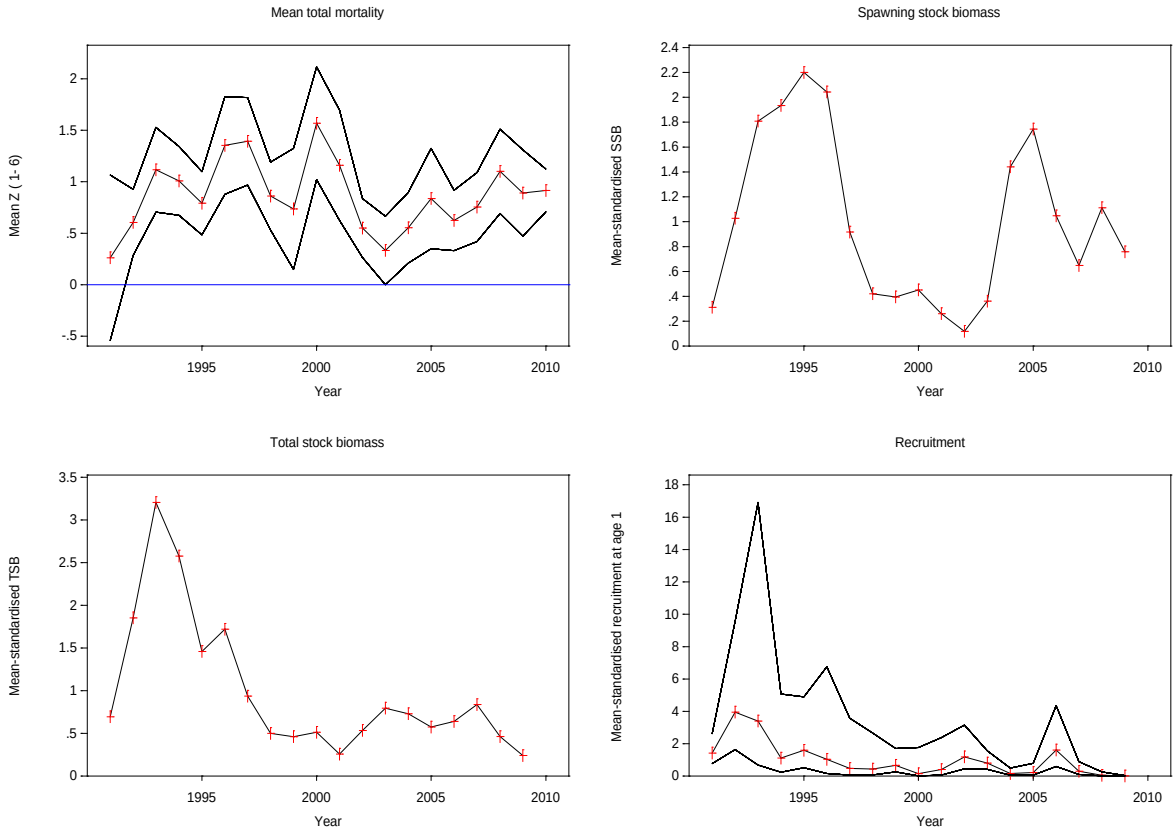


Figure 4.3.19. SURBA analysis for Rockall haddock.

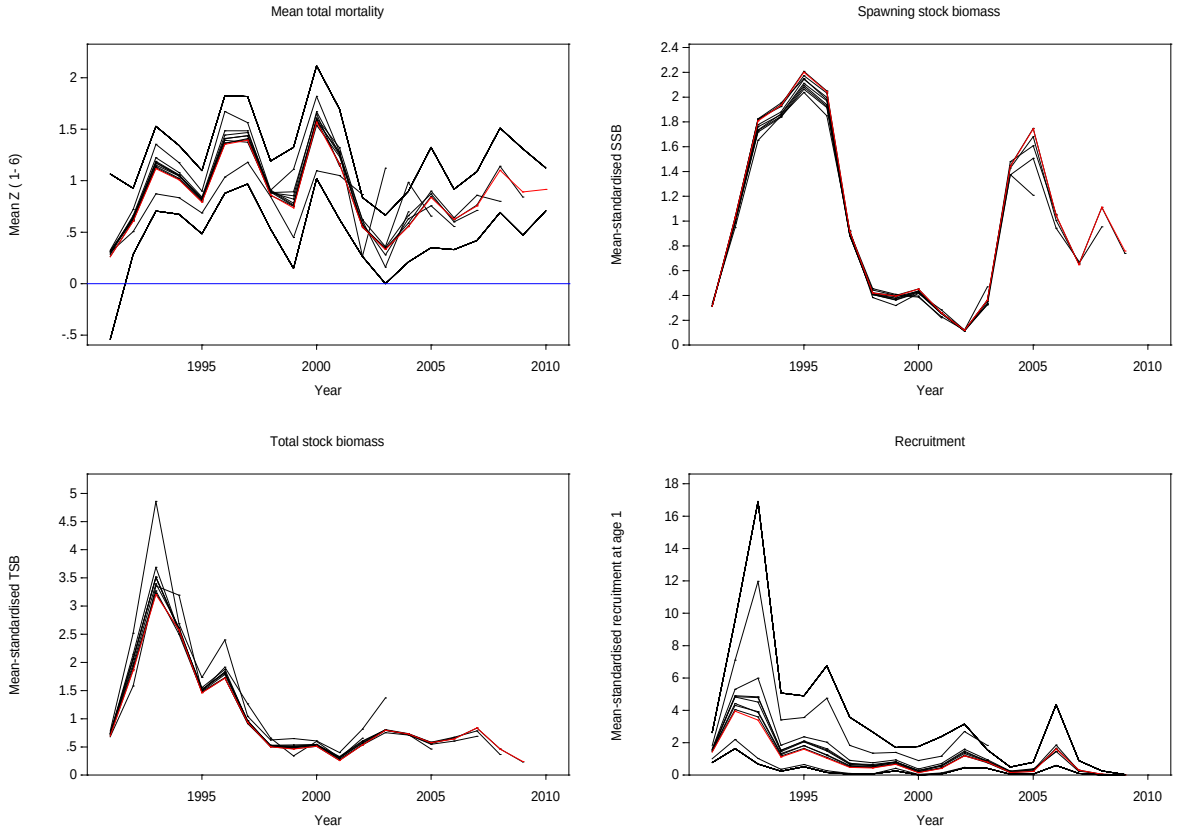


Figure 4.3.19a. SURBA analysis for Rockall haddock. Retrospective plots.

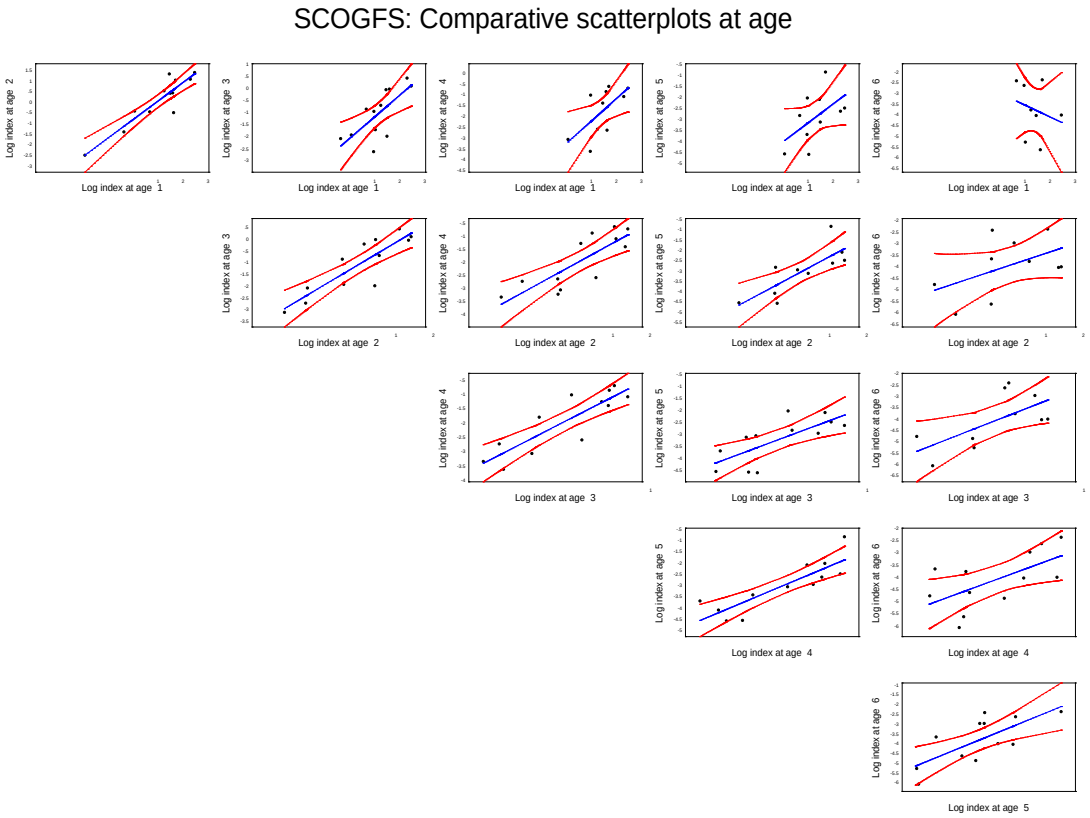


Figure 4.3.19b. SURBA analysis for Rockall haddock. Pairwise plots of age.

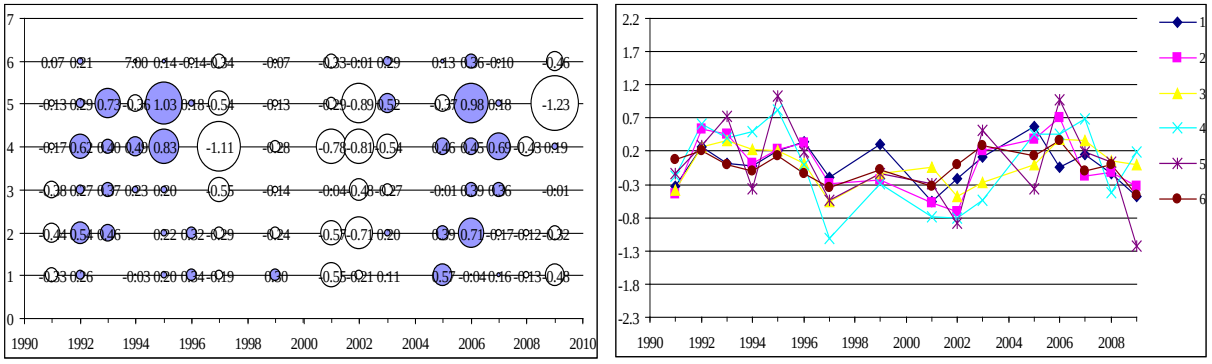


Figure 4.3.20. Haddock in VIb. Log-catchability residual plots (shrinkage 1.0). XSA run 2009: catchability dependent on stock size at ages <4. Old survey indices data.

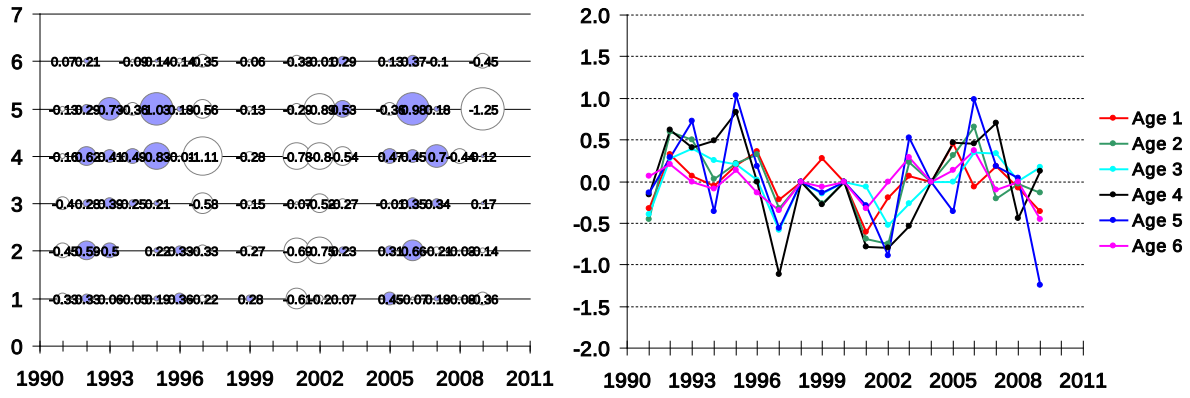


Figure 4.3.21. Haddock in VIb. Log-catchability residual plots (shrinkage 1.0). Final XSA 2010: catchability dependent on stock size at ages <4. Old survey indices data.

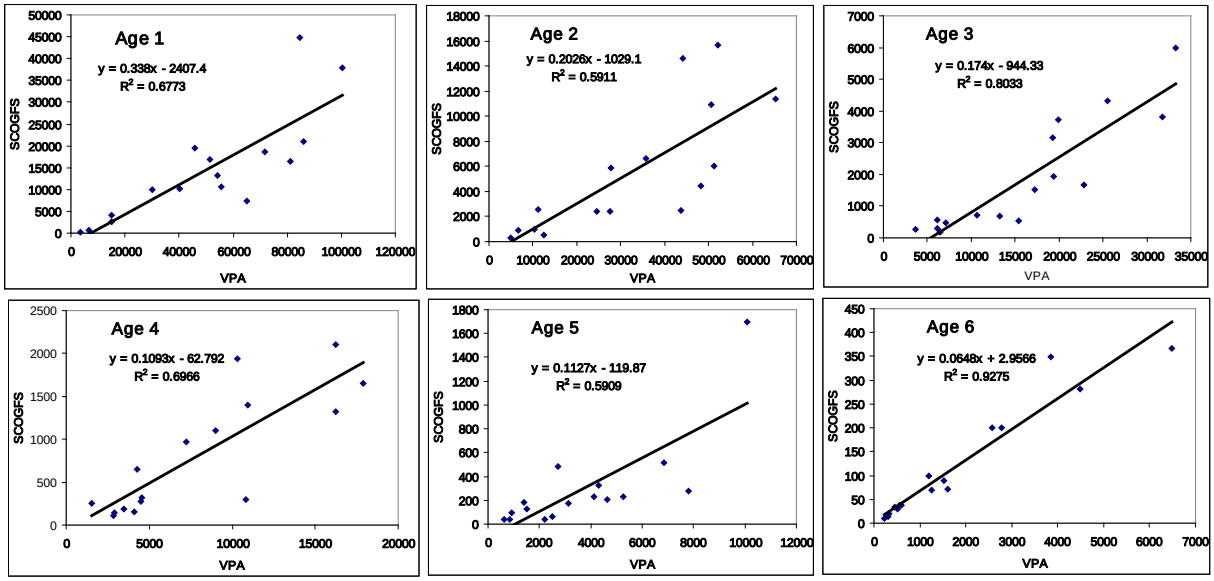


Figure 4.3.22. Haddock in VIb. Adjusted Scottish groundfish survey cpue from the final XSA run plotted against VPA numbers (shrinkage 1.0) at age. Catchability dependent on stock size at ages <4.

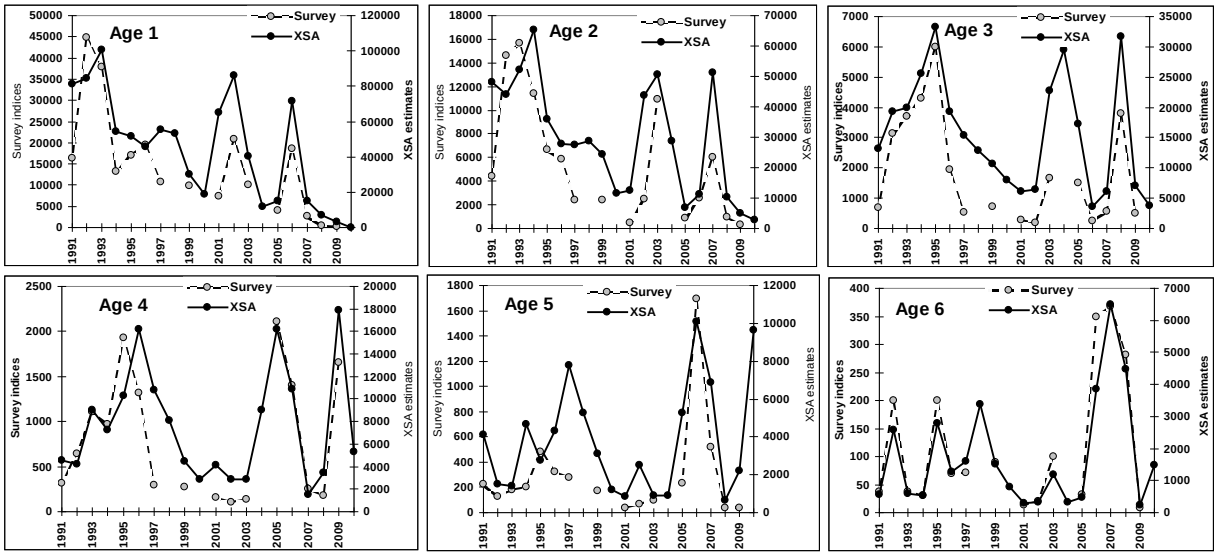


Figure 4.3.23. Haddock in VIb. Survey indices and XSA estimates (shrinkage 1.0) at age. Final XSA: catchability dependent on stock size at ages <4.

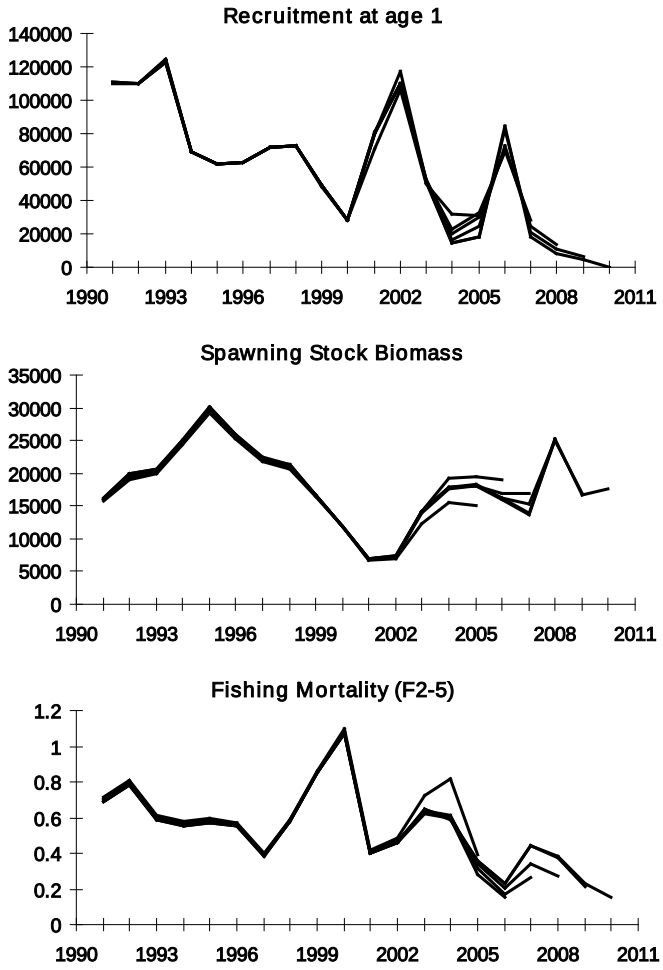


Figure 4.3.24. Haddock in VIb. Retrospective analyses (F shrinkage 1.0).

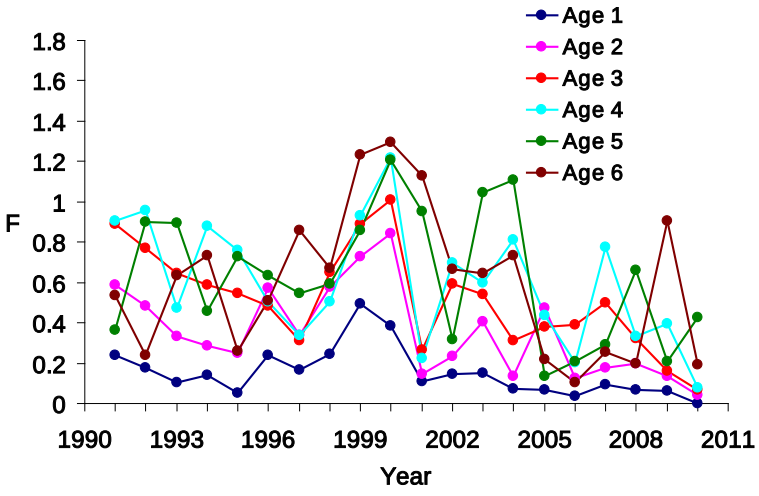


Figure 4.3.25. Haddock in VIb. F at age (F shrinkage 1.0).

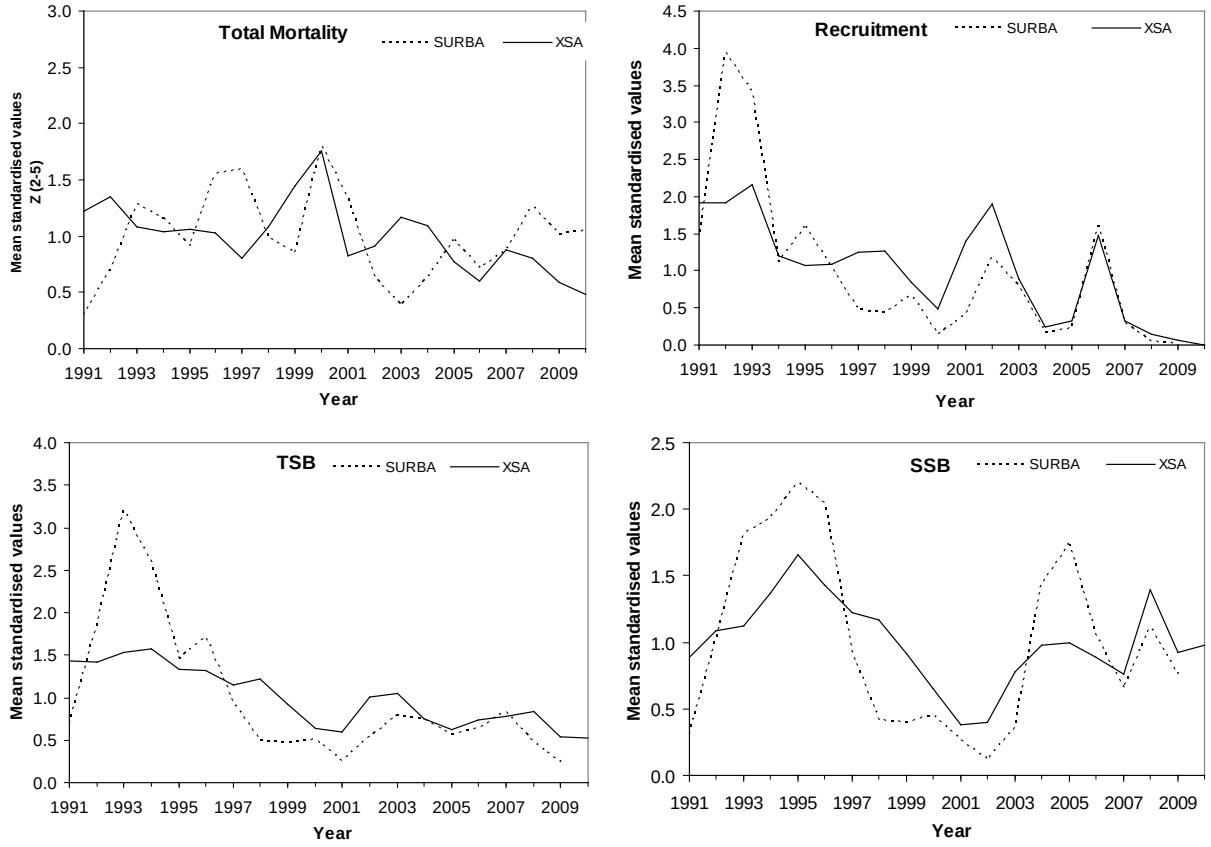


Figure 4.3.26. Haddock in VIb. XSA and SURBA analyses.

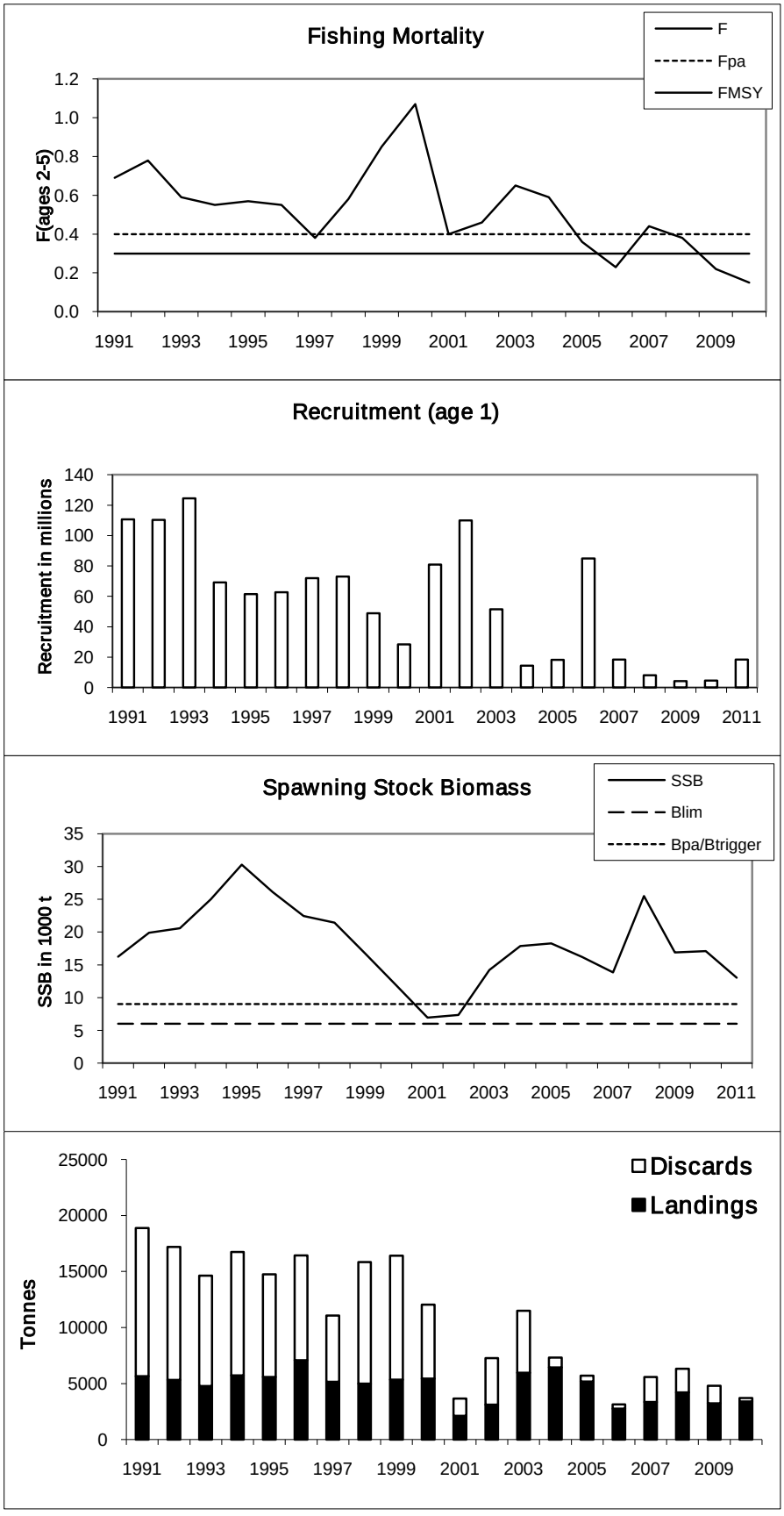


Figure 4.3.27. Haddock in VIb. Summary plots.

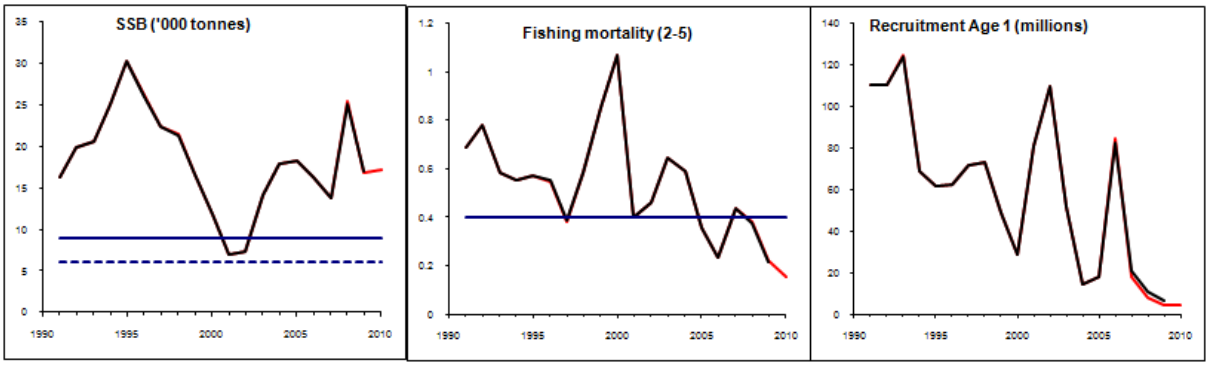


Figure 4.3.28. Haddock in VIb. Comparison of the current assessment (in red) with the previous one (in black).

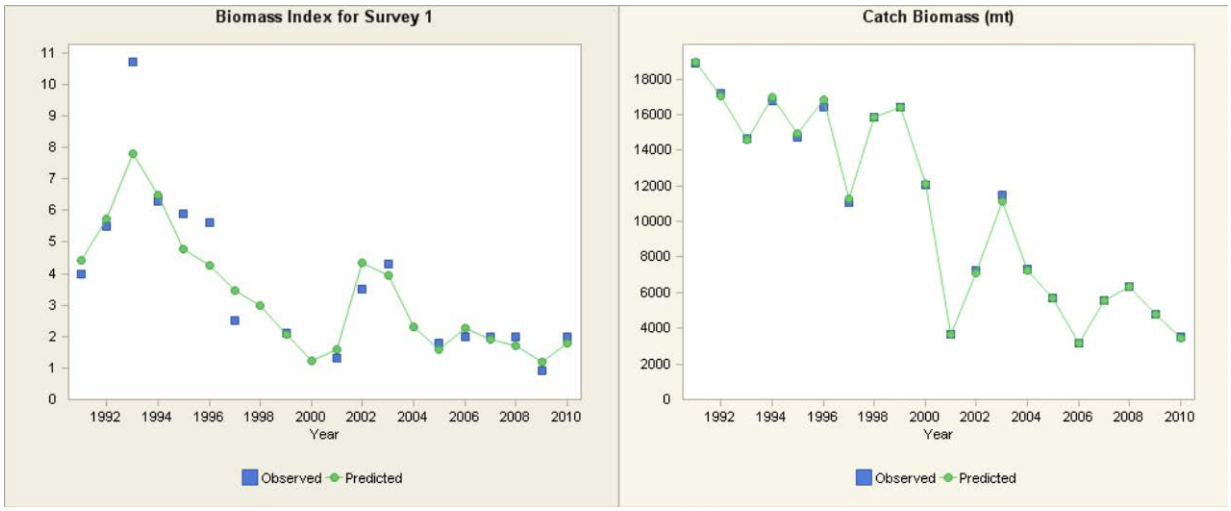


Figure 4.3.29. Haddock in VIb. Comparison observed and predicted by StatCam survey index and catch biomass . Scenario 2.

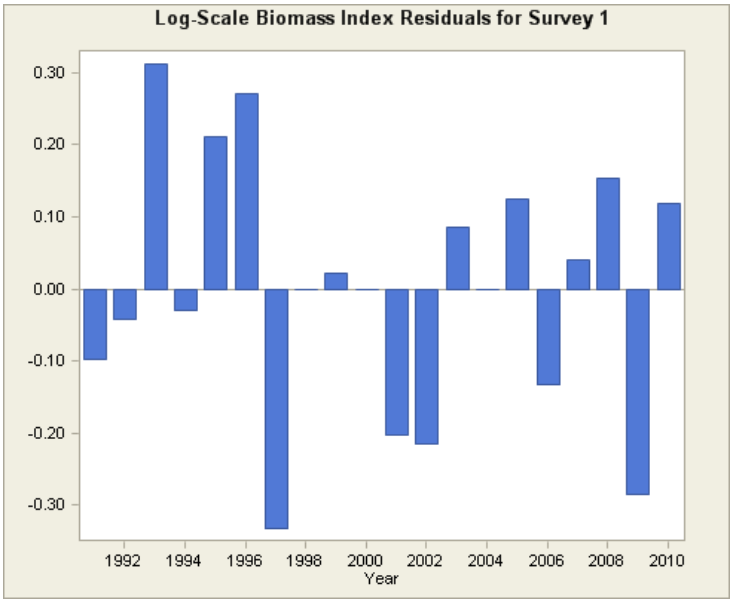


Figure 4.3.30. Haddock in VIb. Log-catchability residuals plot for survey biomass index. Scenario 2 of Statcam run.

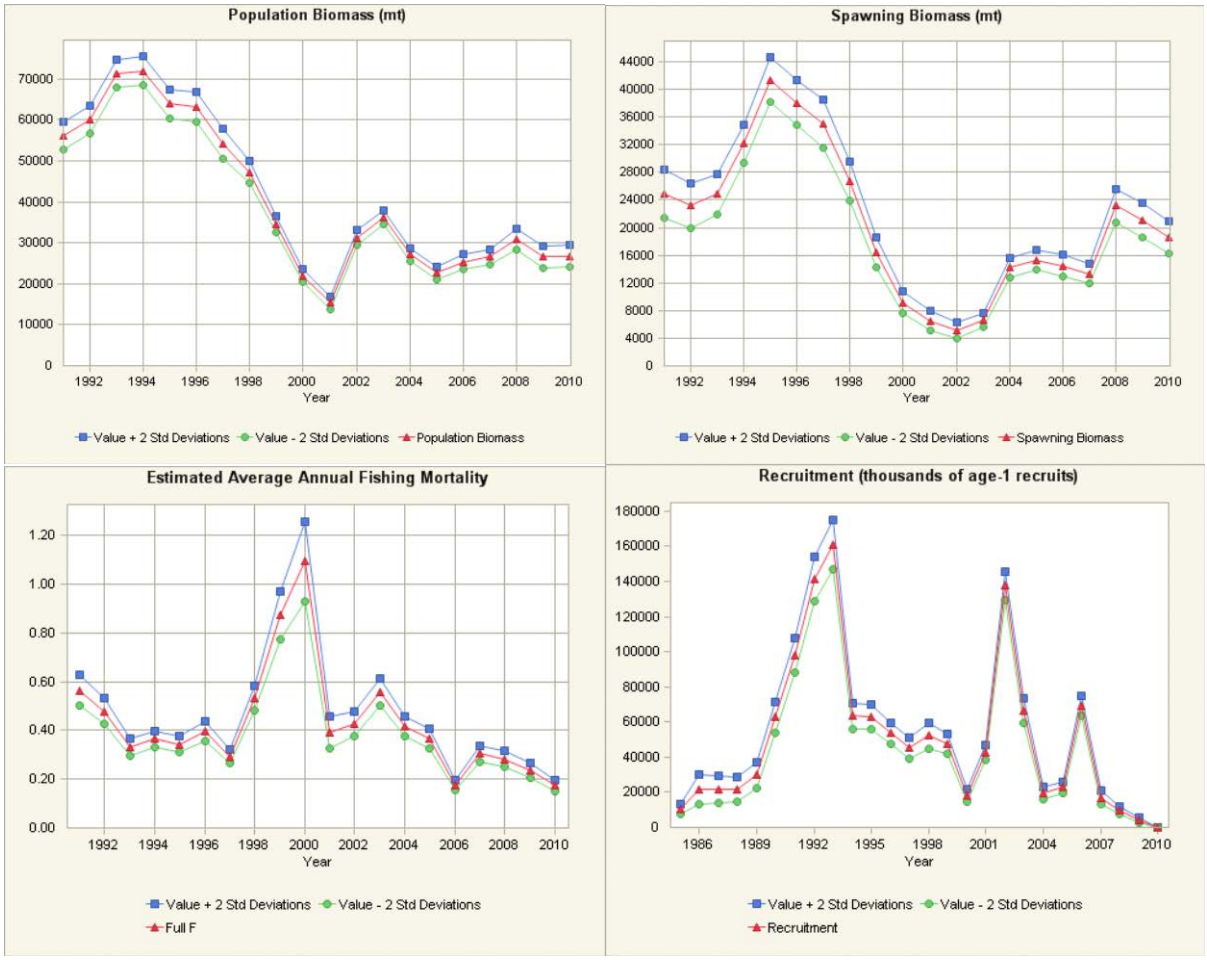


Figure 4.3.31. Haddock in VIb. Population biomass, SSB, fishin mortality and recruitment by Statcam estimation. Scenario 2.

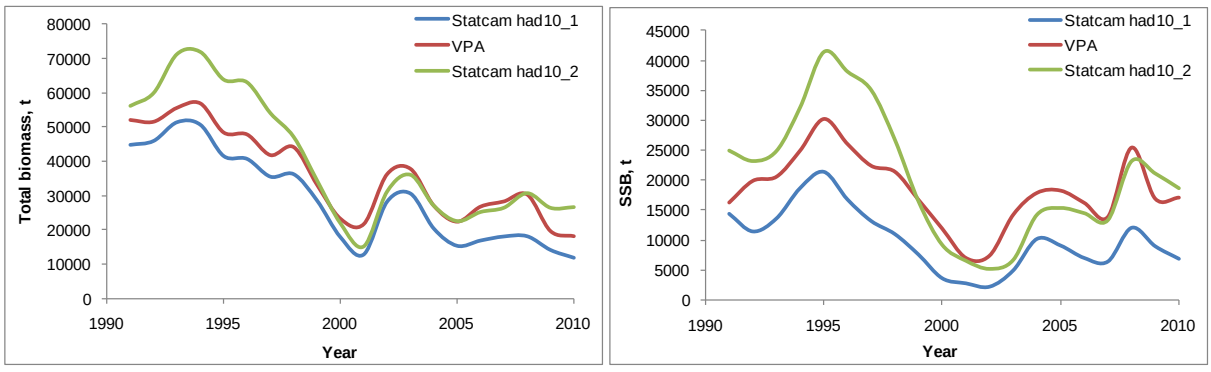


Figure 4.3.32. Haddock in VIb. Comparison of VPA assessment with the statistical catch-at-age model StatCam assessment.

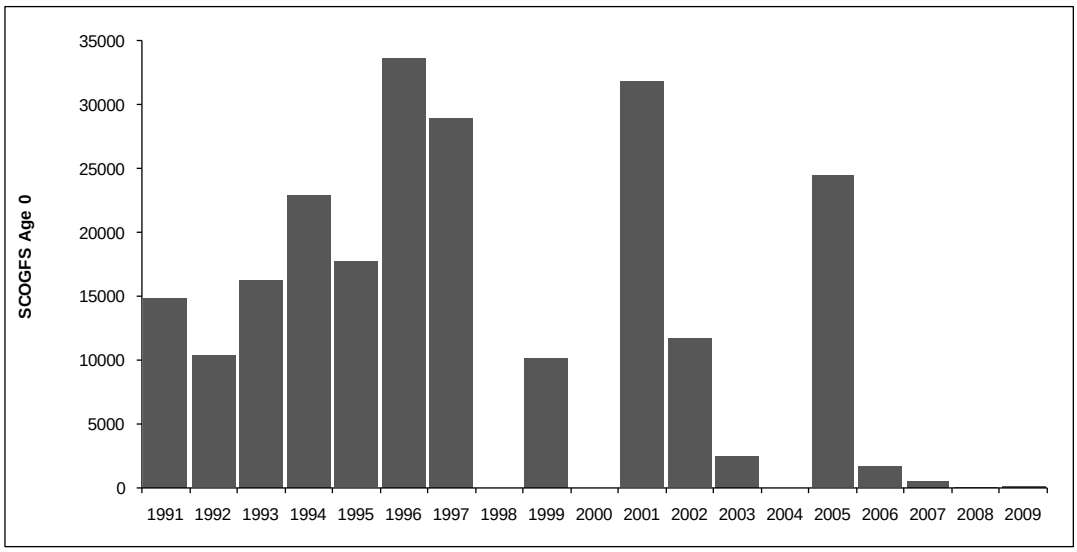


Figure 4.3.33. Haddock in VIb. Scottish Groundfish survey indices of haddock at age 0.

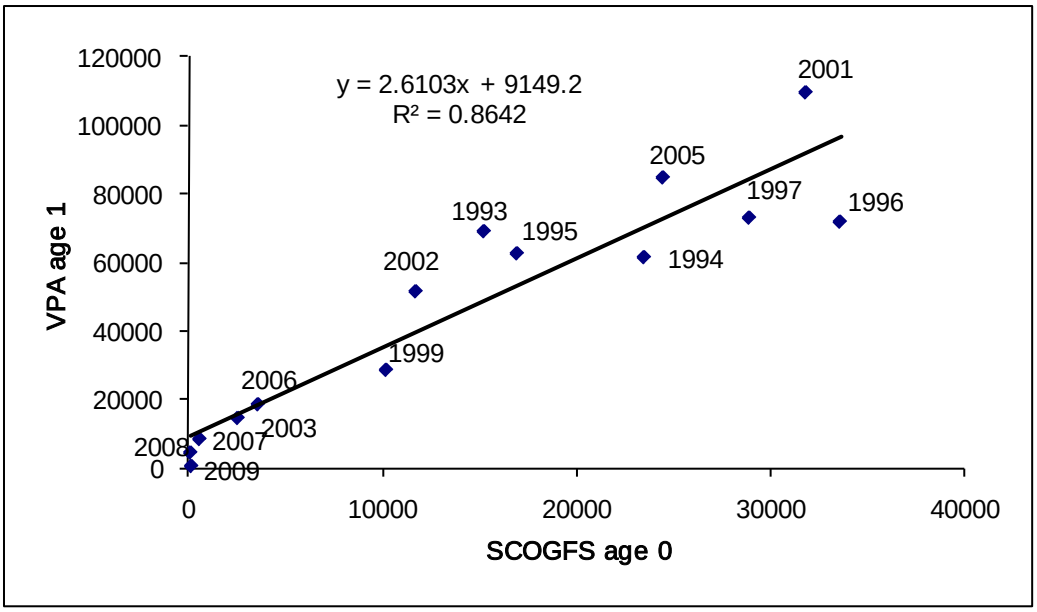


Figure 4.3.34. Haddock in VIb. VPA numbers-at-age 1 from XSA plotted against Scottish Groundfish survey indices of haddock at age 0.

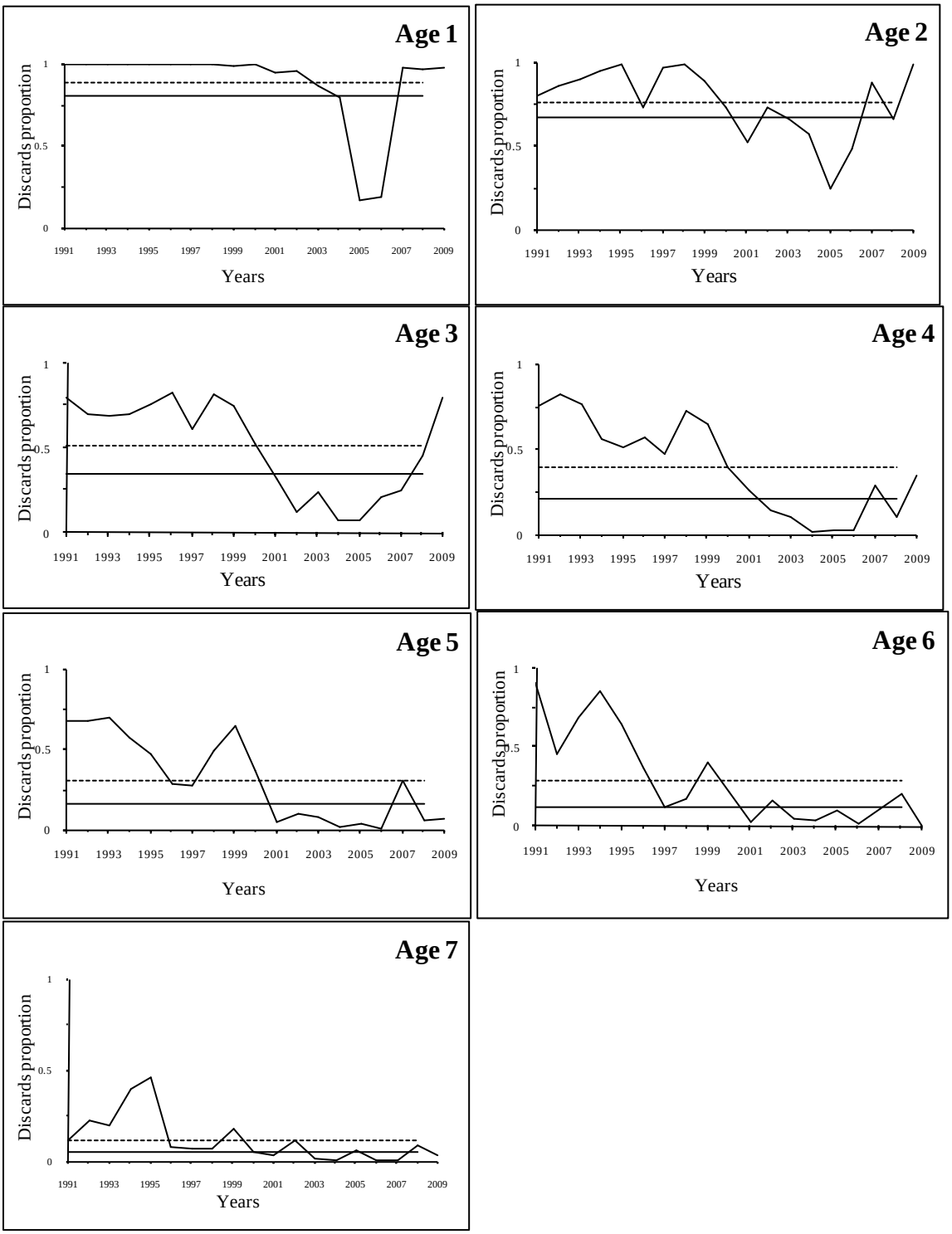


Figure 4.3.35. Haddock in Division VIb. Discard proportion-at-age by year and mean discard proportion-at-age for two periods, 1991–2009 and 1999–2009.

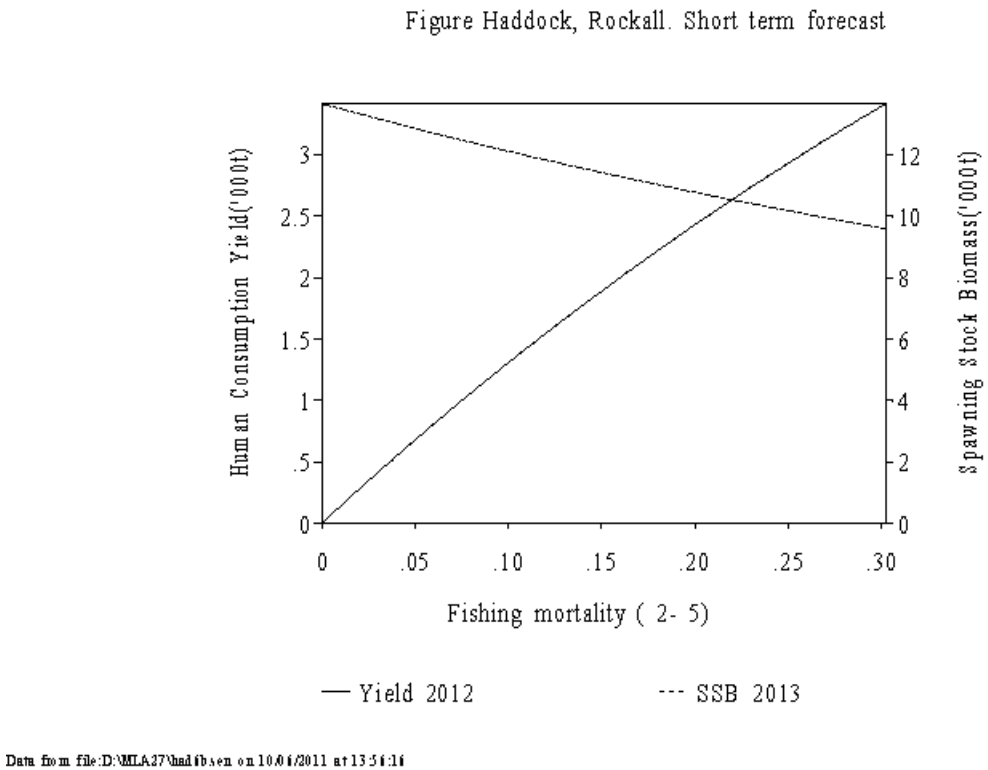


Figure 4.3.36. Haddock in VIb. Short-term forecast.

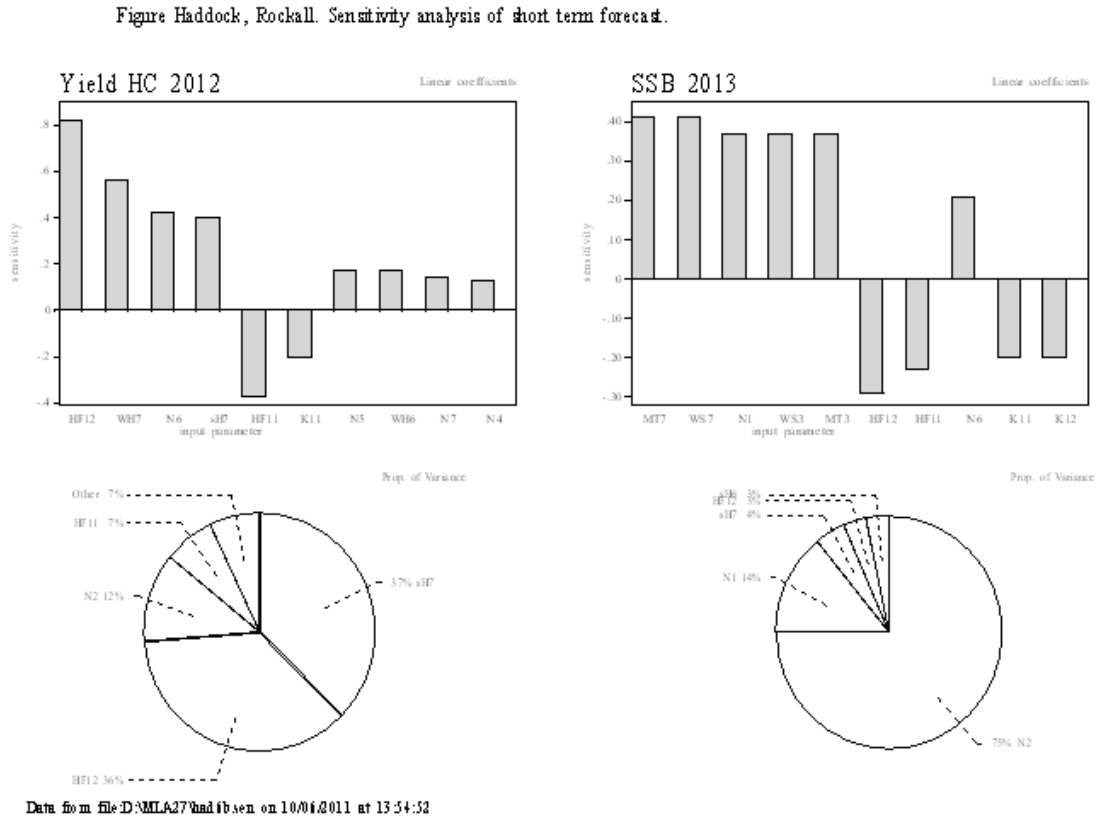


Figure 4.3.37. Haddock in VIb. Delta plots from sensitivity analysis.

Figure Haddock, Rockall. Probability profiles for short term forecast.

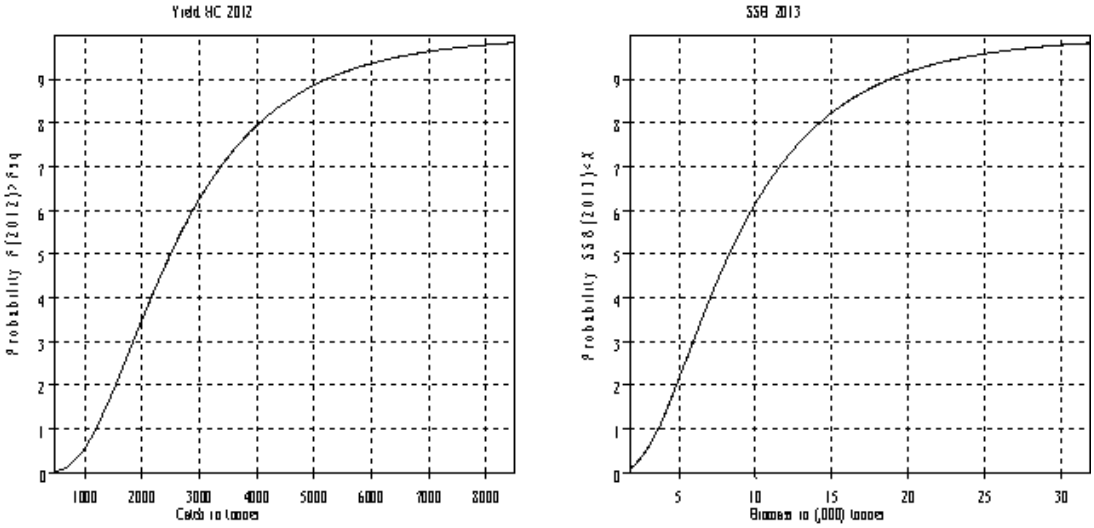


Figure 4.3.38. Haddock in VIb. Probability plots for yield in 2012and SSB in 2013.

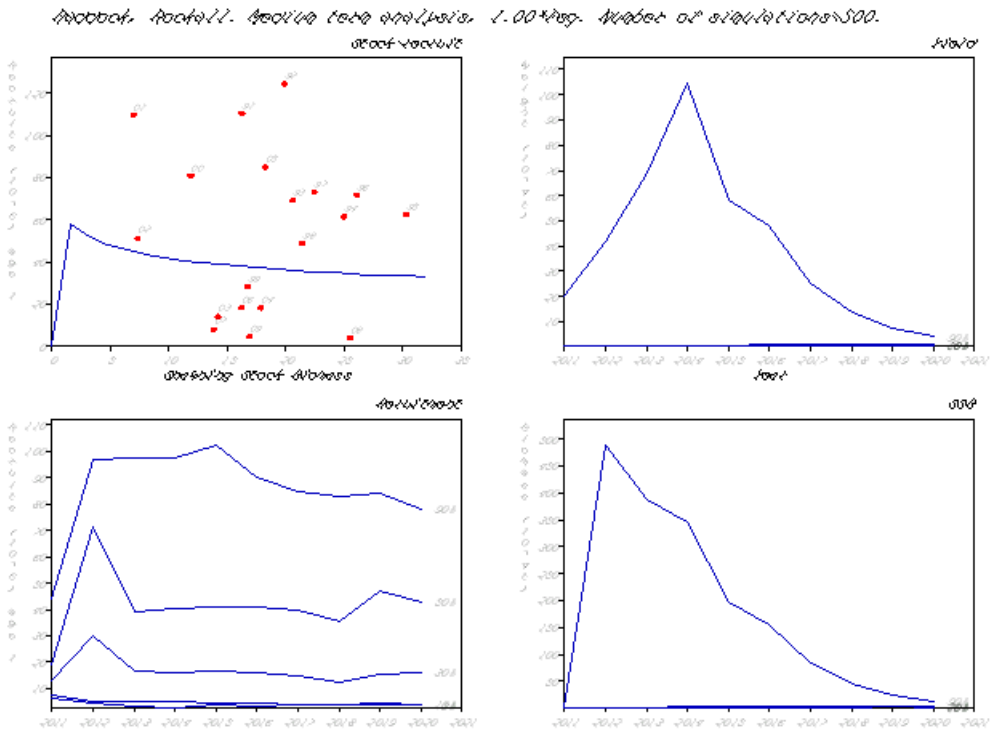


Figure 4.3.39. Haddock VIb. Medium-term analysis.

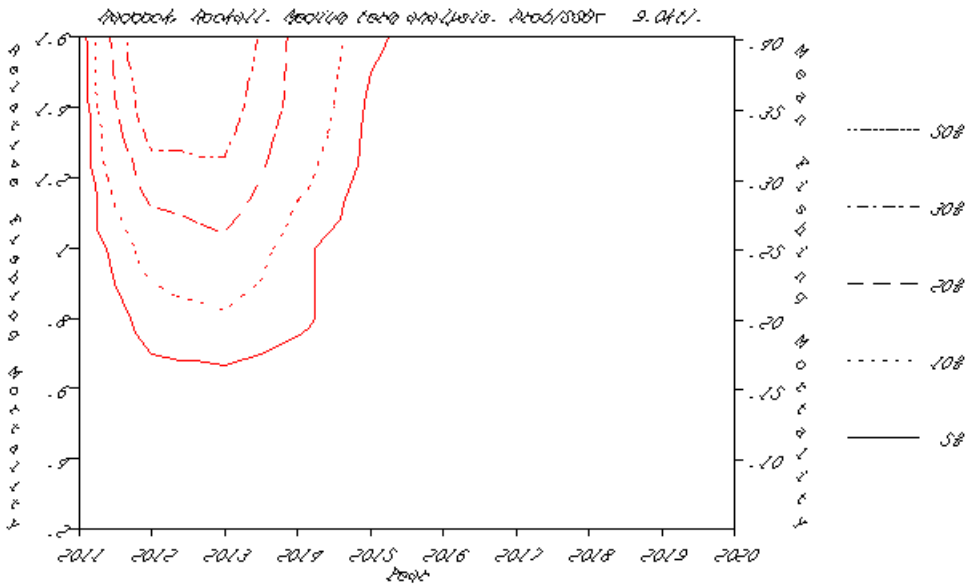


Figure 4.3.40. Haddock VIb. Medium-term analysis.

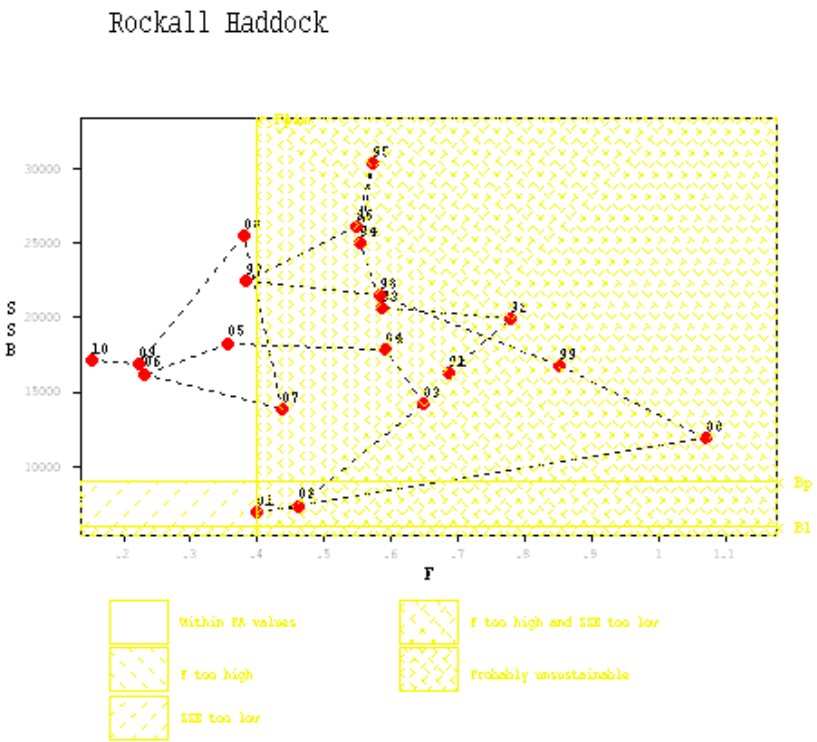


Figure 4.3.41. Haddock in VIb. Biological reference points.

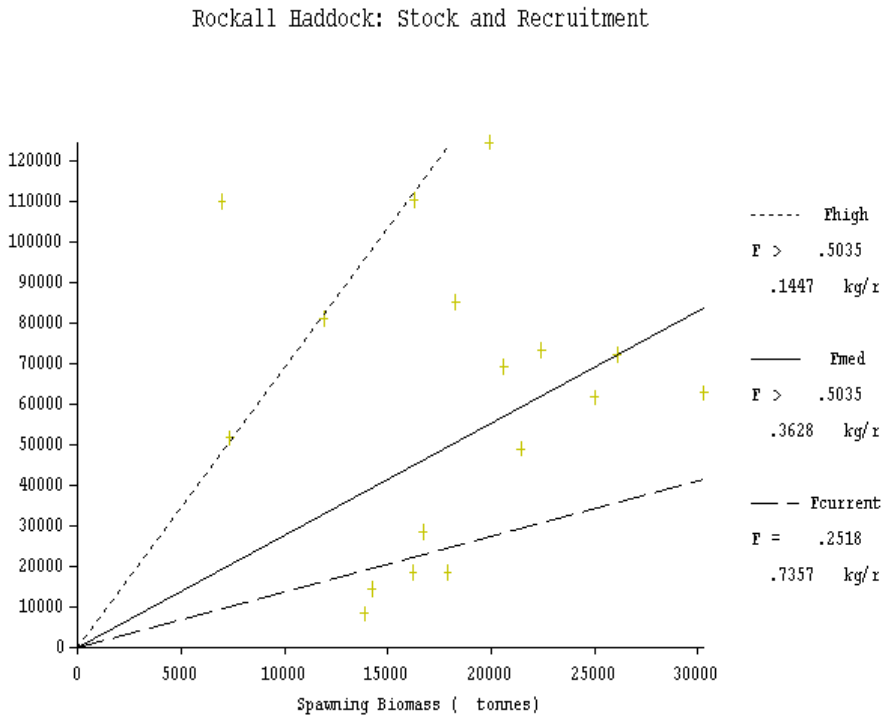


Figure 4.3.42. Haddock in VIb. SSB and recruitment.

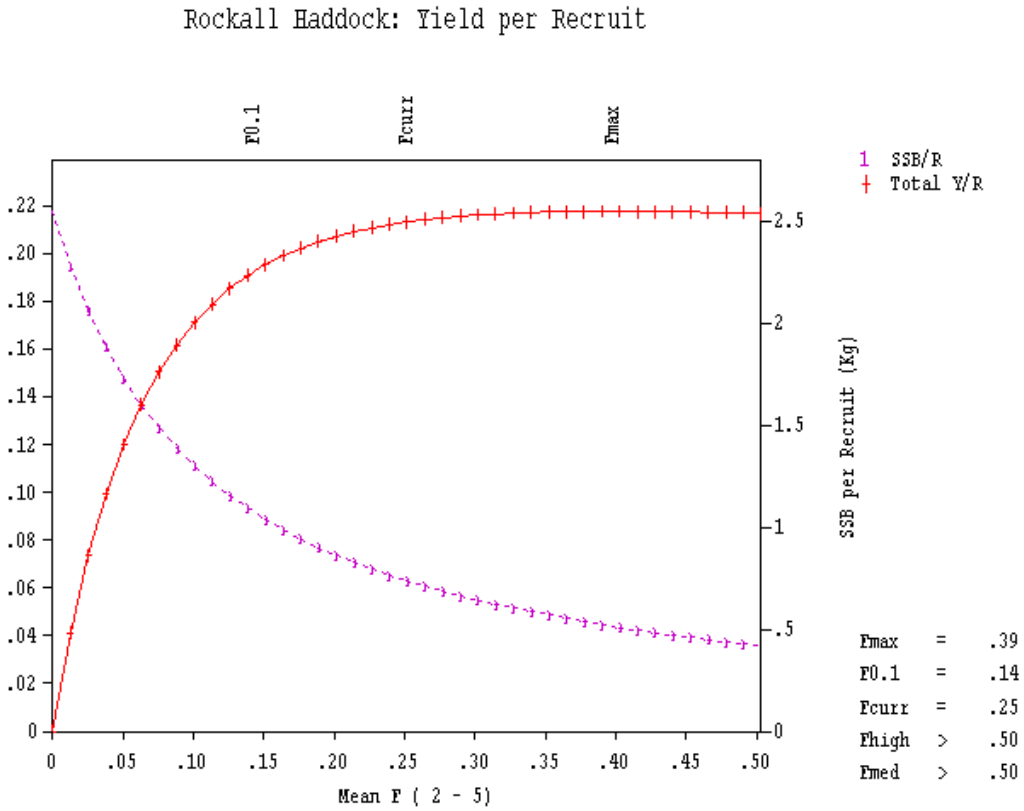


Figure 4.3.43. Haddock in VIb. Yield-per-recruit.

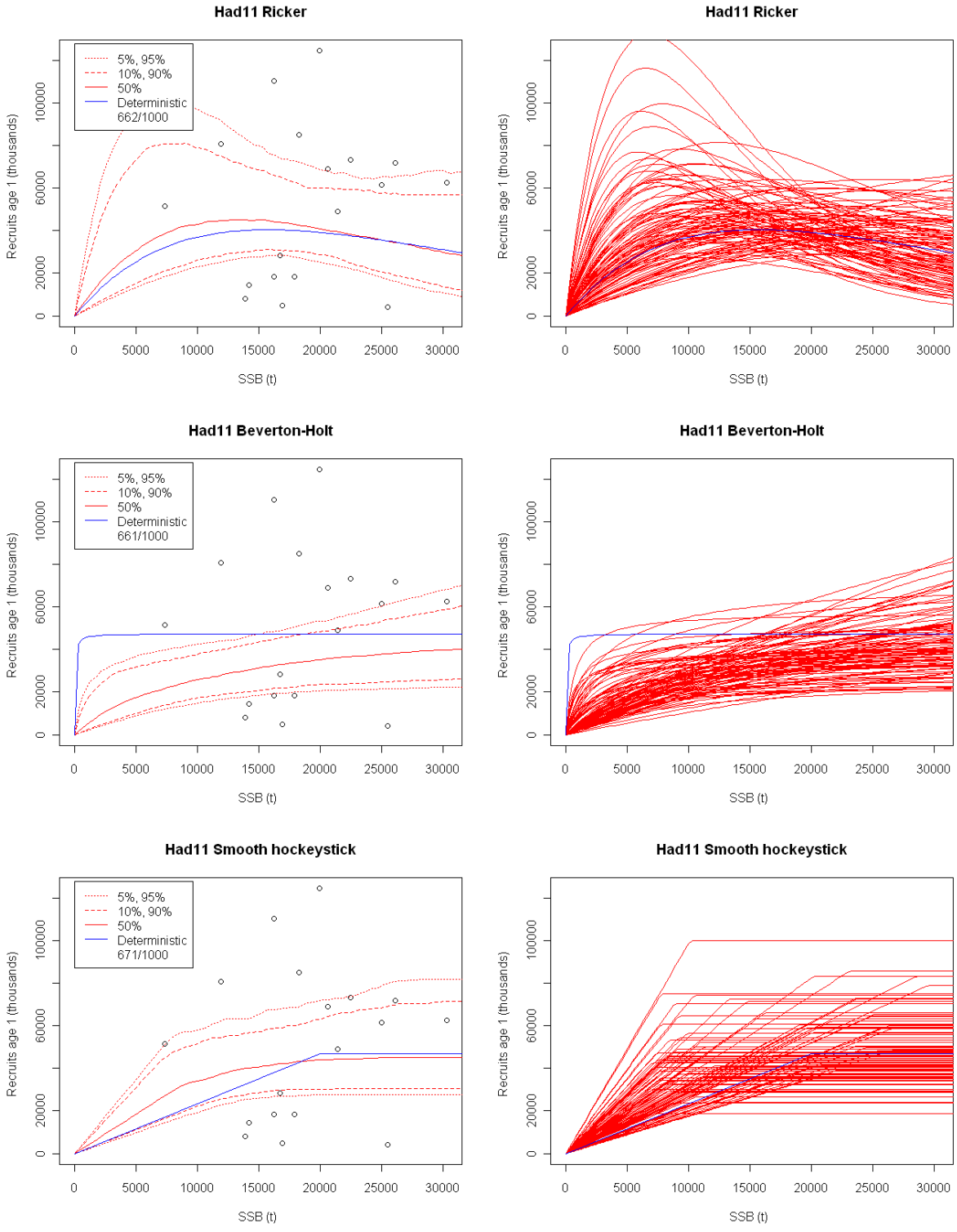


Figure 4.3.44. Haddock in VIb. Fitted stock–recruit relationships with 1000 MCMC resamples. The left-hand plots show the deterministic fit (blue) as well as the confidence intervals from converged estimates of F_{MSY} (red). Right-hand panels show the fits from the first 100 converged MCMC resamples for illustration. The legends show the number of converged values for F_{MSY} from 1000 resamples.

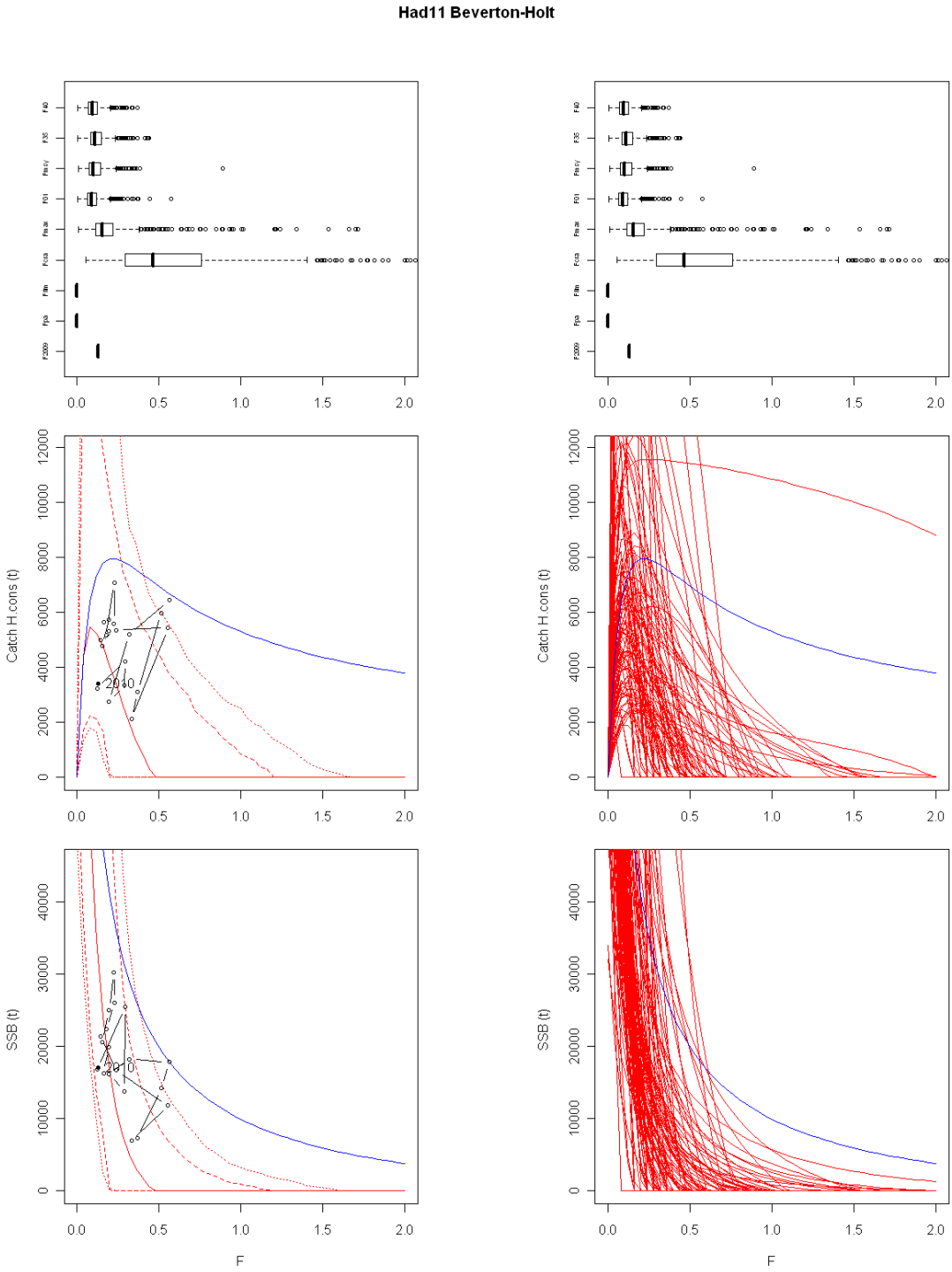


Figure 4.3.45. Haddock in VIb. Estimates of F reference points and equilibrium yield and SSB against mortality using a Beverton and Holt recruitment model. The left-hand plot illustrate the deterministic fit (blue) and confidence intervals of the converged estimates (red) and the right-hand plots show the fit for the first 100 resamples for illustration. The top two plots are identical.

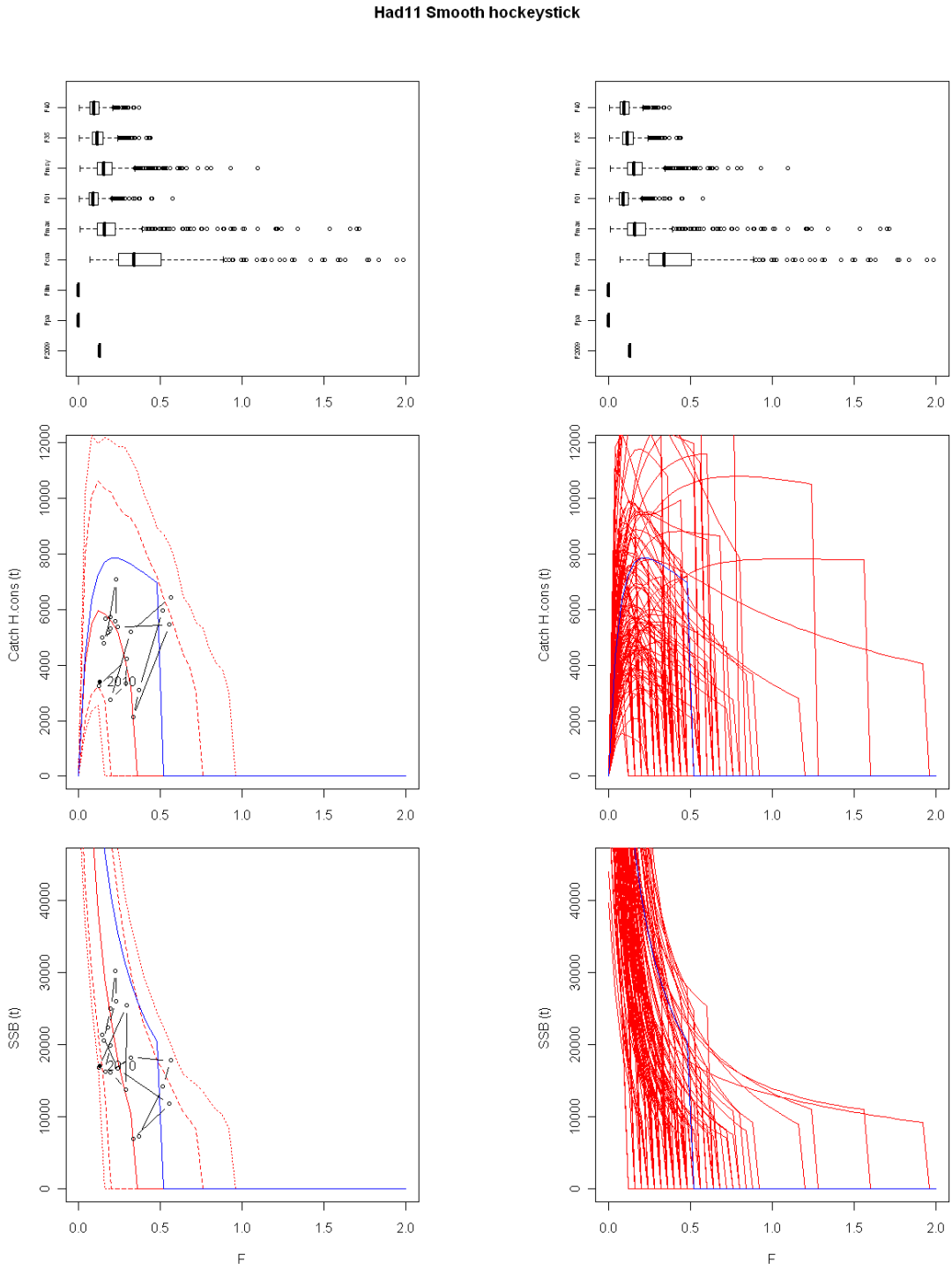


Figure 4.3.46. Haddock in VIb. Estimates of F reference points and equilibrium yield and SSB against mortality using a hockey-stick recruitment model. The left-hand plot illustrate the deterministic fit (blue) and confidence intervals of the converged estimates (red) and the right-hand plots show the fit for the first 100 resamples for illustration. The top two plots are identical.

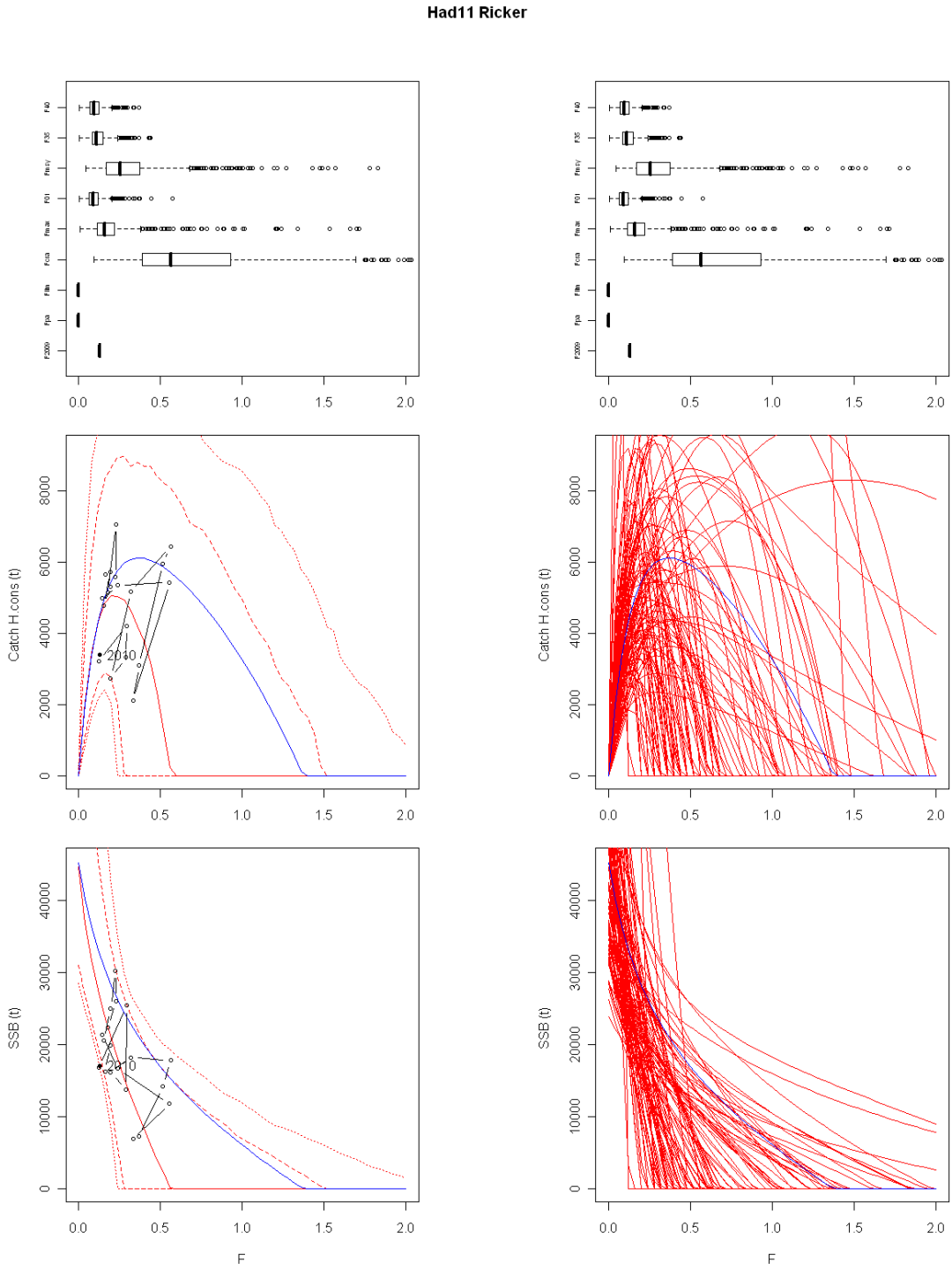


Figure 4.3.47. Estimates of F reference points and equilibrium yield and SSB against mortality using a Ricker recruitment model. The left-hand plot illustrate the deterministic fit (blue) and confidence intervals of the converged estimates (red) and the right-hand plots show the fit for the first 100 resamples for illustration. The top two plots are identical.

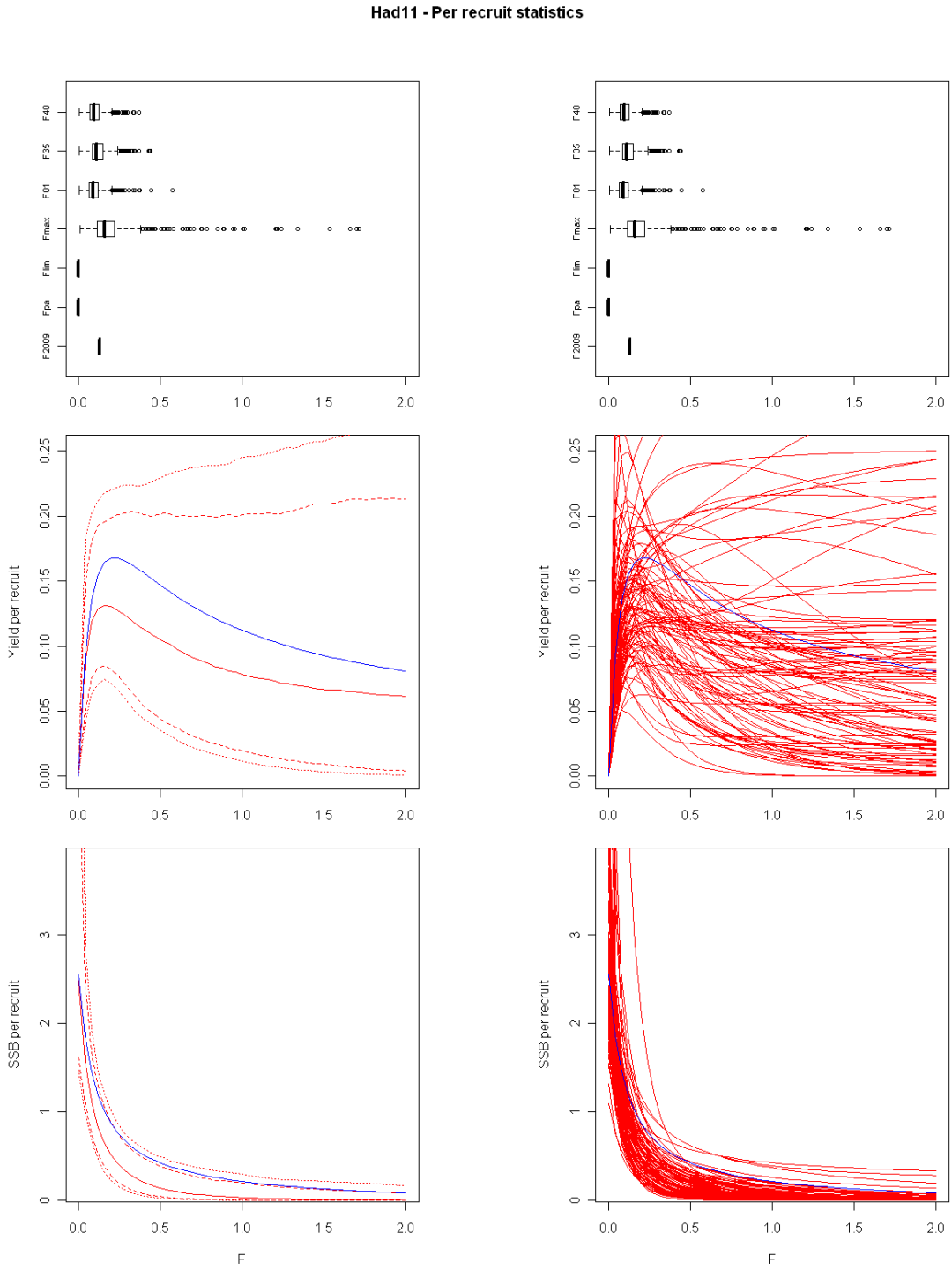


Figure 4.3.48. Fitted of F reference points and equilibrium yield and SSB. The left-hand plot illustrate the deterministic fit (blue) and confidence intervals (red) and the right-hand plots show the fit for the first 100 iterations. The top two plots are identical.

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 significant 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. Recent ACFM review groups have 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 2010 and 2011

ICES advice for 2010 (Single-stock Exploitation Boundaries) was as follows:

"ICES advises on the basis of precautionary considerations that the effort in fisheries that catch anglerfish should not be allowed to increase."

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.

PA considerations

The catch should be reduced and effort in fisheries that catch anglerfish should decrease.

Policy paper

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.

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 summarizes ICES advice and actual management applicable for Northern Shelf anglerfish during 2003–2011.

			West of Scotland			North Sea		
Year	Single-stock exploitation boundary	Basis	TAC[4]	% change in F associated with TAC	WG landings	TAC[5]	% change in F associated with TAC	WG landings
2003	<6700[1]	Reduce F below F_{pa}	3180	49% reduction	4126	7000	49% reduction	8268
2004	<8800[2]	Reduce F below F_{pa} [2]	3180	48% reduction	3296	7000	48% reduction	9027
2005	-	No effort increase[2]	4686	-	n/a	10 314	-	n/a
2006	-	No effort increase[2]	4686	-	n/a	10 314	-	n/a
2007	-	No effort increase[2]	5155	-	n/a	11 345	-	n/a
2008	-	No effort increase[3]	5155	-		11 345	-	
2009	-	No effort increase[3]	5567	-		11 345	-	
2010	-	No effort increase[3]	5567	-		11 345	-	
2011	-	Decrease effort	5456	-		9643	-	

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 and 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 is also available for EU vessels fishing in the Norwegian zone of Subarea IV in 2010.

The fishery in 2010

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 and ICES Division in Tables 5.2.2–5.2.4. In 2010, total [officially reported] landings (11 978 t) were lower than in 2009 (16 539 t). This was due to a reduction in the TAC and in [officially reported] landings in Division VIa by France (Table 5.2.2). Total officially reported landings of anglerfish from the Northern Shelf and ICES Division 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, then declined rapidly during the following five 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 80% of the total landings over 1973–2010.

Uptake of EC quota in 2010, based on the officially reported landings was as follows:

	TAC[1]	Landings	Uptake (%)	TAC			Landings	Uptake (%)
	VI	VI		IV (Norwegian)	IIa & IV	IIa & IV (total)	IIa & IV (total)	
Belgium	196	0	0	45	341	386	131	34
Denmark		0		1258	972	2230	1337	60
France	2412	1183	49		70	70	13	19
Germany	224	0	0	18	367	385	0	0
Ireland	546	617	113				0	
Netherlands	189	0	0	16	258	274	56	20
Spain	210	0	0				0	
Sweden		0			9	9	9	100
UK (total)	1679	2213	132	269	7846	8115	6355	78
Total	5456	4013	74	1500	9643	11 469	7901	69

1TAC applies to VI, Vb(EC), and international waters of XII and XIV.

2 Provisional.

Catches in Division IIIa are not regulated: Table 5.2.4 shows the official landings which came to altogether 476 t in 2010, a figure very similar to last year. The landings by fleet for Denmark (ICES Division IV and IIIa) and Norway (ICES Division IIIa) 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

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 reduc-

tions 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 and 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 and 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 will be held in 2011 and is due to report to ICES in November 2011.

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 Ireland, Denmark, France and Norway in Figure 5.2.4. The adjusted distribution of landings is more indicative of the distribution of fishing effort by trawlers which may not be specifically targeting anglerfish, rather than the underlying distribution of anglerfish (e.g. as observed by the survey in Figure 5.2.8). 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). This and other shortcomings will be addressed at the benchmark exercise due to take place in February 2012.

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 2010 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

Reliable effort data (in terms of hours fished) are not available from the Scottish trawl fleets due to changes in the practices of effort recording and non-mandatory recording of hours fished in recent years. Further details can be found in Section B4 of the Stock Annex and the Report of the 2000 WGNSSK (ICES, 2001). Effort data in terms of days fished 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 have been problems in the scheme in terms of falling participation levels (four vessels in 2008; two vessels in 2009 and 2010): this is unlikely to give a representative picture of the fishery and so updates of these data are not included. After attempting to address the low participation levels by contacting potential participants, MSS has decided to end the project.

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. Trends in lpue have increased in recent years. These trends show some similarity [in direction] to the survey trends (see below) in the case of VIb (Rockall); although the trends are not comparable in the case of VIa, where the surveys indicate a more stable stock.

Denmark

Danish logbook data for anglerfish landings and corresponding effort by main fishery in the North Sea and IIIA for the period 2001–2010 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. There has been a decline in overall (nominal) effort in 2010 compared to the previous two years (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 (1258 t in 2010), 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 the decline in effective effort is probably much less 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. 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 2005–2010 surveys are summarized in Table 5.2.9, with the appropriate error and its propagation. The estimates represent the best available knowledge to date from the six surveys carried out (2005–2010) 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 and 2008;

4) visual counts of anglerfish in areas closed to trawling at Rockall;

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 2010 survey took place in April: the sample locations (n = 168) 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 northwestern North Sea. The highest densities were found on the eastern Rockall plateau. The results of the survey are presented in Table 5.2.9. The total estimate for the Northern Shelf in 2010 was 42 221 t. The 95% confidence limit estimates for this estimate were between 34 629 and 51 466 t. The Relative Standard Errors were 13.1% and 13.3% for abundance and biomass respectively.

Estimates of biomass from the survey in ICES Area IV (21 944 t) were larger than those in Area VI (20 277 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. The difference between the estimates provided here and those provided prior to 2010 can be seen in Figure 5.2.9: the different colours represent the different components in the estimation process. Prior to 2010, estimates of footrope escapes were not available; and because Ireland had participated in the survey, extrapolation into the area southern part of Area VI was not required. Both of these components are now included in the estimation and are highlighted by different colours in the stacked barplots of Figure 5.2.9.

It should also be noted that ageing of anglerfish is still uncertain. The last angler (*Lophius* spp.) otolith exchange took place in 2001 and the last black-bellied angler (*L. budegassa*) otolith exchange took place in 2004. Landa *et al.* (2008), however, noted that previously used ageing criteria are not accurate. There is ongoing research to establish if a new protocol should be established when using illicia to estimate age. Exchanges of otoliths and illicia willl be carried out in 2011, when new ageing criteria are expected (ICES 2010).

The time-series point estimates indicate a decline in numbers over the five year period in all areas except Rockall (Figure 5.2.10), but an increase in biomass to 2008 followed by a sharp decline in 2009 and a subsequent increase in 2010 (Table 5.2.9 and Figure 5.2.10). The estimates of abundance of anglerfish from the surveys from 2005–2009 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 0–3) 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).

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 2005–2010 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 2012, this needs to be based on the 2011 survey which has recently been completed (April 2011). The data from the 2011 survey should be considered along with other ICES survey updates later on in the year.

5.2.1.5 MSY evaluations

In terms of the status of F in relation to F_{msy} there are two major uncertainties. The first is the value of F_{msy}. Previous WG have considered that the fishing mortality corresponding to 35% of the unfished SSB/R could be an approximation of $\mathbf{F}_{MSY}$: this is what F_{pa} was set to ($\mathbf{F}_{35\%SPR} = F_{pa} = 0.30$). Another suitable proxy might be $F_{0.1}$, which like $\mathbf{F}_{35\%SPR}$, would be derived from a yield-per-recruit analysis. However, as yet no assessment is available to determine the fishing mortality [selection] pattern which is required for a Y/R analysis. The second uncertainty is the current level of fishing mortality, where, in the absence of an assessment, this is also unknown. However, if the ageing of anglerfish in the surveys described above is assumed to be accurate and the survey is sampling the population in an unbiased way then a provisional estimate of total mortality (Z) from abundance curves at age would be approximately 0.42. This was estimated (ICES 2009) for the 2004–2001 year classes (ages 6–9 in 2010) as the mean of the four gradients of the abundance (catch) curves for consistent (i.e. $z>0$) segments of the abundance (catch) curves. Given an assumed natural mortality of 0.15 (as used in past assessments) this would imply an F at about 0.27. The average estimate of total mortality for these age classes in 2010 was 0.36. The last time a yield-per-recruit was carried out (ICES 2004), $F_{0.1}$ was estimated at 0.12 and $F_{35\%SPR}$ was 0.12.

F_{pa} for this stock was based on an earlier estimate of $F_{35\%SPR}$ at 0.3. Even with the various uncertainties expressed, it seems likely that this stock is, therefore, being exploited at a fishing mortality close to or in excess of F_{msy}.

5.2.1.6 Biological 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).

5.2.1.7 Management plans

There is no management plan for this stock.

5.2.1.8 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 proven 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 (which account for the majority of landings).

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. How-

ever, participation in this scheme fell significantly in the final year because of data sensitivities associated with the compliance of fishery regulations. The tallybook programme has since been terminated.

Survey data

In addition to obtaining estimates of abundance from swept-area methods (and in future a time-series of data for use in survey based assessments), a visual count method is being 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, in all 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. So far, only three tags have been returned and indicate little movement between release and capture.

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. 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. It is intended that Ireland will participate annually from 2012 onwards.

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 is due to be carried out in 2011. Previous work has shown different age estimates obtained from ilicia and otoliths taken from the same fish. Agreement on a common structure is required.

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 coordinated 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 coordinated, 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 Sub-area 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.

5.2.1.9 Recommendations for the next benchmark

ICES has previously advised a two-stage approach for management of the anglerfish fishery. The first stage was to substantially improve the quality and quantity of data collected in the fishery while maintaining exploitation at its current level. It has stated that this was expected to take at least five years to establish useable time-series. The second stage would then be to use these data to examine alternative management approaches and harvest control rules. The data collection stage of this process is ongoing and an assessment approach is in preparation. WGCSE 2010 considers that significant progress towards assessment has been made for this stock which is still on track for a benchmark meeting in 2012.

The biological data associated with the anglerfish surveys should be evaluated and compared with existing estimates (e.g. maturity-at-age, growth rates, length distributions, sex ratios and species compositions). There are still uncertainties about the validity of age readings of anglerfish: this will be addressed by an age determination exchange. Depending on the outcome of this exchange, the catch-at-age data should then be evaluated for use in any assessment.

Irrespective of any ageing concerns, the survey estimates have underestimated the younger ages. This is despite the recent incorporation of a correction to account for escapes of small fish under the footrope of the survey trawl, which clearly has not accounted for all small fish. Some developments of the latter bias correction are still possible; however, it seems likely that a survey based assessment model could also be developed to determine the absolute abundance of the total population.

A number of recommendations were made at ICES WKAGME for the improvement of the anglerfish surveys. Some of these have been addressed and other will be addressed in the coming year in advance of the Benchmark. These include: improving the survey design in the light of previous estimates of density (allocation of samples to strata); providing estimates for the two species separately so that they may be incorporated separately in any assessment model (for cohort tracking for example); accounting for areas not surveyed in the North Sea using IBTS data; and improving the estimates of footrope escapes.

Finally, it should be stressed that, to date, efforts to extrapolate estimates of abundance into areas that have not been surveyed (southern North Sea and Subarea IIIa) have not proved particularly successful. Additional participation of nations with an interest in this fishery should be encouraged before the next Benchmark. In 2009 only Scotland and Ireland participated in this survey and in 2010 and 2011 only Scotland was able to conduct a survey.

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 2011

No assessment was performed.

ICES advice applicable to 2010 and 2011

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."

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 2010

There has been a significant expansion of the fishery in recent years. This is largely due to a northward expansion of the Norwegian gillnet fishery, which has seen landings double since 2005. The official landings from the areas north of 64° account for approximately 77% of the total figure for Division IIa in 2010, which is 12% higher than in 2009 and 20% higher than 2008.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 5.2.10). The coastal gillnetting accounts for 85–90% of the landings, while 4–6% is taken as bycatch in different offshore gillnet fisheries (Table 5.2.11).

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 20% 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 2010 as reported to ICES for the total Division IIa were 5394 t, which is 21% higher 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 under-report 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 1992–2010, but data are lacking 1997–2001 (Figure 5.2.11). 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 5.2.12). 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 2006–2010, some length data from anglerfish caught as bycatch in other fisheries are presented in Figure 5.2.13.

Surveys

Anglerfish appears in demersal trawl surveys along the Norwegian shelf, but in very small 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 last year 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.

There are limited management controls in this area. Given the rapidly expanding nature of the fishery it would seem sensible to consider what can be done to evaluate the effects of this expansion, to determine an appropriate exploitation regime, and to put effective management measures in place.

5.2.2.5 References

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Table 5.2.1. Anglerfish on the Northern Shelf (IIIa, IV & VI). Total official landings by area (tonnes).

	IIIa	IVa	IVb	IVc	VIa	VIb	Total
1973	140	2085	575	41	9221	127	12189
1974	202	2737	1171	39	3217	435	7801
1975	291	2887	1864	59	3122	76	8299
1976	641	3624	1252	49	3383	72	9021
1977	643	3264	1278	54	3457	78	8774
1978	509	3111	1260	72	3117	103	8172
1979	687	2972	1578	112	2745	29	8123
1980	652	3450	1374	175	2634	200	8485
1981	549	2472	752	132	1387	331	5623
1982	529	2214	654	99	3154	454	7104
1983	506	2465	1540	181	3417	433	8542
1984	568	3874	1803	188	3935	707	11075
1985	578	4569	1798	77	4043	1013	12078
1986	524	5594	1762	47	3090	1326	12343
1987	589	7705	1768	66	3955	1294	15377
1988	347	7737	2061	95	6003	1730	17973
1989	334	7868	2121	86	5729	313	16451
1990	570	8387	2177	34	5615	822	17605
1991	595	9235	2522	26	5061	923	18362
1992	938	10209	3053	39	5479	1089	20807
1993	843	12309	3144	66	5553	681	22596
1994	811	14505	3445	210	5273	777	25021
1995	823	17891	2627	402	6354	830	28927
1996	702	25176	1847	304	6408	602	35039
1997	776	23425	2172	160	5330	899	32762
1998	626	16857	2088	78	4506	900	25055
1999	660	13326	1517	24	4284	1401	21212
2000	602	12338	1617	31	3311	1074	18973
2001	621	12861	1832	21	2660	1309	19304
2002	667	11048	1244	21	2280	718	15978
2003	478	8523	847	20	2493	643	13004
2004	519	8987	851	15	2453	671	13496
2005	458	8424	688	5	3019	958	13552
2006	423	10338	685	3	2785	916	15150
2007	433	10632	749	4	3352	1260	16430
2008	486	11038	769	5	3373	1630	17300
2009	479	10096	658	8	3029	2119	16389
2010	476	6855	598	11	2696	1342	11978
Min	140	2214	575	3	1387	29	5623
Max	938	25176	3445	402	9221	2119	35039
Average	560	8713	1572	81	3972	797	15694

Table 5.2.2. Anglerfish in Subarea VI. Nominal landings (t) as officially reported to ICES.

Anglerfish in 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*
Belgium	3	2	9	6	5	-	5	2	-	-	+	+	-	+	-	-	-	-	-	
Denmark	1	3	4	5	10	4	1	2	1	+	+	.	+	+	-	-	-	-	-	
Faroe Is.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	3	2	1	2	4
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
Germany	1	2	60	67	77	35	72	137	50	39	11	3	27	39	39	1	-	54	79	-
Ireland	250	403	428	303	720	717	625	749	617	515	475	304	322	219	356	392	470	295	328	510
Netherlands	-	-	-	-	-	-	27	1	-	-	-	-	-	-	-	-	-	-	-	
Norway	6	14	8	6	4	4	1	3	1	3	2	1	+	+	1	1	1	2	-	1
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	-	-
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	-	-
UK (total)																			876	1,021
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	2,696
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.

Anglerfish in Division VIb (Rockall).

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010*
Estonia	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-		
Faroe Is.	-	2	-	-	-	15	4	2	2	-	1	-	-	-	-	-	-	1	4	8
France	-	-	29	-	-	-	1	1	…[1]	48	192	43	191	175	293	224	327	327	637	23
Germany	-	-	103	73	83	78	177	132	144	119	67	35	64	66	77	72	222	0	132	
Ireland	272	417	96	135	133	90	139	130	75	81	134	51	26	13	35	53	70	76	91	107
Norway	18	10	17	24	14	11	4	6	5	11	5	3	6	5	4	6	7	5	9	12
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	-	
UK(Scot)	201	224	182	281	199	68	156	189	344	374	367	317	160	294	355	478	475	1096	-	
UK (total)																			1189	1192
Total	923	1089	681	777	830	602	899	900	1401	1074	1309	718	643	671	958	916	1260	1630	2119	1342
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						

Total Anglerfish in Sub-area VI (West of Scotland and Rockall).

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010*
Total official	5,984	6,568	6,234	6,050	7,184	7,010	6,229	5,406	5,685	4,385	3,969	2,998	3,136	3,124	3,977	3,701	4,612	5,003	5,148	4,038
Total ICES	6,280	9,206	10,050	8,816	12,296	18,158	13,735	10,640	9,475	7,516	5,859	4,833	4,266	5,183						

***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*
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	1,143
Faroes	1	-	10	18	20	-	15	10	6	.	2	+	3	11	22	2	+	-	4	
France	124	151	69	28	18	7	7	3*	18[1*]	8	9	8	8	8	4	7	13	13	48	6
Germany	71	68	100	84	613	292	601	873	454	182	95	95	65	20	84	173	186	344	216	
Netherlands	23	44	78	38	13	25	12	-	15	12	3	8	9	38	13	14	14	12	5	8
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
Sweden	14	7	7	7	2	1	2	8	8	78	44	56	8	6	5	5	20	67	…	4
UK(E, W&NI)	129	143	160	169	176	439	2,174	668	781	218	183	98	104	83	34	99	303	13		
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		
UK (total)																			7,830	6101
Total	9,235	10,209	12,309	14,505	17,891	25,176	23,425	16,857	13,326	12,338	12,861	11,048	8,523	8,987	8,424	10,338	10,632	11,038	10,096	7,997

*** 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*
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
Faroes	-	-	2	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	
France	-	1	-	2	-	-	-	-*	…2*	-	-	-	-	+ -	-	-	-		9	6
Germany	4	2	13	15	10	9	18	19	9	14	9	17	11	11	9	14	12	22	17	-
Ireland													1	-	-	-	-	-	-	
Netherlands	285	356	467	510	335	159	237	223	141	141	123	62	42	25	31	33	61	58	36	46
Norway	17	4	3	11	15	29	6	13	17	9	15	10	12	22	16	14	24	15	21	10
Sweden	-	-	-	3	2	1	3	3	4	3	2	9	2	1	4	4	6	9	-	5
UK(E, W&NI)	669	998	1,285	1,277	919	662	664	603	364	423	475	236	167	120	96	108	122	105		
UK (Scotland)	845	733	469	564	472	475	574	424	344	318	378	210	241	138	88	98	172	142		
UK (total)																			193	213
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	658	598

*** 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*
Belgium	13	12	34	37	26	28	17	17	11	15	15	16	9	5	4	3	3	4	6	7
Denmark	2	+	-	+	+	+	+	+	+	+	+	+	+	+	+	-	-		-	-
France	-	-	-	-	-	-	-	10	-	+	-	+	-	-	-	-	-	+	-	1
Germany	-	-	-	-	-	-	-	-	-	+	-	+	+	-	-	-	-	-	-	-
Netherlands	5	10	14	20	15	17	11	15	10	15	6	5	1	-	1	-	1	1	-	2
Norway	-	-	-	-	+	-	-	-	+	-	+	-	-	-	-	-	-	-	1	-
UK(E&W&NI)	6	17	18	136	361	256	131	36	3	1	-	-	10	3	-	-	- …	-		-
UK (Scotland)	-	-	-	17	-	3	1	+	+	+	-	-	-	7	-	-	- …	-		-
UK (Total)																		+	1	1
Total	26	39	66	210	402	304	160	78	24	31	21	21	20	15	5	3	4	5	8	11

*** Preliminary.**

Total North Sea.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010*
Total	11,783	13,301	15,519	18,162	20,920	27,327	25,757	19,023	14,867	13,986	14,714	12,313	9,390	9,853	9,117	11,026	11,385	11,812	10,762	7,464
WG estimate	10,566	11,728	13,078	15,432	15,794	16,240	18,217	14,027	11,719	11,564	12,677	10,334	8,273	9,027						
Unallocated	-1,217	-1,573	-2,441	-2,730	-5,126	-11,087	-7,540	-4,996	-3,148	-2,422	-2,037	-1,979	-1,117	-826						

*** Preliminary.**

Table 5.2.4. Nominal landings (t) of Anglerfish in Division IIIa, 1991–2010, 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*
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
Germany	-	-	1	-	-	1	1	1	2	1	-	1	-	1	1	2	1	1	1	-
Netherlands						-	-	-	-	-	.		3	4	4	3	1	3	-	5
Norway	64	170	154	263	440	309	186	177	260	197	200	242	189	130	100	137	132	144	134	158
Sweden	23	62	89	68	36	25	39	33	36	27	46	55	71	73	79	54	44	51	…	43
Total	595	938	843	811	823	702	776	626	660	602	621	667	478	519	458	423	433	486	479	476

***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	56 863	1 408 312	9029	599 053	655	114	11.52	0.47	12.63	0.019
1996	60 960	1 388 902	7219	469 212	624	74	10.24	0.45	10.25	0.022
1997	63 159	1 462 368	7169	377 836	587	93	9.29	0.40	12.97	0.025
1998	57 398	1 343 782	7337	403 310	558	99	9.72	0.42	13.49	0.024
1999	54 075	1 348 480	8680	437 920	449	64	8.30	0.33	7.37	0.019
2000	52 847	1 325 585	9883	613 229	410	62	7.76	0.31	6.27	0.013
2001	47 224	1 320 179	7232	593 467	315	93	6.67	0.24	12.86	0.011
2002	35 016	1 007 965	2626	217 918	276	41	7.88	0.27	15.61	0.036
2003	39 211	1 536 279	4543	478 464	314	26	8.01	0.20	5.72	0.017
2004	35 217	1 279 049	2234	205 349	210	13	5.96	0.16	5.82	0.029
2005	30 748	1 075 974	3844	216 991	351	35	11.42	0.33	9.11	0.053
2006	28 014	1 031 169	5903	464 965	386	53	13.78	0.37	8.98	0.030
2007	25 373	911 973	6589	548 392	467	69	18.41	0.51	10.47	0.034
2008	17 327	630 615	9740	n/a	295	78	17.03	0.47	8.01	n/a
2009	17 108	567 289	4354		332	91	19		20.90	
2010	24 870	825 760	3280		210	107	21		32.53	

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).

	North Sea						NS	IIIA						IIIA	
Year	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**	**Grand Total**
1992	80	815	261	350	125	63	1694	22	259	32	139	162	37	650	2344
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	347	128	256	79	169	1036	82	97	1	62	48	21	312	1348
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		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	343	1725
2010	12	1242	0	45	34	4	1337	3	66	0	175	18	9	270	1607

Tables 5.2.7. Total Danish Anglerfish landings (tonnes) and effort (days fishing) by fishery. Effort by fishery (from logbook data).

	North Sea							IIIA							
Year	Beam_trawl	Demersal_trawl	Industrial_trawl	Lobster_trawl	Other_gear	Shrimp_trawl	**NS total**	Beam_trawl	Demersal_trawl	Industrial_trawl	Lobster_trawl	Other_gear	Shrimp_trawl	**IIIA total**	**Grand** Total
1992	575	5105	3498	1784	1319	1434	13714	206	2632	256	2547	1097	1145	7885	21599
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	363	1898	1913	2274	957	2548	9954	617	1586	23	1288	391	594	4499	14453
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	4159	9136
2009	175	3936	11	362	338	136	4959	45	815	15	3009	177	578	4640	9599
2010	116	3468	0	255	428	126	4393	24	649	1	2772	198	374	4018	8411

Table 5.2.8. Anglerfish in IV and IIIa. Norwegian landings (tonnes) by fishery in 2005–2009 and preliminary data from 2010.

Fleet	2005 Div IIIa	2005 Div IVa	2006 Div IIIa	2006 Div IVa	2007 Div IIIa	2007 Div Iva	2008 Div IIIa	2008 Div IVa	2009 Div IIIa	2009 Div Iva	2010 Div IIIa	2010 Div Iva
Coastal gillnetting	61	526	103	696	87	574	97	554	90	481	111	443
Offshore gillnetting	1	16	+	19	+	32	+	24	+	21	+	34
Coastal shrimp trawling	22	50	25	46	26	36	27	35	30	29	31	22
Offshore dem trawling	5	102	+	142	8	154	12	206	6	265	5	179
Offshore shrimp trawling	3	68	5	66	8	39	7	32	6	40	5	40
Other gears	7	119	3	36	3	24	+	24	2	23	6	17
Total	100	880	137	1005	132	860	144	875	134	859	158	735

Table 5.2.9. Abundance (millions of individuals) and biomass (thousands of tonnes) estimates from the 2005–2010 Northern shelf anglerfish surveys by ICES area and division.

Abundance (millions)						
ICES Subarea / Division	2005	2006	2007	2008	2009	2010
Subarea IV (partial)	14.201	13.603	15.608	12.582	8.287	7.366
Division VIa	12.201	10.985	8.859	7.719	5.15	5.161
Division VIb	2.049	3.174	4.142	3.924	3.536	3.118
Subarea VI	14.249	14.159	13.000	11.643	8.686	8.279
Northern Shelf (partial)	28.451	27.762	28.608	24.225	16.973	15.645

Biomass (thousand tonnes)						
	2005	2006	2007	2008	2009	2010
Subarea IV (partial)	19.059	21.998	28.572	29.671	17.058	21.944
Division VIa	14.266	12.222	11.157	14.381	6.232	11.59
Division VIb	5.948	6.676	10.526	9.311	12.461	8.687
Subarea VI	20.214	18.898	21.683	23.692	18.693	20.277
Northern Shelf (partial)	39.273	40.896	50.256	53.363	35.751	42.221

Table 5.2.10. Nominal catch (t) of Anglerfish in Division IIa, 1994–2009, as officially reported to ICES and preliminary data for 2010.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010*
Denmark	+	+	+	+	+	+	2	+	-	1	-	-	-	-	+	
Faroes	+	+	+	+	+	-	1	1	2	5	11	4	7	4	2	
France	-	-	-	-	+	-	-	-	-	-	-	1			2	
Germany	1	4	20	53	4	17	65	59	55	70	55	-		-		
Norway	526	893	576	1488	1731	2952	3552	2000	2404	2906	2649	4253	4455	3999	4289	5351
Russia	-	-	-	-	-	-	-	-	-	-	1	-	-	-		
Sweden	-	+	+	+	+	+	+	-	-	-	-	-	-	-		
UK (total)	74	15	5	7	6	30	2	10	15	18	19	86	115	138	152	40
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	2	6	3
Total	601	912	601	1548	1741	2999	3622	2070	2476	2999	2672	4341	4577	4143	4451	5394

***Preliminary.**

Table 5.2.11. Anglerfish in IIa. Norwegian landings (tonnes) by fishery in 2005-2009 and preliminary data for 2010.

Fleet	2005	2006	2007	2008	2009	2010
Coastal gillnetting	2301	3723	4039	3574	3934	4791
Offshore gillnetting	115	261	204	240	171	391
Offshore dem trawling	77	71	52	26	27	25
Coastal Danish seine	54	54	63	75	68	40
Other gears	102	144	98	84	89	104
Total	2649	4253	4456	3999	4289	5351

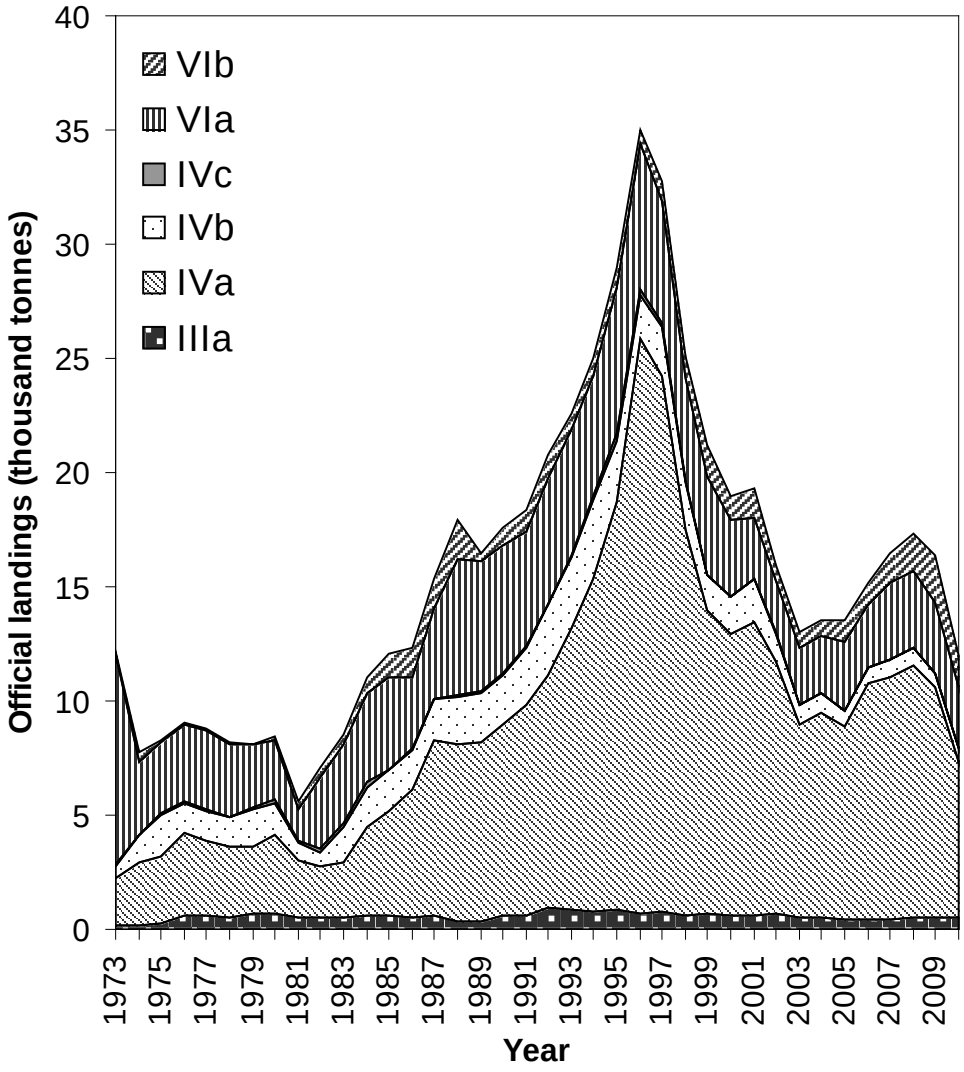


Figure 5.2.1. Northern Shelf anglerfish. Officially reported landings by ICES area.

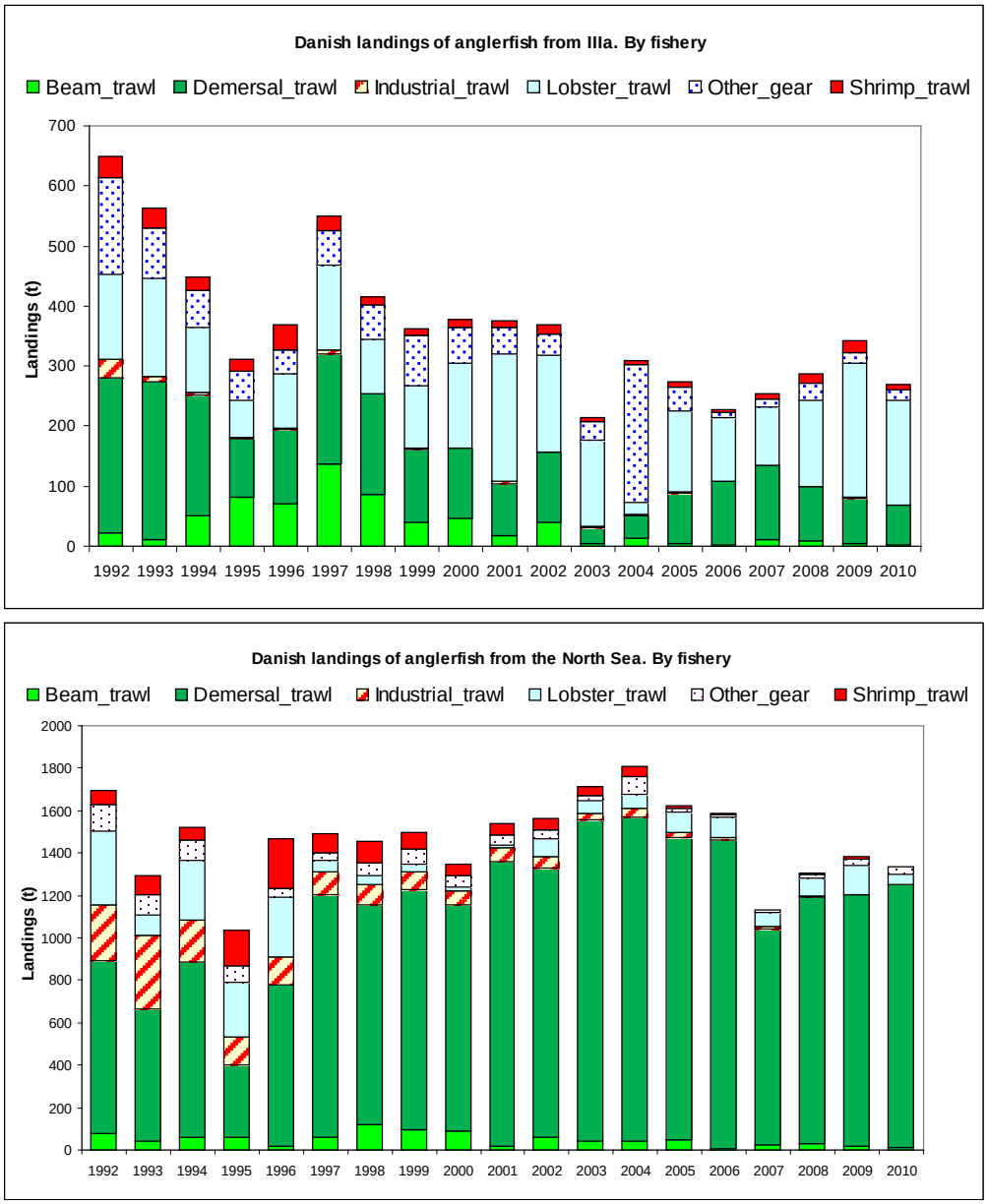


Figure 5.2.2. Danish landings of Anglerfish by fishery in the North Sea (top) and Division IIIa (bottom) 1992–2010.

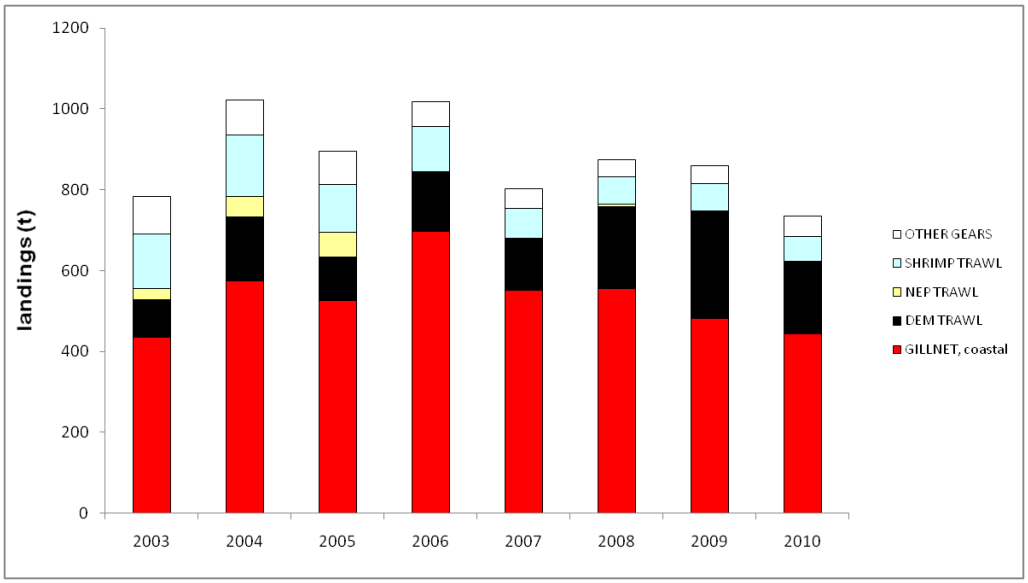


Figure 5.2.3. Anglerfish in Division IVa. Norwegian landings by fleet from 2003–2010.

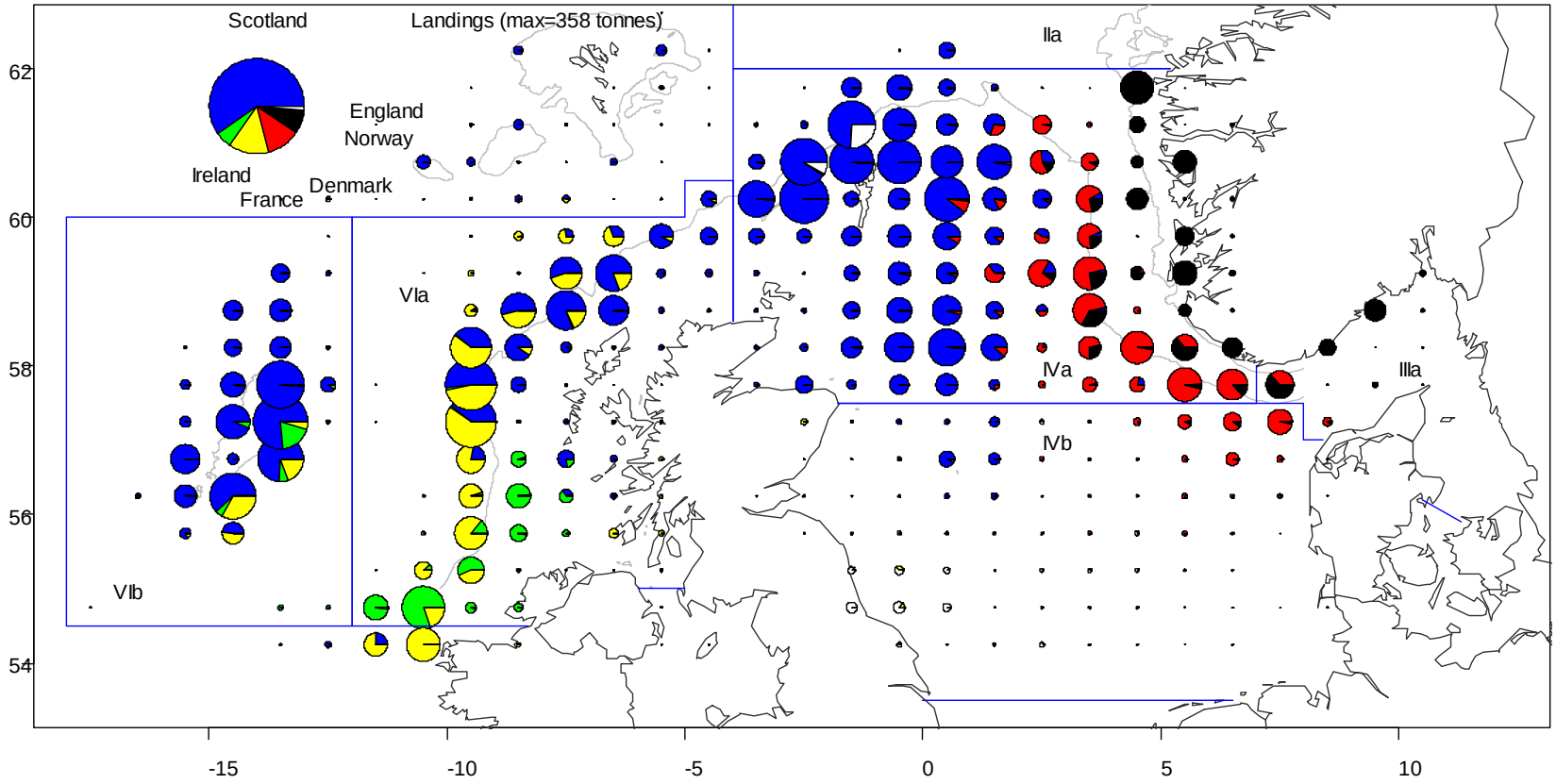


Figure 5.2.4. Map of the European Northern Shelf showing the distribution of reported landings of anglerfish for 2010 from Scotland, Ireland, France, Denmark, Norway, and England. The circles are centred on each ICES rectangle and segmented according to the landings of each country according to the legend. 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).

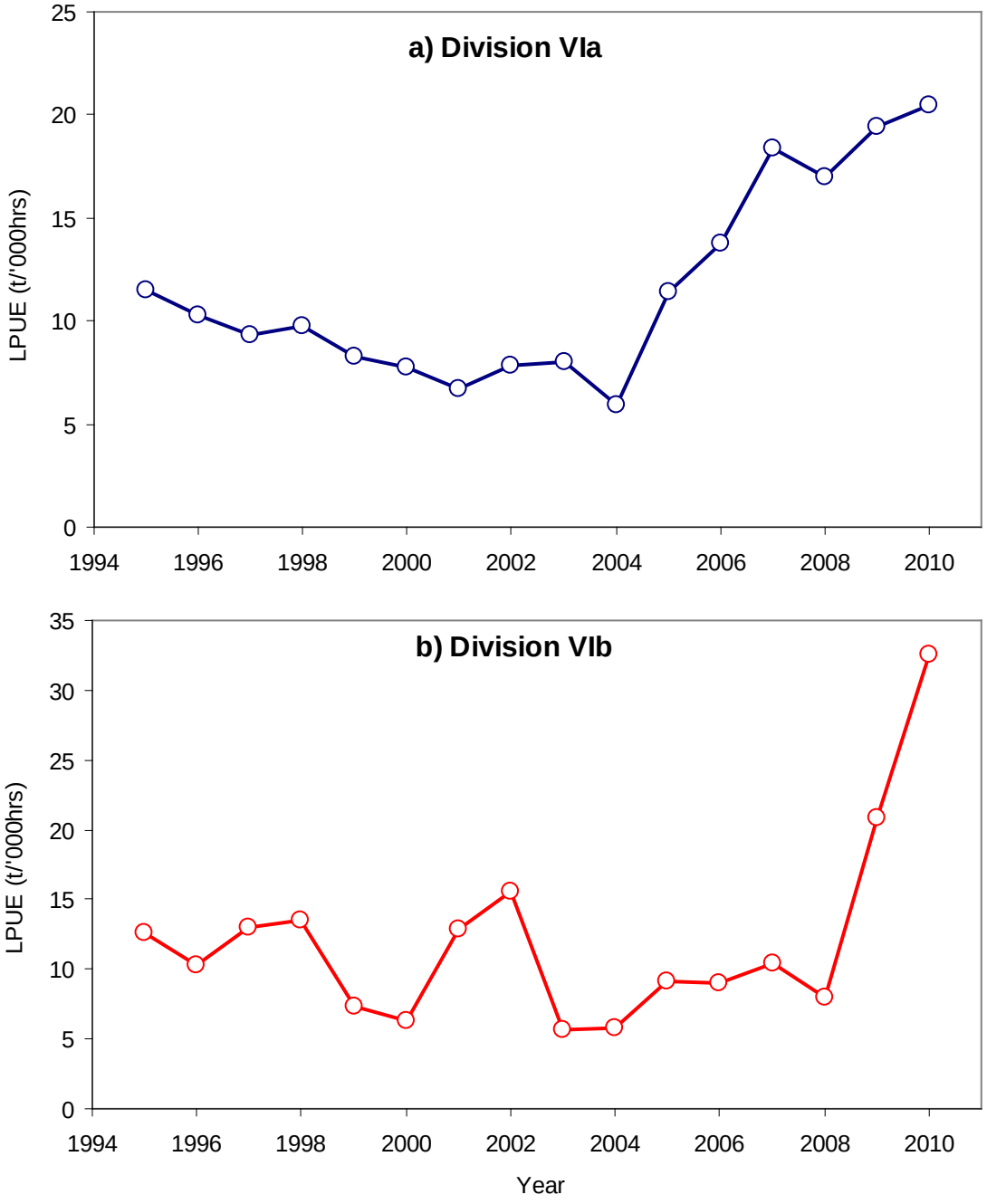


Figure 5.2.5. Lpue for the Irish otter trawl fleet with effort in hours fished for a) Division VIa, and b) Division VIb.

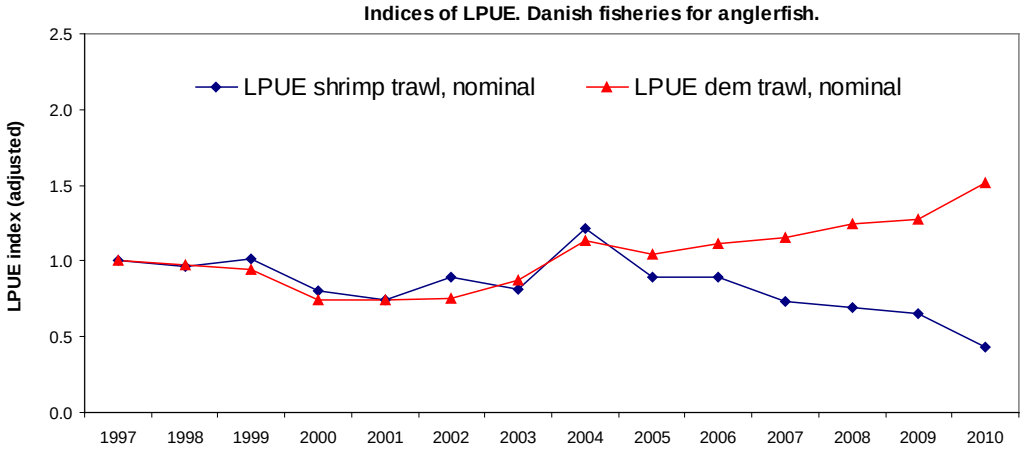


Figure 5.2.6. Anglerfish in the North Sea & Division IIIa. Danish lpue by demersal trawl and shrimp trawl, relative to 1997. Based on nominal logbook records.

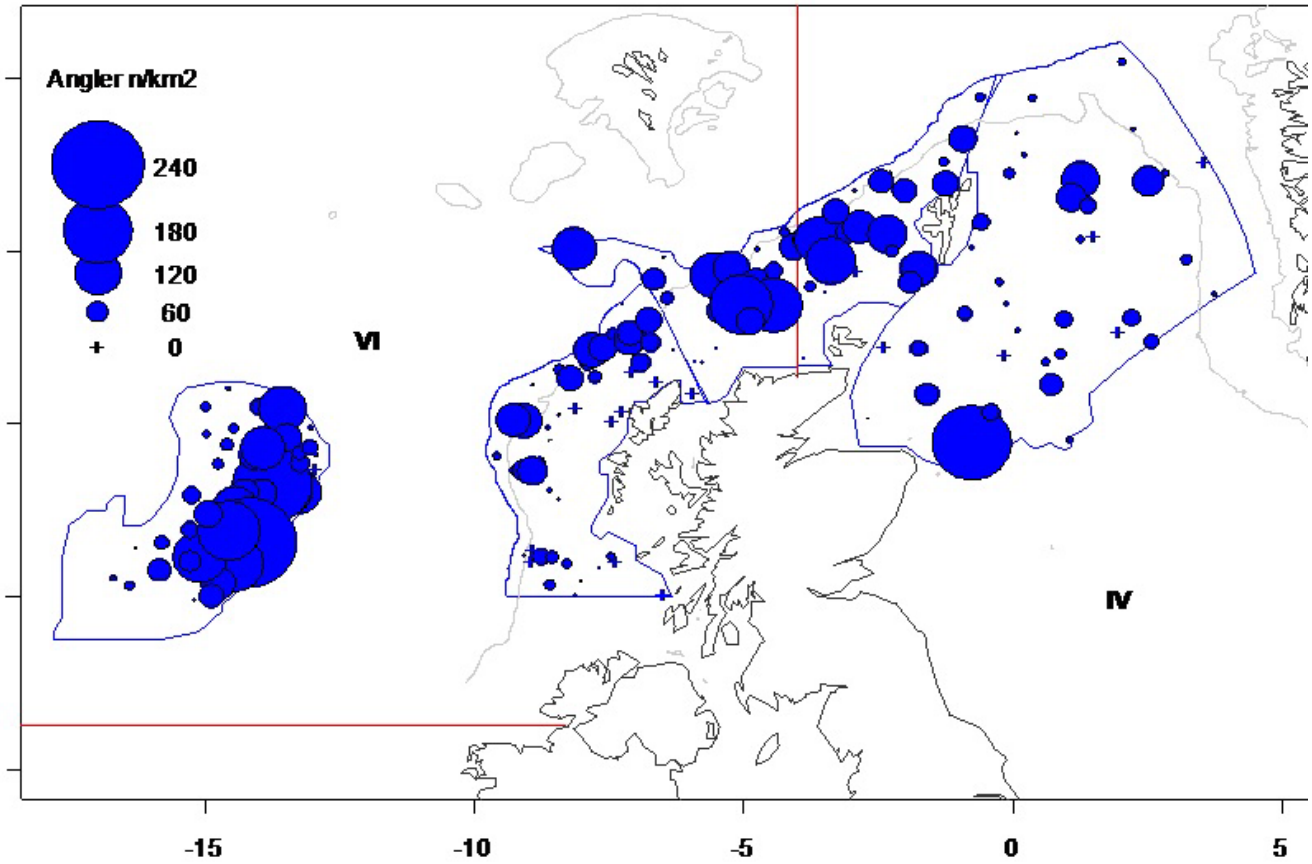


Figure 5.2.7. Map of the northern continental shelf around Scotland showing the number density of anglerfish during the 2010 surveys. Each circle is centred on the sample location and circle size is proportional to the number density in n/km² according to the legend (top left). Trawl densities in this figure account for herding but not footrope escapes. The red lines separate the ICES subareas indicated by roman numerals: IV (east) and VI (west).

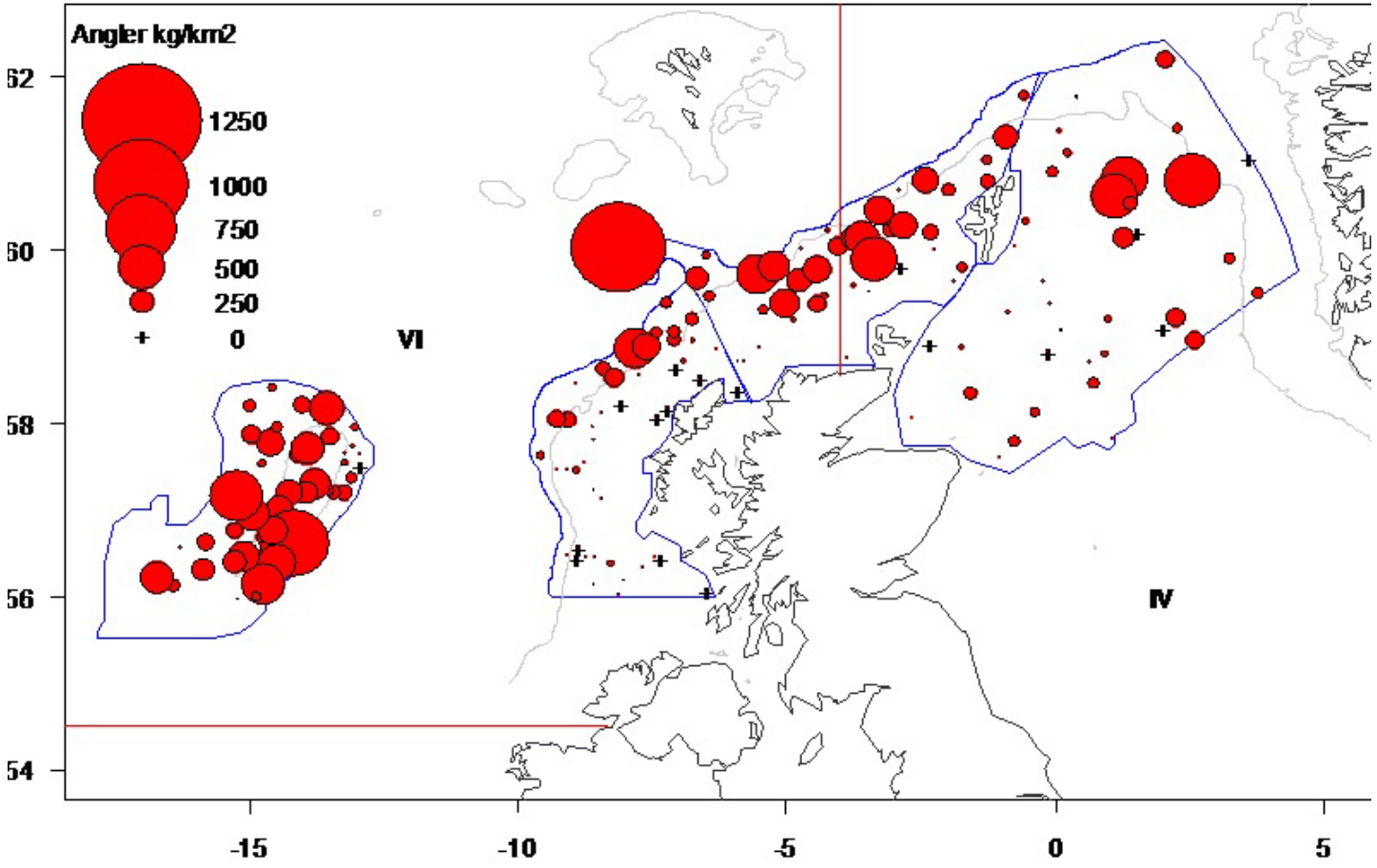


Figure 5.2.8. Map of the northern continental shelf around Scotland showing the weight density of anglerfish during the 2010 anglerfish survey. Each circle is centred on the sample location and circle size is proportional to weight density in kg/km² according to the legend. Trawl densities in this figure account for herding but not footrope escapes. The red lines separate the ICES subareas indicated by roman numerals: IV (east) and VI (west).

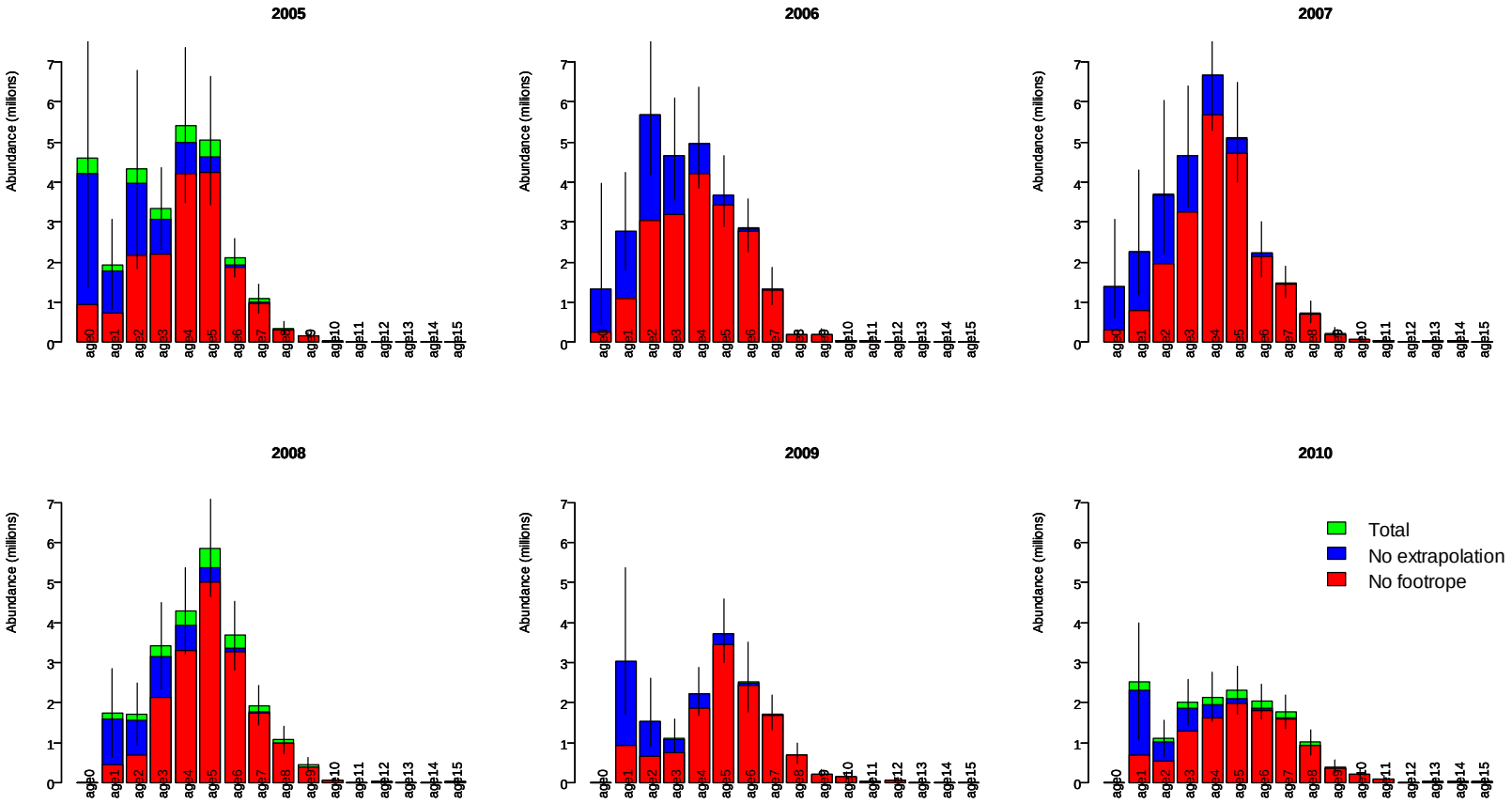


Figure 5.2.9. Estimates of total abundance-at-age for each of the anglerfish surveys 2005–2010. Red bars indicate estimates prior to correction for footrope escapes; blues bars include the latter correction; green bars indicate an additional correction for the unsurveyed part of ICES Division VIa based on data when the area was surveyed by the Irish. Error bars are 95% confidence intervals.

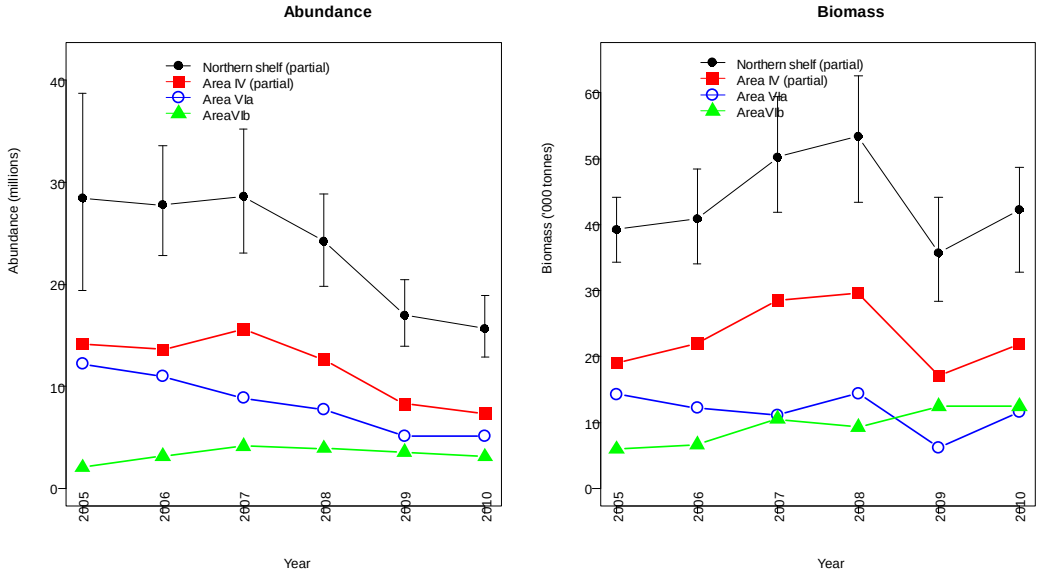


Figure 5.2.10. Estimates of total abundance (left) and biomass (right) of anglerfish for the Northern shelf (black filled circles), with confidence intervals derived from variance estimates of the Scottish surveys. Estimates are also provided for ICES Subarea IV (red filled squares), Division VIa (blue open circles) and Division VIb (green filled triangles). Confidence limits for 2005 biomass are provisional.

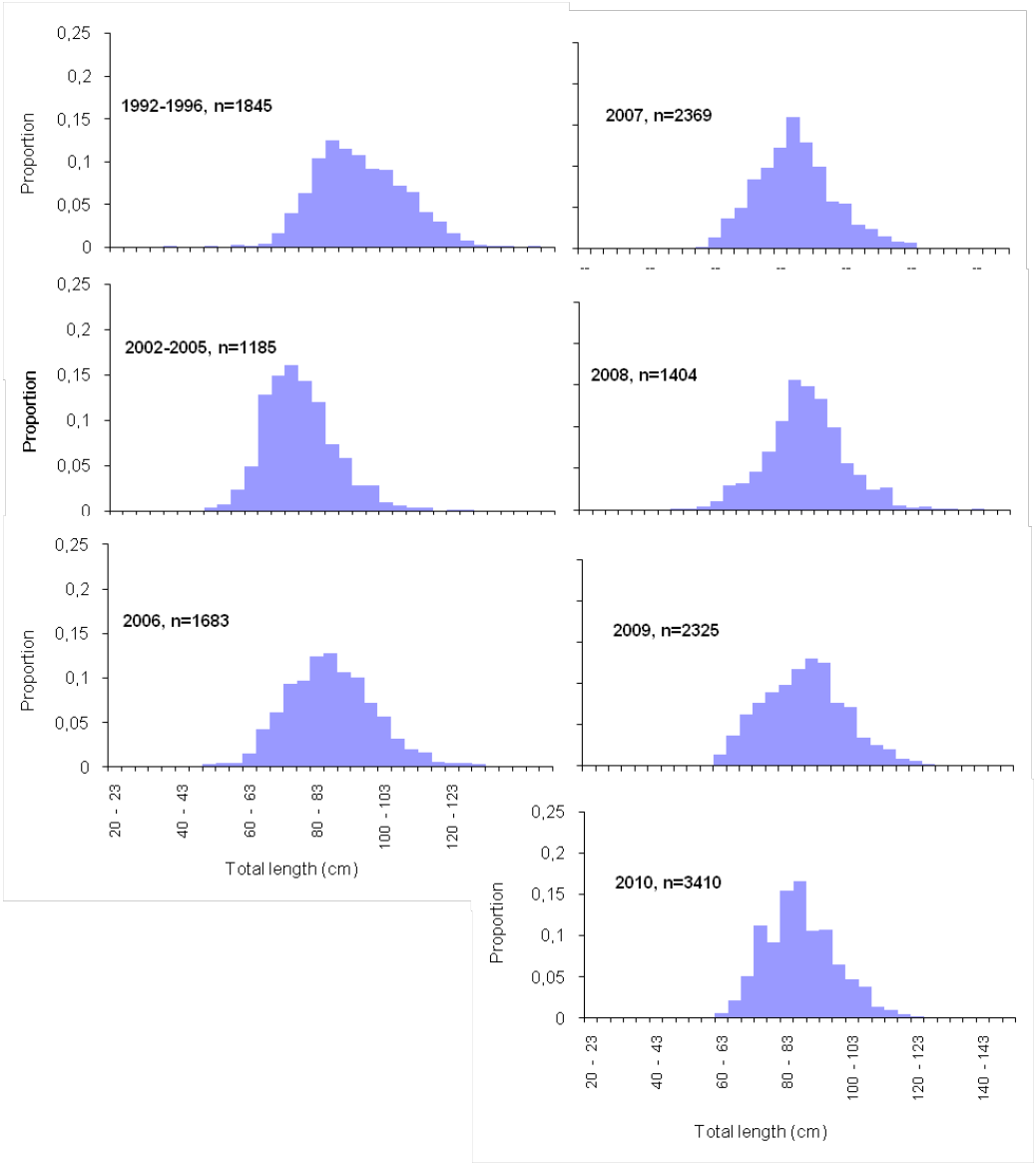


Figure 5.2.11. Anglerfish in IIa. Length distributions for anglerfish caught in the directed coastal gillnetting in Division IIa during 1992–2010. Note that data are lacking for 1997–2001.

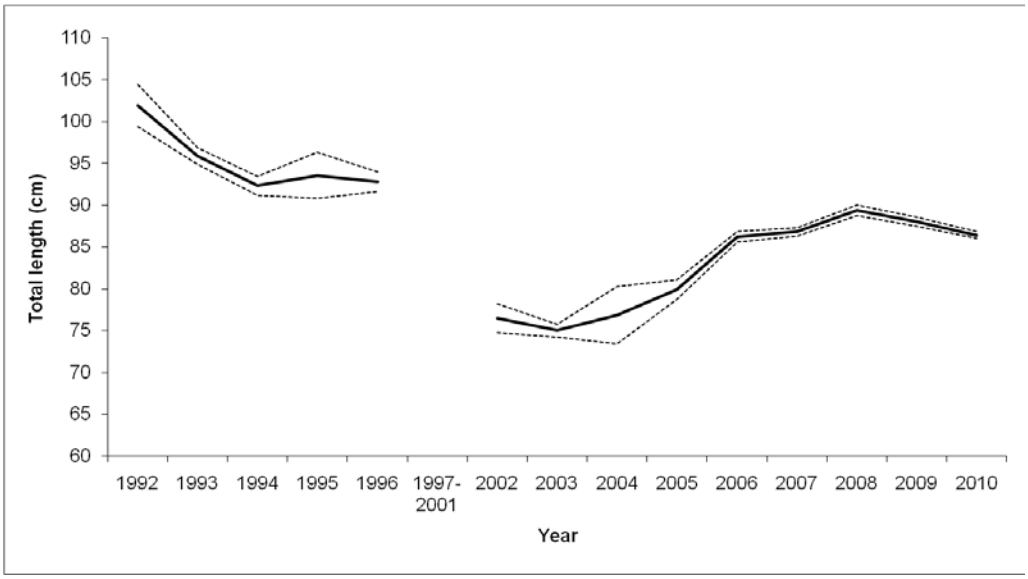


Figure 5.2.12. Anglerfish in IIa. Mean lengths for anglerfish caught in the directed coastal gillnetting in Division IIa during 1992–2010, dotted lines represents ±2SE of the mean. Note that data are lacking for 1997–2001.

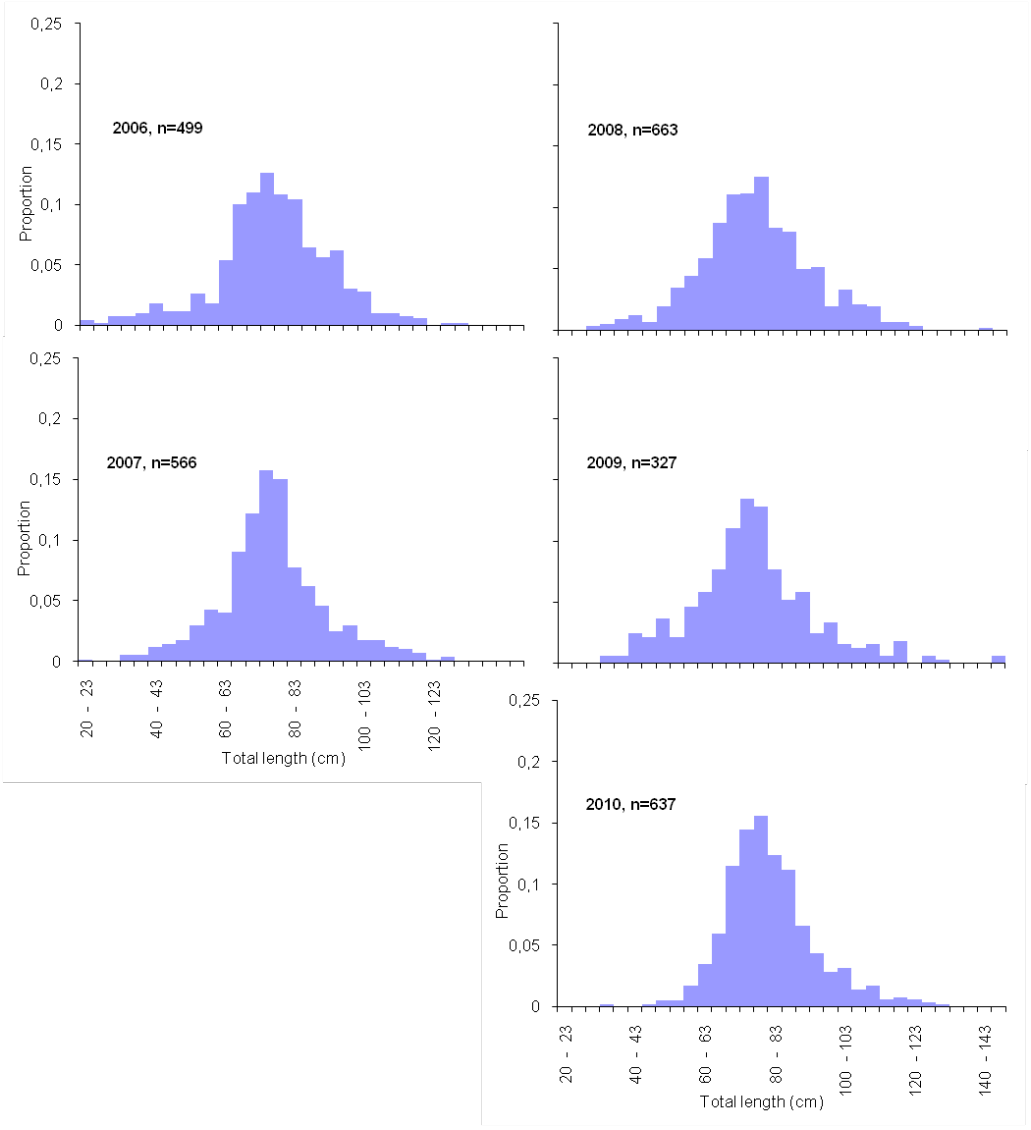


Figure 5.2.13. Anglerfish in IIa. Length distribution for anglerfish caught as bycatch by other gears (offshore gillnetting and longlining) in Division IIa in 2005–2010.

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 2011

ICES has not conducted an analytical assessment of this stock since 1999. Megrim continues to be a monitored stock. The stock was benchmarked in 2011 (WKFLAT, 2011) and an exploration of landings numbers-at-age for VIa only was undertaken. However, due to relatively low age sampling in recent years (post 2002), resulting in poor cohort tracking and the absence of a time-series of age data from IVa (pre 2006) all preclude 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.

As an alternative to an age based approach, biomass dynamic (surplus production) models were explored during WKFLAT (2011). Two non-equilibrium surplus production models (ASPIC, NOAA toolbox) and a Bayesian state space surplus production model (Meyer and Millar, 1999). The latter approach is currently being developed and model outputs from the initial explanatory runs are presented in working document WD07. The exploratory analysis, using fishery-independent survey data from the International Bottom-trawl Survey (1985–2010), indicates a substantial decline in mortality since 2000 with increases in biomass. It should be noted however, that the initial estimates of intrinsic rate of growth appear high compared with other flatfish species and this is largely driven by the recent large increases in survey indices. At this stage, the approach is presented as relative changes in mortality and biomass over time and not in terms of absolute levels.

ICES advice applicable to 2010

ICES advises on the basis of exploitation boundaries in relation to precautionary considerations that the effort in fisheries that catch megrim should not be allowed to increase.

ICES advice applicable to 2011

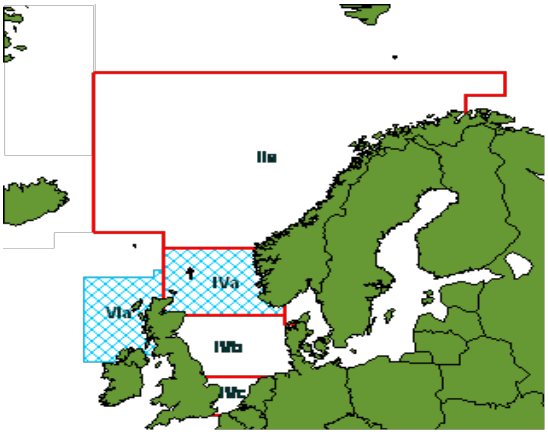
ICES advises that effort should be consistent with no increase in catches.

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		
EU	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/561214)
Spain	385		
France	1 501		
Ireland	439		
United Kingdom	1 062		
EU	3 387		
TAC	3 387		Analytical TAC

Fishery in 2010

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 declines seen in the Scottish TR1 fleets (120 mm mesh) appears to have stabilized at levels well below the earlier part of the time-series. Note that 2010 data are only available for the Irish fleets. 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.

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 used. It should be noted that no landings data were made available to the Working Group by Spain therefore the uptake during 2010 will be higher, while historically, France only utilizes ~10% of its available quota, although this has increased to 20% in 2010, Historically, Spanish uptake has been ~80%.

2010 TAC for VI, EC waters of Vb and international waters of XII and XIV.

	TAC	WG Landings	% TAC uptake[1]
Spain	350	Nr*	
France	1364	270	20%
Ireland	399	364	91%
United Kingdom	966	917	95%
EC Total	3079	1551	50%

***nr – not reported to the Working Group.**

[1] post regulation quota swaps have not been taken into account.

[2] Provisional figures.

The uptake of the TAC for ICES Division IV and IIa was 82%.

2010 TAC for EC IV and IIa.

	TAC	WG landings	% TAC uptake[1]
Belgium	5	0	0%
Denmark	5	22	440%
Germany	5	0	0%
France	29	5	17%
Netherlands	23	1	4%
UK	1690	1439	85%
EC	1757	1439	82%

[1] post regulation quota swaps have not been taken into account.

5.3.1.2 Data

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

As part of the 2011 benchmark for this stock, landings-at-age data from 1990 to 2010 have been compiled based on data from the UK and Ireland for VIa (with the exception of UK data from 2005). The earlier component of the time-series (pre 2000) aggregated landings-at-age across VIa and VIb using a combined ALK. For IVa, raised landings numbers-at-age have been complied for the period 2006–2009, but no data prior to 2006 was made available to WKFLAT (2011).

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. 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 Scotland in 2010 and by Scotland for Division IVa. Landings have increased in recent years and are more in line with historical trends.

Catches of megrim comprise two species, *Lepidorhombus whiffiagonis* and *L. boscii*. Information available to the Working Group indicates that *L. boscii*, are a negligible proportion of the Scottish and Irish megrim catch (Kunzlik *et al*., 1995; Anon, 2001). 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 has not been adjusted. However, the decision to consider megrim in VIa and IVa as single unit stock negates this problem. However, it is unknown whether misreporting from Division VIb is an issue.

Discards

Discard data were made available by Scotland (VIa and IVa) and Ireland (VIa). Scottish data give a discard rate (by weight) of 23% and 26% for IVa and VIa respectively. Irish discards were considerably lower, with 2% discarded by number and 1% by weight. The contrast is probably due to the low usage of TR2 by Ireland in VIa. 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 highgrading of catches on length/quality reasons to maximize the value of a restrictive quota. Other studies (BIM, unpublished data) show that highgrading of damaged fish is in the range of 10 to 15% of the marketable megrim catch.

Surveys

In 2005, Scotland initiated a new industry–science partnership survey to provide an absolute abundance estimate for anglerfish (see Section 5.2). Five surveys have been carried out to date 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, six years of data are available (2005–2010). The data from the 2011 survey (SCO-IV-VI-AMISS-Q2; IRE-IV-VI-AMISS-Q2) are not yet available, but the time-series will be updated as soon as this becomes available (summer 2011). The area stratified survey provides a minimum estimate of absolute abundance as the survey catches are raised based on swept-area raised and weighted by area. The survey assumes that all megrim in the trawl path are retained as there are no catchability estimates for this species. Assuming full retention is overly optimistic therefore providing a minimum estimate of stock biomass.

For the six years of survey data available, the sample locations and the density of megrim are illustrated in Figure 5.3.4 as numbers (number per square kilometre) and in Figure 5.3.5, 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

VIa and IVa are considered as a unit stock and VIb as a separate stock. A combined index for IVa and VIa is presented in Figure 5.3.6.

The results of the survey are presented in Table 5.3.3. Abundance and biomass in VIa/VIa and from 2005 to 2010 have increased considerably.

Using the ratio of the average abundance estimate from the first two years of the time-series with the last two years in line with the method proposed by the EC for setting TACs for category six stocks, gives an increase in relative biomass of 31% for VIb with zero change in biomass in VIa/IVa (Table 5.3.4).

Exploratory analysis to estimate B_{msy} and U_{msy} using a state–space biomass dynamic model is currently being undertaken. This model uses all available survey cpue time-series from the IBTS data from VIa, IVa (Figure 5.3.7). Exploratory runs from this approach indicate that the relative change in biomass in recent years has been stable with the medium estimate increasing in recent years and the relative exploitation rate suggests a downward trend. Converting the exploitation rate to fishing mortality through C/TB=U=F/(F+M)*(1-exp(-(F+M))), where C is catch and TB is total biomass and M is assumed to be 0.15, it is possible to estimate F. The historic trends in total biomass and F are shown in Figure 5.3.8. Attention is drawn to the large credible intervals (Figure 5.3.7) highlighting a high degree of uncertainty in the estimates, although since the introduction of the monkfish survey data (post 2005), the credible intervals have contracted. Additionally, the initial runs estimate a high intrinsic rate of growth (*r)*, and it is considered that these may be too optimistic to be used as the basis for deifying a MSY exploitation rate ($U_{msy} = 2/r$). Until further analysis is undertaken, the absolute estimates of F and total biomass should not be overly interpreted and used as an indication of relative trends only.

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 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 5.3.9 (IVa/VIa). Between 2005 and 2010, both the commercial lpues and the survey cpues trends are reasonable 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.

Logarithmic lpues for two Scottish commercial fleets (SCO TR1 and SCO TR2) in Area IV from 2003 to 2009 are given in Figure 5.3.9. The trends between the two commercial lpue indices are consistent and show a positive trend during the past few years. Care should be taken in interpreting the commercial lpue's given possible shifts in targeting behaviour.

5.3.1.3 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.

5.3.1.4 Short-term projections

There is no accepted analytical assessment for this stock.

5.3.1.5 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 in the fishery.

5.3.1.6 Uncertainties and bias in assessment and forecast

There is no accepted analytical assessment for this stock.

5.3.1.7 Recommendation for next benchmark

This stock was recently subject to benchmark. Due to incomplete age data, particularly for IVa, it was not possible to undertake any exploratory age based assessments. Until a complete landings-at-age matrix is compiled this stock should not be considered for benchmark. Intersessional work on a Bayesian state–space surplus production model is continuing.

5.3.1.8 Management considerations

The TAC in VI has not been fully utilized. 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 in IV has been fully utilized and the data from the anglerfish survey indicate a decrease in biomass in the last year of the time-series, although confidence bands are large. The TAC and assessment area are incompatible.

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.

Meyer and Millar, 1999. BUGS in Bayesian stock assessments. Canadian Journal of Fisheries and Aquatic Sciences; Jun 1999; 56, 6; Canadian Periodicals pg. 1078

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, due to 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 2010

ICES advises on the basis of exploitation boundaries in relation to precautionary considerations that the effort in fisheries that catch megrim should not be allowed to increase.

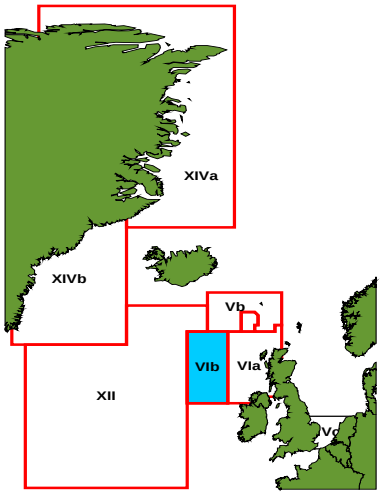
ICES advice applicable to 2011

ICES advises that effort should be consistent with no increase in catches.

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 2010

Following the increases in Irish effort in subdivision VIb from 2004–2008, effort in 2009 (the last available year) has declined significantly (Figure 5.3.10) 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 therefore the uptake during 2010 will be higher, while historically, France only utilizes ~10% of its available quota, Spanish uptake has been ~80%.

2010 TAC for VI, EC waters of Vb and international waters of XII and XIV.

	TAC	WG Landings	% TAC uptake[1]
Spain	350	Nr*	
France	1364	270	20%
Ireland	399	364	91%
United Kingdom	966	917	95%
EC Total	3079	1551	50%

***nr not reported to the Working Group.**

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 5.3.5. The distributions of landings by statistical rectangle from 2007 to 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 VIb by Ireland and Scotland in 2010.

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

No discard data were made available.

Surveys

In 2005, Scotland initiated a new industry–science partnership survey to provide an absolute abundance estimate for anglerfish (see Section 5.2). Five surveys have been carried out to date 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, six years of data are available (2005–2010) as data from the 2011 survey (SCO-IV-VI-AMISS-Q2) are not yet available, but the time-series will be updated as soon as this becomes available (summer 2011). The area stratified survey provides a minimum estimate of absolute abundance as the survey catches are raised based on swept-area raised and weighted by area. The survey assumes that all megrim in the trawl path are retained as there are no catchability estimates for this species. Assuming full retention is overly optimistic therefore providing a minimum estimate of stock biomass.

For the six years of survey data available, the sample locations and the density of megrim are illustrated in Figure 5.3.4 as numbers (number per square kilometre) and in Figure 5.3.5, 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 5.3.11.

The results of the survey are presented in Table 5.3.3. Abundance and biomass in VIb and from 2005 to 2010 has increased considerably (Table 5.3.4) and is stable at higher levels.

Commercial cpue

Logarithmic lpues for Scottish and Irish OTB vessels are available for, VIb. These are presented in Figure 5.3.12. The commercial data does not follow the trends observed in the survey time-series and the commercial lpue's between the two fleets in 2009 are contradictory. Care should be taken in interpreting the commercial lpue's 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 utilized. 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.

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.

Meyer and Millar, 1999. BUGS in Bayesian stock assessments. Canadian Journal of Fisheries and Aquatic Sciences; Jun 1999; 56, 6; Canadian Periodicals pg. 1078.

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.

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	0	1	0	0	1	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
France	398	455	504	517	408	618	462	192	172	0	135	252	79	92	50	48	53	104	92	134	270
Ireland	317	260	317	329	304	535	460	438	433	438	417	509	280	344	278	156	221	191	172	188	318
Netherlands	0	0	0	0	0	0	0	1	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		
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
Offical Total	1924	2154	2125	2047	1907	2451	2044	1795	1622	1394	1424	1630	1105	1105	859	552	662	966	1287	1275	1410
Unallocated	286	278	424	674	786	1047	2010	1477	1083	1254	823	843	723	537	469	9	213	n/a	8	0	0
As used by WG	2210	2432	2549	2721	2693	3498	4054	3272	2705	2648	2247	2473	1828	1642	1328	561	875	1301	1545	1275	1410
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

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
Belgium	4	3	2	7	2	7	5	3	5	4	10	2	5	3	-	-	2	6	3	1.6	
Denmark	2	1	4	6	1	2	7	5	18	21	29	52	8	11	7	1	6	11	31		22
France	-	-	36	25	27	24	14	16	14	.	7	5	6	11	9	3	4	18	21		5
Germany	.	6	3	4	1	2	1	2	4	1	3	1	-	2	2	4	7	16	5	4	
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
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	<0.5	<0.5	1	1	4		2
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		
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
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
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

Table 5.3.3. Estimates of megrim abundance and biomass from Scottish-Irish anglerfish surveys.

	Abundance (millions)						Biomass (tonnes)					
	2005	2006	2007	2008	2009	2010	2005	2006	2007	2008	2009	2010
VIa IVa	15.8	16.8	23.8	26.8	21.3	22.2	6326	5846	8478	9288	7166	8555
VIb	1.1	3.5	4.8	6.5	6.6	9.2	679	910	1289	1728	1507	1911

Table 5.3.4. Changes in relative megrim abundance and biomass from Scottish-Irish anglerfish 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.

	Abundance		Biomass		Percentage Change	
Trend mean (2006/2008)/(2009–2010)	Mean 06/08	Mean 09/10	Mean 06/08	Mean 09/10	Abundance	Biomass
VIa IVa	22.5	21.7	7870	7860	-3%	0%
VIb	4.9	7.9	1309	1709.0	60%	31%

Table 5.3.5. 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
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
Spain	363	587	683	594	574	520	515	628	549	404	427	370	120	93	71	88	59	19	84	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
Offical Total	804	1045	1073	925	1046	816	843	1009	1091	866	964	824	455	632	528	382	344	106	294	226	139
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

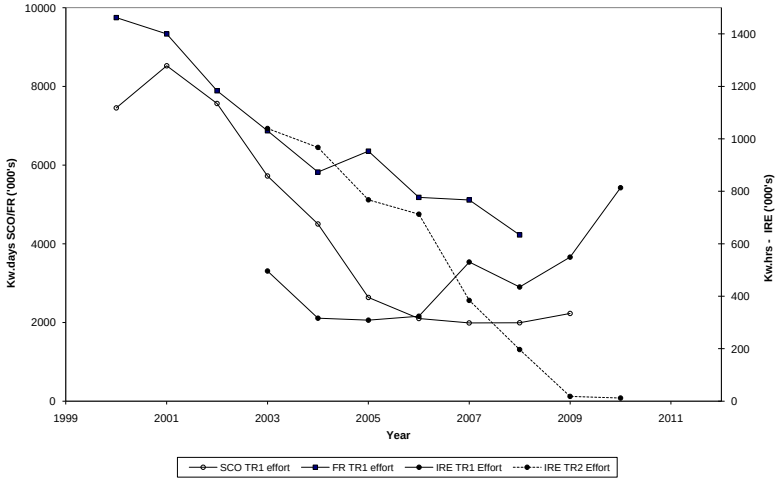


Figure 5.3.1. Fishing effort in ICES Division VIa for Irish, French and Scottish vessels by mesh category.

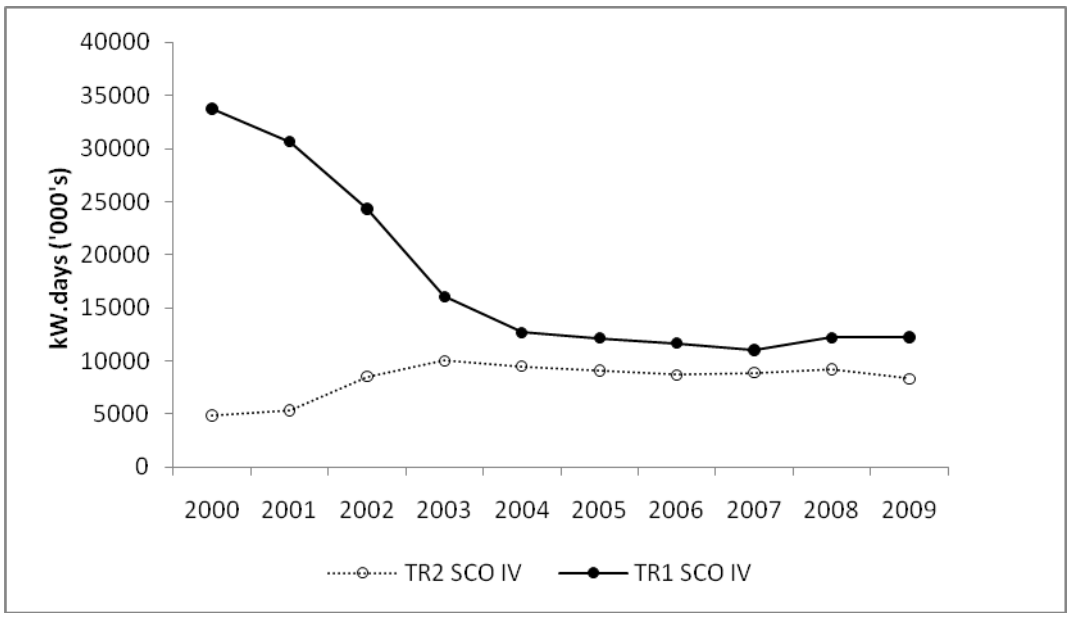


Figure 5.3.2. Scottish TR1 and TR2 effort in ICES Division IVa expressed in kw.days.

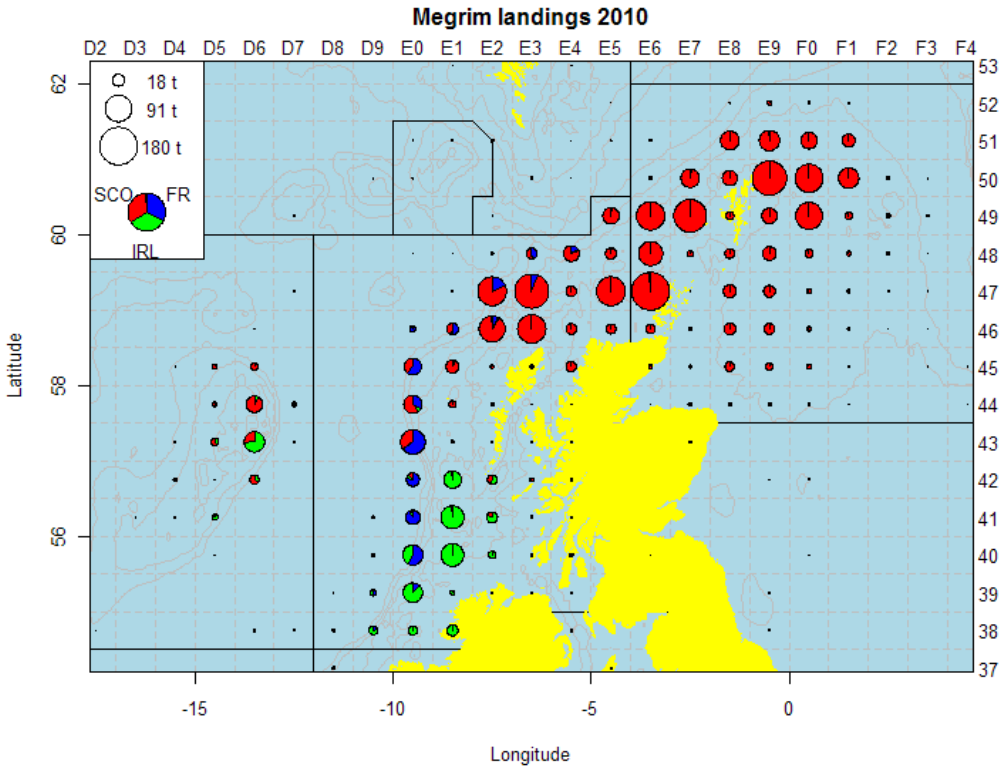


Figure 5.3.3. International megrim landing by ICES statistical rectangle for ICES Divisions VIa, VIb and IVa for 2010.

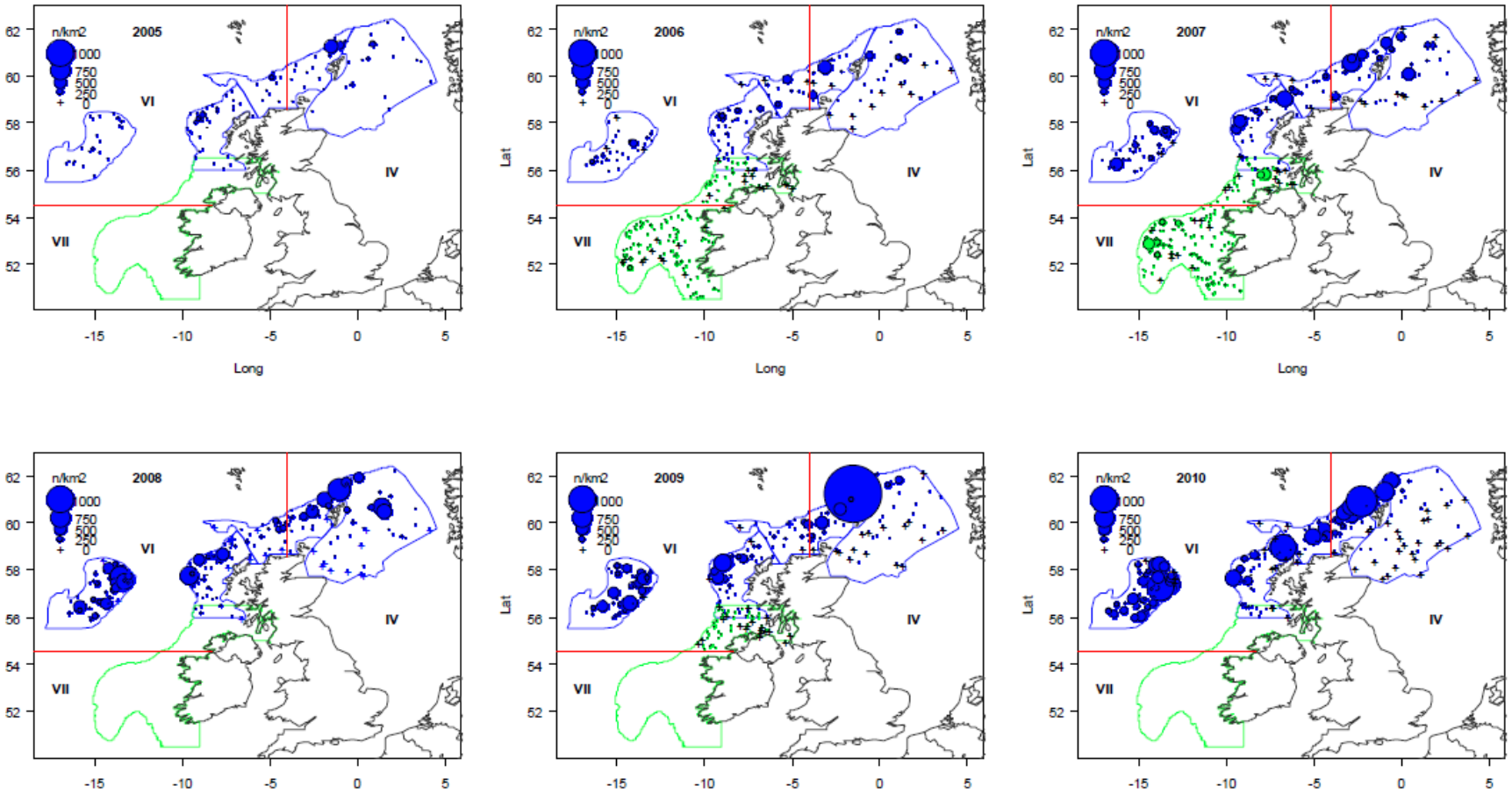


Figure 5.3.4. Maps of the northern continental shelf around the British Isles showing the number density of megrim caught during the anglerfish surveys 2005–2009. Each circle (blue for Scottish surveys; green for Irish surveys) is centred on the sample location and the size of the circle is proportional to the 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).

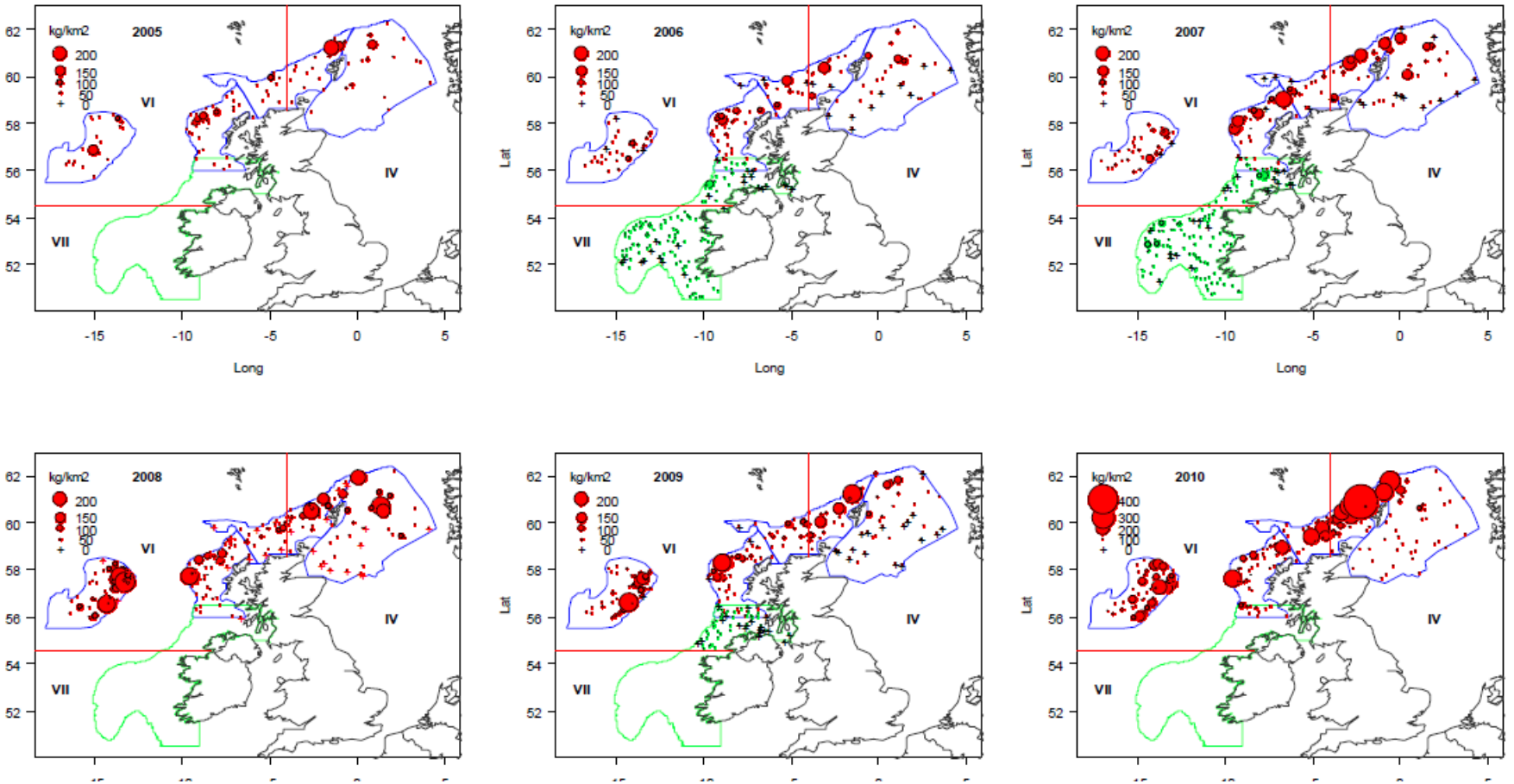


Figure 5.3.5. Maps of the northern continental shelf around the British Isles showing the weight–density of megrim during the anglerfish surveys 2005–2010. Each circle (blue for Scottish surveys; green for Irish surveys) is centred on the sample location and the size of the circle is proportional to 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).

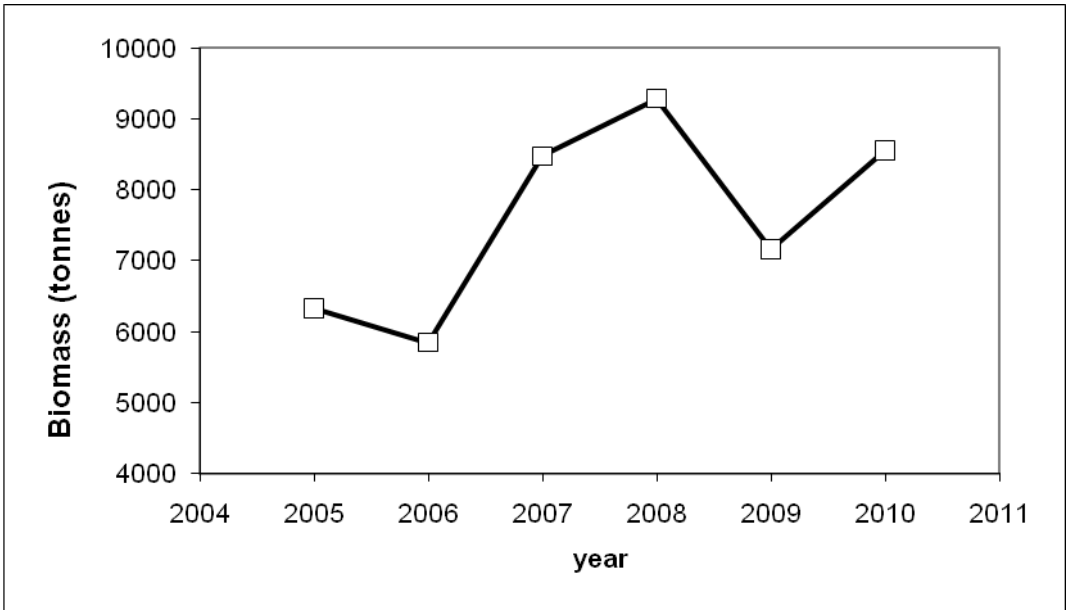


Figure 5.3.6. Change in megrim biomass in ICES Division VIa and IVa combined from the 2005–2010 anglerfish survey.

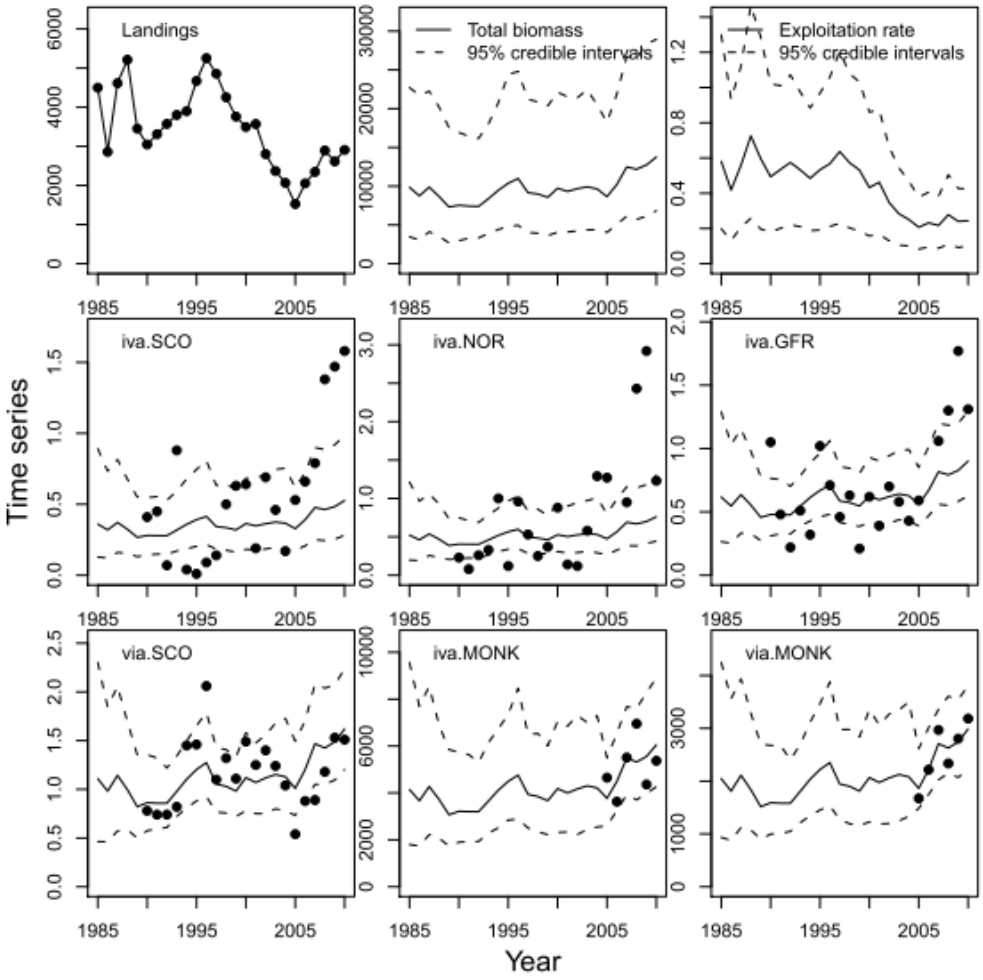


Figure 5.3.7. Trends in landings of VIa and IVa and estimated trends in total biomass and exploitation rate (upper panels) Trends in annual cpue from the NS-IBTS, W-IBTS and IRE-IV.VI.-AMISS-Q2 and SCO-IV.VI.AMISS-Q2 surveys used in the surplus production model. The solid line is the modelled cpue trend across all surveys.

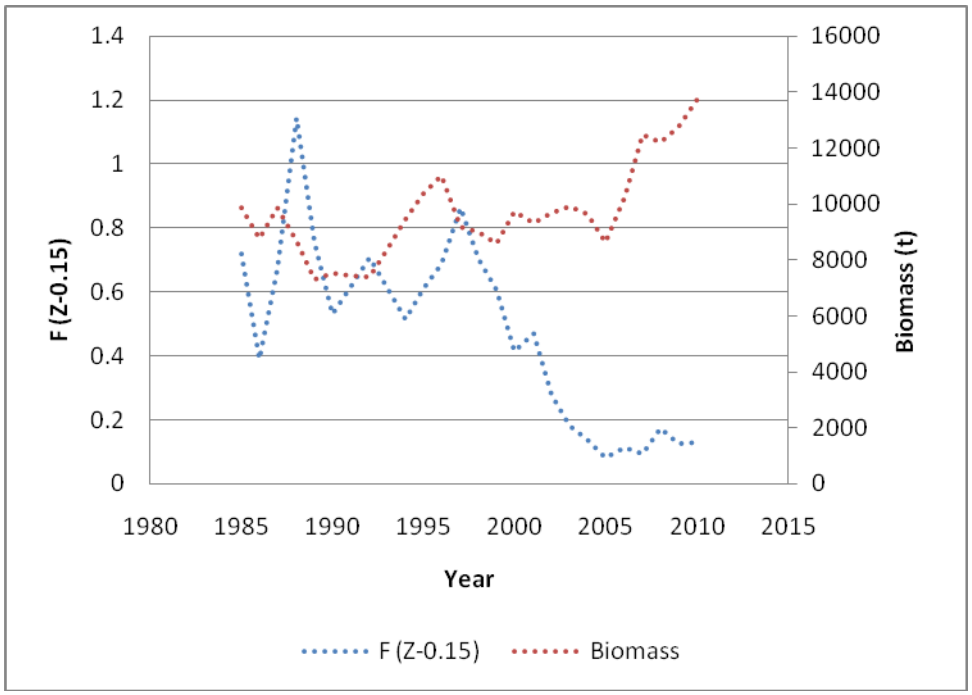


Figure 5.3.8. Change in megrim biomass in ICES Division VIa and IVa combined from the 2005–2010 anglerfish survey.

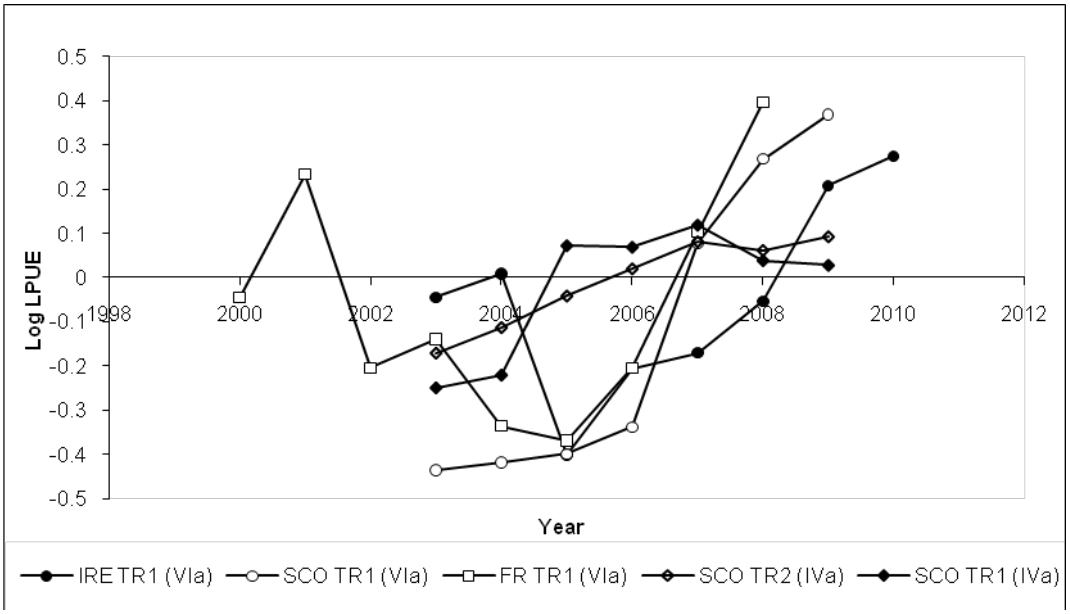


Figure 5.3.9. Change in commercial standardized log lpue and relative to long-term average for Megrim in VIa and IVa.

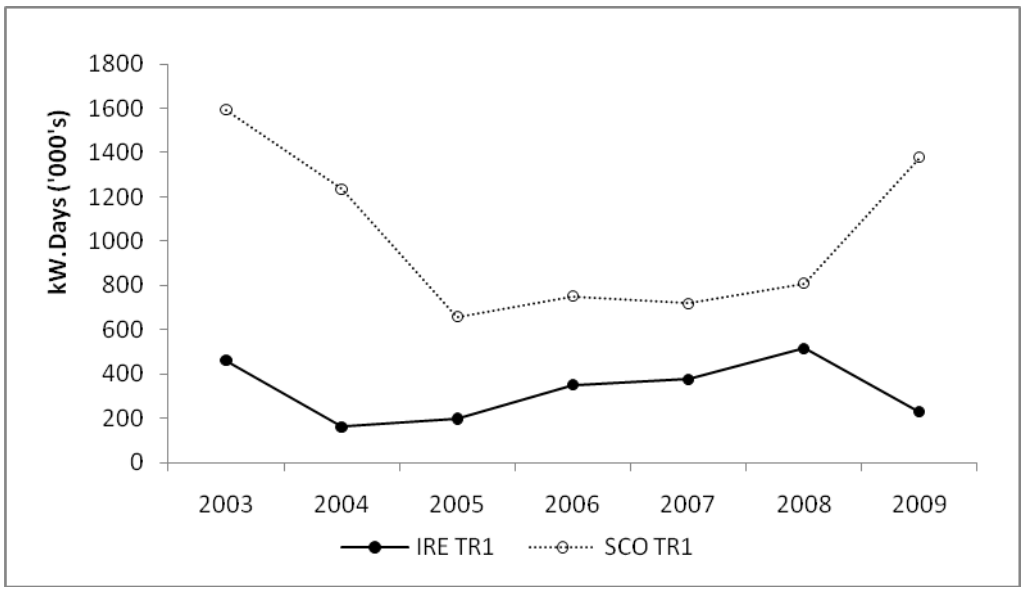


Figure 5.3.10. Irish and Scottish TR1 effort in ICES Subdivision VIb (Rockall) expressed in kw.days.

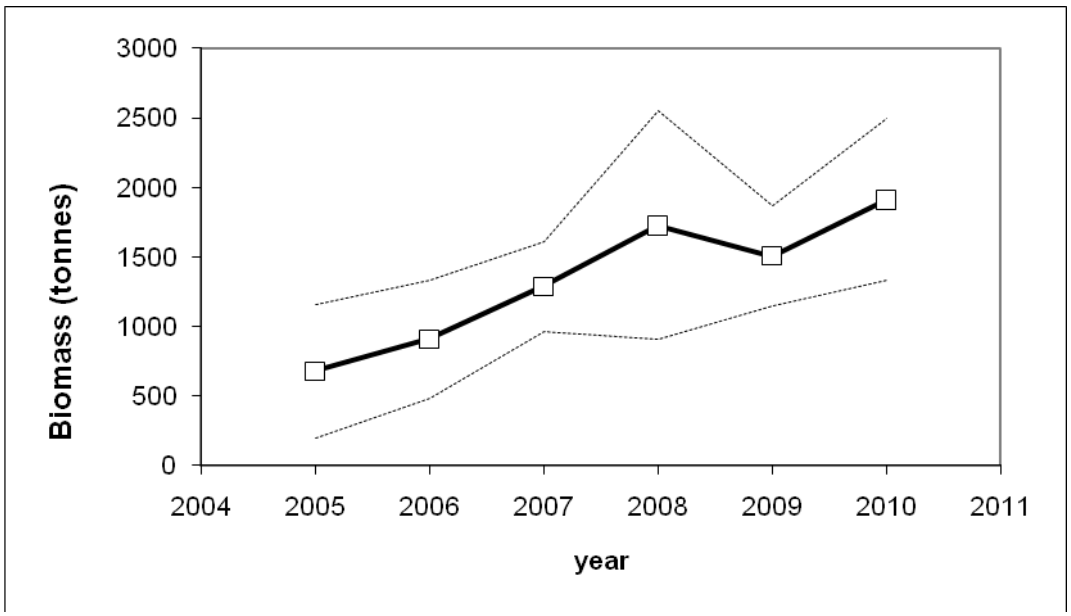


Figure 5.3.11. Change in megrim biomass in ICES Division VIb from the 2005–2010 anglerfish survey.

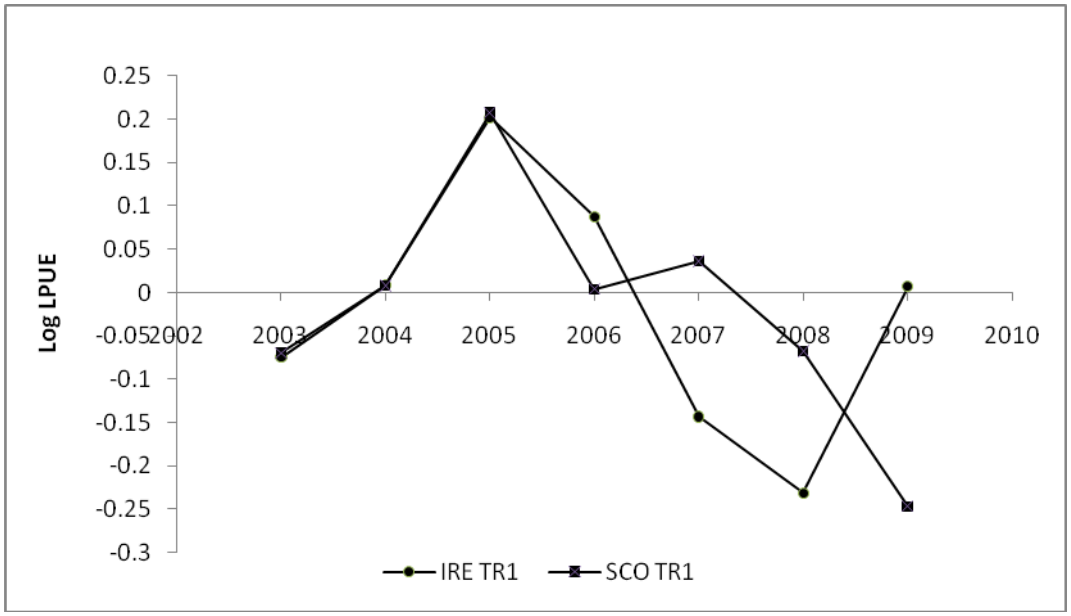


Figure 5.3.12. Change in commercial Log lpue relative to long-term average for Megrim in VIb.

6.1 Irish Sea overview

There is no overview.

6.2 Cod in VIIa

Type of assessment

This is an update assessment. The assessment has not yet been included in ICES benchmarking process.

ICES advice applicable to 2010

"ICES has evaluated the long-term management plan and found it not precautionary. … ICES continues to advise on exploitation boundaries in relation to precautionary limits and recommends that the fisheries for cod be closed until an initial recovery of the cod SSB has been proven. Any catches that are taken in 2010 will prolong the recovery to B_{pa}."

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."

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 2010

Species: Cod *Gadus morhua*		Zone: VIIa (COD/07A.)
Belgium	9	
France	25	
Ireland	444	
The Netherlands	2	
United Kingdom	194	
EU	674	
TAC	674	Analytical TAC

TACs and quotas set for 2011

Species: Cod *Gadus morhua*		Zone: VIIa (COD/07A.)
Belgium	7	
France	19	
Ireland	332	
The Netherlands	2	
United Kingdom	146	
EU	506	
TAC	506	Analytical TAC

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 2010

Landings of cod in 2010 (Table 6.2.1) were the lowest recorded. Northern Ireland landed approximately 60% (Table 6.2.2), with the majority taken by whitefish otter trawlers and *Nephrops* trawlers. The percentages landed into southern Ireland in 2010 have increased to around 30%, with Belgium and UK (England and Wales) having similar values to 2009 at roughly 5% and 4% 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 2010 138 tonnes of cod landings reported as taken in VIIa were reallocated to the Celtic Sea (see Section 7.2.1). WG landings figures in 2010 were 70% of the TAC, and have been at this uptake level or lower since 2003.

6.2.2 Data

An overview of the data provided and used by the WG is provided in Table 6.2.1 in the WGCSE Report.

Fishery landings

The input data on fishery landings and age compositions are split into three periods (Figure 6.2.4):

1) 1968–1990. Landings in this period, provided to ICES by stock coordinators from all countries, were assumed to be accurate and were used directly as the input data for the assessment.

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 (see Stock Annex). For other national landings, the WG figures provided to ICES stock coordinators were used, as in period (1).

3) 2000 onwards. Cod recovery measures were considered to have caused greater problems with estimation of fishery removals than in period (2). The ICES WG landings data provided by stock coordinators for all countries, as in period (1) were input to B-Adapt and the annual total removals (in excess of the assumed M) were estimated within the assessment model.

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
Tonnes	108	54	103	527	558	193	143

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 annual numbers-at-age landed, total landed weight, and the mean weights-at-age in the landings by age class, are given in Tables 6.2.2–6.2.4 and Figures 6.2.1–6.2.4. Previous WG's have shown there are no long-term trends in catch weights-at-age from 1982 onwards. However, weights-at-age prior to 1982 are fixed at constant values lower than estimated for subsequent years, leading to sums-of-products errors, and weights-at-ages 7+ are becoming patchy for the last few years (Figure 6.2.1). Given these problems, and the likelihood of further deterioration in the quality of the older aged fish, revision of historical catch-at-age data and associated weights is needed.

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 continue to show a persistent change in residuals for log catch ratios at ages 1–2 after 1991 (Figure 6.2.5). 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.

Discards data

No discards data are 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 has historically been mainly a function of MLS (35 cm) and therefore mainly restricted to catches of <= 1-gp cod. Discarding patterns appear to have changed in 2010 with the Northern Irish data showing an increase in the discarding of older/larger fish, and the Irish data showing a greater number of 1-gp fish being discarded than 0-gp (Figures 6.2.6 to 6.2.9 and Table 6.2.5). Historical F and recruitment for 1-gp cod are therefore underestimated, but it has not been possible yet to compile a matrix of international fleet-raised discards estimates

by year and age for use in assessments. Belgian estimates are included for the first time this year, and this discards data should be fully evaluated in any future benchmark assessment.

Biological data

The 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 (see Stock Annex for derivation).

Survey data used in assessment

The surveys used in the assessment are described in the Stock Annex, and the series are updated in Table 6.2.6.

Internal consistency of survey data

The survey data during spring each year are of critical importance for tuning the B-Adapt and estimating catch bias because adult cod are better represented than during the autumn surveys. The data for these surveys were screened by fitting the SURBA model using settings described in the Stock Annex, and examining the diagnostic plots. The NIGFS-Mar and ScoGFS-1Q surveys do not exhibit any marked year-effects, and appear to track year-class variations with good consistency (Figure 6.2.10). Strong positive residuals at age 1 are noted for 1994–1996 in the SURBA model fit for NIGFS-Mar (Figure 6.2.10, bottom panels).

Consistency between survey–series

The three series of summer–autumn 0-gp indices used in the update B-Adapt assessment do not consistently follow the trends in year-class effects from the SURBA model applied to the NIGFS-Mar and ScoGFS-1Q data (Figure 6.2.11). While the surveys give similar signals for some year classes, there are some years (e.g. 2001 and 2004–2005 where the series diverge noticeably. The NIGFS-Mar and ScoGFS-1Q SURBA models provide very similar trends in year-class strength.

Commercial cpue

Commercial cpue data are available for this stock but are not currently used in the assessment.

Other relevant data

Table 6.2.6 includes indices of abundance from the UK Fisheries Science Partnership (www. cefas.co.uk/fsp). These are not used in the update assessment and have not yet been evaluated through any benchmarking process, although are presented as supporting evidence (WD 11). The SSB trends from the UK Fisheries Science Partnership trawl surveys support the trends given by the NIGFS-1Q survey from 2004 onwards (Figure 6.2.12) although show less optimistic increases in SSB from 2010.

The state space model SAM was fitted to the Irish Sea cod assessment datasets in order to evaluate an alternative approach to estimating the stock and fishery parameters using differing assumptions. The SAM model assumes that log-transformed stock sizes and fishing mortalities, which are the so-called states, follow separate random walks. Observed catches and survey indices are considered to be random variables with associated observation noise. The model has recently been adopted for the North Sea cod assessment. The SAM model fits exhibit similar patterns in SSB (Figure

6.2.13) and recruitment as B-ADAPT. The overall development in Fbar is very similar in the estimates from SAM and B-ADAPT. Advice based on the SAM model would be equivalent to that from the B-ADAPT fit.

A UK(E&W)-IBTS-Q4 trawl survey-series covering the Irish Sea and Celtic Sea in November commenced in 2004. Cod abundance indices will be provided from this survey in future.

The latest in a series of cod SSB estimates from applications of the annual egg production method, using gene probes to identify early stage cod eggs, are available for 2010 (WD 9). Preliminary estimates are 1113 t (RSE 21%) in the western Irish Sea, 498 t (RSE 23%) in the eastern Irish Sea and 1610 t (RSE 18%) for the whole Irish Sea (Figure 6.2.22**)**. The update B-Adapt assessment provides an SSB estimate of 947 t for the Irish Sea in 2010, roughly 60% of the egg production estimate. Although the estimates vary both methods give SSB below B_{lim}, and both indicate drops in SSB in recent years. These data will be evaluated in future benchmark assessments.

6.2.3 Historical stock development

Deviations from Stock Annex

The assessment does not deviate from the procedure used last year and described in the Stock Annex.

Software used and model options chosen

The B-Adapt method is described in the Stock Annex. Software version B-Adapt-F.exe (13/5/06) was used to allow estimation of removals bias from 2000 onwards.

Model settings for the update assessment are given in Table 6.2.7. B-Adapt can use survey data for the year after the last year of catch data, and in this assessment the survey indices for NIGFS-Mar in 2011 are used. An input F-multiplier for 2011 is required for adjusting the survey indices to the start of the year. In view of the new cod recovery measures which involved a 25% reduction in cod TAC in 2011, an F-multiplier of 0.75 was applied in 2011.

Input data types and characteristics

New data added to the update B-Adapt assessment are the fishery landings data for 2010, the NIGFS-Mar survey data for 2011 and the NIGFS-Oct, UK (BTS-3Q) and NIMIK 0-gp indices for 2010. The update B-Adapt assessment follows the same procedure as in the 2010 assessment by including the sample-based estimates of landings at three major ports from 1991–1999, while estimating removals in excess of the assumed natural mortality rate in subsequent years. The sample based estimates of landings for 2000–2002 and 2005 provide a comparison with the B-Adapt removals estimates.

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 B-Adapt run are given in Table 6.2.8. Note that these are from the non-bootstrap application of the model. The catchability residuals from the update assessment are given in Figure 6.2.14. A trend in catchability residuals for 2–4 year old cod exists in the first five years of the NIGFS-Mar survey-series. This is

not reflected in the SURBA residuals shown in Figure 6.2.10. In contrast, the three positive values at age 1 in 1994–1996 in NIGFS-Mar B-Adapt residuals are evident in the SURBA analysis, indicating a change in survey selectivity.

Final update assessment: retrospective analysis

The estimation of catch bias in B-Adapt effectively removes survey catchability trends from 2000 onwards, and the assessment therefore exhibits no retrospective bias (Figure 6.2.15).

Final update assessment: long–term trends

The population numbers and F at age from the update B-Adapt assessment are given in Tables 6.2.9 and 6.2.10, and the VPA summary data are given in Table 6.2.11. These are the point estimates from the non-bootstrap option. The long-term trends in landings, F, SSB and recruitment are shown in Figure 6.2.16, using the bootstrap option to give 5th and 95th percentiles from 1000 bootstrap runs selecting randomly from the survey catchability residuals. Note that the 50th percentiles generally differ slightly from the point estimates from the non-bootstrap option, but the 2010 F point estimate shows greater divergence from the median bootstrap value implying a degree of bias in this final year.

The B-Adapt estimates of total removals for 2000–2010 (in excess of the WG landings figures and natural mortality M=0.2) may represent unaccounted discards, landings and additional natural mortality. The B-Adapt estimates of total removals (including unaccounted removals) were close to the WG landings figures including sample-based estimates for 2000 and 2001, but the 90% confidence limits of the B-Adapt estimates for 2002 and 2005 lie just above the WG landings estimates.

The recruitment trends from B-Adapt are very similar to the indices from SURBA for the NIGFS-Mar and ScoGFS-1Q surveys (Figure 6.2.17), indicating that the historical trends are well captured by the survey and fishery age-composition data. The SURBA and B-Adapt indices of SSB indicate very low SSB since 2005, but the NIGFS-Mar survey predicts and increase in SSB in 2011 as the 2009 year class enters the SSB. All surveys indicate continued high total mortality rates but given the highly truncated age composition in the stock, and the internal procedure in SURBA for estimating recent Z, the SURBA trends in Z are probably poorly estimated.

In order to investigate the sensitivity of this assessment to the B-Adapt estimates of total removals, another assessment was conducted using the same software and settings, but without estimating the bias. Figure 6.2.18 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 F_{bar} are reasonably consistent between the model runs.

Comparison with previous assessments

The retrospective analysis (Figure 6.2.15) provides a comparison with the results of the assessment carried out in 2010. The current assessment is a direct update without any changes to procedures or data. The current assessment is consistent with the previous assessment.

The state of the stock

The spawning–stock biomass has declined tenfold 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 ($\mathbf{F}_{max}$ and $\mathbf{F}_{0.1}$) associated with high long-term yields and a low risk of depleting the productive potential of the stock.

Recruitment has been below average for the past eighteen years. The 2002 to 2008 year classes are among the smallest on record and all lie below a segmented regression line fitted to the stock–recruit data, indicating lower than expected recruitment given the SSB estimates (Figure 6.2.19). The 2010 data show increased recruitment compared the recent period of poor recruitment, but still below the long-term average. Preliminary indications suggest the 2010 year class is some way below the 2009 estimate, but this recruitment is above the segmented regression line on Figure 6.2.19, and thus indicates a higher than expected recruitment given the estimated SSB. The estimated breakpoint in the regression is close to the B_{pa} of 10 000 t.

6.2.4 Short-term predictions

Due to the inability to identify the source of the bias in removals estimates from B-Adapt assessment, and the relationship between future TACs and total removals, detailed short-term catch forecasts have not been given for this stock for several years. The update B-Adapt assessment, including a 25% F reduction in 2011, indicates a 70% increase in SSB between 2011 and 2012. This is a consequence of the high 2009 recruitment entering the spawning stock, after numerous years of very weak recruitment.

SSB PERCENTILE	2009	2010	2011	2012
5th	908	750	1440	2336
25th	1094	907	1865	3169
50th	1255	1032	2220	3820
75th	1429	1179	2657	4544
95th	1720	1419	3382	5807

6.2.5 Medium-term projections and MSY evaluation

Medium-term projections

Medium-term projections are carried out to look at the possible future trends in the stock in response to changes in total mortality. The contribution of the fishery to the total removals estimates over and above reported landings is unknown.

Estimating recruiting year-class strength

Following the recommendation from RGNSDS (2007) that bootstrapping the 1992–2006 recruitment estimates may have led to overoptimistic forecasts, 2002 was chosen as the starting year for this assessment's medium-term projections.

The stock–recruit plot (Figure 6.2.19) shows that from 2002 to 2008 the recruitment estimates were below the segmented regression line, but above it in 2009 and 2010.

Year	Year class	Source	Number-at-age 0 ('000)
2008	2008	B-Adapt (point estimate)	881
2009	2009	B-Adapt (point estimate)	3240
2010	2010	B-Adapt (point estimate)	1551
2011	2011	Bootstrap 2002–2010 y.c.: (50th percentile)	1263[1]
		GM (2002–2010 y.c.)	1277

[1] **Average of 50th percentiles over 10-year B-Adapt projection**

Scenarios examined

The mortality rate due to removals in excess of the assumed natural mortality of M=0.2 is referred to below as F*. Two medium-term stochastic projections were carried out using the bootstrap option in B-Adapt:

1) Zero F* from 2012 onwards with recruitment estimated from model estimates for the year classes observed from 2002–2010.

2) 25% reduction in F* per year until F* attains the value of F=0.4 adopted by the Commission as the long-term management objective. Recruitment estimated from model estimates for the year classes observed from 2002–2010.

Projection 2 represents annual reductions in F* equivalent to reductions in F that Management Plan may seek to achieve through annual 25% reductions in TAC. However, the bootstrap procedure does not simulate any additional variability and risk associated with limits on interannual TAC variability, or any changes in discarding or compliance.

The removals figures generated in the projection implicitly include the level of removals bias estimated by B-Adapt for 2010 in each simulation. It is currently not possible to attribute these to any actual losses not accounted for in the model inputs, or to any remaining bias due to incorrect assumptions in the B-Adapt implementation.

Model inputs

Model inputs were as follows:

- *Number of simulations*: 1000.
- *Recruitment from 2011 onwards*: bootstrapped in each simulation from model estimates for the year classes described in the scenarios examined section.
- *Status quo F*: B-Adapt F(2–4) for 2010 in each simulation.
- *Intermediate year assumption*: To allow for a potential reduction in F* in 2011 associated with the 25% TAC reduction, an F-multiplier of 0.75 was applied in 2011.

Results

Reducing F* to zero from 2012 onwards allows a high probability (95 percent) of recovery of SSB to above B_{pa} by 2015 (Figures 6.2.20). A stepwise reduction in F* by 25% per year (until the year when the 50th percentile of F* reaches 0.40) is less optimistic (Figure 6.2.21). The results show a 35% probability of SSB > B_{lim} by 2015 and 5% probability of achieving B_{pa}.

F_{msy} evaluations

A full FMSY evaluation was carried out at WGCSE in 2010 and the suggested level of FMSY for this stock was F's 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:

PRECAUTIONARY APPROACH (UNCHANGED SINCE 1998)			
B_{lim}	6000 t	B_{pa}	10 000 t
F_{lim}	1.00	F_{pa}	0.72
F_{msy}	0.25–0.54		

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 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 the B-Adapt modelling approach to estimate subsequent removals from 2000 onwards. The unaccounted removals figures given by B-Adapt could potentially include components due to increased natural mortality and discarding as well as misreported landings or catches from the stock taken outside VIIa, albeit distributed according to the age composition in the landings.

Discarding

Estimates of discards are patchy for Irish Sea cod, although more comprehensive sampling is now required through the EU Data Collection Framework. Discarding has historically been mainly at age 1, and the absence of raised estimates of discarding for all fleets will result in underestimation of historical F at age 1. 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 of 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. It is as yet unclear whether this is a long-term or a temporary change. 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 up to 2011. The surveys in general give consistent signals of fish abundance-at-age. All survey data except the UK(BTS-3Q) indicate a severe depletion of the SSB during a run of very poor recruitment from 2002, with one reasonable recruitment estimated in 2009. The UK(E&W)-BTS-Q3 survey does not show this improved recruitment in 2009, but the data only represent a small area of the Irish Sea and may not be representative of the Irish Sea as a whole. The UK Fisheries-Science Partnership surveys of the Irish Sea cod spawning grounds in spring 2005–2011 (not in the assessment), carried out using commercial trawlers, indicated a widespread distribution of cod mostly at low density but with some localized aggregations (WGCSE 2011, WD11). The time-series of SSB indices shows a downward trend similar to that shown by NIGFS-WIBTS-Q1 which is used in the assessment (Figure 6.2.12), and the highly truncated age composition of cod in the FSP surveys supports the ICES assessment, indicating continuing high mortality rates. Estimates of cod SSB from applications of the annual egg production method, although slightly higher than the B-Adapt estimates, are still below B_{lim} and show a similar trend in SSB to the assessment (Figure 6.2.22).

Model formulation

The B-Adapt estimates of removals bias continue to vary around relatively high values of 2.0–3.0 despite more accurate catch reporting and lack of evidence of significant discarding of cod above MLS. There could potentially be unaccounted losses from other sources, for example due to fishery catches taken outside VIIa during seasonal migrations, a gradual shift in distribution to areas beyond VIIa, or increases in natural mortality. The estimates of bias could also be influenced by any remaining non-randomness of survey catchability or outlying values, or by incorrect assumptions in the model (e.g. constant survey catchability, removals bias not age-dependent). For this reason, the absolute values of the estimated unallocated removals should not be over-interpreted. There is currently no evidence from surveys and fishery age compositions of a significant improvement in age structure that could be caused by management measures. The interpretation in B-Adapt is that there continues to be a 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 midwater 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.

Tagging of cod off Greencastle on the north coast of Ireland (Ó 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 midwater trawlers in the 1980s and 1990s.

Recently more Irish Sea cod mark and recapture experiments, and electronic data storage tag (DST) results have been collected and analysed (Bendall *et al*., 2009). These results show not only spring/summer migrations of cod out of the Irish Sea into the North Channel and VIa, but also migrations south through the deeper channel into the Celtic Sea. This work is continuing and a further 150 cod have been tagged with DST's in the Irish Sea and Celtic Sea in 2010.

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.

6.2.9 Recommendations for next benchmark assessment

Year	Candidate stocks	Supporting justification and comment(s)	Indicated expertise necessary at the benchmark meeting
2012?	Western waters cod stocks (Area VI and VII excl VIId).	Cod stocks in Divisions VI and VII comprise an assemblage of metapopulations with varying degrees of mixing. Fishing effort, predation and other environmental drivers including climate change impact the populations in different ways across the range of the stocks. The stocks have proven difficult to assess due to data deficiencies and an inability to demonstrate responses to changes in fishing effort and other management controls. Improved management advice may benefit more from quantifying the spatial dynamics of cod in relation to spatial variations in fishing and other pressures than by trying to refine the current modelling approaches applied to the current stock definitions and management units. To make progress towards this, an initial Data Workshop is proposed to collate and interpret existing and new data on cod stock structure and mixing, distribution patterns, spatial variations in size/age structure and biological characteristics as well as pressures including predation, fishing and climate. Such analyses will be facilitated by high-resolution spatial data on fishery catches and effort by métier using VMS, rectangle data, employing GIS methods. It will be necessary to develop an international database holding spatially resolved datasets (landings, discards, effort, size/age/biological data, surveys, environmental variables) and data manipulation routines to allow evaluation of the effect on the assessments of altering the stock unit definition. Data on cod movement parameters will be required to allow development of operating models for testing assessment and management procedures and ultimately developing and testing spatially disaggregated assessment models. New datasets e.g. on discarding, biology, predation, surveys and fishing effort/cpue would be evaluated. The Data Workshop would build on and review the outcomes of a major UK collaborative programme on cod stock structure and spatial dynamics, which will be completed in 2011. The ensuing Benchmark Assessment workshop would evaluate the appropriateness of current assessment methods in the light of the Data Workshop outcomes, and explore alternative approaches as candidates for providing management advice. This could potentially include changes to the spatial units for assessment or the development of spatially disaggregated assessment models including mixing coefficients.	

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 or 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 SGMOS (2010) the very low abundance of cod, and the evidence of 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.

Surveys of cod eggs in the Irish Sea (WD 11 and Figure 6.2.23) in 2010 involving the UK and Ireland indicated that spawning of cod reached a peak around 28 February in

the western Irish Sea and around 10 March in the east. Some cod spawning in the western Irish Sea had commenced prior to the cod closure on 15 February, and spawning was effectively completed by mid April, two weeks prior to the reopening of the cod closure. Currently ~30% of the spawning took place in the eastern areas not included in the spring-spawning closure, indicating that the design of the closure may no longer be optimal.

Preliminary 2010 estimates of spawning–stock biomass of cod based on the annual egg production and estimates of fecundity and sex ratio are 1113 t (RSE 21%) in the western Irish Sea, 498 t (RSE 23%) in the eastern Irish Sea and 1610 t (RSE 18%) for the whole Irish Sea (Figure 6.2.22**)**. The update B-Adapt assessment provides an SSB estimate of 947 t for the Irish Sea in 2010, roughly 60% of the egg production estimate. Although the estimates vary both methods give SSB below B_{lim}, and both indicate drops in SSB in recent years.

References

ICES. 2009. Report of the Benchmark and Data Compilation Workshop for Roundfish (WKROUND), January 16–23 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:32. 259 pp.

Bendall, V. Ó Cuaig, M. Schön, PJ. Hetherington, S, Armstrong, M. Graham, N. Righton, D. 2009. Spatio-temporal dynamics of Atlantic cod (*Gadus morhua*) in the Irish and Celtic Sea: results from a collaborative tagging programme. ICES CM 2009/J:06, 35 pp.

Table 6.2.1. Nominal landings (t) of COD in Division VIIa as officially reported to ICES, and figures used by ICES.

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	20101
Belgium	187	142	183	316	150	60	283	318	183	104	115	60	67	26	19	21
France	166	148	268	269	n/a	53	74	116	151	29	35	18[2]	17[2]	3	1[2]	1
Ireland	1,414	2,476	1,492	1,739	966	455	751	1,111	594	380	220	275	608	618[2]	323[2]	289
Netherlands	-	25	29	20	5	1	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-
UK (England, Wales & NI)	2,330	2,359	2,370	2,517	1,665	799	885	1,134	505	646	594	589[2]	423	543[2]	387[2]	282
UK (Isle of Man)	22	27	19	34	9	11	1	7	7	5	n/a	n/a	n/a	2[2]	1[2]	1
UK (Scotland)	414	126	80	67	80	38	32	29	23	15	3	6	2	1[2]	1[2]	-
Total	4,533	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
Unallocated	54	-339	1,418	356	1,909	-143	226	-20	-192	-107	-57	-108	-415	-563	-286	-130
Total as used by WG	4587[3]	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]

[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

(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	58.9	3.7	0.0	32.5	0.2	4.5	0.2	0.0	100

Table 6.2.3. Cod in VIIa. Landings numbers-at-age used in the update B-Adapt assessment.

	Age							
Year	0	1	2	3	4	5	6	7+
1968	0	364	1563	1003	456	177	28	2
1969	0	882	1481	1050	269	186	76	37
1970	0	1317	1385	352	204	163	52	19
1971	0	2739	2022	904	144	67	39	12
1972	0	789	3267	824	250	58	39	20
1973	0	2263	1091	1783	430	173	60	21
1974	0	530	3559	557	494	131	46	28
1975	0	1699	642	1407	294	249	95	22
1976	0	1135	3007	363	500	61	79	25
1977	0	816	511	1233	163	218	31	40
1978	0	687	1092	310	311	39	47	18
1979	0	1762	1288	608	127	164	38	33
1980	0	2533	2797	729	243	49	51	4
1981	0	1299	3635	1448	244	99	23	24
1982	0	345	2284	1455	557	102	57	22
1983	0	814	932	751	499	154	27	19
1984	0	1577	1195	439	240	161	56	19
1985	0	1218	2105	703	158	84	51	26
1986	0	974	2248	699	203	64	33	32
1987	0	4323	1793	841	252	75	19	24
1988	0	2792	4734	702	263	71	27	11
1989	0	582	2163	1886	231	86	21	16
1990	0	710	1075	545	372	70	23	7
1991	0	1973	1408	442	127	98	15	7
1992	0	1375	1243	664	132	42	46	3
1993	0	223	2907	403	119	16	6	7
1994	0	749	569	848	68	20	9	1
1995	0	498	1283	180	163	7	3	3
1996	0	317.6	1112.8	700.3	38.3	38.8	4.4	1.7
1997	0	523.2	1148.8	500.6	212.5	16.5	11.5	4.5
1998	0	204.4	1926.1	335.1	79.9	28	6.5	1.2
1999	0	69.6	842.8	871.1	65.7	21.2	6.2	0.3
2000	0	289	176	107	50	4	1	0.2
2001	0	338	841	53	13	9	0.3	2
2002	0	196	564	405	7	2	2	1
2003	0	45	439	93	35	1	0.1	0.03
2004	0	68	101	158	21	6	1.9	0.6
2005	0	42	224	62	33	5	0.7	0.2
2006	0	14	142	112	16	8.2	3.2	0.2
2007	0	49	205	56	11	0.5	0.4	0
2008	0	13.7	165.7	87.1	9.4	2.7	0.1	0.02
2009	0	19.7	53.2	65.5	16.9	2.9	0.4	0
2010	0	40.2	127.6	15	7.4	1.5	0.3	0.2

Table 6.2.4. Cod in VIIa. Mean weights-at-age in the landings (used for stock and catch).

	Age							
Year	0	1	2	3	4	5	6	7+
1968	0	0.61	1.66	3.33	5.09	6.19	6.76	8.3
1969	0	0.61	1.66	3.33	5.09	6.19	6.76	8.3
1970	0	0.61	1.66	3.33	5.09	6.19	6.76	8.3
1971	0	0.61	1.66	3.33	5.09	6.19	6.76	8.3
1972	0	0.61	1.66	3.33	5.09	6.19	6.76	8.3
1973	0	0.61	1.66	3.33	5.09	6.19	6.76	8.3
1974	0	0.61	1.66	3.33	5.09	6.19	6.76	8.3
1975	0	0.61	1.66	3.33	5.09	6.19	6.76	8.3
1976	0	0.61	1.66	3.33	5.09	6.19	6.76	8.3
1977	0	0.61	1.66	3.33	5.09	6.19	6.76	8.3
1978	0	0.61	1.66	3.33	5.09	6.19	6.76	8.3
1979	0	0.61	1.66	3.33	5.09	6.19	6.76	8.3
1980	0	0.61	1.66	3.33	5.09	6.19	6.76	8.3
1981	0	0.61	1.66	3.33	5.09	6.19	6.76	8.3
1982	0	1.01	1.524	3.488	5.573	7.592	8.697	10.18
1983	0	0.995	1.842	3.988	5.964	7.966	9.306	10.925
1984	0	0.679	1.813	3.808	5.865	7.475	9.818	10.748
1985	0	0.783	2.023	4.244	5.825	7.5	8.81	9.504
1986	0	0.805	1.825	3.862	5.855	7.391	8.116	9.471
1987	0	0.713	2.161	3.91	6.41	7.821	9.888	10.658
1988	0	0.607	1.563	3.756	5.668	8.017	9.749	10.208
1989	0	0.936	1.846	3.223	5.408	6.571	8.256	11.052
1990	0	0.842	1.938	3.572	5.277	7.531	8.398	12.699
1991	0	0.856	1.637	3.542	5.419	6.39	8.507	10.397
1992	0	0.813	1.964	3.993	5.975	6.923	8.509	11.1
1993	0	0.847	1.706	3.666	5.675	7.365	9.486	10.761
1994	0	0.798	1.923	3.608	6.08	7.68	8.272	11.258
1995	0	0.9	1.84	4	5.791	8.452	8.712	9.56
1996	0	0.98	1.625	3.256	5.298	7.721	8.836	12.256
1997	0	0.846	1.937	3.624	5.291	6.115	8.672	11.263
1998	0	0.925	1.647	3.729	5.371	7.033	8.833	12.155
1999	0	0.853	1.624	3.179	5.505	7.517	10.137	12.618
2000	0	0.851	1.985	3.573	5.138	7.148	8.528	7.692
2001	0	0.99	1.823	4.149	5.606	7.332	8.471	9.667
2002	0	0.942	1.836	3.439	5.727	7.708	9.639	10.761
2003	0	1.205	1.662	3.287	5.425	10.198	10.308	13.696
2004	0	1.112	2.202	3.634	6.505	7.638	8.937	7.572
2005	0	0.913	1.938	3.514	5.318	7.739	7.94	12.237
2006	0	0.826	1.843	3.666	4.709	6.393	7.562	12.236
2007	0	0.832	1.852	3.781	5.347	7.991	10.038	0
2008	0	0.894	1.586	3.543	6.001	7.573	9.723	8.123
2009	0	1.097	2.006	3.458	5.314	7.1	6.815	0
2010	0	1.259	2.288	3.931	6.335	7.33	8.69	11.056

Table 6.2.5. Cod in VIIa. Estimates of numbers discarded in 1996–2010. Data are numbers ('000 fish) discarded by each fleet, estimated from numbers per sampled trip raised to total fishing effort by each fleet, for the range of quarters indicated. Sampling scheme (a) provides independent self-sampling estimates for the UK(NI) *Nephrops* fishery also covered by observer data in schemes (b) and (d). An asterisk indicates years/fleets where the data are raised to the trip level rather than to the entire fleet.

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	2009	2010
Age	43 trips	39 trips	48 trips	39 trips	44 trips	43 trips	35 trips	8 trips	0 trips	0 trips	0 trips	0 trips			
0	56	3	0	70	32	4	0	0							
1	82	63	14	83	397	31	22	0							

(b) Observer scheme: N.Ireland vessels catching *Nephrops* (single trawl only) (*not raised to fleet level – no. of fish)

	1996	1997	1998	1999 Q3-4	2000 Q1-3	2001 Q1	2002	2003	2004	2005	2006 Q3-4*	2007 Q1-4	2008 Q1-4	2009 Q1-4	2010 Q1-4
Age	0 trips	0 trips	0 trips	4 trips	6 trips	1 trip	0 trips	0 trips	0 trips	0 trips	9 trips *	29 trips	55 trips	30 trips	36 trips
0				0	0	0					19	5.0	2.5	50.0	4.7
1				0	53	0					7	15.2	2.7	8.7	23.7
2												0.6	0.7	0.3	3.6

(c) Observer scheme: N.Ireland midwater trawl

	1996	1997 Q2-4	1998 Q1-3	1999 Q3-4	2000 Q1	2001 Q1	2002	2003	2004	2005	2006	2007	2008	2009	2010 Q1,2,4
Age	0 trips	n/a	n/a	5 trips	4 trips	2 trips	0 trips	0 trips	0 trips	0 trips	0 trips	0 trips	1 trip	1 trip	3 trips
0		0	0	1.6	0	0							0	0	0.1
1		17	4	0	0.8	0							0.45	0.03	1.70
2		0.5	2	0	0	0							0	0.03	0.1

(d) Observer scheme: N.Ireland twin trawl (*not raised to fleet level – no. of fish)

	1996	1997 Q2-4	1998 Q1-3	1999 Q4	2000 Q1-4	2001 Q1	2002	2003	2004	2005	2006 Q3-4*	2007 Q1-4	2008 Q1-4	2009 Q1-4	2010 Q1-4
Age	0 trips	n/a	n/a	1 trips	10 trips	2 trips	0 trips	0 trips	0 trips	0 trips	incl. with single Nephrops trawls	14 trips	16 trips	18 trips	21 trips
0		12	0	12	33	0						0.8	2.8	172.2	5.0
1		19	38	1	45	0						12.5	12.9	17.9	24.8
2		0.2	13	0	0	0						0.1	0.2	0.0	44.0

Table 6.2.5. Continued.

(e) Observer scheme: Republic of Ireland otter trawlers (*not raised to fleet level – total no. of fish for trips sampled)

	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
Age	8 trips *	8 trips *	7 trips *	4 trips *	10 trips *	2 trips *	1 trip *	9 trips *	11 trips *	8 trips *	5 trips *	15 trips *	18 trips*	12 trips	4 trips
0	52	301	0	8	2320	58	124	0	3213	8268	774	0	0	107	29
1	374	333	202	16	798		176	0	2577	632	150	691	441	8	70
2	6	87	0	0	10		0	0	598	0	0	0	0	0	0

(f) Observer scheme: UK(E&W) Demersal otter trawl

	1996	1997	1998	1999	2000 Q1-2	2001 Q1,2,4	2002 Q1,3,4	2003 Q1,2,4	2004 Q1-4	2005 Q1,2	2006	2007	2008	2009	2010
Age	0 trips	0 trips	0 trips	0 trips	21 trips	8 trips	4 trips	4 trips	7 trips	4 trips					
0					0	0	0	0	0	0	see comment 1				
1					38.91	9.21	3.43	0.6	17.71	1.26					
2					0.05	4.46	0	0.62	0.81	0.36					

(g) Observer scheme: UK(E&W) Nephrops trawl

	1996	1997	1998	1999	2000	2001 Q1,2	2002 Q3,4	2003 Q2	2004 Q1-3	2005 Q2	2006	2007	2008	2009	2010
Age	0 trips	0 trips	0 trips	0 trips	0 trips	8 trips	3 trips	2 trips	7 trips	1 trip					
0						0	0	0	0.03	0	see comment 1				
1						3.09	0.03	0	0.24	0					
2						0.7	0	0	0	0					

(h) Observer scheme: UK(E&W) Danish anchor seine

	1996	1997	1998	1999	2000	2001 Q2	2002 Q3	2003	2004 Q3	2005	2006	2007	2008	2009	2010
Age	0 trips	0 trips	0 trips	0 trips	0 trips	2 trips	1 trip	0 trips	1 trip						
0						0	0		0		see comment 1				
1						0	0		0						

(i) Observer scheme: UK(E&W) beam trawl

	1996	1997	1998	1999	2000 Q2	2001	2002 Q1	2003	2004	2005 Q4	2006	2007	2008	2009	2010
Age	0 trips	0 trips	0 trips	0 trips	1 trip	0 trips	1 trip	0 trips	0 trips	2 trips					
0					0		0			0	see comment 1				
1					4.34		0.54			0					

comment 1 UK data for 2006-2009 available to WGNSDS/WGCSE as length compositions only, for combined gears

Table 6.2.6. Cod in VIIa: survey indices. Approximate relative standard errors for age groups used in the assessment are given for UK(NI) groundfish surveys. Years/ages used in assessments are in bold.

ScoGFS :Scottish spring groundfish survey of the Irish Sea — Numbers per 10 Hours Fishing

Feb-March

Survey	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+
1996	**3**	**31**	**44**	**7**	9	0	0
1997	**22**	**29**	**15**	**13**	2	0	1
1998	**5**	**81**	**27**	**5**	1	0	0
1999	**7**	**33**	**93**	**15**	5	0	0
2000	**51**	**6**	**11**	**16**	0	1	0
2001	**28**	**56**	**1**	**1**	4	0	0
2002	**13**	**18**	**37**	**1**	1	0	0
2003	**8**	**69**	**18**	**9**	0	0	0
2004	**8**	**11**	**49**	**0**	3	0	0
2005	**1**	**25**	**8**	**9**	1	0	0
2006	**2**	**5**	**11**	**0**	2	0	0

ScoGFS :Scottish autumn groundfish survey of the Irish Sea — Numbers per 10 Hours Fishing

October

Survey	0-gp	1-gp	2-gp	3-gp	4-gp
1997	3	28	19	1	2
1998	0	8	42	5	0
1999	164	2	24	6	2
2000	24	136	4	0	0
2001	0	0	7	0	0
2002	0	18	15	9	0
2003	2	0	27	0	0
2004	2	12	5	5	0
2005	3	8	25	2	0

NI-GFS March groundfish survey — Numbers per 3-miles (approx. 1-h tow) — RSE = approximate relative standard error

Survey	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+	RSE(1gp)	RSE(2gp)	RSE(3gp)	RSE(4gp)
1992	23.257	5.005	1.965	0.248	0.000	0.031	0.017	0.58	0.36	0.26	0.40
1993	**1.381**	**6.488**	**0.446**	**0.104**	0.014	0.028	0.000	0.67	0.22	0.25	0.39
1994	**13.804**	**1.097**	**1.203**	**0.084**	0.014	0.000	0.000	0.48	0.35	0.21	0.35
1995	**7.007**	**3.862**	**0.200**	**0.108**	0.000	0.010	0.000	0.30	0.25	0.41	0.39
1996	**11.061**	**3.293**	**1.117**	**0.014**	0.088	0.000	0.013	0.62	0.18	0.21	1.00
1997	**5.373**	**4.158**	**0.667**	**0.214**	0.014	0.000	0.000	0.32	0.21	0.21	0.38
1998	**1.694**	**7.692**	**0.569**	**0.120**	0.000	0.000	0.000	0.21	0.16	0.30	0.53
1999	**0.495**	**2.531**	**2.419**	**0.153**	0.028	0.000	0.000	0.27	0.20	0.15	0.43
2000	**6.296**	**1.011**	**0.346**	**0.330**	0.000	0.023	0.000	0.36	0.13	0.31	0.44
2001	**4.067**	**5.614**	**0.184**	**0.058**	0.040	0.000	0.000	0.29	0.15	0.39	0.42
2002	**6.622**	**2.533**	**3.335**	**0.000**	0.000	0.011	0.000	0.59	0.19	0.38	-
2003	**0.739**	**10.792**	**1.041**	**0.327**	0.037	0.030	0.058	0.32	0.21	0.30	0.26
2004	**2.170**	**1.720**	**0.886**	**0.054**	0.044	0.000	0.000	0.57	0.30	0.21	0.40
2005	**0.635**	**2.251**	**0.294**	**0.280**	0.183	0.000	0.000	0.56	0.29	0.60	0.64
2006	**1.700**	**1.308**	**0.583**	**0.025**	0.000	0.000	0.011	0.52	0.26	0.37	0.71
2007	**1.644**	**1.244**	**0.306**	**0.051**	0.000	0.000	0.000	0.41	0.21	0.38	0.66
2008	**0.407**	**2.172**	**0.130**	**0.052**	0.042	0.010	0.000	0.46	0.32	0.39	0.66
2009	**1.440**	**0.590**	**0.330**	**0.090**	0.000	0.000	0.000	0.60	0.23	0.26	0.68
2010	**10.221**	**2.090**	**0.147**	**0.023**	0.000	0.000	0.000	0.59	0.22	0.34	0.66
2011	**3.540**	**4.147**	**0.460**	**0.023**	0.020	0.000	0.000	0.46	0.26	0.30	0.66

NI-GFS October groundfish survey — Numbers per 3-miles (approx. 1-h tow) — RSE = approximate relative standard error

Survey	0-gp	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+	RSE(0gp)	RSE(1gp)	RSE(2gp)
1992	**0.579**	11.094	0.501	0.476	0.086	0.000	0.000	0.000	0.58	0.36	0.28
1993	**7.808**	5.532	1.464	0.008	0.000	0.000	0.000	0.034	0.43	0.84	0.34
1994	**19.962**	16.725	0.254	0.104	0.000	0.000	0.000	0.000	0.28	0.43	0.42
1995	**7.886**	12.068	0.333	0.000	0.000	0.000	0.000	0.000	0.55	0.91	0.38
1996	**14.813**	4.866	0.501	0.065	0.000	0.000	0.000	0.000	0.42	0.50	0.30
1997	**4.204**	13.222	0.972	0.000	0.000	0.000	0.000	0.000	0.45	0.41	0.40
1998	**0.370**	3.765	1.639	0.057	0.000	0.000	0.000	0.000	0.38	0.36	0.37
1999	**20.225**	0.585	0.325	0.095	0.000	0.000	0.000	0.000	0.34	0.68	0.43
2000	**7.242**	3.016	0.020	0.000	0.000	0.000	0.000	0.000	0.36	0.33	1.00
2001	**8.411**	5.068	1.099	0.000	0.000	0.000	0.000	0.000	0.45	0.35	0.35
2002	**0.897**	4.879	0.377	0.125	0.000	0.000	0.000	0.000	0.86	0.58	0.55
2003	**2.759**	1.614	0.294	0.000	0.000	0.000	0.000	0.000	0.48	0.66	0.63
2004	**4.437**	5.790	0.237	0.000	0.000	0.000	0.000	0.000	0.30	0.48	0.75
2005	**8.245**	7.061	1.077	0.173	0.029	0.000	0.000	0.000	0.52	0.89	0.62
2006	**1.170**	1.302	0.015	0.066	0.000	0.000	0.000	0.000	0.45	0.53	1.00
2007	**0.068**	0.870	0.000	0.030	0.000	0.000	0.000	0.000	0.66	0.80	-
2008	**0.190**	0.170	0.170	0.000	0.000	0.000	0.000	0.000	0.57	1.00	1.00
2009	**5.356**	2.136	0.061	0.000	0.000	0.000	0.000	0.000	0.33	0.76	1.00
2010	**2.780**	1.718	0.030	0.000	0.000	0.000	0.000	0.000	0.35	0.91	1.00

Table 6.2.6. continued.

Irish GFS. Irish groundfish survey of the Irish Sea. RV Celtic Explorer Total nos. per survey
October

	0-gp	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+
2003	16	29	31	3	1	0		
2004	23	74	7	2	0			

UK Fishery Science Partnership western Irish Sea pelagic trawl survey (mean nos. per hour) SSB index = kg/hr
Feb-March (revised)

	0-gp	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+	SSB index
2004		-	-	-	-	-	-	-	13.29
2005		0.000	0.427	1.409	0.990	0.084	0.025	0.035	12.01
2006		0.003	0.536	2.815	0.427	0.104	0.010	0.007	8.26
2007		0.008	0.611	1.322	0.585	0.055	0.058	0.029	11.78
2008		0.003	0.221	0.824	0.147	0.084	0.020	0.019	3.93
2009		0.009	0.171	1.152	0.377	0.099	0.018	0.012	5.10
2010		0.000	0.735	0.452	0.467	0.130	0.023	0.003	4.40
2011		0.000	0.407	1.681	0.144	0.095	0.039	0.017	6.20

UK Fishery Science Partnership eastern Irish Sea otter trawl survey (mean nos. per hour) SSB index = kg/hr
Feb-March (revised)

	0-gp	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+	SSB index
2005		0.06	4.02	0.25	0.38	0.004	0.01	0.00	5.97
2006		0.83	0.77	0.67	0.007	0.042	0.00	0.001	3.31
2007		0.59	1.43	0.09	0.08	0.00	0.00	0.00	1.77
2008		0.01	1.80	0.32	0.02	0.03	0.003	0.01	2.60
2009		0.50	0.36	0.21	0.09	0.01	0.004	0.00	1.56
2010		0.97	0.65	0.03	0.04	0.01	0.000	0.00	0.86
2011		0.46	1.57	0.06	0.00	0.00	0.000	0.00	1.34

ENG BTS-Sept beam trawl survey. No. per 100km
September (revised)

Survey	0-gp
1991	
1992	
1993	**22**
1994	**30**
1995	**40**
1996	**29**
1997	**32**
1998	**2**
1999	**49**
2000	**37**
2001	**24**
2002	**7**
2003	**9**
2004	**22**
2005	**41**
2006	**6**
2007	**4**
2008	**7**
2009	**6**
2010	**4**

NIMIKNET pelagic 0-gp index
May-June

Survey	0-gp
1994	**57.4**
1995	**6.9**
1996	**66.3**
1997	**5.7**
1998	**0.1**
1999	**26.2**
2000	**6.1**
2001	**9.6**
2002	**3.4**
2003	**3.2**
2004	**25.8**
2005	**11.4**
2006	**9.0**
2007	**0**
2008	**0.8**
2009	**23.6**
2010	**5.7**

Table 6.2.7. B-Adapt model settings for update run in 2011. Same settings as 2010.

Setting	Values
Plus group	5-plus
F_{bar} range	2–4 (arithmetic mean)
Year range for tuning VPA	1992 onwards
Surveys after final year of catch data used.	Yes; F_{mult} = 0.75 for 2011 WGCSE
VPA model or cohort analysis used	v (exact)
First age with constant catchability	Entered as 0 for all tuning fleets
q-plateau	Entered as 3 for all tuning fleets
Tapered time weighting applied	No
Number of missing catch multipliers	11 for WGCSE 2011 (bias estimated from 2000 onwards)
No. ages for terminal F mean, and scaling factor for mean	ages = 1; scaling factor = 1.0; arithmetic mean (i.e. F(4) = F(3))
Constraint on F or catch? Stiffness weight (λ)	Constrain F; λ = 1.0
Prior weighting of fleets	None
Output tables	VPA output table 16 (not SOP corrected)

Table 6.2.8. Selected diagnostics from update B-Adapt (not bootstrap run)

Lowestoft VPA Program

16/05/2011 10:49

Adapt Analysis

"IRISH SEA COD WGCSE 2011 COMBS PLUSGROUP"

CPUE data from file cod7tun.txt

Catch data for 43 years : 1968 to 2010. Ages 0 to 5+

Fleet	First year	Last year	First age	Last age	Alpha	Beta
NIGFSMAR(1-4gp)	1993	2011	1	4	0.25	0.35
ScoGFS-Q1 Survey (No	1996	2011	1	4	0.25	0.35
NIGFSOCT(0 2-gp)	1992	2011	0	0	0.83	0.88
ENGBTS-Sept	1993	2011	0	0	0.75	0.79
NIMIKNET	1994	2011	0	0	0.38	0.46

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Fleet	PowerQ ages<x	QPlateau ages>x
NIGFSMAR(1-4gp)	0	3
ScoGFS-Q1 Survey (No	0	3
NIGFSOCT(0 2-gp)	0	3
ENGBTS-Sept	0	3
NIMIKNET	0	3

Catchability independent of stock size for all ages

Bias estimation :

Bias estimated for the final 11 years.

Oldest age F estimates in 1968 to 2011 calculated as 1.000 * the mean F of ages 3- 3

Total F penalty applied lambda = 1.000

Individual fleet weighting not applied

INITIAL SSQ =	1749.69962
PARAMETERS =	15
OBSERVATIONS =	218
SSQ =	100.37616
QSSQ =	93.57441
CSSQ =	6.80176
IFAIL =	0

IFAILCV = 0

Regression weights

	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1	1	1	1	1

Fishing mortalities

Age	2.00E+03	2.00E+03	2.00E+03	2.00E+03	2.01E+03	2006	2007	2008	2009	2010
0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0	0	0
1	2.38E-01	1.50E-01	2.05E-01	1.56E-01	1.26E-01	0.044	0.154	0.14	0.073	0.044
2	7.32E-01	1.24E+00	1.11E+00	7.69E-01	7.90E-01	1.143	0.956	1.048	1.063	1.044
3	1.59E+00	1.74E+00	1.44E+00	1.47E+00	1.20E+00	2.245	1.612	1.556	1.738	1.27
4	1.59E+00	1.74E+00	1.44E+00	1.47E+00	1.20E+00	2.245	1.612	1.556	1.738	1.27

Population numbers (Thousands)

YEAR \ AGE	0	1	2	3	4
2001	4.67E+03	3.27E+03	3.30E+03	1.34E+02	3.29E+01
2002	1.24E+03	3.82E+03	2.11E+03	1.30E+03	2.25E+01
2003	2.08E+03	1.01E+03	2.69E+03	4.99E+02	1.88E+02
2004	1.27E+03	1.70E+03	6.76E+02	7.28E+02	9.68E+01
2005	1.47E+03	1.04E+03	1.19E+03	2.57E+02	1.37E+02
2006	1.20E+03	1.20E+03	7.50E+02	4.44E+02	6.34E+01
2007	3.52E+02	9.85E+02	9.42E+02	1.96E+02	3.85E+01
2008	8.81E+02	2.88E+02	6.91E+02	2.97E+02	3.20E+01
2009	3.24E+03	7.21E+02	2.05E+02	1.99E+02	5.12E+01
2010	1.55E+03	2.65E+03	5.49E+02	5.79E+01	2.86E+01

Table 6.2.8. Continued.

Estimated population abundance at 1st Jan 2011

	0.00E+00	1.27E+03	2.08E+03	1.58E+02	1.33E+01

Taper weighted geometric mean of the VPA populations:

4.13E+03	3.46E+03	2.30E+03	8.31E+02	2.23E+02

Standard error of the weighted Log(VPA populations) :

0.8759	0.8624	0.819	0.8969	1.0834

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	1	2	3	4
Mean Log q	-1.8122	-1.2504	-1.5247	-1.5247
S.E(Log q)	0.5613	0.3839	0.4805	0.7633

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	0.78	1.671	3.04	0.79	18	0.41748	-1.81
2	1.2	-1.532	0.06	0.78	18	0.44415	-1.25
3	1.03	-0.207	1.39	0.74	18	0.50975	-1.52
4	1.13	-0.439	1.45	0.45	17	0.82447	-1.79

Fleet : ScoGFS-Q1 Survey (No

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	1	2	3	4
Mean Log q	-5.4517	-3.7817	-2.8298	-2.8298
S.E(Log q)	0.8618	0.4394	0.6661	0.9357

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	0.81	0.538	5.85	0.48	11	0.72758	-5.45
2	0.79	1.31	4.54	0.81	11	0.33375	-3.78
3	0.65	2.128	4.04	0.8	11	0.37043	-2.83
4	0.93	0.257	2.35	0.65	9	0.63031	-2.18

Fleet : NIGFSOCT(0 2-gp)

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	0
Mean Log q	-1.8146
S.E(Log q)	0.9957

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	0.53	3.662	4.53	0.78	19	0.40903	-1.81

Fleet : ENGBTS-Sept

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	0
Mean Log q	-4.8454
S.E(Log q)	0.7281

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	1.14	-0.517	4.46	0.47	18	0.84579	-4.85

Fleet : NIMIKNET

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	0
Mean Log q	-5.6256
S.E(Log q)	1.2667

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	0.6	1.368	6.46	0.45	16	0.7359	-5.63

Table 6.2.8. Continued.

Year	Est.Landings	Landings	Bias
1968	9779	8541	
1969	9834	7991	
1970	6831	6426	
1971	9549	9246	
1972	10710	9234	
1973	12968	11819	
1974	11955	10251	
1975	10650	9863	
1976	10557	10247	
1977	8173	8054	
1978	5556	6271	
1979	7430	8371	
1980	10534	10776	
1981	13858	14907	
1982	13503	13381	
1983	10183	10015	
1984	8274	8383	
1985	10442	10483	
1986	9819	9852	
1987	12891	12894	
1988	14166	14168	
1989	12781	12751	
1990	7400	7379	
1991	7074	7095	
1992	7715	7735	
1993	7551	7555	
1994	5404	5402	
1995	4587	4587	
1996	4962	4964	
1997	5858	5859	
1998	5309	5318	
1999	4785	4784	
2000	2438	1274	1.915
2001	4205	2252	1.87
2002	6652	2695	2.465
2003	4897	1285	3.793
2004	3548	1072	3.297
2005	2437	910	2.671
2006	2784	840	3.321
2007	1820	702	2.603
2008	1652	662	2.496
2009	1089	466	2.326
2010	1193	464	2.57

Parameters

Age	Survivors	s.e log est
0	1269.45708	0.36934
1	2078.36073	0.32283
2	158.18414	0.47398
3	13.3226	0.47417

Year	Multiplier	s.e log est
33	1.91498	0.22848
34	1.87004	0.24679
35	2.4651	0.23103
36	3.79283	0.23881
37	3.29676	0.24487
38	2.67081	0.2404
39	3.32085	0.22067
40	2.60328	0.2482
41	2.49643	0.25406
42	2.32638	0.2677
43	2.57018	0.28788

Variance covariance matrix

0.13641	0.01262	0.0097	0.00606	0.00921	0.01048	0.0103	0.0098	0.00943	0.0094	0.0095	0.01036	0.01093	0.01112	0.01191
0.01262	0.10422	0.01133	0.00761	0.00903	0.01025	0.01007	0.0096	0.00934	0.0094	0.0095	0.00957	0.00833	0.00665	0.02693
0.0097	0.01133	0.22466	0.00605	0.00876	0.00994	0.00976	0.0093	0.00921	0.0093	0.0094	0.00917	0.0053	0.01129	-0.01148
0.00606	0.00761	0.00605	0.22483	0.00841	0.00952	0.00873	0.0085	0.009	0.009	0.0088	0.00714	0.00481	-0.0041	0.00509
0.00921	0.00903	0.00876	0.00841	0.05221	0.01674	0.00794	0.0078	0.00895	0.0096	0.0097	0.00939	0.00903	0.00883	0.00889
0.01048	0.01025	0.00994	0.00952	0.01674	0.06091	0.01693	0.0068	0.00792	0.0101	0.011	0.01077	0.0103	0.01001	0.01006
0.0103	0.01007	0.00976	0.00873	0.00794	0.01693	0.05338	0.0178	0.00771	0.0079	0.0096	0.01029	0.00998	0.00965	0.00967
0.00983	0.0096	0.0093	0.00847	0.00777	0.0068	0.0178	0.057	0.01665	0.0072	0.0072	0.00901	0.00945	0.00936	0.00935
0.00943	0.00934	0.00921	0.009	0.00895	0.00792	0.00771	0.0167	0.05996	0.019	0.0062	0.00644	0.00819	0.00908	0.00932
0.00941	0.00942	0.00931	0.00903	0.00958	0.01007	0.00789	0.0072	0.019	0.0578	0.0152	0.00578	0.00612	0.00793	0.00898
0.00952	0.00947	0.00942	0.00883	0.00965	0.01095	0.00962	0.0072	0.00615	0.0152	0.0487	0.01732	0.00791	0.00663	0.00794
0.01036	0.00957	0.00917	0.00714	0.00939	0.01077	0.01029	0.009	0.00644	0.0058	0.0173	0.0616	0.02069	0.0071	0.00626

Table 6.2.9. Cod in VIIa. Point estimates of population numbers-at-age from the update B-Adapt assessment. Figures for 2011 are the values assumed for a 25% reduction in F in the intermediate year.

Population numbers (Thousands)

YEAR	0	1	2	3	4	5+
1968	6512	3424	3710	1600	727	330
1969	8506	5332	2475	1640	420	467
1970	15131	6964	3571	711	412	473
1971	5239	12388	4516	1684	268	220
1972	13883	4289	7680	1891	574	269
1973	3107	11366	2802	3367	812	480
1974	11055	2544	7270	1317	1168	485
1975	3533	9051	1606	2777	580	722
1976	5103	2893	5881	740	1020	336
1977	5529	4178	1353	2135	282	500
1978	12082	4527	2686	650	652	218
1979	14196	9892	3087	1222	255	472
1980	7923	11623	6513	1376	459	196
1981	3461	6487	7238	2832	477	286
1982	5264	2833	4142	2685	1028	334
1983	7879	4310	2009	1359	903	362
1984	7922	6451	2796	813	444	437
1985	6350	6486	3864	1221	274	280
1986	18442	5199	4214	1290	375	238
1987	8743	15099	3380	1448	434	203
1988	3803	7158	8481	1170	438	182
1989	4904	3113	3361	2732	335	178
1990	5648	4015	2025	835	570	153
1991	8751	4624	2648	701	201	190
1992	1709	7165	2022	914	182	125
1993	5110	1399	4629	553	163	40
1994	3699	4184	945	1212	97	43
1995	3121	3028	2751	268	243	19
1996	5793	2555	2031	1107	61	71
1997	2106	4743	1806	672	285	44
1998	882	1724	3412	460	110	49
1999	5672	722	1227	1080	81	34
2000	4000	4644	529	260	121	13
2001	4668	3275	3303	134	33	29
2002	1238	3822	2112	1301	22	16
2003	2082	1014	2694	499	188	6
2004	1270	1704	676	728	97	39
2005	1468	1040	1193	257	137	24
2006	1203	1202	750	444	63	46
2007	352	985	942	196	38	3
2008	881	288	691	297	32	10
2009	3240	721	205	199	51	10
2010	1551	2652	549	58	29	8
2011	0	1269	2078	158	13	8

Table 6.2.10. Cod in VIIa. Point estimates of fishing mortality-at-age from the update B-Adapt assessment.

YEAR	AGE						
	0	1	2	3	4	5+	F(2-4)
1968	0	0.1245	0.6164	1.13692	1.13692	1.13692	0.963
1969	0	0.20079	1.04717	1.1811	1.1811	1.1811	1.136
1970	0	0.23302	0.55169	0.7749	0.7749	0.7749	0.700
1971	0	0.27816	0.67049	0.87669	0.87669	0.87669	0.808
1972	0	0.2259	0.62467	0.64557	0.64557	0.64557	0.639
1973	0	0.24688	0.55469	0.85845	0.85845	0.85845	0.757
1974	0	0.25995	0.76226	0.61958	0.61958	0.61958	0.667
1975	0	0.23107	0.5744	0.80211	0.80211	0.80211	0.726
1976	0	0.56022	0.81335	0.76423	0.76423	0.76423	0.781
1977	0	0.24161	0.53305	0.98629	0.98629	0.98629	0.835
1978	0	0.18265	0.58731	0.73405	0.73405	0.73405	0.685
1979	0	0.21794	0.60822	0.78036	0.78036	0.78036	0.723
1980	0	0.2736	0.63284	0.85897	0.85897	0.85897	0.784
1981	0	0.24851	0.79172	0.81347	0.81347	0.81347	0.806
1982	0	0.1439	0.91462	0.88982	0.88982	0.88982	0.898
1983	0	0.23266	0.70515	0.91805	0.91805	0.91805	0.847
1984	0	0.31241	0.62861	0.88556	0.88556	0.88556	0.800
1985	0	0.23117	0.89705	0.98131	0.98131	0.98131	0.953
1986	0	0.23058	0.86803	0.88948	0.88948	0.88948	0.882
1987	0	0.37677	0.86069	0.99513	0.99513	0.99513	0.950
1988	0	0.55588	0.93275	1.0518	1.0518	1.0518	1.012
1989	0	0.23	1.19212	1.36679	1.36679	1.36679	1.309
1990	0	0.21616	0.86141	1.22304	1.22304	1.22304	1.102
1991	0	0.62718	0.86353	1.14933	1.14933	1.14933	1.054
1992	0	0.23688	1.09733	1.52344	1.52344	1.52344	1.381
1993	0	0.19268	1.14022	1.53816	1.53816	1.53816	1.406
1994	0	0.21916	1.05845	1.40628	1.40628	1.40628	1.290
1995	0	0.19947	0.7104	1.28938	1.28938	1.28938	1.096
1996	0	0.1471	0.90539	1.15533	1.15533	1.15533	1.072
1997	0	0.12947	1.16694	1.61263	1.61263	1.61263	1.464
1998	0	0.13986	0.95008	1.53169	1.53169	1.53169	1.338
1999	0	0.11217	1.35273	1.98599	1.98599	1.98599	1.775
2000	0	0.14061	1.17177	1.86649	1.86649	1.86649	1.635
2001	0	0.23841	0.73186	1.58569	1.58569	1.58569	1.301
2002	0	0.14982	1.24391	1.73646	1.73646	1.73646	1.572
2003	0	0.20477	1.10817	1.43923	1.43923	1.43923	1.329
2004	0	0.15637	0.76897	1.47367	1.47367	1.47367	1.239
2005	0	0.12648	0.78969	1.19856	1.19856	1.19856	1.062
2006	0	0.04359	1.14253	2.24474	2.24474	2.24474	1.877
2007	0	0.15384	0.95559	1.6115	1.6115	1.6115	1.393
2008	0	0.14008	1.04754	1.55632	1.55632	1.55632	1.387
2009	0	0.07262	1.06343	1.73785	1.73785	1.73785	1.513
2010	0	0.0439	1.04425	1.27005	1.27005	1.27005	1.195

Table 6.2.11. Cod in VIIa. Summary data from the update B-Adapt assessment. "B-Adapt removals" are the estimated total removals from 2000 onwards in excess of removals due to the assumed natural mortality rate.

Summary (without SOP correction)

Year	Recruits age 0 (thousands)	Total biomass (t)	Spawning stock biomass (t)	Input landings (t)	B-Adapt removals (t)	FBAR 2- 4
1968	6512	19351	13444	8541		0.9634
1969	8506	18040	12241	7991		1.1365
1970	15131	17709	9785	6426		0.7005
1971	5239	23476	11271	9246		0.808
1972	13883	26393	15873	9234		0.6386
1973	3107	30044	20227	11819		0.7572
1974	11055	27155	18121	10251		0.6671
1975	3533	25060	17886	9863		0.7262
1976	5103	21465	13647	10247		0.7806
1977	5529	16614	12673	8054		0.8352
1978	12082	14188	8662	6271		0.6851
1979	14196	19638	10426	8371		0.723
1980	7923	26103	12310	10776		0.7836
1981	3461	29723	18317	14907		0.8062
1982	5264	27025	20249	13381		0.8981
1983	7879	21842	15260	10015		0.8471
1984	7922	18773	11249	8383		0.7999
1985	6350	21980	12055	10483		0.9532
1986	18442	20979	12026	9852		0.8823
1987	8743	28289	12995	12894		0.9503
1988	3803	26056	13492	14168		1.0121
1989	4904	21061	14300	12751		1.3086
1990	5648	14540	8725	7379		1.1025
1991	8751	13177	6531	7095		1.0541
1992	1709	15518	7231	7735		1.3814
1993	5110	12376	6295	7555		1.4055
1994	3699	10460	5995	5402		1.2903
1995	3121	10439	4575	4587		1.0964
1996	5793	10298	5747	4964		1.072
1997	2106	11796	5614	5859		1.4641
1998	882	9889	4811	5318		1.3378
1999	5672	6772	4920	4784		1.7749
2000	4000	6647	2044	1274	2440	1.6349
2001	4668	10227	3252	2252	4211	1.3011
2002	1238	12227	6223	2695	6643	1.5723
2003	2082	8417	4420	1285	4874	1.3289
2004	1270	6970	4152	1072	3534	1.2388
2005	1468	5083	2700	910	2431	1.0623
2006	1203	4612	2763	840	2790	1.8773
2007	352	3538	1637	702	1827	1.3929
2008	881	2670	1733	662	1652	1.3867
2009	3240	2231	1185	466	1084	1.513
2010	1551	5065	947	464	1192	1.1948
2011		6160*	2260*			
Average (1968-2010)	5651	15905	9256	6912	2971	1.0964

* = calculated from surviver point estimates

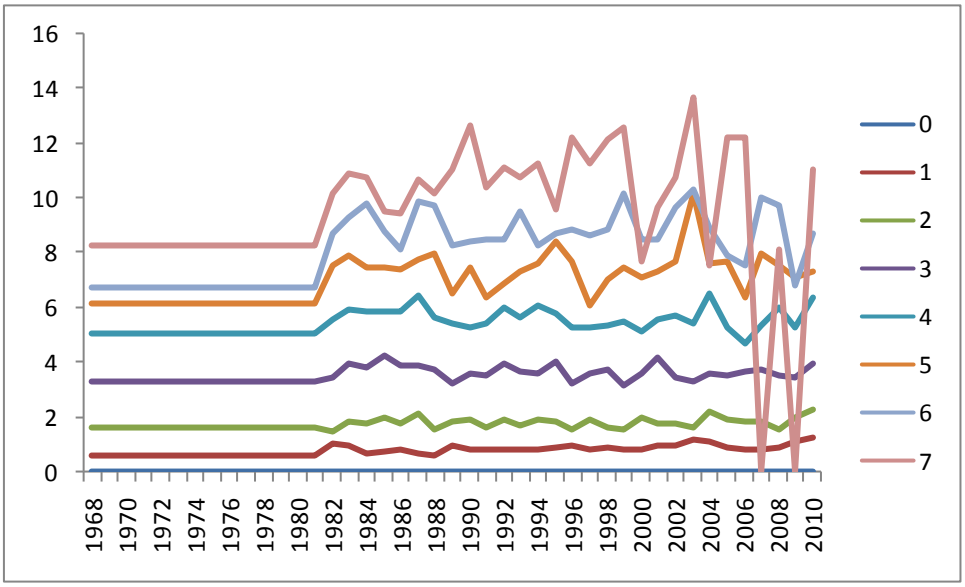


Figure 6.2.1. Cod in VIIa. Catch weights-at-age (same as stock weights).

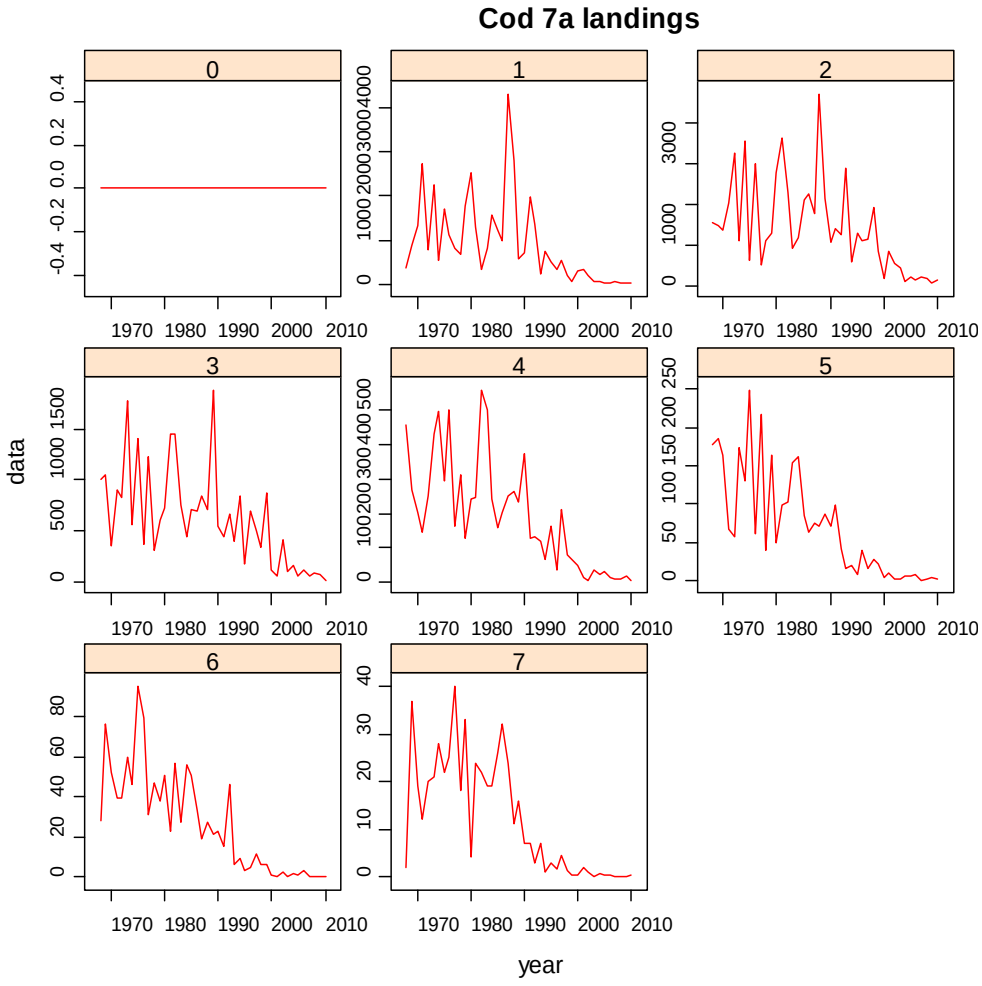


Figure 6.2.2. Cod in VIIa. Landings number per age.

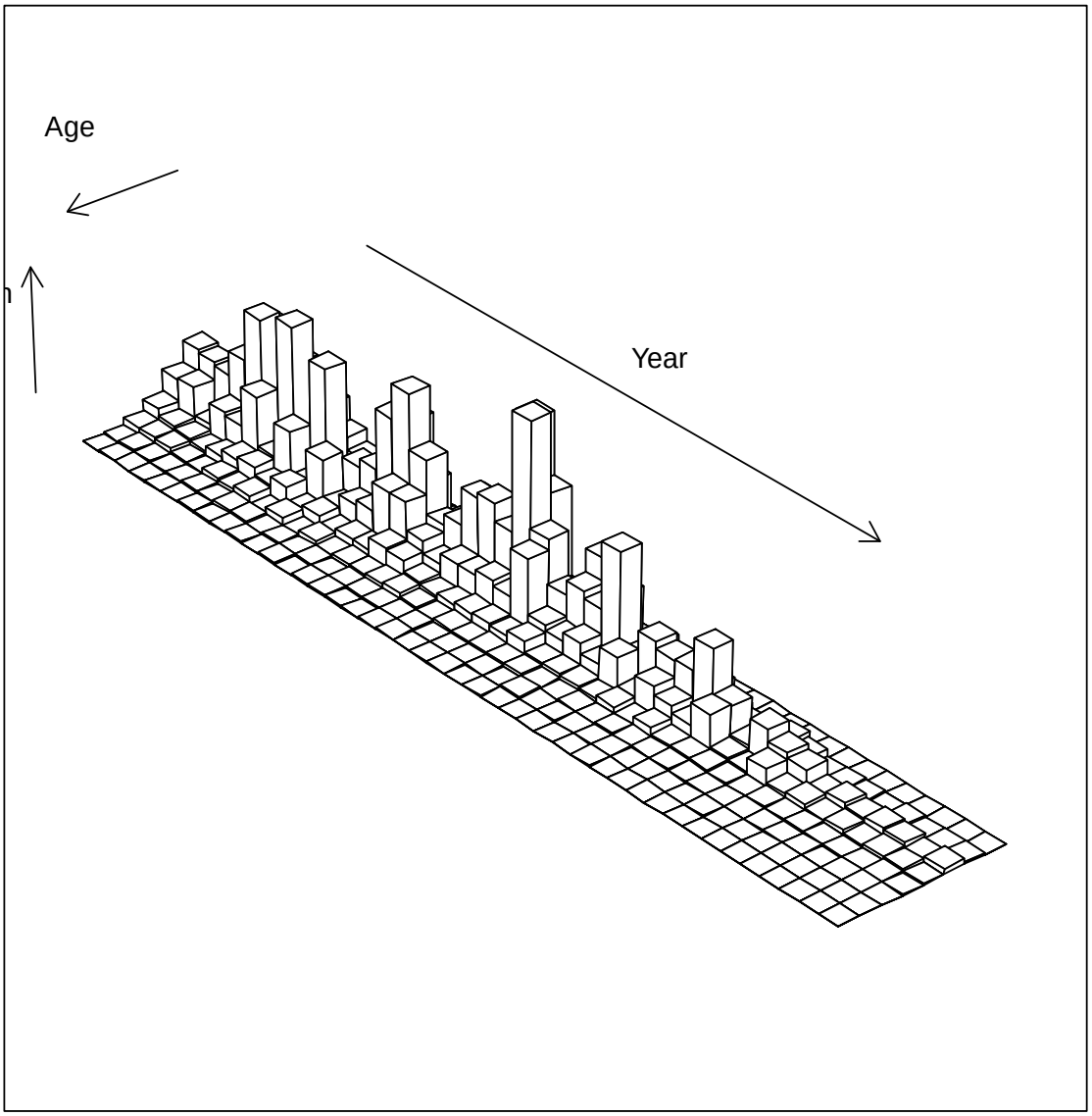


Figure 6.2.3. Cod in VIIa. Landings per age as 3D bars.

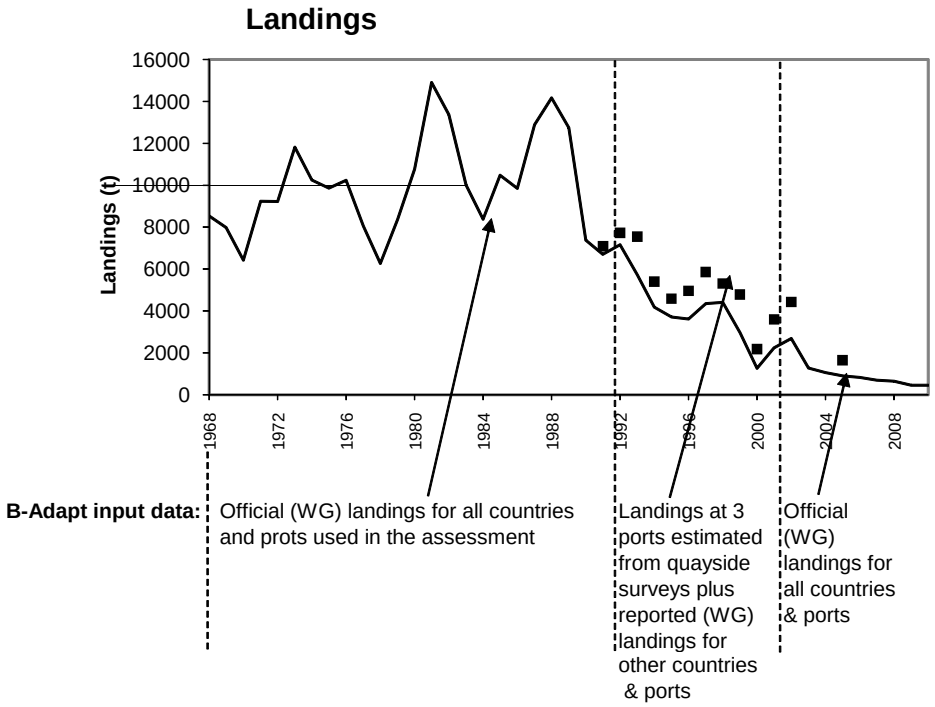


Figure 6.2.4. Cod in VIIa. Landings data used in the B-Adapt assessment.

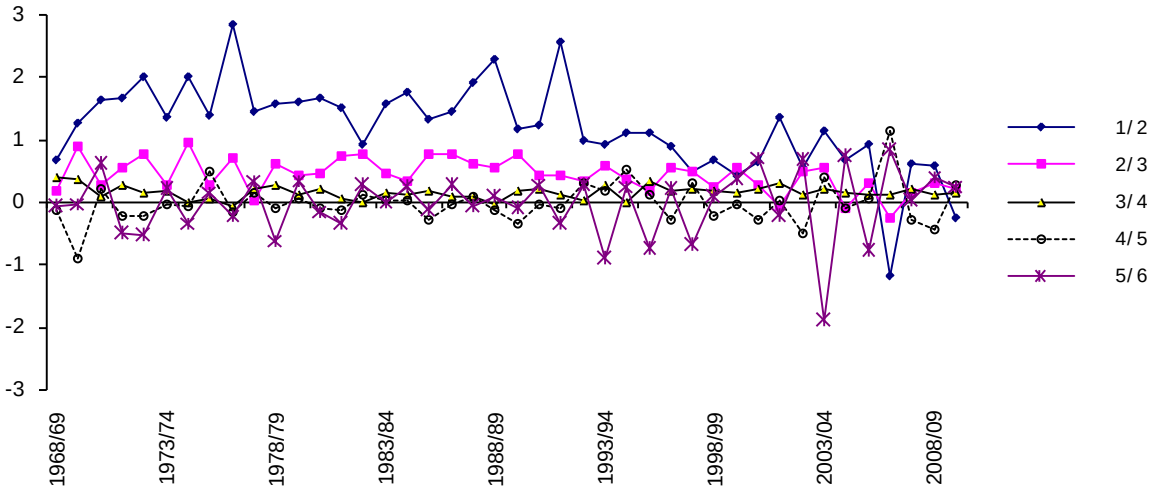
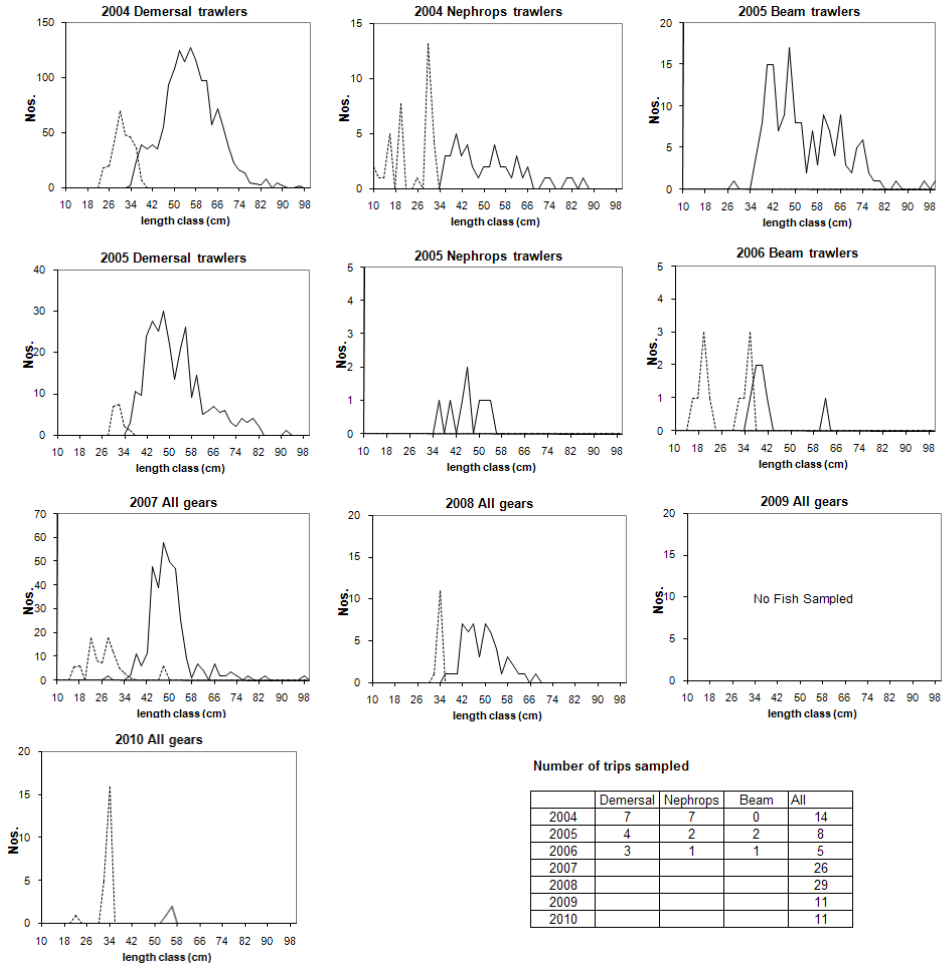


Figure 6.2.5. Cod in VIIa. Separable VPA residuals.



	Demersal	Nephrops	Beam	All
2004	7	7	0	14
2005	4	2	2	8
2006	3	1	1	5
2007				26
2008				29
2009				11
2010				11

Figure 6.2.6. Cod in VIIa. Length frequencies of retained and discarded cod recorded by observers on UK(E&W) fishing vessels in 2004–2010 (nos. for observed trips).

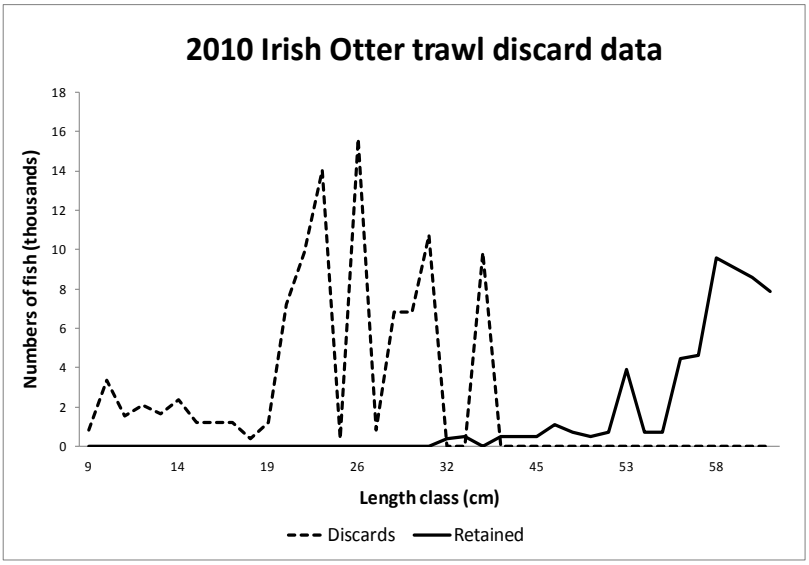


Figure 6.2.7. Cod in VIIa. Length frequencies of retained and discarded cod recorded by observers on Irish otter trawl vessels in 2010, raised to fleet level (no. trips sampled = 4).

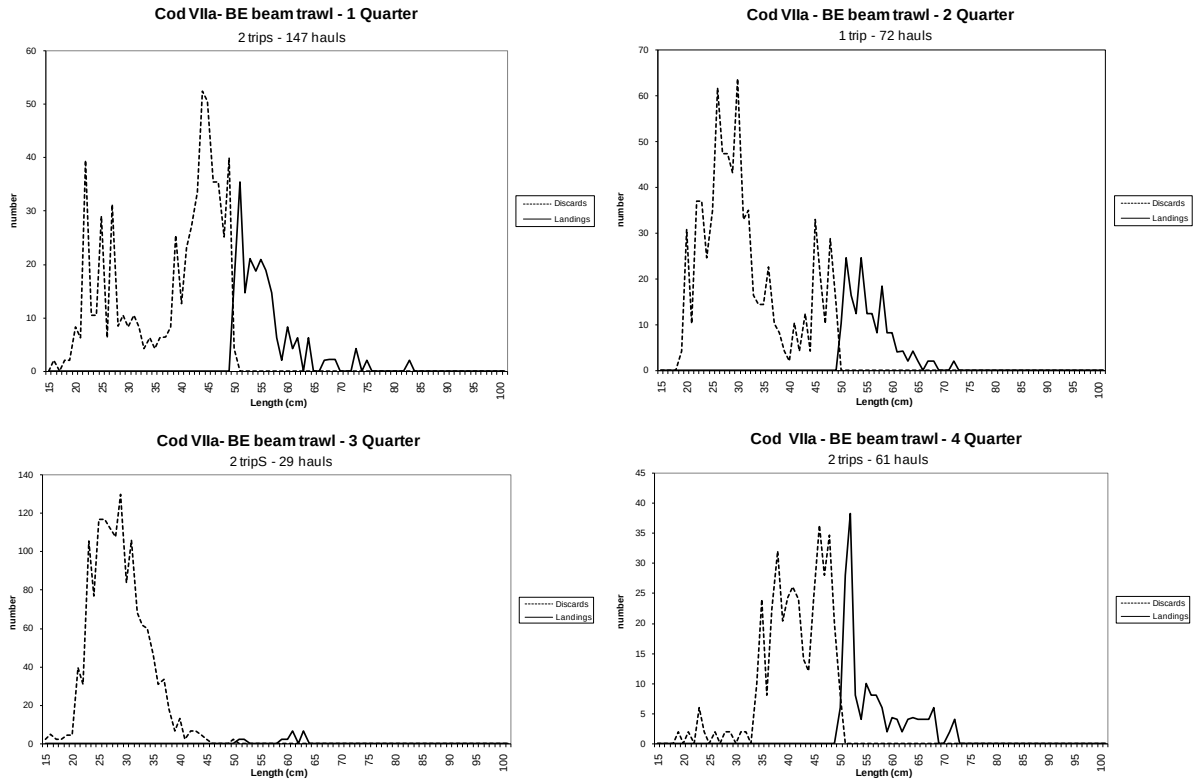


Figure 6.2.8. Cod in VIIa. Belgian length frequencies of retained and discarded cod.

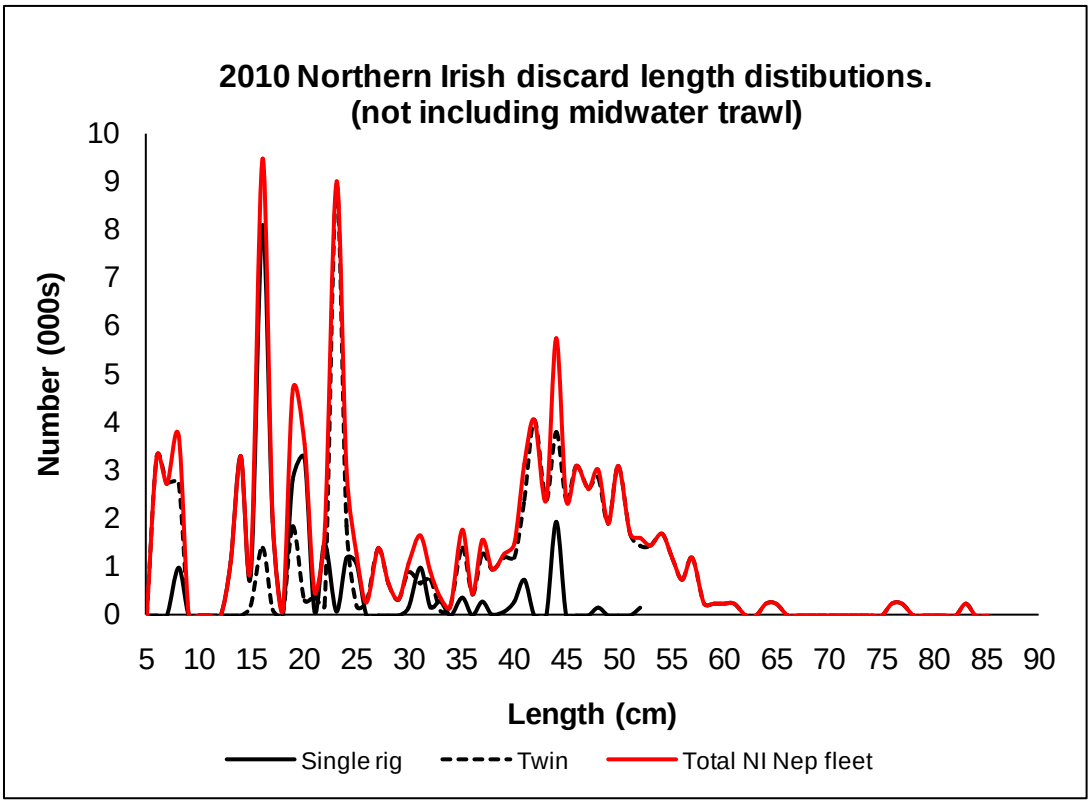


Figure 6.2.9. Cod in VIIa. Length frequencies of discarded cod on Northern Irish Nephrops fleet (single and twin trawl).

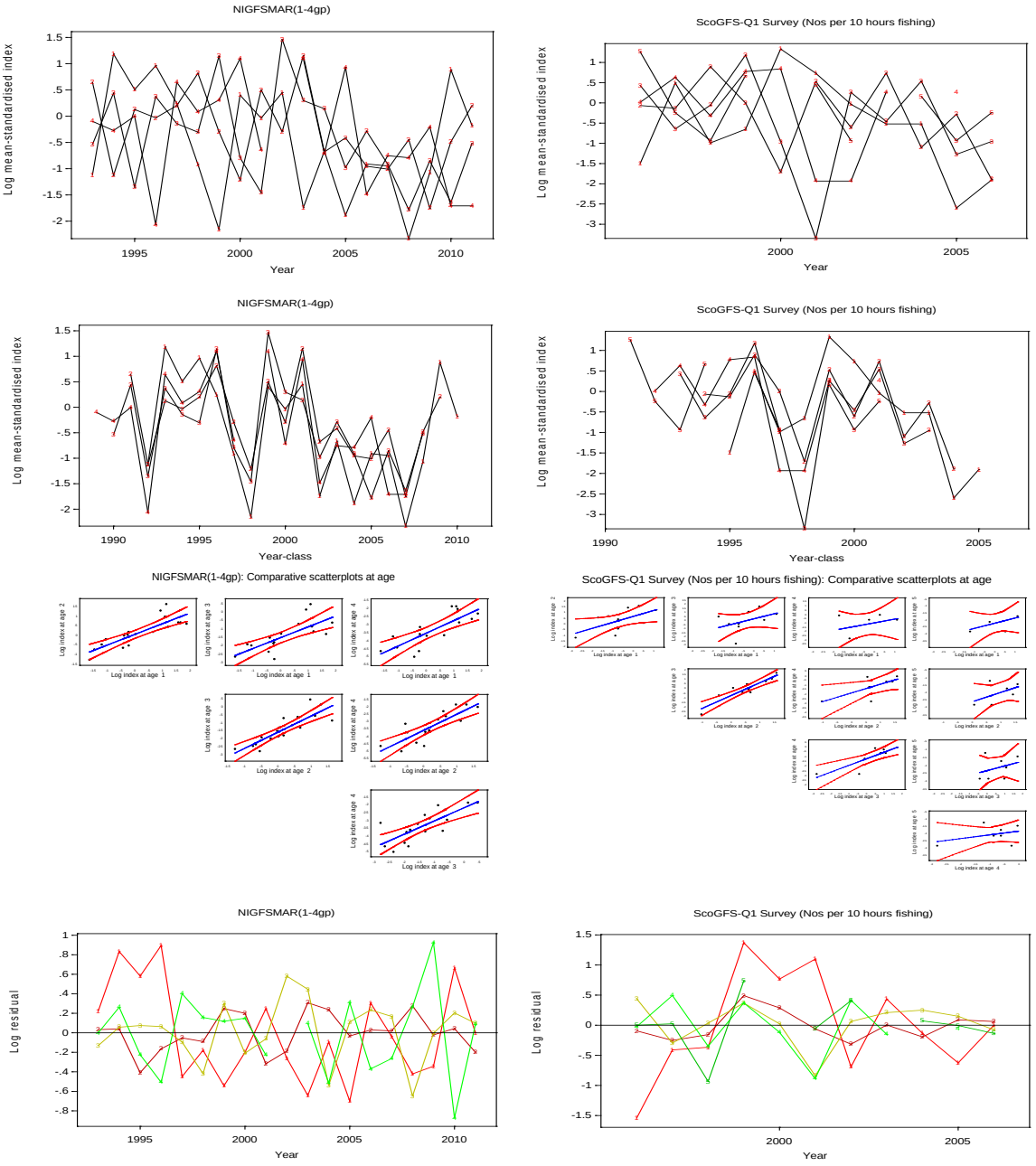


Figure 6.2.10. Cod in VIIa. Log survey indices for NIGFS-Mar and ScoGFS-Q1 trawl surveys by year and year class; comparative scatterplots of indices within year classes, and residuals from Surba model fits.

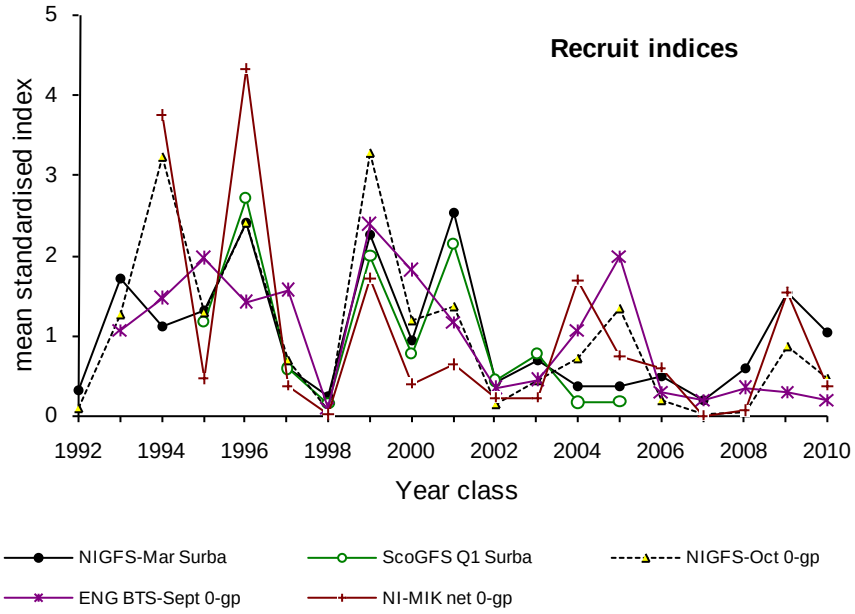


Figure 6.2.11. Cod in VIIa. Consistency between trends in year-class strength estimated from SURBA analysis of NIGFS-Mar and ScoGFS-Q1 surveys and the other 0-gp indices used in the assessment.

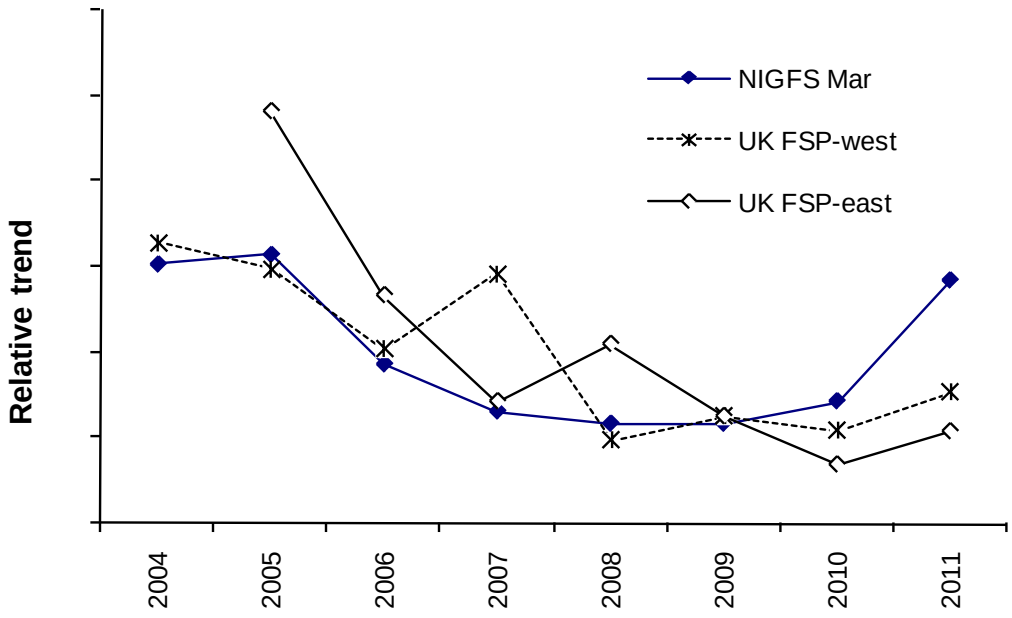


Figure 6.2.12. Cod in VIIa. Trends in empirical SSB indices from 2004 onwards from the NIGFS-Mar compared with equivalent indices from UK Fisheries Science Partnership surveys of the western and eastern Irish Sea in February–March.

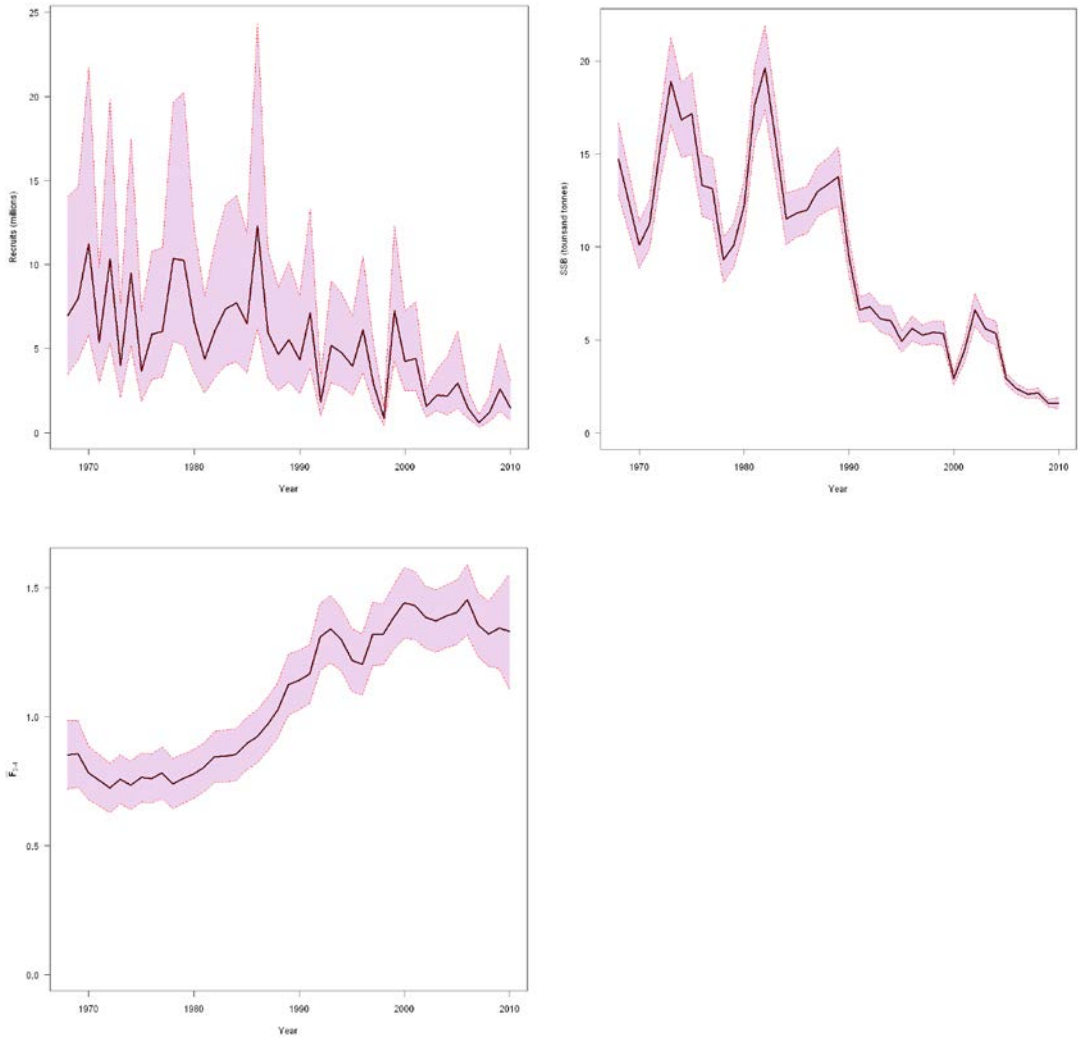


Figure 6.2.13. SAM model estimates of recruitment (top left) spawning-stock biomass (top right) and fishing mortality (bottom left).

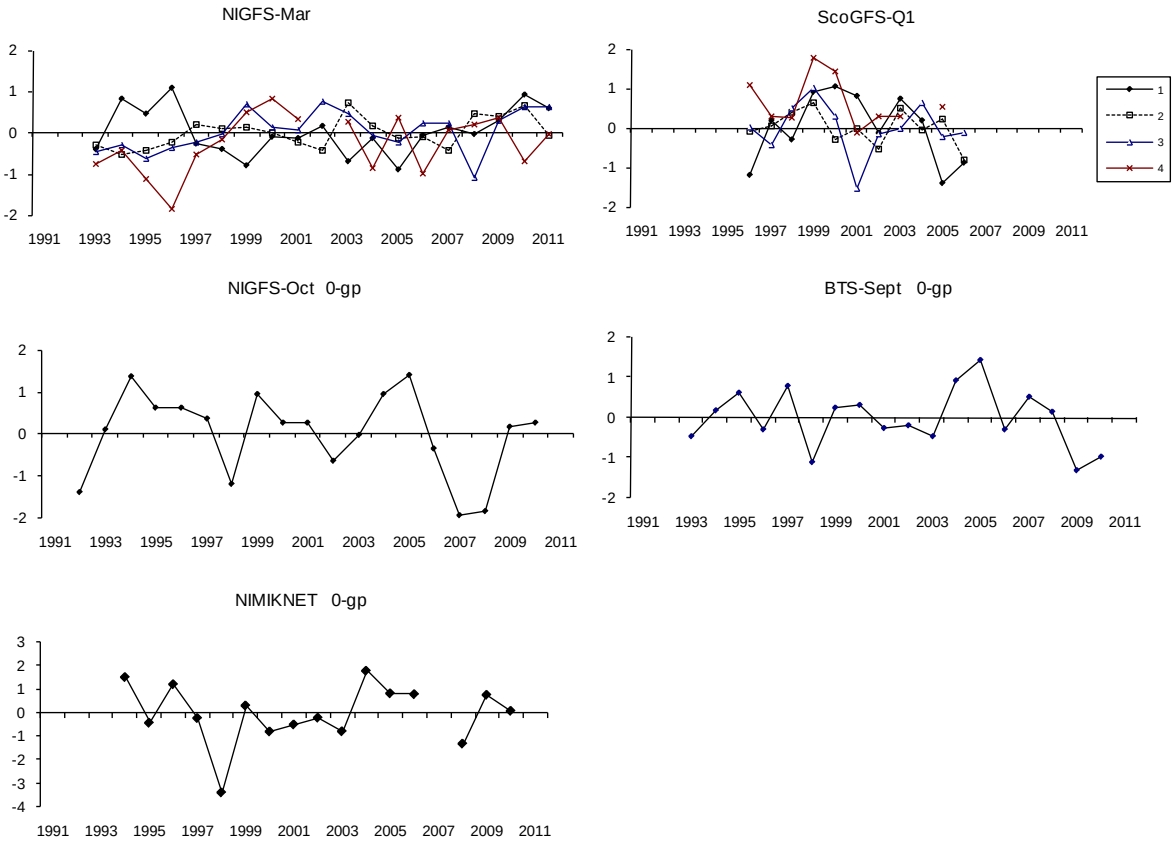


Figure 6.2.14. Cod in VIIa: Catchability residuals from the update B-Adapt run (non-bootstrap option).

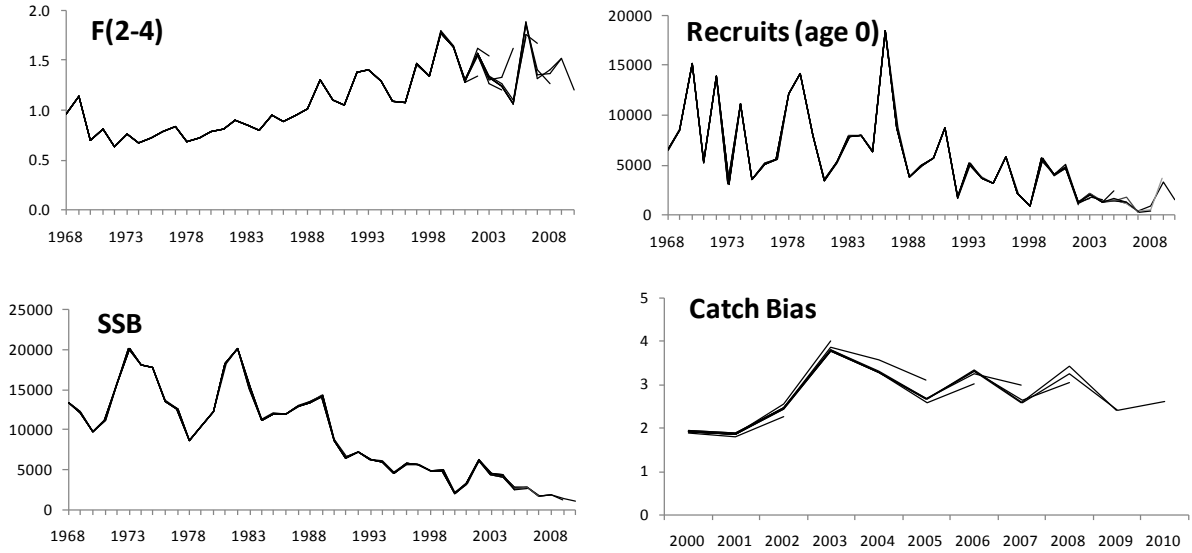


Figure 6.2.15. Retrospective plots for B-Adapt cod assessment. All runs use the non-bootstrap option and therefore give point estimates rather than bootstrap 50th percentiles.

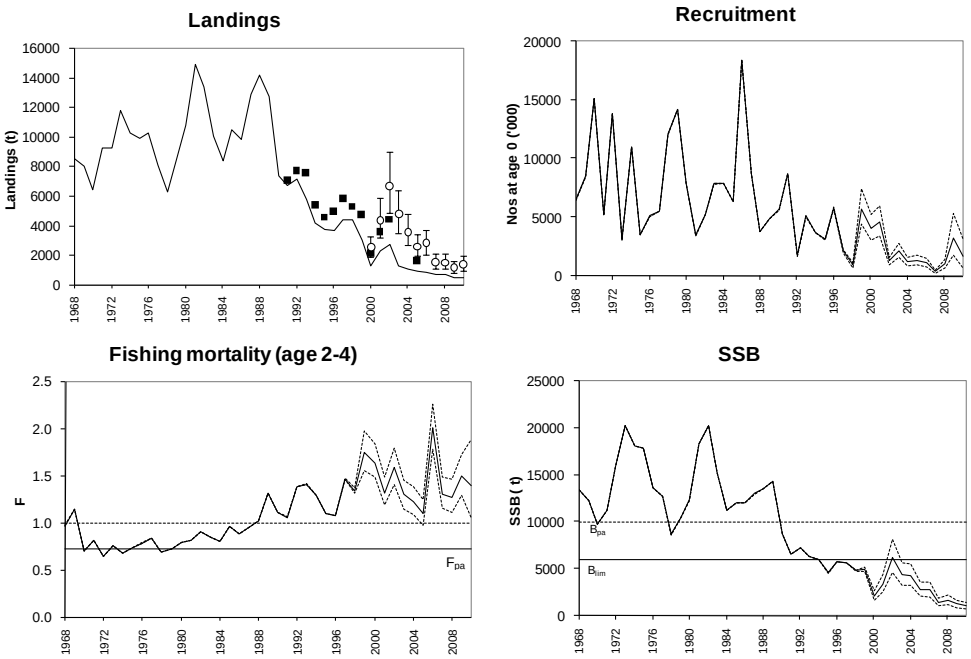


Figure 6.2.16. Stock summary plot from update B-Adapt run. Continuous line on landings plot is the reported landings; filled squares are landings in 1991–2002 and 2005 including sample-based estimates at three ports; open circles with 90% confidence intervals are total removals estimates (in excess of assumed natural mortality) from B-Adapt. Dotted lines on plots are 5th and 95th bootstrap percentiles, with the continuous line the median value.

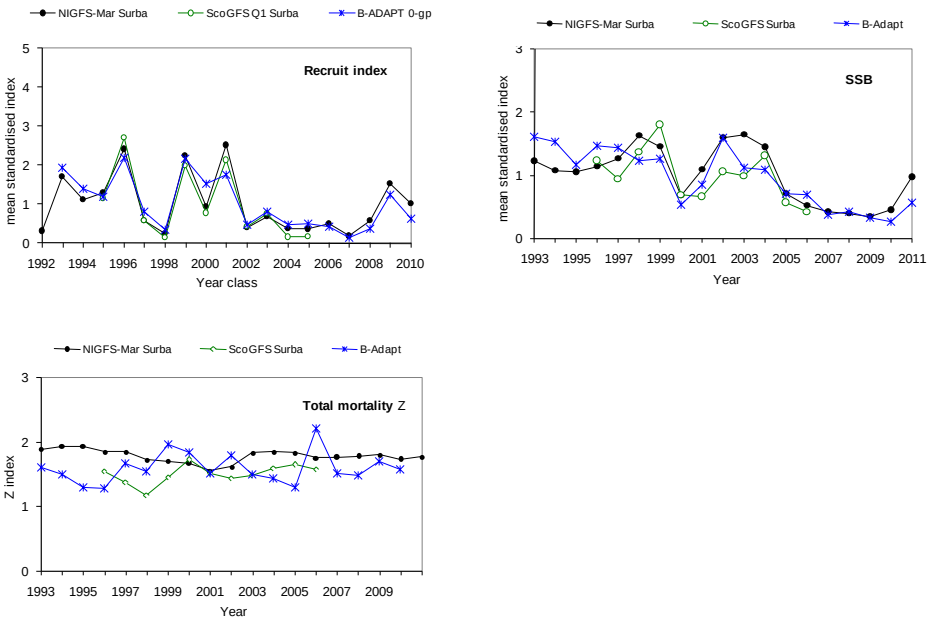


Figure 6.2.17. Cod in VIIa: comparison of updated B-ADAPT stock trends with indices of recruitment, SSB and fishing mortality from SURBA runs with NIGFS-Mar and ScoGFS-Q1 surveys. The B-Adapt estimates of F have been increased by M=0.2 to give Z indices comparable with the SURBA values.

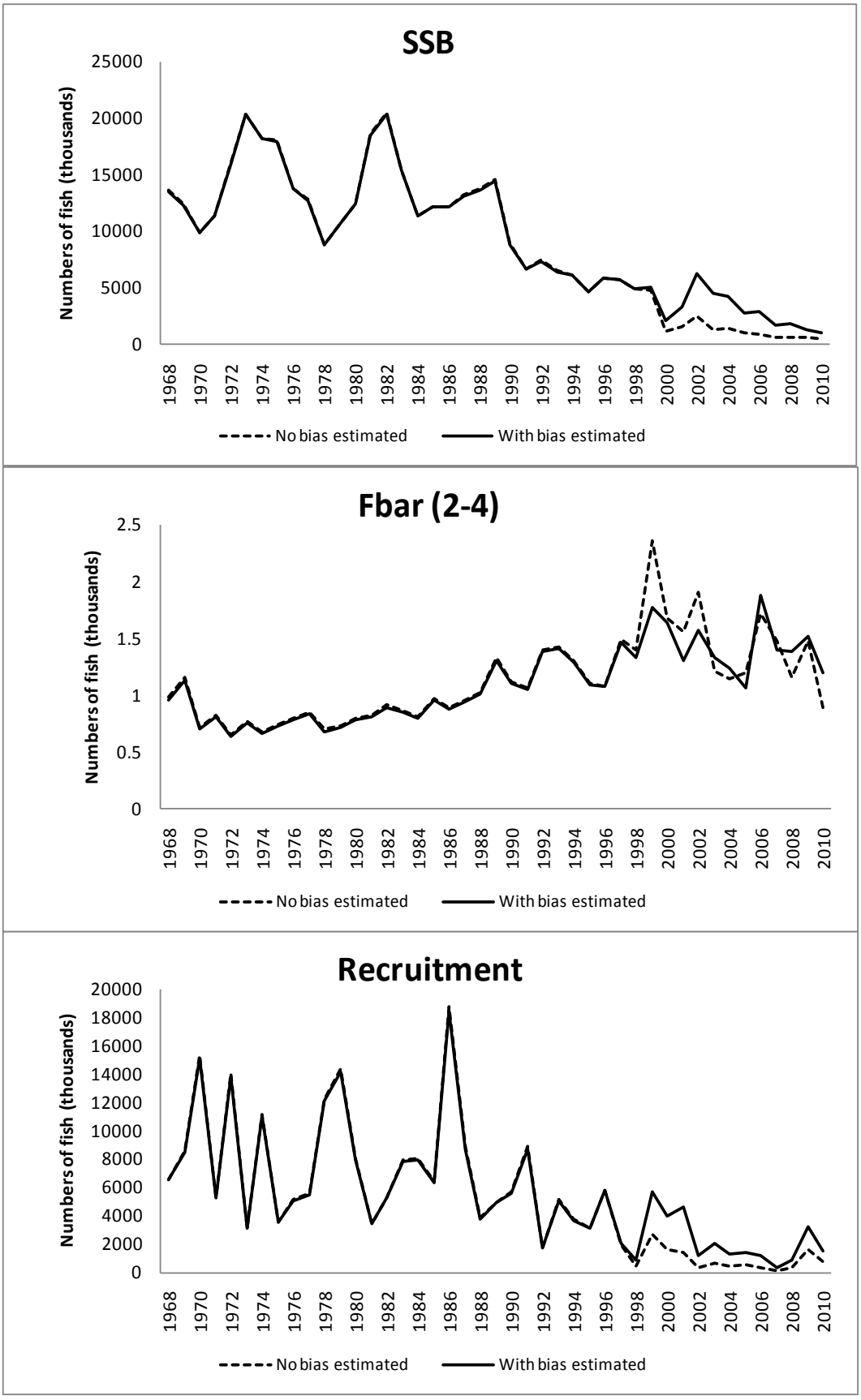


Figure 6.2.18. Comparison plots for non-bootstrap B-Adapt cod assessments with and without the bias estimated.

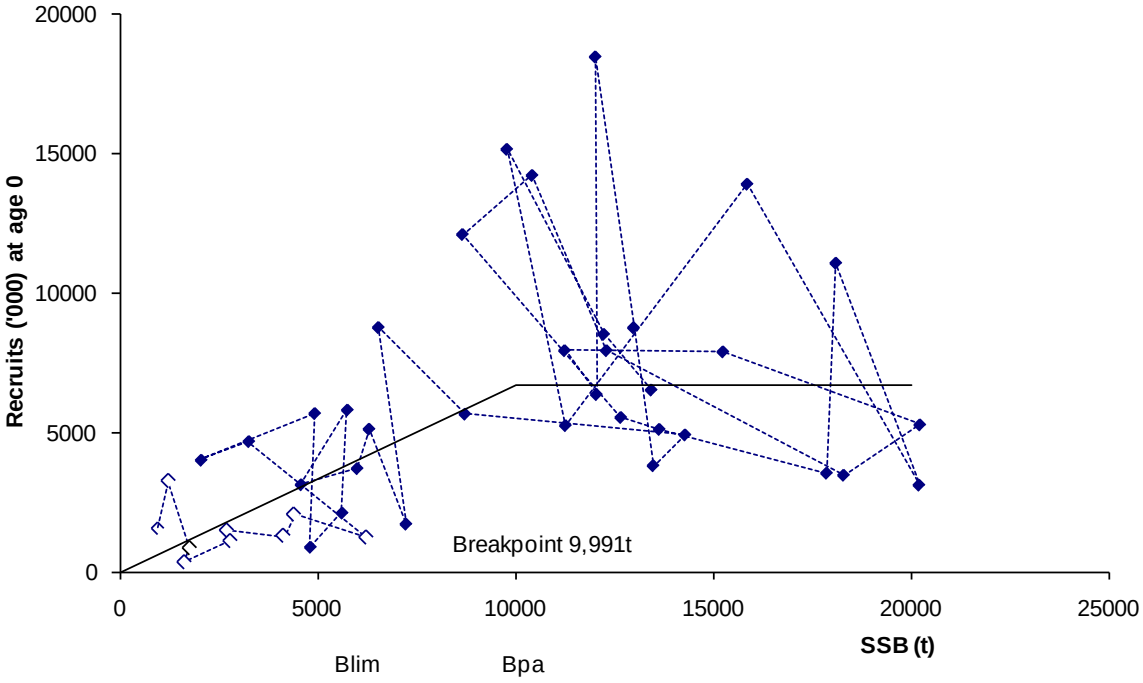


Figure 6.2.19. Cod in VIIa. Stock–recruit data with segmented regression model fitted assuming lognormal variability of recruitment. The most recent nine year classes are indicated by open symbols.

Fbar(2-4)	Year		
Percentile	2011	2012	2013
0.05	0.80	0.00	0.00
0.25	0.92	0.00	0.00
0.5	1.03	0.00	0.00
0.75	1.17	0.00	0.00
0.95	1.40	0.00	0.00

SSB	Year		
Percentile	2011	2012	2013
0.05	1440	2336	4958
0.25	1865	3169	6475
0.5	2220	3820	7779
0.75	2657	4544	9270
0.95	3382	5807	11676

Removals	Year		
Percentile	2011	2012	2013
0.05	1512	0	0
0.25	2034	0	0
0.5	2512	0	0
0.75	3139	0	0
0.95	4078	0	0

P(SSBYear > Blim)			
2011	2012	2013	2015
0.00	0.04	0.82	1.00

P(SSBYear > Bpa)			
2011	2012	2013	2015
0.00	0.00	0.16	0.95

Zero F projection
25% F reduction in 2011
Recruitment used = 2002 - 2010

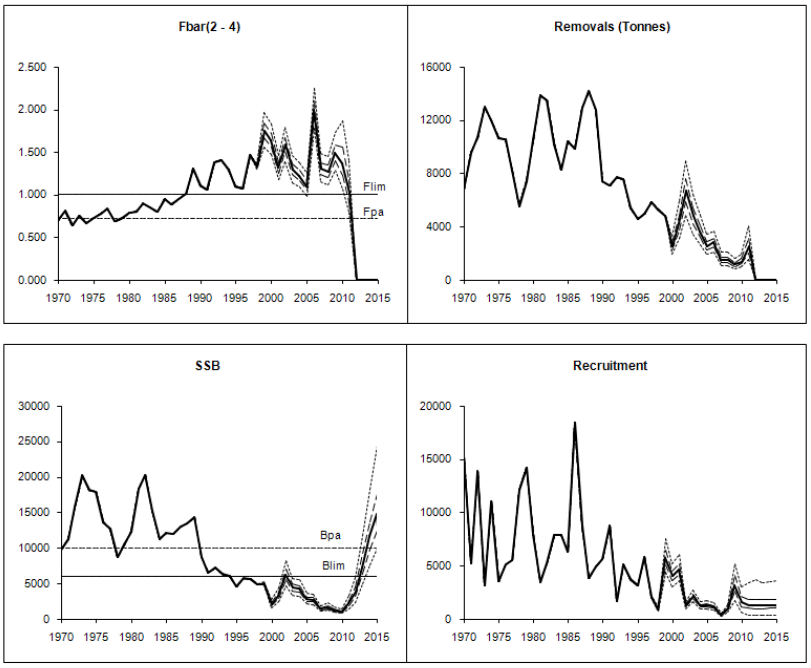


Figure 6.2.20. Cod in VIIa. Projection to 2015 based on the update B-Adapt assessment, assuming 25% F reduction in 2011 and zero F in subsequent years. Recruitment is bootstrapped from the 2002–2010 year classes. Percentiles of F, SSB and removals, and probability of SSB>B_{lim}, are tabulated for selected years.

Fbar(2-4)	Year		
Percentile	2011	2012	2013
0.05	0.80	0.60	0.45
0.25	0.92	0.69	0.52
0.5	1.03	0.77	0.58
0.75	1.17	0.88	0.66
0.95	1.40	1.05	0.79

SSB	Year		
Percentile	2011	2012	2013
0.05	1440	2336	2509
0.25	1865	3169	3285
0.5	2220	3820	4003
0.75	2657	4544	4868
0.95	3382	5807	6456

Removals	Year		
Percentile	2011	2012	2013
0.05	1512	1596	1357
0.25	2034	2077	1742
0.5	2512	2545	2083
0.75	3139	2989	2445
0.95	4078	3742	3318

P(SSBYear > Blim)			
2011	2012	2013	2015
0.00	0.04	0.08	0.35

P(SSBYear > Bpa)			
2011	2012	2013	2015
0.00	0.00	0.00	0.05

25 % reduction in F to F=0.4
Recruitment used = 2002 - 2010

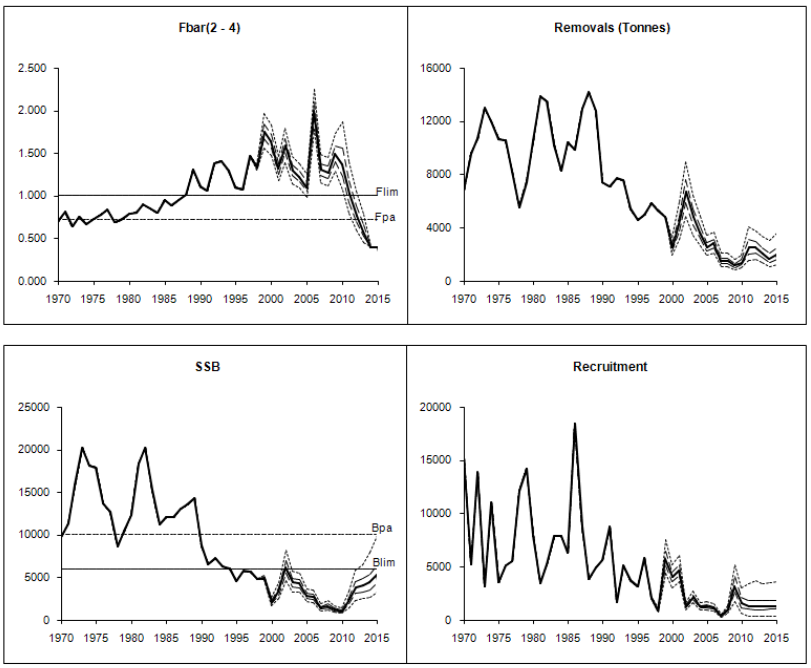


Figure 6.2.21. Cod in VIIa. Projection to 2015 based on the update B-Adapt assessment, assuming 25% annual F reduction in 2011 until the year when median F reaches a value of 0.4. Recruitment is bootstrapped from the 2002–2010 year classes. Percentiles of F, SSB and removals, and probability of SSB>B_{lim}, are tabulated for selected years.

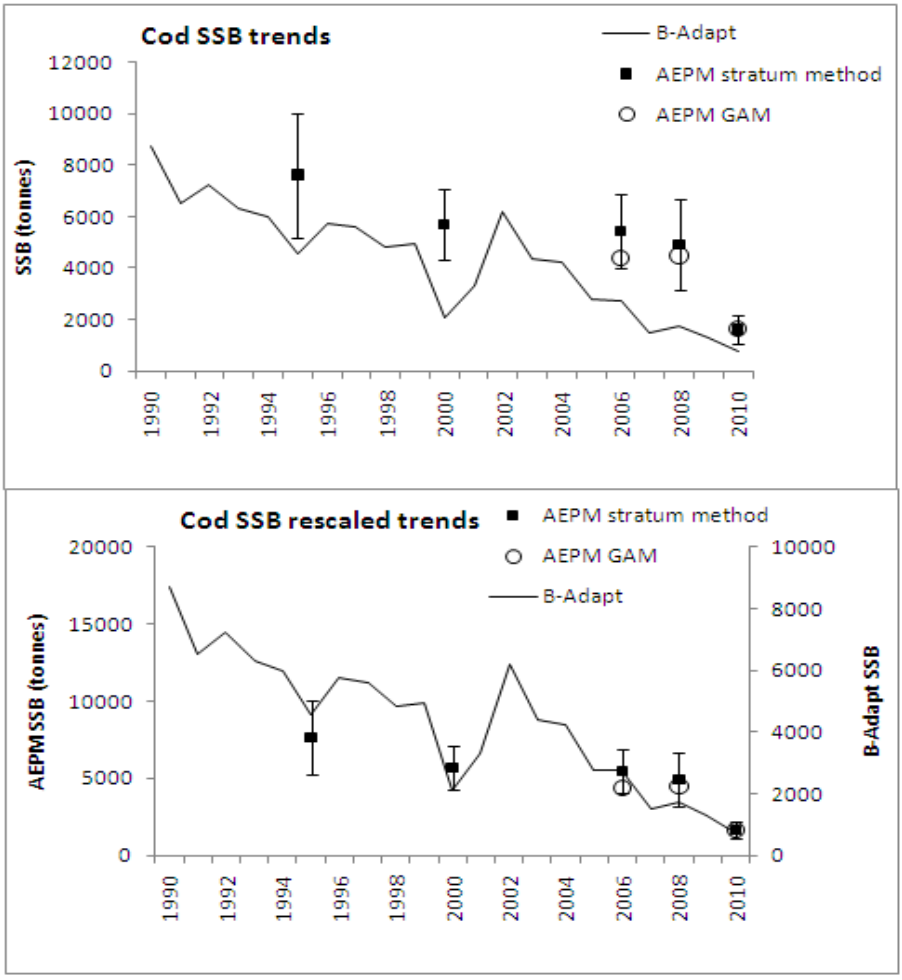


Figure 6.2.22. Time-series of AEPM estimates of SSB for Irish Sea cod (+ 2 SE), based on stratified mean (design-based) estimates, relative to ICES estimates using the B-Adapt model (ICES, 2010). The point estimates of SSB using a GAM model for 2006, 2008 and 2010 are shown. Top plot shows the estimates on the same scale. Bottom plot has the B-Adapt and AEPM estimates re-scaled on different axes to compare the relative trends. (Reproduced from WD 9)

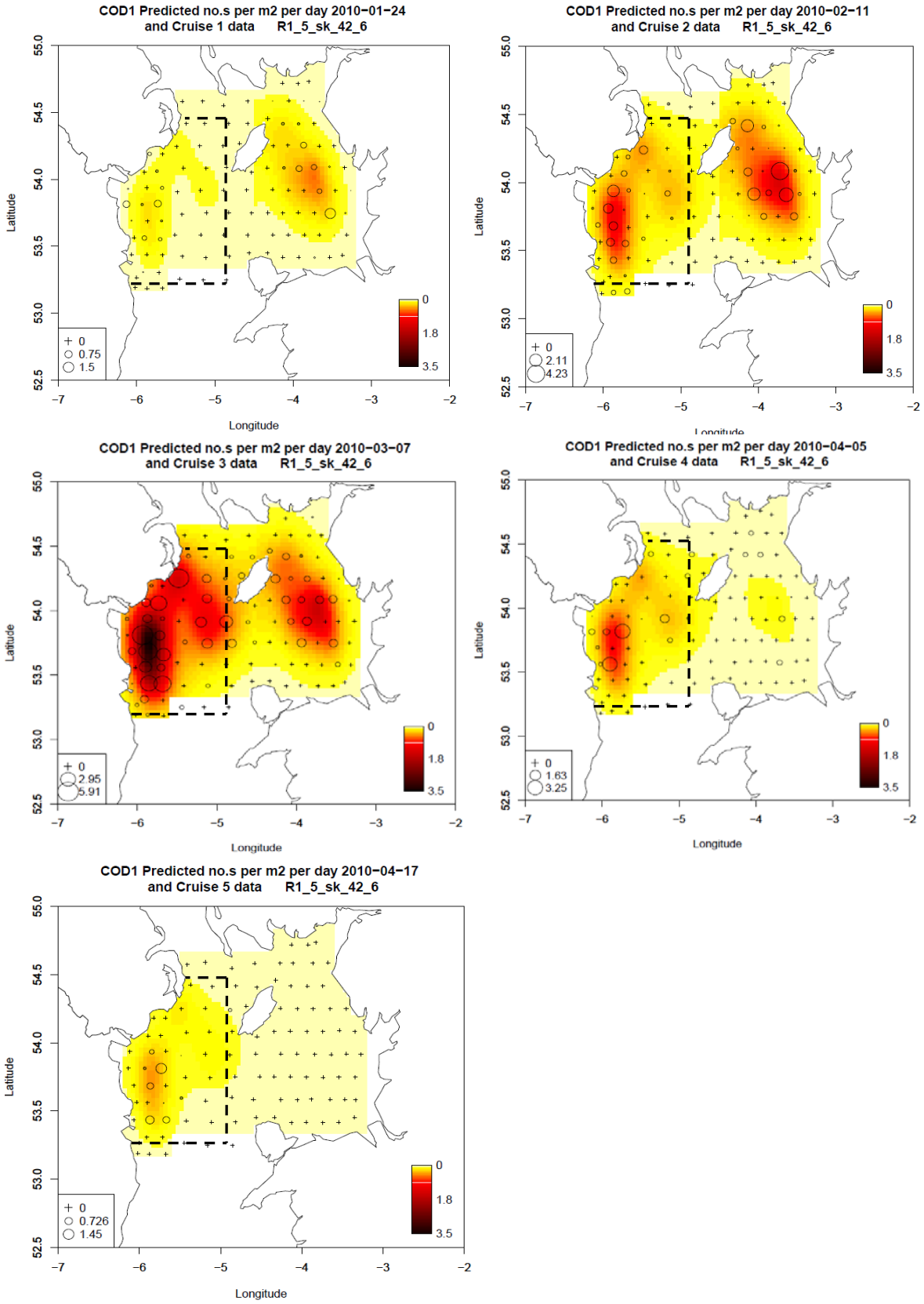


Figure 6.2.23. Annual Egg Production Method (AEPM) distribution of Stage 1 cod eggs during 2010. Station estimates of egg production given by circles, GAM predictions by contours. The dotted line gives an indication of the cod closed area. (Reproduced from WD 9).

6.3 Haddock in Division VIIa

Type of assessment

The Working Group performed an update assessment for this stock in 2011.

ICES advice applicable to 2010

The state of the stock is uncertain. Stock trends indicate an increase in SSB over the time-series but a decrease in 2008. Recruitment in the last two years appears to be below average. Total mortality appears relatively stable. ICES advises on the basis of precautionary considerations that there should be no increase in effort relative to 2009.

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.

6.3.1 General

Stock descriptions and management units

The stock and management units are both ICES Division VIIa (Irish Sea).

Management applicable to 2010 and 2011

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 2010 and 2011 are given below:

2010

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	VIIa (HAD/07A.)
Belgium	23		
France	103		
Ireland	617		
United Kingdom	681		
EU	1 424		
TAC	1 424		Precautionary TAC

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

The minimum landing size for haddock in the Irish Sea is 30 cm.

Fishery in 2010

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 2010 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 2010.

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 2010 were 88% (estimated 597 t of 681 t quota), 54% (333 t of 617 t) and 40% (9 t of 23 t), respectively. The French fleet had <2% 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 74% of the international total in 2010. 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 close 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, but the highly variable. 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 in 2010 compared to recent years; now of similar magnitude to the estimates from the Northern Irish otter trawl fleets.

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 2010. 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

The following parameter estimates were obtained (last year's estimates in parentheses):

Mean LI_{yc} = 79.8 cm (80.3); K = 0.189 (0. 191); t_0 = -0.442 (-0. 418)

Year-class effects giving estimates of asymptotic length relative to the mean were as follows (2008 and 2009 data were combined as there is only one observation for the 2009 year class):

Year class	Effect	Year class	Effect
1990	1.215	2000	0.959
1991	1.153	2001	0.985
1992	1.085	2002	0.948
1993	1.098	2003	0.893
1994	1.112	2004	0.823
1995	1.085	2005	0.843
1996	0.998	2006	0.833
1997	0.974	2007	0.856
1998	0.986	2009	0.895
1999	0.940	2009/2010	0.890

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.

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 1992–2011). 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 2010). . Acronym changed from NIGFS-Oct to NIGFS-WIBTS-Q4.
- UK (NI) Methot–Isaacs–Kidd (MIK) net survey in June (age 0; years 1994–2010).
- UK Fishery Science Partnership (FSP) Irish Sea roundfish survey, 2004–2011 (www.cefas.co.uk/fsp, Amstrong *et al*., WD11).
- UK Irish Sea Annual Egg Production Method survey (AEPM), 2006–2010 (Armstrong *et al.*, WD09).

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, 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 2010 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 ((Armstrong *et al.*, WD10) 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 marked increasing trend in SSB from 2005–2007 then a decreasing trend to 2010 (diverging considerably in 2008).

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 2010
Year range:	1992–2011
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. 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 2011 SSB estimate following the stronger 2009 recruitment. The recruitment estimates at age 1 indicate an above average recruitment in 2009, following two years of poorer recruitment. The strength of the 2010 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 other available 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 2009decline further since last year. The relative SSB estimate for 2010 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. The stock is characterized by highly variable recruitment. The model indicates above average recruitment for the 2009 year class after below average recruitment for the 2007 and 2008 year classes. Recruitment in 2010 is uncertain due to conflicting survey indices. Total mortality remains stable.

6.3.4 Short-term projections

No short-term forecast has been performed for this stock. This year the WG projected the SSB for 2012 using the 2011 survey information. Since maturity for the stock is considered as knife-edge at age 2, all the age classes that will comprise the 2012 SSB are already represented by the 2011 quarter one survey index. SSB for 2012 was projected using an average of the last three years total mortality from the SURBA model, a three year average of stock weights (2009–2011) and ten year geometric mean recruitment.

The projected SSB trend is illustrated in Figure 6.3.10, indicating a stabilization of the decreasing trend in SSB. 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 2007, 2008 and 2010 year classes, suggesting that the projected SSB might also be an overestimate.

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 6.3.13. 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.

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.

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.

Table 6.3.1. Nominal landings (t) of HADDOCK in Division VIIa, 1984–2010, 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
Belgium	15	22	23	30	15	7	9*
France	20	36	20	11	6	3	2*
Ireland	296	139	184	477	319	388	333*
Netherlands	-	-		-	-	-	-
UK (England & Wales)[1]	421	344	419	559	521	446	
UK (Isle of Man)	-	-	-	-	1	1	
UK (N. Ireland)	…	…	…	…	…	…	
UK (Scotland)	9	6	9	1	17	1	
United Kingdom							591*
Total	761	547	655	1078	879	846	936*

*Preliminary.

[1]1989–2010 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, 1972–2010, 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	n/a	942

Table 6.3.3. Haddock in VIIa: Catch numbers-at-age (=landings number-at-age; no discard data included).

Table 1 Landings numbers-at-age		Numbers*10**-3																	
	YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	AGE																		
0		0	0	0	0	0	0	0	0	0	0	n/a	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
2		1250	123	1322	4619	700	6427	519	915	2263	632	n/a	203	523	340	918	391	590	365
3		18	861	107	735	2411	292	4462	238	1116	1853	n/a	751	133	631	695	802	686	484
4		1	3	222	16	203	539	49	374	80	196	n/a	76	219	74	141	239	185	524
	+gp	1	2	5	30	16	35	72	28	127	28	n/a	97	43	78	52	67	56	115
0	TOTALNUM	1364	1019	2997	5509	4615	7393	5193	2014	4183	2829	n/a	1181	956	1130	1819	1610	1610	1506
	TONSLAND	813	1043	1753	3023	3391	4902	4129	1380	2498	1971	n/a	1278	699	647	1066	872	843	942
	SOPCOF %	100	100	100	100	95	100	100	97	100	100	n/a	100	99	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
	AGE																		
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
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
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
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
	+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
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 (1993–2002) 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 1995–2010. 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**	**2009**	**2010**
Age	43 trips	39 trips	48 trips	39 trips	44 trips	43 trips	35 trips	8 trips							
0	4485	100	1552	1274	110	1083	851	0	n/a	n/a	n/a	n/a			
1	229	1209	318	342	2384	140	1073	62	n/a	n/a	n/a	n/a			
2	179	88	210	69	253	199	37	28	n/a	n/a	n/a	n/a			
3	0	0	0	0	0	0	11	0	n/a	n/a	n/a	n/a			

(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**
Age	4 trips	6 trips	1 trip	9 trips	29 trips	55 trips	30 trips	36 trips
0	2185	210	0	8391	901	625	1609	924
1	22	280	1677	809	1553	295	284	763
2	0	57	1593	60	681	124	101	16
3	0	0	0	15	74	16	23	1
4	0	0	0	0	0	1	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**
Age	n/a	n/a	5 trips	4 trips	2 trips	1 trip	1 trip	3 trip
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**
Age	n/a	n/a	1 trips	10 trips	2 trips	2 trip	14 trips	16 trips	18 trips	21 trips
0	34	4	26	10	0	363	369	676	3219	493
1	284	205	3	13	3	59	275	183	315	1849
2	6	382	0	10	19	9	77	70	600	277
3	0.5	0	0	0	0	0	9	6	200	39
4	0	0	0	0	0	0	0	0	1	3

Table 6.3.5. (Cont.) Haddock in VIIa: Estimates of Irish Sea haddock discards 1995–2009.

(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**
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
0	3808	165	565	87	182	5349	47	1169	5663	776	3966	1122	322	5759	233
1	713	11396	1973	58	2193	7354	31	1747	6566	2350	10140	8735	1226	5654	374
2	297	303	3564	59	580	140	0	1178	2301	996	3856	3995	783	334	105
3	0	0	0	0	0	15	0	10	225	120	132	435	44	72	57
4	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0

(f) Observer scheme: Republic of Ireland GEAR TECH otter trawlers (using grids)

	2010
Age	9 trips
0	43
1	125
2	43
3	26
4	1

(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**
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
0	8293	265	2117	1429	292	47	36	17	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	942	12783	2607	496	4597	6432	898	1169	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	476	410	5116	163	916	7494	1104	1809	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	0	4	0	2	5	358	37	1206	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	0	0	0	0	0	15	11	10	n/a	n/a	n/a	n/a	n/a	n/a	n/a

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
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
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

Table 6.3.7. Haddock in VIIa: stock weights-at-age.

Table 3 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
	AGE																			
0		0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0
1		0.097	0.085	0.087	0.085	0.072	0.061	0.058	0.049	0.053	0.057	0.051	0.042	0.032	0.035	0.034	0.038	0.043	0.042	0.041
2		0.429	0.344	0.354	0.367	0.363	0.258	0.229	0.233	0.204	0.218	0.234	0.201	0.168	0.131	0.143	0.138	0.152	0.177	0.174
3		1.077	0.979	0.792	0.794	0.872	0.747	0.566	0.512	0.549	0.475	0.487	0.514	0.460	0.382	0.302	0.323	0.321	0.352	0.405
4		1.797	2.047	1.708	1.315	1.430	1.383	1.286	0.962	0.924	0.974	0.794	0.811	0.900	0.796	0.679	0.514	0.581	0.564	0.609
	+gp	2.592	3.065	3.152	2.512	2.167	2.024	2.140	1.966	1.625	1.485	1.420	1.195	1.260	1.366	1.290	1.055	0.871	0.904	0.868

Table 6.3.8. Haddock in VIIa: Available tuning data (file name: h7ani.tun).

```
IRISH SEA haddock,2011 WG,ANON,COMBSEX,TUNING DATA(effort, nos at age)
104
NIGFS March
1992 2011
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

Fleets below not included in assessment
NIGFS Oct
1991 2010
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
MIK net May/June
1994 2010
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
```

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	0.349	0.013	0	0	0	0.641	0.693	1.085	1.312	1.312
1993	0.055	0.184	0.007	0	0	0.836	0.903	1.415	1.710	1.710
1994	0.400	0.024	0.074	0.002	0	1.003	1.083	1.697	2.051	2.051
1995	5.618	0.147	0.008	0.014	0	1.290	1.394	2.184	2.639	2.639
1996	0.464	1.547	0.036	0.001	0.001	0.920	0.994	1.557	1.882	1.882
1997	9.183	0.185	0.573	0.008	0	1.230	1.329	2.083	2.517	2.517
1998	0.735	2.684	0.049	0.071	0.001	1.224	1.323	2.072	2.504	2.504
1999	2.909	0.216	0.715	0.006	0.006	1.192	1.288	2.018	2.439	2.439
2000	5.613	0.883	0.060	0.095	0.001	1.084	1.172	1.836	2.219	2.219
2001	1.207	1.898	0.274	0.010	0.010	1.196	1.292	2.024	2.446	2.446
2002	6.919	0.365	0.521	0.036	0.001	0.811	0.876	1.373	1.659	1.659
2003	2.146	3.075	0.152	0.132	0.007	0.990	1.070	1.676	2.026	2.026
2004	6.901	0.797	1.055	0.028	0.017	1.103	1.192	1.868	2.257	2.257
2005	10.186	2.290	0.242	0.163	0.003	1.077	1.164	1.823	2.203	2.203
2006	6.600	3.470	0.715	0.039	0.018	0.934	1.009	1.580	1.910	1.910
2007	10.646	2.595	1.265	0.147	0.006	0.968	1.046	1.638	1.980	1.980
2008	3.095	4.045	0.912	0.246	0.020	1.190	1.286	2.015	2.435	2.435
2009	2.210	0.941	1.118	0.122	0.022	1.212	1.309	2.051	2.479	2.479
2010	6.188	0.658	0.254	0.144	0.010	1.130	1.221	1.913	2.312	2.312
2011	6.215	1.999	0.194	0.038	0.014	1.177	1.272	1.993	2.409	2.409

Stock summary						
Year	Recruits	log SE	SSB	TSB	Z(2-3)	SE (Z)
1992	0.349	0.352	0.006	0.040	0.889	0.368
1993	0.055	0.288	0.086	0.091	1.159	0.262
1994	0.400	0.260	0.084	0.118	1.390	0.206
1995	5.618	0.278	0.082	0.571	1.789	0.181
1996	0.464	0.242	0.600	0.640	1.275	0.202
1997	9.183	0.257	0.578	1.239	1.706	0.174
1998	0.735	0.255	0.829	0.874	1.697	0.170
1999	2.909	0.255	0.475	0.643	1.653	0.169
2000	5.613	0.247	0.329	0.604	1.504	0.172
2001	1.207	0.261	0.563	0.627	1.658	0.172
2002	6.919	0.235	0.364	0.758	1.125	0.176
2003	2.146	0.244	0.908	1.018	1.373	0.176
2004	6.901	0.250	0.746	1.036	1.530	0.172
2005	10.186	0.250	0.646	0.972	1.493	0.171
2006	6.600	0.241	0.783	1.014	1.295	0.174
2007	10.646	0.242	0.861	1.223	1.342	0.176
2008	3.095	0.262	1.001	1.118	1.650	0.172
2009	2.210	0.279	0.591	0.686	1.680	0.170
2010	6.188	0.313	0.296	0.556	1.567	0.183
2011	6.215	0.396	0.462	0.716	1.633	0.062

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

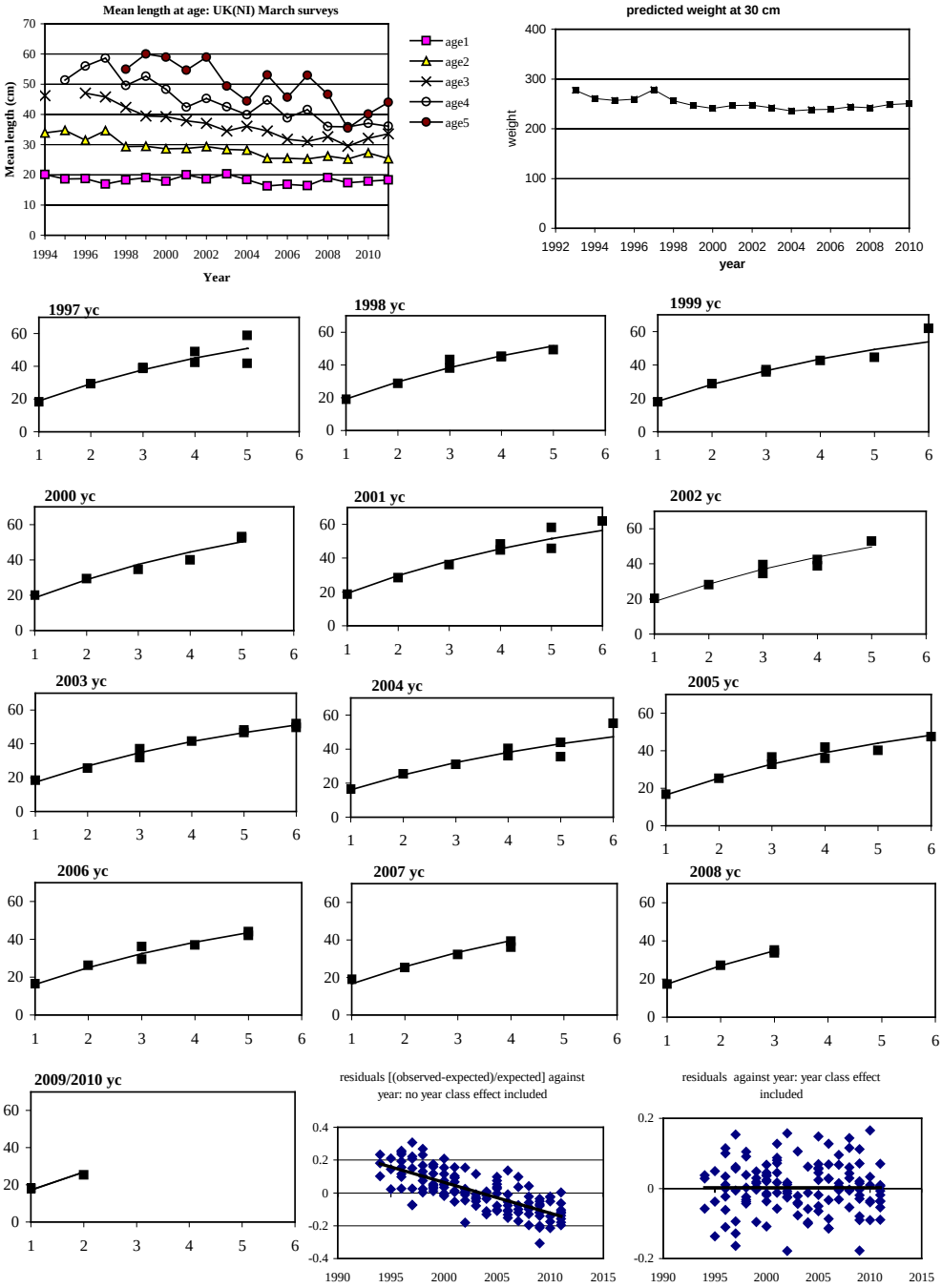


Figure 6.3.1. Haddock in VIIa: Growth of haddock in the Irish Sea. Top two panels: mean length-at-age in UK(NI) groundfish surveys in March, by year and age, and expected mean weight-at-length based on length–weight parameters from each survey. Lower panels: mean length-at-age from March surveys, and 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.

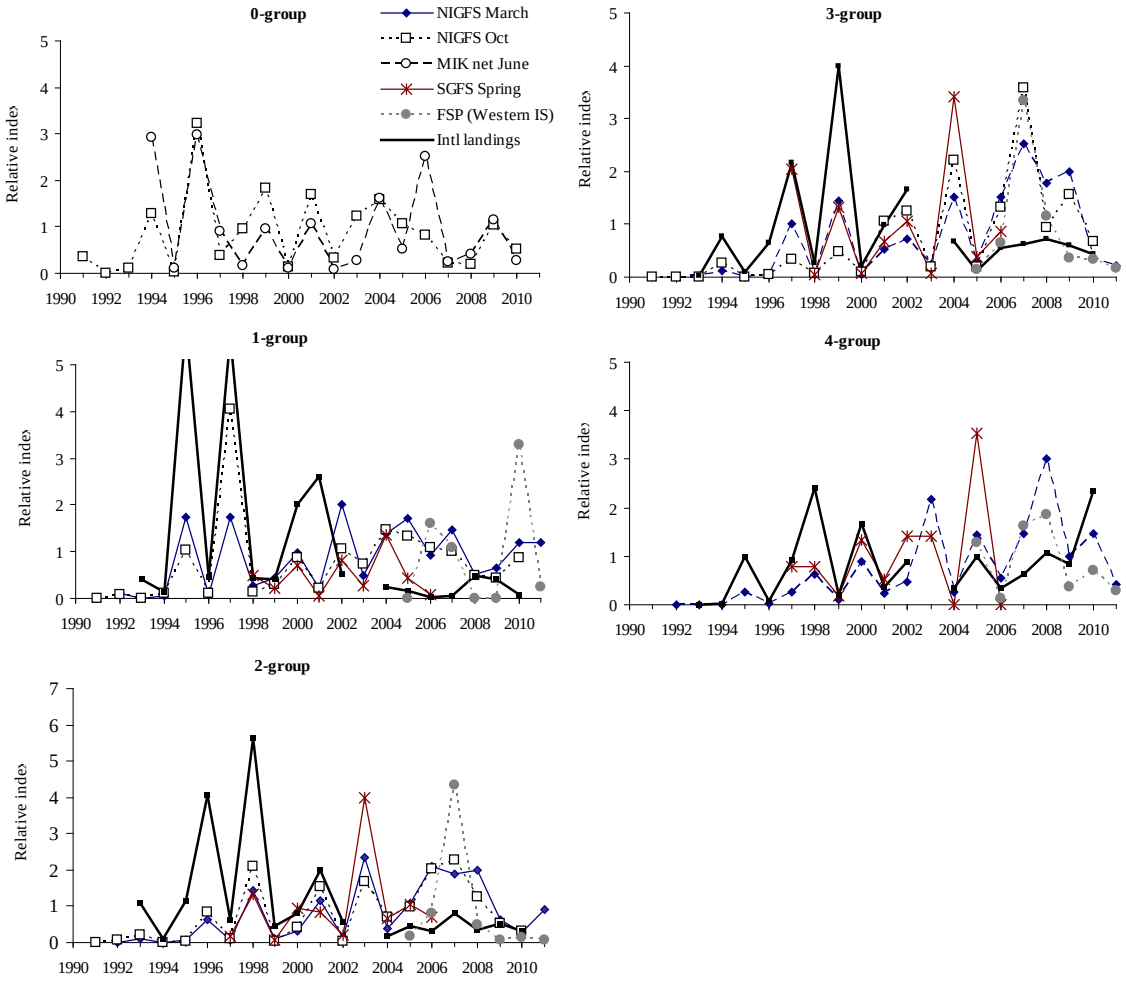


Figure 6.3.2. Haddock in VIIa: Trends in raw survey indices compared with international landings, by age class and year. All values are standardized to the mean for years common to all series in each plot (except for short FSP series).

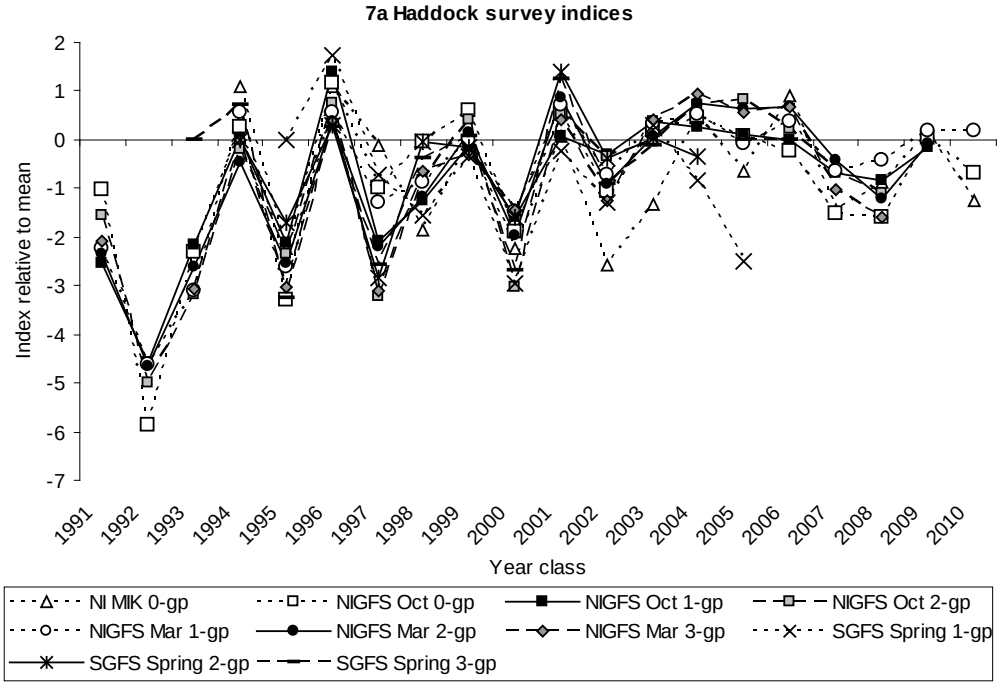


Figure 6.3.3. Haddock in VIIa: Time-series plots of the logarithms of survey indices at age by year class, after standardizing by dividing by the series mean for years from 1991. Data have only been illustrated for the most abundant ages for comparison of year-class signals.

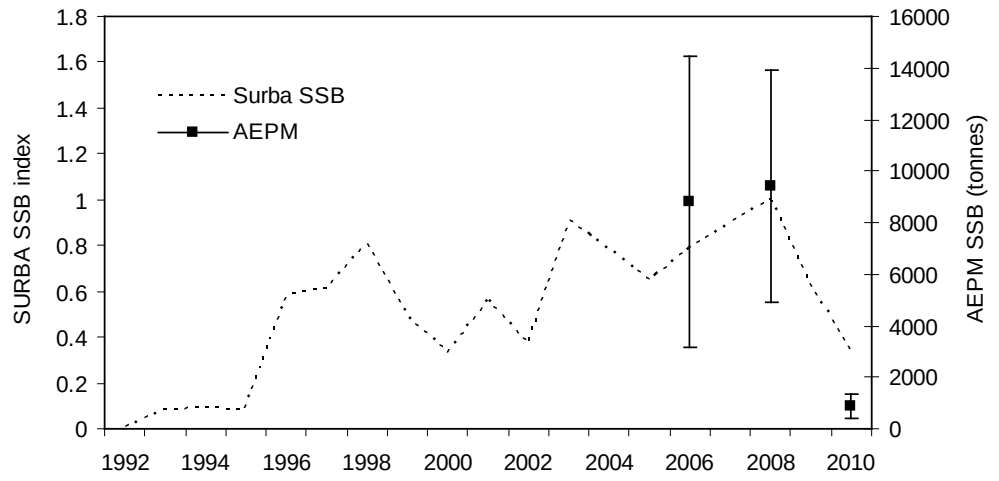


Figure 6.3.4. Haddock in VIIa: Comparison in the relative trends of SSB form 2010 SURBA run and the Irish Sea annual egg production method survey estimates of SSB (+ 2 SE) (Armstrong *et al.*, WD09).

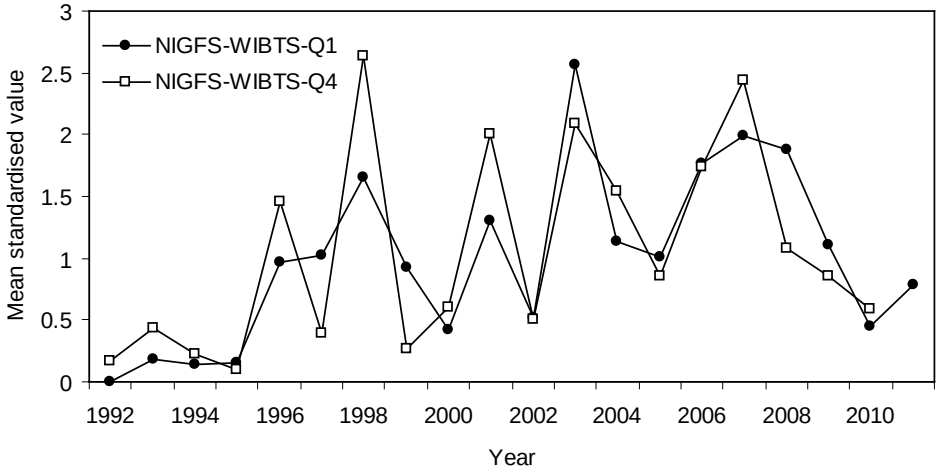


Figure 6.3.5. Haddock in VIIa: Mean Standardized empirical SSB indices from the NIGFS-WIBTS-Q1 and NIGFS- WIBTS-Q4 surveys, based on raw indices up to age 6.

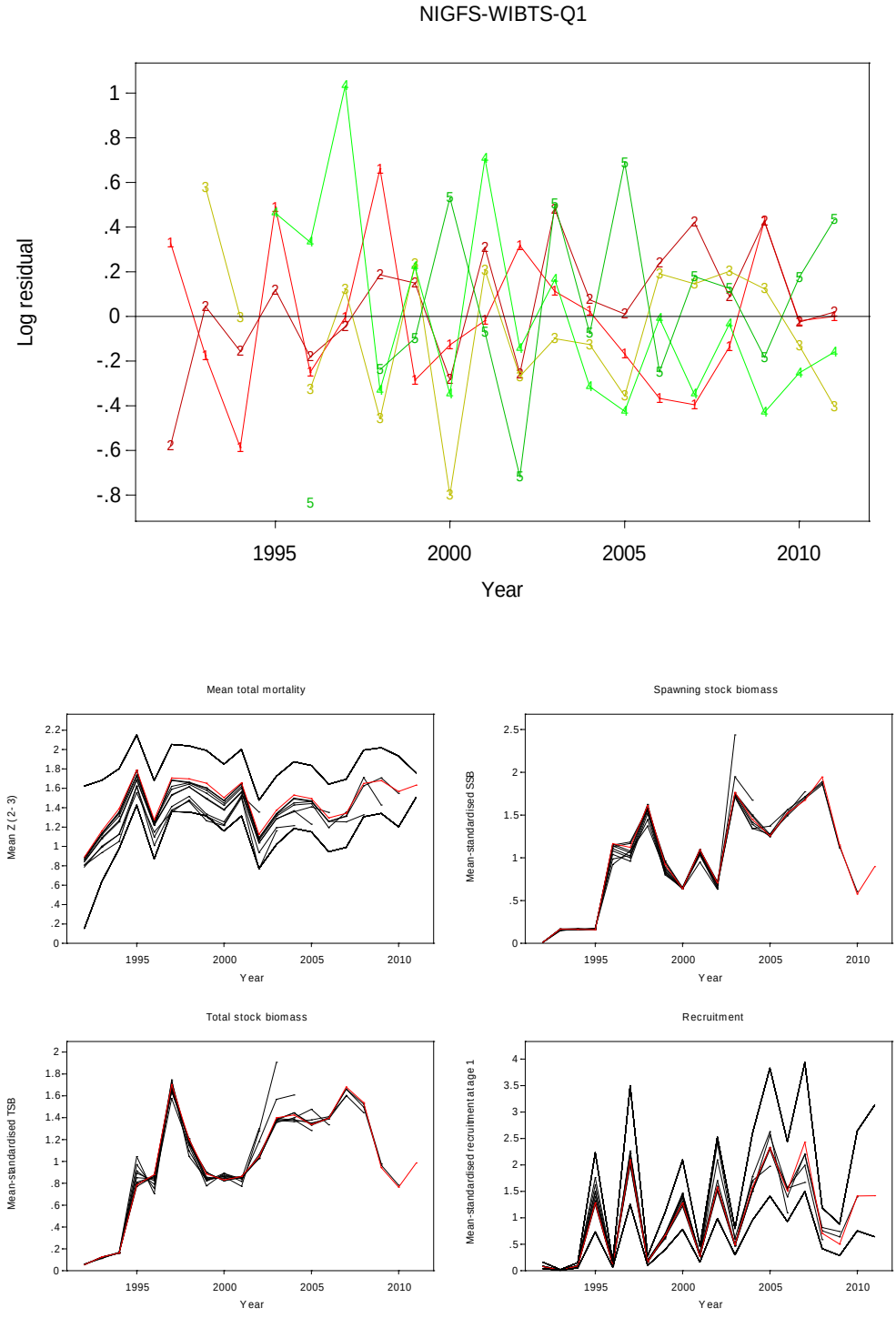


Figure 6.3.6. Haddock VIIa: SURBA 3.0 Residuals at age (top panel) and retrospective plots (bottom panel) for the NIGFS-WIBTS-Q1 survey.

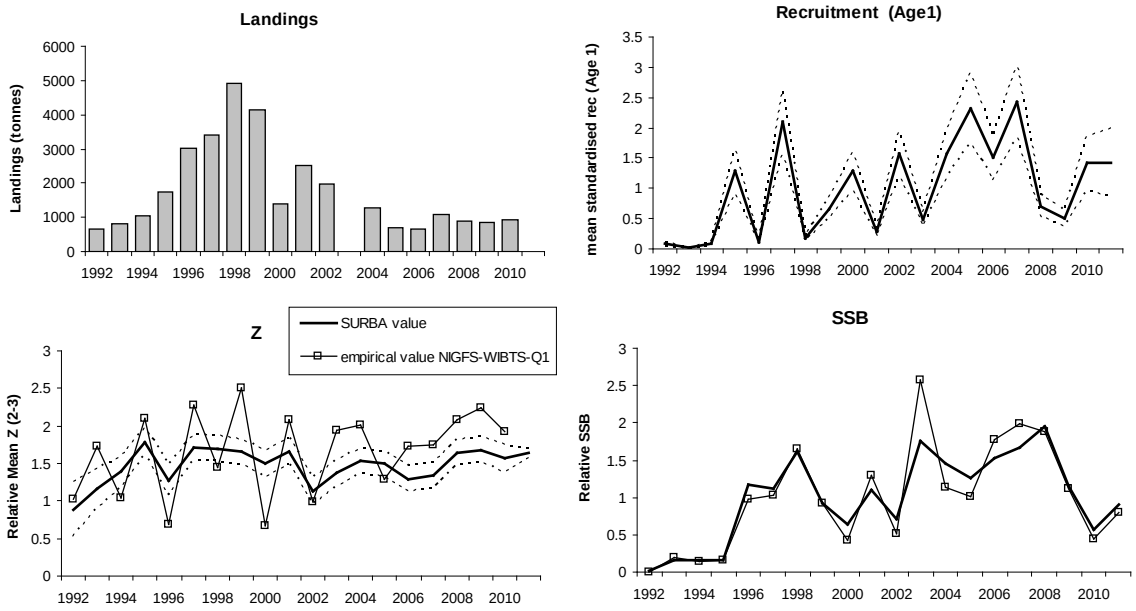


Figure 6.3.7. Haddock VIIa: Summary plots of landings and results of final SURBA 3.0 run using the NIGFS-WIBTS-Q1 survey data. Dotted lines are +/- 1SE. Empirical estimates of SSB and Z given by SURBA from the raw survey data are also shown.

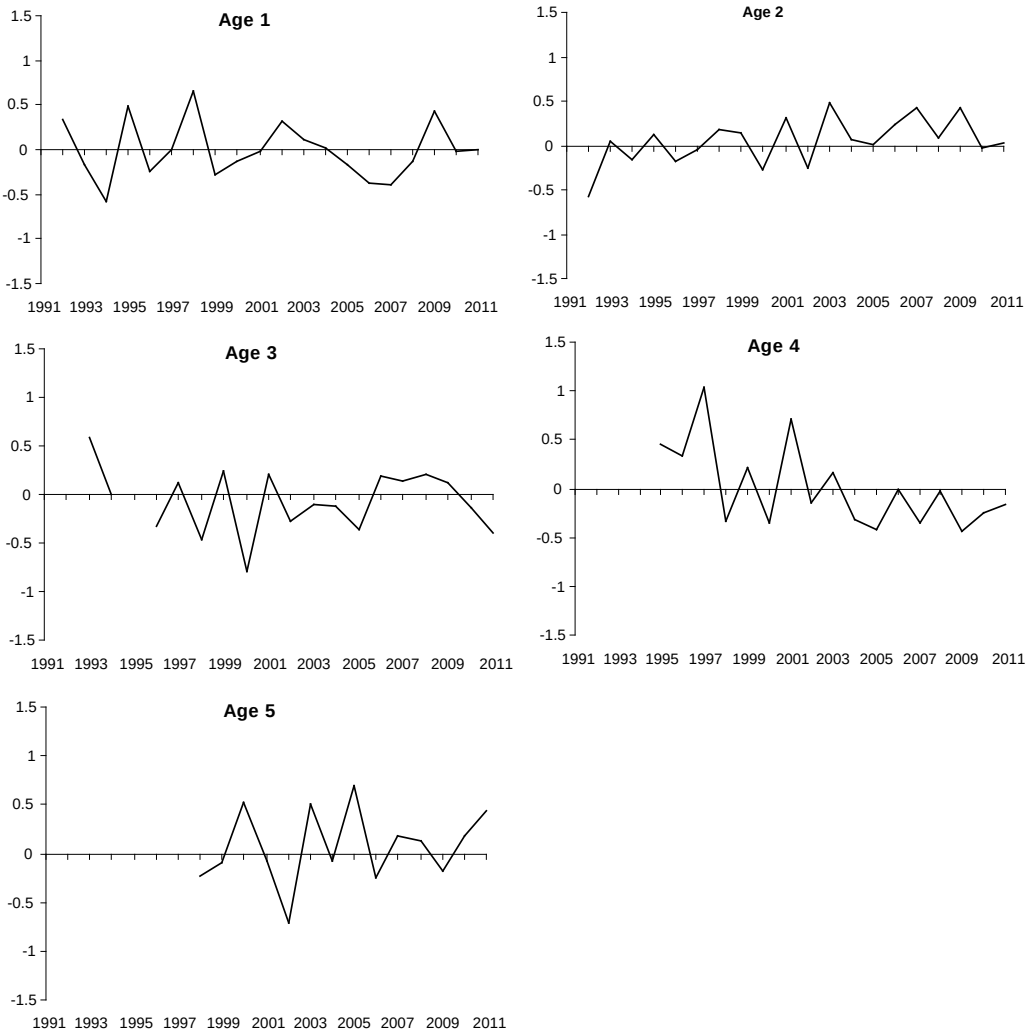


Figure 6.3.8. Haddock VIIa: SURBA 3.0 Residuals at age for final run using the NIGFS-WIBTS-Q1 survey data.

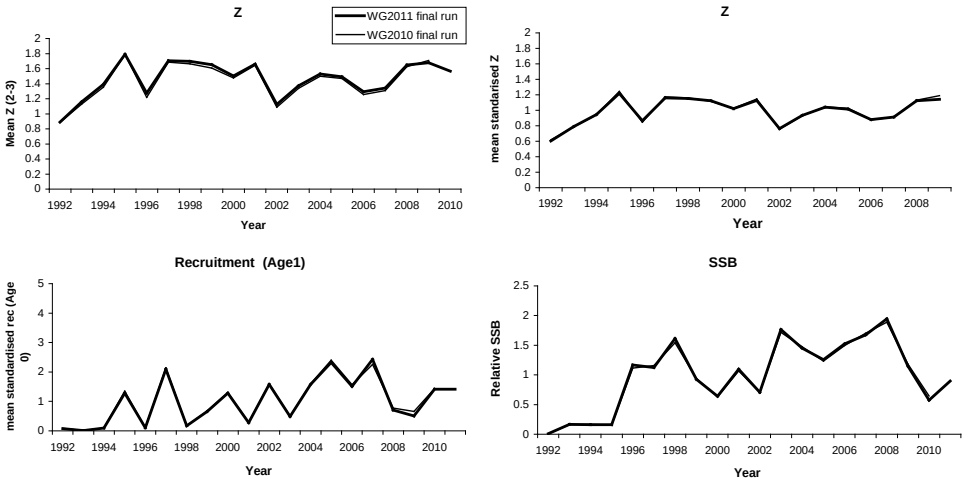


Figure 6.3.9. Haddock VIIa: Trends in SSB, recruitment and Z(2–3) from the 2010 and 2011 SURBA. SSB and recruitment are standardized to the mean for years common to all series (1992–2010) in each plot.

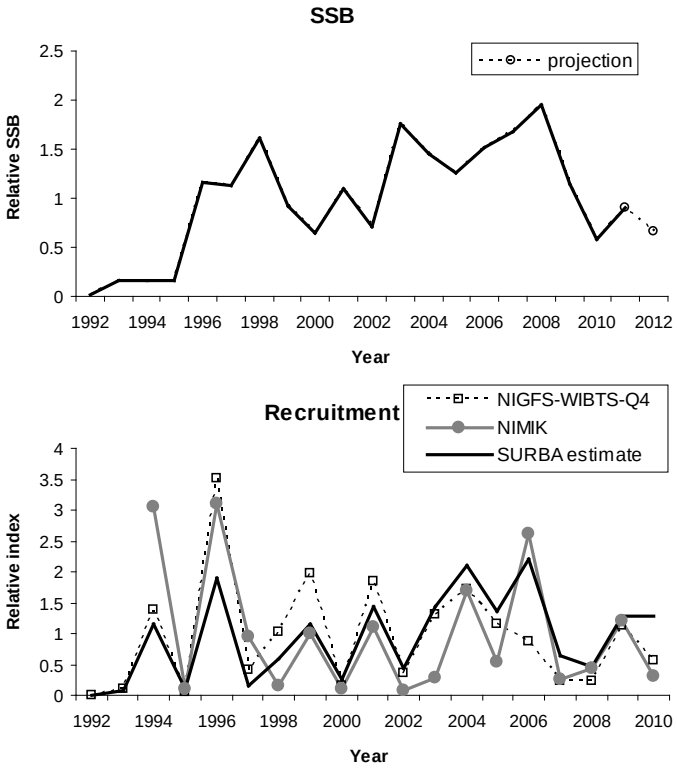


Figure 6.3.10. Haddock VIIa: Trend in SSB form 2011 SURBA projected to 2012 (top panel) and SURBA estimate of recruitment compared to available 0-gp indices. SSB and recruitment are standardized to the mean for years common to all series (1994–2010) in each plot.

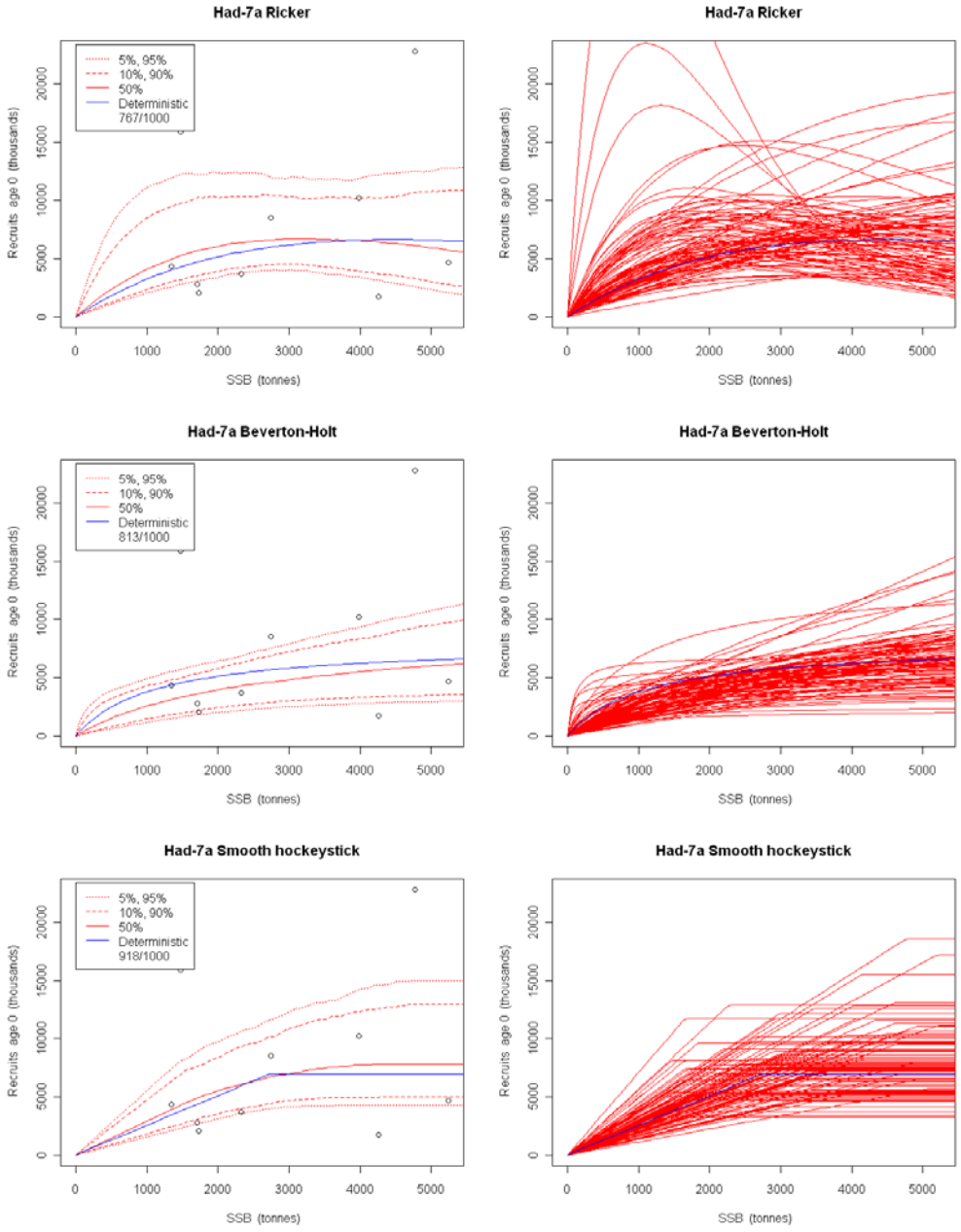


Figure 6.3.11. Haddock VIIa: MSY fitted stock–recruitment relationships. Left hand panels: blue line indicates the deterministic estimate; red line median and percentiles of curves with converged estimates of F_{MSY}. Right hand panels: curves plotted from the first 100 MCMC resamples with converged F_{MSY} estimates. The legends for each recruitment model show the number of converged values of F_{MSY} from the 1000 resamples.

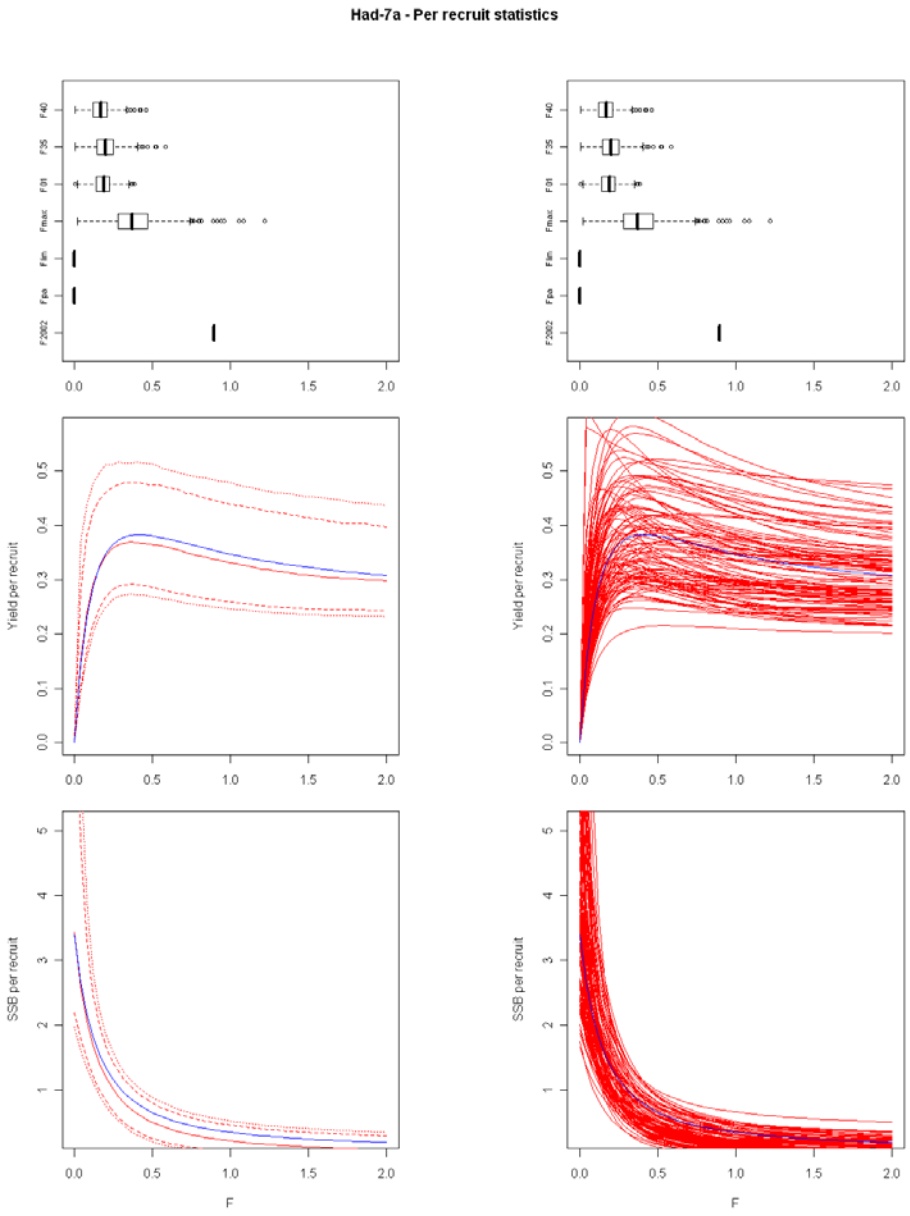
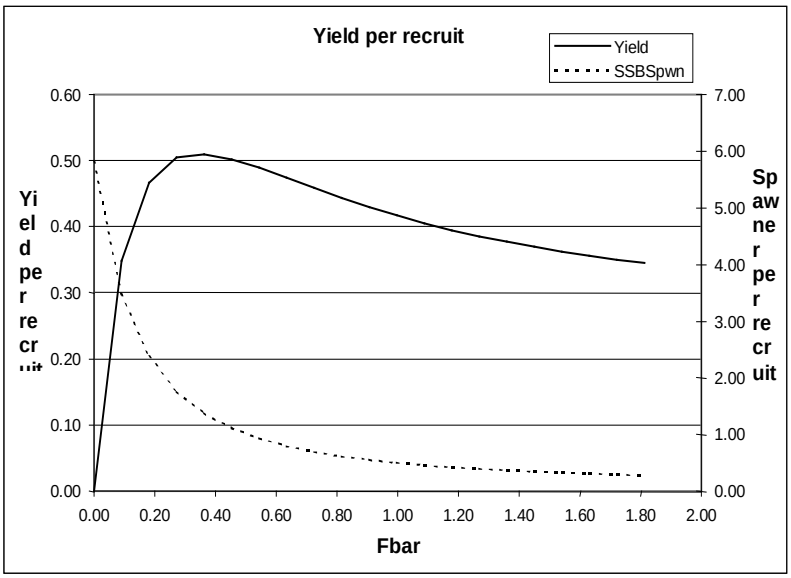


Figure 6.3.12. Haddock VIIa: Fitted yield-per-recruit F reference points, yield-per-recruit and SSB per recruit against fishing mortality with confidence intervals estimated by parametric re-sampling of the selection, weight-at-age, natural mortality and maturity estimates and their c.v. Left hand panels: blue line indicates the deterministic estimate, red lines the median and percentiles. Right hand panels: the first 100 resamples.



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 6.3.13. 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 2011

UWTV survey data are used to calculate absolute abundance estimates for 2010 and catch options following the process defined by WKNEPH (2009). Revisions to the UWTV processing algorithms used to generate abundance estimates for 2008–2009 have resulted in a substantial increase in the abundance estimates for these years.

ICES advice applicable to 2010

The advice was biannual and still valid from the 2008 assessment which implied that effort should not increase compared to 2007 levels.

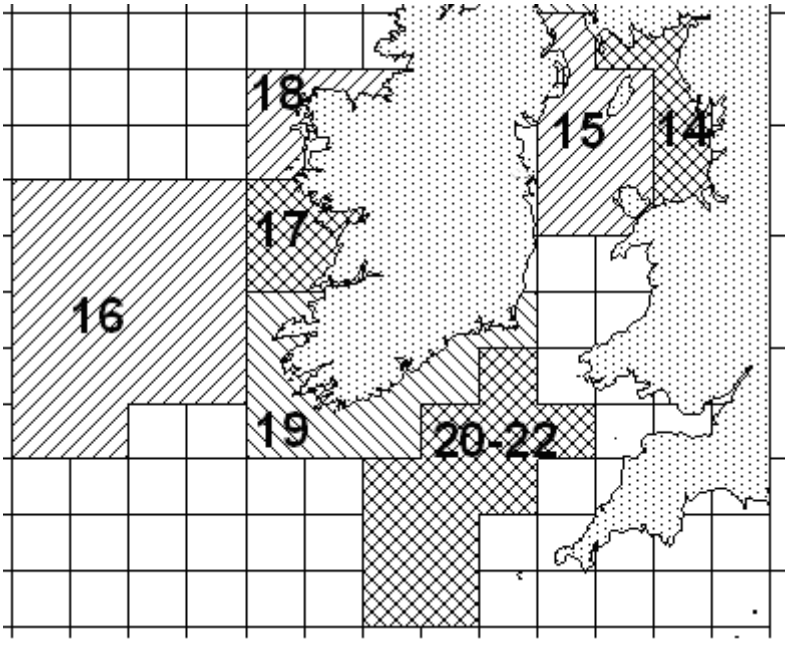
ICES advice applicable to 2011

Transition to an MSY approach with caution at low stock size implying landings of less than 680 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 2010 and 2011

The TAC is currently set for the larger TAC Area VII. The TAC for 2011 was 21 759t a 3% reduction on the 22 432 quota for 2010. 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 2010 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 in 2010

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 less than 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.

Over the last 12 years over 70% of the landings from this fishery were made to Whitehaven and about 20% to Kilkeel but this changed in 2006 and 2010 to ~60% Whitehaven and ~25% Killkeel. Over half of the Northern Ireland and a few of the English vessels use twin or triple trawls and between 2006 and 2010 account for just over 30% of the *Nephrops* landings.

There has been little apparent change in the make-up of the English and Welsh fleet over the last three of years. However the current state of other stocks, technical conservation and cod recovery measures has had an effect on mesh sizes and fishing patterns. Traditionally a summer fishery, anecdotal data and records of monthly landings indicate the season is starting earlier and ending earlier.

6.4.2 Data available

An overview of the data provided and used by the WG is provided in Table 2.3.

Landings

Official landings as reported to ICES from FU14 are presented in Table 6.4.1 and were updated for 2010. 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 2007 were at their highest level since 1978 at 959 t. Landings in 2010 were 20% down on the 2009 level and over 40% down on the peak of 2007. 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 since declined to less than 5% since 2008 (Table 6.4.2).

The official landings as reported by each country were updated for 2010.

Length composition

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 only five samples were made as part of the English discard observer programme and there was no other catch sampling. Landings sampling was undertaken but the catch sampling was considered insufficient to derive catch and discard length frequencies for 2010. As a result none of the length derived metrics have been updated for 2010.

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 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 for 2009 and 2010 in Area VII and the legislation provides the quality control. Landings do not appear to have exceeded the advised TAC for this Functional Unit.

The introduction of the buyers and sellers legislation for 2006 complicates the interpretation of any prior trends. In 2010, most of the landings were made into England with a large proportion of these landings (60 % of the directed landings) being made by visiting Northern Irish vessels. UK *Nephrops* directed effort fluctuated around a downward trend since 1978. After a period of relative stability between 2002–2007 effort has resumed its decline and was at a 35 year low in 2010. 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 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 interannual 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 (Table 6.4.3) and the UK except that the Northern Irish vessels are now reporting lpues at generally the same level as the Republic of Ireland vessels.

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 whereas 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 as more than a change in biological productivity.

Historically, male *Nephrops* predominate 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 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) 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 2007–2010 the UK and the Republic of Ireland carried out an underwater TV survey of the *Nephrops* grounds in the eastern Irish Sea. The survey was of a fixed grid design and was 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 standardized process has been adopted see Stock Annex. The survey area is shown in Figure 6.4.6 giving the survey stations (black circles), VMS coverage (grey dots), and reported fishing area overlayed on BGS sediment data. There is a clear mismatch between the area considered to be fishing ground during interview with fishers compared to the area actually fished as recorded by VMS. The boundary used to define the ground limits for absolute abundance runs close to the outer survey stations.

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 in 2008, 2009 and 2010 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.

The algorithm used to determine the distance towed on each station changed in 2011. GPS measurements are recorded at one second intervals during each tow. Last year 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 while 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 overestimated the distance travelled (typically +30%, but variable depending upon the sea state for any given station) which translated into a reduced density of burrows.

6.4.3 Data analyses

Exploratory analyses of survey data

The TV abundance estimate is now made using a geostatistical approach, as opposed to the approach used last year 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 Kriging process to produce a 3D surface of burrow density on a 500 m*500 m grid, bounded by polygon defined by the outermost survey stations. The area within the polygon is 1032 km^2. Uncertainty estimation of the overall abundance estimate is performed by bootstrapping the counts (resampling with replacement), refitting the semi-variogram and re-estimating the surface.

The surveys show a clear spatial pattern of distribution, largest in the central north of the patch and variable 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.

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 1.14 for FU14 (see Annex) which means the TV survey is likely to overestimate *Nephrops* abundance by 14%. The burrow abundances shown in Table 6.4.6 and Figure 6.4.7 have been adjusted to account for this estimation bias.

Comparison with the density estimates made in 2010 are presented in Table 6.4.7. The change in the algorithm used to calculate distance can be seen in the ratio of survey densities of ~+20% ~30% for 2008 and 2009 respectively. The additional effect of the change to using a geostatistical method is to further increase average denstity which a result of taking into account the spatial relationship of the measured density estimates.

6.4.4 Short-term projections

A landings prediction for 2011 was made for FU14 using the approach agreed at the Benchmark Workshop (WKNEPH, 2009). As the length frequency data for 2010 (and to a lesser extent 2009) to have been poorly represented by sampling, the Length Cohort Analysis 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 table below shows landings predicted at a range of harvest ratios including those equivalent to fishing at F_{msy} proxies for the fishery in 2011 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 to this stock (see below). The inputs to the landings forecast were as follows:

Mean weight in landings (2006–2008) = 28.9 g

Discard rate based on sampling (2006–2008) = 27.9%

Survey bias = 1.14.

			Implied fishery	
	Harvest Rate	Bias-corrected abundance (Millions)	Retained number (Millions)	Landings (tonnes)
	0%	469.45	0.0	0
	2%		6.8	196
	4%		13.5	391
	6%		20.3	587
$F_{current}$	7.4%		25.0	722
	8%		27.1	783
Transition	8.8%		29.8	861
$F_{0.1Male}$	9.62%		32.6	941
$F_{0.1Comb}$	9.81%		33.2	960
	10%		33.8	978
	12%		40.6	1174
$F_{35\%Male}$	12.50%		42.3	1223
$F_{35\%Comb}$	13.00%		44.0	1272
	14%		47.4	1369
	15.00%		50.8	1467
$F_{maxMale}$	15.79%		53.4	1545
	16%		54.2	1565
$F_{maxComb}$	16.40%		55.5	1604
				Basis
Landings Mean Weight (kg)		0.0289	Sampling 2006–2008	
Survey Overestimate Bias		1.14	As per WKNEPH 2009 (See Annex)	
Prop of removals retained by the fishery		0.79	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 multiplers and the resulting level of spawner per recruit as a percentage of the virgin level.

		F_{bar} 20–40mm		Harvest	SPR	
		Female	Male	Rates	Female	Male
$F_{0.1}$	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%
$F_{35\%Spr}$	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%
F_{max}	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. 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 *Nophrops* being the larger.
- This fishery is highly seasonal, in effect a spring to early 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 Ratios at around 7.4% are below.

Only the combined sex F_{msy} and male proxies are considered here to limit the potential of overfishing 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 uncertainties about the stability of the stock over the reference period and uncertainties about the variability of recruitment might suggest that $F_{0.1}$ be used as a proxy.

6.4.7 Management plans

A number of cod recovery measures have been introduced since 2000 to conserve 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 was 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 characterized. Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates.

The effect of this assumption on realized 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 over the last ten years by E &W. However the variability of 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 2008–2010.

The revised algorithm used to derive distance covered by the sledge in considered to be significantly more robust than the previous algorithm.

There may be the need to increase the survey area further south to ensure that the edge of the ground has been sampled.

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 relatively stable although evidence would suggest it has become more targeted. 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. Over the last four years 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, 2000–2010.

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*	563			

Table 6.4.2. Irish Sea east (FU14): Landings (tonnes) by country, 2000–2010.

	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	25	538	0	563

Table 6.4.3. Irish Sea east (FU14): Effort ('000 hours trawling) and lpue (kg/hour trawling) of *Nephrops* directed voyages by UK trawlers, 2000–2010.

	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

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, 2000–2010.

	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

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	
	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 2007–2009. Corrected for bias and Wigtown Bay area.

Year	No stations	Mean station density	Mean Kriged density	Bias-corrected abundance (millions)	95% CI	Removals (millions)	Harvest Rate
2007							
2008	32	0.43	0.49	451.4	93	32.4	7.19%
2009	32	0.33	0.40	369.0	73	33.9	9.20%
2010	26	0.42	0.51	469.5	106	27.0	5.75%

Table 6.4.7. Irish Sea east (FU 14). Comparison of TV survey results with those obtained by WGCSE 2010.

Survey year	2010 burrow density estimate	2011 burrow density estimate	ratio to 2010	2011 kriged density	ratio to 2010
2008	0.36	0.43	1.19	0.49	1.36
2009	0.25	0.33	1.32	0.40	1.60

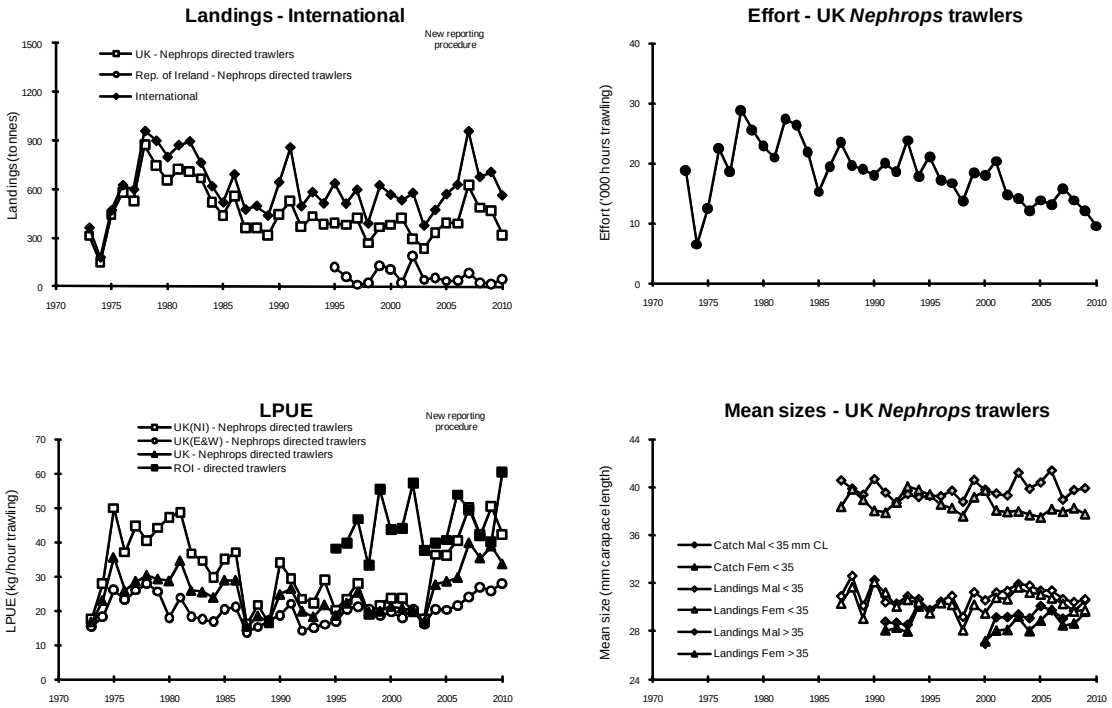


Figure 6.4.1. Irish Sea east (FU14). Long-term trends in landings, effort, lpues and mean sizes of *Nephrops*. Note that Mean sizes were not updated in 2011 due to insufficient sampling levels.

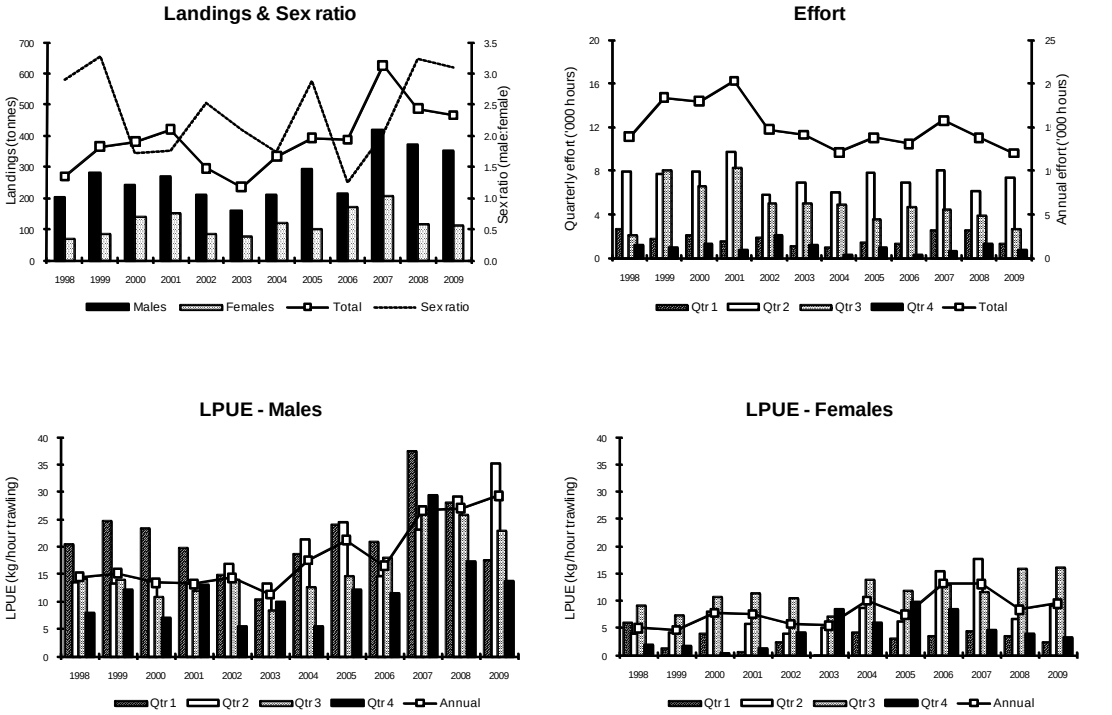


Figure 6.4.2. Irish Sea east (FU14). Landings, effort and lpues by quarter and sex from UK *Nephrops* directed trawlers. Not updated in 2011 due to insufficient sampling levels.

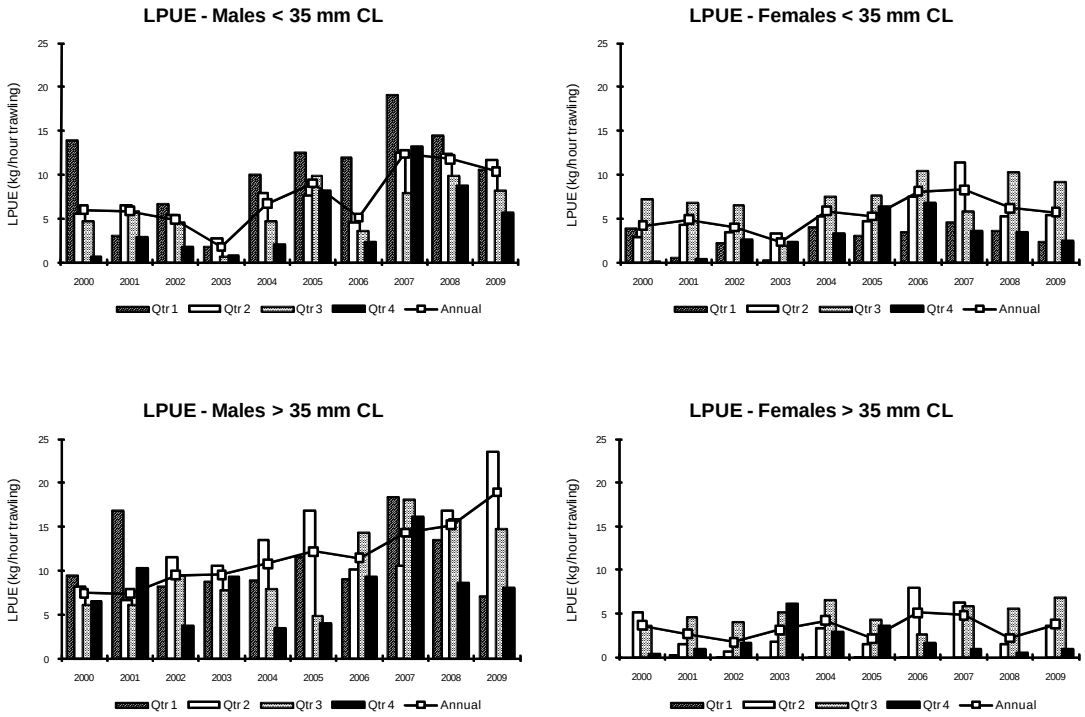


Figure 6.4.3. Irish Sea east (FU14). Lpues by sex and quarter for selected size groups, IK *Nephrops* directed trawlers. Not updated in 2011 due to insufficient sampling levels.

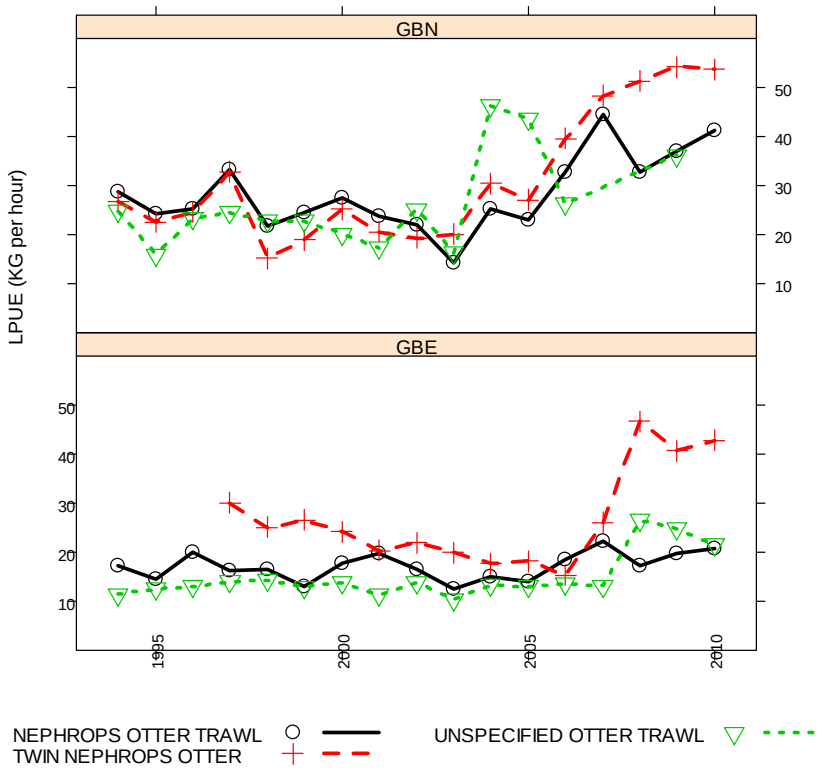


Figure 6.4.4. Lpue (kg per hour) by gear type for English (GBE) and Northern Irish (GBN) vessels targeting *Nephrops* (>25% *Nephrops* in landings, using towed gears 70–99 mm mesh).

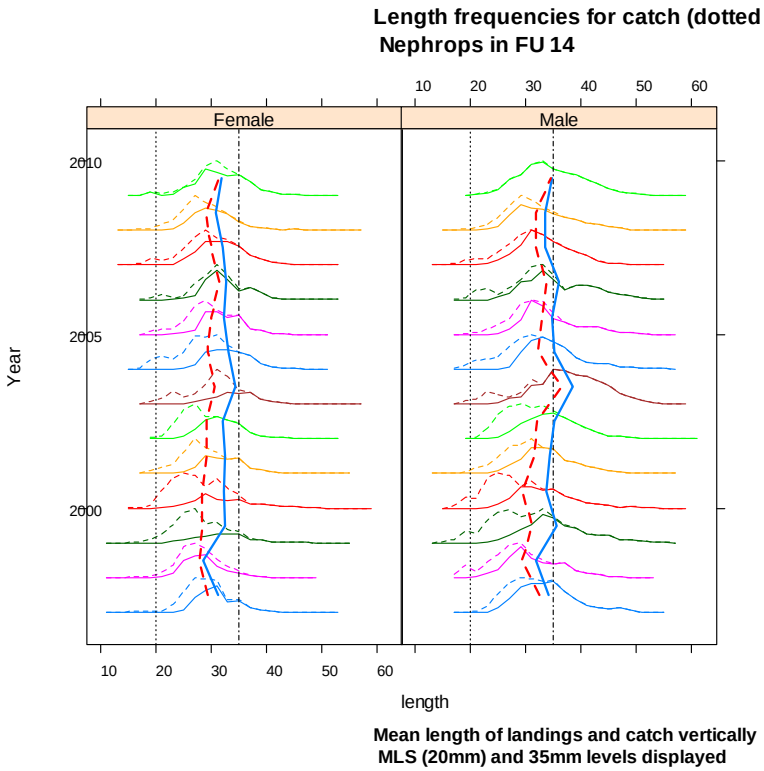


Figure 6.4.5. Irish Sea east (FU14): Length frequency distributions of male and female landings and catch, 1997–2009. Not updated in 2011 due to insufficient sampling levels.

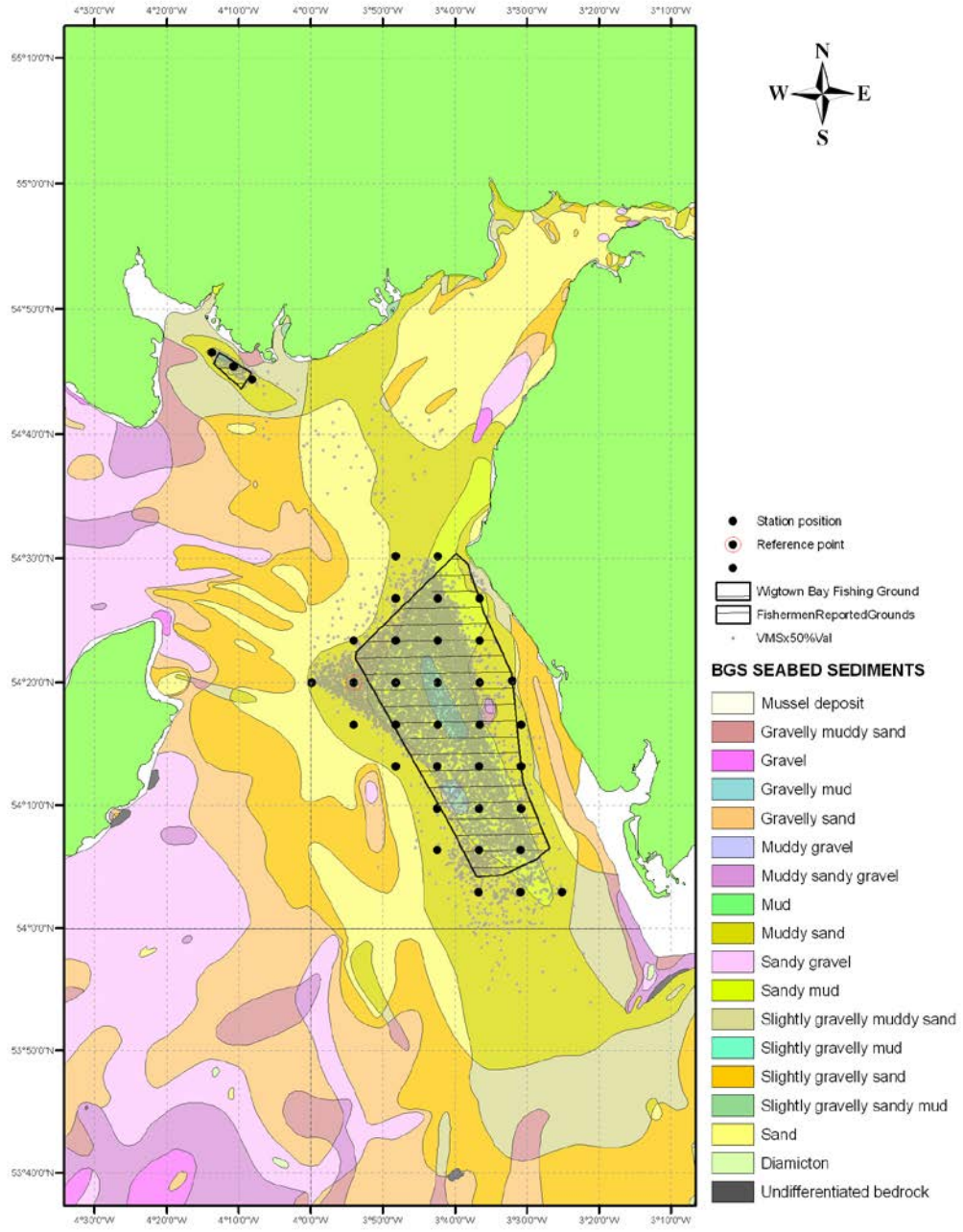


Figure 6.4.6. Irish Sea east (FU14): UWTV Survey stations (black circles), VMS positions for *Nephrops* fishing activity, fishers' reported fishing grounds and BGS sediment map.

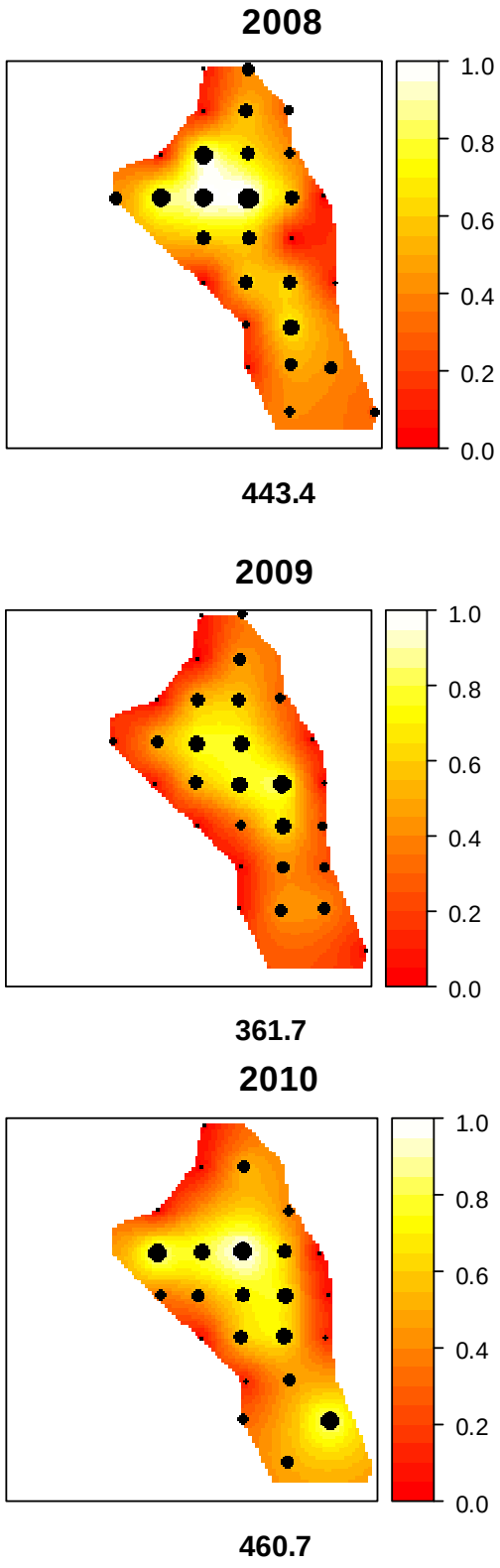


Figure 6.4.7. Irish Sea east (FU14): Burrow density estimates from the UWTV Survey. Abundance estimates given at the bottom of each plot are bias-adjusted (but does not contain the additional 1.9% for Wigtown Bay).

6.5 Irish Sea West, FU15

Type of assessment in 2011

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.

6.5.1 General

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 six 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 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
20–22	Celtic Sea	VIIg,h	28–30 E1; 28–31 E2; 30–32 E3; 31 E4

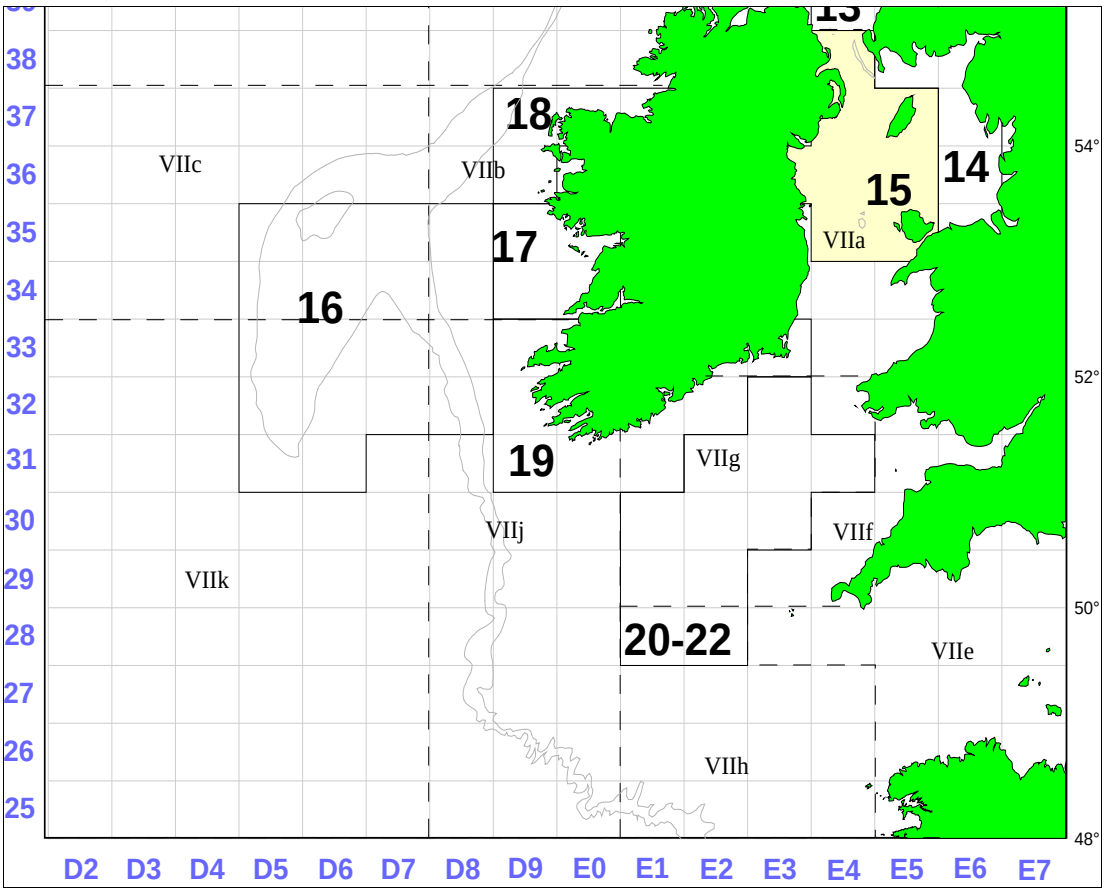


Figure 6.1.1. ***Nephrops*** **Functional Units in Subarea VII. The TAC covers all of Subarea VII. The stock area FU15 is shaded yellow.**

Management applicable to 2010 and 2011

TAC in 2010

Species:	Norway lobster *Nephrops norvegicus*	Zone:	VII (NEP/07.)
Spain	1 346		
France	5 455		
Ireland	8 273		
United Kingdom	7 358		
EU	22 432		
TAC	22 432		Analytical TAC

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

Species:	Norway lobster *Nephrops norvegicus*	Zone:	VIIa, VIIb, VIId and VIIe (NEP/*07BDE.)
Spain	234		
France	3 665		
EU	3 899		
TAC	3 899		Analytical TAC

Species:	Norway lobster *Nephrops norvegicus*	Zone:	VIIc (NEP/08C.)
Spain	87		
France	4		
EU	91		
TAC	91		Analytical TAC

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 2010

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. A decommissioning programme was in operation in Ireland during 2007 and 2008. 14 vessels active in the FU15 fishery were decommissioned. These vessels accounted for approximately 28% of the Irish landings in 2007–2008.

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 2010 was 8963 t and was the third highest since 1999. Ireland's landings were 2578 t, of similar magnitude to 2009 landings. UK vessels landed 6384 t in 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 reduction in effort in 2009, there has been a slight increase in effort in 2010, back to the 2008 levels (Table 6.5.2). Ireland's effort showed a marked reduction in 2009 and effort remained at similar levels in 2010 (Table 6.5.3). The Irish fleet lpue remained at record high levels in 2010, whereas Northern Ireland lpue decreased. The mean sizes of *Nephrops* in the catches of both the Northern Ireland and Ireland fisheries have fluctuated for the last decade (Table 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 24% of the catch by number in 2010 (Table 6.5.6).

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

ICES advice applicable to 2010

"Single–stock exploitation boundaries

June

ICES advises on the basis of exploitation boundaries in relation to high long-term yield and low risk of depletion of production potential that the Harvest Rate for Nephrops fisheries should not exceed $F_{0.1}$. This corresponds to landings of no more than 5465 t for the western Irish Sea stock.

November

ICES advises on the basis of exploitation boundaries in relation to high long-term yield and low risk of depletion of production potential that the Harvest Rate for Nephrops fisheries should not exceed $F_{0.1}$. This corresponds to landings of no more than 5892 t for the western Irish Sea stock."

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.*

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 randomized 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 145

valid stations was covered by the two surveys combined and the data were raised to a stock area of around 5340 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 2010 which was a slightly offset grid from those sampled in 2009. Figure 6.5.6 is a contour plot of the krigged density estimates for FU15 over the period 2003–2010. The survey abundance estimate in 2010 is approximately 8% higher than the 2009 estimate, but 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 rationalization of the survey programme 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 shows a deviating trend over the last two years. The longer time-series of the trawl survey shows that catch rates in the last few years (2005–2010) are close to the mean of the series when UWTV burrow abundances were in the range of 5–6 billion burrows. Mean carapace length-by-sex has remained stable over the time-series (Figure 6.5.4).

6.5.3 Assessment

Approach in 2011

The assessment approach used by WGCSE 2011 is consistent with that set out in the Stock Annex and WK*NEPH* (ICES, 2009).

Last year the final SCAs (Separable cohort analysis) used landings and discard length distributions by sex derived from 2008–2009 sampling only, due to limited sampling in 2006–2007. Since the most recent three years of sampling data were available, three year averages of mean weighs in the landings and proportions retained in the fishery have been used (2008–2010). This is in line with the procedure for other stocks. Different selection patterns between sexes were included in the model to take into account differences in selection observed in the fishery.

Both the SCA and LCA were performed including the three year sampling information (2008–2010). The model fits were similar to last year and the harvest rates corresponding to F_{MSY} proxies were very similar (see table below from the SCA output with level and direction of change from the 2010 WG analysis in parentheses, if any).

		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)

Comparison with previous assessments

The assessment in 2011 is based on trends in population indicators and catch options derived from UWTV surveys as last year, i.e. same methods and similar data. Last year the mean size and discard rates were derived from two years data. A reanalysis was performed using three years data (2008–2010), similar to other stocks, and the results were consistent with last year's assessment. The stock size is estimated to have increased and harvest ratio has decreased slightly 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 2003–2010 (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

The MSY explorations carried out above proved very consistent with that analysis carried out last year. As discussed by WGCSE 2009, no dynamic population model is fitted to the data so no estimates of spawning–stock and recruitment were available to determine F_{MSY}. In response to the recommendations of WKFRAME (2010), the Bell/Dobby combined sex–length cohort analysis (LCA) model used to determine Harvest Rates associated with fishing at $F_{0.1}$ and F_{max} at WK*NEPH* (2009) was adapted to also output estimates of $F_{35\%Spr}$. These F estimates could be used as a proxy for F_{MSY}. The underwater TV survey is presented as the best available information on the FU15 *Nephrops* stock and provides a fishery-independent estimate of *Nephrops* abundance. Catch–length data were available for Ireland and Northern Ireland for 2008 and 2009 and were used in an SLCA model along with the biological parameter described in the Stock Annex. For other stocks three years of length data were used in the analysis

but in this case there was a gap in sampling in 2006 and 2007. YPR curves and other plots generated by the model are shown in Figure 6.5.8. The F multipliers required to achieve the various F_{MSY} proxies are shown in the text table below along with the harvest rates that correspond to those multipliers.

		Fbar 20–40 mm		Harvest Rate	% Virgin Spawner per Recruit	
		Female	Male		Female	Male
$F_{0.1}$	Comb	0.14	0.16	10.6%	40.6%	44.0%
$F_{0.1}$	Female	0.13	0.16	10.2%	41.7%	45.1%
$F_{0.1}$	Male	0.14	0.17	11.0%	39.5%	42.9%
$F_{35\%}$	Comb	0.18	0.22	13.4%	33.1%	36.2%
$F_{35\%}$	Female	0.17	0.20	12.7%	34.7%	37.9%
$F_{35\%}$	Male	0.19	0.23	14.1%	31.6%	34.6%
F_{max}	Comb	0.24	0.29	17.1%	25.5%	28.0%
F_{max}	Female	0.24	0.29	17.1%	25.5%	28.0%
F_{max}	Male	0.24	0.29	17.1%	25.5%	28.0%

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.*). 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 mechanizm and depositional environment due to the western Irish Sea gyre ensures continued good recruitment (Hill *et al*., 1994).
- 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%. 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.

6.5.5 Short-term projections

A landings prediction for 2011 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_{2010} (mean F 2008–2010) for the western Irish Sea is estimated to be slightly below 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 of these over time. Due to the lack of sampling in 2006 and 2007 the deterministic estimates of mean weights in the landings and discard rates were based on 2008 and 2009 sampling only in the 2010 assessment. This year the catch options calculations uses the usual three data (2008–2010). The YPR analysis with the updated three years of data showed that harvest rates for various F_{msy} proxies were very consistent with reference values calculated last year (corresponding harvest rate at F_{max} was 17.2% compared to 17.1% determined last year). The WG concluded that there is no need to update the reference points.

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 3–5%) 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 characterized but is likely to be higher than that observed in the survey.

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 realized 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 underestimated 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 characterized 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% in 2009 and a further 25% in 2010 and is expected to be very restrictive. Although Irish effort decreased by 23% from the 2008 level, the 2010 UK TR2 effort remains at the 2008 level. The implementation of the cod long-term plan is expected to cause large changes in fishing patterns as effort allocations become more restrictive. Vessels may also start using more selective gears to reduce cod catches to less than 1 or 1.5% of total catch. Since 2009, four Irish vessels began using "Swedish grids" in the fishery and significantly reduced bycatches of cod, whiting and haddock (STECF 01-2010).

ICES has repeatedly advised that management should be at a smaller scale than 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

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STECF 01-2010. 33rd Plenary meeting report of the Scientific, Technical and Economic Committee for Fisheries (PLEN-10-01) plenary meeting, 26–30 April 2010, Norwich. Edited by John Casey and Hendrik Dörner.

Table 6.5.1. Irish Sea west (FU15): Landings (tonnes) by country, 2000–2010.

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

* 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, 2000–2010.

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

* 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 2000–2010.

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

* 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, 2000–2010.

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

* 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, 2000–2010.

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

* 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
Max	0.28	0.42
Min	0.03	0.07
Average	0.16	0.27

Table 6.5.7. Irish Sea west (FU15): Results from NI/ROI collaborative UWTV surveys of *Nephrops* grounds in 2003–2010.

Ground	Year	Number of stations	Mean Density (No./M²)	Domain Area (km²)	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%

Table 6.5.8. Irish Sea west (FU15): Catch option table inputs. Data used for 2012 catch prediction are shaded.

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

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)
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
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	590	223	791	0.69	5.14	0.15	8,422	1,658	16.5
Avg. 08–09				0.75					15.27

Table 6.5.9. Irish Sea west (FU15): Catch options at various harvest ratios.

			Implied fishery	
	Harvest rate	Adjusted Survey Index (Millions)	Retained number (Millions)	Landings (tonnes)
MSY framework	17%	4,990	639	9,753
	0%	4,990	0	0
	2%	4,990	75	1,141
	4%	4,990	149	2,281
	6%	4,990	224	3,422
	8%	4,990	299	4,563
	10%	4,990	374	5,704
Male F0.1	11%	4,990	411	6,274
	12%	4,990	448	6,844
Combined F35%	13.4%	4,990	500	7,638
F2010	14.7%	4,990	549	8,383
	16%	4,990	609	9,297
Combined Fmax	17.1%	4,990	639	9,753
	18%	4,990	673	10,267
F2008-2010	18.4%	4,990	686	10,474
	20%	4,990	747	11,407
	22.0%	4,990	822	12,548
	24%	4,990	897	13,689

		Basis
Landings Mean Weight (KG)	0.0153	Sampling 2008–2010
Survey Overestimate Bias	1.14	WKNEPH 2009
Survey Numbers (Millions)	5689	UWTV Survey 2010
Prop of removals retained by the Fishery	0.75	Sampling 2008–2010

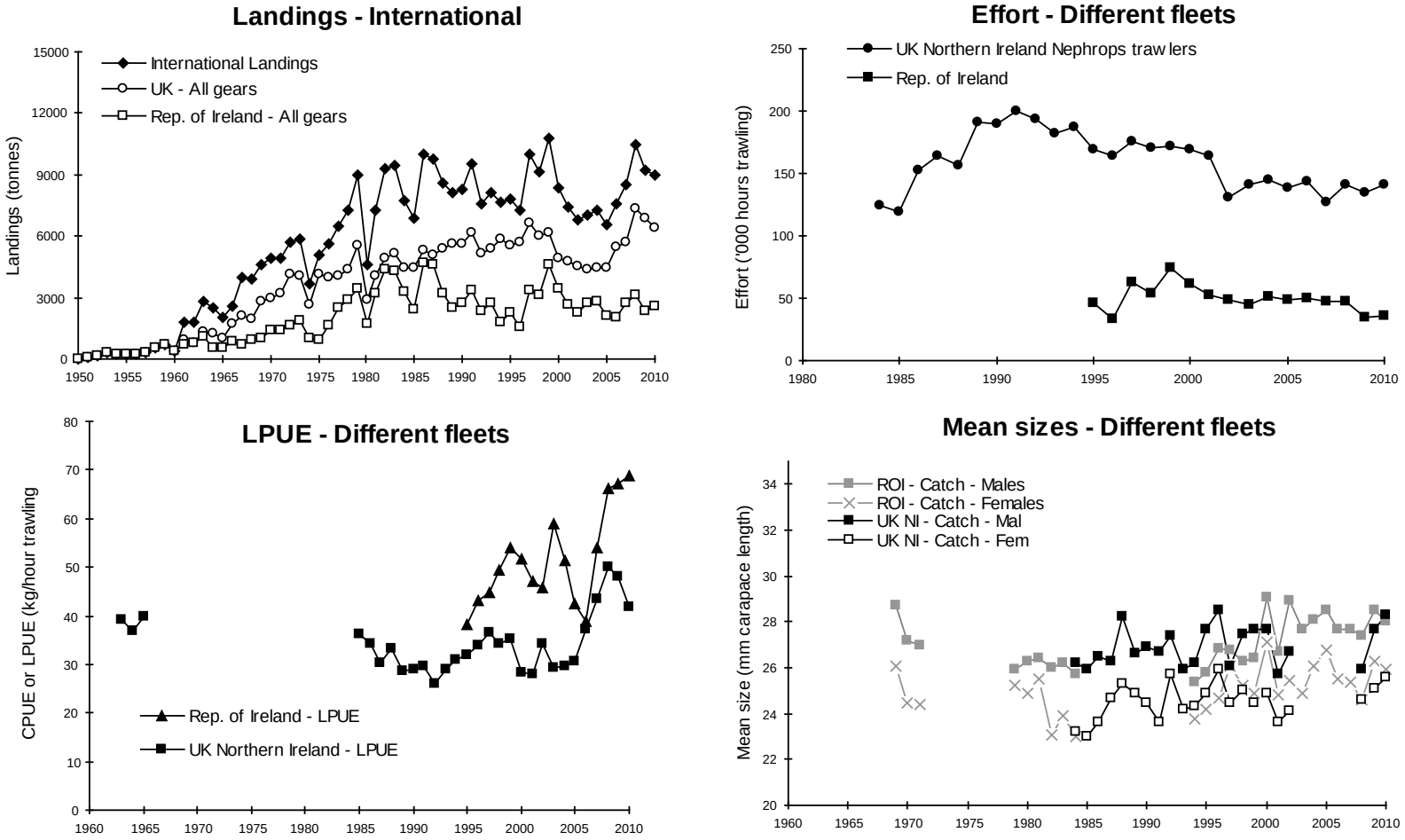


Figure 6.5.1. Irish Sea west (FU15): Long-term trends in landings, effort, cpues and/or lpues, and mean sizes of *Nephrops*.

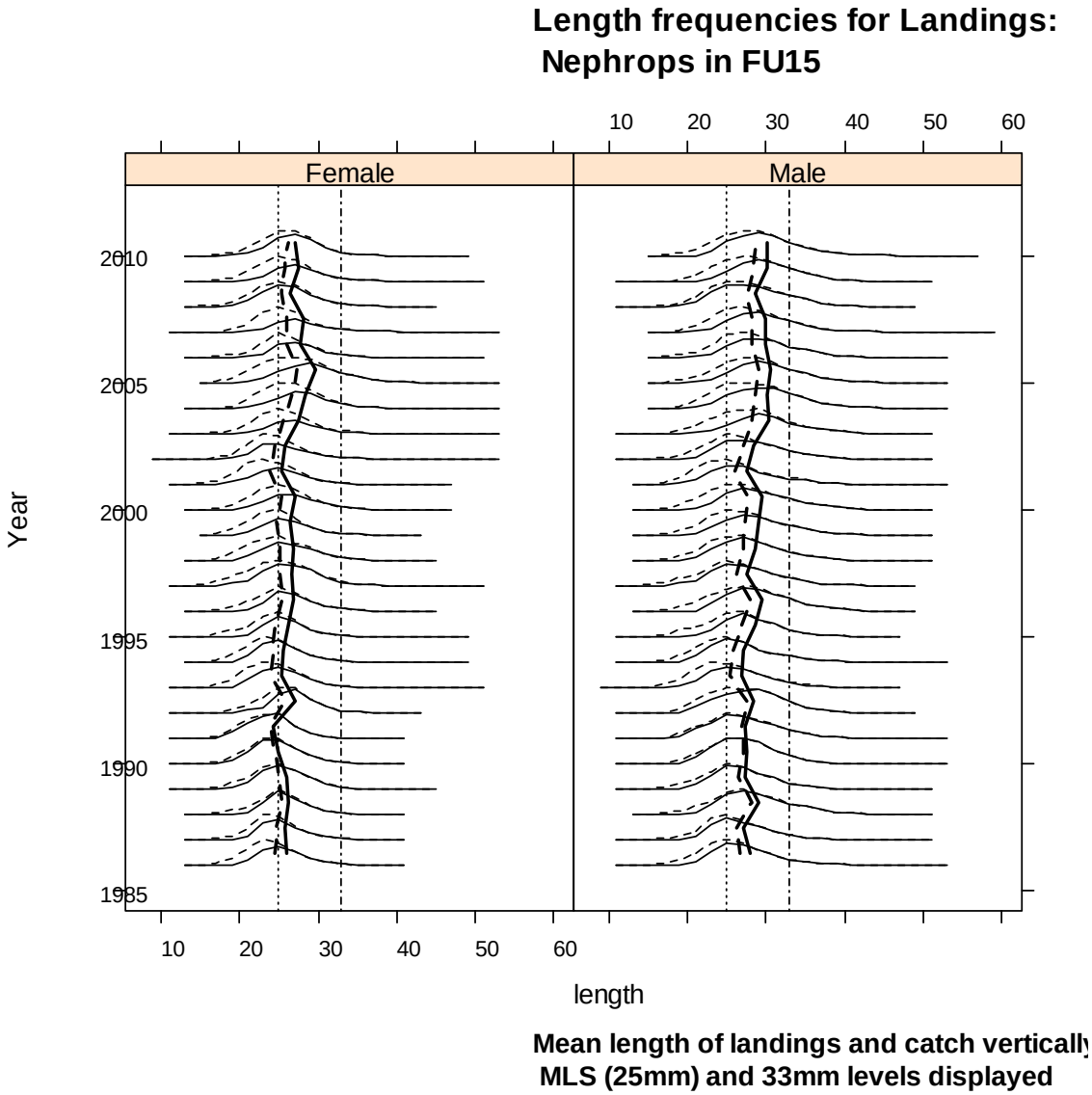


Figure 6.5.2. Irish Sea west (FU15): Length distributions in the landings and catches, 1986–2010.

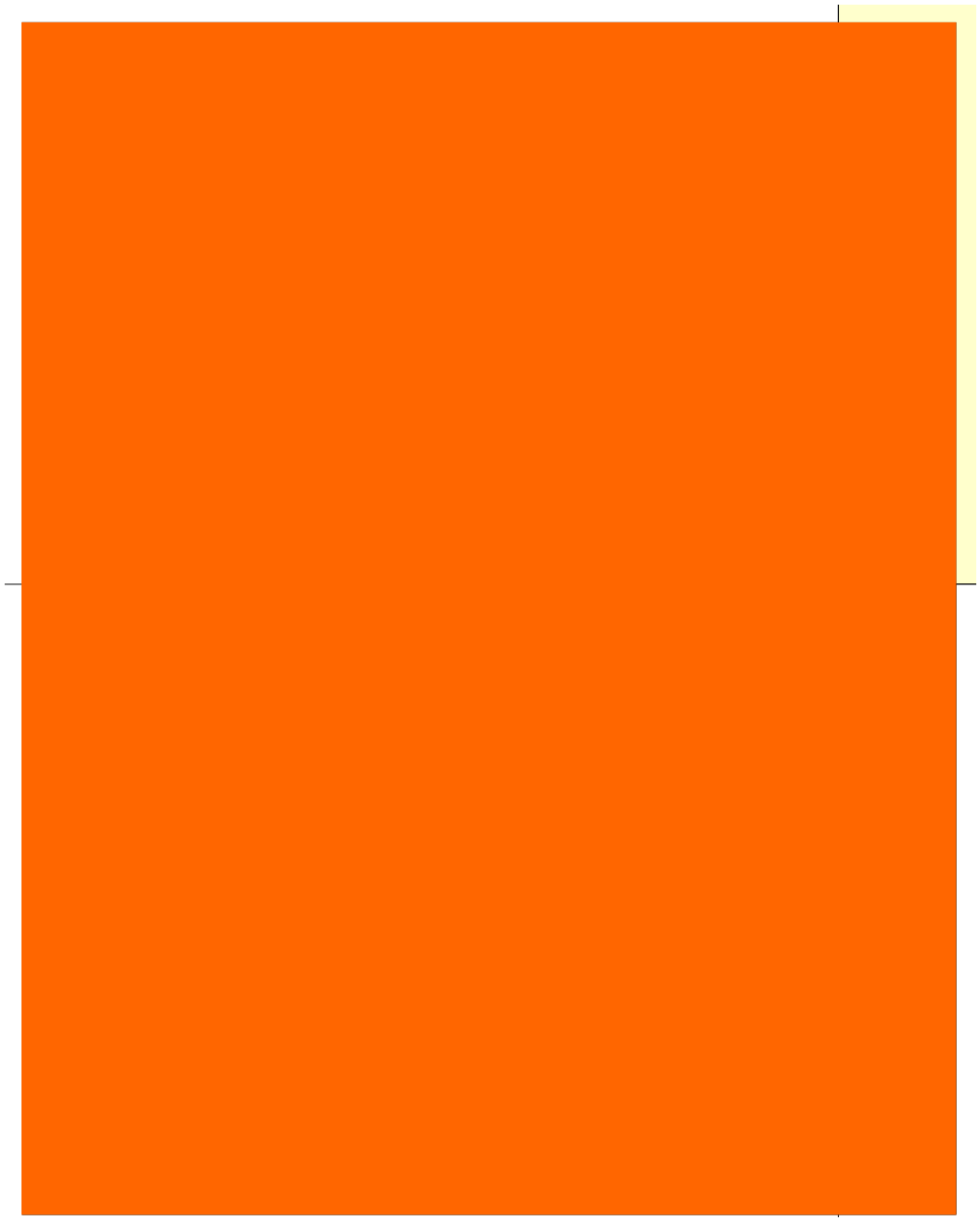


Figure 6.5.3. Irish Sea west (FU15): 2010 UWTV survey planned stations (red crosses) and completed stations (open black circles)

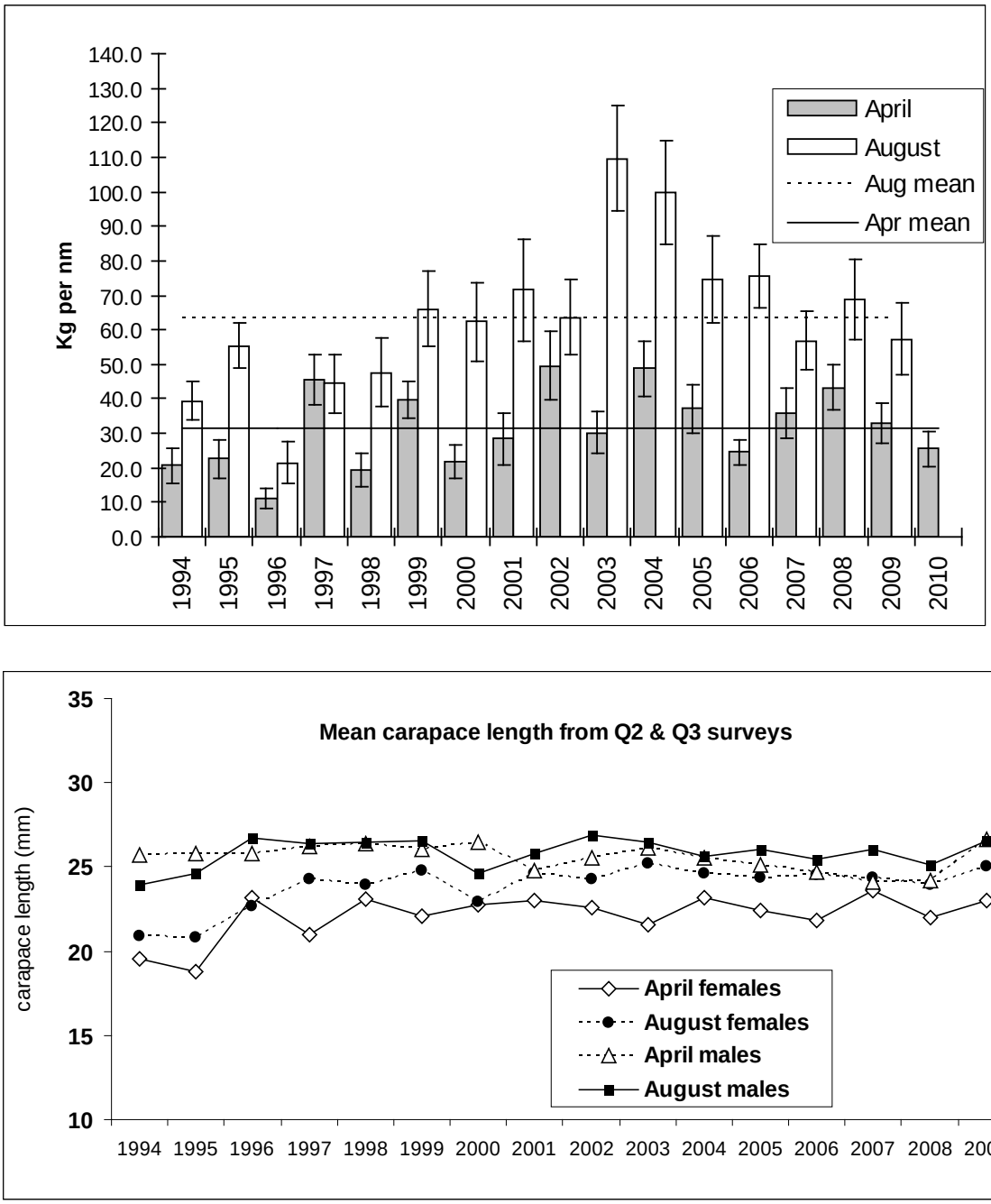


Figure 6.5.4. Irish Sea west (FU15): *Nephrops* catches, sex ratio mean size from NI trawl surveys.

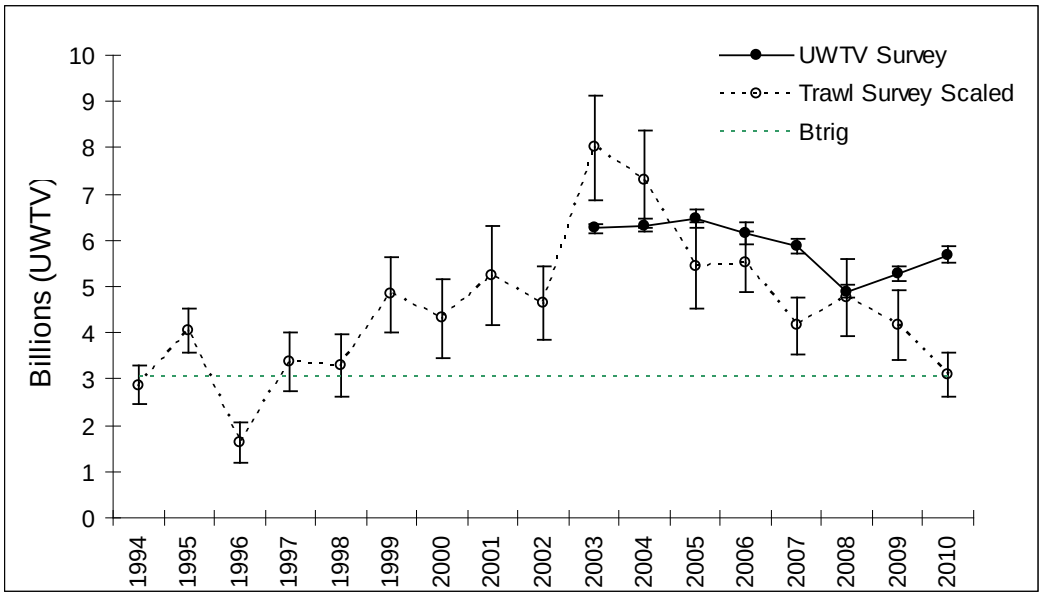


Figure 6.5.5. Irish Sea west (FU15): Revised UWTV index and scaled trawl survey. Cpue along with $B_{trigger}$ based upon mean of five lowest trawl survey values.

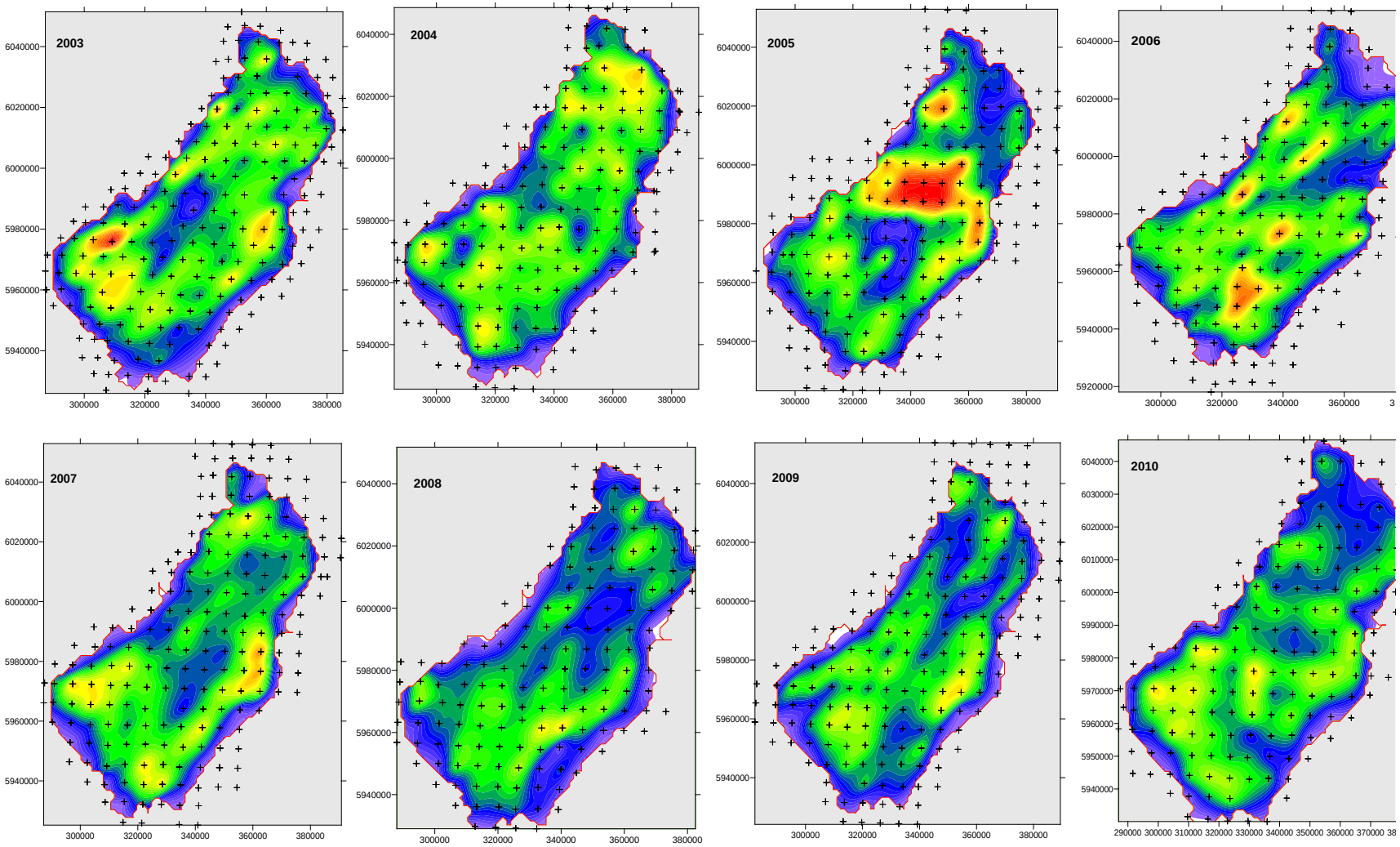


Figure 6.5.6. Irish Sea west (FU15): Contour plots of the krigged density estimates for the Irish Sea from 2003–2010.

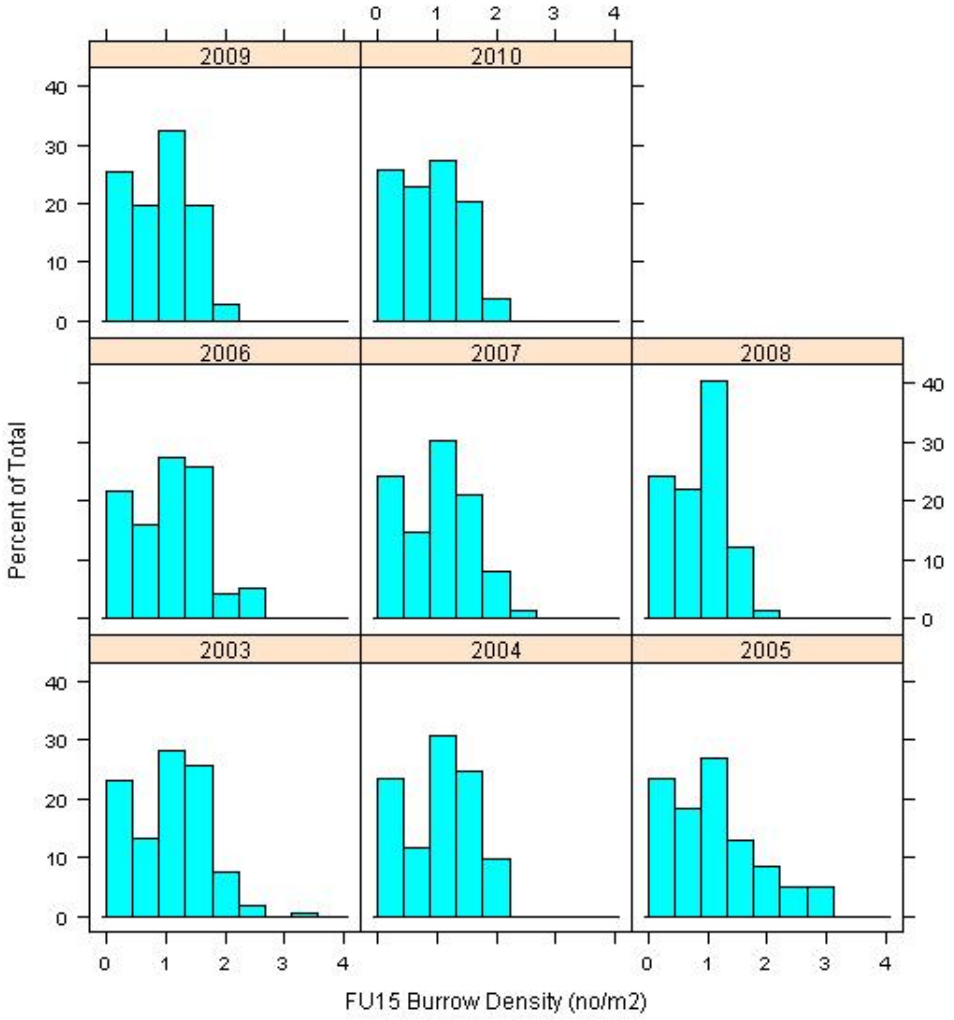


Figure 6.5.7. Irish Sea west (FU15): Burrow density distributions 2003–2010.

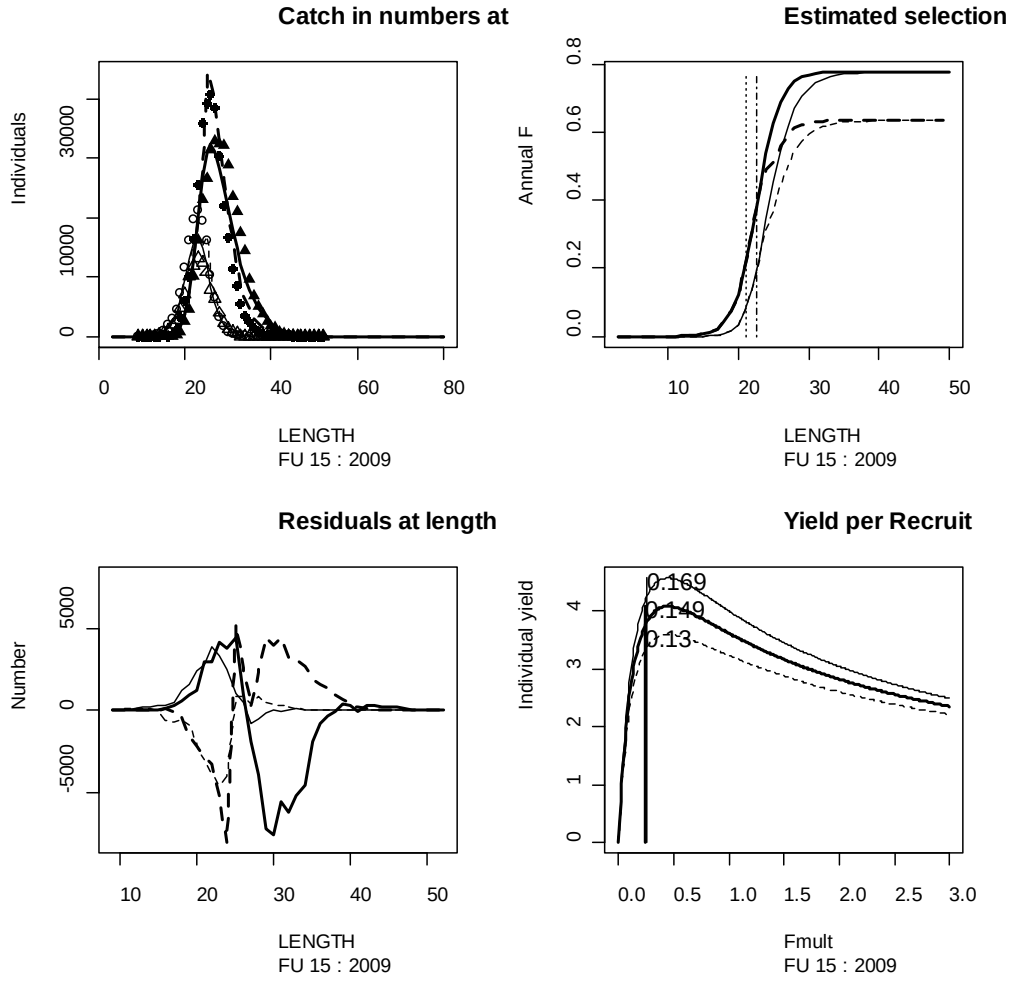


Figure 6.5.8. Irish Sea west (FU15): Separable Cohort analysis (SCA) model fit from 2010 analysis. Solid lines are for males, dashed lines are females, thick lines represent the landings component, the thin lines represent the discarded component. The top left panel gives observed and predicted numbers-at-length 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.

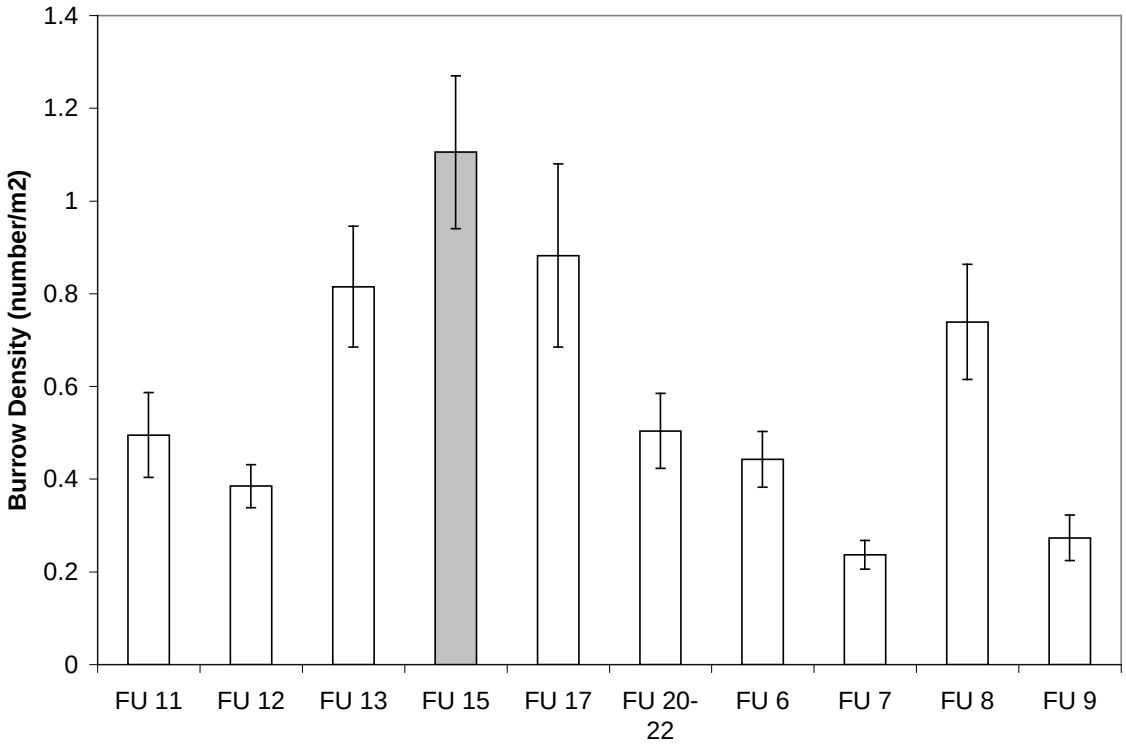
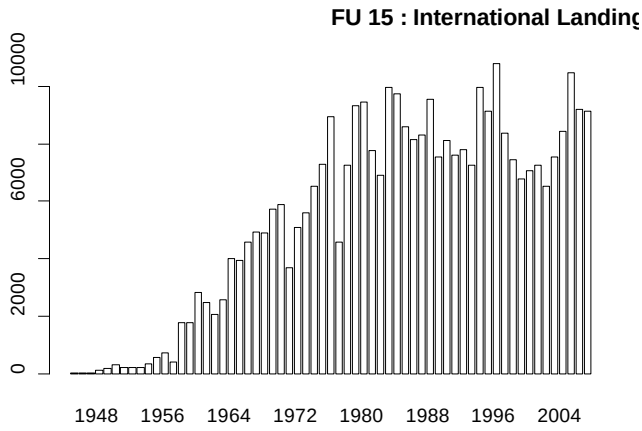
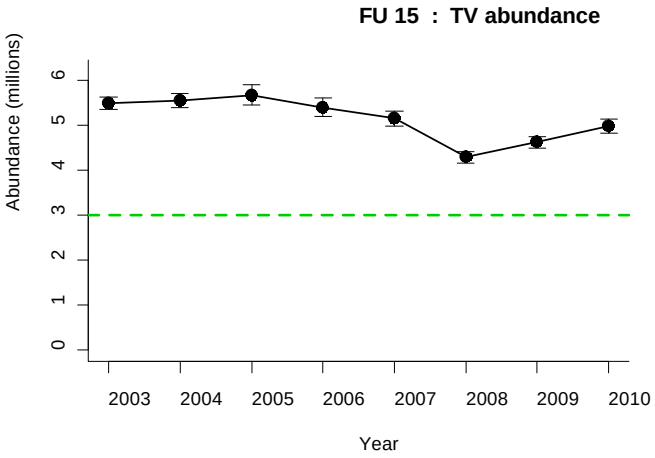


Figure 6.5.9. Irish Sea west (FU15): Estimated burrow density compared with most recent density estimates from surveys carried out on other *Nephrops* populations.





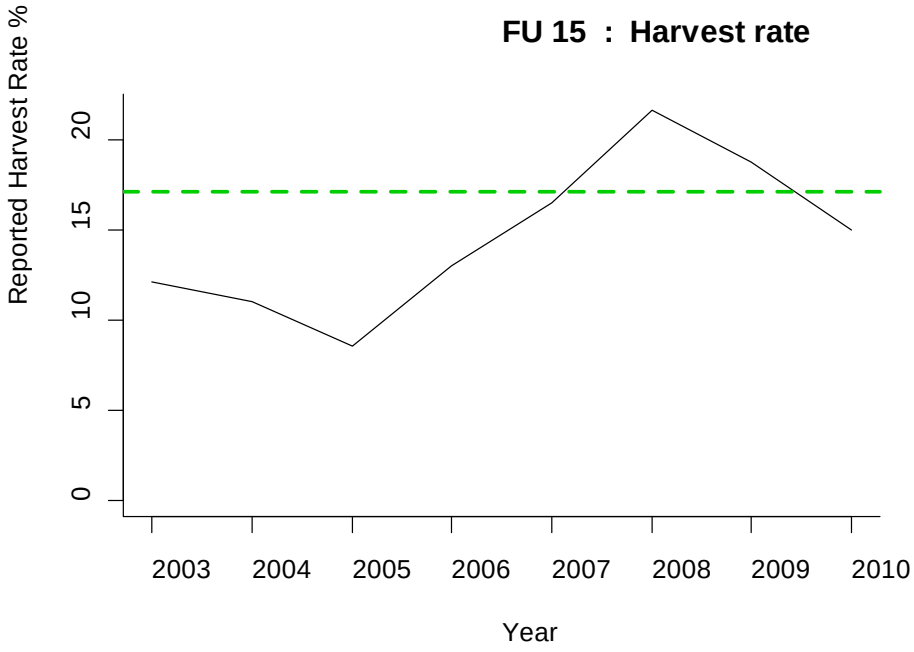


Figure 6.5.10. Irish Sea west (FU15): Stock summary plot of landings (tonnes), UWTV abundance and harvest rate (ratio).

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 (referred to as NIGFS March and NIGFS October in this section) 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 2010

The Single-stock Exploitation Boundary advised by ICES for 2010 was as follows:

- Exploitation boundaries in relation to precautionary limits.

On the basis of the stock status ICES advises that catches of whiting in 2010 should be the lowest possible.

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 to 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.

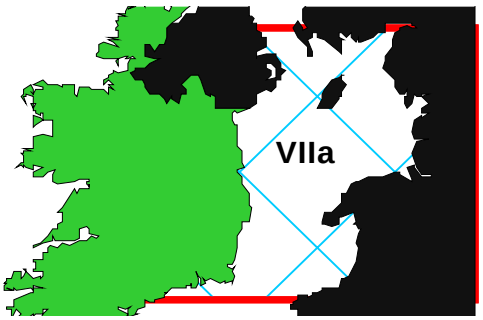
PA considerations

ICES considers that catches should be reduced to the lowest possible levels in 2011.

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 2010 and 2011

The minimum landing size of whiting is 27 cm. The 2011 TAC for whiting VIIa has been reduced from 157 t to 118 t. This TAC has not been considered restrictive, with officially reported VIIa landings totalling 121 t in 2010.

TAC 2010

Species:	Whiting *Merlangius merlangus*	Zone:	VIIa (WHG/07A.)
Belgium	0		
France	5		
Ireland	91		
The Netherlands	0		
United Kingdom	61		
EU	157		
TAC	157		Analytical TAC

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

Fishery in 2010

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 2010 international landings provided to

the Working Group have increased by 19% to those of 2009, although actual numbers remain extremely low, 121 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 2010 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, after the reopening of the Irish Sea codbox.

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.

For a fourth successive year, 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 2010, although show an increase of 19% to 2009, 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. Minor revisions were made to last year's Working Group estimate of landings (1 t).

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 on-board observer trips carried out in 2010 by UK (E&W), UK (NI) and Ireland, showed negligible fish were retained on board, while large numbers of small fish were discarded. Raised discards from the main national fleets landing whiting show over 22 million whiting, greater than 1000 t in weight, were discarded in 2010. 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 1996–2010, 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, 2004–2010, 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).

Mean weights-at-age for the Irish otter trawl fleet are also presented (Figure 6.6.4b).

The length frequency of discards of national sampled fleets in 2010 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. Slight revisions to the NIGFS West-October survey for 1994 were made in the tuning table (Table 10.6.6.2) to reflect the same data as received by the NI data files.

Figure 6.6.2 provides a comparison of mean catch weights of whiting from the eastern and western Irish Sea for UK NIGFS-Mar groundfish surveys from 1992 to March 2011 indicating low level catch rates since 2003.

Further information on whiting distribution is detailed in the results of Fisheries Science Partnership surveys of Irish Sea round fish stocks (www.cefas.co.uk/fsp, WD10). An index of biomass for 2-year-old and older whiting in the eastern Irish Sea survey show elevated values in 2009 and 2010 with a decline in 2011.

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 (SectionB.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 these 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 2009 or 2010. The last assessment for this stock was a survey based assessment in 2007.

Catch-at-age data were not updated and commercial catch data were not explored in 2010.

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 standardized indices and scatterplots of log-index at age for the NIGFS-March are presented in Figures 6.6.6a and Figure 6.6.7a, respectively. Both plots indicate poor internal consistency within the survey. The survey appears to track the 1991 year class but examination of the internal consistency via the scatterplots indicates poor correlation between age classes. Corresponding figures for the NIGFS-Oct are plotted in Figures 6.6.6b and 6.6.7b. 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 Figure 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 March and the NIGFS October surveys. Both NIGFS surveys show slightly increased SSB levels in the terminal year but SSB is still at a low levels compared to earlier on in the time-series.

Figure 6.6.10 shows the residual plots by age for the NIGFS March 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 March is shown in Figure 6.6.11. The temporal F trend is variable in later years with the current year increasing from a relatively low level in 2009; 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 March survey. SSB is declining since 2002 but shows a light upturn in 2011. 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 temporarily declined in 2008. Recruitment is also variable but estimated to be been good in 2006 and 2008. 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 2011 data.

Residual plots by age for the NIGFS October 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 October. 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 vs. 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 appears to have been good in 2006 and 2008. No strong retrospective bias is evident in F, SSB or recruitment, although there appears to be a noisy period for recruitment in 2006–2007.

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

None.

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. These data do not support the evaluation or estimation of F_{msy}. However it is likely that recent F is above F_{msy} at the current selection pattern.

6.6.7 Biological reference points

Precautionary approach reference points

No precautionary reference points have been defined for this stock.

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 to 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. 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). Implementation of such measures should be actively encouraged. Preliminary Irish discard data shows a reduction in 45% by number of whiting on boats using these gear technology mitigation measures.

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.

6.6.12 References

STECF 01. 2011. 36th Plenary meeting report of the Scientific, Technical and Economic Committee for Fisheries (PLEN-11-01) plenary meeting, 11–15 April 2011, Norwich. Edited by John Casey and Hendrik Dörner.

Table 6.6.1. Nominal catch (t) of whiting in Division VIIa, 1988–2010, as officially reported to ICES and Working Group. Discard estimates available until 2001.

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
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
Working Group Estimates	2,762	2,880	1,745	1,487	676	184	158	86	196	81	102

Country	2010*
Belgium	5
France	3
Ireland	97
Netherlands	
UK(Engl. & Wales)[a]	16
Spain	
UK (Isle of Man)	<0.5
UK (N.Ireland)	
UK (Scotland)	
UK	
Total human consumption	121
Estimated Nephrops fishery discards used by the WG[b]	n/a
Working Group Estimates	121

[a] 1989-onwards Northern Ireland included with England and Wales.
[b] Based on UK(N.Ireland) and Ireland data.
* Preliminary (and rounded).

Table 6.6.2. Whiting in 7a. Survey data available to WGCSE 2011. Updated Survey Titles highlighted in bold.

NIGFS West-October : Northern Ireland October Groundfish Survey - Irish Sea West - Nos. per 3 nm

1994	2010						
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

NIGFS West-March : Northern Ireland March Groundfish Survey - Irish Sea West - Nos. per 3 nm

1994	2011					
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

Table 6.6.2. (cont'd). Whiting in 7a. Survey data available to WGCSE 2011.

NIGFS East-October : Northern Ireland October Groundfish Survey - Irish Sea East - Nos. per 3 nm

1994 2010
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

NIGFS East-March : Northern Ireland March Groundfish Survey - Irish Sea East - Nos. per 3 nm

1993 2011
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

Table 6.6.2. (cont'd). Whiting in 7a. Survey data available to WGCSE 2011.

UKE&W-BTS : Corystes Irish Sea Beam Trawl Survey (Sept) - Prime stations only - Effort and numbers-at-age (per km towed)

1988 2010
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

NIGFS-Oct E&W : Northern Ireland October Groundfish Survey - Irish Sea East & West - Nos. per 3 nm

1992 2010
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

Table 6.6.2. (cont'd). Whiting in 7a. Survey data available to WGCSE 2011.

NIGFS-March E&W : Northern Ireland March Groundfish Survey- Irish Sea East & West - Nos. per 3 nm

1992	2011						
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

UKNI-MIK : Northern Ireland MIK Net Survey

1994	2010	
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

ScoGFS Spring : 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

Table 6.6.2. (cont'd). Whiting in 7a. Survey data available to WGCSE 2011.

ScoGFS Autumn : 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

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

Table 6.6.2. (cont'd). Whiting in 7a. Survey data available to WGCSE 2011.

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

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 1996–2010.

	1996		1997		1998		1999		2000		2001		200
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)
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
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
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
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
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
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
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
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
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
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
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
Total weight (t)		520.8		1024.1		1010.3		71.6		434.3		1054.5	

Sampling Information	1996	1997	1998	1999	2000	2001	200
Number of Trips	8	8	7	4	10	2	
Number of Hauls	48	44	58	40	111	34	

	2003		2004		2005		2006		2007		2008		200
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)
0	1921.76	0.016	17091.56	0.018	442.07	0.010	1534.97	0.016	5138.89	0.043	4585.77	0.025	13319.29
1	2419.56	0.036	7347.29	0.034	2531.84	0.035	1483.43	0.060	23000.16	0.038	7879.78	0.040	12913.10
2	1287.21	0.178	731.35	0.101	783.68	0.091	621.58	0.133	3282.67	0.095	1485.70	0.093	712.51
3	603.20	0.246	142.50	0.165	129.28	0.159	99.02	0.218	916.09	0.145	161.03	0.119	2.60
4	108.64	0.268	96.30	0.218	40.12	0.154	16.82	0.312	10.96	0.276	13.46	0.130	0.89
5	0.00	0.000	0.00	0.000	24.48	0.371	0.00	0.000	1.92	0.304	0.00	0.000	0.00
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
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
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
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
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
Total weight (t)		523.6		680.3		201.3		223.2		1544.7		585.3	

Sampling Information	2003	2004	2005	2006	2007	2008	200
Number of Trips	9	11	8	5	15	18	
Number of Hauls	60	122	96	56	90	91	

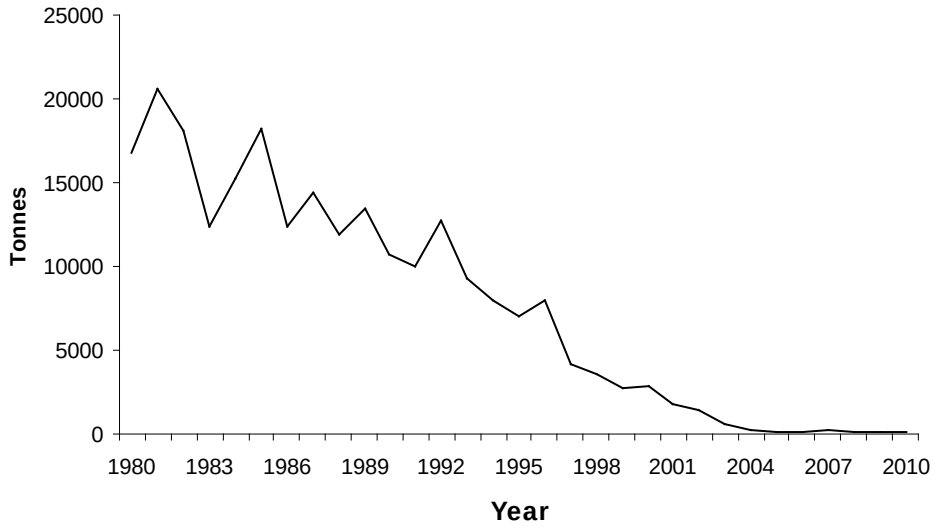


Figure 6.6.1. Whiting VIIa. Working group estimates of landings 1980–2010. Note landings data prior to 2003 has been adjusted for misreporting and includes estimates of discards.

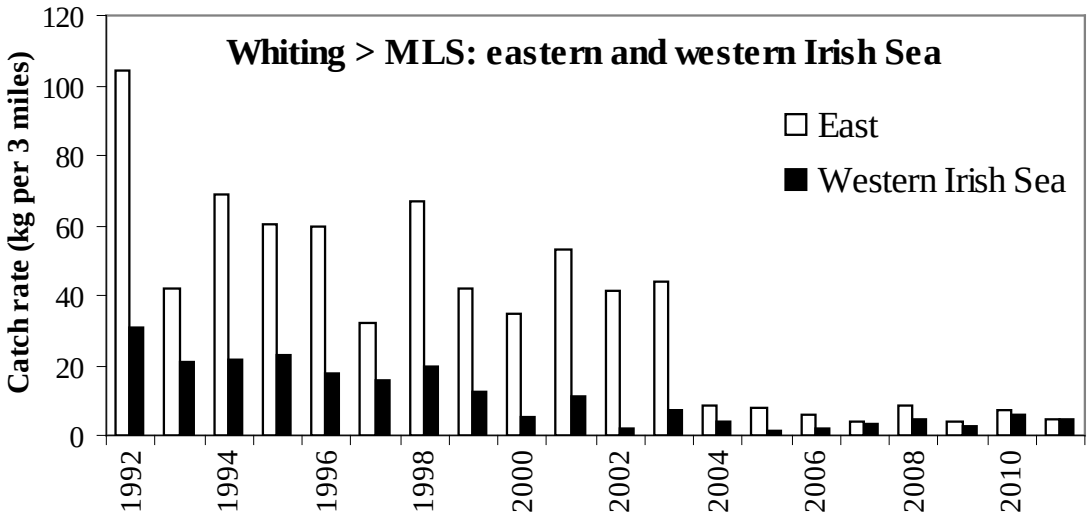


Figure 6.6.2. Eastern and western VIIa whiting mean catch rates in kg per 3-mile tow, for fish at and above the minimum landing size (27 cm) from the UK(NI) March groundfish survey, 1992–2011.

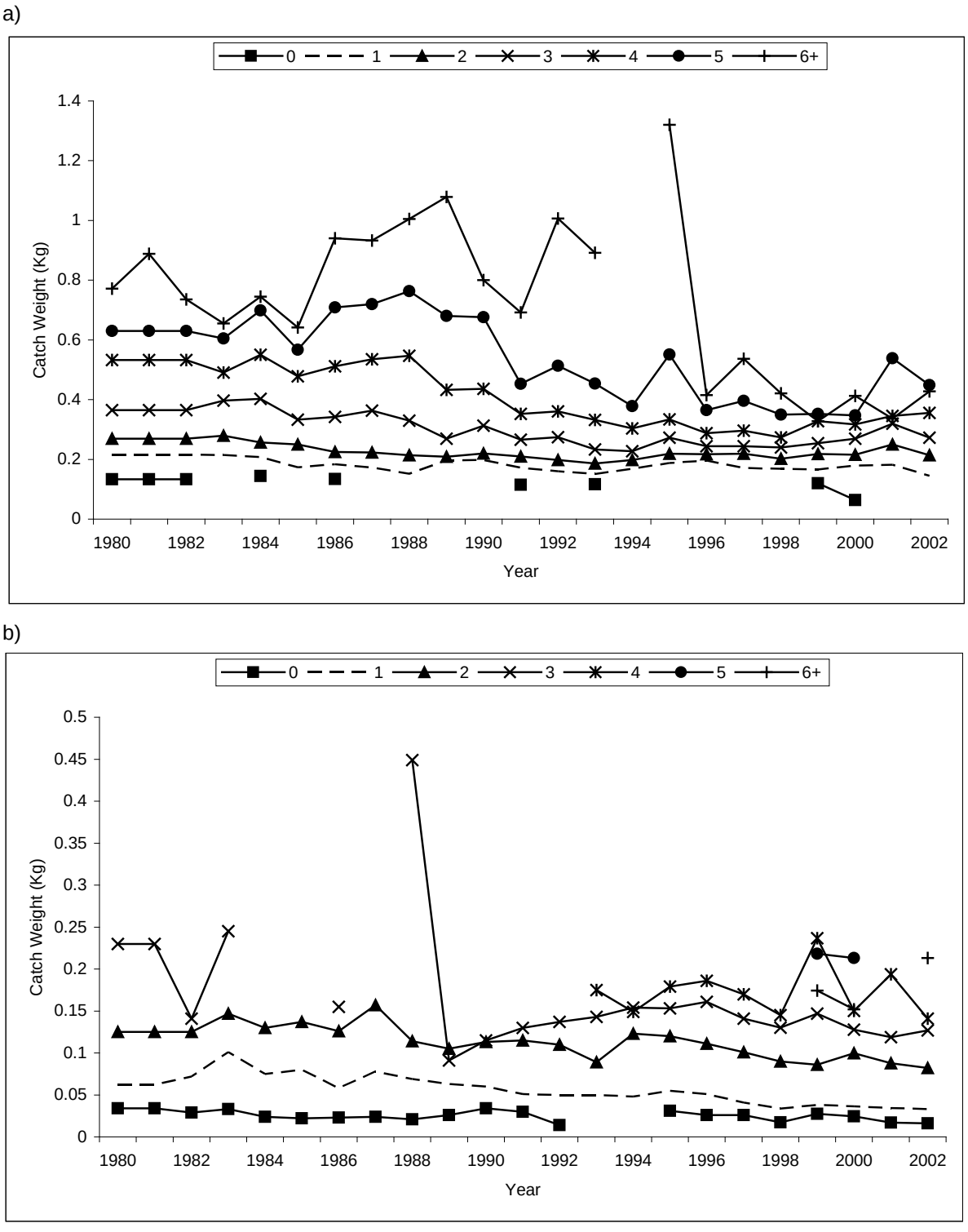


Figure 6.6.3. VIIa whiting International mean weights-at-age in (a) landings (Human Consumption Fishery) and (b) discards, 1980–2002.

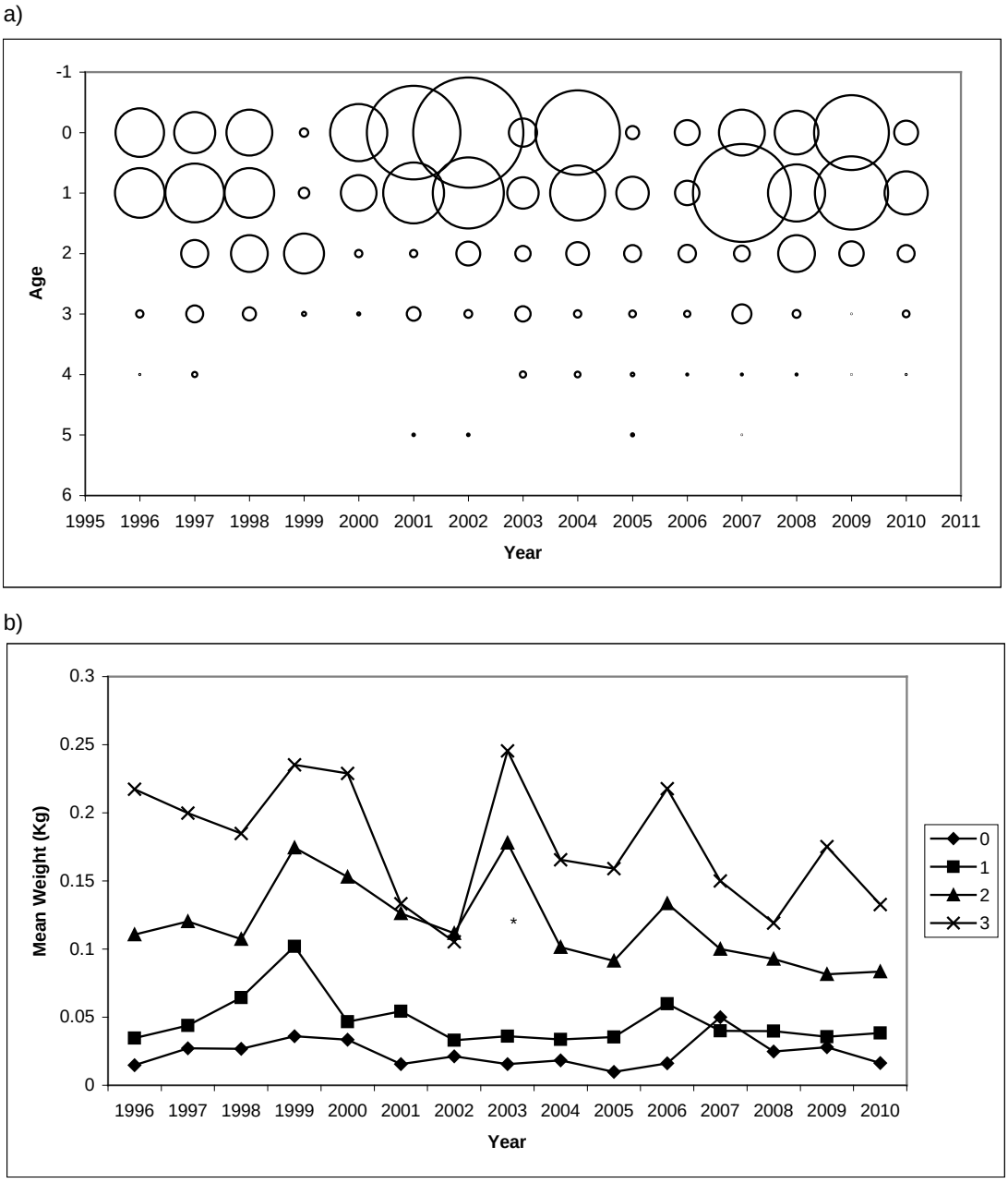
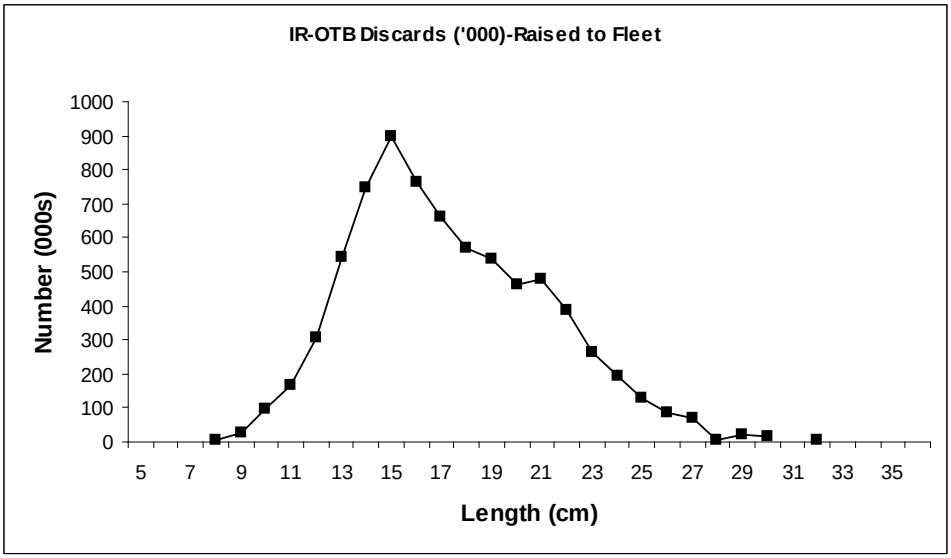
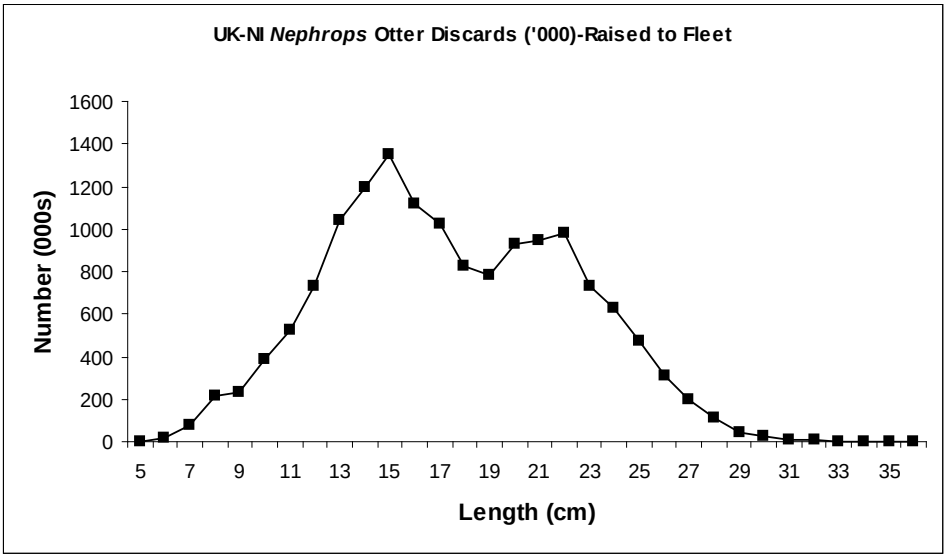


Figure 6.6.4. VIIa whiting discard information for the Irish commercial otter board trawl fleet (a) numbers-at-age and (b) mean weights-at-age, 1996–2010.





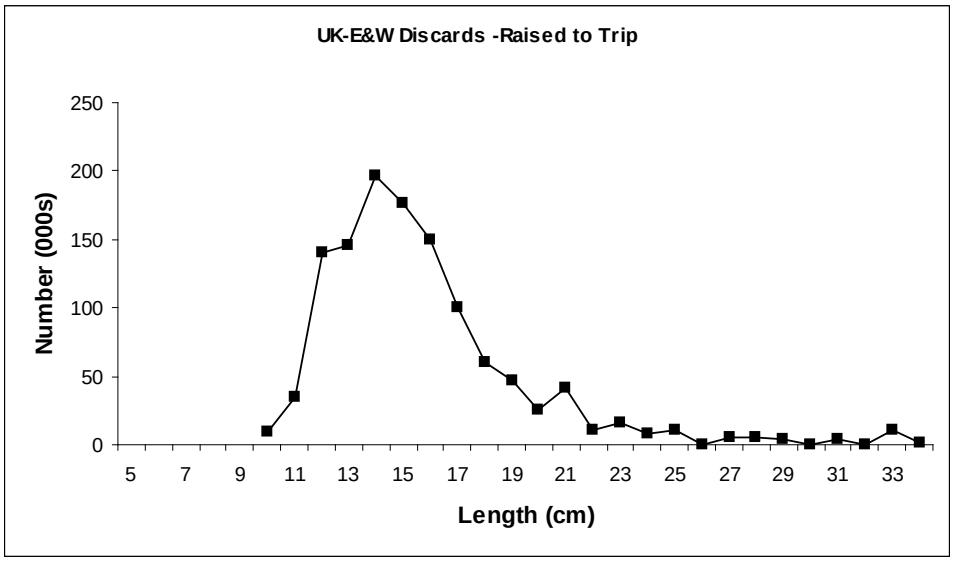
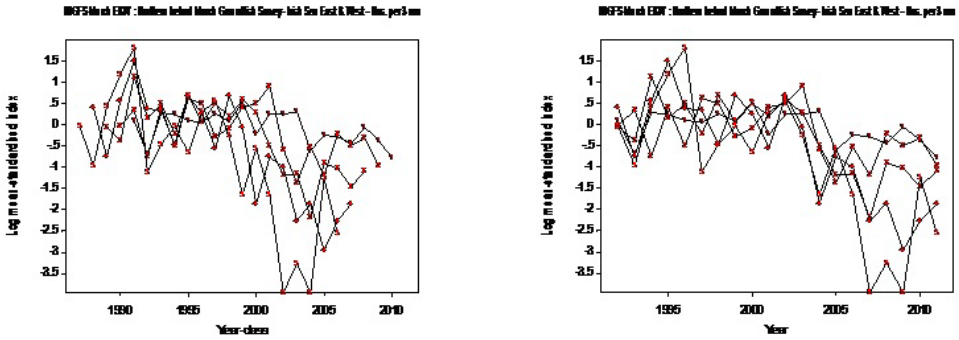


Figure 6.6.5. VIIa Whiting discard length frequency by national fleets in 2010. Note due to low levels of retained catch, and hence low sampling, these data are not presented.

a)



b)

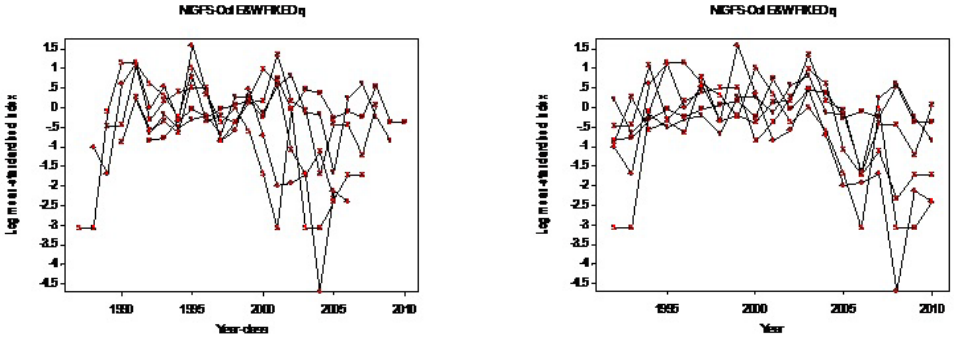
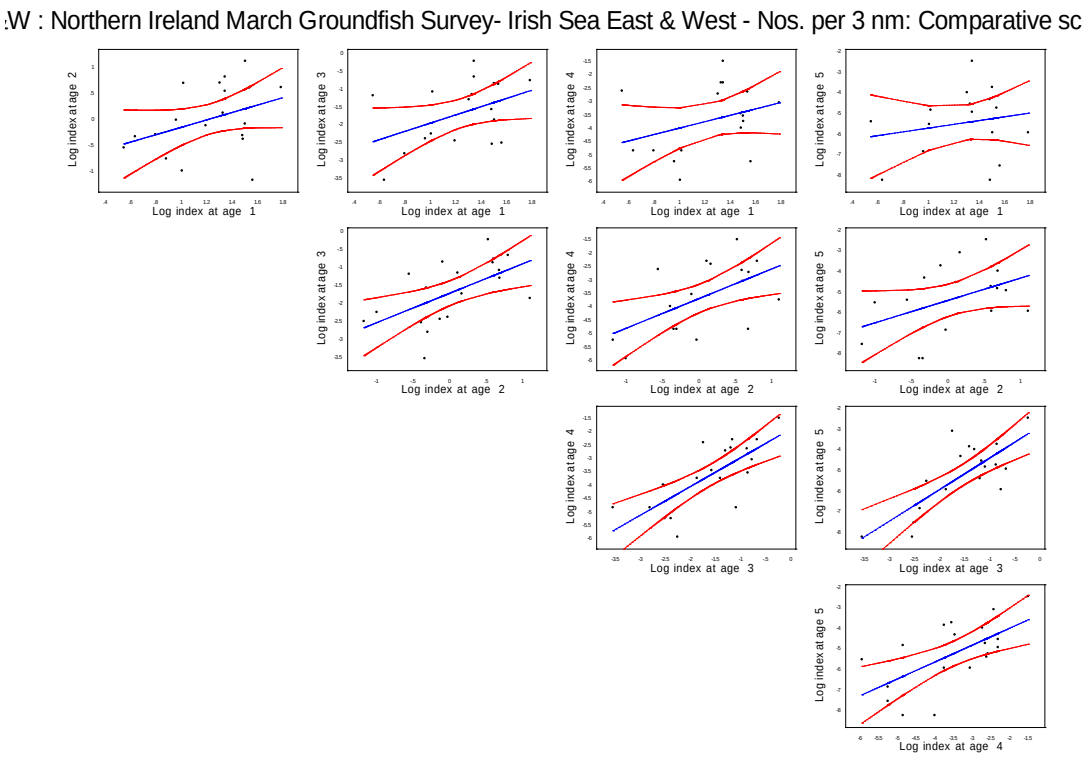


Figure 6.6.6. Log Mean Standardized Indices for (a) NIGFS March and (b) NIGFS October by year class and year.

a)



b)

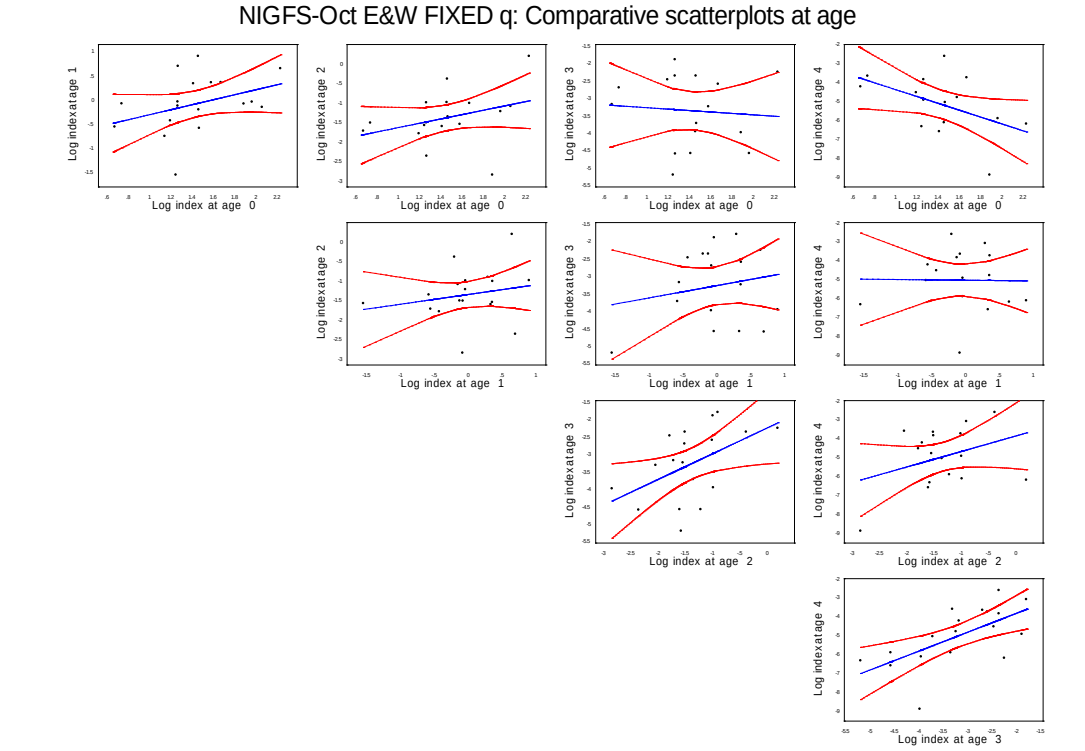
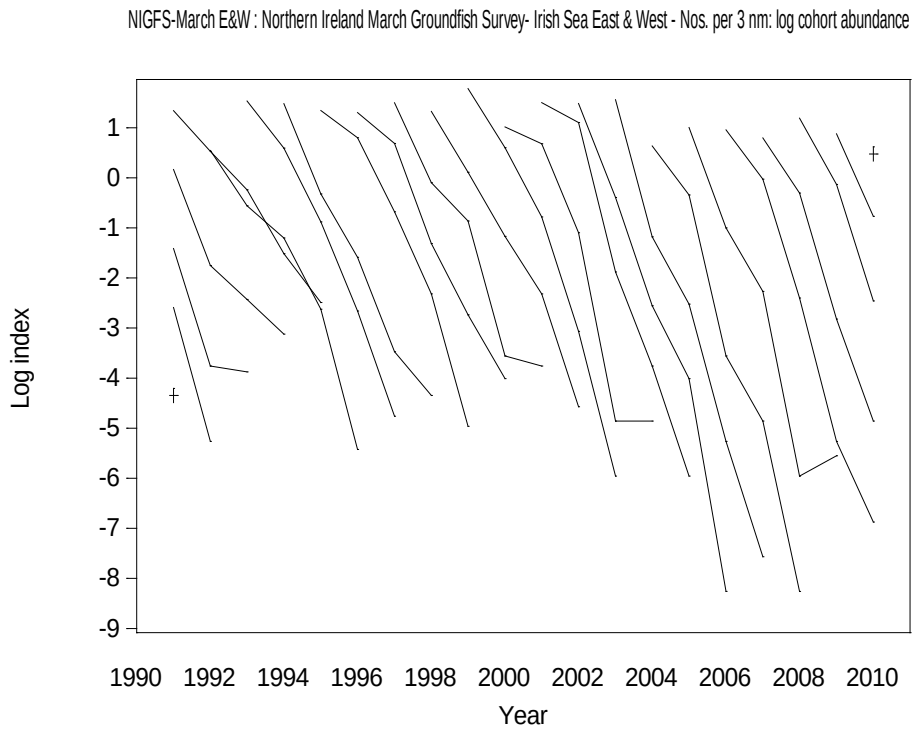


Figure 6.6.7. Scatterplots of Log index-at-age for the NIGFS March (a) and NIGFS October (b) surveys.

a)



b)

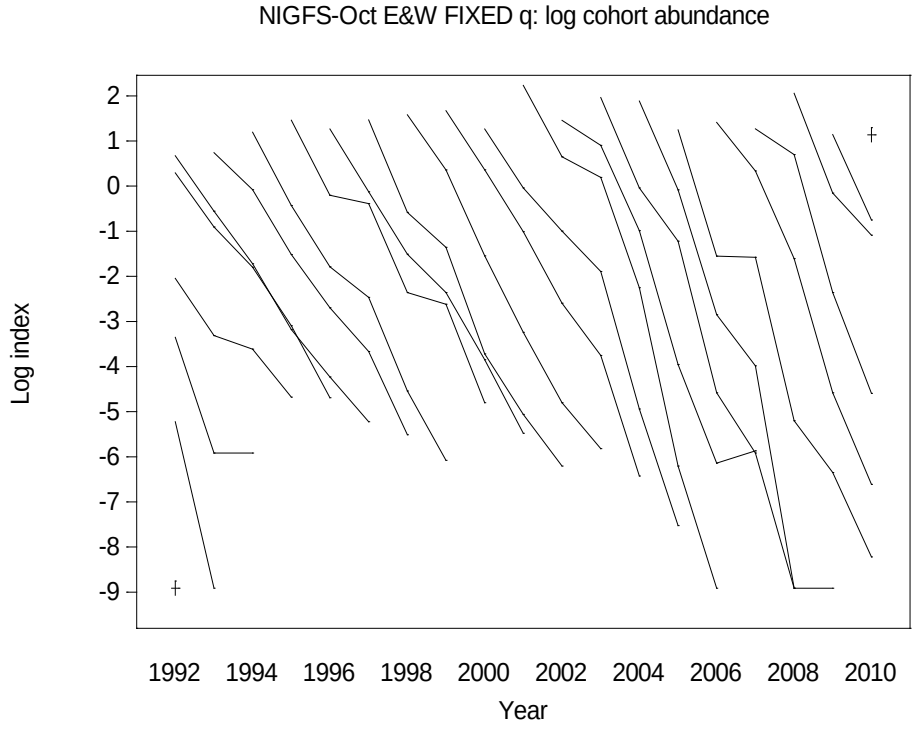
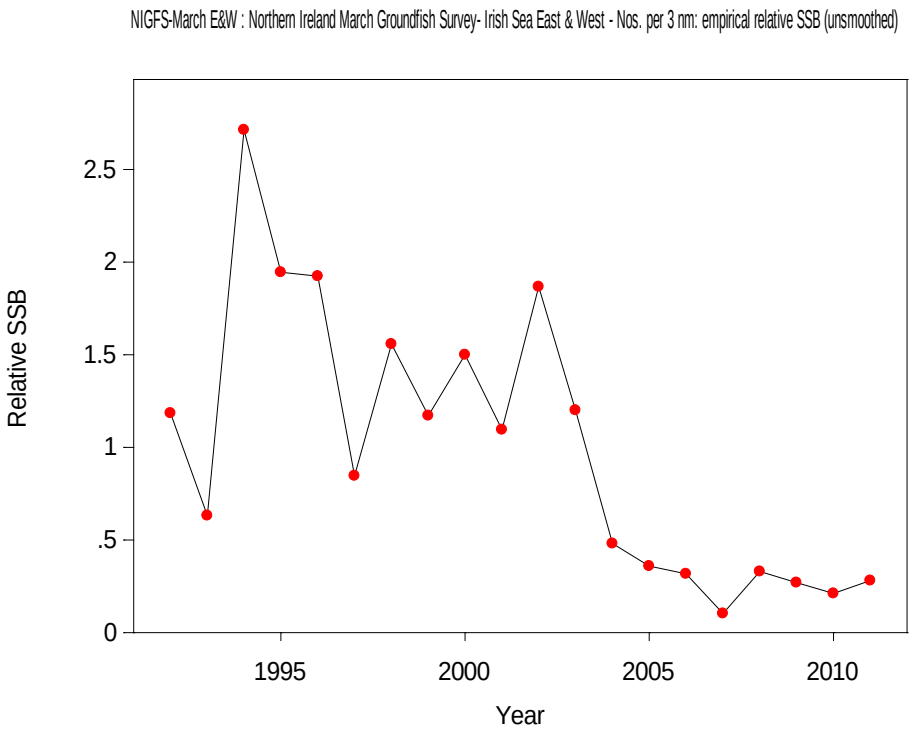


Figure 6.6.8. Catch Curves for NIGFS-March (a) and NIGFS-October (b) surveys.

a)



b)

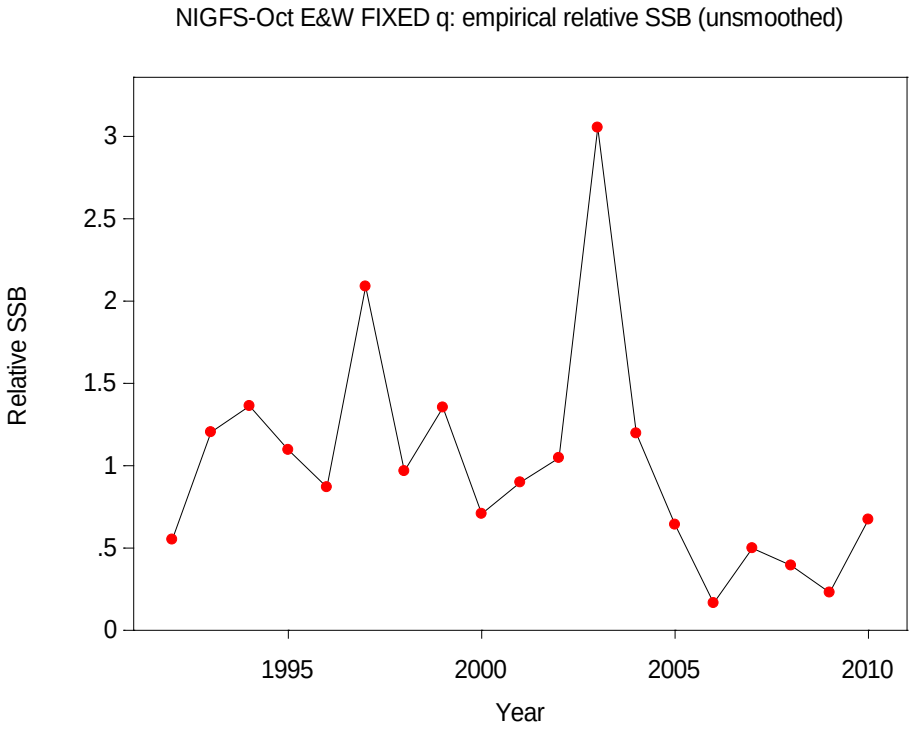


Figure 6.6.9. Empirical Estimates of SSB for NIGFS March (a) and NIGFS October (b) surveys.

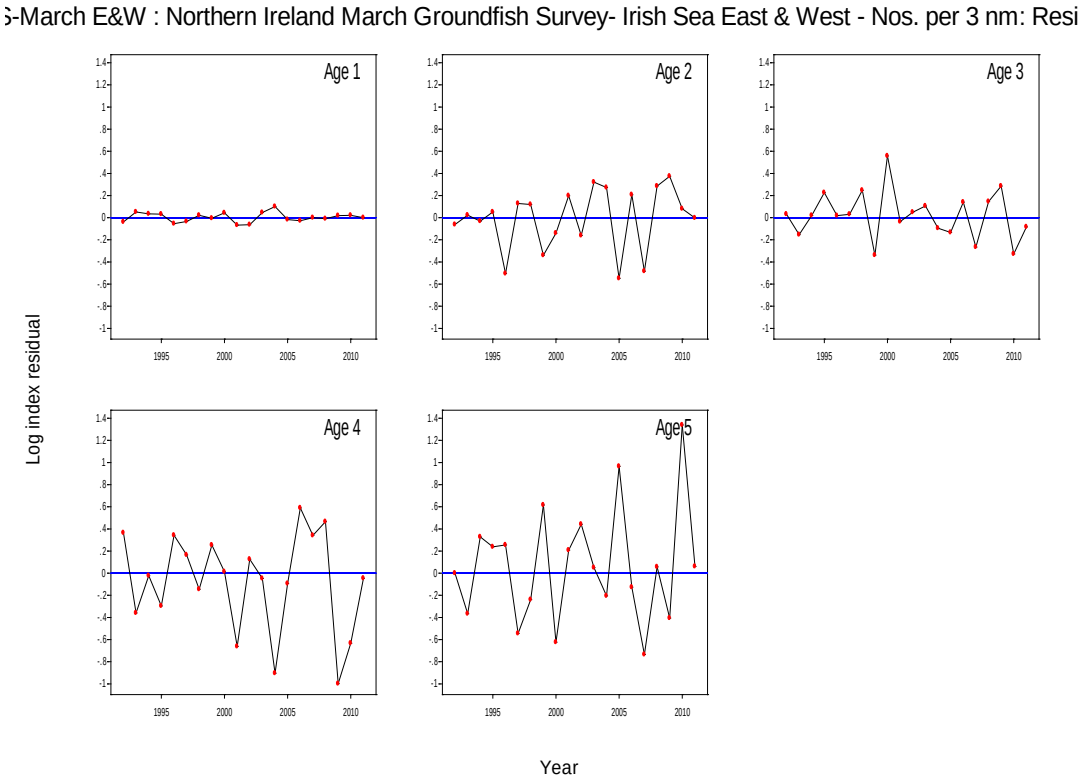


Figure 6.6.10. Residual Plots by Age of the NIGFS March survey.

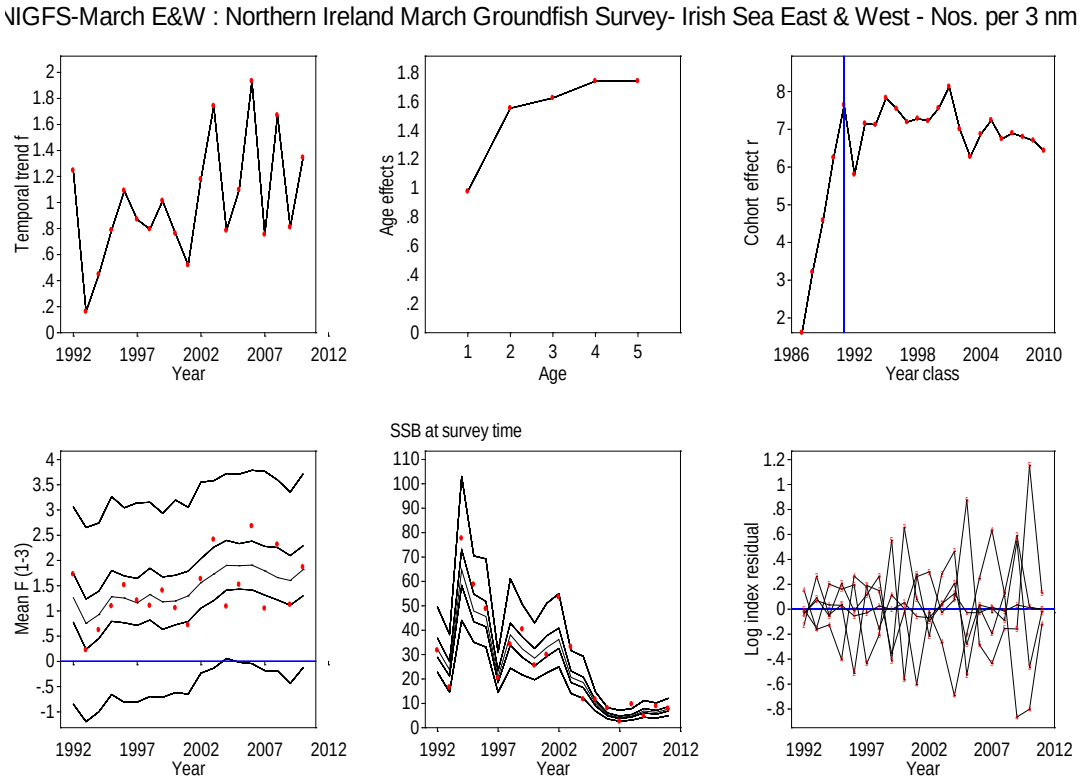


Figure 6.6.11. Stock Summary of the SURBA model fit for the NIGFS March survey. Empirical SSB (red dots) with model estimates of SSB (black line) are shown in bottom centre panel.

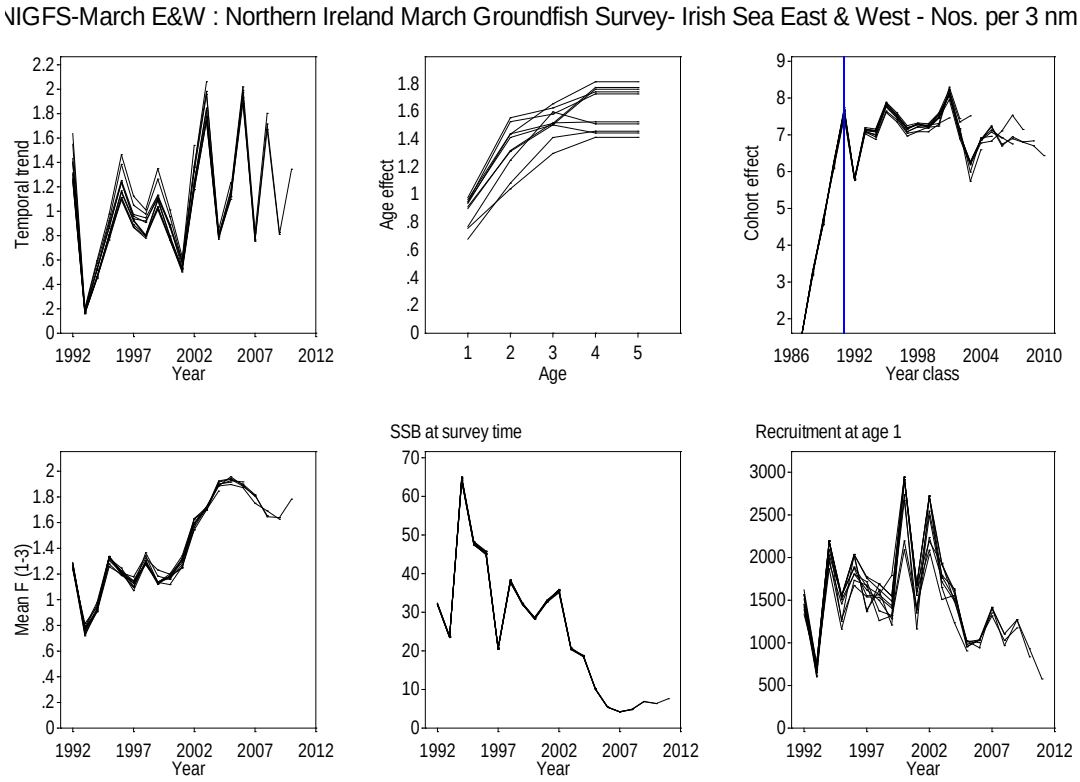


Figure 6.6.12. Retrospective pattern of Single fleet SURBA run for NIGFS March survey.

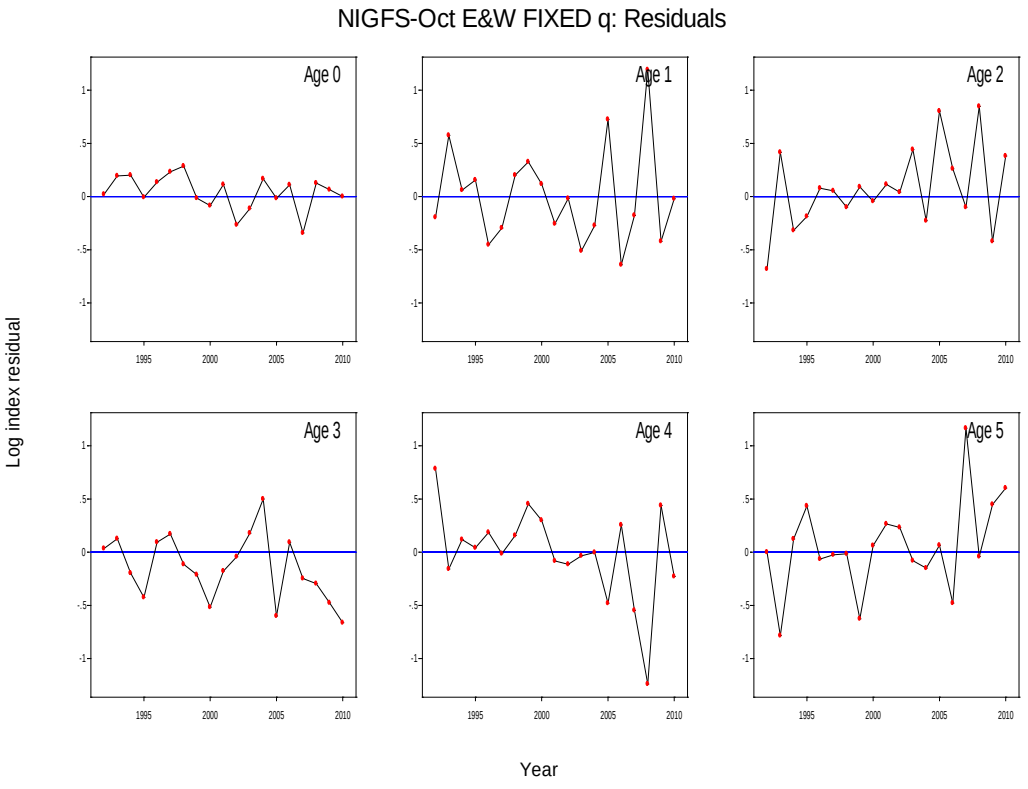


Figure 6.6.13. Residual Plots by Age of the NIGFS October survey.

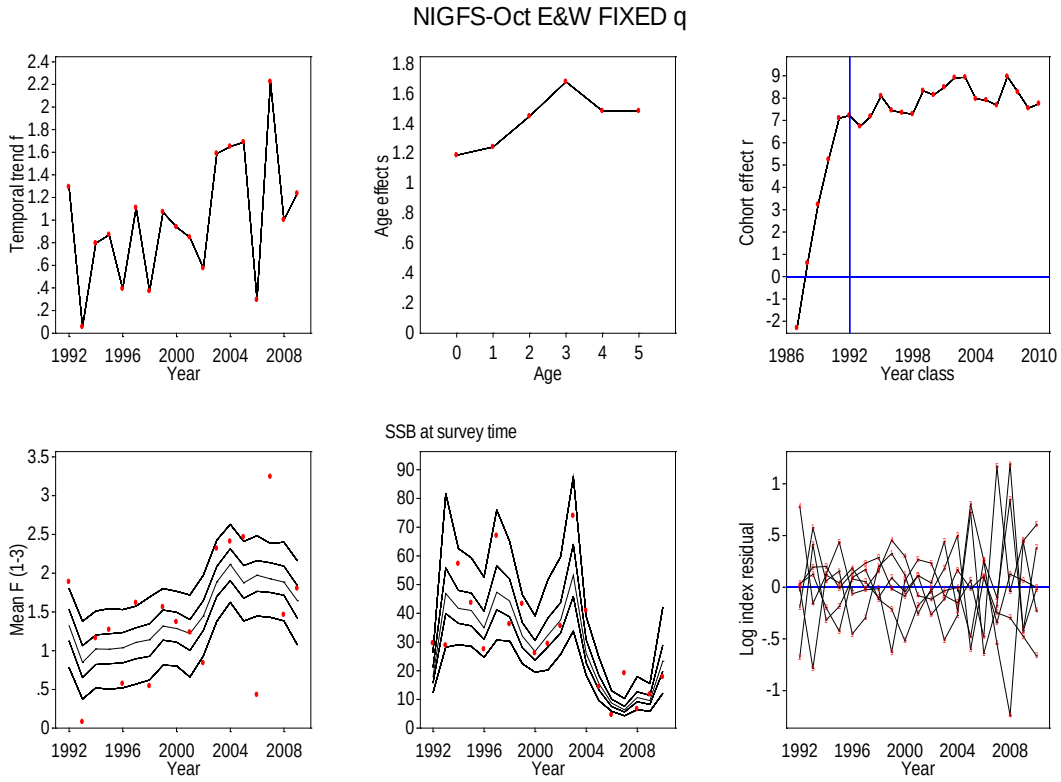


Figure 6.6.14. Stock summary of the SURBA model fit for the NIGFS October survey. Empirical SSB (red dots) with model estimates of SSB (black line) are shown in bottom centre panel.

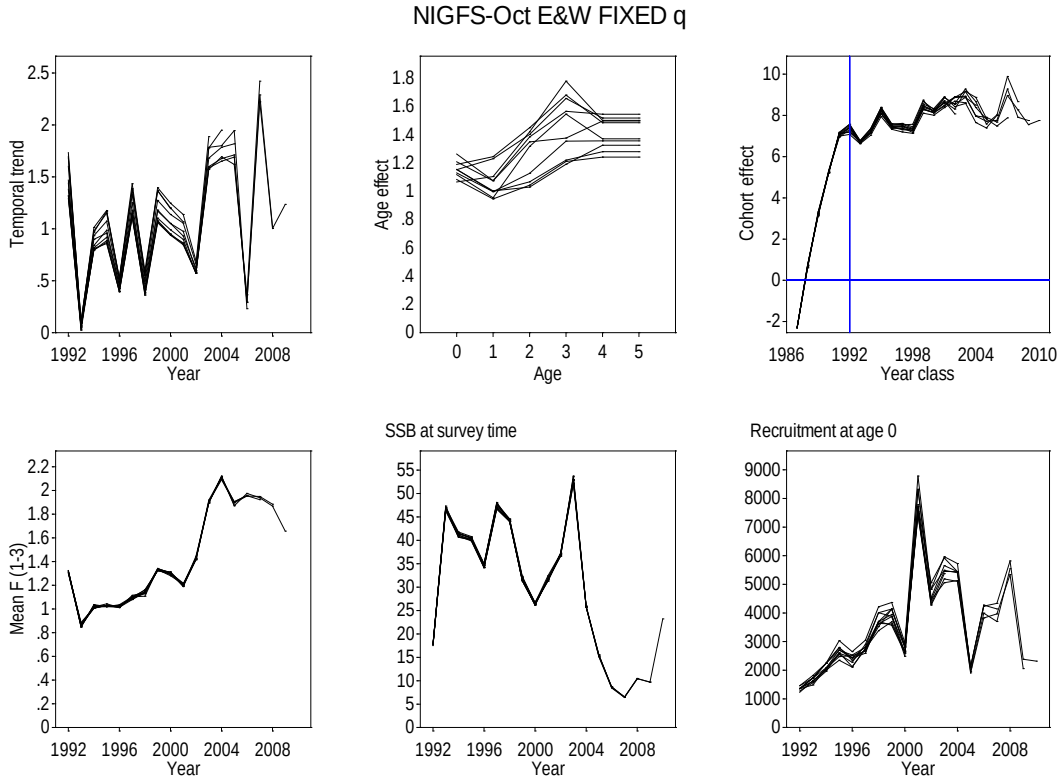


Figure 6.6.15. Retrospective pattern of Single fleet SURBA run for NIGFS October survey.

6.7 Plaice in Division VIIa (Irish Sea)

Type of assessment in 2011

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 2010

ICES advises on the basis of high long-term yield that catches should not exceed 1627 t in 2010.

ICES advice applicable to 2011

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 2010 and 2011

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.

2010

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

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

The fishery in 2010

National landings data reported to ICES and Working Group estimates of total landings are given in Table 6.7.2.1.

The TAC in 2010 was 1627 tonnes and the working group estimate of landings in 2010 was 377 tonnes, which is a 22% decrease in landings comparable to 2009 and only 23% of the TAC in 2010. 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 70% shortfall 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 36%, 31%, 9% and 24% respectively of total landings in 2010. 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 large 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. 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 the years 2004–2010 (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 Northern 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 since 2006 (Figure 6.7.2.8).

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 Northern 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 (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 groundfish 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 standardized cpue plots (Figure 6.7.2.6) indicates that the survey has fair internal consistency and suggests increases in the 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. The biomass index of age 1–4 fish calculated from the UK (E&W)-BTS-Q3 also indicates an upwards trend since 1993 (Figure 6.7.2.2). 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 reached high levels in 2009 and the spring (Q1) index in 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 (revised in 2011 to ensure consistency across years, see WD #, WGCSE 2011) 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).

Work is currently being undertaken to supply cpue values for the Q4 western IBTS survey (UK, E&W) for the Irish Sea area. However, the time-series is currently too short to include in the assessment.

Commercial cpue

All available tuning data are shown in Table 6.7.2.4. Age based tuning data available for this assessment comprise three commercial fleets; the UK(E&W) otter trawl fleet (UK(E&W)OTB, from 2008), the UK(E&W) beam trawl fleet (UK(E&W)BT, from 1989) and the Irish otter trawl fleet (IR-OTB, from 1995). Due to inconsistencies in the available tuning fleets, Irish Sea plaice assessments since 2004 have omitted these indices. For more information see WGNSDS 2004. The effort and catch by these commercial fleets has been very low in recent years and the cpue data are no longer considered informative.

Other relevant data

Table 6.7.2.2 and Figure 6.7.2.1 show that effort levels have decreased 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 2010, landings by the Belgian fleet decreased by 60 tonnes relative to 2009 landings; similarly landings by UK(E&W) decreased by 40 tonnes. In contrast landings by Ireland increased by 17 tonnes, landings decreased by 41 tonnes. The Irish fishery landings in 2009 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 2010 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 (38% and 40% 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 parentheses):

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 are added to the short time-series. In addition, it is highly likely that the discard patterns currently observed differ from those that would have been observed historically as a result of substantial changes in the composition of the gear types that have been used to prosecute the fisheries in which plaice is caught. A model which incorporates estimates of historic discards that are derived from the proportional allocation of the effort deployed by the dominant gear types is considered more appropriate in the long term.

Input data types and characteristics

New data added to the update AP assessment are the fishery landings data for 2010, discard estimates for 2010 and survey data for 2010 for the following surveys: UK (E&W)-BTS-Q3, NIGFS-WIBTS-Q1 and NIGFS-WIBTS-Q4.

Data screening

Data were 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		2010	2011
Assessment model		ICA	**AP**
Tuning fleets	UK (E&W)-BTS-Q3	1989–2009, ages 2–7	**Series omitted**
	Extended UK (E&W)-BTS-Q3	n/a	**1993–2010, 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	1992–2009	**1993–2010**
	NIGFS-WIBTS-Q4	1992–2009	**1993–2010**
Time-series weights		Full time-series - unweighted	**n/a**
Num yrs for separable		9	**n/a**
Reference age		5	**n/a**
Terminal S		1	**n/a**
Catchability model fitted		linear	**n/a**
SRR fitted		No	**n/a**
Selectivity model		n/a	**Linear Time Varying Spline at age (TVS)**
Discard fraction		n/a	**Polynomial Time Varying Spline at age (PTVS)**
Landings num-at-age, range:		2–9+	1–9+
Discards N-at-age, yrs, ages:		n/a	**2004–2010, 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 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 the high discards predicted by the model (Figure 6.7.2.18). A pattern of negative residuals between 2004 and 2008 is present in the residuals of the NIGFS-WIBTS due to fluctuations in the SSB indices, which are due potentially to variability of catchability of the survey (Figure 6.7.2.15). In the catch residuals (Figure 6.7.2.16), negative values are apparent in all years of the discard matrix for age 1 (the model underestimates discards-at-age 1), while in the landings matrix age 8 residuals are all similarly negative since 1999.

The estimated SSB from the AP model shows an increasing trend until 2005, after which time the SSB stabilizes and this is largely in agreement with independent SSB estimates from the Annual Egg Production Method (AEPM, Figure 6.7.2.17; see WD 9). 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 high biomass value in the UK (E&W)-BTS-Q3 in 2004 and the low values all indices (NIGFS-WIBTS-Q1 and -Q4; UK (E&W)-BTS-Q3) during 2006–2008.

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 AP assessment and last year's ICA assessment are shown in Figure 6.7.2.19. The two assessments perform similarly in terms of temporal trends in SSB, recruitment and F_{bar} during the 1990s. However, in the previous ICA assessment the F and SSB did not stabilize 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 Tables 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. Estimated recruitments are highly variable but stable since 2000. Landings have decreased to low levels, and discards have increased slightly: the proportion by weight of the catch discarded has subsequently increased markedly since 2004 (Figure 6.7.2.18) and is now at very high levels (greater than 80%).

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 B_{loss} and evidence of high recruitments 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 and in length-at-age in the survey data. Temporal changes in maturity-at-age should be investigated.

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. Historical data collected by Northern Ireland exist and require further evaluation.

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 UK (E&W)-BTS-Q3 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 re-analysed. 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 of discards should be quantified.	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, decreasing the mesh size may not have the desired result since the market demand for plaice is poor and small plaice are particularly undesirable.

Whereas 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, although 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).

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 [1]
Belgium	321	128	332	327	344	459	327	275	325	482	636	628	431	566	343	194	157	197	138
France	42	19	13	10	11	8	8	5	14	9	8	7	2	9	2	2	2	0.4	0.2
Ireland	1355	654	547	557	538	543	730	541	420	378	370	490	328	272	179	194	102	73	90
Netherlands	-	-	-	-	69	110	27	30	47	-	-	-	-	-	-	-	-	-	-
UK (Eng.&Wales)[2]	1381	1119	1082	1050	878	798	679	687	610	607	569	409	369	422	413	412	300	185	148
UK (Isle of Man)	24	13	14	20	16	11	14	5	6	1	1	1	0	0	0	0	1	…	0.5
UK (N. Ireland)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
UK (Scotland)	70	72	63	60	18	25	18	23	21	11	7	9	4	1	0	0	1	0	0.1
UK (Total)																			
Total	3193	2005	2051	2024	1874	1954	1803	1566	1443	1488	1591	1544	1134	1270	937	802	562	455	377
Discards	-	-	-	-	-	-	-	-	-	-	-	-	620	1195	1259	1734	1270	1224	2516
Unallocated	74	-9	15	-150	-167	-83	-38	34	-72	-15	32	15	9	11	-5	3	1	2	0
Total figures used by the Working Group for stock assessment	3267	1996	2066	1874	1707	1871	1765	1600	1371	1473	1623	1559	1763	2476	2191	2539	1833	1681	2892

[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 standardized 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	1.4	6.3	5.2	4.6	10.9	28.9	64.9	11.9
2007		432	187	17.94	4.22	6.9	1.2	6.1	4.4	3.2	12.6	23.8	73.2	14.0
2008		416	186	9.03	4.47	9.5	0.9	5.2	2.7	1.3	11.5	12.4	58.8	9.5
2009		467	196	6.49	1.21	10.1	1.0	3.8	1.5	0.46	10.0	14.7	41.5	7.6
2010		400	156	10.71	14.39	7.9	1.0	4.8	1.0	0.19	9.2	15.2	45.8	9.4

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 Mar	Estimated mean abundance			Estimated standard error		
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
UK(NI) GFS Oct	**Estimated mean abundance**			**Estimated standard error**		
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

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

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 20 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	

UK BT SURVEY (Sept-Trad) - Prime stations only.

1989–2010

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

UK(E+W)TRAWL FLEET (calculated using ABBT age compositions)

1987–2010

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

1.026 0.0 0.1 1.5 7.0 6.9 4.2 3.1 1.8 1.2 0.5 0.3 0.2 0.0 0.0

UK(E+W)BEAM TRAWL FLEET

1987–2010

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

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 1995–2010

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

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

1964–2010

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

Table 6.7.2.6. Irish Sea plaice: Landings weight-at-age 1 to 15+ (kg) (unsmoothed from 1995, bold).

Plaice in VIIa, 2011

1 3

1964 2010

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 0.355 0.314 0.294 0.297 0.321 0.366 0.434 0.523 0.634 0.767 0.921 1.097 1.295 1.514

Table 6.7.2.7. Plaice VIIa: weight-at-age in the discards (unsmoothed).

Irish Sea plaice, 2010 WG, COMBSEX, PLUSGROUP, Discard weights-at-age (age 0 exc, 9+ set to 0).

1 3 2004–2010

1 14

1

0.075	**0.118**	**0.142**	**0.158**	**0.201**	**0.422**	**0.421**	**0.456**	**0**	**0**	**0**	**0**	**0**	**0**
0.109	0.116	0.133	0.174	0.171	0.252	0.576	0.399	0	0	0	0	0	0
0.126	0.111	0.140	0.143	0.161	0.207	0.310	0.404	0	0	0	0	0	0
0.048	0.083	0.113	0.140	0.150	0.197	0.214	0.266	0	0	0	0	0	0
0.079	0.104	0.116	0.132	0.149	0.194	0.272	0.231	0	0	0	0	0	0
0.035	0.082	0.116	0.150	0.165	0.212	0.217	0.291	0	0	0	0	0	0
0.076	0.088	0.118	0.167	0.181	0.198	0.173	0.201	0	0	0	0	0	0

Table 6.7.2.8. Irish Sea plaice: New stock weights-at-age modified to include discard element (kg) (unsmoothed from 1995, bold).

Irish Sea plaice, 2011 WGCSE, COMBSEX, PLUSGROUP, NEW stock weights (modified to inc. disc element).

1 4 DB 6/5/2011

2004–2010 (not smoothed)

1 14

1

0.084	**0.148**	**0.215**	**0.249**	**0.317**	**0.506**	**0.495**	**0.497**	**0.76**	**0.751**	**0.817**	**1.693**	**2**	**2.327**
0.122	0.139	0.198	0.228	0.266	0.326	0.567	0.449	0.543	0.184	0.913	0.974	0.807	0.982
0.133	0.135	0.171	0.228	0.285	0.357	0.392	0.481	0.585	0.554	0.838	1.415	1.139	1.277
0.052	0.099	0.151	0.213	0.289	0.34	0.334	0.621	0.53	0.9	0.846	0.976	0.878	1.016
0.082	0.117	0.143	0.181	0.27	0.355	0.321	0.564	0.7	0.833	1.122	0.43	1.32	0
0.036	0.092	0.155	0.21	0.262	0.32	0.396	0.465	0.524	0.571	0.591	0.76	0.576	0.475
0.077	0.094	0.145	0.19	0.229	0.248	0.216	0.358	0.53	0.56	0.509	0.882	1.908	1.04

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	95.47752
negative log.likelihood Landings	-9.07453
negative log.likelihood Discards	34.79614
negative log.likelihood UK-BTS	2.80479
negative log.likelihood NI-GFSs	66.95113
AIC	348.955
Nparameters	79
Nobservations	344

Final parameter values	
Ftrend 1	0.798147
Ftrend 2	0.676198
Ftrend 3	0.565213
Ftrend 4	0.411871
Ftrend 5	0.442478
Ftrend 6	0.340938
Ftrend 7	0.253528
Ftrend 8	0.189975
Ftrend 9	0.183881
Ftrend 10	0.202133
Ftrend 11	0.176607
Ftrend 12	0.138986
Ftrend 13	0.198322
Ftrend 14	0.169943

Ftrend 15	0.196883
Ftrend 16	0.17729
Ftrend 17	0.197655
Ftrend 18	0.210536
sel.C 1	3.583611
sel.C 2	6.98169
sel.C 3	-4.65117
sel.C 4	0.580445
sel.C 5	-0.65433
sel.C 6	1.369824
sel.C 7	-0.83792
sel.C 8	-0.10498
logrecruitment 1	21.53691
logrecruitment 2	19.9775
logrecruitment 3	18.41378
logrecruitment 4	16.88014
logrecruitment 5	16.23729
logrecruitment 6	14.97629
logrecruitment 7	13.33269
logrecruitment 8	10.9786
logrecruitment 9	10.62659
logrecruitment 10	10.52677
logrecruitment 11	10.66514
logrecruitment 12	10.75553
logrecruitment 13	10.45032
logrecruitment 14	10.32543
logrecruitment 15	10.59831
logrecruitment 16	10.60356
logrecruitment 17	10.69511
logrecruitment 18	10.4286
logrecruitment 19	10.70252
logrecruitment 20	10.40553
logrecruitment 21	10.55078
logrecruitment 22	10.75297
logrecruitment 23	10.23463
logrecruitment 24	10.26391
Logrecruitment 25	10.49985
Catchability 1	6.625515
sel.U 1	-15.164
sel.U 2	-14.8346
sel.U 3	-16.4949
sel.U 4	-16.396
b1	7.033246
b2	-1.46547
b3	0.838829
b4	-2.01049

b5	0.190955
b6	0.316053
b7	-0.06121
b8	0.592242
b9	0.014284
b10	0.034889
b11	0.038156
b12	-0.02182
sds.land1	-2.37169
sds.land2	-1.6943
sds.land3	3.358717
sds.disc1	-0.64355
sds.disc2	-1.38535
sds.disc3	1.439733
sds.tun1	-2.0092
sds.tun2	1.699316
sds.tun3	-0.16963
sds.biotun1	0.987188
sds.biotun2	-23.9996

Table 6.7.3.2. Irish Sea plaice: Estimated landed numbers-at-age (thousands).

L	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	47	31	26	23	25	14	9	8	7	7	4	3	2	1	1	0	0	0
2	1281	936	754	660	1005	873	530	368	444	408	313	151	205	87	78	53	21	13
3	1542	2239	1650	1254	1699	1831	1660	1121	1061	1475	1141	850	753	627	368	251	211	78
4	1255	1500	1914	1213	1340	1210	1311	1267	1102	1155	1292	926	1240	674	794	375	349	309
5	522	675	777	909	869	660	611	710	882	860	716	706	880	685	502	466	304	311
6	535	272	346	365	626	394	288	262	361	476	354	253	453	350	385	232	293	192
7	370	242	131	164	269	324	207	155	172	257	257	157	190	191	180	141	99	107
8	178	145	102	55	109	128	161	109	104	132	159	139	156	114	151	111	110	72
9+	123	129	87	91	118	208	125	101	76	74	94	99	121	131	50	58	47	58

Table 6.7.3.3. Irish Sea plaice: Estimated discarded numbers-at-age (thousands).

D	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	30 558	19 284	15 324	13 655	15 879	9487	6421	6505	6367	7434	4927	5036	4757	4176	4809	1864	1403	1157
2	17 108	9992	6781	5258	7477	6383	4013	3033	4201	4662	4543	2944	5606	3526	4970	5527	3806	4301
3	3412	3834	2306	1507	1853	1909	1746	1254	1329	2185	2105	2060	2528	3074	2782	3073	4429	2953
4	160	205	286	203	258	274	358	428	471	640	951	926	1728	1340	2309	1635	2329	3242
5	0	0	1	2	3	6	11	27	64	115	170	283	572	692	752	995	883	1176
6	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
8	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

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
1	58 606	41 216	37 301	42 836	46 888	34 556	30 498	40 067	40 278	44 140	33 813	44 468	33 042	38 207	46 769	27 851	28 679	36 310
2	35 487	23 400	18 498	18 717	25 172	26 683	21 736	21 013	29 418	29 735	32 159	25 356	34 703	24 834	29 960	36 958	22 949	24 115
3	10 694	14 300	10 538	9354	11 053	14 378	16 859	15 012	15 442	21 727	21 610	23 959	19 580	25 321	18 631	21 830	27 536	16 759
4	3759	4852	7001	5641	5707	6475	9243	11 755	11 083	11 450	15 832	16 116	18 515	14 284	18 980	13 565	16 239	20 063
5	1384	2008	2707	4147	3674	3563	4349	6630	8833	8351	8469	11 934	12 553	13 633	10 776	13 919	10 142	11 887
6	1250	739	1149	1672	2823	2440	2535	3272	5188	6945	6490	6679	9654	9768	10 796	8379	10 972	7880
7	801	608	401	695	1140	1917	1793	1978	2656	4262	5711	5423	5685	8136	8335	9213	7213	9455
8	385	364	313	233	462	758	1395	1396	1609	2194	3538	4824	4663	4864	7036	7223	8038	6305
9+	266	325	266	386	502	1228	1081	1295	1176	1227	2097	3408	3617	5555	2337	3765	3403	5077

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
1	0.798	0.681	0.570	0.412	0.444	0.344	0.253	0.189	0.183	0.197	0.168	0.128	0.166	0.123	0.115	0.074	0.053	0.034
2	0.789	0.678	0.562	0.407	0.440	0.339	0.250	0.188	0.183	0.199	0.174	0.139	0.195	0.167	0.197	0.174	0.194	0.210
3	0.670	0.594	0.505	0.374	0.415	0.322	0.241	0.183	0.179	0.197	0.173	0.138	0.195	0.168	0.197	0.176	0.197	0.213
4	0.507	0.464	0.404	0.309	0.351	0.278	0.212	0.166	0.163	0.182	0.163	0.130	0.186	0.162	0.190	0.171	0.192	0.208
5	0.508	0.438	0.362	0.265	0.289	0.220	0.164	0.125	0.121	0.132	0.117	0.092	0.131	0.113	0.132	0.118	0.132	0.142
6	0.600	0.492	0.383	0.263	0.267	0.188	0.128	0.089	0.077	0.075	0.060	0.041	0.051	0.039	0.039	0.030	0.029	0.026
7	0.667	0.544	0.424	0.288	0.288	0.197	0.130	0.087	0.071	0.066	0.049	0.031	0.036	0.025	0.023	0.016	0.015	0.012
8	0.669	0.543	0.424	0.288	0.287	0.197	0.131	0.087	0.071	0.066	0.049	0.031	0.036	0.025	0.023	0.016	0.015	0.012
9+	0.669	0.543	0.424	0.288	0.287	0.197	0.131	0.087	0.071	0.066	0.049	0.031	0.036	0.025	0.023	0.016	0.015	0.012

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	3631	6650	9203	0.477	0.562	0.661	2794	4655	7284	42 145	58 355	80 174
1994	3865	5990	7897	0.421	0.501	0.613	2230	3218	4605	32 170	41 079	53 007
1995	4276	6217	7865	0.331	0.407	0.496	1730	2374	3299	29 740	37 237	45 718
1996	5123	7082	9011	0.234	0.297	0.366	1374	1872	2500	35 619	42 726	51 476
1997	5763	7681	9694	0.263	0.334	0.438	1816	2396	3161	39 586	46 547	56 097
1998	7067	9372	12 004	0.191	0.252	0.331	1351	1822	2472	29 062	34 409	40 933
1999	7894	10 675	13 828	0.137	0.181	0.238	906	1246	1645	25 570	30 361	36 110
2000	9134	12 319	15 922	0.107	0.141	0.188	828	1091	1441	33 988	39 761	47 409
2001	11 920	15 986	20 570	0.102	0.134	0.184	949	1251	1665	34 339	40 132	47 330
2002	14 101	18 675	23 773	0.106	0.142	0.186	1114	1512	1933	37 831	43 977	51 208
2003	16 896	22 351	28 444	0.098	0.127	0.164	1033	1363	1743	29 132	33 742	38 893
2004	17 602	22 922	28 958	0.079	0.100	0.132	973	1212	1501	38 513	44 246	51 412
2005	19 007	24 338	30 506	0.104	0.136	0.173	1361	1839	2253	28 064	32 862	39 520
2006	19 984	25 592	32 115	0.093	0.118	0.150	1163	1614	2029	31 872	37 945	46 034
2007	19 109	24 352	30 130	0.108	0.138	0.180	1130	1393	1704	38 215	46 324	57 779
2008	19 800	25 277	31 697	0.088	0.119	0.157	1040	1418	1779	22 660	28 064	35 010
2009	18 816	23 957	29 889	0.099	0.133	0.182	1069	1370	1664	22 222	28 690	36 994
2010	18 724	24 095	30 508	0.105	0.147	0.207	1256	1598	2078	27 295	36 373	48 674

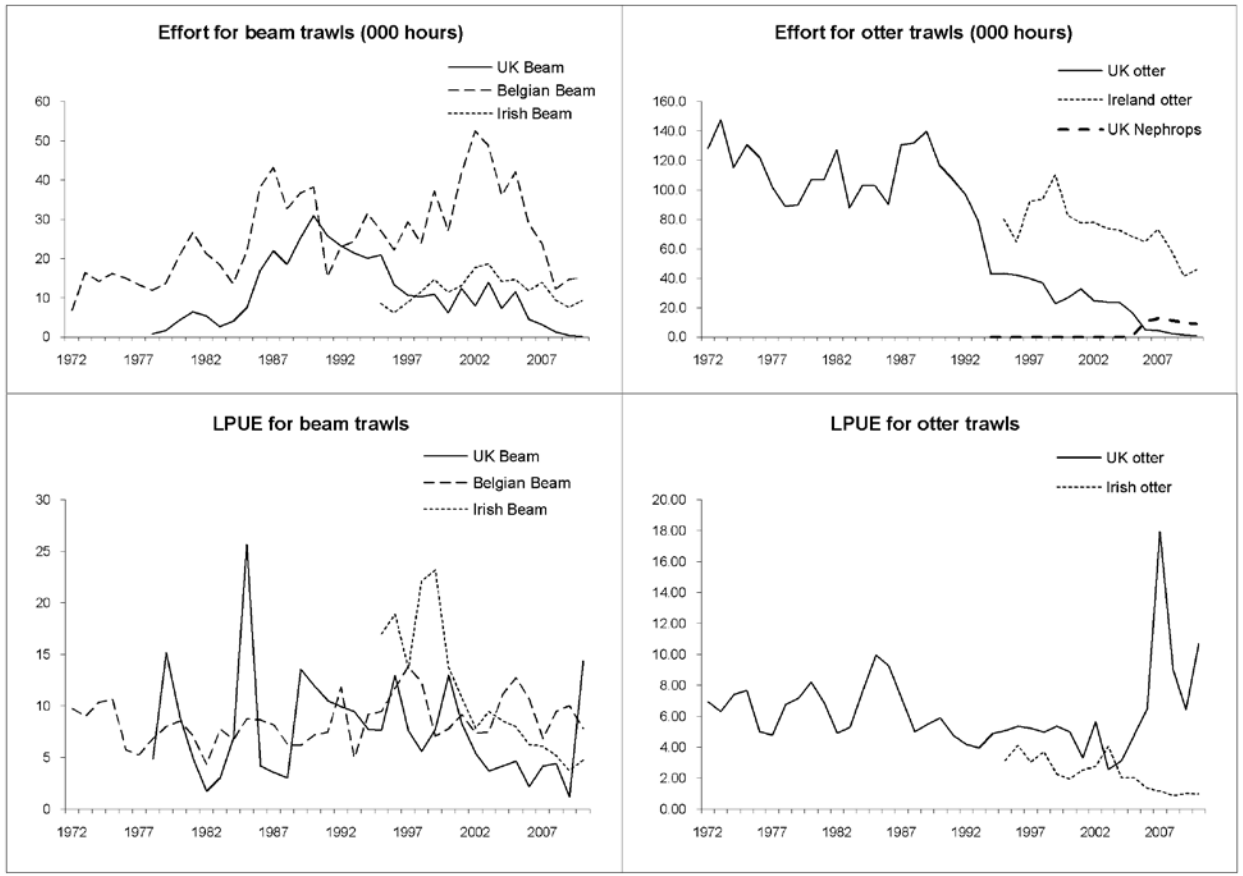


Figure 6.7.2.1. Irish Sea plaice: Effort and lpue for commercial fleets (note addition of effort by UK *Nephrops* trawlers).

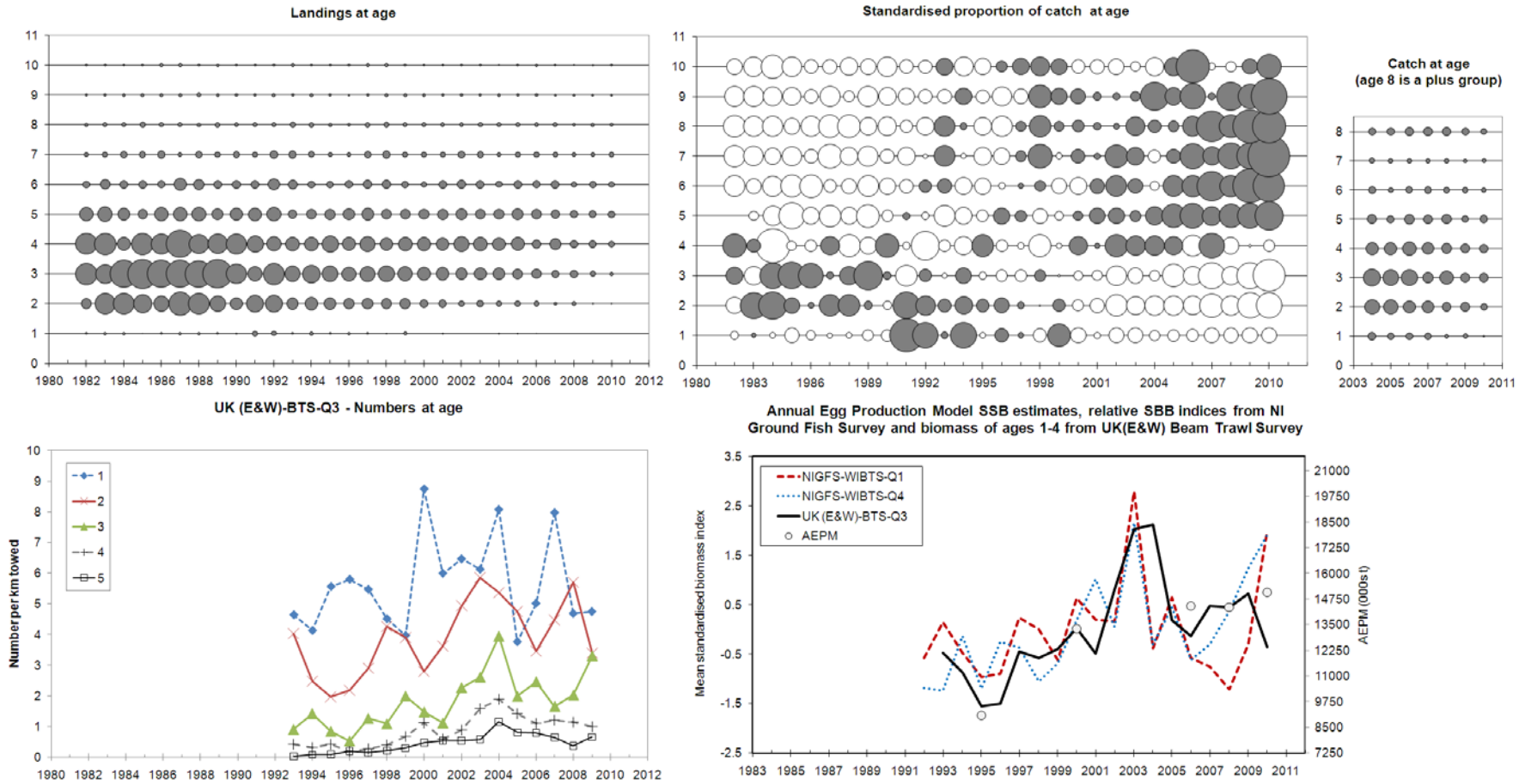


Figure 6.7.2.2. Catch and survey data: raw landings-at-age data (top left), mean standardized proportion at age (top centre, grey bubbles are positive values and white bubbles are negative); raw catch-at-age data (discards plus landings, topright); UK(E&W)-BTS-Q3 (extended area) cpue (bottom left); standardized 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 standardized proportion-at-age = [(proportion-at-age in year) – mean(proportion-at-age over all years)] / STDEV(proportion-at-age over all years).

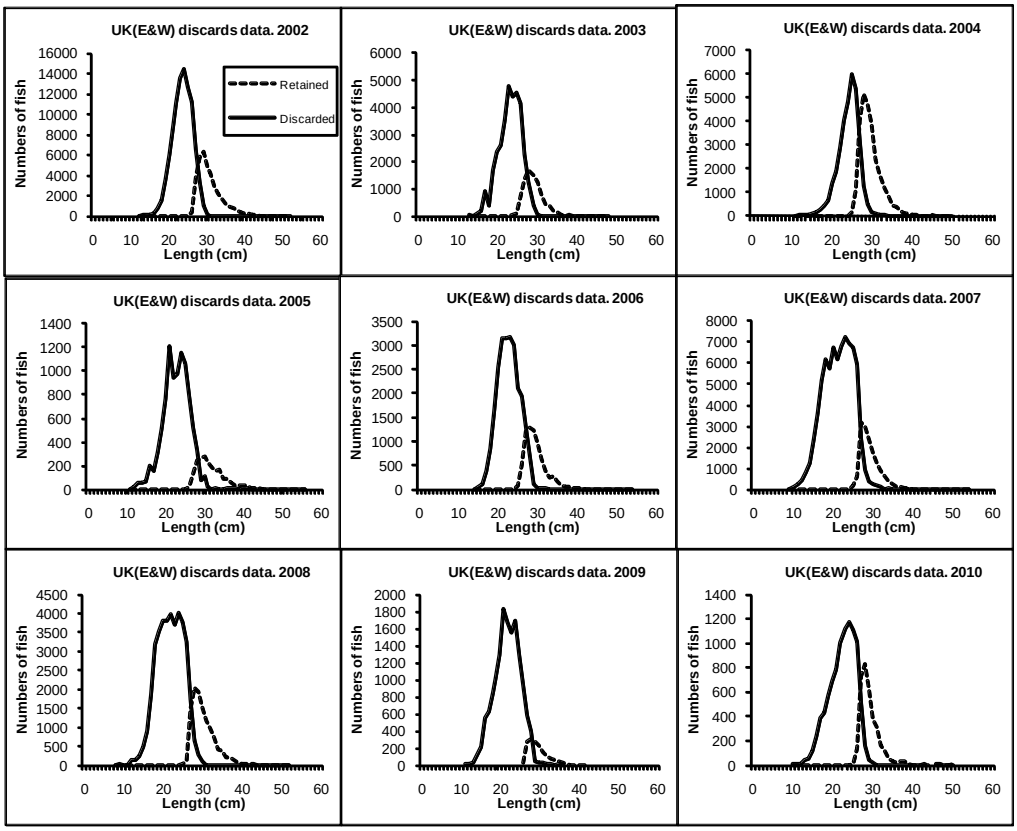


Figure 6.7.2.3. Length distributions of discarded and retained catches from UK(E&W).

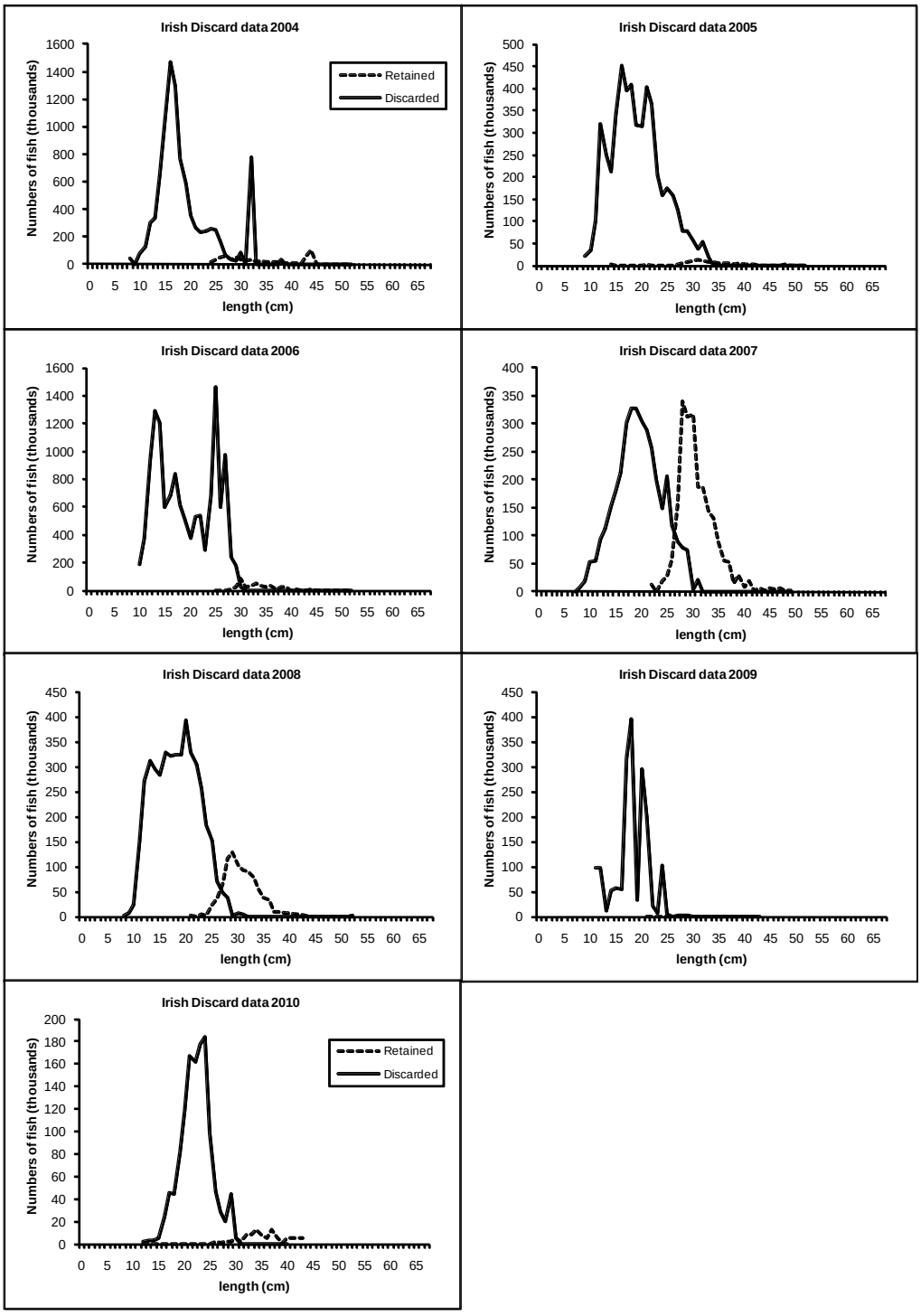


Figure 6.7.2.4. Length distributions of discarded and retained catches from Ireland.

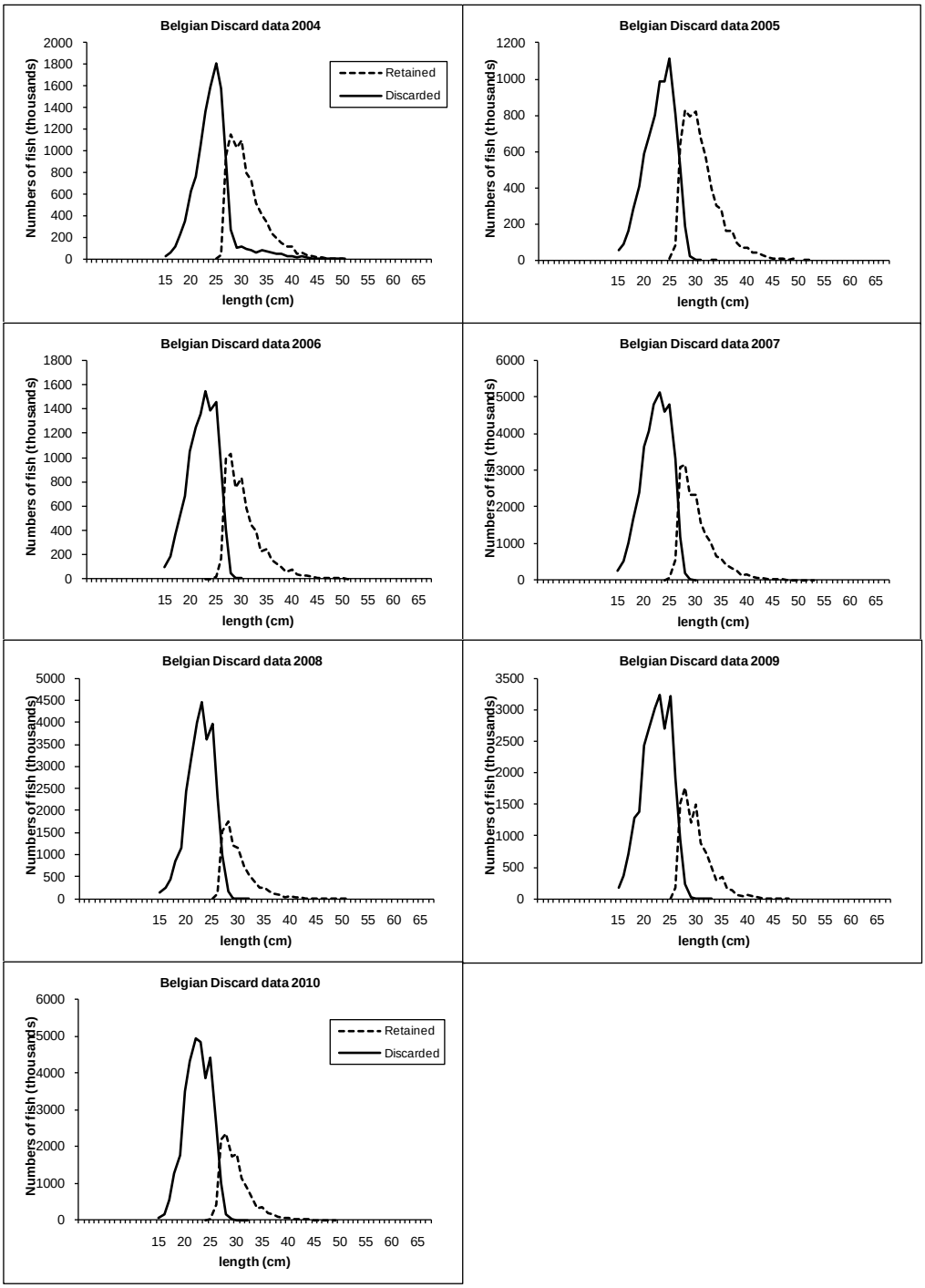


Figure 6.7.2.5. Length distributions of discarded and retained catches from Belgium.

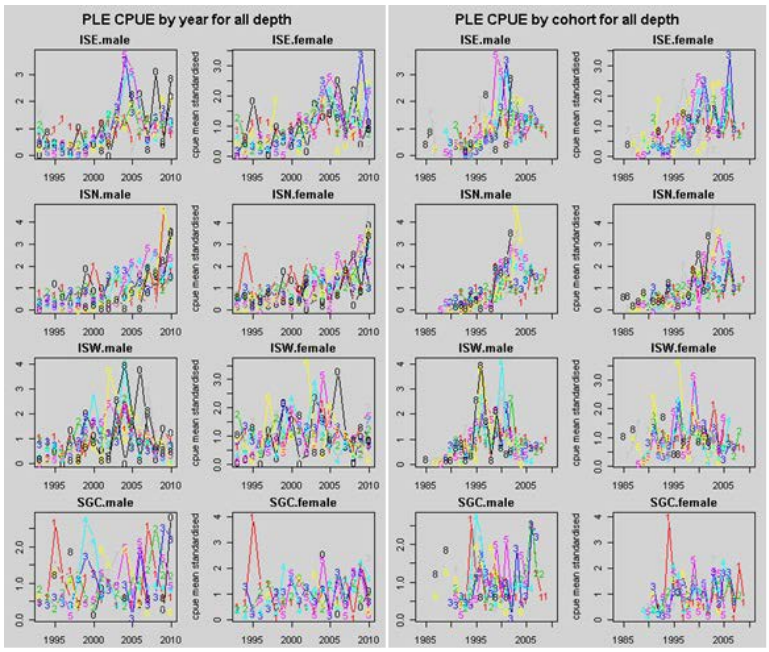


Figure 6.7.2.6. UK (E&W)-BTS-Q3 mean standardized cpue by age by year and by year class. Mean standardized by age = cpue age i / mean(cpue age i over all years).

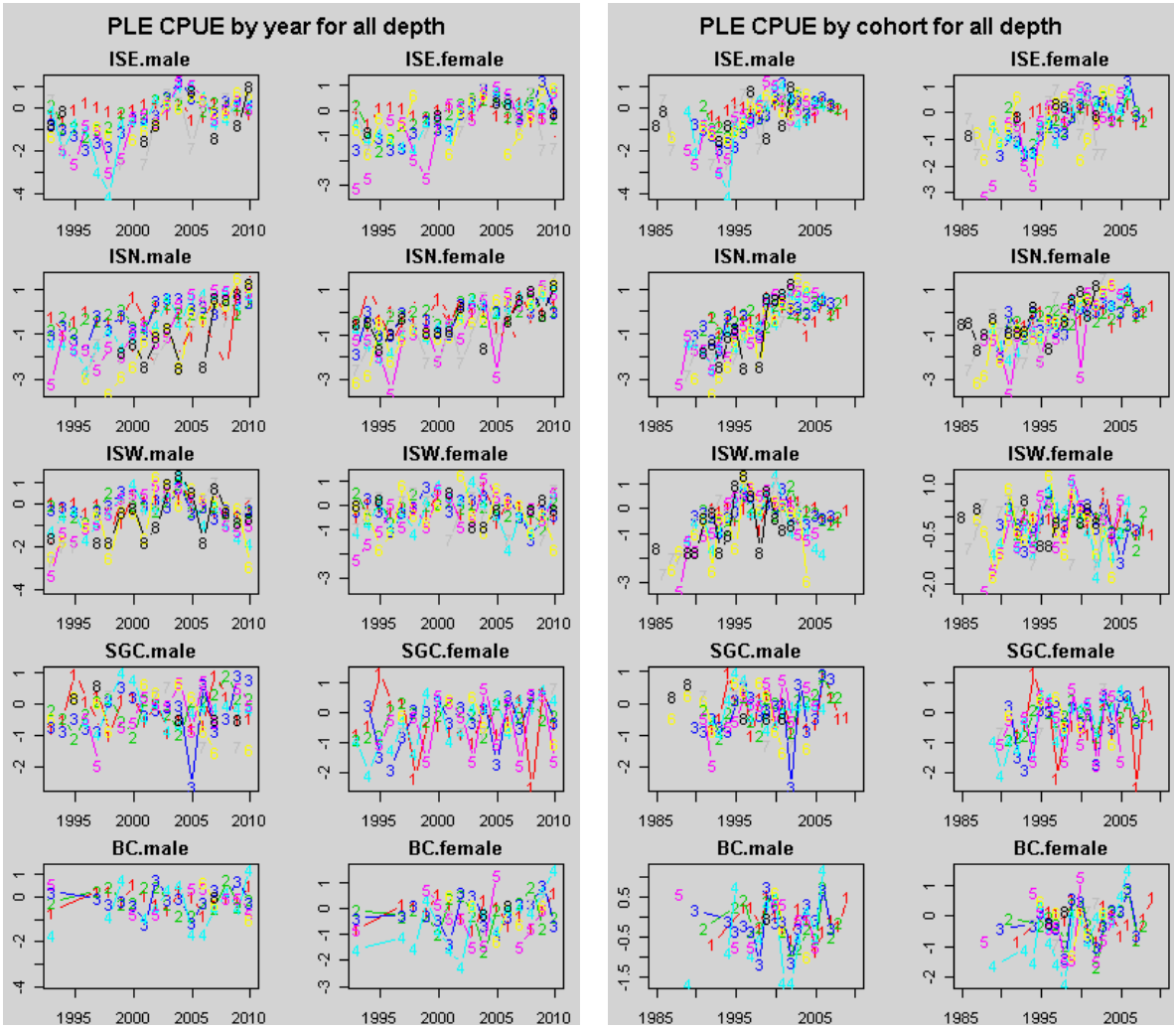


Figure 6.7.2.6. continued. log(mean standardized cpue) by age for UK (E&W)-BTS-Q3 by year and by year class. Mean standardization by age as in Figure 6.7.2.5.

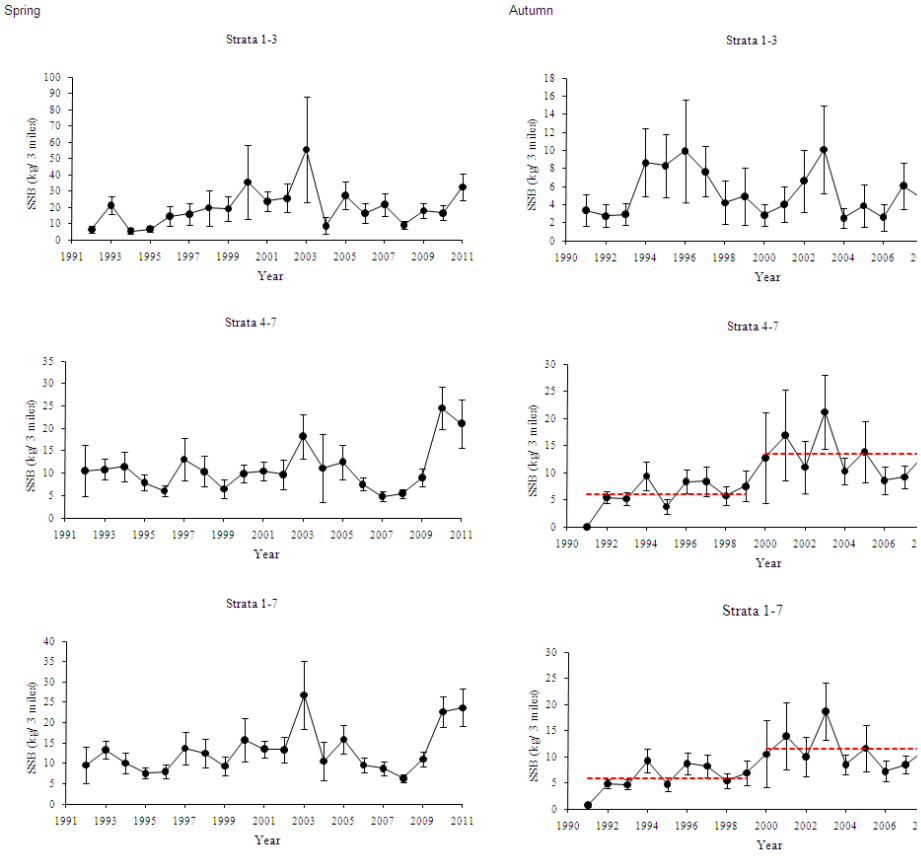


Figure 6.7.2.7. Northern Irish groundfish survey SSB indices split into spring (left hand panels) and autumn (right hand panels) sampling by western strata (1–3), eastern strata (4–7) and total survey area (strata 1–7) with confidence intervals (± 1 standard error, vertical lines) and mean biomass (kg/3 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.

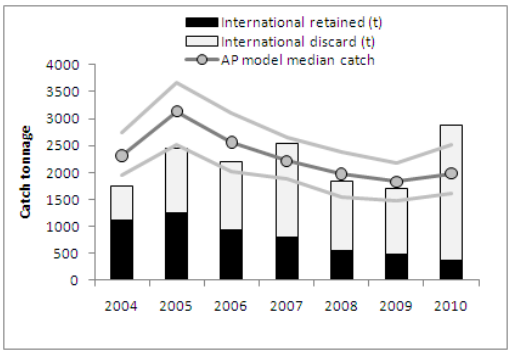


Figure 6.7.2.8. Plaice in VIIa: WG raised international catch tonnage vs. AP model estimates with uncertainty bounds.

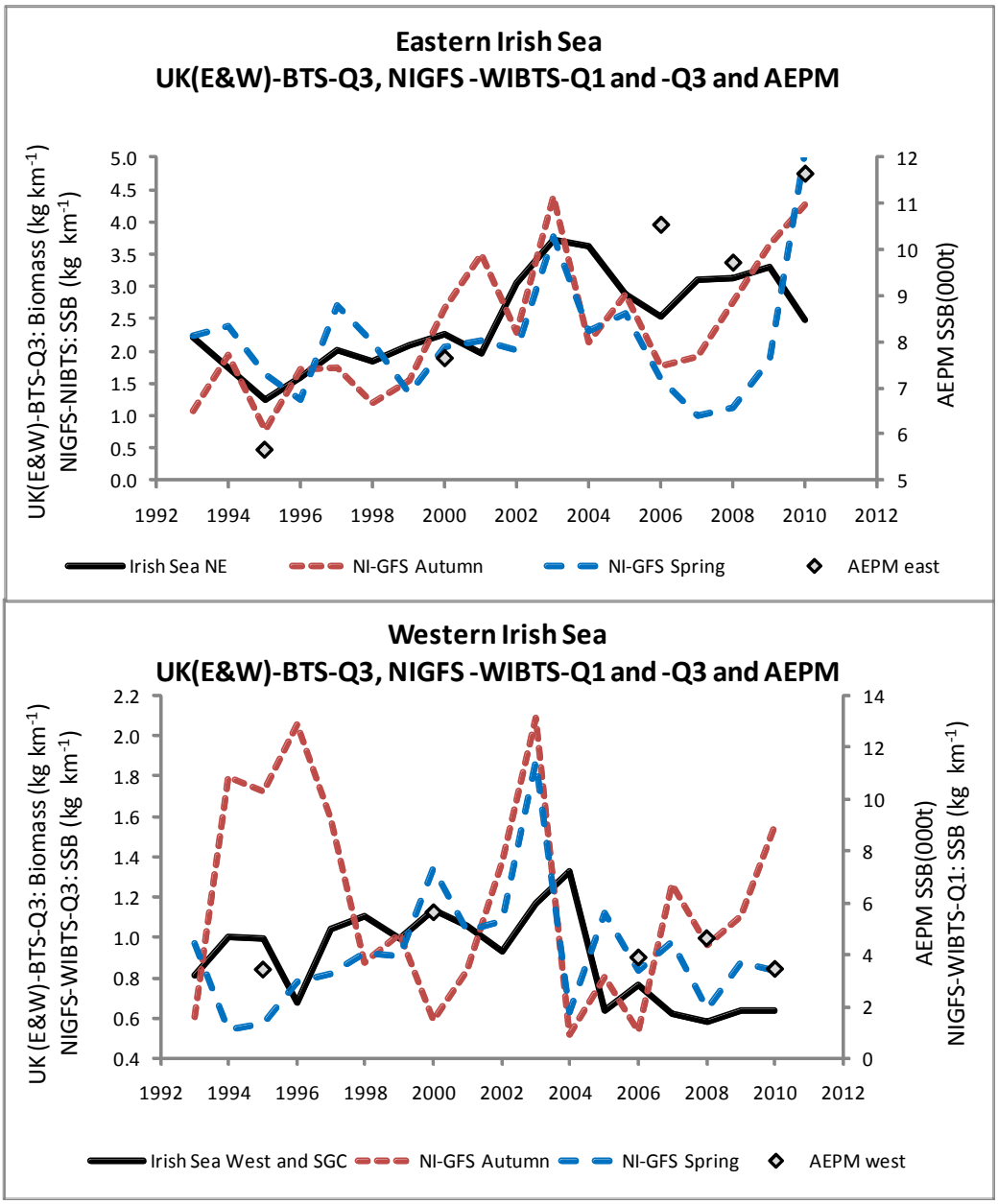


Figure 6.7.2.9. Trends in SSB indices (kg per km towed) from the UK (E&W)-BTS-Q3 (black line) and the NIGFS-WIBTS-Q1 and -Q3 (blue and red dashed lines respectively) in the eastern Irish Sea (top) and the western and southern Irish Sea (bottom). Also shown (grey diamonds, right axis) are the estimates of SSB from the Annual Egg Production Method (AEPM) from Armstrong *et al.* (2011).

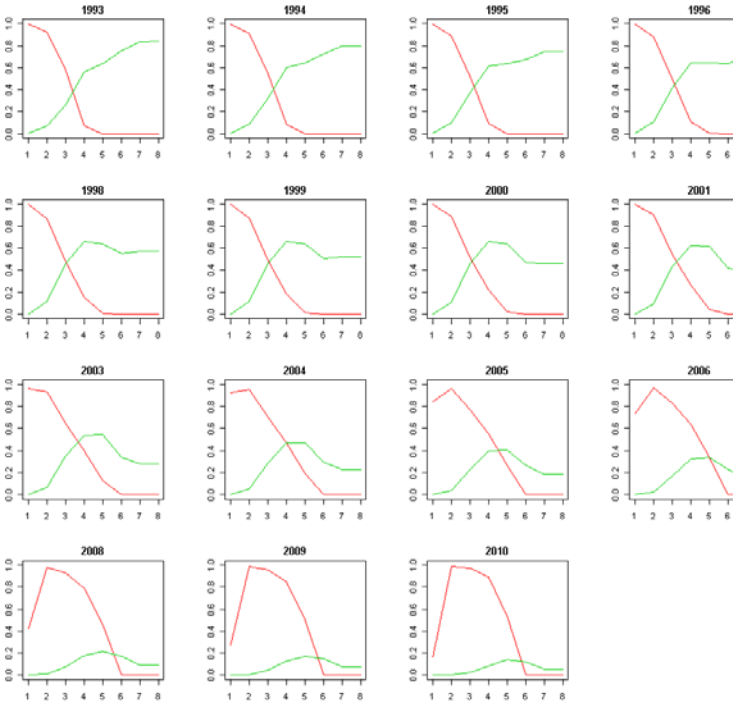


Figure 6.7.2.10. Selectivity of the fishery split into the landed (green) and discarded (red) components as estimated by the AP model.

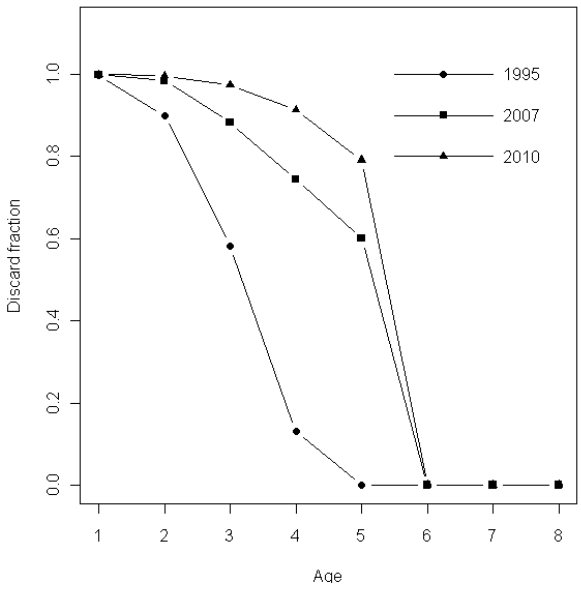


Figure 6.7.2.11. Change in the discard fraction at age over time as estimated by the AP model.

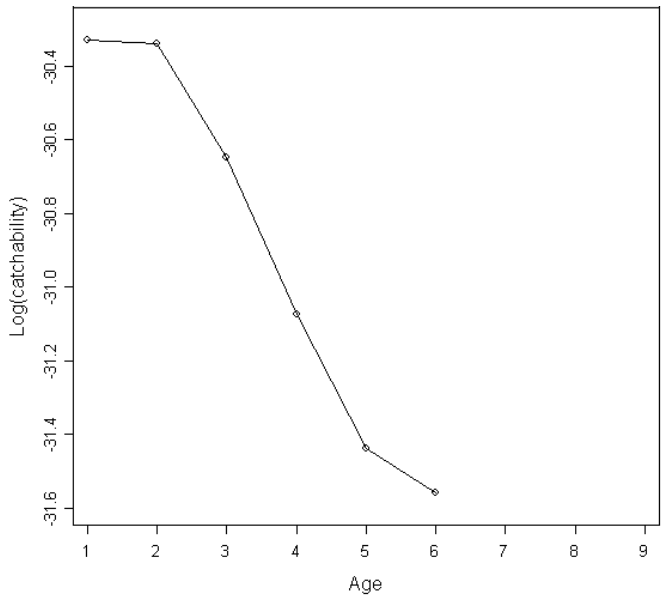


Figure 6.7.2.12. Log-catchability for the UK (E&W)-BTS-Q3 extended index as estimated by the AP model.

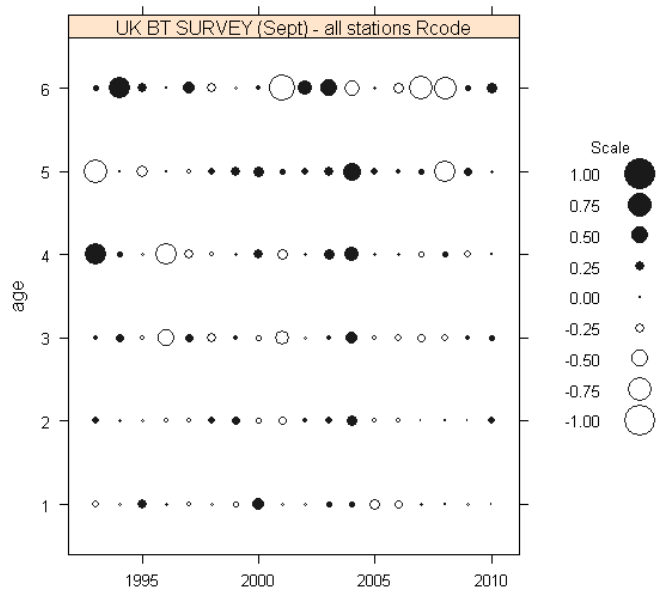


Figure 6.7.2.13. Residual plot (left) for the UK (E&W)-BTS-Q3extended area index.

Bubbles are log(observed)–log(expected). Expected values were estimated by the AP model.

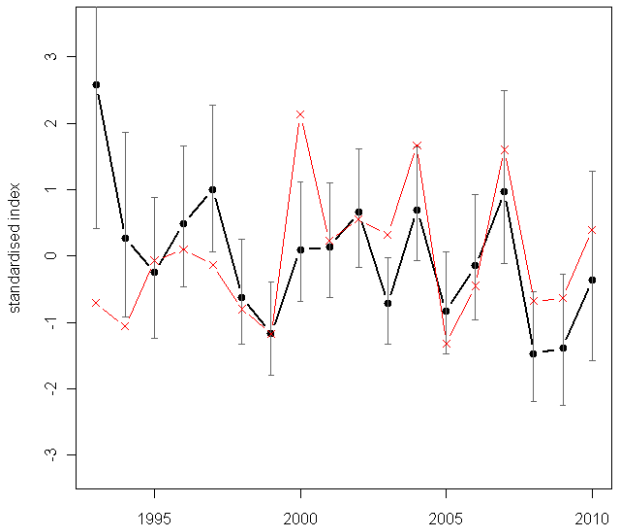


Figure 6.7.2.14. Age 1 index from the UK (E&W)-BTS-Q3extended area index (red and crosses) and recruitment (black and circles) estimated by the AP model.

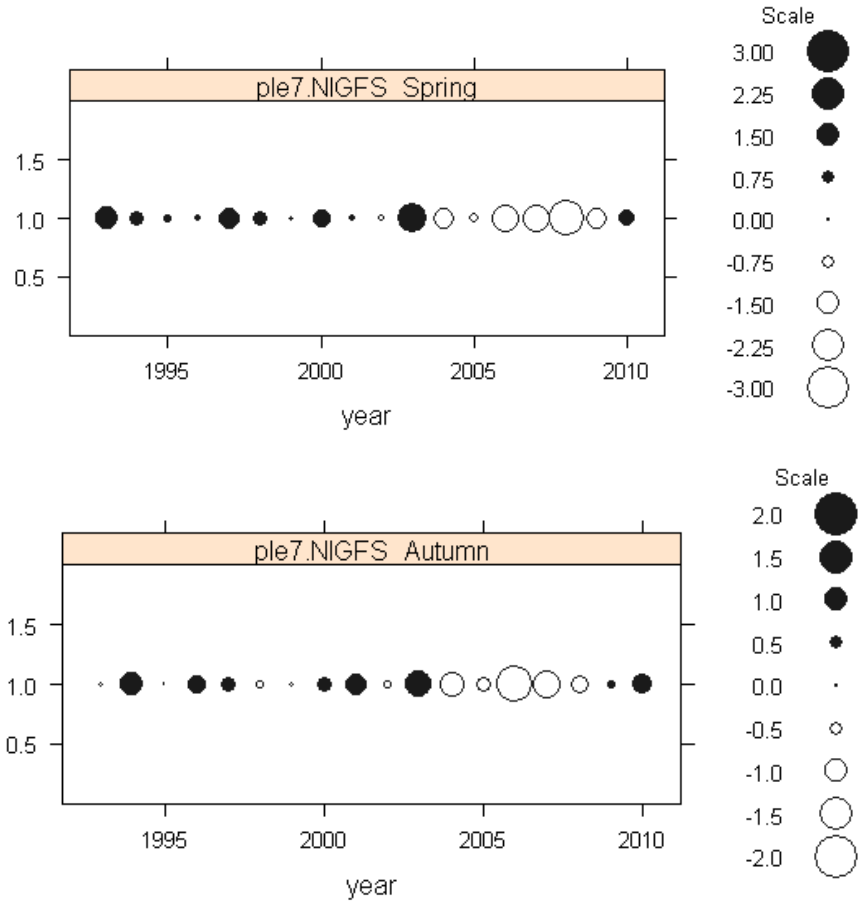


Figure 6.7.2.15. Residual plots for the NIGFS-WIBTS-Q1 (top) and -Q4 (bottom).

Bubbles are (observed mean standardized SSB)–(expected mean standardized SSB). Expected values were estimated by the AP model.

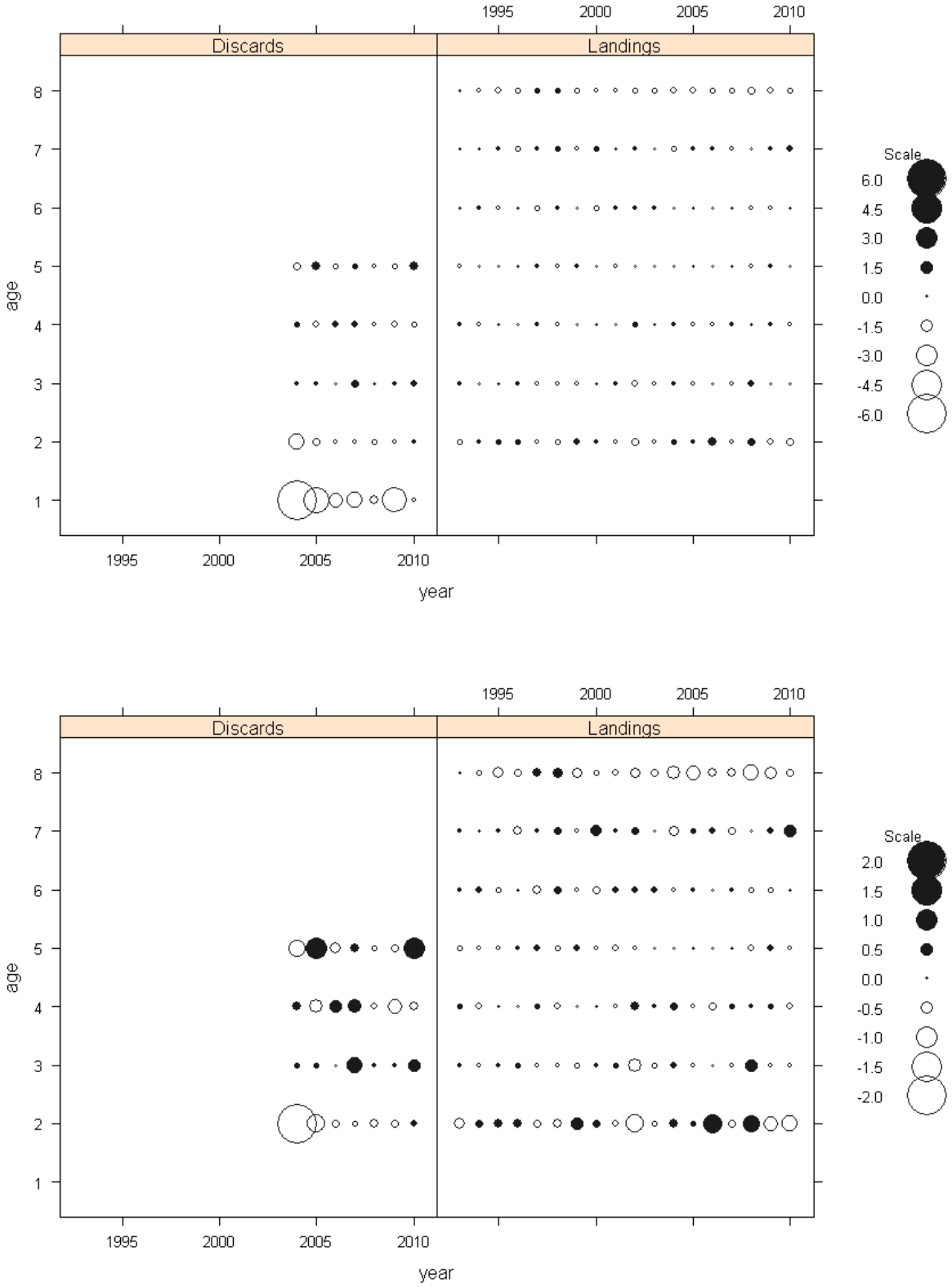


Figure 6.7.2.16. Residual plots for discards (left) and landings (right) with (bottom) and without (top) bubbles drawn for age 1. Bubbles are log(observed)–log(expected). Expected values were estimated by the AP model.

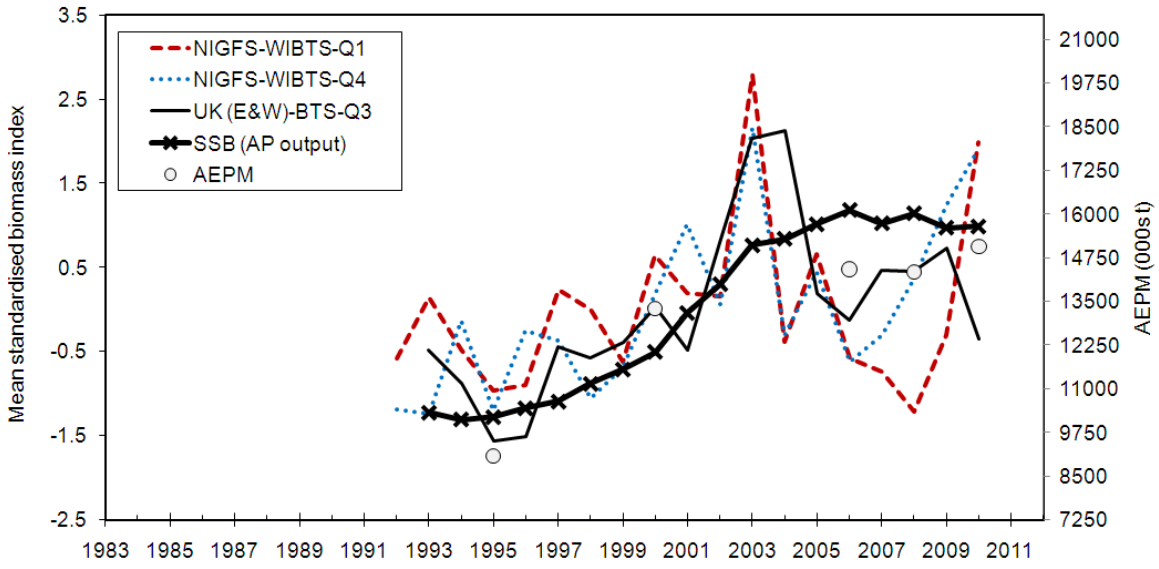


Figure 6.7.2.17. AP model estimates of mean standardized SSB (black line) overlain with standardized NI-GFS in spring (blue) and autumn (green) relative SSB indices, standardized biomass (ages 1–4) from the UK(E&W)-BTS (grey line) and AEPM SSB index (circles, right axis).

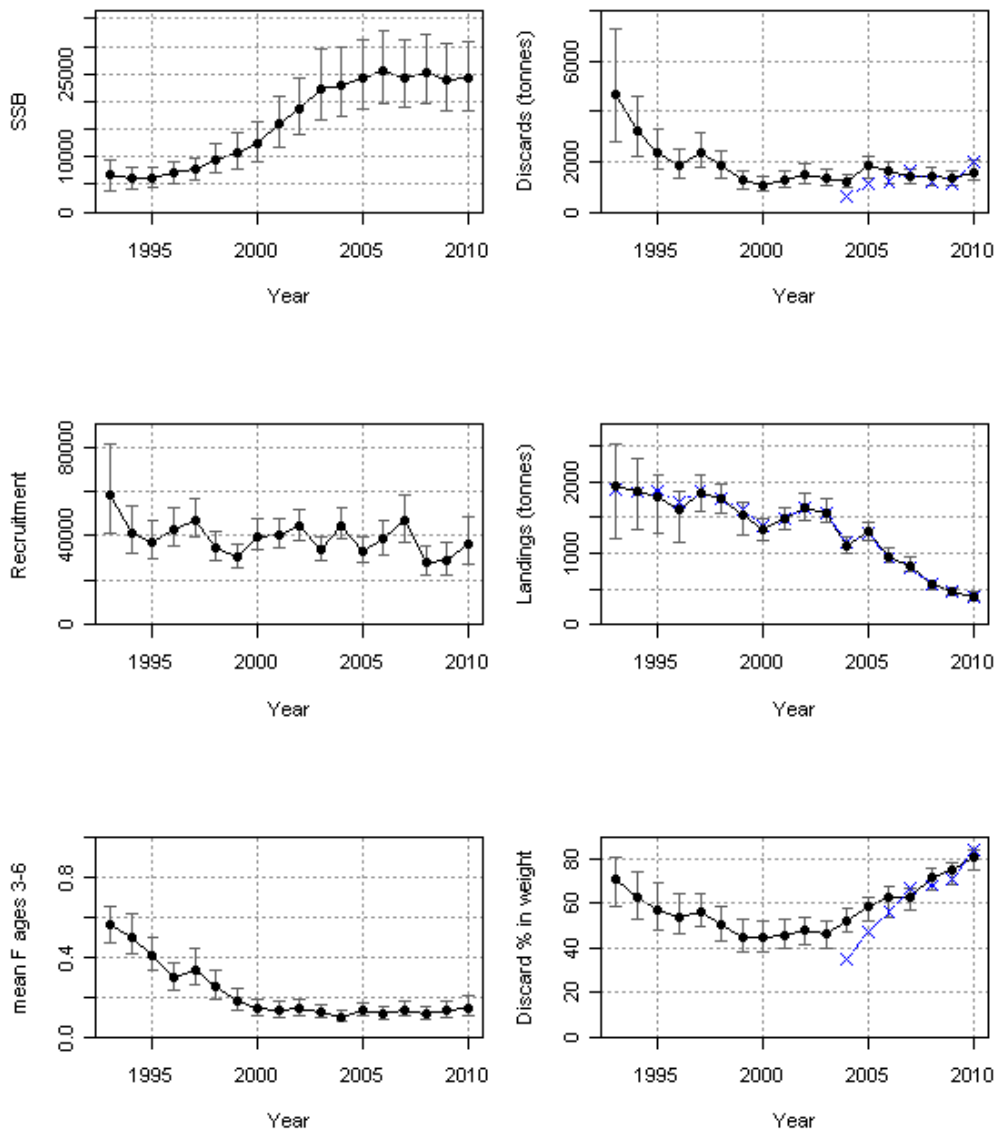


Figure 6.7.2.18. Modelled SSB (tonnes, top left), recruitment (thousands, centre left), F_{bar} (ages 3–6, bottom left) discard tonnage (top right), landed tonnage (centre right) and % discarded by weight (bottom right). Modelled using the AP model. Raw data shown in blue with crosses.

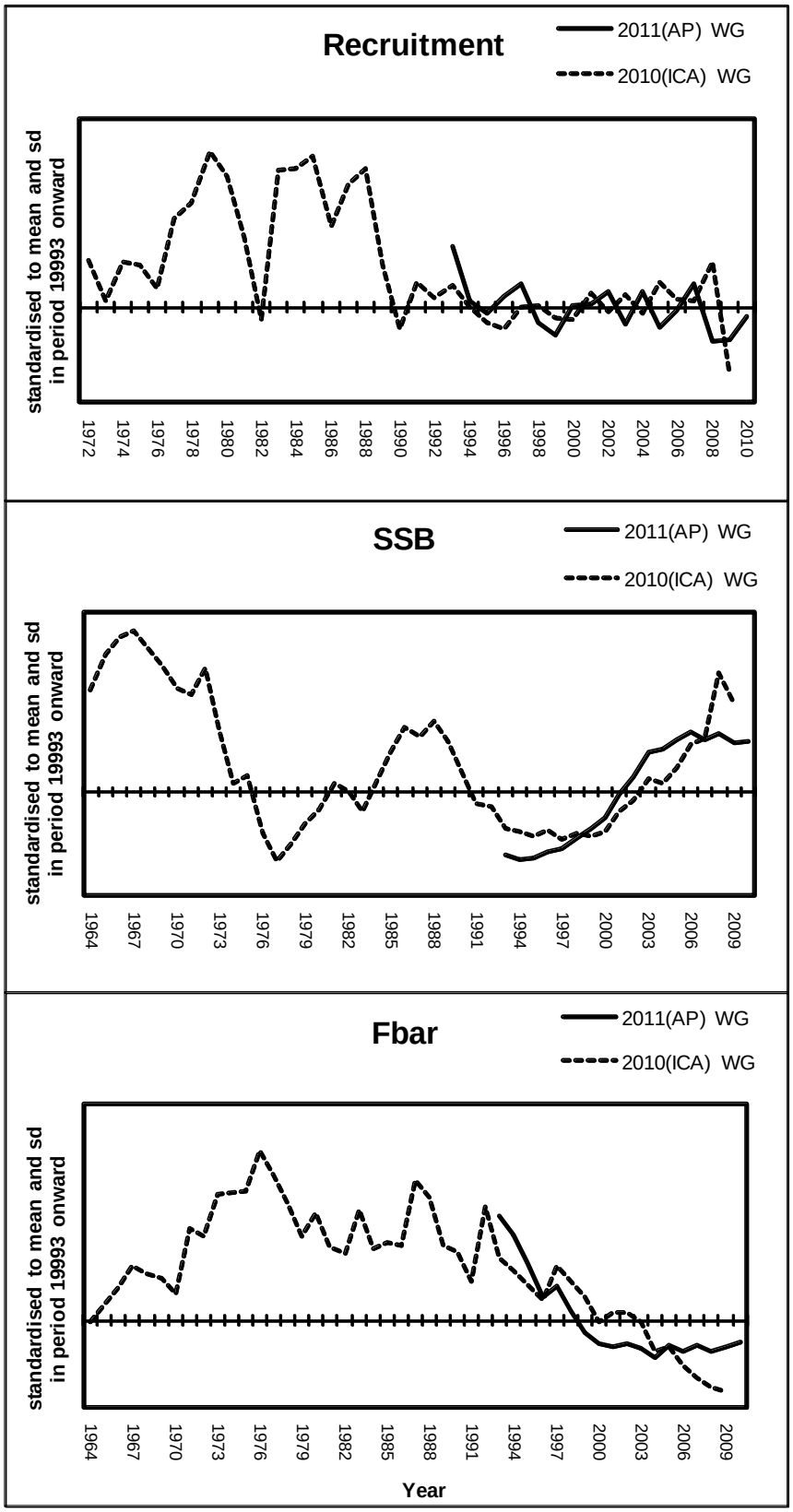


Figure 6.7.2.19. Comparison of recruitment (age 1), SSB and F_{bar}(ages 3–6) between 2010 (WGCSE 2010, ICA model) and 2011 (WGCSE 2011, AP model) assessments.

6.8 Sole in Division VIIa (Irish Sea)

Type of assessment in 2011

This assessment is an update assessment with the assessment settings agreed at the benchmark meeting (WKFLAT 2011) in February 2011.

Given the improved performance of the assessment with regards to the retrospective pattern and the overall consistency, WKFLAT recommended the following changes to the 2010 assessment.

- The use of a combined age–length key by pooling the raw data of the three main countries (Belgium, UK and Ireland);
- Mean catch weights taken from the combined age–weight key;
- Mean stock weights derived from the mean catch weights by cohort interpolation (Rivard weight calculator);
- The UK march survey (UK(E&W)-BTS-Q1) was omitted from the assessment;
- No taper weighting applied instead of the linear time weighting (over 20 years);
- Catchability independent of age for ages >= 4 instead of ages >= 7.

ICES advice applicable to 2010

In 2010 ICES classifies the stock as suffering reduced reproductive capacity and at risk of being harvested unsustainably.

ICES advice applicable to 2010

Single-stock exploitation boundaries

Considering the options in the outlook for 2010, ICES advises on the basis of exploitation boundaries in relation to precautionary limits that no fishing of sole should take place in the Irish Sea in 2010.

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

ICES advice applicable to 2011

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.

Technical comments made by the Review Group (RGCS)

1) RCT3 input file has wrong data from March BTS compared with Table 6.8.6. This series should be removed from RCT as it has no input to recent year-class forecasts.

2) The short-term forecast uses an F_{sq} that predicts landings of 439 t in 2010, larger than the TAC of 402 t, and likely to be overoptimistic given the 65% TAC uptake in 2009 and the dramatic effort reduction in fleets taking sole in recent years.

The UK(E&W)-BTS-Q1 survey was cancelled from the European survey programme after 1999 and therefore does not provide information to the recent year-class estimates. WKFLAT 2011 decided to omit the UK(E&W)-BTS-Q1 survey from the assessment. In line with that the UK(E&W)-BTS-Q1 series was also excluded from the RCT3 run, as suggested by the review group.

The predictions from the unscaled *status quo* forecast for 2010 are indeed very optimistic considering the decline in fishing mortality and effort in the last three years. Given the downward trend in F over the last three years, ACOM decided to use the F pattern observed over the last three years, rescaled to the final year F (2009). This F_{sq} results in landings of 386 t for 2010, which is more in line with the 2010 TAC of 402 t.

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 and 2011, Council Regulation (EC) N°53/2010 and Council Regulation (EC) N°57/2011 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 2010

Species:	Common sole *Solea solea*	**Zone:**	VIIa (SOL/07A.)
Belgium	186		
France	2		
Ireland	73		
The Netherlands	58		
United Kingdom	83		
EU	402		
TAC	402		Analytical TAC

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

Fishery in 2010

A full description of the fishery is provided in the Stock Annex, Section A2.

The Working Group estimated the total international landings at 275 t in 2010 (Table 6.8.1), which is about 32% below the 2010 TAC (402 t) and also 30% below last year's forecast of 390 t.

The main countries fishing for Irish Sea sole are Belgium and Ireland.

The Belgian beam trawl effort has declined since 2002, however in 2010 it remains stable at around the lowest level in the time-series. The Irish beam trawl effort has increased slightly in 2010 following a decline since 2003. The Irish otter trawl effort has also increased a little in 2010 however it is still comparable with the historically lowest value reported in 2009.

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 at the beginning of the 2000s, the landings have fallen to under 350 t in the last three years.

The WG estimated the total international landings at 275 t in 2010 (Table 6.8.1), of which 79% (215 t) was landed by Belgium, 17% (47 t) by Ireland, 2% (7 t) by the UK (England & Wales) and the remainder by Northern Ireland, Scotland, Isle of Man and France. These landing-figures are the lowest in the time-series, corresponding to an international uptake of only 68% of the agreed TAC in 2010 (402 t).

The working group estimate of the 2009 landings was slightly revised upwards due to minor (0.4%) revisions of the landings by France, Isle of Man 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 (50–70%) 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 2010 were available from the countries that take the major part of the international landings (98%) (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 2010 (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 2010 were taken from the combined age–weight key (Table 6.8.4).

Stock weights-at-age for 2010 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.

This 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.

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 2010 discard rates from the beam trawl fleets are 4% for Belgium and 5% 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 on board Belgian (beam trawl), UK (all gears) and Irish (beam 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

Cpue and effort-series were available from the UK (E&W) September beam trawl survey (UK(E&W)-BTS-Q3) (1988–2010) 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. In this year's assessment the March survey (UK(E&W)-BTS-Q1) was omitted as recommended by WKFLAT 2011. The cpue 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 is has dropped gradually to the lowest value in 2010 (28 kg/100 km fished).

Detailed information on the survey protocols and area coverage can be found in the Stock Annex.

Commercial cpue

Commercial cpue and effort data were available for Belgian beam trawlers, UK (E&W) beam and otter trawlers and Irish otter and beam trawlers. Minor revisions have been made to the Belgian cpue series for 2006 and 2009 because of a change in the data extraction procedure. The cpue and effort-series from Irish beam and otter trawlers have also slightly been revised for the recent years (2006–2009).

Trends in cpue 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. 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 three 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 low-

est level in 2010. The Irish otter trawlers have also shown a marked reduction in effort since 1999.

Cpue for both UK and Belgian beam trawlers was at a high level in the late seventies and early eighties but since early 2000s, cpue for these fleets has fluctuated at a lower level. Since 2007 there has been a small increase in cpue. Irish beam trawl cpue shows a declining trend over the whole time-series. The cpue of both Irish and UK otter trawlers show a decline over the whole time-series.

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 99 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 logcatch 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 tuning data were examined for trends in catchability by carrying out XSA tuning runs (lightly shrunk (se=2.5), mean q model for all ages, full time-series and untapered), using the UK(E&W)-BTS-Q3 data (available in ICES files). The log-catchability residual pattern showed no trends and no year effects.

At the Benchmark meeting (WKFLAT 2011), tuning indices of UK(E&W)-BTS-Q3 were examined for inconsistencies using SURBA version 3.0. This analysis showed good cohort tracking and consistency between ages for year-class strength (see WKFLAT 2011 report).

Final update assessment

The model settings for the final assessment are summarized below (parameters were changed in 2011 following Benchmark conclusions).

Assessment Year	:2010	:2011
Assmnt Model	:XSA	:XSA
Fleets	:	:
Bel Beam Trawl	: omitted	:omitted
UK Trawl	:omitted	:omitted
UK Sept BTS	:1988–2009 2–7	:1988–2010 2–7
UK Mar BTS	:1993–1999 2–7	:**omitted**

Time-series Wts	:linear 20 yrs	:**no taper weighting**
Power Model	: none	:none
Q plateau	:7	:**4**
Shk se	:1.5	:1.5
Shk age-yr	: 5 yrs 3 ages	: 5 yrs 3 ages
Pop Shk se	: 0.3	: 0.3
Prior Wting	: none	: none
Plusgroup	: 8	: 8
F_{bar}	: 4–7	: 4–7

The final XSA output is given in Table 6.8.9 (diagnostics), Table 6.8.10 (fishing mortalities) and Table 6.8.11 (stock numbers). Log-catchability residuals for the final assessment are given in Figure 6.8.4. A summary of the XSA results is given in Table 6.8.12 and trends in yield, fishing mortality, recruitment and spawning–stock biomass are shown in Figure 6.8.5. Retrospective patterns for the final run are shown in Figure 6.8.6.

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.

The recommendations from WKFLAT 2011 have resolved the retrospective pattern seen in the previous assessment where there was a downwards revision of SSB. Fishing mortality has a slightly improved retrospective pattern. The recruitment levels appear to be consistently estimated throughout the retrospective period.

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.

With the addition of the 2010 data and the changes made at WKFLAT 2011, estimates of fishing mortality and SSB were revised slightly. In last year's assessment, fishing mortality and SSB for 2009 were estimated to be 0.28 and 1183 t respectively; this year's estimates for 2009 are 0.36 and 1130 t, an upward revision of 28% for F and a downward revision of 4% for SSB. The estimated recruitment by XSA in 2009 (2397 thousand fish) was revised downward by 11% in 2010 (2144 thousand fish).

Recruitment trends are very similar, whereas the historical estimates of F show a slight underestimation compared to the 2010 WG assessment. The SSB estimates from the updated assessment are somewhat overestimated for the earlier part of the time-series, but are comparable in the recent years.

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 (275 t) in 2010. 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 2009 SSB declined to the lowest estimate of the time-series (1130 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 (6331 thousand fish) and the 2010 recruitment (year class 2008) is estimated to be the lowest in the time-series (834 thousand fish).

6.8.3 Short-term projections

Estimating year-class abundance

The 2008 year class is now estimated at 834 thousand fish at age 2, which is 66% lower than the RCT3-value (2489 thousand fish) used in last year's forecast. The current estimate of the 2008 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 2010 (59 fish).

The 2009 year class (age 2 in 2011) was estimated using RCT3 (input in Table 6.8.13, output in Table 6.8.14). The RCT3 estimate (1679 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 long-term GM (5216 thousand fish) recruitment was assumed for the 2010 and subsequent year classes.

The working group estimates of year-class strength used for prediction can be summarized as follows:

Year class	XSA	GM 70–08	RCT3
2008	834	5216	-
2009	-	5216	1679
2010 & 2011	-	5216	

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 2008–2010. Catch and stock weights-at-age were also averages for the years 2008–2010. Population numbers at the start of 2011 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 323 t in 2011 (the agreed TAC is 390 t) and 320 t in 2012. Assuming *status quo* F will result in a SSB of 1371 t in 2012 and 1716 t in 2013.

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 11% and 29% respectively of the landings in 2012 and about 5% and 45 % respectively of the 2013 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 2012 are 220 t and 450 t. There is about 85% probability that at current fishing mortality SSB will fall below B_{lim} (2200 t in 2012).

6.8.4 MSY explorations

Investigations for possible F_{MSY} candidates for this stock were carried out at last year's WGCSE. 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.

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 probabili ty of avoiding $\mathbf{F}_{lim}$.
$\mathbf{F}_{max}$=0.55		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 2011, are given in Table 6.8.19 and Figure 6.8.8. Current fishing mortality (0.31) is well above F_{MSY} (0.16). F_{max} is calculated by this year's assessment to 0.55, 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 coordinate 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 2006 was only in the range of 50–70%. 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 may be 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 this year's assessment the settings were changed according to the outcome of the WKFLAT 2011.

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 no apparent stock–recruitment relationship for this stock and no evidence of reduced recruitment at low levels of SSB (Figure 6.8.10).

SSB in 2010 is estimated to be well below B_{lim}. Recruitment-at-age 2 has been well below average since 2001, and in 2010 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 below 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 45% of the predicted SSB in 2013 is based on that assumption. The GM (70–08) recruitment used for year classes 2010 and 2011 may be an optimistic 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.

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	-2	275	402

[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**
2	29	113	31	368	25
3	895	434	673	363	891
4	1009	2097	730	2195	576
5	467	1130	1537	557	1713
6	1457	232	537	815	383
7	289	878	172	267	422
+gp	2537	1887	1500	1143	971
TOTALNUM	6683	6771	5180	5708	4981
TONSLAND	1785	1882	1450	1428	1307
SOPCOF %	100	100	100	100	100

Age/Year	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**
2	262	29	221	65	108	187	70	8	37
3	733	375	416	958	1027	939	580	346	165
4	2386	1332	1292	649	3433	1968	1668	1241	998
5	539	2330	774	1009	829	3055	1480	1298	758
6	842	247	1066	442	637	521	1640	711	757
7	157	544	150	638	326	512	114	641	416
+gp	1006	739	648	587	620	1145	865	397	709
TOTALNUM	5925	5596	4567	4348	6980	8327	6417	4642	3840
TONSLAND	1441	1463	1147	1106	1614	1941	1667	1338	1169
SOPCOF %	100	100	100	100	100	100	100	100	100

Age/Year	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**
2	651	154	141	189	32	179	564	1317	363
3	786	1601	3336	3348	444	771	1185	1270	2433
4	380	1086	3467	4105	4752	775	986	841	918
5	610	343	961	3185	2102	3978	598	300	556
6	343	334	235	844	1310	1178	2319	226	190
7	424	164	277	307	203	552	592	1173	156
+gp	557	739	848	808	516	255	466	459	929
TOTALNUM	3751	4421	9265	12786	9359	7688	6710	5586	5545
TONSLAND	1058	1146	1995	2808	1999	1833	1583	1212	1259
SOPCOF %	100	100	100	100	100	100	100	100	100

Age/Year	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
2	83	122	132	60	789	167	301	178	240
3	543	1342	920	469	713	1728	1069	908	1438
4	1966	1069	1444	1188	474	466	1258	909	822
5	559	1578	737	741	710	256	297	601	717
6	251	394	1010	430	408	315	115	150	511
7	199	133	179	509	258	191	136	55	80
+gp	686	524	350	347	531	423	232	258	272
TOTALNUM	4287	5162	4772	3744	3883	3546	3408	3059	4080
TONSLAND	1023	1374	1266	1002	1003	911	863	818	1053
SOPCOF %	100	100	100	100	100	100	100	100	100

Age/Year	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
2	148	436	295	536	111	171	99	92	21
3	927	824	850	1052	666	356	354	414	333
4	1618	965	337	626	645	348	191	333	231
5	738	794	363	271	202	243	196	146	176
6	573	302	300	314	112	86	157	132	65
7	253	217	137	279	150	41	56	127	71
+gp	216	344	178	368	377	298	210	162	157
TOTALNUM	4473	3882	2460	3446	2263	1543	1263	1406	1054
TONSLAND	1090	1014	709	855	569	492	332	325	275
SOPCOF %	100	100	101	100	101	100	100	100	100

Table 6.8.3. Sole in VIIa. Annual lenght distributions by country (2010).

Length (cm)	UK (England & Wales) All gears	Belgium All gears	Ireland All gears
20			55
21		22	277
22		6038	666
23	59	40876	888
24	763	86324	2996
25	587	134522	3495
26	1702	107873	6602
27	1291	102855	11319
28	1174	92239	13371
29	1115	60263	14481
30	1350	56234	12539
31	587	41552	11374
32	1291	38274	9432
33	763	28285	7823
34	1232	21166	6103
35	469	18716	6325
36	646	12788	4883
37	587	10593	5770
38	352	8420	4272
39	587	4621	2497
40	587	4577	1942
41	352	2338	1997
42	117	1972	1609
43	587	919	721
44	293	698	555
45	176	612	499
46	117	94	111
47		169	333
48		29	111
49		51	0
50		51	55
51			55
52			
53			
54			
55			
56			
57			
58			
59			
60			
Total	16784	883171	133156

Table 6.8.4 - Sole in VIIa. Catch weights at age (kg)

Age/Year	**1970**	**1971**	**1972**	**1973**	**1974**
2	0.13	0.152	0.126	0.151	0.138
3	0.153	0.178	0.164	0.178	0.174
4	0.178	0.204	0.201	0.204	0.209
5	0.204	0.23	0.237	0.23	0.241
6	0.232	0.257	0.272	0.256	0.272
7	0.26	0.284	0.306	0.283	0.301
+gp	0.3769	0.4194	0.4169	0.3918	0.3956
SOPCOF %	1	0.9997	1.0004	0.9999	1

Age/Year	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**
2	0.13	0.12	0.085	0.093	0.134	0.146	0.162	0.112	0.189
3	0.172	0.161	0.146	0.147	0.165	0.169	0.183	0.171	0.212
4	0.21	0.2	0.202	0.197	0.199	0.193	0.207	0.225	0.238
5	0.244	0.239	0.251	0.243	0.234	0.219	0.234	0.275	0.266
6	0.275	0.276	0.293	0.286	0.271	0.247	0.264	0.321	0.298
7	0.303	0.313	0.33	0.326	0.311	0.275	0.296	0.362	0.332
+gp	0.3671	0.4574	0.387	0.4294	0.4507	0.3801	0.452	0.4564	0.4577
SOPCOF %	0.9999	0.9996	0.9996	0.9997	0.9997	1.0007	1.0002	1.0002	0.9997

Age/Year	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**
2	0.191	0.144	0.122	0.135	0.111	0.125	0.135	0.133	0.149
3	0.225	0.189	0.164	0.164	0.147	0.163	0.162	0.172	0.177
4	0.257	0.231	0.203	0.196	0.183	0.201	0.192	0.208	0.207
5	0.288	0.272	0.241	0.231	0.218	0.237	0.227	0.241	0.239
6	0.318	0.31	0.277	0.268	0.252	0.271	0.265	0.272	0.274
7	0.347	0.346	0.311	0.308	0.286	0.304	0.307	0.3	0.31
+gp	0.4085	0.4296	0.4071	0.4615	0.4188	0.3887	0.414	0.3452	0.3788
SOPCOF %	0.9998	0.9994	0.9994	0.9998	0.999	1.0001	1.0004	0.9995	0.9992

Age/Year	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
2	0.102	0.175	0.129	0.156	0.154	0.187	0.179	0.14	0.175
3	0.156	0.198	0.182	0.193	0.197	0.209	0.217	0.189	0.18
4	0.205	0.227	0.232	0.228	0.237	0.234	0.252	0.25	0.271
5	0.248	0.261	0.277	0.263	0.275	0.263	0.285	0.311	0.293
6	0.285	0.301	0.318	0.296	0.311	0.295	0.314	0.368	0.326
7	0.318	0.346	0.356	0.327	0.345	0.331	0.341	0.428	0.42
+gp	0.3701	0.5093	0.4507	0.4104	0.4068	0.4399	0.3992	0.5042	0.438
SOPCOF %	0.9994	1.0007	0.9998	1.0003	1.0015	1	1.0005	0.9981	1

Age/Year	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
2	0.162	0.16	0.17	0.16	0.179	0.172	0.148	0.141	0.166
3	0.172	0.187	0.219	0.203	0.194	0.224	0.189	0.195	0.193
4	0.211	0.247	0.289	0.256	0.224	0.296	0.248	0.229	0.266
5	0.283	0.294	0.338	0.286	0.297	0.36	0.279	0.279	0.285
6	0.328	0.342	0.371	0.312	0.293	0.38	0.291	0.277	0.321
7	0.333	0.326	0.383	0.326	0.318	0.429	0.386	0.261	0.308
+gp	0.3746	0.415	0.4436	0.3515	0.3494	0.4785	0.3919	0.2767	0.3354
SOPCOF %	1.003	1.0015	1.0141	0.9996	1.0057	0.9989	0.9963	0.9993	1.0009

Table 6.8.5 - Sole in VIIa. Stock weights at age (kg)

Age/Year	**1970**	**1971**	**1972**	**1973**	**1974**
2	0.13	0.152	0.126	0.151	0.138
3	0.153	0.178	0.164	0.178	0.174
4	0.178	0.204	0.201	0.204	0.209
5	0.204	0.23	0.237	0.23	0.241
6	0.232	0.257	0.272	0.256	0.272
7	0.26	0.284	0.306	0.283	0.301
+gp	0.377	0.419	0.417	0.392	0.396

Age/Year	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**
2	0.13	0.12	0.085	0.093	0.134	0.146	0.162	0.112	0.189
3	0.172	0.161	0.146	0.147	0.165	0.169	0.183	0.171	0.212
4	0.21	0.2	0.202	0.197	0.199	0.193	0.207	0.225	0.238
5	0.244	0.239	0.251	0.243	0.234	0.219	0.234	0.275	0.266
6	0.275	0.276	0.293	0.286	0.271	0.247	0.264	0.321	0.298
7	0.303	0.313	0.33	0.326	0.311	0.275	0.296	0.362	0.332
+gp	0.367	0.457	0.387	0.429	0.451	0.380	0.452	0.456	0.458

Age/Year	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**
2	0.191	0.144	0.122	0.135	0.111	0.125	0.135	0.133	0.149
3	0.225	0.189	0.164	0.164	0.147	0.163	0.162	0.172	0.177
4	0.257	0.231	0.203	0.196	0.183	0.201	0.192	0.208	0.207
5	0.288	0.272	0.241	0.231	0.218	0.237	0.227	0.241	0.239
6	0.318	0.31	0.277	0.268	0.252	0.271	0.265	0.272	0.274
7	0.347	0.346	0.311	0.308	0.286	0.304	0.307	0.3	0.31
+gp	0.409	0.430	0.407	0.462	0.419	0.389	0.414	0.345	0.379

Age/Year	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
2	0.102	0.175	0.129	0.156	0.154	0.187	0.179	0.124	0.151
3	0.156	0.198	0.182	0.193	0.197	0.209	0.217	0.158	0.159
4	0.205	0.227	0.232	0.228	0.237	0.234	0.252	0.23	0.226
5	0.248	0.261	0.277	0.263	0.275	0.263	0.285	0.303	0.271
6	0.285	0.301	0.318	0.296	0.311	0.295	0.314	0.345	0.318
7	0.318	0.346	0.356	0.327	0.345	0.331	0.341	0.41	0.393
+gp	0.370	0.509	0.451	0.410	0.407	0.440	0.399	0.530	0.450

Age/Year	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
2	0.145	0.144	0.15	0.144	0.152	0.156	0.134	0.129	0.158
3	0.174	0.174	0.187	0.186	0.177	0.2	0.181	0.17	0.165
4	0.195	0.207	0.232	0.237	0.213	0.24	0.236	0.208	0.228
5	0.277	0.249	0.289	0.288	0.276	0.284	0.288	0.263	0.256
6	0.31	0.311	0.331	0.325	0.289	0.336	0.324	0.278	0.3
7	0.33	0.327	0.362	0.348	0.315	0.354	0.383	0.276	0.292
+gp	0.397	0.383	0.419	0.383	0.348	0.419	0.424	0.319	0.305

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
BEL	TBB	716	0.05	2007–2009	209	0.04
UK	TBB	284	0.08	2002,2005–2007	1.703	n/a
	OTB	61	0.05	2002–2009	1.025	0.00
	TWIN OTB	4	0.01	2003,2004,2007	0.014	n/a
	NEPH OTB	25	0.08	2003,2006–2009	3.327	0.05
	TWIN NEPH	6	0.02	2002,2003,2008	0.501	n/a
IRL	TBB	427	0.02	2003–2009	38.3	0.05
	NEPH OTB	16	0.56*	2003–2009	9.0	0.29*

*** 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. n/a=not available.**

Table 6.8.7 - Sole in VIIa. Effort and CPUE series.

	CPUE							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	0.44	27.8	-	0.20	4.09	11.1	0.2	1.0	45.5	9.42

All CPUE 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 2010
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

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 2008
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

UK(E&W)-C0T UK Commercial Otter trawl

1991 2010
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
1.03	0	0	0.1	0.2	0.2	0.1	0.1	0.2	0.1	0	0.1	0.1	0

IR-COT Irish Commercial Otter trawl

1995 2005
1 1 0 1
2 10

70682	6.8	17.7	25.5	9.2	25.8	3.6	0.8	1.5	1.9	1995
58166	0	5.7	12.9	12.7	4.7	4.7	2.2	0.2	0	1996
75029	27.8	10.2	4.1	9.2	6.4	3.5	3.9	1	0.2	1997
81073	5.5	40.7	14.7	6.6	12.3	5.4	2.7	4.1	1	1998
93221	26.6	36.8	30.9	5.1	3.8	5.3	2.4	0.5	1.2	1999
64320	1.6	13.2	13.4	11	3.4	1.1	1	0.4	0	2000
77541	0.2	6.1	18.6	18.6	10.8	2.1	4.1	1.3	0.3	2001
39996	20.3	20	30.2	16.4	8.2	2.9	2.4	1.4	0.5	2002
73854	0.9	35.9	21.7	9.8	3.3	0.5	0.8	0.2	0.2	2003
72507	9	15.1	4.1	3.2	1.9	1.6	0.3	0.2	0.1	2004
##										
31142	4	1.7	1.6	1.6	0.6	0.1	0	0	0	2005
##										

Please note the 2005 data is based only on Q3 and Q4 data and has not been raised to annual effort.
It should not be included as part of this time series.

Table 6.8.9 - Sole in VIIa. Diagnostics

Lowestoft VPA Version 3.1

12/05/2011 14:14

Extended Survivors Analysis

IRISH SEA SOLE 2011 WG COMBSEX PLUSGROUP.

CPUE data from file sol7atun.txt

Catch data for 41 years. 1970 to 2010. Ages 2 to 8.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
UK (E&W)-BTS-Q3□	1988	2010	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	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2	0.056	0.069	0.161	0.087	0.203	0.09	0.101	0.054	0.046	0.027
3	0.277	0.281	0.575	0.473	0.446	0.371	0.409	0.278	0.294	0.209
4	0.303	0.505	0.467	0.432	0.678	0.48	0.3	0.356	0.406	0.237
5	0.249	0.433	0.441	0.285	0.655	0.425	0.296	0.245	0.448	0.346
6	0.273	0.288	0.281	0.263	0.378	0.549	0.286	0.283	0.232	0.326
7	0.45	0.188	0.15	0.178	0.37	0.278	0.351	0.272	0.346	0.169

1

XSA population numbers (Thousands)

YEAR \ AGE	2	3	4	5	6	7
2001	4.65E+03	6.25E+03	3.30E+03	3.42E+03	2.25E+03	2.32E+02
2002	2.35E+03	3.98E+03	4.29E+03	2.21E+03	2.41E+03	1.55E+03
2003	3.08E+03	1.98E+03	2.72E+03	2.34E+03	1.29E+03	1.63E+03
2004	3.70E+03	2.37E+03	1.01E+03	1.54E+03	1.36E+03	8.84E+02
2005	3.06E+03	3.07E+03	1.34E+03	5.93E+02	1.05E+03	9.49E+02
2006	1.35E+03	2.26E+03	1.78E+03	6.14E+02	2.79E+02	6.50E+02
2007	1.87E+03	1.12E+03	1.41E+03	9.96E+02	3.63E+02	1.46E+02
2008	1.99E+03	1.53E+03	6.70E+02	9.47E+02	6.70E+02	2.47E+02
2009	2.14E+03	1.71E+03	1.05E+03	4.25E+02	6.71E+02	4.57E+02
2010	8.34E+02	1.85E+03	1.15E+03	6.32E+02	2.46E+02	4.81E+02

Estimated population abundance at 1st Jan 2011

2	3	4	5	6	7
0.00E+00	7.34E+02	1.36E+03	8.22E+02	4.05E+02	1.60E+02

Taper weighted geometric mean of the VPA populations:

2	3	4	5	6	7
4.88E+03	4.47E+03	3.29E+03	2.02E+03	1.22E+03	7.25E+02

Standard error of the weighted Log(VPA populations) :

2	3	4	5	6	7
0.7294	0.6947	0.7523	0.7671	0.7736	0.7516

1

Log catchability residuals.

Fleet : UK (E&W)-BTS-Q3□

Age	1988	1989	1990
2	0.02	0.01	0.38
3	0.6	0.37	-0.12
4	0.09	0.16	-0.17
5	-0.32	0.05	1.04
6	-0.18	-0.2	0.33
7	-0.1	0.07	0.16

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	0.48	-0.07	-0.3	0.13	0.17	-0.3	0.05	0.39	-0.18	-0.02
3	-0.3	0.47	-0.27	-0.04	0.29	-0.66	-0.07	0.09	-0.02	-0.22
4	-0.84	0.52	-0.02	-0.2	0.13	-0.18	-0.07	-0.68	0.36	0.37
5	-0.55	0.04	-0.27	0.09	-0.51	-0.17	0.08	-0.68	0.4	-0.09
6	-0.16	0.21	-0.04	0.54	0	-0.14	-0.14	-0.27	0.4	0.18
7	-0.23	-0.21	-0.14	0.17	-0.39	-0.19	0.24	0.18	0.17	-0.16

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2	-0.07	-0.91	0.13	0.02	-0.05	0.25	-0.24	-0.01	0.06	0.06
3	-0.22	-0.23	-0.16	0.43	-0.37	0.11	0.24	0.05	0.05	-0.03
4	-0.42	0.14	0.3	-0.01	-0.14	-0.03	0.29	0.11	0.29	0.01
5	-0.11	-0.35	0.25	0.49	0	0.77	0.31	0.4	0.7	-0.14
6	-0.08	0.08	0.01	0.06	0.19	0.27	-0.01	0.15	0.34	-0.37
7	-0.03	-0.04	-0.26	0.33	-0.05	-0.22	-0.05	-0.21	-0.1	-0.48

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	-7.4384	-7.7953	-8.0184	-8.0184	-8.0184	-8.0184
S.E(Log q)	0.2847	0.3014	0.3277	0.4416	0.2378	0.2162

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	0.9	1.25	7.52	0.87	23	0.25	-7.44
3	0.97	0.289	7.8	0.79	23	0.3	-7.8
4	0.94	0.612	8.01	0.85	23	0.31	-8.02
5	1.15	-1.134	8.05	0.73	23	0.5	-7.96
6	1.03	-0.535	8	0.93	23	0.24	-7.97
7	0.98	0.367	8.05	0.94	23	0.21	-8.09

1

Terminal year survivor and F summaries :

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2008

Fleet	ES	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3□	776	0.3	0	0	1	0.961	0.025
F shrinkage mean	192	1.5				0.039	0.099

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
734	0.29	0.28	2	0.944	0.027

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2007

Fleet	ES	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3□	1381	0.215	0.043	0.2	2	0.975	0.206
F shrinkage mean	729	1.5				0.025	0.361

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1359	0.21	0.08	3	0.366	0.209

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2006

Fleet	ES	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3□	836	0.183	0.018	0.1	3	0.978	0.233
F shrinkage mean	391	1.5				0.022	0.445

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
822	0.18	0.07	4	0.369	0.237

Age 5 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2005

Fleet	ES	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3□	407	0.175	0.12	0.68	4	0.971	0.344
F shrinkage mean	325	1.5				0.029	0.415

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
405	0.18	0.1	5	0.592	0.346

1

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2004

Fleet	ES	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3□	161	0.167	0.19	1.13	5	0.975	0.326
F shrinkage mean	149	1.5				0.025	0.347

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
160	0.17	0.17	6	1.001	0.326

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2003

Fleet	ES	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK (E&W)-BTS-Q3□	372	0.146	0.163	1.11	6	0.984	0.167
F shrinkage mean	190	1.5				0.016	0.304

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
368	0.15	0.15	7	1.039	0.169

1
1

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	0.1332
4	0.2956	0.3988	0.3518	0.3621	0.3157	0.3032	0.4193	0.3255	0.2866	0.3645	0.3925
5	0.4445	0.5545	0.5057	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	0.9481
7	0.3909	0.4416	0.4517	0.431	0.4453	0.3962	0.4281	0.3704	0.3583	0.4759	0.6384
+gp	0.3909	0.4416	0.4517	0.431	0.4453	0.3962	0.4281	0.3704	0.3583	0.4759	0.6384
FBAR 4-7	0.39	0.4405	0.4506	0.43	0.4442	0.3953	0.4271	0.3696	0.3575	0.4747	0.6364

Age/Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
2	0.0164	0.0034	0.007	0.0448	0.0099	0.0062	0.0584	0.0095	0.0435	0.1103	0.1135
3	0.1486	0.095	0.0809	0.18	0.133	0.272	0.1767	0.1698	0.2943	0.393	0.3427
4	0.3282	0.4761	0.3821	0.2413	0.3584	0.4161	0.5536	0.3612	0.4415	0.661	0.4741
5	0.5101	0.4066	0.5304	0.3773	0.3178	0.5474	0.7421	0.5421	0.515	0.6411	0.3783
6	0.6019	0.4359	0.3906	0.4306	0.3249	0.3331	1.2288	0.6935	0.59	0.5691	0.4705
7	0.4817	0.441	0.4358	0.3507	0.3346	0.4336	0.8457	1.0286	0.6274	0.5916	0.5597
+gp	0.4817	0.441	0.4358	0.3507	0.3346	0.4336	0.8457	1.0286	0.6274	0.5916	0.5597
FBAR 4-7	0.4805	0.4399	0.4347	0.35	0.3339	0.4325	0.8425	0.6563	0.5435	0.6157	0.4707

Age/Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	0.0789	0.014	0.0242	0.0712	0.0253	0.1006	0.0247	0.0603	0.0267	0.0558	0.0686
3	0.2815	0.1459	0.2892	0.2285	0.3423	0.4094	0.2961	0.1947	0.2323	0.2768	0.2811
4	0.3953	0.343	0.4182	0.5089	0.4562	0.6087	0.4548	0.3247	0.2257	0.3034	0.505
5	0.5856	0.3949	0.451	0.5035	0.4721	0.481	0.6936	0.5202	0.2263	0.2494	0.4334
6	0.3884	0.5061	0.4736	0.516	0.5483	0.4575	0.3608	0.687	0.4795	0.2727	0.2879
7	0.6132	0.797	0.4875	0.3626	0.4717	0.6622	0.3568	0.2324	0.7382	0.4504	0.1882
+gp	0.6132	0.797	0.4875	0.3626	0.4717	0.6622	0.3568	0.2324	0.7382	0.4504	0.1882
FBAR 4-7	0.4956	0.5103	0.4576	0.4728	0.4871	0.5524	0.4665	0.4411	0.4174	0.3189	0.3536

Age/Year	2003	2004	2005	2006	2007	2008	2009	2010	FBAR 07-09
2	0.1612	0.0874	0.2033	0.0905	0.1009	0.0537	0.0462	0.0268	0.0422
3	0.5745	0.4731	0.4464	0.3705	0.4089	0.2784	0.2942	0.2095	0.2607
4	0.4674	0.4322	0.6781	0.4801	0.2998	0.3561	0.4061	0.2369	0.333
5	0.4406	0.2847	0.6547	0.4246	0.2965	0.2453	0.4483	0.3462	0.3466
6	0.2815	0.2629	0.3781	0.5488	0.2862	0.2829	0.2319	0.3262	0.2803
7	0.1504	0.1779	0.3696	0.2778	0.3507	0.2725	0.3458	0.1686	0.2623
+gp	0.1504	0.1779	0.3696	0.2778	0.3507	0.2725	0.3458	0.1686	
FBAR 4-7	0.335	0.2894	0.5202	0.4328	0.3083	0.2892	0.358	0.2695	

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
2	3695	10178	3186	13136	5872	6682	3858	15776	9045	8860	5077
3	8349	3316	9102	2853	11536	5289	5797	3463	14065	8122	7914
4	4145	6703	2587	7596	2237	9591	4089	4888	2738	11815	6373
5	1368	2791	4071	1647	4785	1476	6408	2433	3194	1860	7425
6	4389	794	1450	2221	980	2700	823	3582	1465	1930	894
7	939	2586	498	802	1235	505	1642	509	2227	905	1141
+gp	8212	5534	4321	3418	2829	3221	2222	2193	2042	1714	2538
TOTAL	31098	31902	25215	31673	29453	29463	24838	32845	34776	35206	31380

Age/Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
2	4511	2476	5582	15623	16437	24166	3503	3547	4425	5678	12505
3	4416	4015	2232	5015	13517	14728	21732	2989	3179	3834	4802
4	6267	3444	3304	1863	3790	10708	10151	16479	2283	2143	2342
5	3894	4084	1936	2040	1324	2397	6391	5281	10390	1328	1001
6	3813	2116	2461	1031	1266	872	1254	2753	2779	5618	833
7	313	1890	1238	1507	606	828	565	332	1245	1394	2877
+gp	2368	1166	2102	1973	2723	2524	1477	837	572	1091	1120
TOTAL	25583	19190	18854	29052	39664	56220	45074	32218	24873	21086	25479

Age/Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	5029	6295	5361	2019	2529	8663	7195	5405	7098	4648	2348
3	10424	4205	5617	4735	1701	2231	7088	6351	4604	6253	3977
4	2956	7118	3288	3806	3409	1093	1341	4770	4730	3302	4250
5	1319	1801	4570	1958	2070	1955	538	770	3120	3415	2208
6	621	664	1098	2634	1071	1168	1093	243	414	2251	2408
7	358	381	362	619	1423	560	669	690	111	232	1551
+gp	2119	1304	1421	1206	966	1146	1477	1174	516	785	1321
TOTAL	22824	21768	21718	16976	13169	16816	19401	19402	20592	20886	18099

Age/Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	GM ST 70-08	AM ST 70-08
2	3078	3705	3063	1349	1872	1991	2144	834	0	5216	6501
3	1982	2371	3071	2261	1115	1531	1708	1852	734	4687	5887
4	2717	1010	1336	1778	1413	670	1049	1151	1359	3478	4476
5	2343	1540	593	814	996	947	425	632	822	2164	2776
6	1294	1364	1049	279	363	670	671	246	405	1287	1654
7	1634	884	949	650	146	247	457	481	160	742	955
+gp	2586	1146	1248	1629	1056	923	581	1062	1180		
TOTAL	15634	12019	11309	8561	6960	6980	7033	6258	4661		

Table 6.8.12 - Sole in VIIa. Summary

	RECRUITS Age 2	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 7
1970	3695	7133	6437	1785	0.2773	0.39
1971	10178	7406	6222	1882	0.3025	0.4405
1972	3186	5727	5011	1450	0.2894	0.4506
1973	13136	6555	5123	1428	0.2787	0.43
1974	5872	6190	5069	1307	0.2579	0.4442
1975	6682	6230	5360	1441	0.2688	0.3953
1976	3858	5503	4890	1463	0.2992	0.4271
1977	15776	5511	4491	1147	0.2554	0.3696
1978	9045	6246	5093	1106	0.2171	0.3575
1979	8860	6891	5687	1614	0.2838	0.4747
1980	5077	6433	5517	1941	0.3518	0.6364
1981	4511	5917	5173	1667	0.3223	0.4805
1982	2476	4757	4340	1338	0.3083	0.4399
1983	5582	4936	4111	1169	0.2844	0.4347
1984	15623	6835	4632	1058	0.2284	0.35
1985	16437	7930	5688	1146	0.2015	0.3339
1986	24165	9641	7036	1995	0.2835	0.4325
1987	3503	8695	7279	2808	0.3858	0.8425
1988	3547	6139	5654	1999	0.3535	0.6563
1989	4425	5347	4790	1833	0.3826	0.5435
1990	5678	4469	3795	1583	0.4171	0.6157
1991	12905	4658	3345	1212	0.3623	0.4707
1992	5029	4605	3581	1259	0.3516	0.4956
1993	6295	3997	3356	1023	0.3048	0.5103
1994	5361	5169	4219	1374	0.3257	0.4576
1995	2019	4149	3700	1266	0.3421	0.4728
1996	2529	3223	2849	1002	0.3517	0.4871
1997	8663	3593	2620	1003	0.3828	0.5524
1998	7195	4476	3200	911	0.2847	0.4665
1999	5405	4547	3507	863	0.2461	0.4411
2000	7098	4103	3294	818	0.2483	0.4174
2001	4648	4528	3764	1053	0.2798	0.3189
2002	2346	4263	3814	1090	0.2858	0.3536
2003	3078	3861	3458	1014	0.2933	0.335
2004	3705	2930	2441	709	0.2904	0.2894
2005	3063	2649	2197	855	0.3892	0.5202
2006	1349	2007	1749	569	0.3254	0.4328
2007	1872	1753	1491	492	0.3299	0.3083
2008	1991	1678	1422	332	0.2334	0.2892
2009	2144	1394	1130	325	0.2876	0.358
2010	834	1400	1218	275	0.2257	0.2695
2011	1679 [1]	1472 [2]	1276 [2]			0.3056 [3]
Arith. Mean	6313	4963	4092	1234	0.3022	0.4437
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

[1] RCT3

[2] Forecast

[3] Mean F 2008-2010

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	
	1970	3186	-11	-11
	1971	13136	-11	-11
	1972	5872	-11	-11
	1973	6682	-11	-11
	1974	3858	-11	-11
	1975	15776	-11	-11
	1976	9045	-11	-11
	1977	8860	-11	-11
	1978	5077	-11	-11
	1979	4511	-11	-11
	1980	2476	-11	-11
	1981	5582	-11	-11
	1982	15623	-11	-11
	1983	16437	-11	-11
	1984	24165	-11	-11
	1985	3503	-11	-11
	1986	3547	196	-11
	1987	4425	304	118
	1988	5678	534	218
	1989	12905	1286	1712
	1990	5029	309	148
	1991	6295	330	220
	1992	5361	408	83
	1993	2019	154	60
	1994	2529	126	246
	1995	8663	577	886
	1996	7195	716	1158
	1997	5405	293	539
	1998	7098	464	385
	1999	4648	284	354
	2000	2346	61	91
	2001	3078	210	205
	2002	3705	240	242
	2003	3063	165	406
	2004	1349	110	53
	2005	1872	93	107
	2006	1991	125	125
	2007	-11	150	126
	2008	-11	59	57
	2009	-11	-11	25
S2				
S1				

Table 6.8.14 - Sole in VIIa.

Analysis by RCT3 ver3.1 of data from file :

S7ARCT.TXT

Irish Sea sole recruits - age 2

Data for 2 surveys over 40 years : 1970 - 2009

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .00
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2008

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
S2	.84	3.66	.23	.867	21	4.09	7.08	.270	.719
S1	.80	3.97	.49	.601	20	4.06	7.20	.559	.168
VPA Mean =						8.55	.682	.113	

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									
S1	.80	3.97	.49	.601	20	3.26	6.56	.598	.566
VPA Mean =						8.55	.682	.434	

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2008	1433	7.27	.23	.33	2.02		
2009	**1679**	**7.43**	**.45**	**.99**	**4.81**		

Table 6.8.15 - Sole in VIIa
Input for catch forecast and Fmsy analysis

Input: F mean 08-10 not rescaled to F2010
Catch and stock weights are mean 08-10
Recruits age 2 in 2012 and 2013 GM (70-08)

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N2	1679	0.99	WS2	0.140	0.11
N3	734	0.29	WS3	0.172	0.05
N4	1359	0.21	WS4	0.224	0.06
N5	822	0.18	WS5	0.269	0.06
N6	405	0.28	WS6	0.301	0.08
N7	160	0.17	WS7	0.317	0.18
N8	1180	0.15	WS8	0.349	0.19
H.cons selectivity			Weight in the HC catch		
sH2	0.042	0.33	WH2	0.152	0.09
sH3	0.261	0.17	WH3	0.192	0.02
sH4	0.333	0.26	WH4	0.248	0.07
sH5	0.347	0.29	WH5	0.281	0.01
sH6	0.280	0.17	WH6	0.296	0.08
sH7	0.262	0.34	WH7	0.318	0.20
sH8	0.262	0.34	WH8	0.335	0.17
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		
HF11	1	0.1	K10	1	0.1
HF12	1	0.1	K11	1	0.1
HF13	1	0.1	K12	1	0.1
Recruitment in 2012 and 2013					
R12	5216	0.75			
R13	5216	0.75			

Table 6.8.16 Sole in VIIa - Management option table

MFDP version 1a
Run: Sole7A1
IRISH SEA SOLE,2011 WG
Time and date: 18:47 12/05/2011
Fbar age range: 4-7

2011 Biomass	SSB	FMult	FBar	Landings
1472	1276	1.0000	0.3056	323

2012 Biomass	SSB	FMult	FBar	Landings	2013 Biomass	SSB
1906	1371	0.0000	0.0000	0	2737	2036
.	1371	0.1000	0.0306	36	2699	2000
.	1371	0.2000	0.0611	71	2663	1965
.	1371	0.3000	0.0917	105	2627	1931
.	1371	0.4000	0.1222	138	2593	1898
.	1371	0.5000	0.1528	171	2560	1865
.	1371	0.6000	0.1833	202	2527	1834
.	1371	0.7000	0.2139	233	2495	1803
.	1371	0.8000	0.2445	263	2464	1774
.	1371	0.9000	0.2750	292	2434	1745
.	1371	1.0000	0.3056	320	2405	1716
.	1371	1.1000	0.3361	348	2376	1689
.	1371	1.2000	0.3667	375	2348	1662
.	1371	1.3000	0.3972	401	2321	1636
.	1371	1.4000	0.4278	427	2295	1611
.	1371	1.5000	0.4584	452	2269	1587
.	1371	1.6000	0.4889	476	2244	1563
.	1371	1.7000	0.5195	500	2219	1539
.	1371	1.8000	0.5500	523	2195	1517
.	1371	1.9000	0.5806	545	2172	1494
.	1371	2.0000	0.6111	567	2150	1473

Input units are thousands and kg - output in tonnes

Fmult corresponding to Fpa = 1.0						
.	1371	1	0.3056	320	2405	1716
Fmult corresponding to FMSY = 0.524						
.	1371	0.524	0.1601	178	2552	1858
Fmult corresponding to FHCR-MSY = 0.229						
.	1371	0.229	0.07	81	2653	1955
Fmult corresponding to FHCR-MSY transition = 0.622						
.	1371	0.622	0.1901	209	2520	1827

Bpa = 3100 t

Table 6.8.17 Sole in VIIa. Detailed results

MFDP version 1a
Run: Sole7A1
Time and date: 18:55 12/05/2011
Fbar age range: 4-7

Year: 2011 F multiplier: 1 Fbar: 0.3056

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
2	0.0422	66	10	1679	236	638	90	638	90
3	0.2607	161	31	734	126	521	90	521	90
4	0.3330	367	91	1359	304	1318	295	1318	295
5	0.3466	230	65	822	221	806	217	806	217
6	0.2803	94	28	405	122	405	122	405	122
7	0.2623	35	11	160	51	160	51	160	51
8	0.2623	260	87	1180	412	1180	412	1180	412
Total		1213	323	6339	1472	5028	1276	5028	1276

Year: 2012 F multiplier: 1 Fbar: 0.3056

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
2	0.0422	205	31	5216	732	1982	278	1982	278
3	0.2607	319	61	1456	251	1034	178	1034	178
4	0.3330	138	34	512	115	496	111	496	111
5	0.3466	246	69	881	237	864	232	864	232
6	0.2803	123	36	526	158	526	158	526	158
7	0.2623	61	19	277	88	277	88	277	88
8	0.2623	205	69	933	326	933	326	933	326
Total		1298	320	9801	1906	6112	1371	6112	1371

Year: 2013 F multiplier: 1 Fbar: 0.3056

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
2	0.0422	205	31	5216	732	1982	278	1982	278
3	0.2607	990	190	4524	778	3212	553	3212	553
4	0.3330	274	68	1015	227	985	221	985	221
5	0.3466	93	26	332	89	325	87	325	87
6	0.2803	131	39	564	170	564	170	564	170
7	0.2623	79	25	360	114	360	114	360	114
8	0.2623	185	62	842	294	842	294	842	294
Total		1959	442	12853	2405	8270	1716	8270	1716

Input units are thousands and kg - output in tonnes

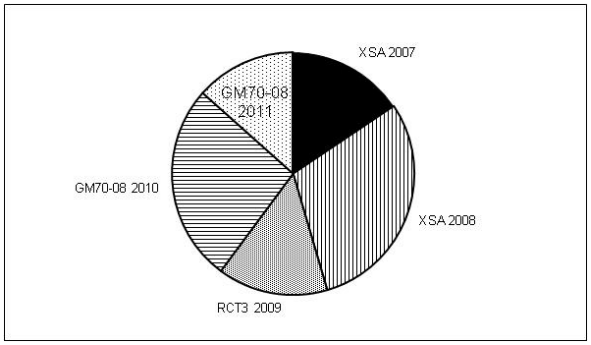
Table 6.8.18 **Sole VIIa**
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

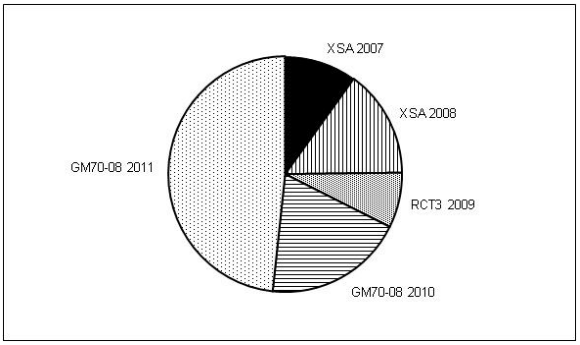
Year-class	2007	2008	2009	2010	2011
Stock No. (thousands) of 2 year-olds	2144	834	1679	5216	5216
Source	XSA	XSA	RCT3	GM70-08	GM70-08
Status Quo F:					
% in 2011 landings	20.1	28.2	9.6	3.1	-
% in 2012 landings	11.3	21.6	10.7	19.1	9.7
% in 2011 SSB	17.0	23.1	7.0	7.0	-
% in 2012 SSB	11.5	16.9	8.1	13.0	20.3
% in 2013 SSB	6.6	9.9	5.1	12.9	32.2

GM : geometric mean recruitment

Sole VIIa : Year-class % contribution to

a) 2012 landings **b) 2013 SSB**





XSA 2007 XSA 2008 RCT3 2009 GM70-08 2010 GM70-08 2011

Table 6.8.19 - Sole in VIIa Yield per recruit summary table

MFYPR version 2a
Run: S7A_Y
Time and date: 18:14 12/05/2011
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	10.5083	3.0875	9.5866	2.9458	9.5866	2.9458
0.1000	0.0306	0.2005	0.0590	8.5059	2.4006	7.5869	2.2596	7.5869	2.2596
0.2000	0.0611	0.3310	0.0953	7.2028	1.9572	6.2864	1.8168	6.2864	1.8168
0.3000	0.0917	0.4225	0.1192	6.2901	1.6494	5.3763	1.5095	5.3763	1.5095
0.4000	0.1222	0.4900	0.1355	5.6171	1.4247	4.7059	1.2853	4.7059	1.2853
0.5000	0.1528	0.5417	0.1471	5.1017	1.2543	4.1929	1.1155	4.1929	1.1155
0.6000	0.1833	0.5826	0.1554	4.6952	1.1213	3.7888	0.9830	3.7888	0.9830
0.7000	0.2139	0.6156	0.1616	4.3671	1.0152	3.4629	0.8774	3.4629	0.8774
0.8000	0.2445	0.6429	0.1661	4.0970	0.9288	3.1951	0.7915	3.1951	0.7915
0.9000	0.2750	0.6657	0.1695	3.8712	0.8574	2.9715	0.7205	2.9715	0.7205
1.0000	0.3056	0.6850	0.1721	3.6797	0.7976	2.7822	0.6612	2.7822	0.6612
1.1000	0.3361	0.7017	0.1740	3.5156	0.7469	2.6201	0.6109	2.6201	0.6109
1.2000	0.3667	0.7161	0.1754	3.3734	0.7035	2.4799	0.5679	2.4799	0.5679
1.3000	0.3972	0.7287	0.1764	3.2490	0.6660	2.3576	0.5308	2.3576	0.5308
1.4000	0.4278	0.7399	0.1771	3.1394	0.6333	2.2500	0.4985	2.2500	0.4985
1.5000	0.4584	0.7498	0.1776	3.0422	0.6047	2.1546	0.4703	2.1546	0.4703
1.6000	0.4889	0.7587	0.1779	2.9553	0.5793	2.0696	0.4453	2.0696	0.4453
1.7000	0.5195	0.7667	0.1780	2.8772	0.5569	1.9933	0.4232	1.9933	0.4232
1.8000	0.5500	0.7739	0.1781	2.8067	0.5368	1.9246	0.4035	1.9246	0.4035
1.9000	0.5806	0.7805	0.1781	2.7427	0.5187	1.8623	0.3858	1.8623	0.3858
2.0000	0.6111	0.7866	0.1780	2.6843	0.5024	1.8056	0.3698	1.8056	0.3698

Reference point	F multiplier	Absolute F
Fbar(4-7)	1.0000	0.3056
FMax	1.8056	0.5517
F0.1	0.5769	0.1763
F35%SPR	0.561	0.1714

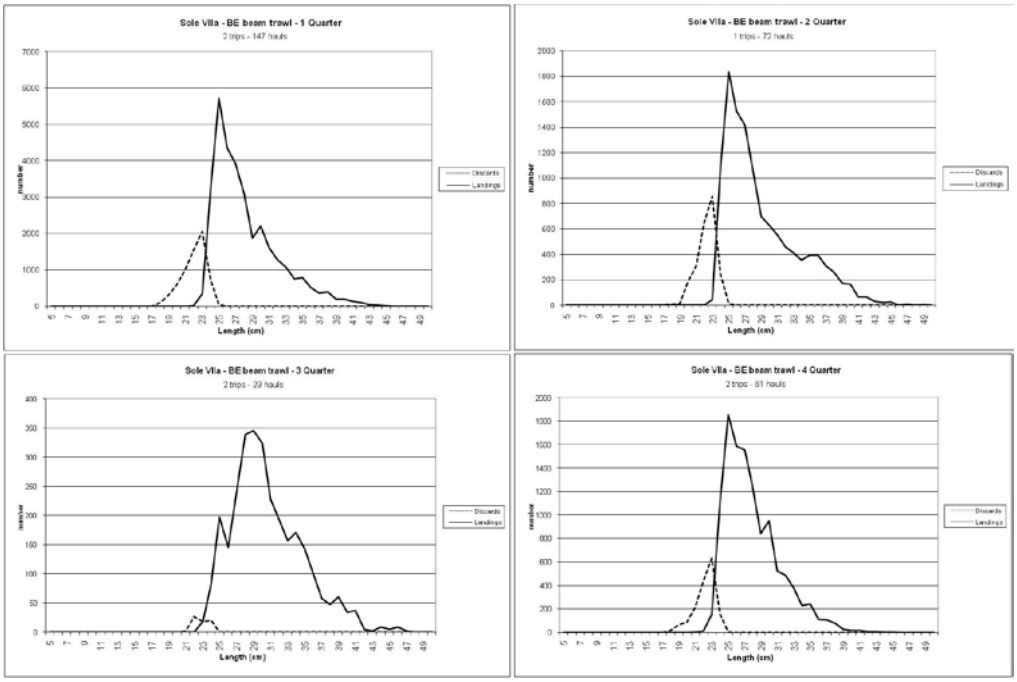


Figure 6.8.1a. Sole VIIa-BE Length distributions of discarded and retained fish from discard sampling studies.

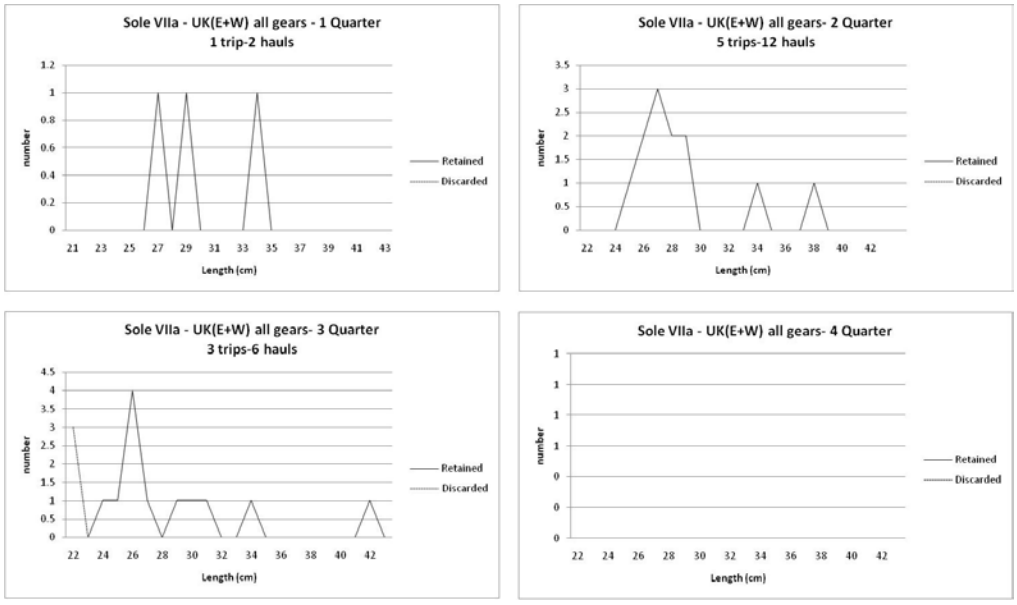


Figure 6.8.1b. Sole VIIa-UK Length distributions of discarded and retained fish from discard sampling studies.

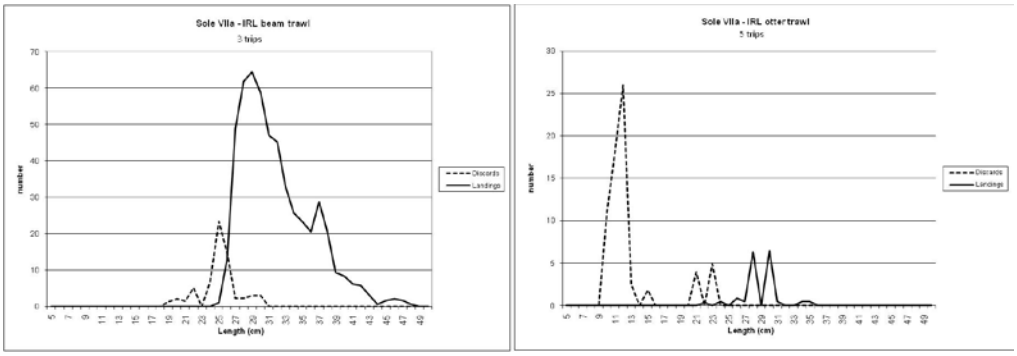


Figure 6.8.1c. Sole VIIa-IRL Length distributions of discarded and retained fish from discard sampling studies.

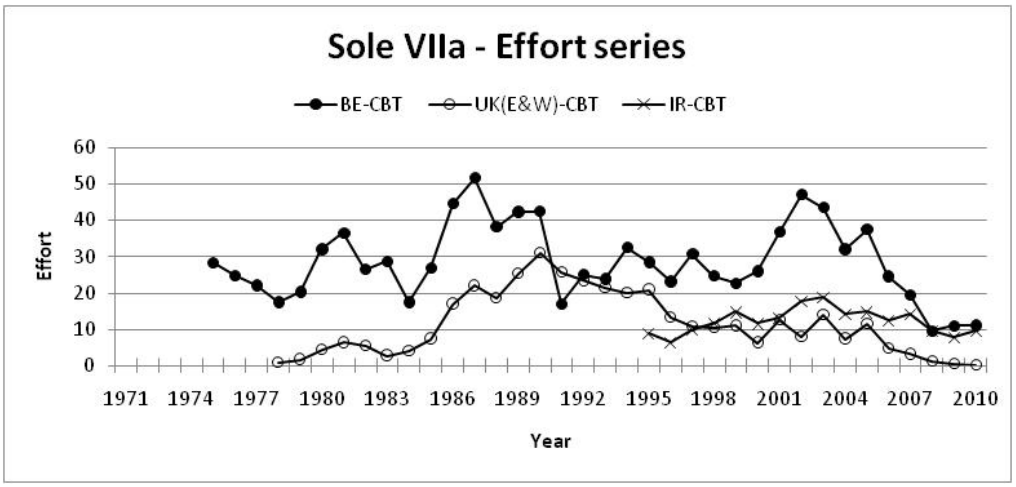


Figure 6.8.2a. Sole in VIIa. Effort series.

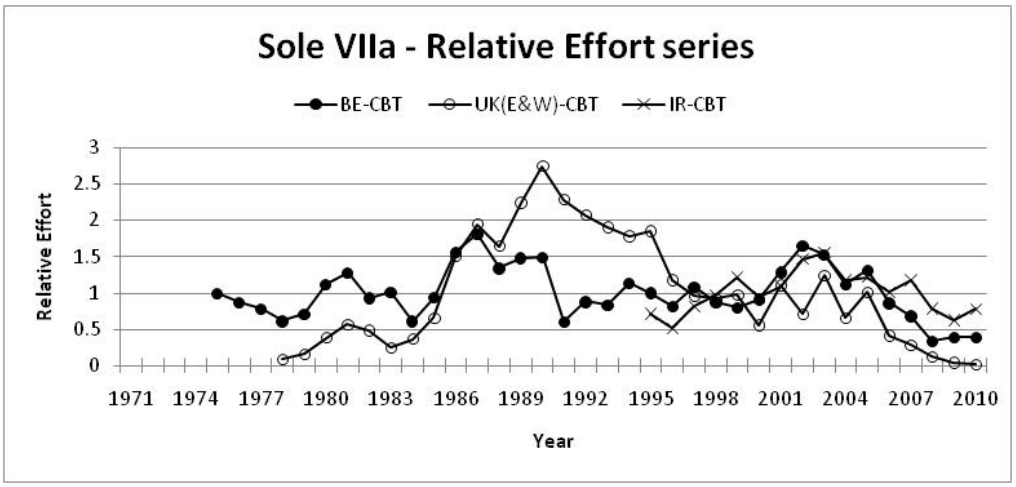


Figure 6.8.2b. Sole in VIIa. Relative effort series.

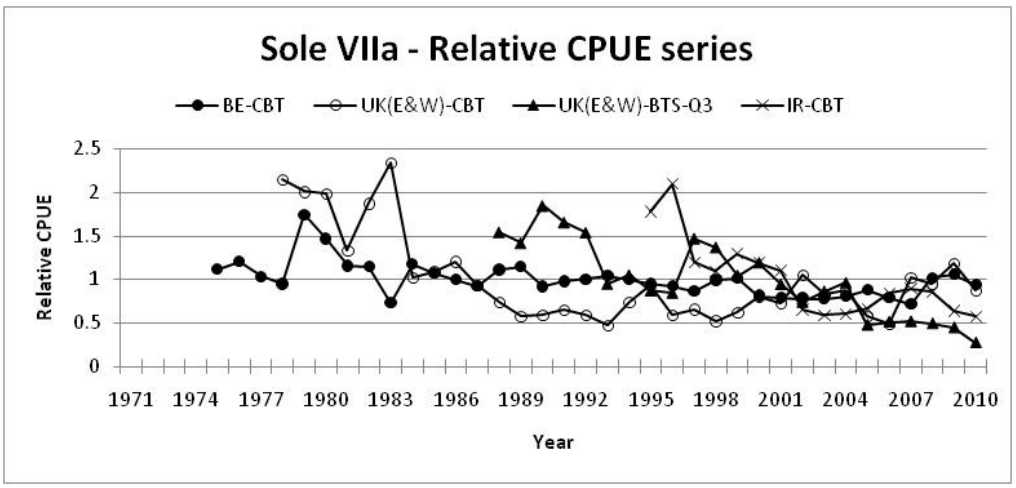


Figure 6.8.2c. Sole in VIIa. Relative cpue series.

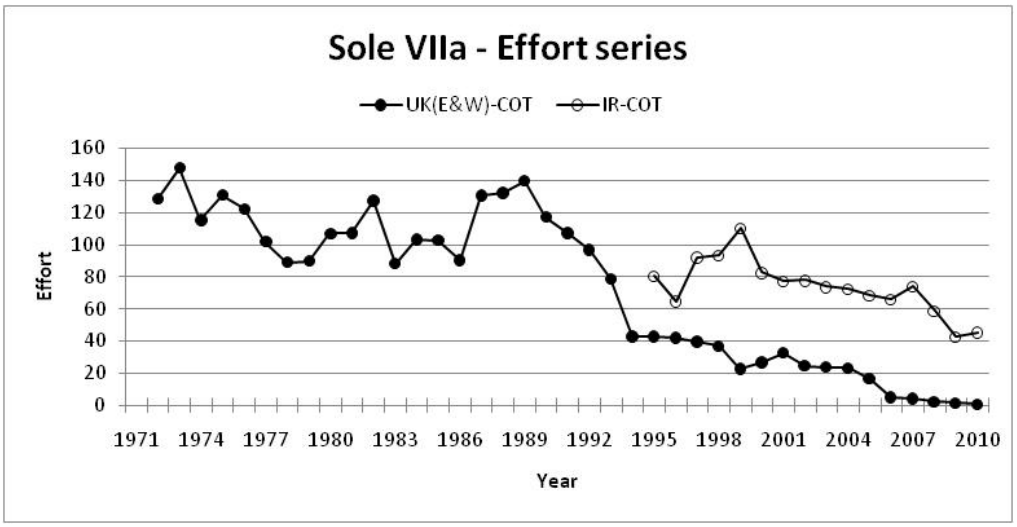


Figure 6.8.3a. Sole in VIIa. Effort series.

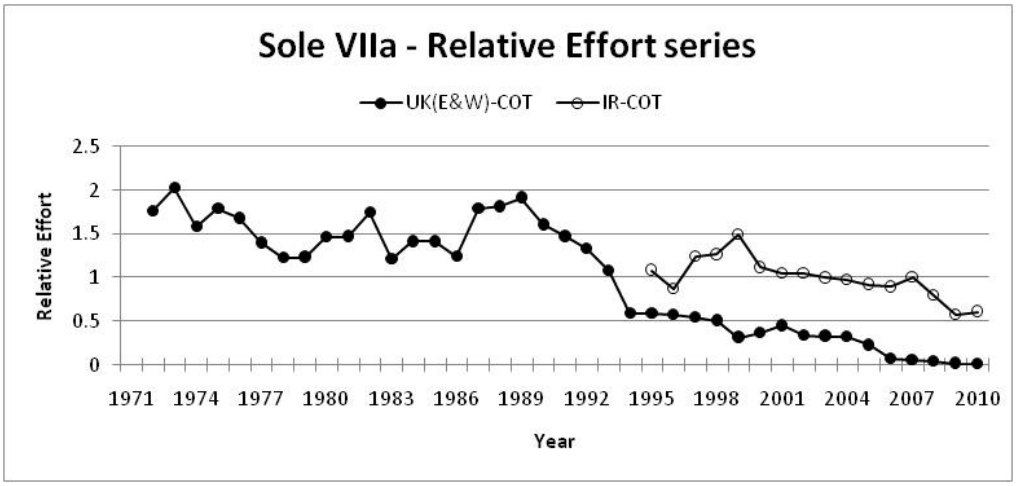


Figure 6.8.3b. Sole in VIIb. Relative effort series.

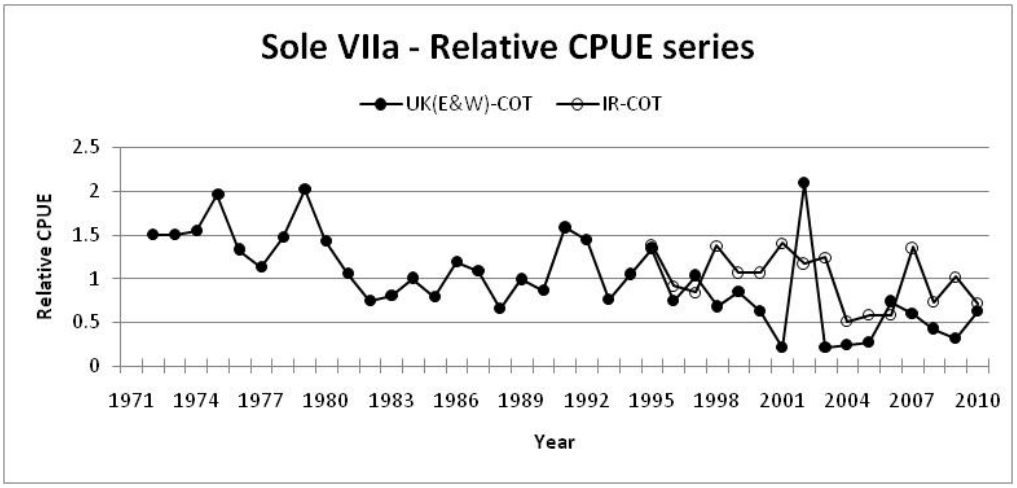


Figure 6.8.3c. Sole in VIIa. Relative cpue series.

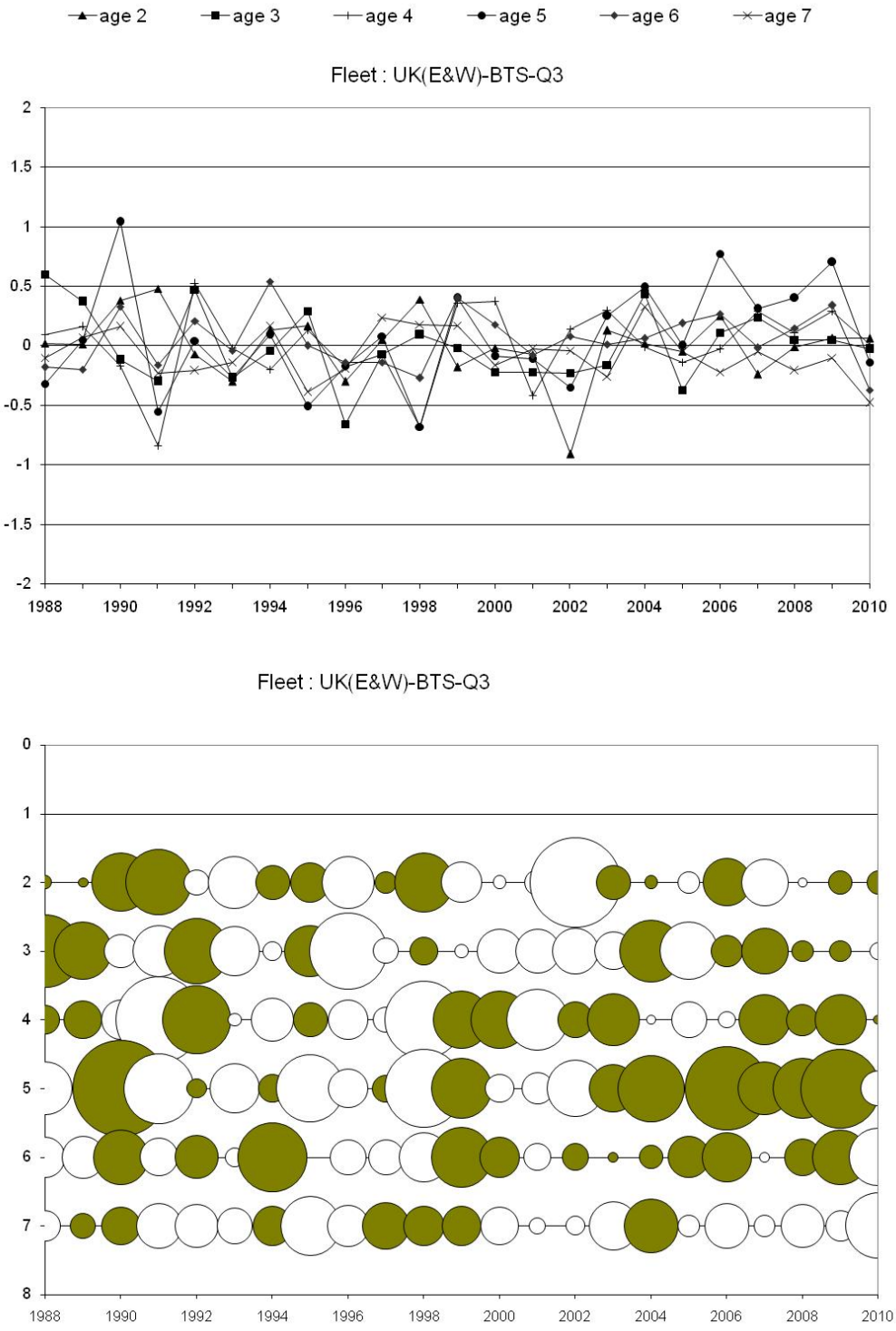


Figure 6.8.4. VIIa Sole log-catchability residual plots. Final XSA.

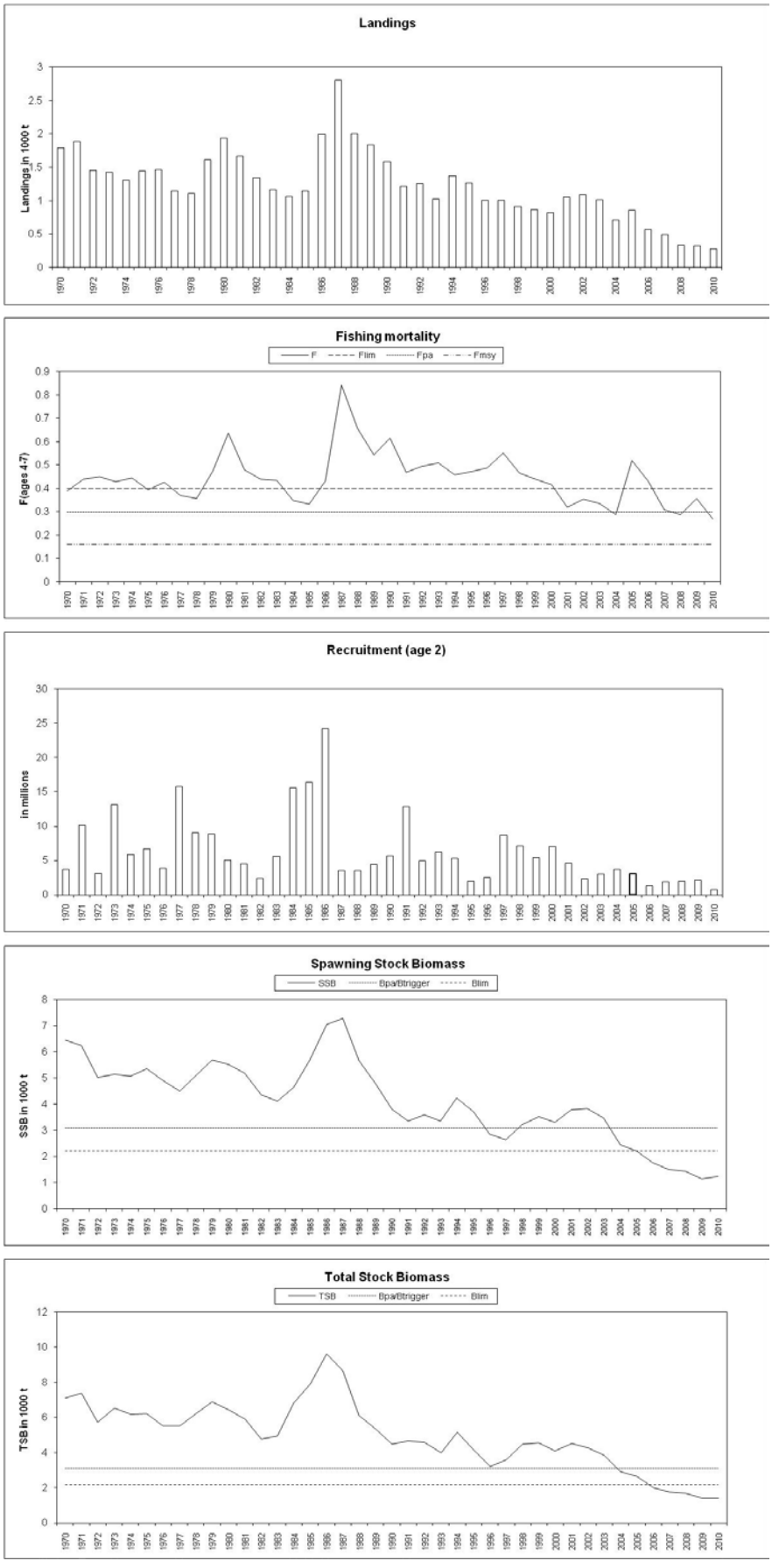


Figure 6.8.5. Sole in VIIa. Summary plots.

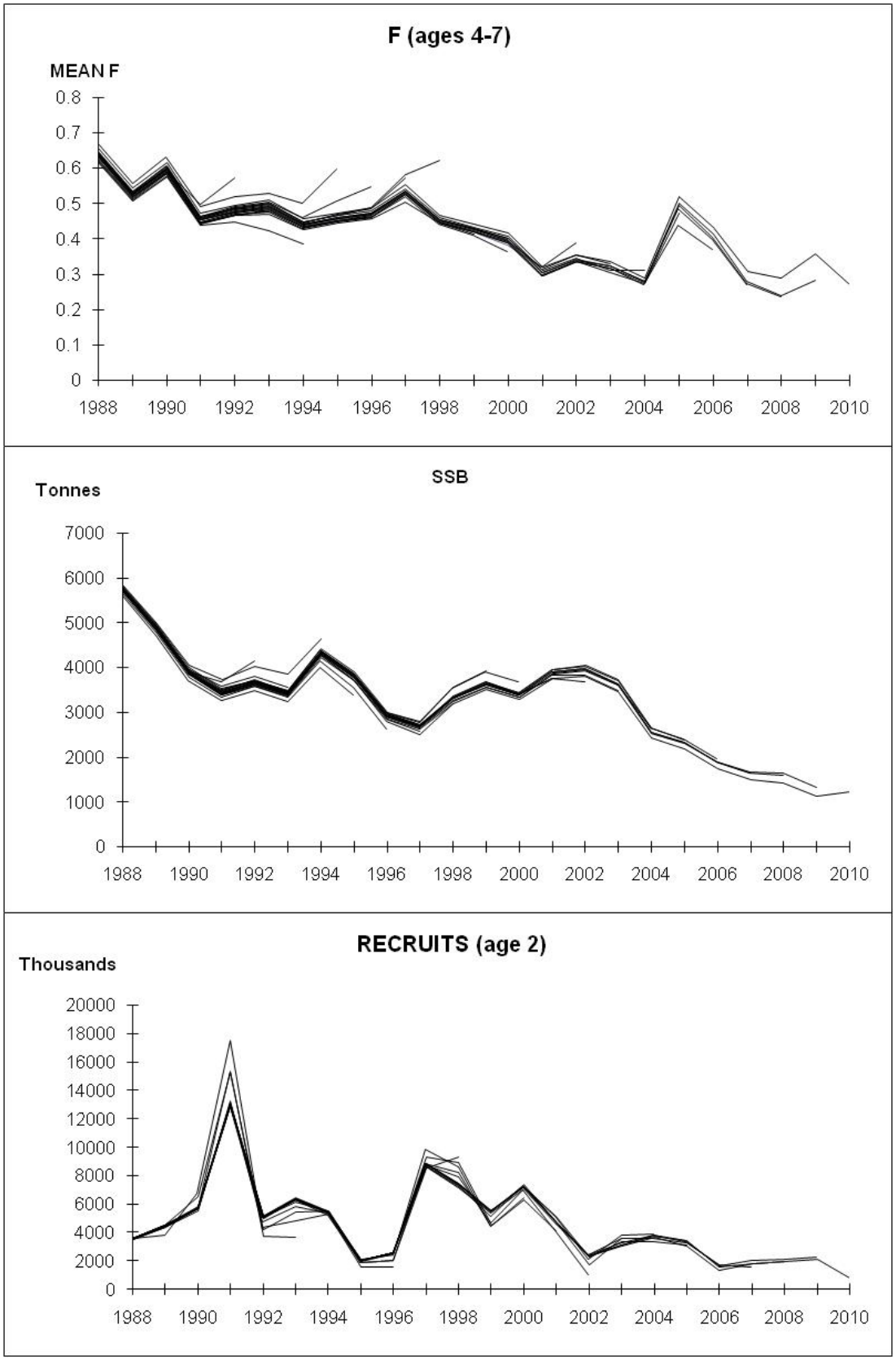


Figure 6.8.6. Sole VIIa retrospective XSA analyses (shrinkage SE=1.5).

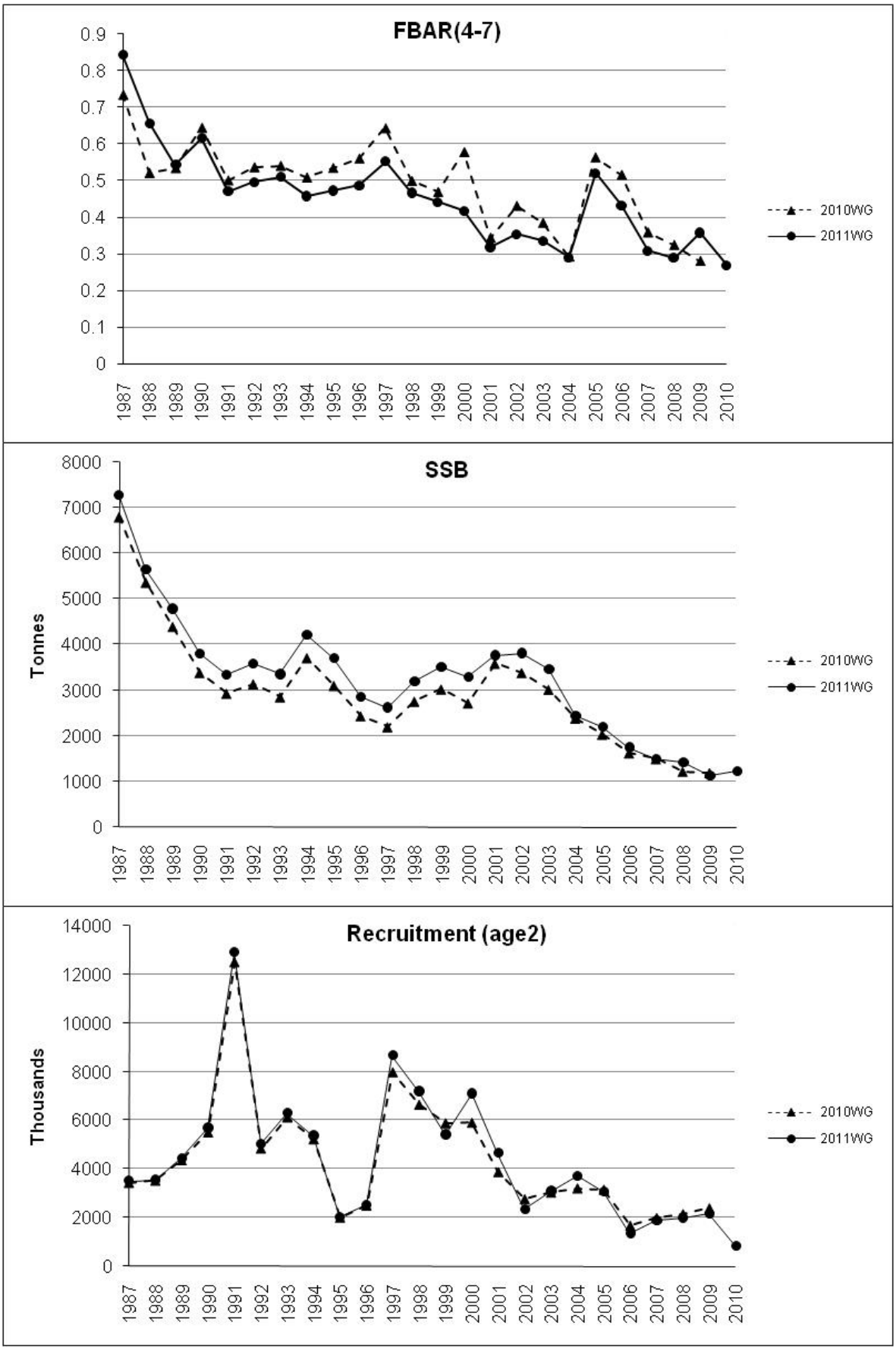
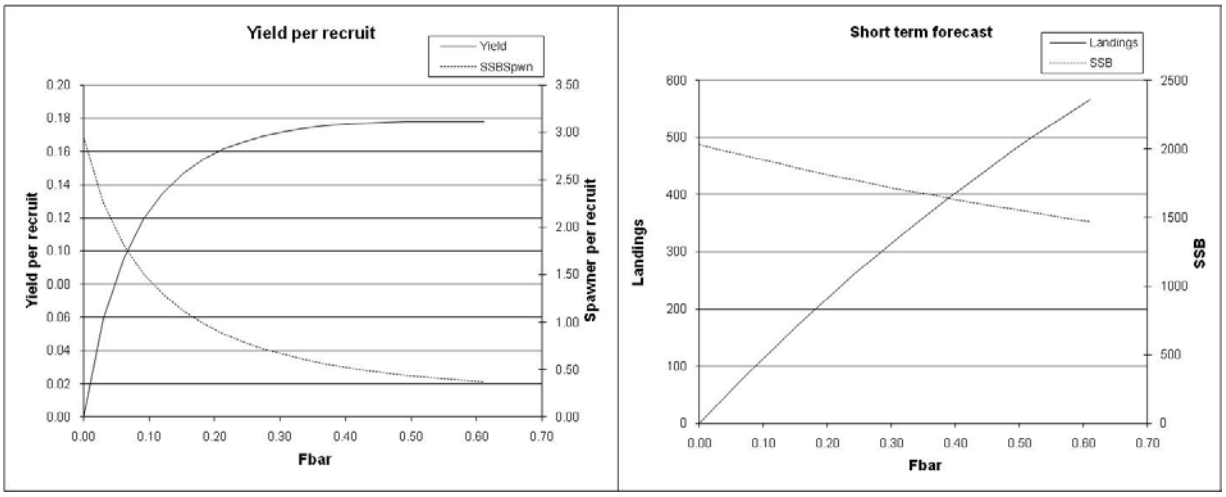


Figure 6.8.7. Sole VIIa comparison with last year's assessment.



MFYPR version 2a
Run: S7A_Y
Time and date: 18:47 12/05/2011

Reference point	F multiplier	Absolute F
Fbar(4-7)	1.0000	0.3056
FMax	1.8056	0.5517
F0.1	0.5769	0.1763
F35%SPR	0.5610	0.1714

MFDP version 1a
Run: Sole7A1
IRISH SEA SOLE,2011 WG
Time and date: 18:47 12/05/2011
Fbar age range: 4-7

Input units are thousands and kg - output in tonnes

Figure 6.8.8. Sole in VIIa. Yield-per-recruit and short-term forecast plots.

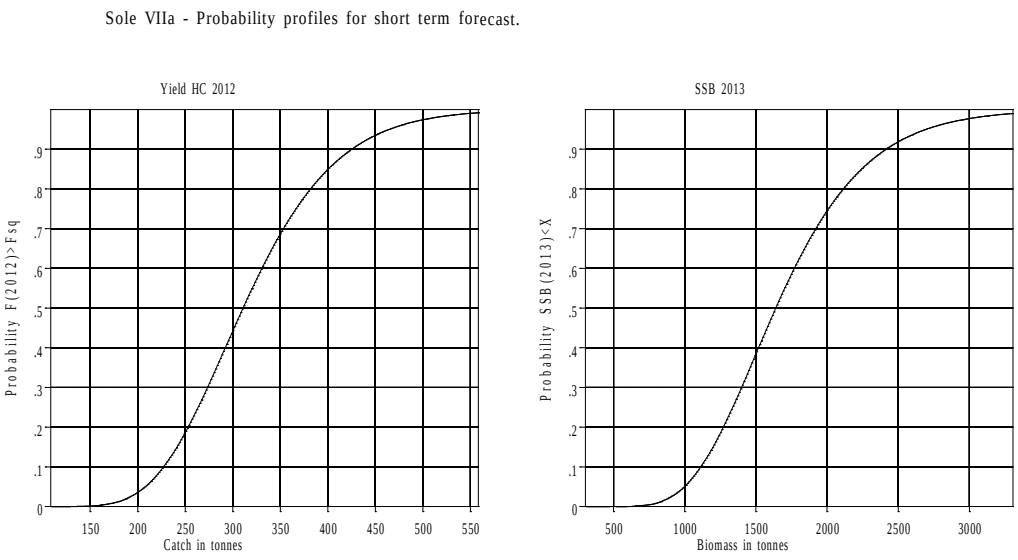


Figure 6.8.9. Sole VIIa-probability profiles for short-term forecast.



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 2010

Trends analysis

For Celtic Sea cod, the Benchmark Workshop WKROUND 2009 concluded that more work was required before this stock could be benchmarked. The Review Group of WGCSE 2009 added that shortcomings of the data and reconstruction of datasets should be completed in order to continue using an aged based assessment in future.

The recommendations made by WKROUND 2009 were:

- Improvement of the quality of assessment input data, of documentation on data correction in the Stock Annex and data integration and fishery description at regional level through a regional database.
- Evaluation of sampling levels by fleet required to get precise discard estimates for stock assessment. The RG concurred with the conclusion drawn by the Benchmark that cooperative projects with industry on self sampling, and reference fleets, etc should be developed to obtain better estimates of discards. Datasets obtained through fishers science partnerships should be used to complement those discard data collected by fishery observers.
- Estimates of "true landings" as reported landings data and landings equivalents since 2003 are thought to be underestimated.
- International coordination on maturity sampling as there is evidence that maturity has changed for this stock. A directed survey might be needed.
- Improvement on knowledge of stock structure and migration behaviour.
- Reduction of noise in the data from the surveys.

Solutions to those recommendations have been suggested by WGCSE in 2010. Some effort to improve the knowledge of this stock is currently done through survey and industry–science partnerships with new data already available which will be scrutinized during next benchmark in 2012. Those initiatives are summarized later in this section.

The Review Group of WGCSE 2010 noted that the specific TOR for VIIe–k cod was in 2010 to perform an update assessment (as opposed to SALY). The WG last year followed the WKROUND advice not to perform an analytical assessment due to catch uncertainties .The Review Group noted that *"this unfortunately precludes any presentation of long-term trends in SSB, F and recruitment other than the separable VPA recruitment series presented, and it is not possible to see if the addition of new data has affected the WKROUND conclusions. This leaves a critical cod stock with very little quantitative advice on stock status."* This year, an exploratory XSA has been carried out. The used data includes the extra years of corrected data for highgrading and misreporting since 2008.

ICES advice applicable to 2010

"ICES advises on the basis of precautionary considerations that fishing effort and catches should be reduced although it is not possible to determine the appropriate scale of such reduction."

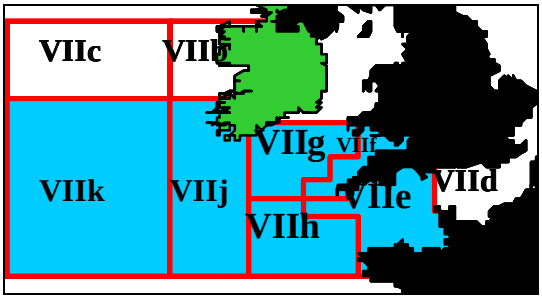
ICES advice applicable to 2011

"ICES advises that catches of cod should be reduced although it is not possible to determine the appropriate scale of such reduction."

7.2.1 General

Stock description and management units

The 2011 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 but 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 since 2009.

TAC 2010

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

TAC 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.

Fishery in 2010

Landings data used by the WG are shown in Table 7.2.1. The French landings have been revised upward for 2009 from 2027 t to 2080 t. French landings data for 2009 were updated and are considered preliminary for 2010 with minor revisions expected for WGCSE 2012. No revision was required for Ireland, UK, Netherlands and Belgium.

International landings have decreased in 2009 and 2010 to around 3200 t after the 2007 peak of 4200 t, which corresponded to approximately half of the average (8200 t) of the time-series. They are now close to their lowest historical values. Since 1988, French landings accounted for ~70% of the international landings and they have declined to around 59% of the total in the last three years. French landings indicate that only 68% of the national quota has been taken. This is mainly related to 1) decommissioning of a substantial number of vessels since 2009; 2) low fish market prices for cod landings which led the vessels to direct their fishing effort towards other demersal species (e.g. haddock).

Irish landings accounted on average at 14% but more recently ~30%. UK and Belgium have contributed on average to 9% and 2%.

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 table below.

Year	2004	2005	2006	2007	2008	2009	2010
Mis alloc (t)	108	54	103	527	558	193	143

French landings have been corrected with highgrading estimates from 2003 to 2005. The method used to estimate the highgraded component is described in WD#1 of the WG SSDS 2006. For smaller length classes, a scaling of French numbers-at-length based on UK length frequencies or UK number-at-length has been used to estimate length compositions of the French component of highgrading. The accuracy of this method is unknown but it probably underestimates the highgrading levels for those years. Unfortunately, the sampling level of total catch at sea in that period was too poor to get an estimate of the level of bias.

This method was not applied from 2006 onward because highgrading was also observed in the UK landings. Instead, self sampling data obtained in 2008–2009 have been used to estimate the French highgrading level, assuming that the discarding practices in 2006–2007 were the same as those observed in 2008 for the main self-sampled fleet. Applying this method back to 2003 was considered inappropriate. The representatives of Fishermen Organisations at WKROUND 2009 indicated that the discarding level was probably not the same in earlier years as highgrading practices are linked to the level of the TAC. The whole method has been described in the WD#17 of WKROUND 2009.

The estimates of highgrading by year are slightly revised when annual landings statistics are updated. In 2011, the time-series of estimates is:

Year	2003	2004	2005	2006	2007	2008	2009	2010
HG (t)	210	148	74	432	592	322	25	7

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.

Both assumed Irish area misreporting and French highgrading estimates since 2003 in percentages of the landings are summarized in the table below:

Year	2003	2004	2005	2006	2007	2008	2009	2010
%	3	7	4	14	23	22	7	5

Highgrading also occurred in the UK catches in 2007–2008 but given the low level of landings, it has not been estimated.

The MLS of the Belgian landings is currently set at 50 cm since 2008.

Fishery–science partnerships

French self-sampling programme

In 2009, the French self-sampling programme has been 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 have partici-

pated, 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 have participated. 38 trips were sampled in 2008, 86 in 2009 and 43 in 2010; summarized in the text tables below. 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 programme 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
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	

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. 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.

Retained and discarded part of the catch will 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, 12381 cod have been measured, 9709 in the retained part and 2672 in the discarded part of the catch.

Since 2010, sampling data are provided by the Professional Organization (P.M.A) in a database currently located at Ifremer/Lorient.

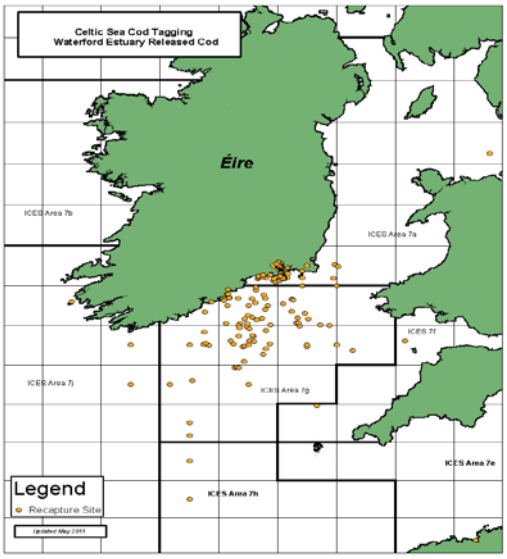
Motivation of the crew or the vessel owners could remain a problem in future. The reasons are that 1) the effort of the industry to provide more biological data is not linked with incentives in setting TAC and quotas, 2) there has been in 2009 and after a pragmatic fit between the quota set and the fleet 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 was presented to 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 & 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 fishers 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 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 ICES Study Group on Survey Trawl Standardization (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 (Figure 7.2.1).

The first of such surveys was carried out by the Marine Institute from 14–23 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 average catch rates for the entire survey area were 30.1 cod per km^2 and 25.3 kg per km^2. There was no significant difference in catch rates between the random scientific stations and the stations selected by industry. Catches were dominated by small, young individuals and 80% were one year old. Higher catches were found inside the Celtic Sea Conservation Area although there was no difference found in the maturity pattern. Growth rate in the survey area was rapid and higher than for other cod stocks. The combination of good recruitment and fast growth provides an opportunity for high yields to be taken by the fishing industry in this area.

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

Tables 7.2.2 and 7.2.3 show the annual length structure of the landings per métier and country and the catch numbers-at-age respectively.

It is noticeable that this stock has always been composed of a few age classes. The catch number-at-age table (Table 7.2.3) 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 fish. This is the strongest recruitment since 2000. Age 2 represented 30% of the total number of landed fish.

Discards

Table 7.2.4 and Figure 7.2.2a–d show the length structure of landings and discards per country and quarter with a split by métier for France. French information is split into self-sampling (Figure 7.2.2d) and on-board observer programmes. It is noticeable that the majority of the cod discarded result from the highgrading behaviour, for

France and UK. Discarding of undersized individuals is at low level for all countries. Comparisons with last year's report show the landings/discards pattern is strongly variable between fleets and years. This year, discards for the French fleets have substantially changed from last year. In 2009, age 1 individuals (30–45 cm) were mainly discarded. In 2010, most of them were landed. Discards in UK and Irish fleets were substantial for age 1 individuals and shows well the 2009 year class. The discard pattern in 2010 has not changed from 2009 with most individuals below 40–45 cm being discarded. 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.

Biological

Catch in numbers-at-age (Figure 7.2.3) and stock weights are given respectively in Tables 7.2.5 and 7.2.6. The final year estimates are consistent with the recent historical values.

Natural mortality, percentage of F before spawning and maturity ogive 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

Tables 7.2.7 present the survey dataseries.

Internal consistency of the two ongoing surveys both part of DCF IBTS Q4 (FR-EVHOE & IR-GFS7gj combined) has been explored using SURBA software. The number of fish sampled during those surveys remains low as those species are not specifically targeted. The raw abundance indices (number of individuals caught per 30 minutes tow) of FR-EVHOE have been provided to the WG. WGCSE in 2010 estimated that indices have an average CV of around 25% and have changed since 2002 within the confidence intervals.

Figure 7.2.4a summarizes the single fleet analysis for FR-EVHOE. The tracking of recruitment is well defined for the relatively good YC 1996, 1999 and 2000, and poor YC 2001 and 2002, especially at age 1. The weakness seems to be in-between year consistency especially for the older ages. The log residuals show a low level of noise, resulting from the recurrent low catch rates.

Figure 7.2.4b represents the single fleet analysis for IR-GFS7gj. The short time-series prevents conclusions on the consistency, but the tracking of recent year classes is consistent with FR-EVHOE except for the 2007 YC.

For both surveys, year class 2009 provides a strong signal indicating a strong recruitment.

Figure 7.2.4c represents SURBA model estimates of mean Z for the three single fleets. Each time-series of Z fluctuates within the magnitude of the uncertainty, resulting in non-robust general trends. Moreover, SURBA is known to provide poor estimates of parameters for the most recent years. As a result, no clear trend can be seen from the surveys.

Overall, no clear trend of change in mortality can be derived from any of the survey indices.

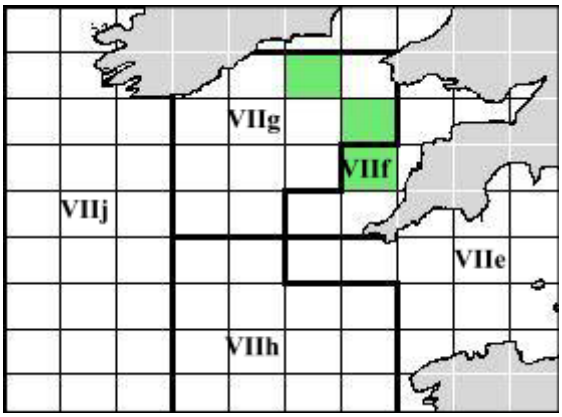
Figure 7.2.4d represents SURBA model estimates for recruitment for both separate and combined surveys. All indices suggest a strong recruitment for year class 2009.

Commercial cpue

Tables 7.2.8a, 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. French catch and effort data for 2009 were not available at the time of the meeting. 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.

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 has been 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: None.

No analytical assessment was carried out on this stock in 2008 and 2009, following the recommendations from WKROUND 2009 and the lack of revision of the available datasets.

An exploratory analysis on the MSY approach was performed last year following the guidelines defined during WKFRAME using the YPR software (http://nft.nefsc.noaa.gov/). YPR has been used to explore the expected yield under equilibrium conditions, of growth, maturity and natural mortality, for a given or assumed fishery pattern, across a range of exploitation levels. With a natural mortality of M=0.2, assuming a fishing mortality between 0.82 and 0.85, the fishing mortality appeared twice above the value of F_{max} and three times the value of $F_{0.1}$ and $F_{40\%}$. These F_{max} and $F_{0.1}$ estimates are very much in line with those obtained from historical XSA

assessments for this stock (see previous WGSSDS reports). Fishing mortality from historical XSA assessments have been well above $F_{max.}$ and in line with those obtained here.

Exploratory XSA

This year, following the recommendations of the Review Group of WGCSE 2010, considering better estimates of misreporting and highgrading that have been made available to the Working Group since WKROUND 2009, an exploratory assessment using XSA has been carried out based on revised landings to include misreporting and highgrading.

The model parameters used prior its abandon at WKROUND 2009 were reused as follow:

Catch data range		1971–2010
Age range		1–7+
Commercial tuning-series		
	FR GADOIDSQ2+3+4	1983–2008
	FR-*NEPHROPS*	1987–2008
	UK-WECOT	1989–2010
	IR-7JG-OT combined	1995–2008
Scientific Surveys		
	UK-WCGFS	1992–2004
	FR-EVHOE	1997–2010
	IR-GFSgj	2003–2010
Taper	No	
Age s catch dep. Stock size	None	
q plateau	5	
F shrinkage se	1	
Year range	5	
age range	3	
age range of mean F	2–5	

The tuning indices used are in Table 7.2.9. Diagnostics tables are in Tables 7.2.10–7.2.13.

Summary plots (Figure 7.2.9) from the exploratory XSA show that fishing mortality has declined since 2005 to levels close to those around the years 1985–1990. This pattern is consistent with the overall observed decrease of fishing effort in recent years. Recruitment is the highest since 1987. This also consistent with the strong recruitment of year class 2009 observed by surveys and samplings at sea and at fish market. SSB seems to have increased since 2005 and appears to be at stable levels around the period 2007–2010. These results should be considered with caution considering this analysis does not include discards which have been variable between years and fleets.

In summary, this exploratory analysis suggests that F has decreased, SSB is stable and recruitment is high. This is consistent at least for F and recruitment with the available information.

Diagnostics show for survivors at age 1 that signals are rather similar between the French and Irish surveys. FR-EVHOE has higher standard errors than IR-GFS. Both surveys contribute explains 67% of the signal. Indices from UK-WECOT and IR-7GJ-OTB are rather consistent although those indices are based from distinct areas (respectively VIIe and VIIgj).

Diagnostics show for survivors at age 2 that the signal is equally driven by surveys and commercial indices. Indices from both surveys are again rather similar. Commercial indices have more differences between them.

For older ages, the signal is less driven by surveys than by commercial indices. UK-WECOT and IR-7GJ-OTB mainly drive the assessment. The weight of the French Fleet is lower due to the constraints at quarter 1 with the closure of the Trevose Box. They however gain more relative weight for ages 5 and 6.

The assessment appears to be driven at low ages by surveys (with a large number of young fish) and at higher ages by commercial indices which target bigger fish. Survey do not specifically target cod and especially older cod therefore the number of older individuals is rather lower adding noises to the assessment for older ages (3+ years and old fish). Another exploratory assessment has been made based only on FR-EVHOE and IR-GFSgj surveys (Figure 7.2.10 and Table 7.2.14). The outputs are similar to the previous assessment. This highlights that the assessment is mostly driven by the survey indices. Considering that older fish are rarely caught during surveys, some further development (e.g. for the benchmark in 2012) may include combining lower age indices from surveys to higher age class from commercial fleets.

A retrospective analysis has been carried out back to 2001 (Figure 7.2.11) with a limited set of indices excluding fleets with too short time-series. The following fleets were kept:

- FR-GADOIDQ2+3+4
- FR-*NEPHROPS*
- UK-WECOT(E+W)
- IR-7J-OT
- UK-WCGFS
- FR-EVHOE

Recruitment and spawning-stock biomass tend to be slightly underestimated. F_{bar} (2–5) is slightly overestimated. The differences might be attributed with the uncertainties regarding the changes in discards practices. Overall, retrospective pattern does not appear to be substantial and the trends observed appear similar to those observed in past assessment (e.g. WGSSDS, 2008).

7.2.3 Short-term projections

No short-term projections were carried out.

7.2.4 Medium-term projection

No medium-term projections were carried out.

7.2.5 Biological reference points

WKROUND 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. The biological reference points are then recalled below:

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)

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 assessment of this stock is impaired by a strong uncertainty in the level of catches, especially since the TAC became constraining from 2003 onward. For this reason, and until a more reliable information is available, WKROUND 2009 concluded that the current assessment procedure treating catch numbers as unbiased was no longer appropriate. Surveys lack robust trends mainly due to their low catch rates.

7.2.8 Recommendation for next benchmark

This stock should be benchmarked with the other WGCSE cod stocks in January 2012.

Cod VIIe–k	WKROUND 2009 concluded that more work is required before Celtic Sea cod can be benchmarked successfully. WGCSE 2010 reviewed the available infromation and several improvements have occurred since WKROUND. There is now a time-series of self-sampling highgrading estimates. Discard and misreporting rates appear to have changed between years and fleets. Historical time-series of discards are required in order to include discards into the assessment. There is evidence from sampling on the Irish "biological survey" that maturity has changed for this stock. WKROUND 2009 found that the use of new estimates increase SSB by up to 20% which is significant and warrants future sampling to obtain improved estimates of maturity-at age. If new information is available for the next benchmark (e.g from the Irish Celtic Sea cod survey), the use of new ogive should be investigated.	Expert Group members

	WKROUND 2009 considered the use of other models than XSA (B-Adapt, SAMS). Due to time constraints and lack of data, analysis have been preliminary during WKROUND. Further work is needed to investigate the suitability of those models and to identify the proper settings to use for assessment.	Modelling experts
	There is a growing body of new tagging information (e.g. Irish tagging studies) that may prove useful to assess stock structure and possible mortality rate.	Tagging experts
	There is a new dedicated survey for the stock that need to be considered and the two other IBTS survey-series should be examined to see if a combined index might be possible.	Survey experts
	Ultimately the Benchmark should aim to develop an assessment and advice framework for the provision of MSY and precautionary advice form the information available.	

7.2.9 Management considerations

Fishing mortality from historical assessments have been well above potential F_{msy} proxies for this stock. It is not possible to determine current fishing mortality rates due uncertain catch-at-age data and surveys. This was also the case last year when ICES advised "that fishing effort and catches should be reduced although it is not possible to determine the appropriate scale of such reduction".

The geographical range of the stock appears to have contracted significantly according to the international landings and lpue distribution maps. 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 in recent years has been poor except for the strong year class 2009 which represented 40% of landings in number in 2010. 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.

In the recent past 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 is 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 five 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.

7.2.10 References

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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 based on UK data		WKROUND 2009 HG based on 2008 FR self sampling data		WGCSE 2011 HG based on 2009–2010 FR self sampling data	
1999	326	5488	1883	897	0	8594						
2000	208	4281	1302	744	0	6535						
2001	347	6033	1091	838	0	8309						
2002	555	7368	694	618	0	9235	**HG FR**	**Total**	**HG FR**	**Total**	**HG FR**	**Total**
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

(*) provisional for 2010.

Scaled landings 1971–1987 (SSDS WG 1999).

Table 7.2.2. Cod in Divisions VIIe–k. 2010 Landings in numbers-at-length (cm).

	France VIIe–k	France VIIe–k	France VIIe–k	UK VII e–k	UK VII e–k	Ireland
	Otter Trawl *Nephrops*	Otter Trawl Demersal fish	Miscellaneous gear	Beam trawl	All bar beam trawl	VIIg,j
Length	FR-Otter Trawl *Neph* VIIek	FR-Otter Trawl Demersal VIIek	FR-Misc gear VIIek	UK Beam Trawl VIIek	UK Bar Beam Trawl VIIek	IRL VIIek (all gear)
24						
25						
26	4	112				148
27		224				148
28		336			126	0
29		673				296
30	13	730	10			1144
31		224			126	1400
32		271				3871
33	5	575				5043
34	17	722	26		832	3804
35	1354	9119	26	5	738	9574
36	1466	13383	52	24	3551	12304
37	1408	16687	52	75	3542	16047
38	1280	19628	78	55	6747	14130
39	1107	18399	208	174	5767	14231
40	981	18352	208	152	6052	15819
41	891	23547	182	222	3620	13486
42	842	26279	796	272	6747	13091
43	545	25844	443	372	1441	12417
44	551	20378	234	597	4448	13716
45	465	25025	629	535	1087	11874
46	469	17737	189	745	1069	13277
47	481	17451	52	678	977	12151
48	436	14856	376	687	1860	10938
49	529	11465		923	2064	9865
50	553	12873	375	954	2254	9895
51	566	11853	1583	1077	1772	7593
52	403	11532	596	782	823	9214
53	659	10482	122	522	2244	9795
54	558	10130	685	563	569	8892
55	547	7461	23	624	525	7960
56	570	10473	632	466	472	8147
57	463	8027	214	412	463	8138
58	650	13548	122	1100	663	5698
59	528	10283	302	411	611	6996

	France VIIe–k	**France VIIe–k**	**France VIIe–k**	**UK VII e–k**	**UK VII e–k**	**Ireland**
	Otter Trawl *Nephrops*	Otter Trawl Demersal fish	Miscellaneous gear	Beam trawl	All bar beam trawl	VIIg,j
Length	FR-Otter Trawl *Neph* VIIek	FR-Otter Trawl Demersal VIIek	FR-Misc gear VIIek	UK Beam Trawl VIIek	UK Bar Beam Trawl VIIek	IRL VIIek (all gear)
60	569	9761	435	403	571	7802
61	599	12771	223	331	583	5051
62	548	8323	175	313	558	5223
63	447	10644	493	346	457	4474
64	419	9890	124	465	565	5777
65	346	7397	364	397	740	3345
66	370	10806	234	292	616	4086
67	319	7996	122	256	1024	3566
68	220	7551	74	266	661	3285
69	199	5798	428	143	827	3790
70	207	7599	301	281	957	3050
71	309	6642	9	212	609	3693
72	293	4980	196	209	702	2464
73	191	4237	252	294	804	3276
74	208	8600	233	257	539	2453
75	134	4191	174	122	662	2534
76	467	6086	76	288	558	2144
77	346	6480	268	273	654	2772
78	301	4316	340	268	618	2618
79	214	4633	709	185	746	3414
80	189	4547	257	170	1069	1649
81	151	5385	438	263	828	2296
82	248	3792	650	201	1304	2898
83	226	2576	177	211	857	2461
84	303	5754	363	181	1143	2429
85	262	5216	549	169	586	3278
86	160	4732	583	148	726	2073
87	157	3806	23	124	561	2004
88	337	5151	724	207	996	2677
89	316	4760	529	211	446	2513
90	142	4406	56	109	487	2303
91	333	3736	61	80	651	2096
92	180	4025	464	124	697	2019
93	194	2723	353	85	371	1954
94	91	2834	79	59	350	2098
95	175	2425	33	99	277	1374
96	136	2489	55	85	237	1309
97	160	1667		59	279	1591

	France VIIe–k	**France VIIe–k**	**France VIIe–k**	**UK VII e–k**	**UK VII e–k**	**Ireland**
	Otter Trawl *Nephrops*	Otter Trawl Demersal fish	Miscellaneous gear	Beam trawl	All bar beam trawl	VIIg,j
Length	FR-Otter Trawl *Neph* VIIek	FR-Otter Trawl Demersal VIIek	FR-Misc gear VIIek	UK Beam Trawl VIIek	UK Bar Beam Trawl VIIek	IRL VIIek (all gear)
98	116	3472	33	34	172	1079
99	89	962	28	60	244	1407
100	105	1499		39	99	1240
101	181	1442		44	40	744
102	90	2351	334	28	78	401
103	17	1086	259	34	66	437
104	160	743		34	112	274
105	108	774		45		230
106	24	658		18	24	265
107	7	633	56	24	27	80
108	9	489		35	30	66
109		1324	33	18		168
110	8	981		4	14	0
111		282		0	9	0
112	14	43		0	9	0
113	14	34		4	2	88
114	5			0		0
115	2	280		0		26
116				8		32
117	8					
118						
119						
120	2					
121						
122						
123						
124						
125						
Total	29 765	624 456	19 586	21 041	87 431	411 477
Tw	83.7	1691.0	78.3	65.663	207.569	1034
Mean length	57.6	574.1	9898.6	61.1	694.3	54.5
Mean Weight	2.812	2.708	3.998	3.121	2.374	2.513

Table 7.2.3. Cod in Divisions VIIe–k (Celtic Sea). Catch numbers-at-age. Area reallocation (IRL 2004 to 2010) and highgrading (FR 2003–2010) included.

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Run title : Cod in Divisions VIIe-k,WGCSE11,index file
At  5/05/2011  15:18

   Table  1    Catch numbers-at-age                          Numbers*10**-3
   YEAR,       1971,    1972,    1973,    1974,    1975,    1976,    1977,    1978,    1979,    1980,

   AGE
     1,          725,       4,     332,       1,     673,      51,      25,     197,     438,     609,
     2,          461,     774,     239,     224,     136,    1456,     416,     497,     357,    1213,
     3,          557,     110,     346,      40,     185,      61,     236,     129,     263,     285,
     4,           96,     205,      60,     118,      61,     107,      15,     116,      68,     175,
     5,           35,      45,      74,      38,     105,      11,      60,      20,     104,      52,
     6,           17,      26,      17,      37,      20,      22,       2,      34,      19,      55,
   +gp,           11,      17,      11,      36,      33,       7,      17,      20,      32,      14,
0  TOTALNUM,    1902,    1181,    1079,     494,    1213,    1715,     771,    1013,    1281,    2403,
   TONSLAND,    5782,    4737,    4015,    2898,    3993,    4818,    3059,    3647,    4650,    7243,
   SOPCOF %,     100,     100,     100,     100,     100,     100,     100,     100,     100,     100,


   Table  1    Catch numbers-at-age                          Numbers*10**-3
   YEAR,       1981,    1982,    1983,    1984,    1985,    1986,    1987,    1988,    1989,    1990,

   AGE
     1,          315,      76,    1285,     737,     726,     651,    2741,    1830,     666,     360,
     2,         3086,    1157,     529,    1210,    1245,    1303,     946,    5443,    2639,     846,
     3,          811,     888,     540,     134,     465,     673,     448,     320,    2483,    1006,
     4,          153,     169,     424,      97,      61,     254,     250,     133,     149,     663,
     5,           41,      36,      77,      94,      40,      30,      62,      46,      77,      79,
     6,           20,      19,      21,      22,      47,      31,      20,      21,      18,      21,
   +gp,           12,       5,      11,       5,      15,      17,      15,       8,      11,      16,
0  TOTALNUM,    4438,    2350,    2887,    2299,    2599,    2959,    4482,    7801,    6043,    2991,
   TONSLAND,   10597,    8766,    9641,    6631,    8317,   10475,   10228,   17191,   19809,   12749,
   SOPCOF %,     100,     101,     100,     100,     101,     100,      98,     100,     100,      99,


   Table  1    Catch numbers-at-age                          Numbers*10**-3
   YEAR,       1991,    1992,    1993,    1994,    1995,    1996,    1997,    1998,    1999,    2000,

   AGE
     1,         1377,    1434,     274,    1340,     823,     617,    1184,     639,     496,    1693,
     2,         1034,    2601,    2371,     692,    3320,    2248,    1870,    2545,    1141,     464,
     3,          229,     329,     928,    1199,     310,    1199,     951,     641,     756,     419,
     4,          330,      64,      79,     258,     284,     134,     297,     254,     158,     169,
     5,          203,      70,      24,      27,      73,      95,      48,      99,      59,      44,
     6,           48,      53,      19,      10,      13,      43,      22,      36,      36,      17,
   +gp,           14,      17,      16,      17,       5,       4,       6,       8,      14,      14,
0  TOTALNUM,    3235,    4568,    3711,    3543,    4828,    4340,    4378,    4222,    2660,    2820,
   TONSLAND,    9336,    9747,   10425,   10620,   11709,   12681,   12035,   11431,    8594,    6536,
   SOPCOF %,     100,     100,     100,     100,     100,     100,     100,     100,     100,     100,


   Table  1    Catch numbers-at-age                          Numbers*10**-3
   YEAR,       2001,    2002,    2003,    2004,    2005,    2006,    2007,    2008,    2009,    2010,

   AGE
     1,         1091,     210,     103,     341,     295,     368,     491,     123,     161,     532,
     2,         2373,    2069,     556,     298,     664,     994,    1245,     769,     281,     434,
     3,          136,     883,     827,     175,     138,     249,     409,     312,     324,     122,
     4,           98,      64,     217,     168,      52,      25,      60,     101,      96,      91,
     5,           70,      33,      15,      59,      45,      14,       9,      24,      37,      42,
     6,           19,      12,       9,       8,      11,      13,       4,       4,      10,       9,
   +gp,           19,      11,       7,       7,       2,       5,       4,       4,       2,       2,
0  TOTALNUM,    3806,    3282,    1734,    1056,    1207,    1668,    2222,    1337,     911,    1313,
   TONSLAND,    8308,    9236,    6420,    3672,    3062,    3776,    4830,    3961,    3292,    3229,
   SOPCOF %,     100,     100,     100,     100,     100,     100,     100,     100,     100,      77,
1
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Table 7.2.4a. Cod in Divisions VIIe–k. Length structure of landings and discards from sampling by UK.

UK - Sampled data raised to trips sampled.

Length	Q1	Q1	Q2	Q2	Q3	Q3	Q4	Q4
(cm)	Retained	Discarded	Retained	Discarded	Retained	Discarded	Retained	Discarded
15	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0
18	0	0	0	4	0	0	0	0
19	0	0	0	2	0	0	0	0
20	0	14	0	20	0	0	0	0
21	0	4	0	37	0	0	0	0
22	0	28	0	66	0	0	0	0
23	0	31	0	49	0	1	0	0
24	0	48	0	79	0	1	0	0
25	0	42	0	69	0	10	0	0
26	0	63	0	48	0	6	0	0
27	0	84	0	62	0	15	0	5
28	0	36	0	63	0	3	0	9
29	0	41	0	62	0	43	0	11
30	0	39	0	33	0	28	0	10
31	1	53	0	20	0	13	0	25
32	0	19	0	13	0	56	0	35
33	0	10	0	16	0	30	0	41
34	0	6	1	15	0	84	0	75
35	0	13	0	10	3	38	1	62
36	0	0	0	19	4	42	12	50
37	0	3	1	13	2	17	22	11
38	1	12	2	4	3	12	21	14
39	0	0	0	2	6	24	52	13
40	1	3	0	0	6	25	27	5
41	1	2	0	4	3	6	38	4
42	4	2	0	10	4	0	23	6
43	2	0	0	0	3	1	28	8
44	2	0	0	0	1	0	20	4
45	5	0	0	0	4	0	18	3
46	7	3	0	0	4	0	23	3
47	5	5	0	0	1	0	19	20
48	2	1	0	0	3	0	9	5
49	4	1	0	1	1	0	9	7
50	6	5	0	0	0	4	17	20
51	3	6	2	1	1	0	10	9
52	1	10	0	1	1	0	8	9
53	1	5	1	2	0	1	5	11

Length	Q1	Q1	Q2	Q2	Q3	Q3	Q4	Q4
(cm)	Retained	Discarded	Retained	Discarded	Retained	Discarded	Retained	Discarded
54	4	7	0	9	0	0	8	1
55	3	2	6	4	1	0	4	1
56	3	11	3	3	2	0	3	3
57	4	3	3	5	1	1	2	2
58	2	4	2	2	0	0	6	0
59	3	2	3	4	3	0	1	0
60	2	3	1	2	2	2	4	0
61	0	5	3	2	1	1	0	0
62	0	5	3	0	1	0	2	0
63	1	1	0	1	1	2	3	1
64	1	4	1	0	4	1	2	0
65	0	4	0	2	1	0	2	0
66	0	3	0	2	1	0	3	0
67	0	5	1	2	1	4	1	0
68	0	3	0	2	1	1	3	0
69	4	5	1	5	0	2	5	1
70	1	11	0	1	2	0	5	0
71	0	7	0	0	0	0	6	1
72	2	13	2	0	2	1	2	0
73	0	15	0	1	1	0	6	1
74	3	15	0	5	0	3	2	1
75	0	17	1	0	2	0	3	0
76	1	7	0	1	0	1	1	1
77	0	10	1	1	0	0	1	1
78	1	5	2	2	0	0	6	0
79	1	5	3	2	0	0	7	0

Table 7.2.4a. Continued.

Length	Q1	Q1	Q2	Q2	Q3	Q3	Q4	Q4
(cm)	Retained	Discarded	Retained	Discarded	Retained	Discarded	Retained	Discarded
80	0	5	0	0	0	0	3	1
81	0	6	1	1	0	0	0	1
82	3	5	1	1	1	0	2	1
83	1	8	1	1	1	0	4	1
84	3	6	1	0	0	1	6	0
85	2	3	0	2	0	0	3	2
86	4	1	1	1	0	0	8	1
87	2	5	1	2	1	0	1	2
88	3	4	3	2	1	0	4	1
89	3	1	2	1	1	0	2	2
90	11	1	1	1	5	0	3	1
91	2	0	0	1	1	0	2	3
92	3	0	0	0	0	0	5	1
93	5	0	0	1	0	0	5	2
94	4	1	0	0	0	0	4	2
95	5	0	0	1	0	0	2	2
96	9	0	1	0	0	0	1	0
97	1	0	0	2	0	0	5	0
98	1	0	0	1	1	0	0	1
99	2	0	0	2	0	0	1	0
100	1	0	0	1	0	0	0	1
101	0	0	1	0	0	0	0	0
102	0	0	0	1	1	0	0	0
103	2	0	0	2	0	0	0	0
104	0	0	0	1	0	0	0	0
105	0	0	1	0	0	0	1	0
106	0	0	4	1	0	0	0	0
107	0	0	0	1	0	0	0	0
108	0	0	0	1	0	0	0	0
109	0	0	0	0	0	0	0	0
110	0	0	0	2	0	0	0	0
111	0	0	0	1	0	0	1	0
112	0	0	0	0	0	0	0	0
113	0	0	0	0	0	0	0	0
Total N	149	682	62	556	90	478	513	513
Trips sampled	32		22		29		12	

Table 7.2.4b. Cod in Divisions VIIe–k. Length structure of landings and discards from sampling by Ireland in 2010. No of Trips= 40, No. of hauls = 473. Raised (using trips as variable).

Frequency ('000)			Frequency ('000)		
Length (cm)	Discards	Retained Catch	Length (cm)	Discards	Retained Catch
14	2.15	0.00	61	0.00	5.37
15	3.51	0.00	62	0.00	7.98
16	0.00	0.00	63	0.00	5.35
17	2.15	0.00	64	0.00	7.29
18	4.01	0.00	65	0.00	2.34
19	3.22	0.00	66	0.00	6.82
20	12.70	0.00	67	0.00	5.07
21	11.35	0.00	68	0.00	4.79
22	37.69	0.00	69	0.00	4.74
23	65.53	0.00	70	0.00	3.95
24	37.17	0.00	71	0.00	3.60
25	116.90	0.00	72	0.00	3.65
26	102.28	0.00	73	0.00	4.90
27	155.92	0.00	74	0.00	0.73
28	143.76	0.00	75	0.00	2.91
29	251.17	3.20	76	0.00	2.08
30	125.70	0.00	77	0.00	1.65
31	100.68	0.00	78	0.00	3.94
32	97.41	0.74	79	0.00	2.36
33	128.88	2.10	80	0.00	1.80
34	146.22	3.48	81	0.00	0.82
35	63.64	3.60	82	0.00	0.73
36	92.09	8.68	83	0.00	1.08
37	30.01	11.48	84	0.00	1.98
38	37.45	10.07	85	0.00	1.58
39	48.77	11.43	86	0.00	0.19
40	4.98	11.80	87	0.00	0.36
41	0.00	11.07	88	0.00	0.36
42	0.00	11.53	89	0.00	0.31
43	0.00	11.71	90	0.00	1.53
44	0.00	11.01	91	0.00	0.00
45	0.00	8.01	92	0.00	1.09
46	0.00	10.01	93	0.00	1.12
47	0.00	5.12	94	0.00	0.31
48	0.00	8.19	95	0.00	0.63
49	0.00	7.51	96	0.00	0.36
50	0.00	9.40	97	0.00	0.31
51	0.00	4.55	98	0.00	0.99
52	0.00	12.21	99	0.00	0.99
53	0.00	13.07	100	0.00	1.17
54	0.00	10.64	101	0.00	0.00
55	0.00	12.31	102	0.00	0.00
56	0.00	8.07	103	0.00	0.63
57	0.00	5.82	104	0.00	0.31
58	0.00	3.81	105	0.00	0.00
59	0.00	4.57	106	0.00	0.00
60	0.00	7.44	107	0.00	0.00
			108	0.00	0.27

Table 7.2.4c. Cod in Divisions VIIe–k 2010. Length structure of French landings and discards from the self-sampling Programme. Sampling data raised by landing ratio to the total catch of the fleet targeting *Nephrops*.

	Q1	Q1	Q2	Q2	Q3	Q3
Length	Discarded	Retained	Discarded	Retained	Discarded	Retained
15	0	0	54	0	0	0
16	0	0	54	0	0	0
17	0	0	108	0	0	0
18	0	0	217	0	0	0
19	0	0	271	0	0	0
20	0	0	596	0	0	0
21	0	0	217	0	0	0
22	0	0	705	0	258	0
23	0	0	813	0	0	0
24	0	0	380	0	258	0
25	0	0	434	0	258	0
26	0	0	325	107	516	0
27	0	0	325	215	1032	0
28	0	0	380	322	1548	0
29	0	0	163	645	1548	0
30	0	0	813	537	4129	0
31	0	0	325	215	2065	0
32	0	0	434	157	1548	103
33	0	0	217	113	774	206
34	0	0	380	282	1290	409
35	0	0	596	1174	4645	7178
36	0	0	0	1969	516	7886
37	0	328	380	2379	774	10177
38	0	716	108	2365	258	9752
39	0	0	54	2041	258	9849
40	0	526	0	1473	0	10892
41	0	2258	0	1571	0	11238
42	0	1921	0	1150	0	15311
43	0	2147	0	1053	0	13838
44	0	2763	0	793	0	8554
45	0	3976	0	157	0	10936
46	0	3068	0	277	0	8519
47	0	4120	0	723	0	5982
48	0	2896	0	925	0	5111
49	0	3003	0	906	0	3146
50	0	4818	0	2443	0	3397
51	0	2940	0	2865	0	2512
52	0	2612	0	4229	0	2540
53	0	3457	0	3751	0	1478
54	0	1952	0	3088	0	2377

	Q1	Q1	Q2	Q2	Q3	Q3
Length	Discarded	Retained	Discarded	Retained	Discarded	Retained
55	0	1216	0	2773	0	1547
56	0	2028	0	4538	0	2612
57	0	832	0	3101	0	2413
58	0	1012	0	4015	0	5060
59	0	465	0	3867	0	3501
60	0	539	0	2552	0	5076
61	0	494	0	4055	0	5446
62	0	86	0	1989	0	3323
63	0	189	0	2095	0	5492
64	0	349	0	1554	0	3871
65	0	232	0	730	0	5152
66	0	211	0	1273	0	5724
67	0	365	0	1197	0	2425
68	0	681	0	194	0	2974
69	0	670	0	279	0	2161
70	0	796	0	623	0	2719
71	0	760	0	481	0	4138
72	0	927	0	752	0	2216
73	0	337	0	1241	0	1022
74	0	758	0	1533	0	5221
75	0	921	0	945	0	1332
76	0	566	0	602	0	2946
77	0	1190	0	1039	0	2732
78	0	784	0	710	0	2388
79	0	916	0	1002	0	2138

Table 7.2.4c. Continued.

	Q1	Q1	Q2	Q2	Q3	Q3
Length	Discarded	Retained	Discarded	Retained	Discarded	Retained
80	0	768	0	1344	0	1659
81	0	1360	0	1347	0	1939
82	0	928	0	1206	0	1010
83	0	983	0	707	0	367
84	0	1649	0	967	0	1543
85	0	2093	0	1937	0	679
86	0	2032	0	1108	0	686
87	0	194	0	1304	0	996
88	0	2106	0	1240	0	1050
89	0	1452	0	1270	0	729
90	0	695	0	1252	0	895
91	0	1522	0	1084	0	491
92	0	955	0	1468	0	941
93	0	889	0	894	0	313
94	0	1055	0	757	0	650
95	0	733	0	582	0	691
96	0	193	0	711	0	1034
97	0	753	0	455	0	34
98	0	485	0	751	0	256
99	0	172	0	102	0	348
100	0	398	0	557	0	134
101	0	514	0	178	0	576
102	0	398	0	61	0	555
103	0	261	0	331	0	373
104	0	184	0	335	0	31
105	0	21	0	176	0	341
106	0	0	0	476	0	31
107	0	277	0	211	0	0
108	0	259	0	109	0	106
109	0	184	0	67	0	309
110	0	0	0	228	0	0
111	0	0	0	67	0	203
112	0	0	0	0	0	0
113	0	0	0	0	0	33
114	0	0	0	0	0	0
115	0	198	0	74	0	0
116	0	0	0	0	0	0
117	0	0	0	0	0	0
118	0	0	0	0	0	0
119	0	0	0	0	0	0
120	0	0	0	0	0	0
Number of trips	13		17		8	
Number of sampled hauls	255		681		318	
Number of total hauls	528		729		319	

Table 7.2.4d. Cod in Divisions VIIe–k. Length structure of French landings and discards from on-board observer programme. Otter trawlers targeting demersal fish.

	Retained					Discarded			
	OT_DEF					OT_DEF			
Length (cm)	2010 - Q1	2010 - Q2	2010 - Q3	2010 - Q4	Length (cm)	2010 - Q1	2010 - Q2	2010 - Q3	2010 - Q4
20	0	0	0	0	20	0	0	0	0
21	0	0	0	0	21	0	0	0	0
22	0	0	0	0	22	0	1	0	0
23	0	0	0	0	23	1	0	1	1
24	0	0	0	0	24	4	1	0	2
25	0	0	0	0	25	3	5	1	1
26	0	1	0	0	26	5	6	2	2
27	0	2	0	0	27	10	11	4	1
28	0	3	0	0	28	5	13	3	3
29	0	6	0	0	29	5	19	16	7
30	0	5	0	2	30	1	29	13	5
31	0	2	0	0	31	2	23	26	8
32	0	2	1	0	32	0	26	24	11
33	0	1	2	1	33	3	21	31	8
34	0	4	3	0	34	1	18	34	8
35	0	12	41	1	35	1	19	12	5
36	0	21	46	9	36	0	14	15	2
37	2	27	60	13	37	0	12	10	3
38	4	25	58	24	38	0	10	8	2
39	0	23	70	27	39	0	8	11	1
40	3	20	76	28	40	0	0	14	0
41	14	20	75	42	41	0	0	7	2
42	18	15	111	35	42	0	0	4	0
43	16	15	108	38	43	0	0	9	0
44	23	13	71	43	44	0	0	1	0
45	35	4	89	53	45	0	0	3	2
46	30	6	70	38	46	0	0	5	0
47	36	14	52	47	47	0	0	1	1
48	33	17	46	49	48	0	0	1	1
49	28	17	34	38	49	0	0	0	0
50	39	30	37	17	50	0	0	0	0
51	29	29	19	27	51	0	0	0	0
52	23	35	23	14	52	0	0	1	0
53	30	31	12	15	53	0	1	0	0
54	16	24	14	18	54	0	0	0	0
55	9	23	13	11	55	0	0	0	0
56	16	34	16	6	56	0	0	0	0
57	6	30	19	11	57	0	0	0	0
58	10	35	35	16	58	0	0	0	0
59	4	30	22	11	59	0	0	0	0

	Retained					Discarded			
	OT_DEF					OT_DEF			
Length (cm)	2010 - Q1	2010 - Q2	2010 - Q3	2010 - Q4	Length (cm)	2010 - Q1	2010 - Q2	2010 - Q3	2010 - Q4
60	4	21	36	9	60	0	0	0	0
61	5	37	33	10	61	0	1	0	0
62	3	20	27	17	62	0	0	2	0
63	3	19	33	16	63	0	0	0	0
64	7	17	25	22	64	0	0	0	0
65	4	10	35	11	65	0	0	0	0
66	6	13	29	25	66	0	0	0	0
67	5	11	14	20	67	0	0	0	0
68	8	3	17	21	68	0	0	0	0
69	9	4	10	20	69	0	0	0	0
70	15	8	17	16	70	0	0	0	0
71	12	6	19	7	71	0	0	0	0
72	12	10	11	6	72	0	0	0	0
73	5	12	7	8	73	0	0	0	0
74	9	18	21	9	74	0	0	0	0
75	11	11	11	8	75	0	0	0	0
76	8	11	14	10	76	0	0	0	0
77	10	15	13	10	77	0	0	0	0
78	10	10	13	2	78	0	0	0	0
79	8	12	13	5	79	0	0	0	0

Table 7.2.4d. Continued.

	Retained					Discarded			
	OT_DEF					OT_DEF			
Length (cm)	2010 - Q1	2010 - Q2	2010 - Q3	2010 - Q4	Length (cm)	2010 - Q1	2010 - Q2	2010 - Q3	2010 - Q4
80	8	13	10	6	80	0	0	0	0
81	9	15	13	5	81	0	0	0	0
82	9	14	7	6	82	0	0	0	0
83	9	7	5	7	83	0	0	0	0
84	10	8	8	7	84	0	0	0	0
85	19	17	8	3	85	0	0	0	0
86	13	14	7	6	86	0	0	0	0
87	3	17	11	10	87	0	0	0	0
88	17	12	7	4	88	0	1	0	0
89	12	15	9	9	89	0	0	0	0
90	9	15	6	7	90	0	0	0	0
91	10	15	7	7	91	0	0	0	0
92	11	16	11	5	92	0	0	0	0
93	9	10	6	5	93	0	0	0	0
94	10	11	9	4	94	0	0	0	0
95	6	8	8	4	95	0	0	0	0
96	3	9	12	5	96	0	0	0	0
97	8	8	1	3	97	0	0	0	0
98	6	9	5	9	98	0	0	0	0
99	2	2	4	2	99	0	0	0	0
100	4	9	3	2	100	0	0	0	0
101	6	4	8	2	101	0	0	0	0
102	4	2	4	3	102	0	0	0	0
103	3	5	2	1	103	0	0	0	0
104	1	5	1	2	104	0	0	0	0
105	1	3	3	2	105	0	0	0	0
106	0	5	1	1	106	0	0	0	0
107	2	3	0	1	107	0	0	0	0
108	4	2	1	0	108	0	0	0	0
109	1	1	2	1	109	0	0	0	0
110	0	1	0	3	110	0	0	0	0
111	0	1	1	0	111	0	0	0	0
112	0	0	0	1	112	0	0	0	0
113	0	0	1	0	113	0	0	0	0
114	0	0	0	0	114	0	0	0	0
115	1	1	0	0	115	0	0	0	0
Number of fish	788	1121	1802	1019		41	239	259	76
Number of hauls	252	451	579	490		252	451	579	490

Table 7.2.4e. Cod in Divisions VIIe–k. Length structure of French landings and discards from on-board observer programme. Otter trawlers targeting *Nephrops*.

	Retained					Discarded			
	OT_CRU					OT_CRU			
length (cm)	2010 - Q1	2010 - Q2	2010 - Q3	2010 - Q4	length (cm)	2010 - Q1	2010 - Q2	2010 - Q3	2010 - Q4
20	0	0	0	0	20	0	0	0	0
21	0	0	0	0	21	0	0	3	1
22	0	0	0	0	22	0	2	2	0
23	0	0	0	0	23	0	3	1	0
24	0	0	0	0	24	1	5	3	0
25	0	0	0	0	25	1	5	1	0
26	0	0	0	1	26	1	9	3	0
27	0	0	0	0	27	2	14	8	2
28	0	0	0	0	28	3	14	8	3
29	0	0	0	0	29	0	22	15	3
30	0	0	2	0	30	1	18	25	4
31	0	0	0	0	31	0	20	30	9
32	0	0	0	0	32	0	18	27	8
33	0	0	1	0	33	0	21	32	9
34	0	0	1	0	34	0	9	44	4
35	0	0	512	3	35	0	9	18	1
36	0	1	548	2	36	0	6	14	1
37	0	1	508	3	37	0	4	17	1
38	0	0	483	9	38	0	6	10	2
39	0	1	395	7	39	0	3	5	3
40	0	2	336	11	40	0	2	3	1
41	1	6	267	23	41	0	2	5	0
42	2	3	211	25	42	0	2	3	0
43	3	2	119	33	43	0	0	0	0
44	2	7	90	38	44	0	0	1	0
45	7	4	68	26	45	0	0	0	0
46	2	9	39	34	46	0	0	0	0
47	14	3	29	24	47	0	0	0	0
48	8	5	25	25	48	0	0	0	0
49	11	8	13	16	49	0	0	0	0
50	11	7	16	7	50	0	0	0	0
51	12	9	17	12	51	0	0	0	0
52	5	7	21	7	52	0	0	0	0
53	5	18	22	5	53	0	0	0	0
54	4	12	27	3	54	0	0	0	0
55	5	12	19	3	55	0	0	0	0
56	3	16	33	0	56	0	0	0	0
57	6	13	23	6	57	0	0	0	0
58	9	19	47	2	58	0	0	0	0

	Retained					Discarded			
	OT_CRU					OT_CRU			
length (cm)	2010 - Q1	2010 - Q2	2010 - Q3	2010 - Q4	length (cm)	2010 - Q1	2010 - Q2	2010 - Q3	2010 - Q4
59	2	13	45	4	59	0	0	0	0
60	2	20	51	3	60	0	0	0	0
61	1	12	56	5	61	0	0	0	0
62	1	13	46	4	62	0	0	0	0
63	2	9	45	7	63	0	0	0	0
64	0	7	39	9	64	0	0	0	0
65	1	8	43	10	65	0	0	0	0
66	3	7	27	13	66	0	0	0	0
67	1	6	25	8	67	0	0	0	0
68	3	3	25	6	68	0	0	0	0
69	5	1	27	12	69	0	0	0	0
70	4	3	21	8	70	0	0	0	0
71	4	4	16	11	71	0	0	0	0
72	2	9	7	6	72	0	0	0	0
73	5	3	2	7	73	0	0	0	0
74	2	6	5	6	74	0	0	0	0
75	2	4	5	2	75	0	0	0	0
76	7	11	10	5	76	0	0	0	0
77	3	7	11	4	77	0	0	0	0
78	4	7	10	3	78	0	0	0	0
79	2	5	5	1	79	0	0	0	0

Table 7.2.4e. Continued.

	Retained					Discarded			
	OT_CRU					OT_CRU			
length (cm)	2010 - Q1	2010 - Q2	2010 - Q3	2010 - Q4	length (cm)	2010 - Q1	2010 - Q2	2010 - Q3	2010 - Q4
80	3	3	5	3	80	0	0	0	0
81	2	2	13	3	81	0	0	0	0
82	5	4	11	1	82	0	0	0	0
83	1	7	10	4	83	0	0	0	0
84	1	11	16	2	84	0	0	0	0
85	4	4	10	2	85	0	0	0	0
86	2	4	7	5	86	0	0	0	0
87	3	3	11	1	87	0	0	0	0
88	4	9	7	4	88	0	0	0	0
89	2	7	13	4	89	0	0	0	0
90	1	5	8	3	90	0	0	0	0
91	0	9	10	5	91	0	0	0	0
92	2	4	11	3	92	0	0	0	0
93	1	6	14	2	93	0	0	0	0
94	0	2	10	1	94	0	0	0	0
95	3	4	5	3	95	0	0	0	0
96	1	4	5	3	96	0	0	0	0
97	1	3	3	6	97	0	0	0	0
98	2	2	7	1	98	0	0	0	0
99	1	3	2	2	99	0	0	0	0
100	2	1	5	1	100	0	0	0	0
101	2	2	6	2	101	0	0	0	0
102	1	2	6	2	102	0	0	0	0
103	0	1	4	1	103	0	0	0	0
104	3	3	2	1	104	0	0	0	0
105	2	2	0	2	105	0	0	0	0
106	1	0	0	0	106	0	0	0	0
107	0	1	0	1	107	0	0	0	0
108	0	0	1	1	108	0	0	0	0
109	0	0	0	0	109	0	0	0	0
110	0	0	3	0	110	0	0	0	0
111	0	0	0	0	111	0	0	0	0
112	0	1	0	0	112	0	0	0	0
113	0	1	0	0	113	0	0	0	0
114	0	0	1	0	114	0	0	0	0
115	0	0	1	0	115	0	0	0	0
116	0	0	0	0	116	0	0	0	0
117	0	0	1	0	117	0	0	0	0
118	0	0	0	0	118	0	0	0	0
119	0	0	0	0	119	0	0	0	0
120	0	0	1	0	120	0	0	0	0
Number of fish	216	433	4602	528		9	194	278	52
Number of hauls	53	154	156	191		53	154	156	191

Table 7.2.4f. Cod in Divisions VIIe–k. Length structure of Belgium landings and discards from on-board observer programme.

	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings
Length	2 trips		8 trips		8 trips		4 trips	
(cm)	14 hauls		14 hauls		16 trips		80 hauls	
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0
17	0	0	6	0	0	0	0	0
18	0	0	4	0	0	0	0	0
19	2	0	30	0	0	0	0	0
20	6	0	157	0	0	0	0	0
21	52	0	238	0	0	0	0	0
22	58	0	316	0	10	0	0	0
23	86	0	427	0	14	0	0	0
24	80	0	377	0	84	0	2	0
25	120	0	450	0	182	0	4	0
26	145	0	362	0	153	0	2	0
27	122	0	360	0	137	0	6	0
28	97	0	301	0	170	0	12	0
29	79	0	216	0	113	0	10	0
30	72	0	227	0	69	0	12	0
31	46	0	197	0	66	0	14	0
32	34	0	128	0	58	0	25	0
33	32	0	96	0	32	0	24	0
34	25	0	103	0	41	0	47	0
35	11	0	86	0	34	0	8	0
36	6	0	50	0	30	0	22	0
37	12	0	44	0	10	0	30	0
38	9	0	29	0	18	0	28	0
39	18	0	8	0	10	0	29	0
40	9	0	6	0	35	0	20	0
41	9	0	12	0	12	0	18	0
42	9	0	10	0	14	0	14	0
43	11	0	8	0	10	0	12	0
44	11	0	8	0	12	0	16	0

	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings
Length	2 trips		8 trips		8 trips		4 trips	
(cm)	14 hauls		14 hauls		16 trips		80 hauls	
45	15	0	25	0	2	0	10	0
46	4	0	23	0	2	0	8	0
47	2	0	16	0	6	0	7	0
48	8	0	23	0	0	0	0	0
49	4	0	17	0	0	0	4	0
50	0	11	4	10	0	0	2	2
51	0	4	4	23	0	4	0	6
52	0	6	2	10	0	0	0	0
53	0	14	2	16	0	0	0	6
54	0	9	2	10	0	2	0	2
55	0	16	4	8	0	2	0	8
56	0	7	0	8	0	2	0	2
57	0	11	2	6	0	6	0	4
58	0	0	4	6	0	0	0	0
59	0	2	0	4	0	0	0	0
60	0	0	2	10	0	4	0	0
61	0	7	0	4	0	0	0	0
62	0	4	2	6	0	2	0	0
63	0	0	0	12	0	4	0	0
64	0	2	0	27	0	2	0	0
65	0	0	2	41	0	0	0	0
66	0	7	0	0	0	2	0	0
67	0	4	0	2	0	0	0	2
68	0	7	0	2	0	0	0	0
69	0	2	0	0	0	0	0	0

Table 7.2.4f. Continued.

	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
	Discards	Landings	Discards	Landings	Discards	Landings	Discards	Landings
Length	2 trips		8 trips		8 trips		4 trips	
(cm)	14 hauls		14 hauls		16 trips		80 hauls	
70	0	4	0	0	0	0	0	0
71	0	2	0	0	0	0	0	0
72	0	4	0	0	0	0	0	2
73	0	4	0	0	0	0	0	0
74	0	2	0	0	0	0	0	0
75	0	0	0	0	0	2	0	0
76	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0
78	0	2	0	0	0	0	0	0
79	0	0	0	2	0	0	0	0
80	0	0	0	0	0	0	0	0
81	0	2	0	0	0	0	0	0
82	0	2	0	0	0	0	0	0
83	0	0	0	0	0	0	0	0
84	0	0	0	0	0	0	0	0
85	0	0	0	0	0	0	0	0
86	0	3	0	0	0	0	0	0
87	0	2	0	0	0	0	0	0
88	0	0	0	0	0	0	0	0
89	0	0	0	0	0	0	0	2
90	0	0	0	0	0	0	0	0
91	0	0	0	0	0	0	0	0
92	0	0	0	0	0	0	0	0
93	0	0	0	0	0	0	0	0
94	0	2	0	0	0	0	0	0
95	0	2	0	0	0	0	0	0
96	0	0	0	0	0	0	0	0
97	0	0	0	0	0	0	0	0
98	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0
101	0	4	0	0	0	0	0	0
Total	1194	149	4394	210	1324	32	386	36
% number	801	3	2095		4154		1070	

Table 7.2.5. Cod in Divisions VIIe–k. Catch weight-at-age.

```
    Run title : Cod in Divisions VIIe-k,WGCSE11,index file
    At  5/05/2011  15:18


       Table  2    Catch weights-at-age (kg)
       YEAR,       1971,    1972,    1973,    1974,    1975,    1976,    1977,    1978,    1979,    1980,

       AGE
         1,        .9080,   .9080,   .9080,   .9080,   .9080,   .9080,   .9080,   .9080,   .9080,   .9080,
         2,       2.1930,  2.1930,  2.1930,  2.1930,  2.1930,  2.1930,  2.1930,  2.1930,  2.1930,  2.1930,
         3,       4.8310,  4.8310,  4.8310,  4.8310,  4.8310,  4.8310,  4.8310,  4.8310,  4.8310,  4.8310,
         4,       7.4640,  7.4640,  7.4640,  7.4640,  7.4640,  7.4640,  7.4640,  7.4640,  7.4640,  7.4640,
         5,       9.6690,  9.6690,  9.6690,  9.6690,  9.6690,  9.6690,  9.6690,  9.6690,  9.6690,  9.6690,
         6,      11.7840, 11.7840, 11.7840, 11.7840, 11.7840, 11.7840, 11.7840, 11.7840, 11.7840, 11.7840,
       +gp,      14.8159, 14.4792, 14.6675, 14.9506, 14.5262, 15.1279, 15.7144, 15.2267, 14.3395, 13.8620,
0    SOPCOFAC,    1.0006,   .9972,   .9982,   .9966,  1.0011,  1.0029,  1.0004,   .9974,  1.0006,  1.0003,


       Table  2    Catch weights-at-age (kg)
       YEAR,       1981,    1982,    1983,    1984,    1985,    1986,    1987,    1988,    1989,    1990,

       AGE
         1,        .9450,   .9450,   .9790,   .9810,  1.0010,  1.0540,   .9090,   .9060,   .8440,   .8800,
         2,       1.5490,  2.2420,  2.5250,  2.6450,  2.6370,  2.5540,  2.5040,  2.1870,  2.0130,  2.3000,
         3,       4.3850,  4.4740,  4.9610,  5.2840,  5.5210,  5.3980,  5.2640,  5.3180,  4.7060,  4.6240,
         4,       7.5650,  7.7970,  7.4570,  7.8280,  8.0820,  7.4400,  8.0890,  7.9970,  7.6380,  7.1880,
         5,       9.0600, 10.2500,  9.9650,  9.7580, 10.4070, 10.7820, 10.4470, 10.6490,  9.4380,  9.0450,
         6,      12.7500, 12.4650, 12.0100, 11.6720, 11.4690, 12.3960, 13.5740, 12.4860, 12.9170, 11.7130,
       +gp,      14.7237, 15.4408, 16.4710, 15.3396, 14.3697, 13.5580, 15.3490, 14.6217, 13.3935, 14.8144,
0    SOPCOFAC,    1.0002,  1.0146,  1.0006,   .9984,  1.0092,  1.0000,   .9844,   .9997,  1.0003,   .9900,


       Table  2    Catch weights-at-age (kg)
       YEAR,       1991,    1992,    1993,    1994,    1995,    1996,    1997,    1998,    1999,    2000,

       AGE
         1,        .9050,   .8150,   .8710,   .8740,   .8060,   .7870,   .7710,   .8530,   .9930,   .8630,
         2,       2.1350,  1.9160,  2.0430,  2.0000,  1.9730,  1.8770,  2.0390,  1.8960,  2.0980,  2.5410,
         3,       4.9870,  4.9160,  4.5080,  4.4920,  4.5890,  4.6390,  4.5160,  4.4610,  4.4950,  4.6290,
         4,       6.7380,  7.3590,  6.8660,  7.9260,  7.5600,  6.9970,  7.3890,  6.8810,  7.3260,  7.0420,
         5,       8.8650,  9.7440,  8.4310, 10.0920,  9.7500,  9.8540,  9.7190,  9.3290,  8.9450,  9.5020,
         6,      10.8090, 11.4980, 10.9420, 12.2120, 11.1520, 11.4070, 11.8200, 11.2160, 11.2550, 10.6600,
       +gp,      14.1344, 12.6295, 12.3344, 14.0578, 14.0814, 12.3707, 14.3670, 14.0713, 14.6309, 12.1360,
0    SOPCOFAC,    1.0000,  1.0000,  1.0009,  1.0000,   .9999,  1.0000,  1.0006,  1.0012,  1.0017,   .9995,


       Table  2    Catch weights-at-age (kg)
       YEAR,       2001,    2002,    2003,    2004,    2005,    2006,    2007,    2008,    2009,    2010,

       AGE
         1,        .7940,   .7570,   .8890,   .8840,   .7760,   .7890,   .7720,   .8470,   .9230,   .8530,
         2,       2.0290,  1.8800,  1.8440,  2.1770,  2.1180,  1.7930,  1.6570,  1.8040,  2.3840,  2.2260,
         3,       5.1120,  4.7280,  4.2740,  4.5430,  3.9070,  4.7160,  4.2760,  4.5410,  4.2480,  4.7890,
         4,       7.8580,  6.7640,  6.6670,  7.0730,  6.1680,  7.4040,  7.4630,  7.1640,  6.7210,  7.2850,
         5,       9.8320,  9.3600,  9.5060,  9.4350,  9.1940,  9.1860,  9.6970,  9.2290,  8.8950,  9.9750,
         6,      11.4230, 10.7740, 11.0640, 10.8020, 11.5440, 11.6460, 11.8630, 11.0950, 10.5840, 11.9480,
       +gp,      13.8977, 13.1661, 12.1431, 12.8979, 10.0370, 12.3902, 12.8190, 13.3042, 10.3420,   .0000,
0    SOPCOFAC,     .9991,   .9996,   .9992,  1.0014,  1.0020,  1.0005,  1.0011,  1.0026,   .9989,   .7715,
1
```

Table 7.2.6. Cod in Divisions VIIe–k. Stock weight-at-age = 1st quarter values.

```
Run title : Cod in Divisions VIIe-k,WGCSE11,index file
At  5/05/2011  15:18


  Table  3    Stock weights-at-age (kg)
  YEAR,       1971,    1972,    1973,    1974,    1975,    1976,    1977,    1978,    1979,    1980,

  AGE
    1,         .6620,   .6620,   .6620,   .6620,   .6620,   .6620,   .6620,   .6620,   .6620,   .6620,
    2,        1.7090,  1.7090,  1.7090,  1.7090,  1.7090,  1.7090,  1.7090,  1.7090,  1.7090,  1.7090,
    3,        4.4440,  4.4440,  4.4440,  4.4440,  4.4440,  4.4440,  4.4440,  4.4440,  4.4440,  4.4440,
    4,        7.3210,  7.3210,  7.3210,  7.3210,  7.3210,  7.3210,  7.3210,  7.3210,  7.3210,  7.3210,
    5,        9.5290,  9.5290,  9.5290,  9.5290,  9.5290,  9.5290,  9.5290,  9.5290,  9.5290,  9.5290,
    6,       11.6050, 11.6050, 11.6050, 11.6050, 11.6050, 11.6050, 11.6050, 11.6050, 11.6050, 11.6050,
  +gp,       14.5404, 14.1778, 14.3755, 14.5822, 14.2402, 14.8683, 15.3589, 14.9079, 14.0056, 13.5130,


  Table  3    Stock weights-at-age (kg)
  YEAR,       1981,    1982,    1983,    1984,    1985,    1986,    1987,    1988,    1989,    1990,

  AGE
    1,         .4600,   .7040,   .4460,   .5120,   .5810,   .5280,   .5220,   .9060,   .8440,   .6130,
    2,        1.5490,  1.4880,  1.9450,  1.9510,  2.0700,  1.9020,  1.9470,  1.6210,  1.4630,  1.7740,
    3,        2.2840,  3.8760,  4.4670,  4.9280,  5.3330,  5.2860,  4.8770,  4.8870,  4.5140,  4.3900,
    4,        7.8060,  7.4070,  7.3530,  7.4330,  8.3760,  7.3820,  7.9460,  7.7770,  7.6150,  7.1860,
    5,       10.5440,  9.6240,  9.7520,  9.5520, 10.8510, 10.6890, 10.3080, 10.3020,  9.4380,  8.4860,
    6,       11.4390, 12.3160, 11.2230, 12.1800, 11.5850, 12.3930, 14.4190, 11.7860, 12.6920, 10.7030,
  +gp,       14.6123, 15.7394, 17.4511, 15.2018, 14.9743, 14.4820, 15.4457, 13.4600, 14.1533, 14.6578,


  Table  3    Stock weights-at-age (kg)
  YEAR,       1991,    1992,    1993,    1994,    1995,    1996,    1997,    1998,    1999,    2000,

  AGE
    1,         .5390,   .6630,   .7030,   .6050,   .6120,   .6730,   .4700,   .4210,   .7780,   .5610,
    2,        1.5380,  1.3180,  1.3850,  1.7540,  1.4440,  1.2830,  1.4100,  1.3140,  1.5420,  1.6960,
    3,        4.7910,  4.6000,  4.2780,  4.1890,  4.3460,  4.4710,  4.0790,  4.3400,  4.2520,  4.2230,
    4,        6.5240,  6.5580,  6.5740,  7.7200,  7.4520,  6.7470,  7.1120,  6.6760,  7.1260,  6.6270,
    5,        8.6310,  9.3420,  8.0660,  9.7220,  9.1400,  9.8770,  9.0440,  9.3030,  8.7000,  9.3260,
    6,       10.6720, 11.2850, 10.8150, 12.1010, 10.6460, 11.4240, 11.1560, 11.1720, 11.1420, 10.5050,
  +gp,       13.8090, 12.4660, 12.1295, 13.9081, 14.0514, 12.8480, 13.7300, 12.8280, 15.2226, 11.4651,


  Table  3    Stock weights-at-age (kg)
  YEAR,       2001,    2002,    2003,    2004,    2005,    2006,    2007,    2008,    2009,    2010,

  AGE
    1,         .6300,   .3520,   .4820,   .5910,   .5880,   .7030,   .7220,   .8690,   .9380,   .8190,
    2,        1.4550,  1.2570,  1.3270,  1.2580,  1.6880,  1.2160,  1.3990,  1.4490,  1.6290,  1.4240,
    3,        4.9040,  4.4520,  4.1110,  4.0530,  4.0750,  4.2330,  3.7940,  4.1880,  3.8650,  4.3730,
    4,        7.8720,  7.0460,  6.6010,  6.7590,  5.9450,  6.8190,  6.9900,  6.8960,  6.5570,  6.9840,
    5,       10.1920,  9.4000,  9.1830,  9.3720,  9.0180,  8.8950,  9.8090,  8.8810,  8.9850,  9.8910,
    6,       11.6130, 10.6140, 10.6350, 10.1580, 11.3330, 11.4870, 12.2730, 11.5430, 10.5670, 11.6630,
  +gp,       13.8257, 13.6879, 12.5877, 12.6100, 11.4870, 11.6694, 14.8977, 12.7292, 12.9810,   .0000,
```

Table 7.2.7. Cod in Divisions VIIe–k. Series of surveys indices scrutinized at WGCSE.

```
Cod in Divisions VIIe-k, tuning fleets,WGCSE11

102
FR-EVHOE Groundfish  Oct-Nov survey in VIIf,g,h,j, numbers per 30 mn

1997    2010
1       1       0.75    1
1       6
1       0.213   0.095   0.246   0.117   0.048   0
1       0.212   0.52    0.207   0.045   0.045   0
1       0.155   0.184   0.283   0.015   0.03    0.015
1       1.046   0.041   0.118   0.064   0.013   0
1       0.716   0.18    0.029   0.038   0.018   0.007
1       0.033   0.313   0.148   0       0.015   0
1       0.052   0.041   0.142   0.061   0.008   0
1       0.066   0.144   0.072   0.122   0.046   0
1       0.255   0.12    0.055   0       0.026   0
1       0.125   0.139   0       0.048   0.045   0
1       0.321   0.206   0.117   0.033   0       0
1       0.217   0.141   0.117   0.096   0       0
1       0.237   0.092   0.132   0.078   0       0.023
1       1.805   0.210   0.028   0.094   0       0

IR-GFS-7GJ combined: Irish Grounfish Survey (IBTS 4th Qrt)- Cod number per 1h

2003    2010
1       1       0.79    0.92
1       5
1       0.45    0.52    0.53    0.15    0
1       0.64    0.21    0.07    0.04    0.04
1       2.87    0.28    0.11    0       0
1       1.36    0.46    0.06    0       0
1       1.88    0.65    0.21    0.06    0
1       0.36    0.98    0.24    0.03    0
1       1.16    0.14    0.17    0.03    0
1       10.09   0.82    0.02    0.07    0
```

Table 7.2.8a. 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	Incomplete											
2010	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	Incomplete								
2010	datasets/not usable								

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.

	UK (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	117.1	3.0				80	64.6	1.2
1973	223	118.5	1.9				58	69.5	0.8
1974	192	91.6	2.1				55	50.1	1.1
1975	136	100.3	1.4				38	54.7	0.7
1976	97	88.2	1.1				32	56.1	0.6
1977	119	88.5	1.3				78	55.4	1.4
1978	116	83.2	1.4	6	24.7	0.3	70	48.8	1.4
1979	130	73.5	1.8	14	44.0	0.3	74	49.9	1.5
1980	228	85.6	2.7	39	76.7	0.5	84	50.0	1.7
1981	324	104.3	3.1	63	87.6	0.7	76	46.9	1.6
1982	362	104.7	3.5	84	115.0	0.7	65	38.5	1.7
1983	163	82.1	2.0	84	135.3	0.6	73	52.6	1.4
1984	237	86.7	2.7	129	131.5	1.0	77	52.9	1.5
1985	249	90.3	2.8	145	152.5	1.0	64	57.7	1.1
1986	233	84.7	2.8	164	135.7	1.2	80	49.5	1.6
1987	221	84.3	2.6	246	177.1	1.4	96	45.1	2.1
1988	270	89.1	3.0	248	194.9	1.3	155	53.4	2.9
1989	186	84.1	2.2	230	198.2	1.2	105	54.7	1.9
1990	314	99.5	3.2	307	207.6	1.5	128	53.1	2.4
1991	243	76.7	3.2	258	203.2	1.3	84	40.8	2.0
1992	232	86.4	2.7	256	196.1	1.3	81	39.9	2.0
1993	181	61.9	2.9	220	208.4	1.1	43	39.2	1.1
1994	79	53.7	1.5	174	220.0	0.8	41	38.8	1.1
1995	115	52.3	2.2	239	243.1	1.0	55	35.5	1.5
1996	120	60.5	2.0	303	260.8	1.2	59	30.5	1.9
1997	149	66.7	2.2	299	264.8	1.1	79	33.3	2.4
1998	119	62.1	1.9	265	254.6	1.0	62	29.8	2.1
1999	90	98.4	0.9	257	251.4	1.0	47	27.5	1.7
2000	111	104.1	1.1	187	259.0	0.7	52	30.5	1.7
2001	110	85.3	1.3	256	272.7	0.9	59	31.9	1.8
2002	80	83.0	1.0	130	249.5	0.5	34	28.3	1.2
2003	58	72.3	0.8	103	282.1	0.4	24	25.1	1.0
2004	44	75.7	0.6	96	273.9	0.3	15	25.6	0.6
2005	41	76.4	0.5	102	270.3	0.4	17	21.1	0.8
2006	55	83.3	0.7	91	252.0	0.4	13	21.1	0.6
2007	49	87.6	0.6	111	239.9	0.5	22	22.4	1.0
2008	49	71.2	0.7	71	216.9	0.3	24	19.9	1.2
2009	27	73.8	0.4	67	190.9	0.4	13	21.4	0.6
2010	31	77.6	0.4	65	195.9	0.3	15	26.1	0.6

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.

	IRELAND											
	Ir Otter trawlers VIIg			Ir Beam trawlers VIIg			Ir Scottish seiners VIIg			Ir Gillnet VIIg		
Year	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	111.27	6.43	17.3	114.92		
1996	569.3	60.0	9.5	112.6	26.8	4.2	164.87	9.73	16.9	338.84		
1997	401.9	65.1	6.2	131.5	28.3	4.7	215.24	16.13	13.3	52.81		
1998	450.6	72.3	6.2	166.9	35.3	4.7	264.14	14.94	17.7	87.32		
1999	300.9	51.7	5.8	190.6	40.9	4.7	64.59	8.01	8.1	211.92		
2000	279.4	60.6	4.6	180.6	37.0	4.9	106.04	9.90	10.7	157.03		
2001	339.5	69.4	4.9	96.6	39.7	2.4	111.09	16.33	6.8	107.99		
2002	213.0	77.7	2.7	57.9	31.6	1.8	70.84	20.86	3.4	34.13		
2003	167.4	86.8	1.9	57.1	49.3	1.2	38.07	20.91	1.8	31.17		
2004	190.2	97.0	2.0	74.3	54.9	1.4	54.86	19.38	2.8	60.65		
2005	294.9	124.4	2.4	118.7	49.6	2.4	66.13	14.81	4.5	77.697		
2006	390.0	119.2	3.3	128.6	60.5	2.1	90.98	14.79	6.2	63.73		
2007	323.0	136.5	2.4	96.2	55.9	1.7	58.52	15.82	3.7	85.44		
2008	349.9	125.8	2.8	85.4	37.2	2.3	55.59	11.65	4.8	91.07		
2009	405.9	137.1	3.0	74.4	38.0	2.0	34.63	8.19	4.2	86.16		
2010	523.8	140.6	3.7	94.7	40.2	2.4	54.30	9.69	5.6	77.46		

	IRELAND											
	Ir Otter trawlers VIIj			Ir Beam trawlers VIIj			Ir Scottish seiners VIIj			Ir Gillnet VIIj		
Year	Landings	Effort	Lpue	Landings	Effort	Lpue	Landings	Effort	Lpue	Landings	Effort	Lpue
1995	338.5	93.7	3.6	0.0	0.2	0.2	75.52	5.26	14.4	179.57		
1996	326.4	70.2	4.6	8.7	1.5	5.9	124.55	8.15	15.3	64.96		
1997	352.8	83.2	4.2	3.4	1.8	1.9	115.81	10.73	10.8	45.47		
1998	262.7	89.6	2.9	19.2	5.2	3.7	103.37	6.61	15.6	59.13		
1999	76.7	40.6	1.9	27.5	7.4	3.7	9.57	1.41	6.8	24.01		
2000	95.5	64.6	1.5	21.2	6.9	3.1	23.71	3.49	6.8	13.98		
2001	140.7	67.7	2.1	10.4	3.0	3.5	27.95	4.42	6.3	12.69		
2002	150.1	90.4	1.7	5.4	3.1	1.7	24.65	8.87	2.8	12.23		
2003	74.4	111.3	0.7	8.8	9.0	1.0	14.72	9.15	1.6	6.17		
2004	36.1	92.0	0.4	2.5	2.2	1.2	11.57	9.18	1.3	4.21		
2005	40.6	73.9	0.5	4.7	2.4	1.9	17.76	6.09	2.9	3.30		
2006	42.7	65.9	0.6	2.0	1.5	1.3	15.64	5.33	2.9	7.18		
2007	39.0	80.5	0.5	7.8	2.4	3.3	9.83	3.51	2.8	6.50		
2008	33.5	66.5	0.5	2.6	1.1	2.3	9.46	2.84	3.3	6.66		
2009	26.6	73.1	0.4	4.7	2.8	1.7	8.90	3.33	2.7	7.52		
2010	51.9	85.3	0.6	1.7	1.0	1.7	17.04	4.35	3.9	7.86		

Table 7.2.9. Cod in Divisions VIIe–k. Tuning indices used for exploratory XSA.

```
Cod in Divisions VIIe-k, tuning fleets,WGCSE09

109
FR-GADOIDQ2+3+4 trawlers in VIIfgh  (effort hours fished, n° individuals)

1983       2008
1          1          0.25       1
1          7
74992      260899     98470      83167      51148      8708       2115       702        572        104        0
60554      264776     384489     34198      25074      19906      5260       935        437        0          0
73397      164991     240550     91883      13287      7830       9379       1514       913        0          0
85302      148440     222666     130804     49043      8106       5991       4158       40         0          0
107781     1316826    279848     110620     18501      7118       1708       1275       810        69         0
184408     611840     2024182    84860      41087      8973       5934       559        178        1109       0
166279     207852     813228     548423     29672      15390      5014       1389       784        526        0
155175     138846     311610     222389     124462     16526      6539       744        99         99         0
127064     362141     301828     35757      53178      34282      8598       1315       1087       0          0
132970     607817     492100     68181      9279       8984       5550       1371       89         0          0
155514     109856     674880     92481      17324      4642       4335       2188       633        134        0
121829     266023     117323     153569     30545      4085       1183       1013       369        0          0
128219     154493     617967     54352      54795      18932      4101       360        1064       0          0
123025     129647     526800     179949     18438      12552      4950       835        0          0          0
168156     154549     489043     185037     56522      12127      8228       1443       180        0          0
139326     131195     401923     81432      23640      9972       3497       908        753        262        131
138767     71952      142275     93463      22704      6301       4502       1186       1229       0          141
115310     340457     77158      33382      16050      3556       1798       1272       198        128        0
138521     297665     563912     19119      11523      8243       2818       1230       531        0          0
121794     65876      637726     168485     13416      4586       1956       409        958        417        272
91951      20159      158283     130617     31516      1855       1498       744        151        66         0
83130      32301      50715      33878      13601      5483       524        51         0          0          47
79120      24413      119375     8391       5027       6992       2273       281        55         195        0
55637      81151      145045     20670      2832       1422       1002       599        0          0          0
63360      114102     212783     61307      10796      1715       558        667        205        46         0
50415      18989      92047      25440      9205       2448       358        141        256        0          4
FR-NEPHROPS trawlers in VIIfgh (effort in hours fished, n° individuals)

1987       2008
1          1          0          1
1          7
191020     171757     81278      52746      23485      6513       3474       2209       572        0          0
172625     65228      505300     58116      18370      4627       2818       462        272        448        0
180285     34563      188872     192486     20017      10775      2101       1149       212        150        0
230684     21416      89684      91512      58839      7705       3522       1244       59         0          0
226146     75858      112496     25967      28891      14338      3934       1735       958        0          0
278998     111808     343353     57068      7023       9674       6450       1780       0          0          0
270056     8018       329369     114425     14046      2239       3051       2477       624        174        0
260993     252260     72275      124690     27001      4607       998        1276       112        0          0
240953     68020      496186     35291      33012      13081      2259       630        277        0          0
220922     55213      312231     123538     15095      10286      4442       1069       0          0          0
188417     66023      246609     100660     26480      6035       2803       379        0          0          0
155789     21185      199640     62447      22498      9037       2518       526        293        88         0
151470     30026      126600     50043      11822      3977       3592       479        454        0          0
194560     182011     46785      59385      22741      5160       1237       1394       376        0          0
171813     181989     288579     11628      12475      6849       2298       1209       548        0          0
172969     17408      295819     85715      6785       4737       1475       1051       192        47         47
200830     8630       76748      157290     41895      3331       1985       2252       390        0          0
161277     42683      48862      31193      29642      9297       1325       533        572        0          135
149785     23764      90000      11083      5094       10502      1972       102        33         16         0
137118     43216      144234     30017      4441       2430       3705       1090       189        0          0
102160     55030      140834     57818      10360      2225       1057       743        210        30         0
96987      22944      109279     42109      18589      5933       1333       950        366        76         0
UK-WECOT(E+W)Otter trawlers inVIIe, effort in 000's hours, numbers-at-age in 000's

1988  2010
1  1  0  1
1  6
53.402 59.047 38.995 0.728 0.178 0.076 0.194
54.707 3.49 12.604 11.944  0.835 0.75 0
53.05 4.783 3.591 11.303 5.755 1.245 0
40.789 27.281 3.388 1.789 2.664 2.547 1.022
39.909 14.758 29.177 1.993 0.636 0.468 0.923
39.174 0.73 10.494 3.703 0.25 0.141 0.102
38.768 18.196 1.402 3.165 1.208 0.166 0.063
35.453 10.755 24.948 1.959 0.647 0.098 0.013
30.541 4.259 14.297 4.475 0.42 0.095 0.103
33.281 30.644 7.783 4.526 1.656 0.462 0.27
29.802 3.832 13.999 3.394 1.297 0.317 0.102
27.516 2.297 3.100 6.927 0.865 0.247 0.136
30.493 19.065 2.024 1.858 1.946 0.526 0.305
31.900 7.723 16.722 1.026 0.365 0.622 0.107
28.346 1.151 8.922 3.165 0.136 0.135 0.059
25.052 0.312 2.679 3.268 0.536 0.046 0.024
25.584 1.005 1.019 0.872 0.793 0.189 0.035
21.129 0.750 4.031 0.423 0.213 0.170 0.083
21.058 0.605 2.934 1.011 0.054 0.061 0.022
22.352 2.266 4.208 1.965 0.250 0.022 0.026
19.860 1.979 4.415 1.649 0.459 0.079 0.015
21.412 0.360 1.575 1.103 0.224 0.086 0.018
26.062 3.662 0.952 0.942 0.425 0.112 0.033
IR-7J-OT Irish otter trawlers in VIIj, effort in 000s hours, N in 000s
```

Table 7.2.9. Continued.

```
1995       2008
1          1          0          1
1          6
93.642     30.597     121.744    9.697      7.883      0.505      0.222      0.044
70.226     23.109     54.566     49.072     5.6        1.197      0.787      0
83.171     26.433     69.525     30.08      8.289      0.997      0.115      0
89.61      17.685     77.44      10.809     7.534      2.833      1.147      0.236
40.61      0.992      9.714      7.894      2.783      0.394      0.187      0.099
78.499     21.299     6.65       5.494      3.23       0.982      0.267      0.102
83.84      21.418     51.569     2.569      1.76       0.428      0.107      0
90.446     10.898     44.185     10.786     1.392      0.22       0.109      0
118.809    1.935      8.802      11.822     0.884      0.218      0.026      0
91.957     6.154      6.154      11.877     1.622      0.859      0.054      0
73.919     10.613     10.613     12.326     3.143      0.739      0.382      0.19
65.346     23.346     23.346     14.377     1.983      0.394      0.179      0.031
80.485     9.898      9.898      16.569     1.588      0.187      0          0
66.349     0.597      13.715     1.998      0.329      0.062      0          0
IR-7G-OT Irish otter trawlers in VIIg, effort in 000s hours, N in 000s

2004       2008
1          1          0          1
1          7
96.991     40.668     21.027     12.303     6.798      1.908      0.401      0.115      0          0          0
124.395    80.602     50.632     24.284     11.276     3.76       0.646      0.236      0.038      0          0
118.364    29.629     108.106    37.295     2.458      0.977      1.106      0          0.121      0          0
131.323    15.307     62.794     37.138     6.312      1.011      0.499      0.036      0.036      0          0
129.313    3.078      69.57      35.902     8.996      1.839      0.46       0.113      0.098      0.071      0.015
IR-7GJ-OTB Irish otter trawlers in VIIg,j aggregated effort in 000s hours, N in 000s

2004       2010
1          1          0          1
1          7
188.948    46.822     32.904     13.925     7.657      1.962      0.401      0.000
198.31466  91.215     62.957     27.427     12.015     4.143      0.836      0.000
183.70985  52.974     122.483    39.278     2.852      1.156      1.136      0.000
211.80805  25.205     79.363     38.727     6.499      1.011      0.499      0.000
195.6619167           3.675      83.285     37.900     9.324      1.901      0.460      0.000
207.6318667           27.572     22.824     44.433     14.834     6.863      1.518      0.120
140.6473333           90.502     71.353     16.454     13.196     6.519      2.869      0.719
UK-WCGFS West Coast March survey, effort in mn towed, numbers *10**2, final survey in 2004

1992       2004
1          1          0.15       0.25
1          5
3774       2800       7100       400        200        200
3602       500        7250       4850       1230       100
1915       7400       600        3180       1130       300
3439       11200      14520      880        1400       700
3695       1300       6800       8500       1000       800
3826       3700       3200       3400       700        100
3744       1800       2500       2000       700        500
3823       200        1500       300        400        100
4092       3000       0          410        200        200
3700       1450       1100       1000       100        100
3387       200        5450       2960       430        100
2326       0          579        3154       410        100
1689       1400       0          200        1000       200
FR-EVHOE Groundfish  Oct-Nov survey in VIIf,g,h,j, numbers per 30 mn

1997       2010
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      0.210      0.028      0.094      0          0          2010
```

Table 7.2.9. Continued.

IR-GFSgj Irish Groundfish Survey (IBTS 4th Qtr) - VIIg-VIIjcombined Cod number-at-age (Effort Standardized to 1hr)

2003	2010							
1	1	0.79	0.92					
1	6							
1	0.45	0.52	0.53	0.15	0.00	0.00	0.00	2003
1	0.64	0.21	0.07	0.04	0.04	0.00	0.00	2004
1	2.87	0.28	0.11	0.00	0.00	0.00	0.00	2005
1	1.36	0.46	0.06	0.00	0.00	0.03	0.00	2006
1	1.88	0.65	0.21	0.06	0.00	0.00	0.00	2007
1	0.36	0.98	0.24	0.03	0.00	0.00	0.00	2008
1	1.16	0.14	0.17	0.03	0.00	0.00	0.00	2009
1	10.09	0.82	0.02	0.07	0.00	0.00	0.00	2010

IR-GFSg Irish Groundfish Survey (IBTS 4th Qtr) - VIIg Cod number-at-age (Interim indices for new Celtic Explorer series)

2003	2010							
1	1	0.79	0.92					
0	7							
832	0	6	10	10	4	0	0	2003
980	6	16	6	2	1	1	0	2004
845	2	29	8	1	0	0	0	2005
1046	1	38	11	2	0	0	1	2006
1168	0	50	16	7	2	0	0	2007
1139	0	10	25	6	1	0	0	2008
1018	4	32	4	5	1	0	0	2009
1381	1	286	27	1	1	0	0	2010

IR-GFSj Irish Groundfish Survey (IBTS 4th Qtr) - VIIj Cod number-at-age (Interim indices for new Celtic Explorer series)

2003	2010							
1	1	0.79	0.92					
0	7							
780	0	3	2	2	0	0	0	2003
720	0	1	0	0	0	0	0	2004
881	0	27	0	1	0	0	0	2005
901	0	3	2	0	0	0	0	2006
874	0	7	3	0	0	0	0	2007
873	0	1	4	1	0	0	0	2008
747	0	1	0	0	0	0	0	2009
1021	4	59	3	0	1	0	0	2010

Table 7.2.10. Cod in Divisions VIIe–k. XSA diagnostics.

```
Lowestoft VPA Version 3.1

   7/06/2011  14:00

 Extended Survivors Analysis

 Cod in Divisions VIIe-k,WGCSE11,index file

 cpue data from file fleets.txt

 Catch data for  40 years. 1971 to 2010. Ages  1 to   7.

      Fleet,           First, Last, First, Last, Alpha,  Beta
                     ,   year, year,  age ,  age
 FR-GADOIDQ2+3+4 traw,   1983, 2010,   1,     6,   .250,  1.000
 FR-NEPHROPS trawlers,   1987, 2010,   1,     6,   .000,  1.000
 UK-WECOT(E+W)Ottertr,   1989, 2010,   1,     6,   .000,  1.000
 IR-7J-OT Irish otter,   1995, 2010,   1,     6,   .000,  1.000
 IR-7G-OT Irish otter,   2004, 2010,   1,     6,   .000,  1.000
 IR-7GJ-OTB Irish ott,   2004, 2010,   1,     6,   .000,  1.000
 UK-WCGFS West Coast ,   1992, 2010,   1,     5,   .150,   .250
 FR-EVHOE Groundfish ,   1997, 2010,   1,     6,   .750,  1.000
 IR-GFS-7GJ combined:,   2003, 2010,   1,     6,   .790,   .920
 IR-GFS: Irish Ground,   2003, 2010,   0,     6,   .790,   .920
 IR-GFS: Irish Ground,   2003, 2010,   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 >=    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 =    .300

      Prior weighting applied :
      Fleet  Weight
      FR-GADOI  1.00
      FR-NEPHR  1.00
      UK-WECOT  1.00
      IR-7J-OT   .00
      IR-7G-OT   .00
      IR-7GJ-O  1.00
      UK-WCGFS  1.00
      FR-EVHOE  1.00
      IR-GFS-7  1.00
      IR-GFS:    .00
      IR-GFS:    .00

 Tuning had not converged after   30 iterations


 Total absolute residual between iterations
 29 and  30 =     .00226

 Final year F values
 Age         ,      1,      2,      3,      4,      5,      6
 Iteration 29,  .0511,  .4332,  .8247,  .4208,  .3655,  .1236
 Iteration 30,  .0511,  .4331,  .8242,  .4205,  .3646,  .1233


1


 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,  2001,  2002,  2003,  2004,  2005,  2006,  2007,  2008,  2009,  2010

      1,  .227,  .172,  .140,  .210,  .121,  .139,  .229,  .169,  .101,  .051
      2,  .916,  .891,  .938,  .758,  .809,  .750,  .958,  .679,  .722,  .433
      3,  .726, 1.143, 1.210,  .911, 1.027,  .845,  .823,  .677,  .693,  .824
      4,  .867,  .949, 1.025,  .877,  .777,  .505,  .496,  .487,  .452,  .420
      5, 1.243,  .838,  .603,  .899,  .615,  .488,  .341,  .376,  .330,  .365
      6, 1.034,  .726,  .574,  .775,  .403,  .357,  .248,  .249,  .265,  .123



1
 XSA population numbers (Thousands)

                                AGE
 YEAR ,           1,            2,            3,            4,            5,            6,

 2001 ,    5.94E+03, 4.37E+03, 2.91E+02, 1.87E+02, 1.09E+02, 3.26E+01,
```

```
2002 ,    1.47E+03, 3.88E+03, 1.43E+03, 1.15E+02, 6.43E+01, 2.57E+01,
2003 ,    8.71E+02, 1.01E+03, 1.30E+03, 3.74E+02, 3.66E+01, 2.28E+01,
2004 ,    1.99E+03, 6.20E+02, 3.23E+02, 3.18E+02, 1.10E+02, 1.64E+01,
2005 ,    2.87E+03, 1.32E+03, 2.38E+02, 1.06E+02, 1.08E+02, 3.66E+01,
2006 ,    3.13E+03, 2.08E+03, 4.82E+02, 6.96E+01, 4.01E+01, 4.79E+01,
2007 ,    2.65E+03, 2.23E+03, 8.06E+02, 1.70E+02, 3.44E+01, 2.01E+01,
2008 ,    8.74E+02, 1.72E+03, 7.01E+02, 2.90E+02, 8.46E+01, 2.00E+01,
2009 ,    1.84E+03, 6.04E+02, 7.16E+02, 2.92E+02, 1.46E+02, 4.75E+01,
2010 ,    1.18E+04, 1.36E+03, 2.40E+02, 2.93E+02, 1.52E+02, 8.58E+01,

Estimated population abundance at 1st Jan 2011

   ,     0.00E+00, 9.18E+03, 7.25E+02, 8.63E+01, 1.58E+02, 8.66E+01,

Taper weighted geometric mean of the VPA populations:

   ,     3.09E+03, 1.99E+03, 7.63E+02, 2.85E+02, 1.11E+02, 4.59E+01,

Standard error of the weighted Log(VPA populations) :

   ,        .8134,    .7597,    .7221,    .5953,    .5954,    .6260,
1

Log-catchability residuals.


Fleet : FR-GADOIDQ2+3+4 traw

 Age  ,  1983,  1984,  1985,  1986,  1987,  1988,  1989,  1990
    1 ,   .81,  1.01,   .46,   .41,   .69,   .14,   .40,  -.11
    2 ,   .20,   .78,  -.02,  -.01,   .13,  -.08,  -.06,   .42
    3 ,   .41,   .45,   .29,   .48,   .32,  -.53,   .12,   .11
    4 ,   .09,   .48,   .21,   .80,  -.20,  -.11,  -.51,   .16
    5 ,  -.12,   .22,  -.16,   .38,  -.14,  -.16,   .12,  -.04
    6 ,   .03,   .21,  -.20,   .01,  -.65,   .05,   .35,   .26


 Age  ,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000
    1 ,   .05,   .49,  -.21,  -.43,  -.68,  -.55,  -.96,  -.23,  -.01,   .16
    2 ,   .30,  -.28,  -.24,  -.67,  -.23,  -.06,  -.11,  -.32,  -.72,  -.27
    3 ,  -.09,   .21,  -.71,  -.07,  -.39,   .03,   .04,  -.23,  -.22,  -.51
    4 ,   .42,  -.20,  -.04,  -.24,   .29,  -.32,  -.06,  -.25,  -.07,  -.40
    5 ,   .49,   .03,   .14,  -.22,   .33,   .19,  -.05,  -.37,  -.09,  -.52
    6 ,   .74,  -.10,   .22,   .28,   .61,   .15,   .51,   .21,   .00,   .14


 Age  ,  2001,  2002,  2003,  2004,  2005,  2006,  2007,  2008,  2009,  2010
    1 ,  -.01,  -.02,  -.42,  -.64, -1.29,   .19,   .62,   .13, 99.99, 99.99
    2 ,  -.07,   .29,   .55,  -.10,   .07,   .13,   .44,  -.08, 99.99, 99.99
    3 ,  -.61,   .34,   .50,   .47,  -.50,  -.06,   .38,  -.22, 99.99, 99.99
    4 ,  -.38,   .42,   .43,  -.23,  -.14,  -.10,   .21,  -.26, 99.99, 99.99
    5 ,   .18,   .02,  -.18,   .08,   .22,  -.10,   .02,  -.27, 99.99, 99.99
    6 ,   .19,   .02,   .07,  -.44,   .06,  -.71,  -.62,  -.83, 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,   -7.6535,   -6.2434,   -6.4854,   -6.6922,   -6.8380,   -6.8380,
S.E(Log q),     .5529,     .3406,     .3786,     .3256,     .2345,     .3952,



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,     .724,      7.71,     .68,     26,     .50,   -7.65,
 2,    1.11,    -.960,      6.08,     .77,     26,     .38,   -6.24,
 3,     .92,     .809,      6.51,     .80,     26,     .35,   -6.49,
 4,     .94,     .658,      6.63,     .82,     26,     .31,   -6.69,
 5,     .89,    1.578,      6.61,     .90,     26,     .20,   -6.84,
 6,     .90,     .826,      6.52,     .75,     26,     .36,   -6.82,
1


Fleet : FR-NEPHROPS trawlers

 Age  ,  1983,  1984,  1985,  1986,  1987,  1988,  1989,  1990
    1 , 99.99, 99.99, 99.99, 99.99,  -.27,  -.39,   .15,  -.72
    2 , 99.99, 99.99, 99.99, 99.99,  -.54,  -.27,  -.48,  -.13
    3 , 99.99, 99.99, 99.99, 99.99,  -.18,   .00,  -.25,  -.40
    4 , 99.99, 99.99, 99.99, 99.99,   .09,  -.12,  -.25,  -.33
    5 , 99.99, 99.99, 99.99, 99.99,  -.24,  -.19,   .23,  -.62
    6 , 99.99, 99.99, 99.99, 99.99,   .07,  -.05,  -.05,  -.17


 Age  ,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000
    1 ,  -.44,  -.30, -1.72,   .41,  -.47,  -.33,  -.28,  -.52,   .65,   .65
    2 ,  -.16,  -.26,  -.37,  -.76,   .03,  -.04,   .19,  -.04,   .19,  -.18
    3 ,  -.21,   .07,  -.27,  -.28,  -.62,  -.17,   .07,   .15,  -.18,   .30
    4 ,  -.14,  -.53,  -.10,  -.44,  -.18,  -.40,  -.25,   .22,  -.14,   .11
    5 ,  -.45,  -.11,  -.59,  -.28,  -.09,  -.07,  -.27,  -.03,  -.13,  -.11
    6 ,  -.14,  -.18,  -.12,  -.16,  -.05,  -.04,  -.11,   .21,   .21,  -.25
```

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	.93	-.05	-.39	.63	-.29	.32	1.07	1.33	99.99	99.99
2	.16	.29	.15	.34	.28	.36	.65	.59	99.99	99.99
3	-.50	.07	.65	.52	-.08	.22	.65	.46	99.99	99.99
4	.16	.06	.59	.57	-.07	.19	.44	.53	99.99	99.99
5	.26	.25	.22	.49	.58	.14	.43	.58	99.99	99.99
6	.30	-.04	.16	.39	-.10	.33	.18	.47	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	-9.3603	-7.5172	-7.4390	-7.5298	-7.5399	-7.5399
S.E(Log q)	.6967	.3625	.3551	.3266	.3510	.2113

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.18	-.784	9.57	.48	22	.83	-9.36
2	1.14	-1.137	7.47	.76	22	.41	-7.52
3	1.09	-.722	7.49	.78	22	.39	-7.44
4	1.11	-.880	7.73	.77	22	.36	-7.53
5	1.23	-1.470	8.23	.66	22	.42	-7.54
6	1.16	-1.507	8.11	.82	22	.23	-7.50

1

Fleet : UK-WECOT(E+W)Ottertr

Age	1983	1984	1985	1986	1987	1988	1989	1990
1	99.99	99.99	99.99	99.99	99.99	99.99	-.14	.06
2	99.99	99.99	99.99	99.99	99.99	99.99	-.48	-.37
3	99.99	99.99	99.99	99.99	99.99	99.99	-.51	.30
4	99.99	99.99	99.99	99.99	99.99	99.99	-.64	.41
5	99.99	99.99	99.99	99.99	99.99	99.99	.41	.68
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	1.06	.43	-1.38	.50	.41	-.10	1.50	.25	.60	1.06
2	-.44	.73	-.37	-1.29	.46	.36	-.02	.47	-.30	.05
3	.16	-.02	-.45	-.72	-.27	-.18	.03	.22	.87	.01
4	.78	.61	-.61	-.05	-.60	-.41	.30	.61	.54	1.10
5	1.19	.46	.23	-.04	-1.42	-1.12	.54	-.08	.45	1.11
6	1.87	1.48	.06	.64	-1.64	-.17	-1.37	.31	.30	1.86

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	.27	-.14	-.82	-.47	-.97	-1.26	.21	1.27	-1.29	-1.05
2	.51	.11	.39	-.18	.65	-.15	.17	.48	.44	-1.20
3	.08	-.10	.18	.11	-.06	.03	.11	.13	-.36	.43
4	-.09	-.45	-.10	.38	.31	-.75	-.18	.01	-.80	-.38
5	1.20	.16	-.33	.08	.07	-.02	-1.01	-.50	-1.05	-1.01
6	.57	.20	-.52	.25	.34	-1.27	-.35	-.78	-1.53	-1.77

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	-10.1703	-9.0280	-8.7653	-9.1230	-9.1928	-9.1928
S.E(Log q)	.8557	.5492	.3398	.5460	.7655	1.0989

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	.77	1.178	9.71	.57	22	.66	-10.17
2	.88	.783	8.87	.69	22	.49	-9.03
3	1.19	-1.683	9.14	.81	22	.39	-8.77
4	.81	1.323	8.45	.70	22	.43	-9.12
5	.85	.605	8.51	.45	22	.66	-9.19
6	.97	.064	9.10	.21	20	1.09	-9.27

1

Fleet : IR-7J-OT Irish otter

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	99.99	99.99	99.99	99.99	.22	.50	.18	.40	-.89	-.04
2	99.99	99.99	99.99	99.99	.51	.31	.69	.51	-.11	-.27
3	99.99	99.99	99.99	99.99	-.27	.75	.38	-.35	-.02	-.48
4	99.99	99.99	99.99	99.99	.30	.73	.37	.65	.70	.03

```
    5 , 99.99, 99.99, 99.99, 99.99,  -.81,   .52,   .34,   .96,   .47,   .73
    6 , 99.99, 99.99, 99.99, 99.99,   .17,   .97,  -.89,  1.57,   .17,   .72


 Age  ,  2001,  2002,  2003,  2004,  2005,  2006,  2007,  2008,  2009,  2010
    1 ,   .06,   .68,  -.81,  -.20,   .16,   .99,   .14, -1.40, 99.99, 99.99
    2 ,   .10,  -.02,  -.54,  -.23,  -.20,   .23,  -.82,  -.16, 99.99, 99.99
    3 ,  -.60,  -.66,  -.72,   .81,  1.42,   .92,   .33, -1.51, 99.99, 99.99
    4 ,  -.11,   .10, -1.78,  -.81,  1.12,  1.09,  -.23, -2.15, 99.99, 99.99
    5 ,  -.19,  -.57,  -.39,   .26,   .23,   .66,  -.21, -2.00, 99.99, 99.99
    6 ,  -.46,  -.40, -2.05,  -.65,   .56,  -.37, 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,   -9.9086,   -8.4637,   -8.1349,   -8.4981,   -9.1363,   -9.1363,
S.E(Log q),     .6471,     .4233,     .8030,     .9858,     .7762,     .9655,



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,     .66,    2.426,      9.24,     .81,     14,     .36,   -9.91,
 2,     .72,    3.004,      8.25,     .90,     14,     .24,   -8.46,
 3,    1.51,   -1.005,      8.90,     .24,     14,    1.21,   -8.13,
 4,    2.05,   -1.167,     11.64,     .09,     14,    1.99,   -8.50,
 5,     .80,     .643,      8.19,     .45,     14,     .63,   -9.14,
 6,     .47,    1.863,      6.24,     .56,     12,     .41,   -9.19,
1


Fleet : IR-7G-OT Irish otter

 Age  ,  2001,  2002,  2003,  2004,  2005,  2006,  2007,  2008,  2009,  2010
    1 , 99.99, 99.99, 99.99,   .92,   .95,  -.08,  -.64, -1.14, 99.99, 99.99
    2 , 99.99, 99.99, 99.99,   .09,  -.02,   .31,  -.32,  -.06, 99.99, 99.99
    3 , 99.99, 99.99, 99.99,  -.21,   .58,   .28,  -.35,  -.30, 99.99, 99.99
    4 , 99.99, 99.99, 99.99,  -.29,  1.02,  -.15,  -.20,  -.37, 99.99, 99.99
    5 , 99.99, 99.99, 99.99,   .00,   .33,  -.03,  -.01,  -.28, 99.99, 99.99
    6 , 99.99, 99.99, 99.99,   .29,  -.44,  -.14,  -.23,  -.29, 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,   -9.1869,   -7.6050,   -7.1322,   -7.6369,   -8.1315,   -8.1315,
S.E(Log q),     .9305,     .2294,     .4085,     .5752,     .2182,     .3313,



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,     .50,    1.148,      8.42,     .64,      5,     .45,   -9.19,
 2,    1.11,    -.409,      7.64,     .81,      5,     .29,   -7.60,
 3,    2.43,   -1.899,      8.55,     .37,      5,     .77,   -7.13,
 4,    1.76,    -.962,      9.56,     .35,      5,    1.02,   -7.64,
 5,     .91,     .437,      7.79,     .89,      5,     .22,   -8.13,
 6,    1.42,    -.962,     10.40,     .64,      5,     .40,   -8.29,
1


Fleet : IR-7GJ-OTB Irish ott

 Age  ,  2001,  2002,  2003,  2004,  2005,  2006,  2007,  2008,  2009,  2010
    1 , 99.99, 99.99, 99.99,   .62,   .82,   .28,  -.40, -1.07,   .03,  -.28
    2 , 99.99, 99.99, 99.99,   .13,   .00,   .25,  -.31,  -.03,  -.31,   .27
    3 , 99.99, 99.99, 99.99,  -.36,   .61,   .27,  -.40,  -.27,  -.19,   .33
    4 , 99.99, 99.99, 99.99,  -.43,   .98,  -.02,  -.36,  -.42,   .01,   .24
    5 , 99.99, 99.99, 99.99,  -.35,   .19,  -.18,  -.24,  -.35,   .28,   .64
    6 , 99.99, 99.99, 99.99, 99.99,  -.21,  -.42, 99.99, 99.99,   .12,   .26


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,   -9.4092,   -7.8677,   -7.5197,   -8.0054,   -8.3986,   -8.3986,
S.E(Log q),     .6502,     .2395,     .3963,     .5019,     .3791,     .3144,
```

```
 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,     .84,     .524,      9.17,     .69,      7,     .58,   -9.41,
  2,     .95,     .279,      7.83,     .85,      7,     .25,   -7.87,
  3,    2.17,   -2.293,      9.17,     .44,      7,     .66,   -7.52,
  4,    1.58,   -1.094,      9.60,     .42,      7,     .78,   -8.01,
  5,     .72,    1.740,      7.29,     .88,      7,     .24,   -8.40,
  6,     .64,    1.294,      6.81,     .86,      4,     .18,   -8.46,
1


 Fleet : UK-WCGFS West Coast

  Age  ,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000
     1 , 99.99,  -.21,  -.68,  1.28,  1.47,  -.49,   .22,   .22, -1.25,  -.14
     2 , 99.99,   .38,   .39,  -.36,   .97,   .46,  -.04,  -.50,  -.34, 99.99
     3 , 99.99,  -.88,   .60,   .65,  -.28,   .94,   .27,   .13, -1.93, -1.12
     4 , 99.99,  -.35,  1.23,   .72,   .31,   .43,  -.57,  -.17,  -.45, -1.35
     5 , 99.99,  -.39,  -.06,  1.28,   .59,   .75, -1.10,   .11,  -.85,  -.17
     6 , No data for this fleet at this age


  Age  ,  2001,  2002,  2003,  2004,  2005,  2006,  2007,  2008,  2009,  2010
     1 ,  -.59, -1.09, 99.99,  1.25, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
     2 , -1.35,   .45,  -.06, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
     3 ,   .66,   .32,   .87,  -.23, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
     4 , -1.40,   .64,  -.19,  1.15, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
     5 ,  -.88,  -.35,   .55,   .52, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
     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 ,         1,         2,         3,         4,         5
 Mean Log q,   -8.9561,   -8.0222,   -7.4564,   -7.2239,   -7.1322,
 S.E(Log q),     .9213,     .6306,     .8641,     .8441,     .7160,



 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,     .61,    1.575,      8.71,     .63,     12,     .53,   -8.96,
  2,     .74,     .968,      8.04,     .61,     11,     .47,   -8.02,
  3,     .72,    1.000,      7.29,     .54,     13,     .62,   -7.46,
  4,    1.10,    -.192,      7.39,     .24,     13,     .97,   -7.22,
  5,    1.16,    -.318,      7.54,     .27,     13,     .86,   -7.13,
1


 Fleet : FR-EVHOE Groundfish

  Age  ,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000
     1 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99,  -.86,  -.15,   .40,   .71
     2 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99,  -.94,   .60,   .15,  -.48
     3 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99,   .17,   .35,   .54,   .20
     4 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99,   .08,  -.28, -1.24,   .02
     5 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99,   .19,  -.11,   .27,  -.69
     6 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99,  -.01, 99.99


  Age  ,  2001,  2002,  2003,  2004,  2005,  2006,  2007,  2008,  2009,  2010
     1 ,   .46, -1.27,  -.32,  -.85,   .06,  -.72,   .47,  1.13,   .41,   .54
     2 ,  -.60,   .05,  -.59,  1.00,   .10,  -.26,   .25,  -.12,   .54,   .30
     3 ,  -.67,  -.27,  -.16,   .30,   .44, 99.99,  -.21,  -.19,  -.08,  -.42
     4 ,   .02, 99.99,  -.06,   .67, 99.99,   .93,  -.34,   .18,  -.06,   .09
     5 ,  -.18,  -.19,  -.46,   .45,  -.36,  1.08, 99.99, 99.99, 99.99, 99.99
     6 ,  -.10, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99,   .04, 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,   -9.1081,   -8.5263,   -7.7390,   -7.5929,   -7.2665,   -7.2665,
 S.E(Log q),     .7096,     .5356,     .3618,     .5306,     .5120,     .0785,



 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,     .92,     .337,      9.01,     .59,     14,     .68,   -9.11,
  2,    1.36,   -1.229,      8.91,     .49,     14,     .71,   -8.53,
  3,     .91,     .669,      7.62,     .82,     13,     .34,   -7.74,
  4,    1.57,   -1.225,      8.74,     .31,     12,     .82,   -7.59,
  5,    1.21,    -.488,      7.86,     .40,     10,     .65,   -7.27,
  6,     .86,    1.103,      6.80,     .98,      3,     .06,   -7.29,
1
```

```
 Fleet : IR-GFS-7GJ combined:

  Age  ,  2001,  2002,  2003,  2004,  2005,  2006,  2007,  2008,  2009,  2010
     1 , 99.99, 99.99,  -.10,  -.52,   .54,  -.28,   .29,  -.31,   .06,   .32
     2 , 99.99, 99.99,   .56,  -.01,  -.44,  -.44,   .01,   .44,  -.42,   .29
     3 , 99.99, 99.99,   .84,  -.05,   .81,  -.66,   .06,   .21,  -.14, -1.08
     4 , 99.99, 99.99,  1.09,  -.19, 99.99, 99.99,   .52,  -.72,  -.76,   .06
     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,   -7.1728,   -7.1633,   -7.4411,   -7.8683,     .0000,     .0000,
 S.E(Log q),     .3656,     .4066,     .6575,     .7198,     .0000,     .0000,
```

```
 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,     .82,    1.418,      7.28,     .91,      8,     .28,   -7.17,
  2,     .94,     .191,      7.16,     .64,      8,     .41,   -7.16,
  3,     .71,    1.012,      7.09,     .67,      8,     .47,   -7.44,
  4,    1.06,    -.039,      7.99,     .11,      6,     .85,   -7.87,
  5,     .00,     .000,       .00,     .00,      0,     .00,     .00,
  6,     .00,     .000,       .00,     .00,      0,     .00,     .00,
1
```

```
 Fleet : IR-GFS: Irish Ground

  Age  ,  2001,  2002,  2003,  2004,  2005,  2006,  2007,  2008,  2009,  2010
     1 , 99.99, 99.99,  -.38,  -.33,  -.03,  -.05,   .36,  -.16,   .31,   .29
     2 , 99.99, 99.99,   .48,   .14,  -.14,  -.54,  -.17,   .32,  -.31,   .23
     3 , 99.99, 99.99,   .74,   .11,  -.03,  -.41,   .20,   .08,   .01,  -.70
     4 , 99.99, 99.99,  1.35,  -.16, 99.99, 99.99,   .66,  -.55,  -.48,  -.81
     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,  -11.0280,  -10.8428,  -11.1334,  -11.5662,     .0000,     .0000,
 S.E(Log q),     .2923,     .3471,     .4274,     .8340,     .0000,     .0000,
```

```
 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,     .82,    1.845,     10.45,     .95,      8,     .21,  -11.03,
  2,    1.15,    -.468,     11.40,     .62,      8,     .42,  -10.84,
  3,     .67,    2.595,      9.49,     .91,      8,     .21,  -11.13,
  4,    1.11,    -.061,     12.19,     .08,      6,    1.03,  -11.57,
  5,     .00,     .000,       .00,     .00,      0,     .00,     .00,
  6,     .00,     .000,       .00,     .00,      0,     .00,     .00,
1
```

```
 Fleet : IR-GFS: Irish Ground

  Age  ,  2001,  2002,  2003,  2004,  2005,  2006,  2007,  2008,  2009,  2010
     1 , 99.99, 99.99,   .71, -1.08,  1.57,  -.72,   .40,  -.48, -1.13,   .73
     2 , 99.99, 99.99,   .46, 99.99, 99.99,  -.57,  -.03,   .28, 99.99,  -.14
     3 , 99.99, 99.99,  -.03, 99.99,   .70, 99.99, 99.99,  -.67, 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,  -12.7457,  -12.3684,  -11.9041,     .0000,     .0000,     .0000,
S.E(Log q),     .9910,     .3986,     .6864,     .0000,     .0000,     .0000,



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,     .75,     .696,     11.51,     .57,      8,     .78,  -12.75,
 2,    4.43,   -1.411,     29.45,     .05,      5,    1.58,  -12.37,
 3,    2.10,    -.871,     17.95,     .39,      3,    1.54,  -11.90,
 4,     .00,     .000,       .00,     .00,      0,     .00,     .00,
 5,     .00,     .000,       .00,     .00,      0,     .00,     .00,
 6,     .00,     .000,       .00,     .00,      0,     .00,     .00,
1


Terminal year survivor and F summaries :

Age  1   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-GADOIDQ2+3+4 traw,        1.,   .000,       .000,    .00,   0,  .000,     .000
FR-NEPHROPS trawlers,        1.,   .000,       .000,    .00,   0,  .000,     .000
UK-WECOT(E+W)Ottertr,     3228.,   .875,       .000,    .00,   1,  .101,     .139
IR-7J-OT Irish otter,        1.,   .000,       .000,    .00,   0,  .000,     .000
IR-7G-OT Irish otter,        1.,   .000,       .000,    .00,   0,  .000,     .000
IR-7GJ-OTB Irish ott,     6944.,   .695,       .000,    .00,   1,  .160,     .067
UK-WCGFS West Coast ,        1.,   .000,       .000,    .00,   0,  .000,     .000
FR-EVHOE Groundfish ,    15790.,   .735,       .000,    .00,   1,  .143,     .030
IR-GFS-7GJ combined:,    12682.,   .388,       .000,    .00,   1,  .514,     .037
IR-GFS: Irish Ground,        1.,   .000,       .000,    .00,   0,  .000,     .000
IR-GFS: Irish Ground,        1.,   .000,       .000,    .00,   0,  .000,     .000

  F shrinkage mean  ,     2922.,   1.00,,,,                        .081,     .152

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     9185.,       .28,      .29,    5,   1.039,   .051


1
Age  2   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-GADOIDQ2+3+4 traw,        1.,   .000,       .000,    .00,   0,  .000,     .000
FR-NEPHROPS trawlers,        1.,   .000,       .000,    .00,   0,  .000,     .000
UK-WECOT(E+W)Ottertr,      213.,   .473,       .039,    .08,   2,  .124,    1.045
IR-7J-OT Irish otter,        1.,   .000,       .000,    .00,   0,  .000,     .000
IR-7G-OT Irish otter,        1.,   .000,       .000,    .00,   0,  .000,     .000
IR-7GJ-OTB Irish ott,      914.,   .276,       .082,    .30,   2,  .369,     .358
UK-WCGFS West Coast ,        1.,   .000,       .000,    .00,   0,  .000,     .000
FR-EVHOE Groundfish ,     1016.,   .443,       .053,    .12,   2,  .140,     .327
IR-GFS-7GJ combined:,      856.,   .289,       .114,    .39,   2,  .324,     .378
IR-GFS: Irish Ground,        1.,   .000,       .000,    .00,   0,  .000,     .000
IR-GFS: Irish Ground,        1.,   .000,       .000,    .00,   0,  .000,     .000

  F shrinkage mean  ,      325.,   1.00,,,,                        .044,     .792

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      725.,       .17,      .18,    9,   1.087,   .433


1
Age  3   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-GADOIDQ2+3+4 traw,       98.,   .563,       .000,    .00,   1,  .030,     .752
FR-NEPHROPS trawlers,      324.,   .712,       .000,    .00,   1,  .019,     .293
UK-WECOT(E+W)Ottertr,      139.,   .294,       .131,    .45,   3,  .239,     .585
IR-7J-OT Irish otter,        1.,   .000,       .000,    .00,   0,  .000,     .000
IR-7G-OT Irish otter,        1.,   .000,       .000,    .00,   0,  .000,     .000
IR-7GJ-OTB Irish ott,       81.,   .247,       .296,   1.20,   3,  .272,     .859
UK-WCGFS West Coast ,        1.,   .000,       .000,    .00,   0,  .000,     .000
FR-EVHOE Groundfish ,       75.,   .303,       .367,   1.21,   3,  .217,     .904
IR-GFS-7GJ combined:,       49.,   .285,       .229,    .80,   3,  .170,    1.176
IR-GFS: Irish Ground,        1.,   .000,       .000,    .00,   0,  .000,     .000
IR-GFS: Irish Ground,        1.,   .000,       .000,    .00,   0,  .000,     .000

  F shrinkage mean  ,       87.,   1.00,,,,                        .053,     .822

Weighted prediction :
```

```
 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       86.,        .14,      .14,   15,   1.013,   .824


1
 Age  4   Catchability constant w.r.t. time and dependent on age

 Year class = 2006

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,     F
 FR-GADOIDQ2+3+4 traw,       172.,   .297,       .295,    .99,   2,  .072,     .392
 FR-NEPHROPS trawlers,       310.,   .330,       .181,    .55,   2,  .059,     .236
 UK-WECOT(E+W)Ottertr,       120.,   .280,       .152,    .54,   4,  .223,     .521
 IR-7J-OT Irish otter,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-7G-OT Irish otter,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-7GJ-OTB Irish ott,       158.,   .251,       .114,    .45,   4,  .251,     .419
 UK-WCGFS West Coast ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FR-EVHOE Groundfish ,       159.,   .288,       .076,    .27,   4,  .212,     .417
 IR-GFS-7GJ combined:,       188.,   .310,       .122,    .39,   4,  .142,     .364
 IR-GFS: Irish Ground,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-GFS: Irish Ground,         1.,   .000,       .000,    .00,   0,  .000,     .000

   F shrinkage mean  ,       113.,   1.00,,,,                        .040,     .548

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       158.,       .13,      .07,   21,    .549,   .420


1
 Age  5   Catchability constant w.r.t. time and dependent on age

 Year class = 2005

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,     F
 FR-GADOIDQ2+3+4 traw,        87.,   .263,       .211,    .80,   3,  .101,     .362
 FR-NEPHROPS trawlers,       142.,   .270,       .067,    .25,   3,  .101,     .237
 UK-WECOT(E+W)Ottertr,        55.,   .285,       .264,    .93,   5,  .196,     .522
 IR-7J-OT Irish otter,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-7G-OT Irish otter,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-7GJ-OTB Irish ott,       113.,   .246,       .205,    .84,   5,  .332,     .291
 UK-WCGFS West Coast ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FR-EVHOE Groundfish ,        76.,   .294,       .099,    .34,   4,  .141,     .405
 IR-GFS-7GJ combined:,        66.,   .330,       .221,    .67,   4,  .088,     .456
 IR-GFS: Irish Ground,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-GFS: Irish Ground,         1.,   .000,       .000,    .00,   0,  .000,     .000

   F shrinkage mean  ,        70.,   1.00,,,,                        .041,     .433

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       87.,        .12,      .10,   25,    .796,   .365


1
 Age  6   Catchability constant w.r.t. time and age (fixed at the value for age)  5

 Year class = 2004

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,     F
 FR-GADOIDQ2+3+4 traw,        55.,   .230,       .204,    .89,   4,  .155,     .138
 FR-NEPHROPS trawlers,       105.,   .232,       .088,    .38,   4,  .153,     .075
 UK-WECOT(E+W)Ottertr,        38.,   .300,       .315,   1.05,   6,  .132,     .192
 IR-7J-OT Irish otter,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-7G-OT Irish otter,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-7GJ-OTB Irish ott,        73.,   .215,       .115,    .53,   6,  .399,     .106
 UK-WCGFS West Coast ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FR-EVHOE Groundfish ,        60.,   .297,       .112,    .38,   4,  .080,     .126
 IR-GFS-7GJ combined:,        51.,   .323,       .291,    .90,   4,  .053,     .148
 IR-GFS: Irish Ground,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-GFS: Irish Ground,         1.,   .000,       .000,    .00,   0,  .000,     .000

   F shrinkage mean  ,        11.,   1.00,,,,                        .028,     .541

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       62.,        .11,      .10,   29,    .906,   .123


1
1
```

Table 7.2.11. Cod in Divisions VIIe–k. Fishing mortality-at-age.

Table 8 Fishing mortality (F) at age										
YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
AGE										
1	0.3018	0.0078	0.249	0.0022	0.2123	0.0481	0.0163	0.1381	0.1214	0.0888
2	0.809	0.6151	0.8558	0.2653	0.4592	0.981	0.6742	0.5077	0.3971	0.5741
3	0.7095	0.451	0.6237	0.3239	0.3659	0.3846	0.4005	0.4534	0.5578	0.645
4	0.6013	0.6242	0.4775	0.4473	1.2461	0.3741	0.1518	0.3506	0.461	0.9338
5	0.3938	0.6387	0.4815	0.6414	0.9494	0.7885	0.3721	0.3106	0.6159	0.792
6	0.573	0.5761	0.5318	0.4744	0.8628	0.5199	0.31	0.374	0.5494	0.7983
+gp	0.573	0.5761	0.5318	0.4744	0.8628	0.5199	0.31	0.374	0.5494	0.7983
0 FBAR 2- 5	0.6284	0.5822	0.6096	0.4195	0.7551	0.6321	0.3997	0.4056	0.508	0.7362
YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	0.1096	0.0646	0.3678	0.2089	0.2308	0.2532	0.2022	0.2839	0.351	0.1635
2	0.8544	0.7329	0.8371	0.7161	0.6529	0.8421	0.7161	0.7839	0.8632	1.0569
3	1.0031	0.6433	0.9579	0.5195	0.6756	0.9368	0.8093	0.5662	1.0878	1.0167
4	0.9015	0.5789	0.7475	0.4345	0.476	1.0326	1.2175	0.6014	0.5676	1.0264
5	0.5832	0.5456	0.5733	0.3581	0.3203	0.456	0.7747	0.7649	0.875	0.6829
6	0.8379	0.5944	0.7278	0.3149	0.3052	0.4422	0.6356	0.6617	0.7964	0.6273
+gp	0.8379	0.5944	0.7278	0.3149	0.3052	0.4422	0.6356	0.6617	0.7964	0.6273
0 FBAR 2- 5	0.8355	0.6252	0.7789	0.507	0.5312	0.8169	0.8794	0.6791	0.8484	0.9457
YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	0.2284	0.2305	0.1428	0.1809	0.1574	0.154	0.222	0.2427	0.4165	0.3004
2	0.9755	0.8961	0.7415	0.6417	0.9163	0.8413	0.9578	1.0573	0.9137	0.8925
3	0.9693	1.0278	0.9994	1.1357	0.6778	1.0836	1.1448	1.1158	1.1443	1.1084
4	1.2268	0.8176	0.7474	0.8744	0.9453	0.7171	0.8954	1.1997	0.9619	0.878
5	1.108	0.9794	0.8663	0.6237	0.6596	1.0297	0.6138	0.8907	1.0728	0.7982
6	1.298	1.0408	0.8014	1.2083	0.7116	1.1146	0.7117	1.4977	1.0165	1.1299
+gp	1.298	1.0408	0.8014	1.2083	0.7116	1.1146	0.7117	1.4977	1.0165	1.1299
0 FBAR 2- 5	1.0699	0.9302	0.8386	0.8189	0.7997	0.9179	0.9029	1.0659	1.0232	0.9193
YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE										
1	0.2268	0.1725	0.1401	0.2096	0.1206	0.139	0.2292	0.1692	0.1014	0.0511
2	0.9157	0.891	0.9383	0.7584	0.809	0.7497	0.9582	0.679	0.7221	0.4331
3	0.7256	1.1428	1.2103	0.9115	1.0271	0.8452	0.8234	0.677	0.6935	0.8242
4	0.8669	0.9487	1.0246	0.8775	0.7766	0.5054	0.4958	0.487	0.4522	0.4205
5	1.2425	0.838	0.6032	0.8991	0.6155	0.4879	0.3413	0.3763	0.3295	0.3646
6	1.0336	0.7256	0.5744	0.7751	0.4033	0.3568	0.2478	0.2495	0.2646	0.1233
+gp	1.0336	0.7256	0.5744	0.7751	0.4033	0.3568	0.2478	0.2495	0.2646	0.1233
0 FBAR 2- 5	0.9377	0.9551	0.9441	0.8616	0.807	0.647	0.6547	0.5548	0.5493	0.5106

Table 7.2.12. Cod in Divisions VIIe–k. Stock numbers-at-age.

Table 10	Stock number at age (start of year)				Numbers*10**-3						
	YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	AGE										
	1	3075	565	1665	500	3888	1201	1713	1688	4233	7925
	2	919	1862	459	1063	408	2574	937	1380	1204	3069
	3	1212	335	824	160	667	211	790	391	680	663
	4	235	488	175	362	95	379	118	433	203	319
	5	119	105	214	89	189	22	213	83	250	105
	6	43	66	46	108	38	60	8	120	50	111
	+gp	28	42	29	104	62	19	70	70	83	28
0	TOTAL	5630	3464	3411	2385	5348	4467	3850	4166	6703	12219
	YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
	AGE										
	1	3355	1343	4614	4320	3892	3217	16551	8184	2486	2638
	2	5937	2461	1031	2615	2870	2530	2045	11071	5044	1433
	3	1415	2069	968	366	1046	1223	892	818	4139	1742
	4	285	425	890	304	178	436	392	325	380	1142
	5	103	95	195	345	161	91	127	95	146	176
	6	39	47	45	90	198	96	47	48	36	50
	+gp	23	12	23	20	63	52	35	18	22	37
0	TOTAL	11156	6452	7767	8060	8408	7644	20089	20558	12254	7219
	YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	AGE										
	1	7454	7698	2275	8950	6244	4778	6573	3278	1609	7212
	2	1834	4857	5005	1615	6115	4367	3354	4310	2105	869
	3	408	566	1623	1952	696	2003	1542	1054	1226	691
	4	516	127	166	489	513	289	555	402	283	320
	5	335	124	46	64	167	163	116	186	99	88
	6	73	91	38	16	28	71	48	51	62	28
	+gp	21	29	32	26	11	6	13	11	24	22
0	TOTAL	10641	13490	9184	13113	13775	11678	12199	9291	5408	9230
	YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	AGE										
	1	5941	1465	871	1993	2870	3133	2649	874	1845	11804
	2	4373	3877	1009	620	1323	2083	2232	1724	604	1365
	3	291	1433	1302	323	238	482	806	701	716	240
	4	187	115	374	318	106	70	170	290	292	293
	5	109	64	37	110	108	40	34	85	146	152
	6	33	26	23	16	37	48	20	20	48	86
	+gp	32	23	18	14	7	18	20	20	9	19
0	TOTAL	10965	7004	3633	3394	4688	5874	5931	3713	3659	13958

Table 7.2.13. Cod in Divisions VIIe–k. XSA Summary table.

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 5
	Age 1					
1971	3075	12742	8928	5782	0.6476	0.6284
1972	565	10984	8225	4737	0.5759	0.5822
1973	1665	9815	7668	4015	0.5236	0.6096
1974	500	9127	7411	2898	0.391	0.4195
1975	3888	10062	6628	3993	0.6024	0.7551
1976	1201	10096	6301	4818	0.7646	0.6321
1977	1713	10314	7687	3059	0.398	0.3997
1978	1688	11621	8617	3647	0.4232	0.4056
1979	4233	13488	8934	4650	0.5205	0.508
1980	7925	18428	9436	7243	0.7676	0.7362
1981	3355	18058	10329	10597	1.026	0.8355
1982	1343	17453	13011	8766	0.6737	0.6252
1983	4614	17745	13443	9641	0.7172	0.7789
1984	4320	16078	10361	6631	0.64	0.507
1985	3892	20249	13534	8317	0.6145	0.5312
1986	3217	19104	13405	10475	0.7814	0.8169
1987	16551	22616	10764	10228	0.9502	0.8794
1988	8184	33674	14616	17191	1.1761	0.6791
1989	2486	33202	23970	19809	0.8264	0.8484
1990	2638	22592	17856	12749	0.714	0.9457
1991	7454	16116	9888	9336	0.9442	1.0699
1992	7698	17475	8069	9747	1.2079	0.9302
1993	2275	17729	10923	10425	0.9544	0.8386
1994	8950	21382	12912	10620	0.8225	0.8189
1995	6244	21480	11611	11709	1.0084	0.7997
1996	4778	22230	14295	12681	0.8871	0.9179
1997	6573	19808	12740	12035	0.9446	0.9029
1998	3278	16739	11123	11431	1.0277	1.0659
1999	1609	13644	9593	8594	0.8958	1.0232
2000	7212	11929	6457	6536	1.0122	0.9193
2001	5941	14933	7021	8308	1.1833	0.9377
2002	1465	13776	9402	9236	0.9824	0.9551
2003	871	10380	8275	6420	0.7758	0.9441
2004	1993	6791	4817	3672	0.7623	0.8616
2005	2870	6988	3768	3062	0.8126	0.807
2006	3133	8371	4325	3776	0.873	0.647
2007	2649	10160	5863	4830	0.8238	0.6547
2008	874	9426	6621	3961	0.5982	0.5548
2009	1845	9327	6503	3292	0.5062	0.5493
2010	11804	17449	6317	3229	0.5112	0.5106
Arith.						
Mean	4164	15590	9791	7804	0.7817	0.7458
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 7.2.13. Cod in Divisions VIIe–k. Comparison between XSA outputs using all tuning indices and an exploratory run based only on survey indices.

Year	Recuits (age 1)		SSB		FBAR 2–5	
	Standard	Survey only	Standard	Survey only	Standard	Survey only
	XSA		XSA		XSA	
1971	3075	3075	8928	8927	0.6284	0.6285
1972	565	565	8225	8223	0.5822	0.5824
1973	1665	1662	7668	7665	0.6096	0.6099
1974	500	498	7411	7404	0.4195	0.4199
1975	3888	3882	6628	6616	0.7551	0.7569
1976	1201	1197	6301	6280	0.6321	0.6346
1977	1713	1701	7687	7645	0.3997	0.4022
1978	1688	1669	8617	8550	0.4056	0.4095
1979	4233	4143	8934	8830	0.508	0.5159
1980	7925	7713	9436	9241	0.7362	0.7596
1981	3355	3256	10329	9939	0.8355	0.8911
1982	1343	1313	13011	11993	0.6252	0.6976
1983	4614	4613	13443	11836	0.7789	0.9207
1984	4320	4313	10361	8472	0.507	0.5936
1985	3892	3863	13534	11638	0.5312	0.587
1986	3217	3235	13405	12472	0.8169	0.8499
1987	16551	16565	10764	10362	0.8794	0.8925
1988	8184	8180	14616	14516	0.6791	0.697
1989	2486	2494	23970	23896	0.8484	0.8798
1990	2638	2635	17856	17735	0.9457	0.9307
1991	7454	7470	9888	10048	1.0699	1.0584
1992	7698	7682	8069	8158	0.9302	0.926
1993	2275	2302	10923	10947	0.8386	0.8151
1994	8950	8947	12912	13047	0.8189	0.8174
1995	6244	6256	11611	11667	0.7997	0.791
1996	4778	4769	14295	14392	0.9179	0.9263
1997	6573	6559	12740	12780	0.9029	0.8825
1998	3278	3261	11123	11265	1.0659	1.0632
1999	1609	1599	9593	9548	1.0232	1.0125
2000	7212	7230	6457	6419	0.9193	0.9544
2001	5941	5902	7021	6789	0.9377	1.0016
2002	1465	1530	9402	9209	0.9551	1.0206
2003	871	869	8275	8107	0.9441	0.9576
2004	1993	1976	4817	4834	0.8616	0.8241
2005	2870	2689	3768	3885	0.807	0.7923
2006	3133	2998	4325	4240	0.647	0.6205
2007	2649	2605	5863	5983	0.6547	0.7519
2008	874	805	6621	5556	0.5548	0.7091
2009	1845	2022	6503	5107	0.5493	0.8127
2010	11804	14517	6317	4504	0.5106	0.6864

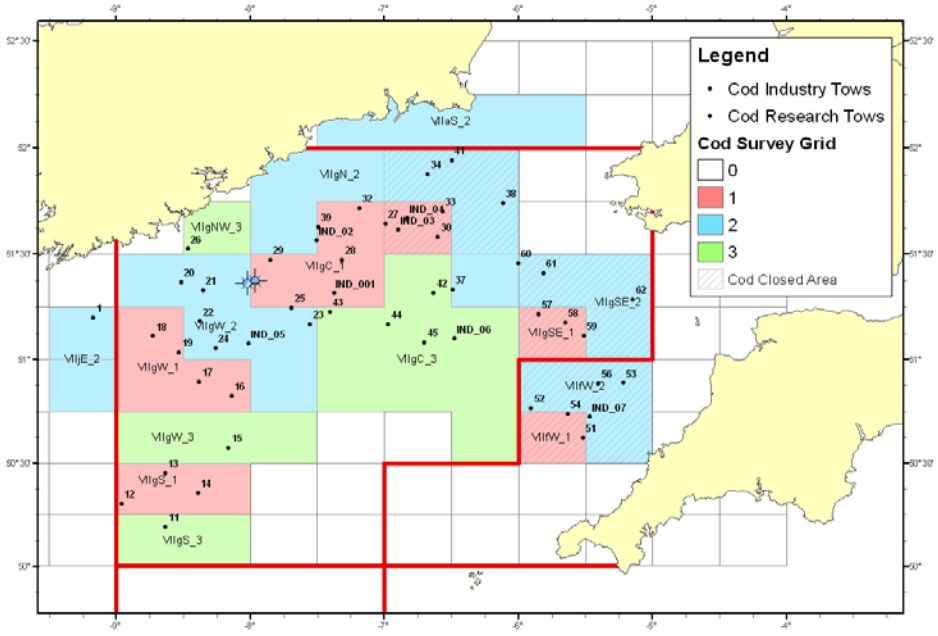


Figure 7.2.1. Irish industry and science survey. Map of sampled stations.

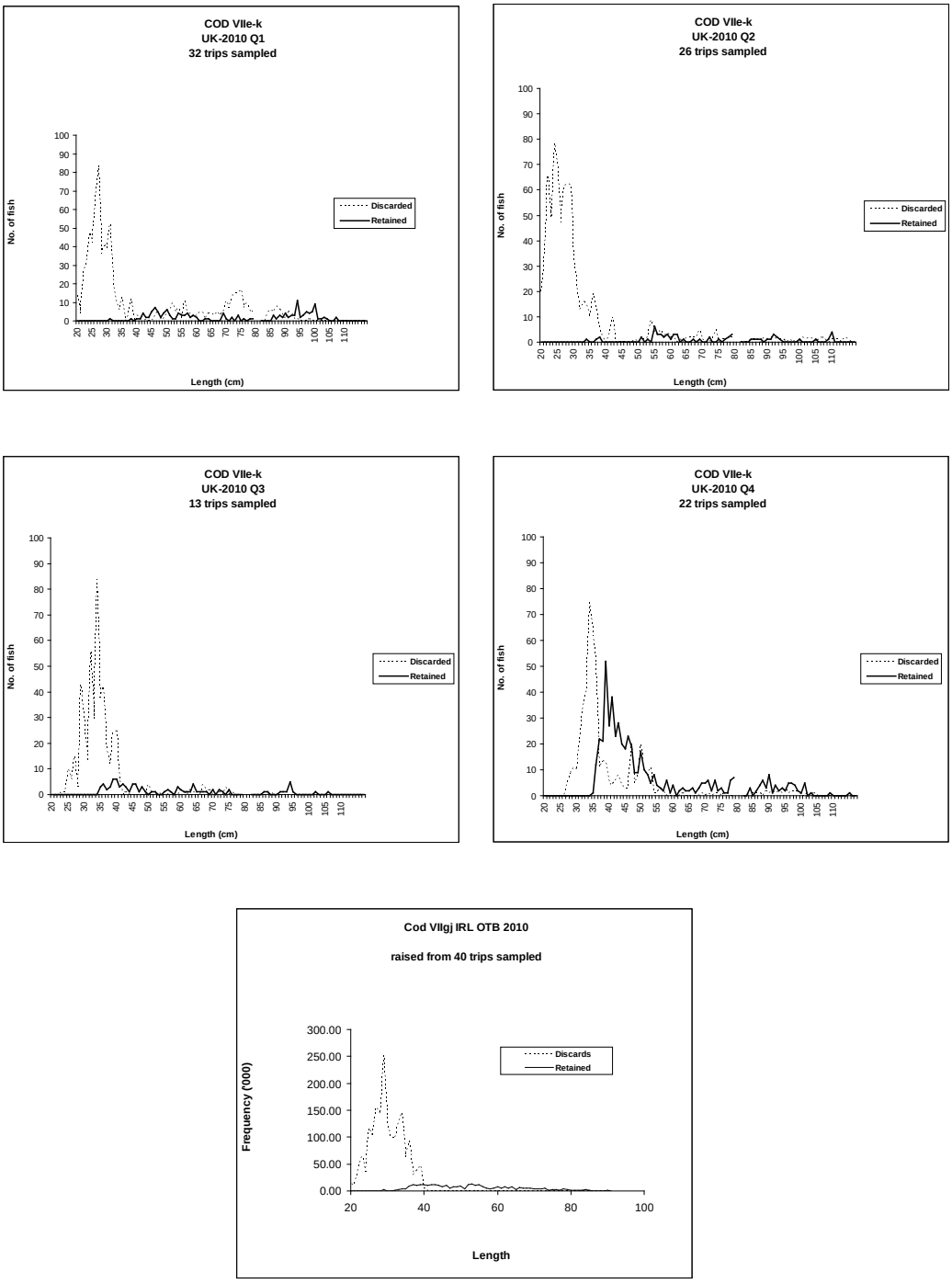


Figure 7.2.2a. Cod in Divisions VIIe–k. 2010 Quarterly or annual length compositions of UK, Irish discards raised using effort ratio for Irish data, from hauls sampled for UK.

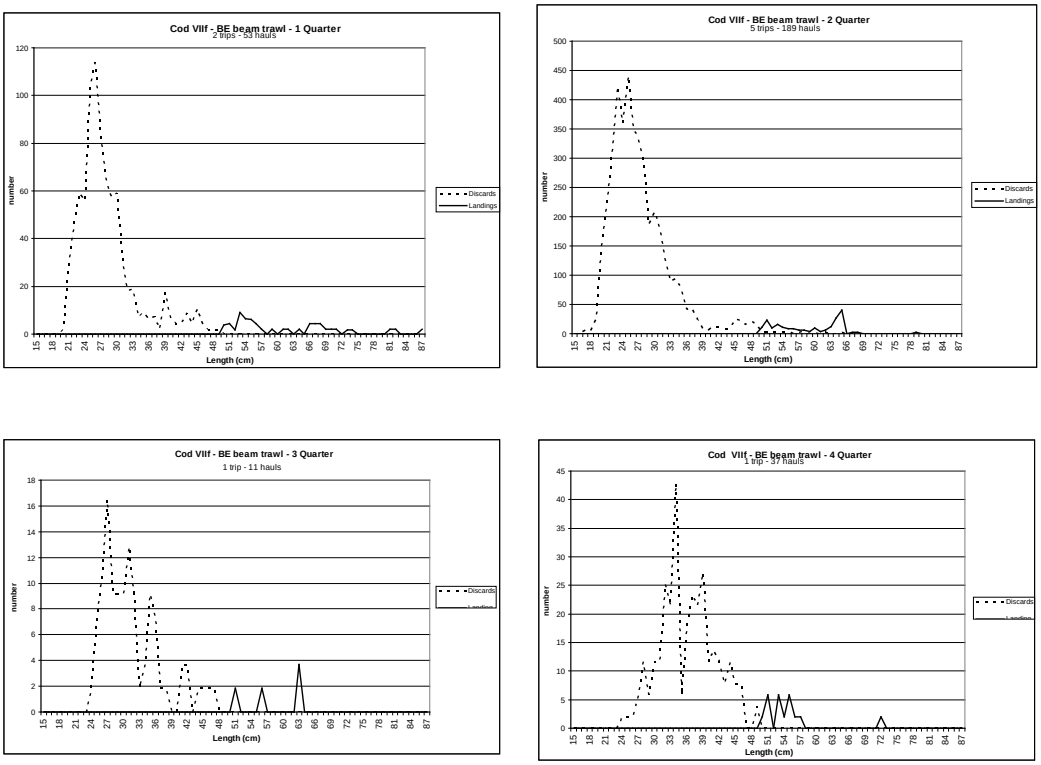


Figure 7.2.2b. Cod in Divisions VIIe–k. 2010 Quarterly or annual length compositions of Belgian discards from observers at sea.

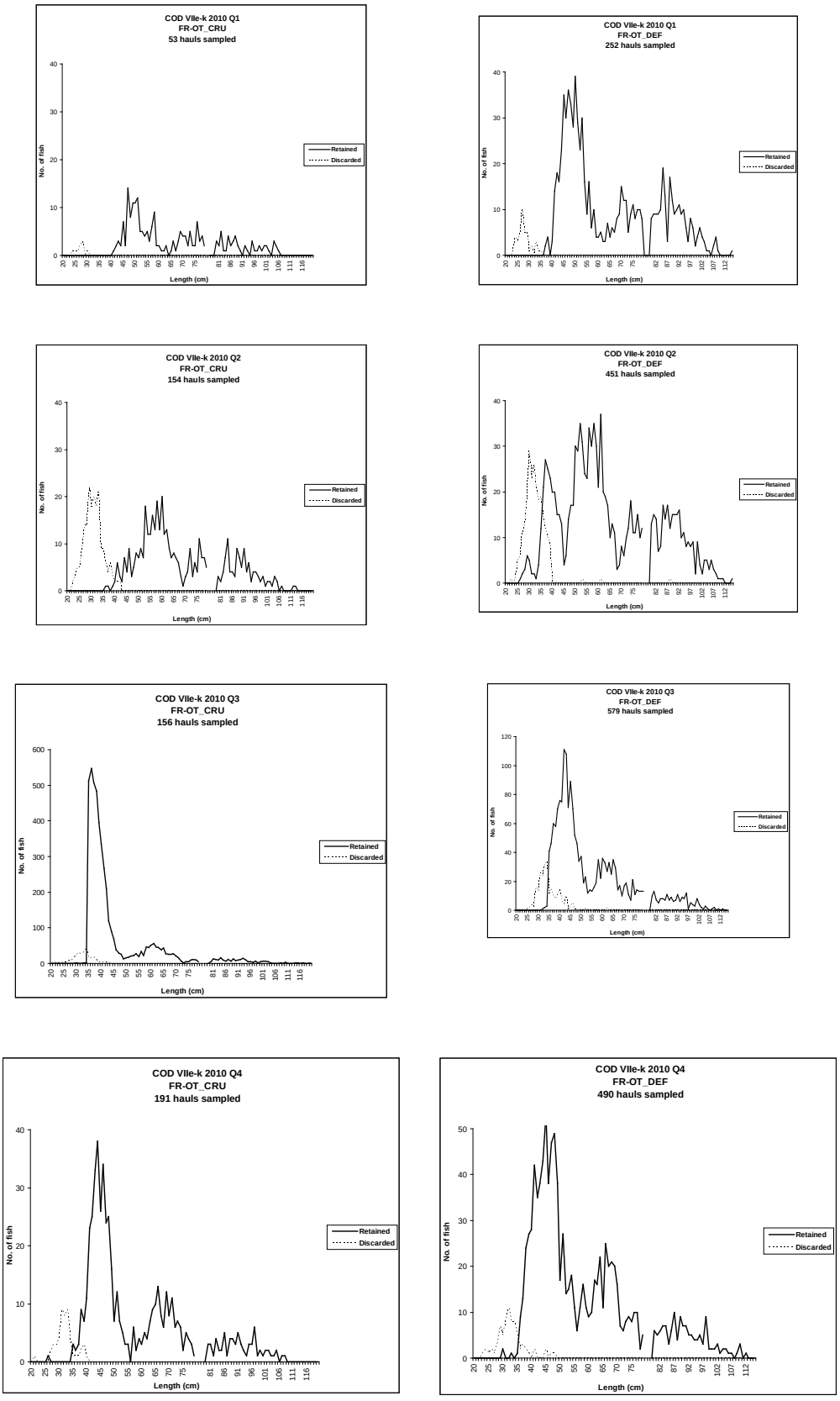
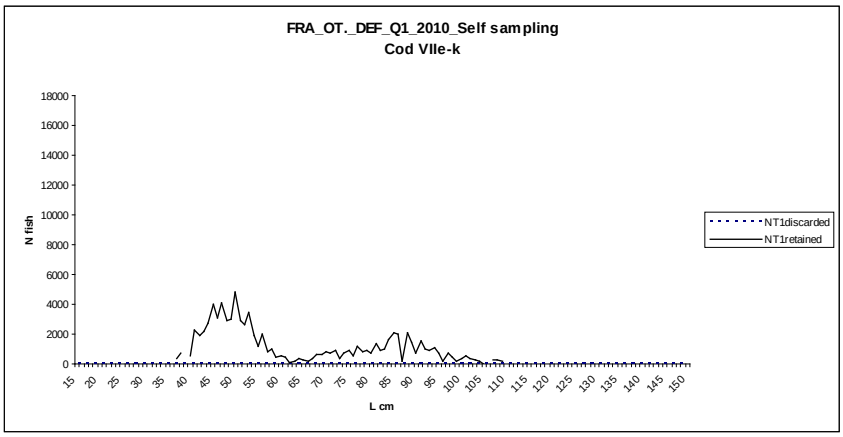
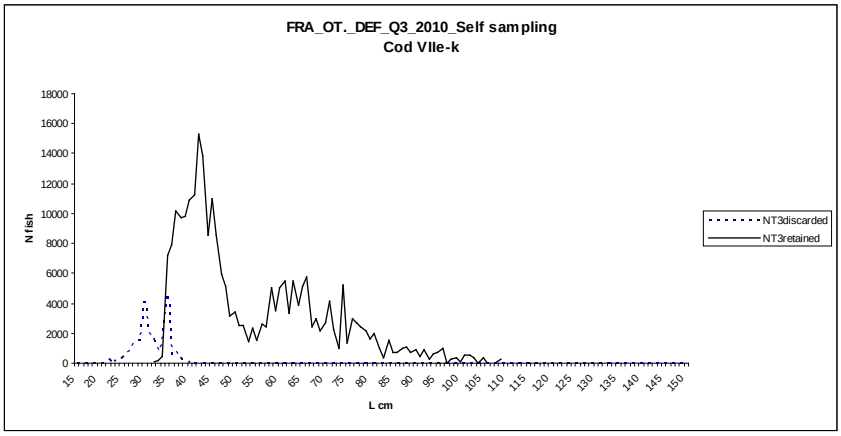


Figure 7.2.2c. Cod in Divisions VIIe–k. 2010 Quarterly or annual length compositions of French discards from observers at sea.





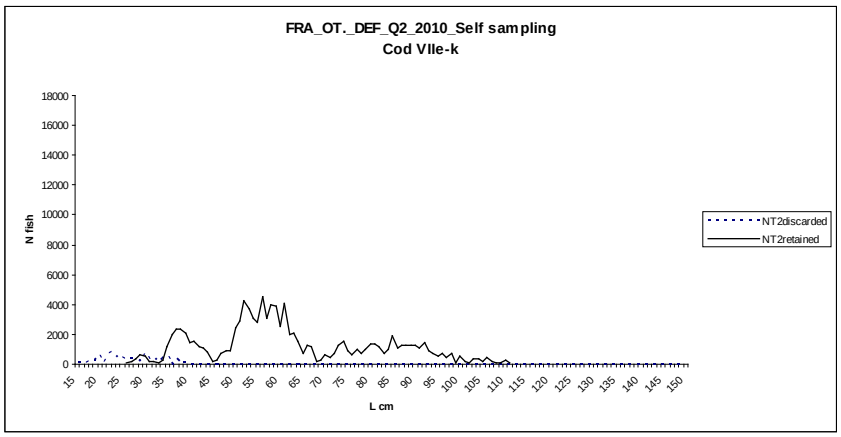


Figure 7.2.2d. Cod in Divisions VIIe–k. 2009 Quarterly length composition of French landings and discards. Self-sampling programme.

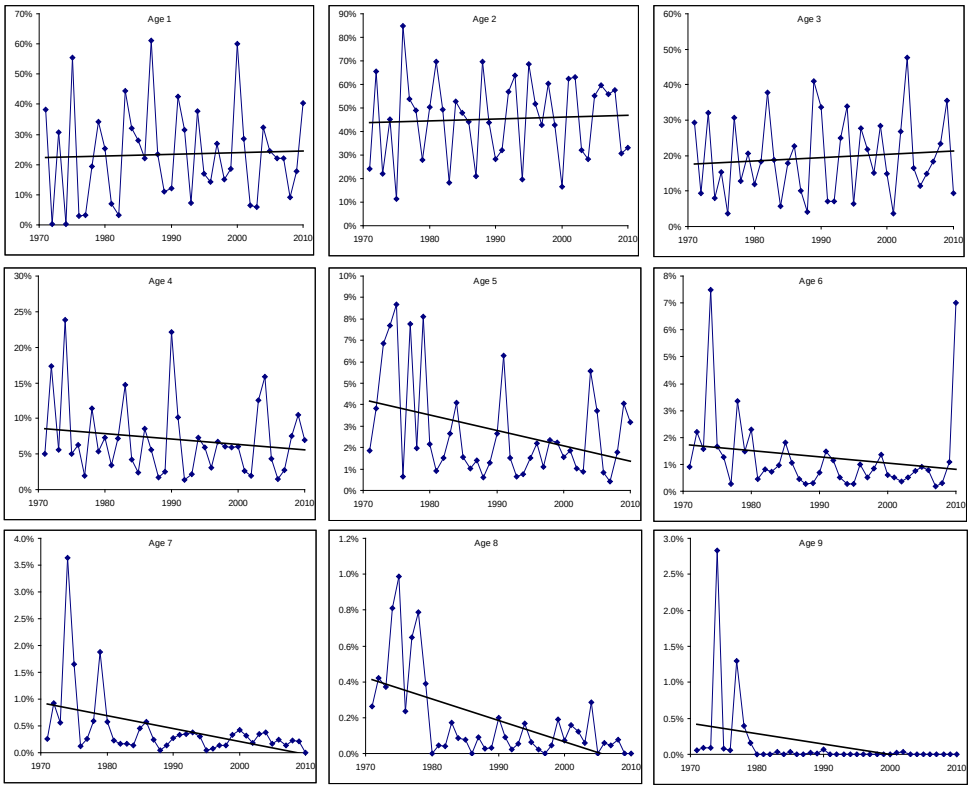
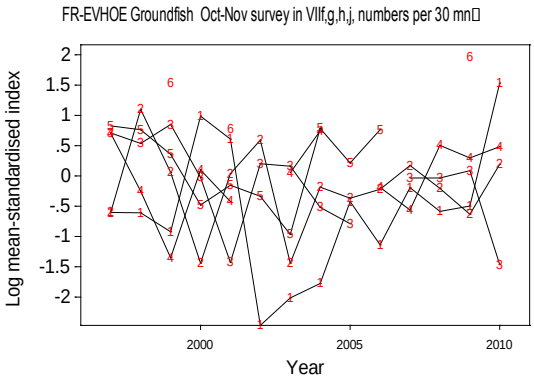
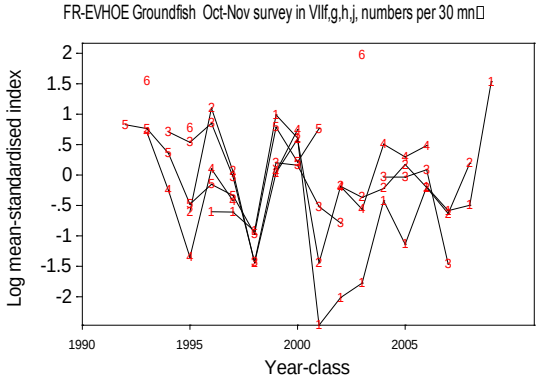
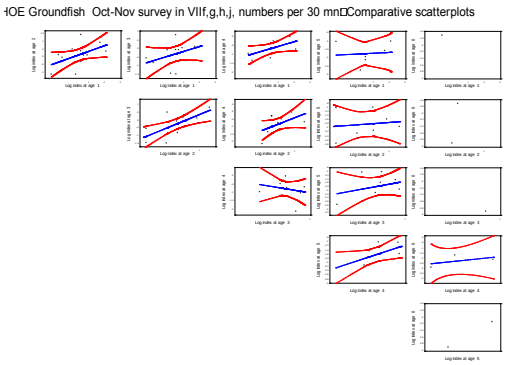
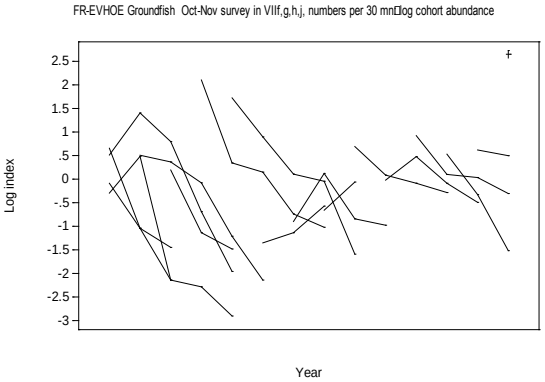


Figure 7.2.3. Cod in Divisions VIIe–k. Percentage of landings accounted for by each age class in Celtic Sea cod over the time-series.









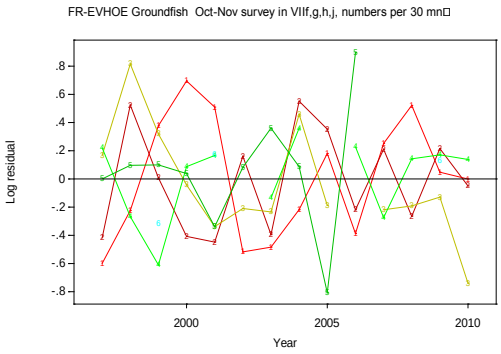


Figure 7.2.4a. Cod in VII e–k. Diagnostics SURBA v3.0 plots for IBTS Q4 (FR-EVHOE) survey, age groups 1–5. Log mean standardized indices by year and age class, scatterplots, catch curves, and residuals. (Single fleet).

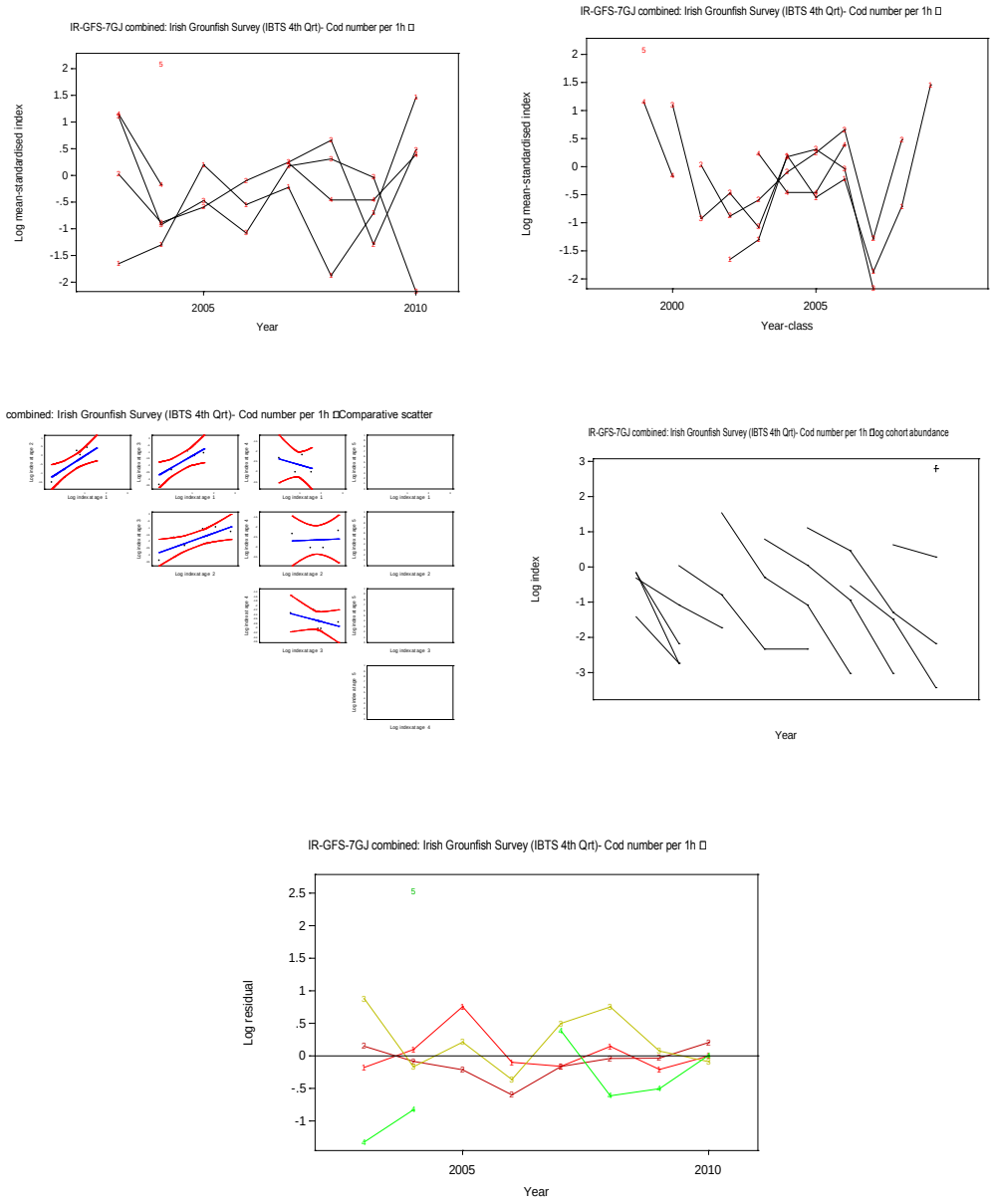
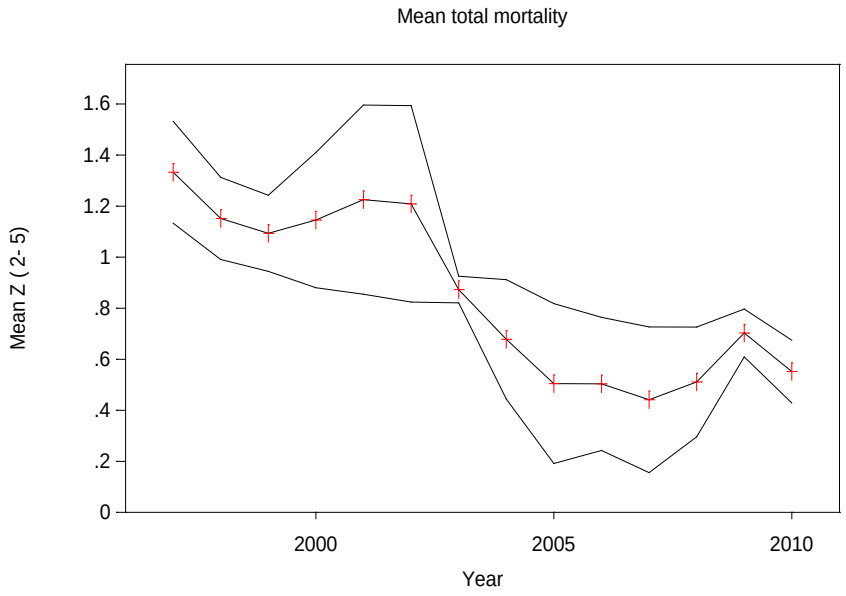
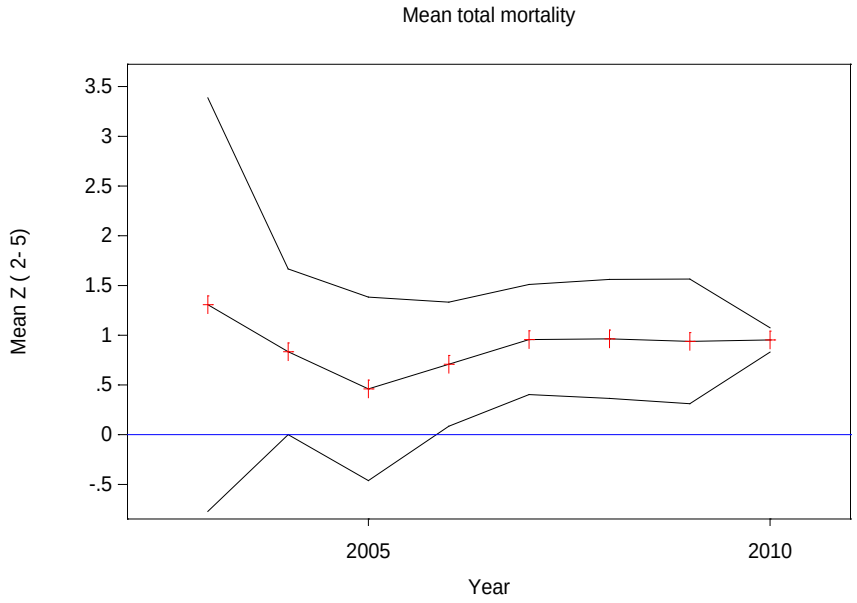


Figure 7.2.4b. Cod in VII e–k. Diagnostics SURBA v3.0 plots for IBTS Q4 (IR-GFS7gj) survey, age groups 1–5. Log mean standardized indices by year and age class, scatterplots, catch curves, and residuals. (Single fleet).



FR-IBTS Q4 – EVHOE survey



IR-GFS 7gj survey

Figure 7.2.4c. Cod in VII e–k. Trends of relative mean Z. SURBA v3.0 plots for the two surveys used separately.

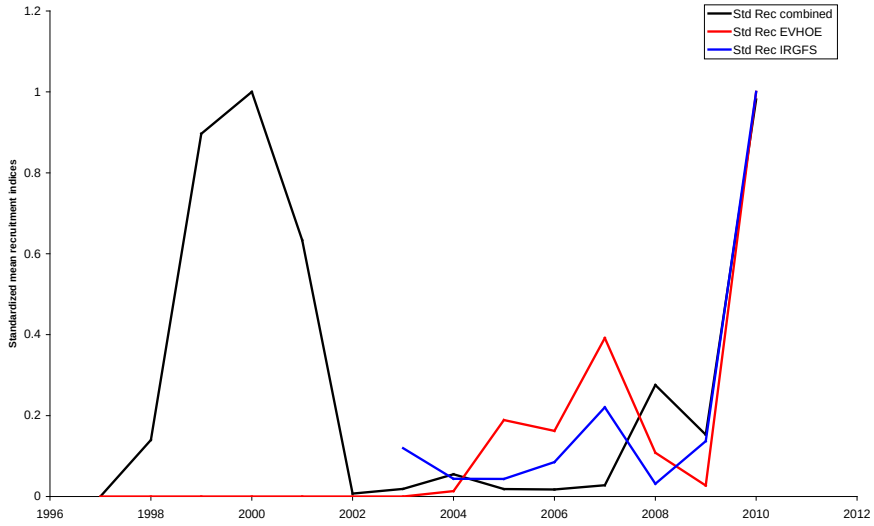
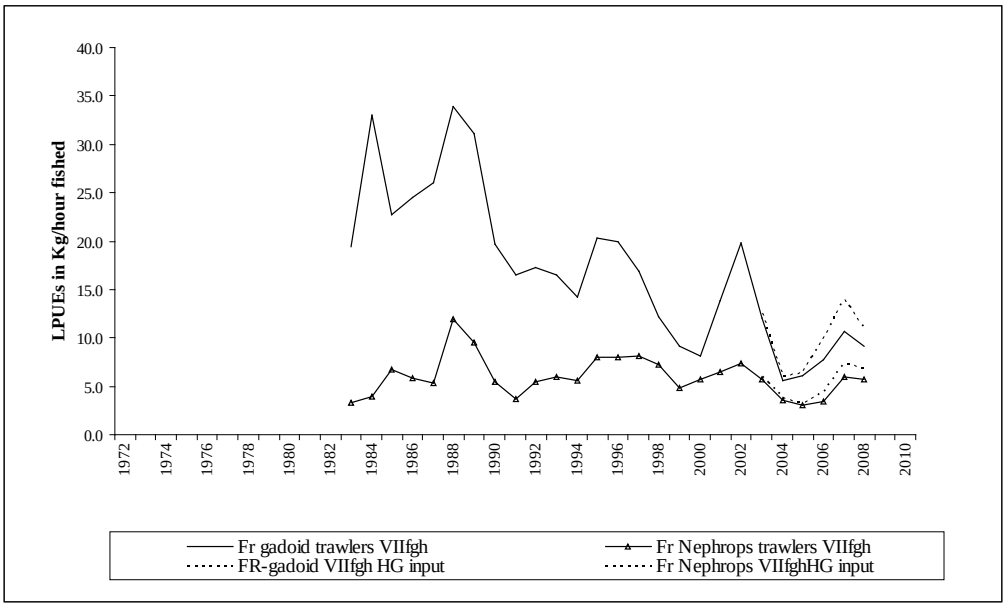


Figure 7.2.4d. Comparative trends of recruitment estimates from a Surba v3.0. Mean standardized indices for both FR-IBTS Q4 (EVHOE), IR-GFS and combined surveys.



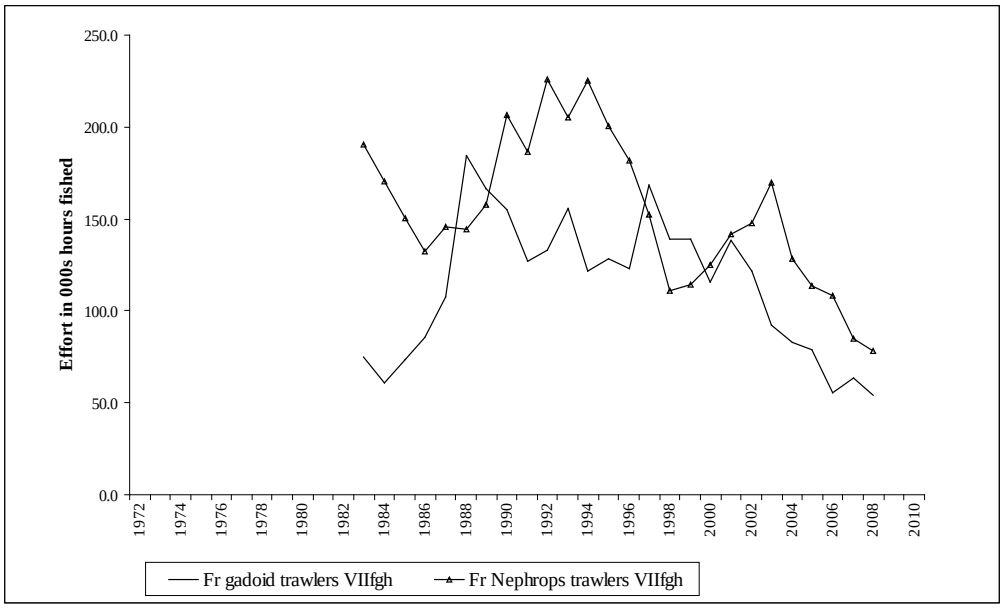


Figure 7.2.5a. Cod in Divisions VIIe–k. Trends of lpues and effort. French Gadoid trawlers and French *Nephrops* trawlers in VIIfgh.



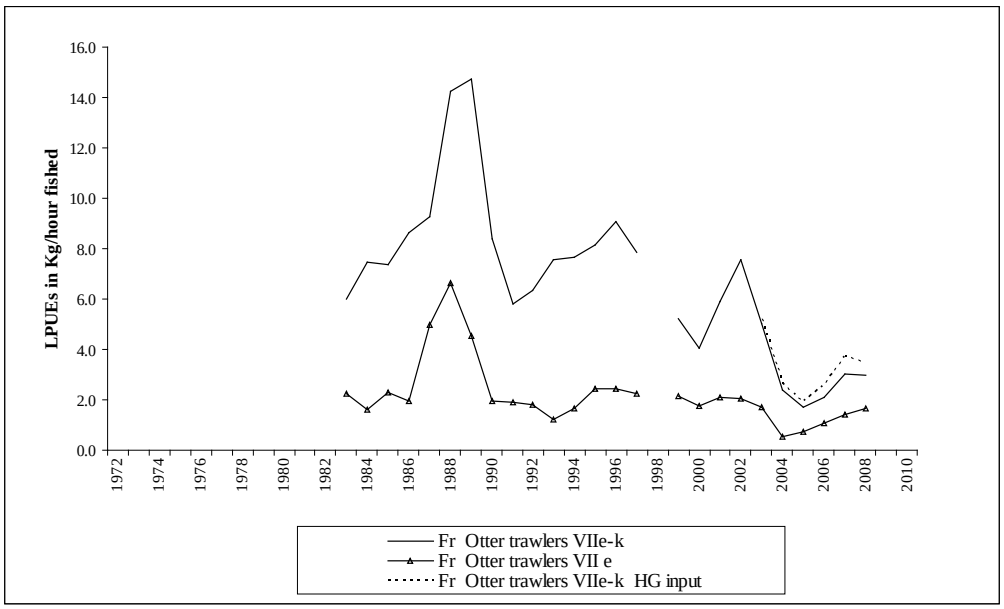


Figure 7.2.5a. Continued. Cod in Divisions VIIe–k. Trends of lpues and effort. French otter trawlers in VIIe–k (including Gadoid trawlers and *Nephrops* trawlers in VIIfgh) and French otter trawlers in VIIe.

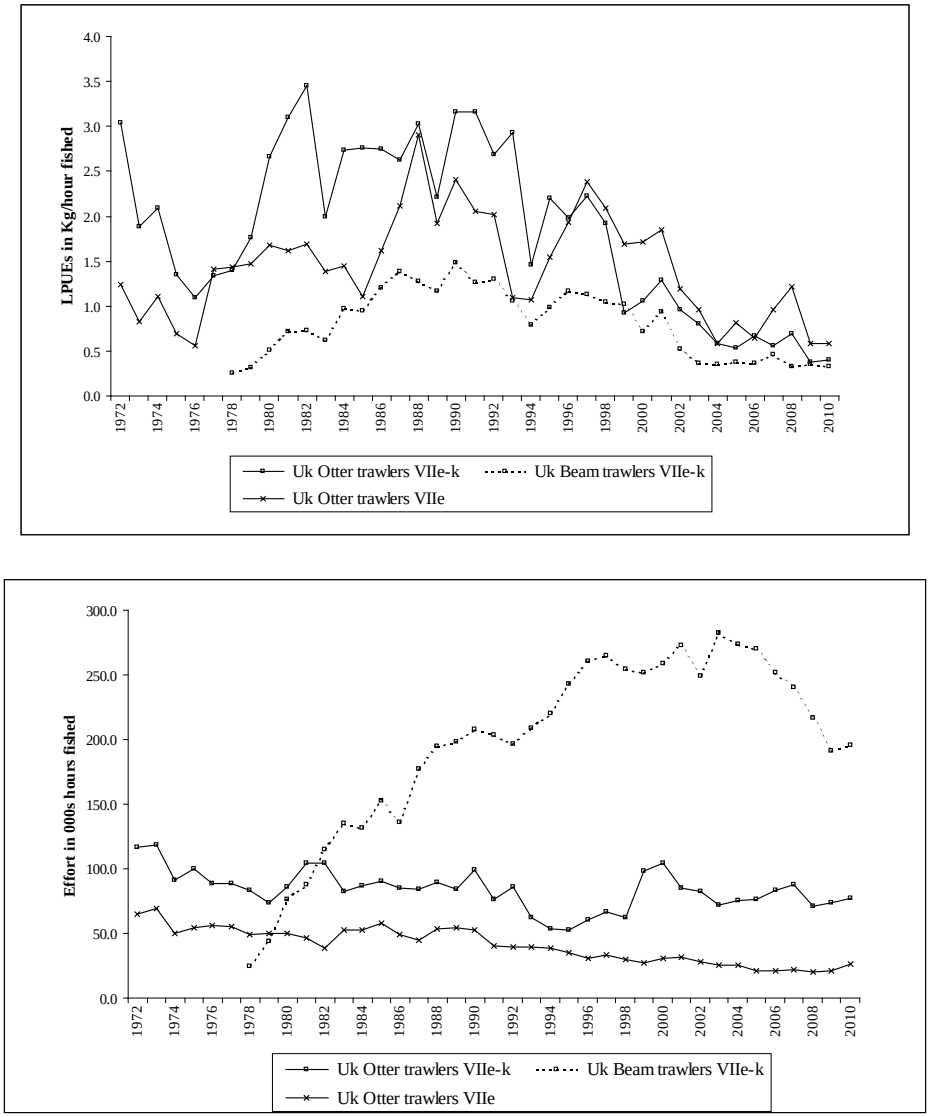
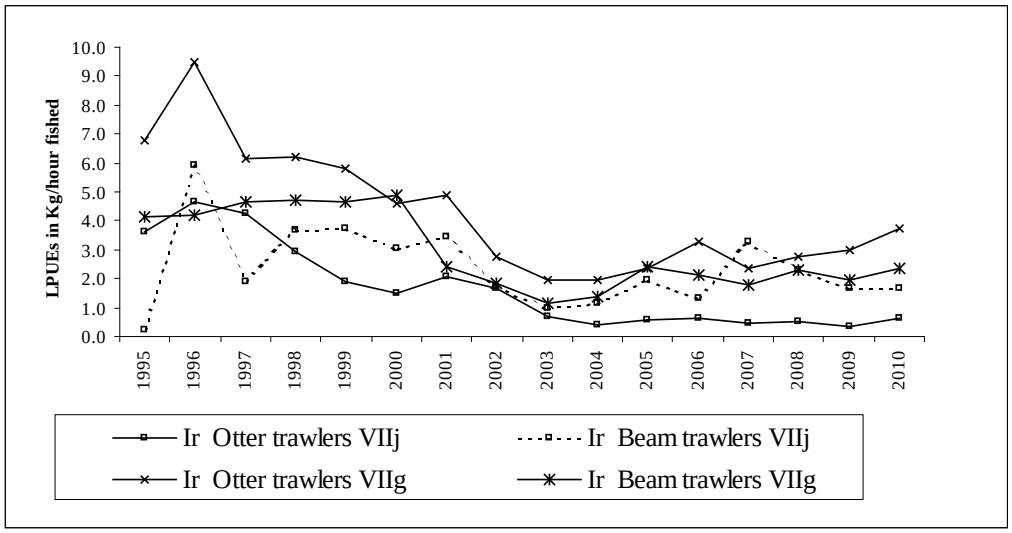


Figure 7.2.5a. Continued. Cod in Divisions VIIe–k. Trends of lpues and effort. UK otter trawlers in VIIe–k and VIIe, UK beam trawlers in VIIe–k.



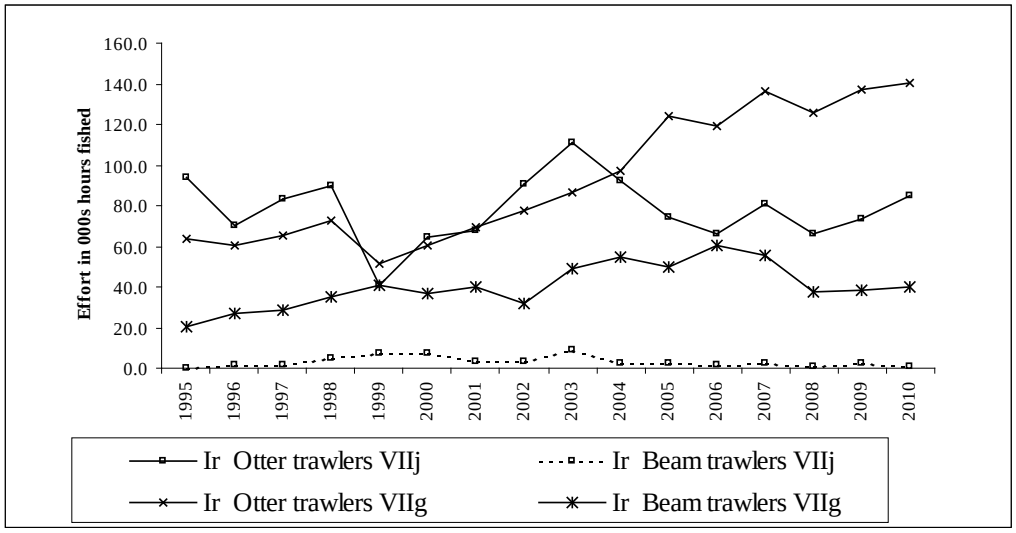


Figure 7.2.5b. Cod in Divisions VIIe–k. Trends of lpues and effort. Irish otter trawlers in VIIg and VIIj, Irish beam trawlers in VIIg and VIIj.

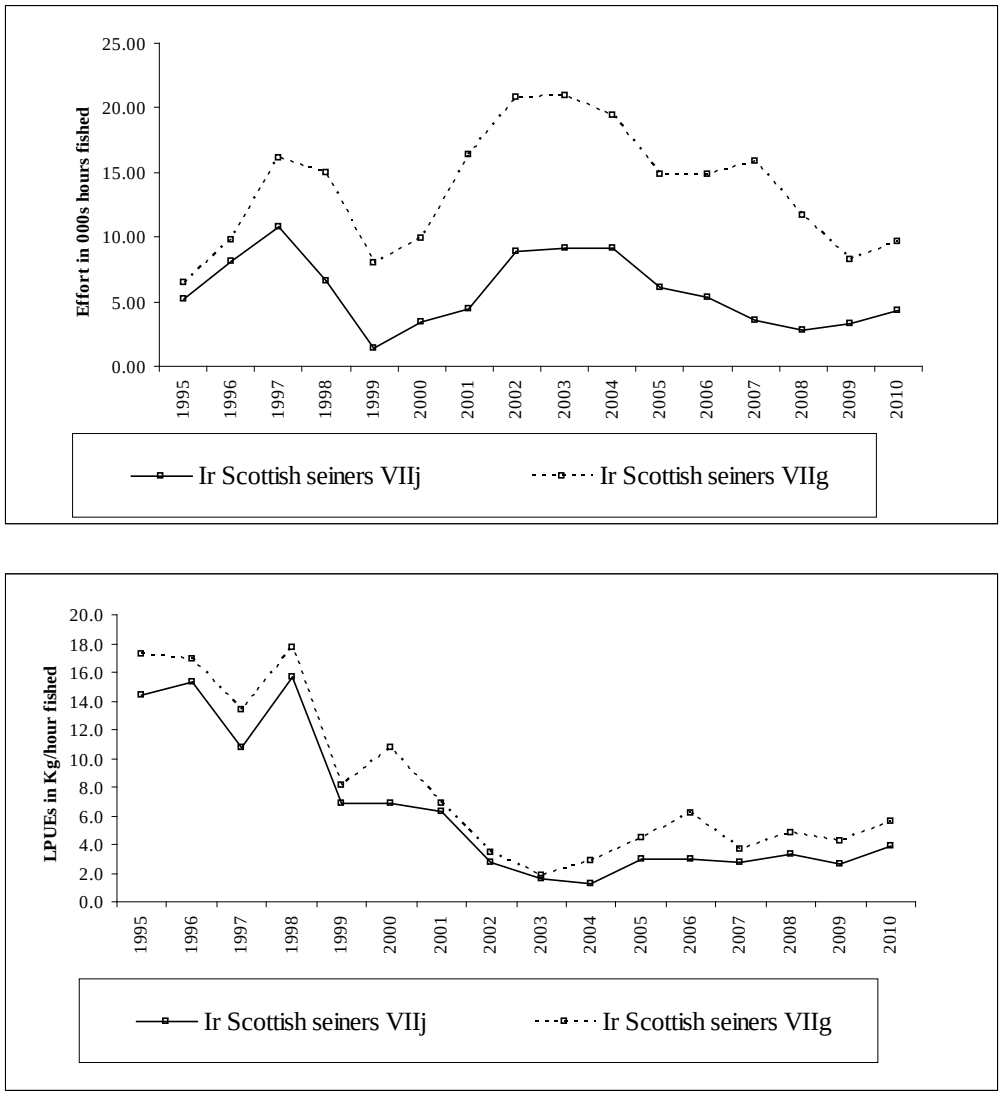


Figure 7.2.5b. Cod in Divisions VIIe–k. Trends of lpues and effort. Irish Scottish seiners in VIIg and VIIj.

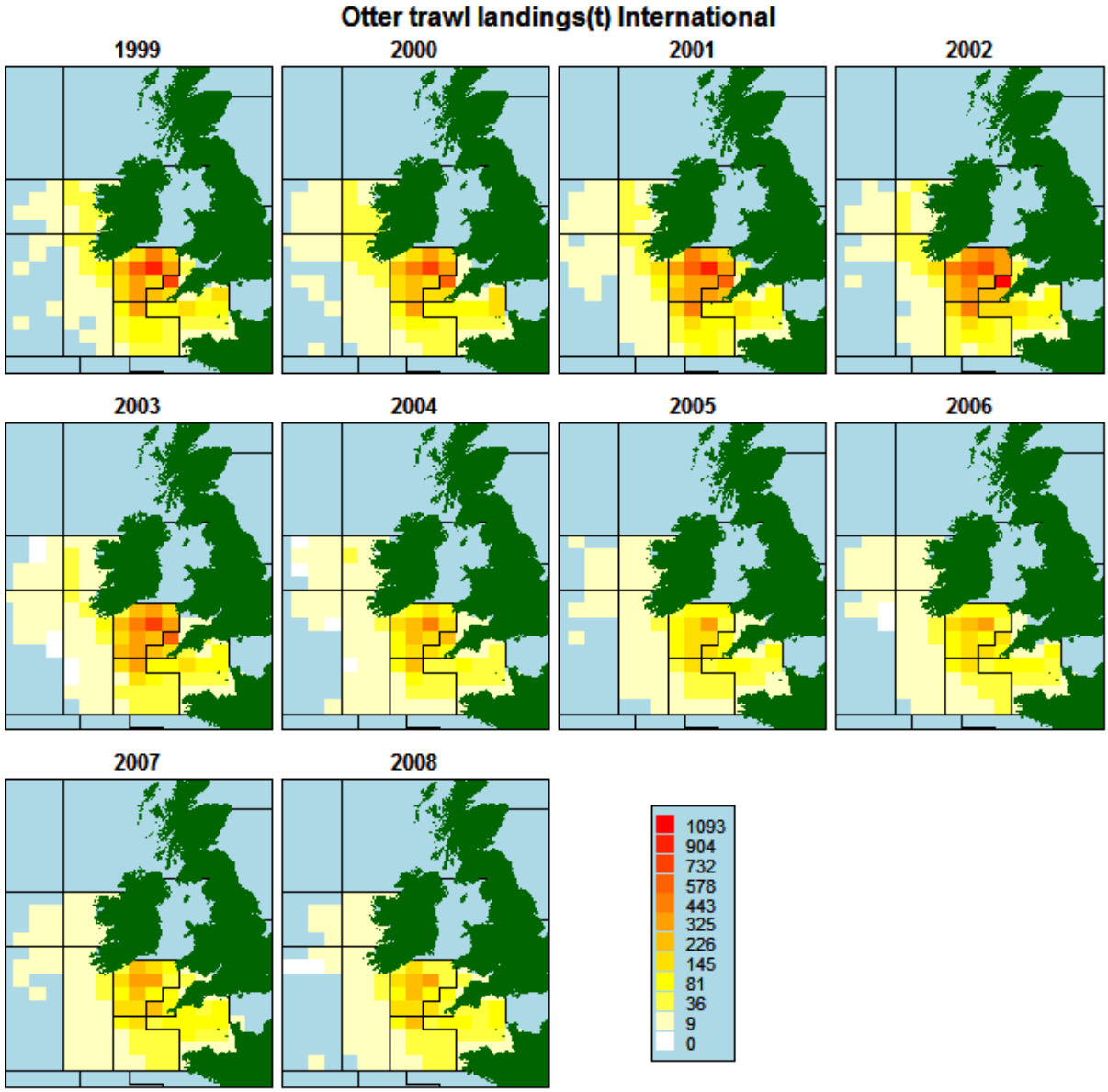


Figure 7.2.6. Cod in VII e–k. Distribution of landings by otter trawlers in the TAC area.

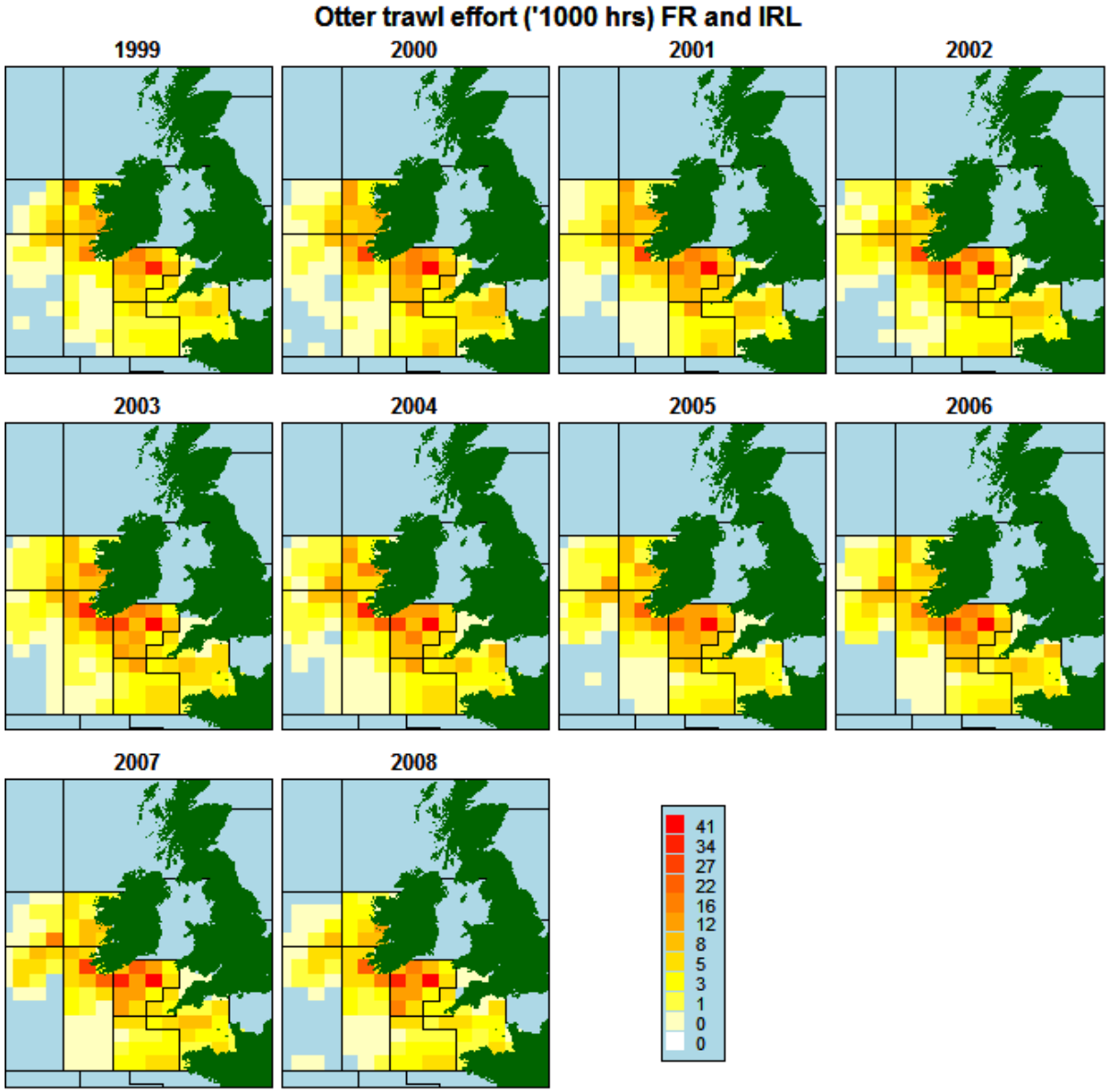


Figure 7.2.7. Cod in VII e–k. Distribution of effort by French and Irish otter trawlers in the TAC area.

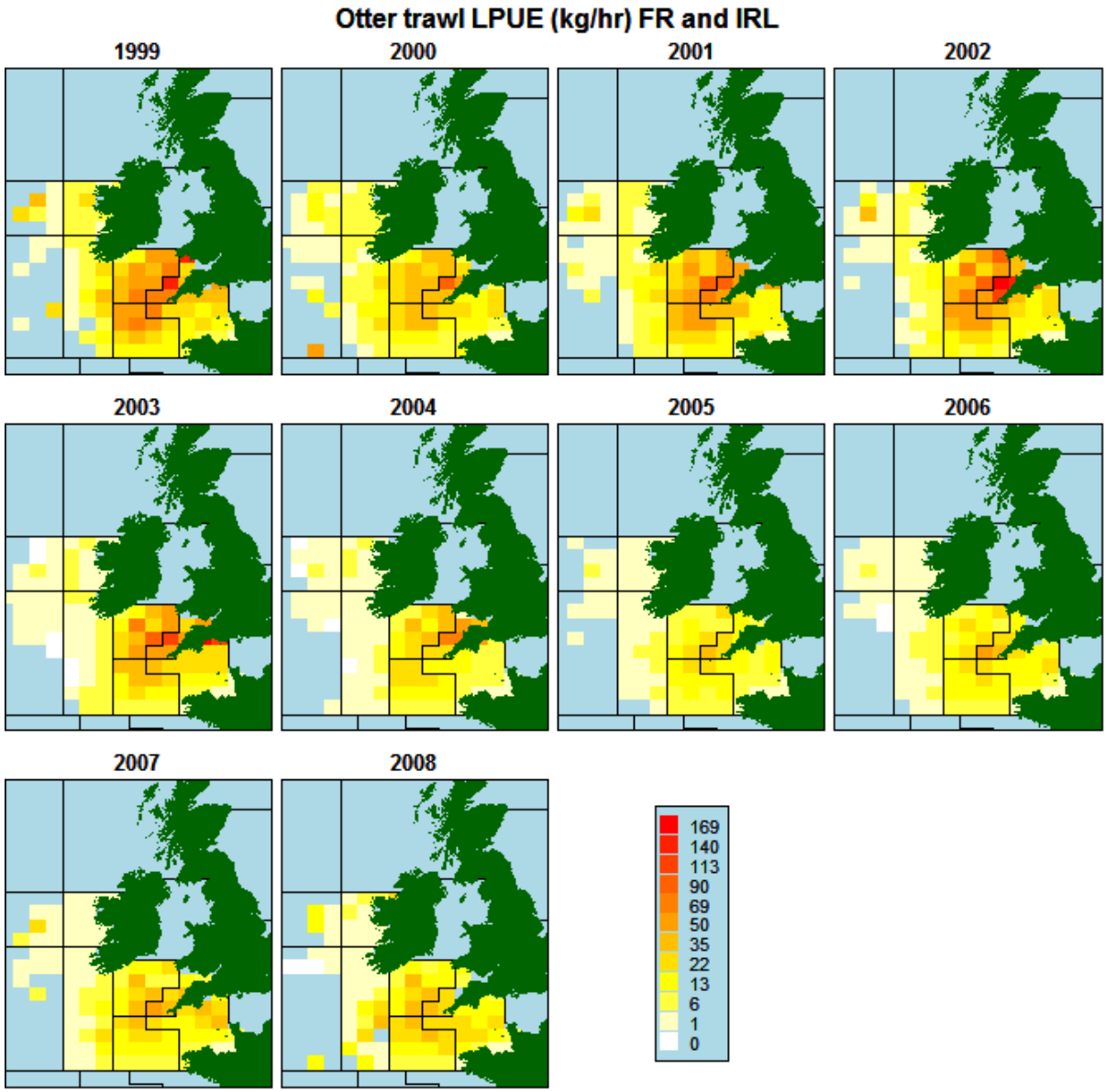


Figure 7.2.8. Cod in VII e–k. Distribution of lpues by French and Irish otter trawlers in the TAC area.

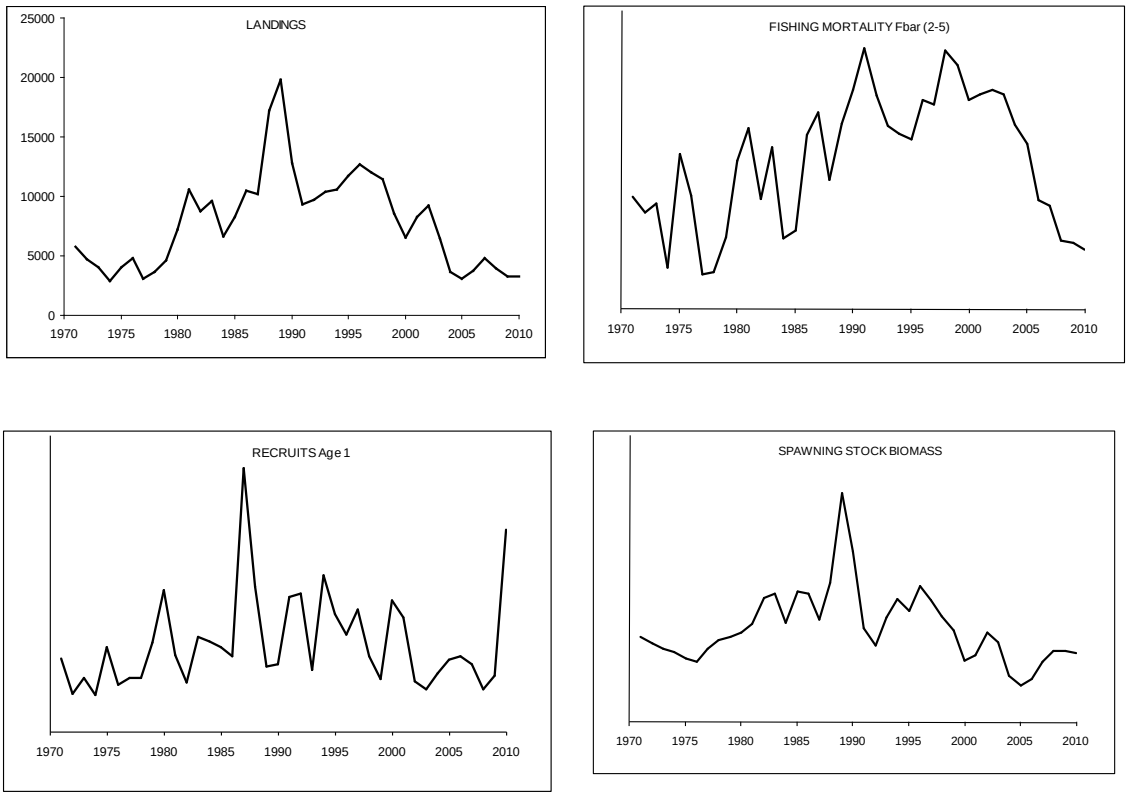


Figure 7.2.9. Cod in VII e–k. Summary plots. Exploratory XSA.

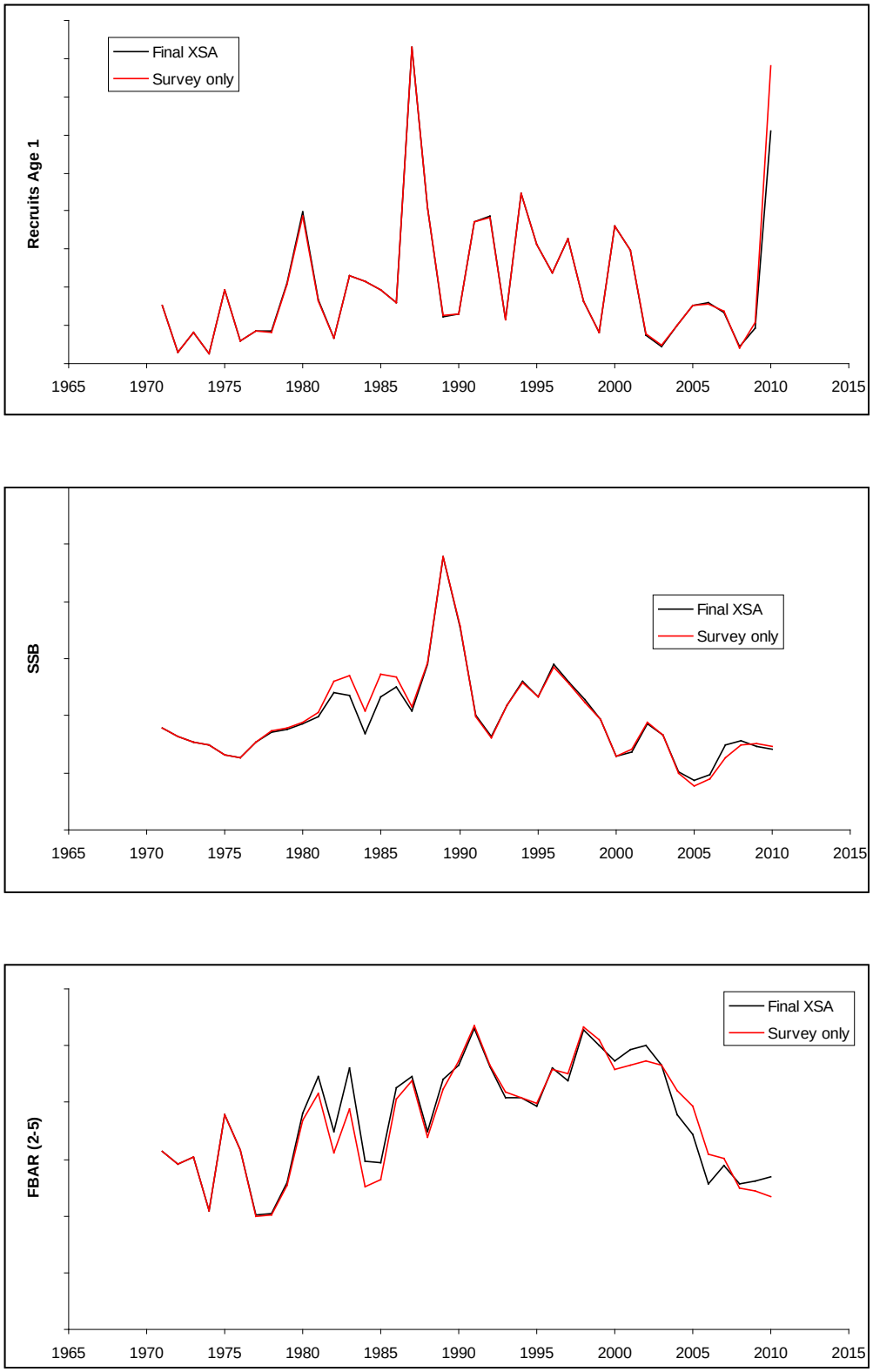


Figure 7.2.10. Cod in VII e–k. Summary. Exploratory XSA based on survey indices only.

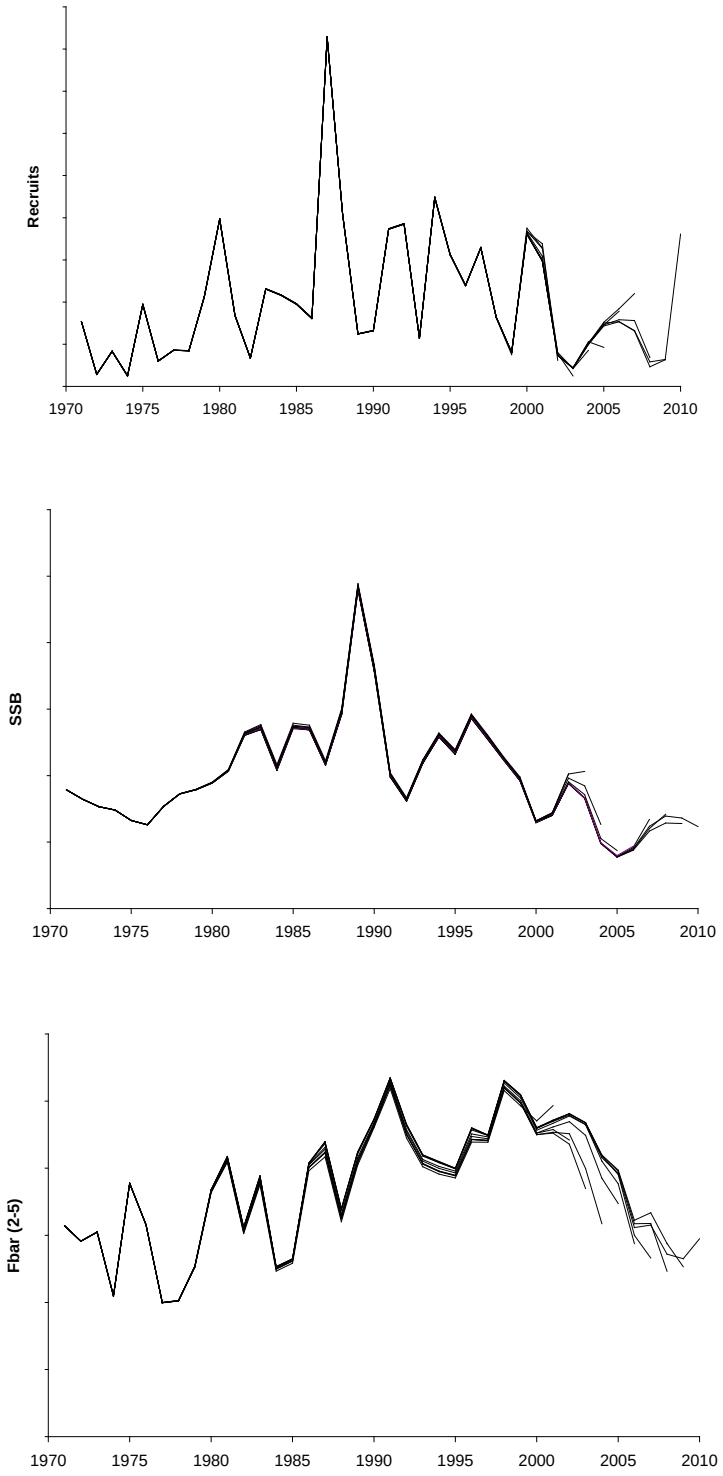


Figure 7.2.11. Cod in VIIe–k. Retrospective plots. Exploratory XSA.

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 1995–2009 as officially reported to ICES.

Country	1995	1996	1997	1998	1999	2000	2001	2002
France	91	115	71	44	…[1]	46	38	54
Germany	-	-	3	-	-	-	-	-
Ireland	282	353	177	234	154	141	107	59
Netherlands	-	-	-	-	-	-	+	-
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
UK(Scotland)	66	12	7	9	1	-		1
UK								
Total	**473**	**519**	**301**	**318**	**172**	**194**	**150**	**122**

Country	2003	2004	2005	2006	2007	2008	2009	2010
France	33	13	13	10	18	14	5	17
Germany								
Ireland	59	60	32	16	11	18	29	37
Netherlands	1							
Norway				1	1			
Spain								
UK(E/W/NI)	8		0	1	2	1		1
UK(Scotland)	1	10		0				
UK								
Total	**102**	**83**	**45**	**28**	**32**	**33**	**34**	**55**

[1]**See VIIg-k.**

7.4 Haddock in Divisions VIIb–k

Type of assessment in 2011

Update.

ICES advice applicable to 2010 and 2011

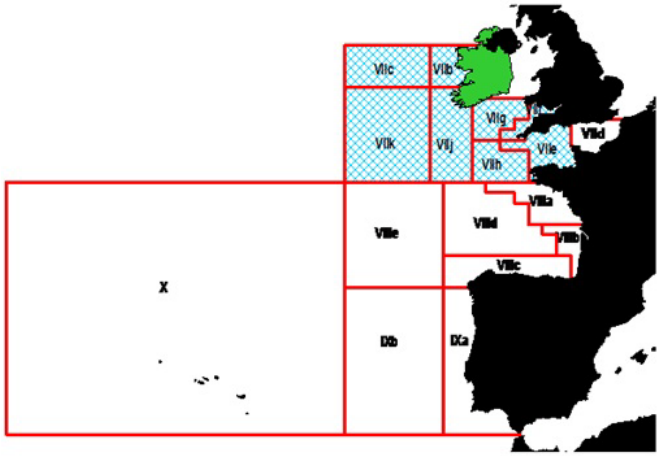
"Effort should not be allowed to increase, reduce discard rates."

"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."

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 2010 and 2011

TAC Table 2010

Species:	Haddock *Melanogrammus aeglefinus*	Zone:	VIIb-k, VIII, IX and X; EU waters of CECAF 34.1.1 (HAD/7X7A34)
Belgium	129		
France	7 719		
Ireland	2 573		
United Kingdom	1 158		
EU	11 579		
TAC	11 579		Analytical TAC

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.

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.

Fishery in 2010

The official landings reported to ICES and Working Group estimates of the landings and discards are given in Table 7.4.1. The historic landings are also shown in Figure 7.4.1. Ireland provided minor revisions to the landings figures for 2009. France provided a major update to the landing figures for 2009 (-775 t) due to previous problems with the French database. The 2009 international landings figure of 10 028 t was revised to 9276 t. The 2010 landings were estimated by the WG to be 9 6864 t.

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 are still below the TAC but the quota appeared to become restrictive again for Ireland and Belgium (but not for France and the UK).

7.4.2 Data

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

Numbers–at–length

Length compositions of landings were available for haddock landed into Ireland, France and the UK in 2010 (Table 7.4.2; Figure 7.4.2a). Length distributions of the various fleets are quite similar with the exception of the UK beam trawl fleet.

Discard length distributions for 2010 are shown in Figure 7.4.2b. Most of the discarding in 2010 appears to have been fish under the MLS of 30 cm.

Discard numbers–at–age

Irish otter trawl discard data were raised to the national level using the number of trips as auxiliary variable as described in the Stock Annex (all métiers combined). The numbers of OTB (Otter Bottom Trawl) discard trips by year and métier are given in Table 7.4.3a and the total number of OTB trips is given in Table 7.4.3b. Irish discard data from VIIgj were used to estimate international discards by using the ratio of the international effort in VIIe–k to the Irish effort in VIIgj (Table 7.4.3c). French effort data were not available for 2009 and 2010, therefore the average 2006–2008 effort was assumed for these years.

Figure 7.4.3a shows the Irish discard numbers-at-age and the discard numbers-at-age raised to international levels. Figure 7.4.3b shows the proportions-at-age that are discarded; over the last 10 years 90% of 1-year-olds, 54% of 2-year-olds and 17% of 3-year-olds have been discarded. By number, 70% of the total catch was discarded (45% by weight; average last ten years).

Landings numbers–at–age

Landings numbers-at-age were raised using the procedure described in the Stock Annex. Landings numbers-at-age are given in Table 7.4.4a, discard numbers-at-age are given in Table 7.4.4b and catch numbers-at-age in Table 7.4.4c. Discards account for a large proportion of the catch numbers up to age 3. 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.

Mean landings weights-at-age are given in Table 7.4.5a, catch weights-at-age are given in Table 7.4.5b and stock weights are given in Table 7.4.5c. Figure 7.4.4 shows the stock weights-at-age. There appear to be some cyclical trends in the stock-weights-at-age, particularly in the three-year running average weights.

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. Irish Q1 survey data from 2004–2009 in VIIbgj (WD 3; WGCSE 2010) 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 surveys are described in the Stock Annex. Available survey indices and tuning fleet data are given in Table 7.4.6. Survey data tuning-series were made available by Ireland, the UK, and France. Commercial tuning fleets were made available by Ireland; the French tuning fleet data for 2009 and 2010 were not available due to problems with the French logbooks database.

The standardized indices are given by year in Figure 7.4.5a and by cohort in Figure 7.4.5b. In addition to the indices that were used in the assessment, the Irish Groundfish Survey (IGFS–WIBTS- 4Q) indices in VIIb and VIIj are shown.

Figure 7.4.6 shows the standardized recruitment (age 0 and 1) indices for all available current surveys (some of which not used in the assessment). All surveys except the IGFS-WIBTS-Q4(7b) survey indicate that the 2009 recruitment is the highest in the time-series and that the 2010 recruitment is well below average.

Commercial lpue

Effort and lpue data are given in Table 7.4.7 and Figure 7.4.7. Lpue has shown an increasing trend in recent years suggesting improved availability of haddock. French effort is unknown but unlikely to have increased over the last two years.

Other relevant data

Figure 7.4.1a gives a long-term overview of the landings of haddock which may give some information on availability of haddock before the assessment time-series started, although effort is unknown. 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 9000 t

7.4.3 Historical stock development

Model used: eXtended Survival Analysis (XSA)

Software used: FLR, VPA95

Exploratory data analysis and the assessment were carried out using FLR under R version 2.8.1 with packages FLCore 2.2, FLAssess 2.0.1, FLXSA 2.0 and FLEDA 2.0. The final assessment was also run using the Lowestoft VPA95 software.

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\Exploratory runs' on SharePoint.

One particular exploratory assessment will be highlighted here: The catch numbers-at-age are likely to be estimated with low precision for the youngest ages due to the inclusion of (imprecise) discard data. To investigate the sensitivity of the assessment to the catch numbers at these ages, an assessment run was performed where the catch numbers-at-ages 0, 1 and 2 replaced with zeros. For these ages the total mortality is then assumed to be equal to the natural mortality which was set at 0.7 to account for the fishing mortality. This exploratory assessment showed virtually identical estimates for F_{bar} 3–5 while SSB and recruitment showed very similar trends. This suggests that the trends from the assessment are not very sensitive to the uncertainty in the catch numbers-at-age that is introduced by the inclusion of the discards.

Final update assessment

The final assessment was run with the same settings as last year. The only difference is that no data were available for the French commercial tuning fleet (FR7fgGAD) in 2009 and 2010.

Input data types and characteristics:

Type	Name	Year range	Age range
Caton	Catch in tonnes	1993–2010	0–8+
Canum	Catch-at-age in numbers	1993–2010	0–8+
Weca	Weight-at-age in the catch	1993–2010	0–8+
West	Weight-at-age at spawning time.	1993–2010	0–8+
M_{prop}	Proportion of M before spawning	1993–2010	0–8+
F_{prop}	Proportion of F before spawning	1993–2010	0–8+
Mat_{prop}	Proportion mature-at-age	1993–2010	0–8+
Nat_{mor}	Natural mortality	1993–2010	0–8+

A plusgroup of 8+ was used. Age group 0 was included in the assessment data to allow inclusion of 0-group indices in the XSA runs. However, catch numbers-at-age 0 were set to zero to avoid spurious F-shrinkage effects at this age.

Model Options:

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

Tuning data:

Type	Name	Year range	Age range
Survey	UK WCGFS	1996–2004	Not used
Survey	EVHOE-WIBTS-Q4	1997–present	0–5
Survey	IRL-WCGFS	1999–2002	Not used
Survey	IGFS-WIBTS-Q4 (7g)	1999–present	0–5
Survey	IGFS-WIBTS-Q4 (7b)	2003–present	Not used
Survey	IGFS-WIBTS-Q4 (7j)	2003–present	Not used
Commercial	IRL-OTB (7bj)	1995–present	2–7
Commercial	FR-GAD	2002–2008	2–6

The XSA diagnostics are given in Table 7.4.8a. The estimated fishing mortality is quite variable. The catchability regressions and residuals are given in Figure 7.4.8, the residuals are relatively large and some year effects are apparent. The catchability re-

gression for age 7 is very tight, suggesting that the model adjusts the population numbers at that age to the tuning data. Increasing the fleet SE threshold can prevent this; however the assessment results do not change noticeably when the SE is increased, therefore last year's settings were not changed. The full fishing mortality and stock numbers-at-age tables are given in Table 7.4.8b and 7.4.8c.

The weighting applied to the terminal survivor estimates is shown in Figure 7.4.9. The 2010 cohort takes equal weight from the two surveys. The French Gadoid fleet gets relatively little weight because no 2009–2010 data were available. F-shrinkage does not account for much of the weighting in any of the cohorts.

The retrospective analysis was run back to 2003. The results are shown in Figure 7.4.10. F_{bar} for recent has been revised downwards somewhat in the latest assessment. The estimated high recruitment in 2009 has not been affected by the inclusion of the 2010 data. SSB shows virtually no retrospective change.

Comparison with previous assessments

The XSA settings have not changed since 2007. The landings figures for 2009 were revised downwards by 7%. Figure 7.4.11 shows a comparison of the current and last year's assessment. Last year's estimates of F_{bar}, SSB, and recruitment have not changed significantly.

State of the stock

The state of the stock is not precisely known. However SSB has shown an overall increasing trend over the time-series.

The stock summary is given in Table 7.4.9 and Figure 7.4.11. Following good recruitment in 1999, 2001 and 2002 the SSB and catch increased. Recruitment has also been relatively high in 2007–2008 and exceptionally high in 2009 and the catches have increased since 2008, however most of these increased catches were discarded, mostly because they were under the MLS but possibly also due to restrictive quota.

7.4.4 Short–term projections

Short-term projections are presented here for reference only; they are not considered reliable because recruitment of haddock is characterized by sporadic events, therefore the use of geometric mean recruitment (1993–2008) for 2011–2013 provides a very uncertain estimate of future recruitment.

Short-term projections were performed using MFDP1a software.

Recruitment for 2011–2013 was estimated at 38 338 (GM 93-08; thousands). Three year averages were used for F and weights-at-age. Input data for the short-term forecast are given in Table 7.4.10. Landings and discard numbers and weights were supplied separately. Table 7.4.11 gives the management options. Estimates of the relative contribution of recent year classes to the 2012 landings and 2013 SSB are shown in Table 7.4.12. The high recruitment in 2009 accounts for 87% of the projected landings in 2011 and for 60% of the SSB in 2013.

7.4.5 MSY evaluation

WGCSE 2010 performed an MSY evaluation. Because haddock stocks are characterized by extreme recruitment events; recruitment modelled from a stock–recruitment (SR) relationship is therefore only a useful concept in the long term. Additionally, the time-series is quite short and there is little information to inform the SR model.

Because the assessment is indicative of trends only, F reference points should only be interpreted in a relative sense.

The stock–recruit relationship of haddock is not well captured by any of the models and the underlying data do not support the provision of absolute estimates of F_{msy}. However it is likely that current F is well above any F_{msy} proxy.

7.4.6 Biological reference points

Precautionary approach reference points

It is not possible to derive precautionary reference points for this stock from the short time-series of information available.

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 2010 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

France and the UK have collected discard data in recent years and WD1 provides a comparison of the French and Irish discarding data. The document concludes that the French fleets do not appear to catch many one-year-olds while the Irish fleets do. Therefore the number of one year olds in the catch-at-age matrix is likely to be overestimated (because this is based on Irish data raised to international effort levels). However, reducing these numbers to 30% of their original value did not affect the assessment trends noticeably except for a small reduction in the recruitment estimates. The French and Irish fleets had similar selection ogives. Therefore it should be possible to include the French discard data in the assessment at the next benchmark, while retaining the use of the Irish-only data for the period for which no French data are available.

The problem remains that the number of discard trips remains 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 will be considerable.

Exploratory assessments have shown that SSB estimates are sensitive to the inclusion of young fish (aged 1 and 2) but the absolute estimates of F_{bar} do not change noticeably if the catch numbers of fish aged 2 and less are set to zero. Therefore the uncertainty introduced by the inclusion of discard numbers-at-age is not likely to affect estimates of F_{bar} or trends in recruitment.

Surveys

None of the available surveys cover the full assessment area. The EVHOE-WIBTS-Q4 survey covers the southern end of the area (VIIh+f and the southern part of VIIg+j) while the IGFS-WIBTS-Q4 (VIIg) survey only covers VIIj. The IGFS-WIBTS-Q4 (VIIb)

and IGFS-WIBTS-Q4 (VIIj) are not currently included but should be considered at the next benchmark.

7.4.9 Recommendation for next benchmark

Review Group comments

Comments from the Review Group were addressed as far as possible without performing a benchmark assessment. The Stock Annex was amended to take some of the Review Group comments into account.

Regarding the strong 2009 cohort, the review group concluded that: "A key question is where in the Celtic Seas this abundance of small haddock will be located, and hence where would measures to avoid discarding be best targeted. The WG should monitor the distribution of these fish through surveys and observer data and provide managers with this information" This issue is addressed in WD2. The Working Document concludes that juvenile haddock are widely distributed throughout the stock area. However there are some areas where the catch rate of juveniles is particularly high and discard rates are also high (mainly to the west of the Aran grounds in VIIb and the northwest of VIIg). The 2009 year class does not seem to have a different distribution from juveniles in other years. Fishing effort in the areas with large numbers of juveniles is low to moderate which may offer some protection from discarding.

Recommendations for future work

The following issues can be explored in preparation for a future benchmark (proposed for 2013).

- The French discard data should be included in the assessment. WD1 indicates that it may be valid to use estimate historic discarding levels from the Irish data and recent discarding levels from Irish and French data. This would require the French discard data to be age-disaggregated and raised to the French fleets. Various methods of raising the discards to national and international level should be explored.
- The two survey tuning fleets (EVHOE-WIBTS-Q4 and IGFS-WIBTS-Q4 (VIgj)) show very good agreement on the trends in the 0-group (Figure 7.4.6). The new Irish Groundfish Survey in VIIb and VIIj (IGFS-WIBTS-Q4 (VIIb) and (VIIj); not used in the analysis) generally agrees with the other surveys. It is believed that a significant amount of recruitment takes place in VIIb and the north of VIIj, these divisions are not covered by the EVHOE or IGFS-WIBTS-Q4 (VIIg) indices; therefore it would be worth considering including all IRGFS indices at the next benchmark assessment.
- EVHOE tuning fleet data from 1997 to 2000 are based on Irish survey Age–Length Keys. The time-series is now sufficiently long to omit these years.
- The Irish commercial tuning fleets should be split according to target species assemblage. Additionally, vessel-effects may be modelled and/or the spatial location of the fishing activity may be taken into account by making use of VMS data (e.g. Gerritsen, 2011, WD to WKCPUEFFORT).
- The Review Group suggested in 2010 that *"a model that allows for catch by multiple fleets should be developed to account for differences between countries and gear types. The RG suggests that in order to account for numerous fleets a forward projection, statistical catch-at-age model should be considered in the next*

benchmark assessment, because it may be a more appropriate method than the XSA model due to its increased flexibility. In addition, such a model will allow for error in catch-at-age, which is important for a fishery with such high and uncertain levels of discards. It might also be possible under such a framework to more readily and easily include all the surveys, even those for which sampling has been discontinued."

7.4.10 Management considerations

Management by TAC is inappropriate to 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 70% of the catch has been discarded (45% by weight). The TAC has not been restrictive in recent years but since 2009 the national quota of Ireland and Belgium appeared to have become restrictive. The catches are increasing as the 2009 cohort enters the fishery; and despite a moderate increase in TAC in 2011, the quota are likely to become restrictive for all countries resulting in increased levels of discarding.

An analysis of Irish landings and discards by métier (2003–2009 data; Anon, *in prep*) indicates that although the *Nephrops* fleets have very high discarding rates of haddock (>70% by weight), in absolute terms these fleets only contribute 10% of the Irish haddock discards in the Celtic Sea. The demersal OTB and SSC fleets in VIIgj contribute 82% of the haddock discards.

Métier	Landings (t)	Discards (t)	Discard Rate
OTB VIIg Dem	7164	6007	46%
SSC VIIgj Dem	4622	6098	57%
OTB VIIj Dem	2395	1599	40%
TBB VIIefgh Dem	1301	1358	51%
OTB VIIgfh *Neph*	269	1202	82%
OTB VIIj *Neph*	147	393	73%
OTB VIIf Dem	106	55	34%

Source Anon (*in prep*).

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.

7.4.11 References

Anon. *in prep*. Demersal discard atlas; An Overview of Irish Discarding and Potential Solutions.

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.

WD 01. WGCSE. 2011. Discarding of Haddock in VIIb–k; Comparison between the Irish and French discard data 2005–2010.

WD 02. WGCSE. 2011. Distribution of Juvenile Haddock in VIIb–k based on IGFS and EVHOE WIBTS- 4Q surveys.

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	1193[2]	4541	
1994	123	2788	908	240	17	4076	55	4131	1193[2]	5324	
1995	189	2964	966	266	83	4468	2	4470	470	4941	6000
1996	133	4527	1468	439	86	6653	103	6756	1398	8154	14000
1997	246	6581	2789	569	85	10270	557	10827	2104	12931	14000
1998	142	3674	2788	444	312	7360	308	7668	355	8023	20000
1999	51	2725	2034	278	159	5247	-365	4882	620	5502	22000
2000	90	3088	3066	289	123	6656	755	7411	6984	14395	16600
2001	165	4842	3608	422	665	9702	-1070	8632	1941	10573	12000
2002	132	4348	2188	315	106	7089	-686	6403	7506	13909	9300
2003	118	5781	1867	393	82	8241	-95	8146	8194	16341	8185
2004	136	6130	1715	313	159	8453	128	8581	5350	13931	9600
2005	167	4174	2037	292	197	6867	-219	6648	2546	9194	11520
2006	99	3190	1875	274	209	5647	-264	5383	2083	7466	11520
2007	119	4142	1930	386	52	6629	-119	6510	3243	9753	11520
2008	108	3639	1800	566	121	6234	815	7049	9277	16326	11579
2009	131	5419	2983	716	48	9297	-21	9276	7276	16552	11579[3]
2010[1]	170	6249	2611	850	1	9881	-17	9864	12369	22233	11579[3]

[1] preliminary data

[2] No discard data available, the avereage effort for **1995-1999** was used to estimate discards

[3] 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	167 (148)	6267 (8877)	2609 (2959)	789 (1332)	34	9864 (13316)

Table 7.4.2. Length frequency distributions ('000) of the landings of haddock in VIIb–k in 2010. FR OT_DEF and FR OT_CRU are the French gadoid and *Nephrops* fleets. IRL OTB is the Irish otter trawl fleet, UK trawl includes all trawl gears except beam trawl.

	FR OT_DEF	FR OT_CRU	IRL OTB	IRL OTB	IRL OTB	UK Trawl	UK Beam
	VIIfgh	VIIfgh	VIIbc	VIIfgh	VIIjk	VIIe-k	VIIe-k
	Landings		Landings	Landings	Landings	Landings	Landings
Length (cm)	5992	68	252	1080	520	666	105
22	0.0	0.0	0.0	0.4	0.0	0.0	0.0
23	0.0	0.0	0.1	0.0	0.4	0.0	0.0
24	0.1	0.0	0.1	0.8	1.4	0.0	0.0
25	0.0	0.0	0.1	1.2	3.6	0.0	0.0
26	1.6	0.0	0.1	0.8	8.2	0.0	0.0
27	2.9	0.0	0.1	0.8	9.6	0.5	0.0
28	5.0	0.1	0.8	2.1	14.6	0.5	0.0
29	25.1	0.2	2.0	10.6	24.0	1.6	0.0
30	75.3	0.5	4.5	25.5	24.9	3.8	0.1
31	168.0	1.2	7.0	29.3	29.8	8.8	4.4
32	290.5	2.1	11.9	60.4	35.5	29.5	5.4
33	373.7	2.2	13.6	100.4	45.2	27.6	17.5
34	455.5	4.3	17.1	130.3	53.8	49.4	21.7
35	456.0	3.7	17.9	126.1	52.3	30.8	13.7
36	625.6	3.5	23.4	144.3	46.0	50.0	9.5
37	632.9	5.5	19.9	146.0	43.6	39.7	5.7
38	602.7	5.0	25.1	134.2	45.2	59.3	4.9
39	588.6	3.9	29.0	121.6	38.8	52.3	3.2
40	510.3	4.2	25.4	108.8	34.3	64.6	2.5
41	441.9	3.5	21.0	98.4	36.3	55.4	4.3
42	381.0	3.5	18.5	81.0	32.1	48.5	2.8
43	304.5	1.8	14.9	58.1	34.2	45.8	2.9
44	267.9	3.2	13.4	67.7	26.7	33.7	3.7
45	226.7	2.2	10.4	43.8	26.2	52.6	3.0
46	183.4	2.4	10.1	49.9	20.7	39.8	4.5
47	199.2	2.5	8.4	45.9	15.2	33.7	3.6
48	149.8	2.0	7.4	30.5	12.1	18.0	3.1
49	131.1	1.4	5.7	24.6	11.3	18.3	2.4
50	112.6	1.8	4.4	14.4	9.6	20.1	2.9
51	83.0	1.6	5.1	9.7	8.1	10.2	1.8
52	91.6	1.4	4.1	8.9	6.6	10.6	1.6
53	61.7	1.1	3.1	6.2	6.5	4.2	0.7
54	49.0	1.2	2.9	5.1	4.8	7.0	1.4
55	44.1	1.2	2.9	5.5	3.9	9.2	1.2
56	36.2	0.8	3.3	5.3	2.8	3.3	1.0
57	30.0	0.6	2.5	2.3	3.7	4.7	1.0
58	30.7	0.5	1.5	3.2	4.9	1.3	1.2
59	31.6	0.5	1.6	0.6	3.1	0.9	0.5
60	24.6	0.7	1.3	2.0	2.4	0.9	0.8
61	21.4	0.6	1.2	1.3	2.2	0.8	0.7
62	21.7	0.5	1.1	1.7	1.7	0.7	1.0
63	20.2	0.4	1.1	2.0	1.4	0.8	0.6
64	25.0	0.4	1.0	0.9	1.2	2.5	0.7
65	15.2	0.3	0.8	1.1	1.4	0.4	0.6
66	16.3	0.2	0.3	0.6	1.1	0.4	0.4
67	22.2	0.3	0.6	0.7	0.6	0.1	0.1
68	8.7	0.2	0.2	0.3	0.9	0.2	0.1
69	13.0	0.1	0.1	0.3	0.5	0.3	0.2
70	11.6	0.1	0.1	0.0	0.0	0.1	0.3
71	5.4	0.1	0.0	1.6	0.5	0.3	0.3
72	8.6	0.0	0.0	0.3	0.0	0.0	0.2
73	5.2	0.0	0.0	0.0	0.3	0.3	0.2
74	3.3	0.1	0.1	0.0	0.0	0.1	0.0
75	5.6	0.1	0.0	0.3	0.3	0.0	0.1
76	2.0	0.2	0.0	0.3	0.0	0.1	0.0
77	1.7	0.0	0.0	0.0	0.0	0.0	0.0
78	0.3	0.0	0.0	0.3	0.3	0.0	0.0
79	0.6	0.0	0.0	0.0	0.0	0.0	0.0
80	2.9	0.0	0.0	0.3	0.0	0.0	0.0
81	0.4	0.0	0.0	0.0	0.0	0.0	0.0
82	0.2	0.0	0.0	0.0	0.0	0.0	0.0
83	0.1	0.0	0.0	0.0	0.0	0.0	0.0
84	0.2	0.0	0.0	0.0	0.0	0.0	0.0
85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86	0.0	0.0	0.0	0.0	0.0	0.0	0.0
87	0.2	0.0	0.0	0.0	0.0	0.0	0.0

Table 7.4.3. Overview of the number of OTB (otter trawl) discard trips, the total number of OTB trips and the raising factor used to raise the Irish discard data to international discards.

a). Number of Irish OTB discard trips by year and metier

Metier	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
OTB VIIb Neph	1	1	0	5	2	2	1	1	2	1	5	6	4	1	0	6	4	2	44
OTB VIIbc Dem	0	3	0	0	1	0	0	0	0	0	1	0	0	0	2	1	1	0	9
OTB VIIck Neph	1	1	0	0	1	1	2	0	0	0	0	0	0	0	1	1	2	0	10
OTB VIIg Dem	3	3	0	0	5	2	1	0	0	0	2	10	7	1	4	2	4	1	45
OTB VIIgfh Neph	4	6	0	2	1	1	1	1	2	2	2	2	3	0	10	4	7	6	54
OTB VIIj Dem	1	1	2	4	0	2	2	0	2	0	7	3	6	1	2	2	2	4	41
OTB VIIj Neph	0	0	0	0	0	0	0	0	0	0	2	2	2	0	0	0	1	0	7
Other gears VIIbk	1	0	0	1	3	4	0	0	0	0	3	5	3	0	0	1	2	0	23
Total discard trips	11	15	2	12	13	12	7	2	6	3	22	28	25	3	19	17	23	13	233

b). Total number of Irish OTB trips by year and Division

Metier	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
OTB VIIb	1352	860	949	1267	1156	1192	1115	941	1468	1333	973	788	990	942	903	779	17008
OTB VIIg	1834	1763	1913	1979	1342	1408	1474	1732	1773	1891	2337	2308	2825	2843	2641	2706	32769
OTB VIIj	2181	1808	1916	1976	838	1136	1699	1756	2405	2049	1675	1411	2248	2157	2139	2300	29694
Total OTB VIIbgj	5367	4431	4778	5222	3336	3736	4288	4429	5646	5273	4985	4507	6063	5942	5683	5785	79471

c). Effort (1000h) and the raising factor used to raise the Irish VIIgj discard data to international discards

Fleet	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
IRL OTB VIIb	56*	56*	65	41	50	64	62	63	61	47	64	60	47	40	41	37	38	43	817
IRL OTB VIIgj	138*	132*	157	130	148	162	92	125	137	168	198	189	198	185	217	192	210	226	2376
International VIIe-k**	413	366	394	361	441	413	397	400	413	428	415	384	376	348	389	334	362	381	5933
Raising Factor (INT 7ek/IRL 7	3.00	2.78	2.50	2.77	2.97	2.55	4.31	3.19	3.01	2.54	2.09	2.03	1.90	1.88	1.79	1.74	1.72	1.69	2.50

* Average of 1995-99

** Includes IRL OTB VIIgj, FR GAD VIIfgh and UK Trawl VIIe-k

*** assuming average effort 2006-8 for France

Table 7.4.4. (a) Catch numbers-at-age of haddock in VIIb–k. (b) Landings numbers-at-age. (c) Discard numbers-at-age.

a) Haddock VIIbk - Landings numbers at age

0	1	2	3	4	5	6	7	8	9	10	
9	494	3311	954	815	257	130	130	42	3	0	#1993
0	1491	2934	870	461	297	66	25	63	0	0	#1994
25	2237	1185	1090	462	581	338	161	44	0	0	#1995
0	2399	10373	1206	648	260	275	126	71	10	10	#1996
0	1581	12102	3119	694	580	239	130	33	42	22	#1997
3	640	3264	6199	846	302	252	179	73	56	6	#1998
0	622	2585	1560	1646	245	80	44	14	3	0	#1999
28	4676	2344	587	535	589	134	23	14	2	0	#2000
11	3998	8036	1053	282	295	298	51	29	7	0	#2001
1	872	4216	3354	760	39	88	73	19	5	2	#2002
16	665	8293	1998	1149	112	42	48	41	10	0	#2003
4	117	5870	4540	881	573	50	12	16	3	0	#2004
0	783	833	4166	1884	436	114	4	13	3	0	#2005
0	831	3313	1431	2106	376	64	7	0	0	0	#2006
0	653	6198	2566	503	827	149	29	3	2	0	#2007
0	1528	3854	4212	914	216	358	65	11	1	0	#2008
0	777	6723	3304	1880	475	140	107	24	2	0	#2009
0	1235	4612	5788	866	472	156	65	53	6	1	#2010

b) Haddock VIIbk - Discard numbers at age

0	1	2	3	4	5	6	7	8	9	10	
577	3092	1488	95	7	2	0	0	0	0	0	#1993
577	3092	1488	95	7	2	0	0	0	0	0	#1994
12740	1620	81	0	0	0	0	0	0	0	0	#1995
192	4144	1497	42	19	6	0	0	0	0	0	#1996
849	5795	2997	228	6	1	0	0	0	0	0	#1997
423	602	534	33	0	0	0	0	0	0	0	#1998
539	2759	367	7	0	0	0	0	0	0	0	#1999
3945	37367	5891	247	12	0	0	0	0	0	0	#2000
1049	7294	1871	196	13	1	0	0	0	0	0	#2001
11543	22260	7206	901	52	4	0	0	0	0	0	#2002
11303	25087	10001	395	150	0	0	0	0	0	0	#2003
1470	4365	10011	1203	65	79	0	0	0	0	0	#2004
1223	3412	3020	1907	78	0	0	0	0	0	0	#2005
6091	5108	656	0	0	0	0	0	0	0	0	#2006
2173	6538	4056	306	5	5	0	0	0	0	0	#2007
2659	29268	8659	1017	40	0	0	0	0	0	0	#2008
5604	17296	7921	285	34	0	0	0	0	0	0	#2009
525	49143	8297	1287	0	0	0	0	0	0	0	#2010

c) Haddock VIIbk - Catch numbers at age

0	1	2	3	4	5	6	7	8	9	10	
585	3586	4799	1049	822	259	130	130	42	3	0	#1993
577	4583	4422	965	468	299	66	25	63	0	0	#1994
12766	3857	1265	1090	462	581	338	161	44	0	0	#1995
192	6543	11870	1248	667	266	275	126	71	10	10	#1996
849	7377	15099	3348	700	581	239	130	33	42	22	#1997
425	1242	3798	6232	846	302	252	179	73	56	6	#1998
539	3380	2951	1567	1646	245	80	44	14	3	0	#1999
3973	42044	8234	834	547	589	134	23	14	2	0	#2000
1060	11292	9908	1248	294	296	298	51	29	7	0	#2001
11544	23132	11422	4255	812	43	88	73	19	5	2	#2002
11319	25752	18294	2392	1299	112	42	48	41	10	0	#2003
1474	4482	15881	5742	947	652	50	12	16	3	0	#2004
1223	4194	3853	6073	1962	436	114	4	13	3	0	#2005
6091	5939	3969	1431	2106	376	64	7	0	0	0	#2006
2173	7192	10254	2872	508	832	149	29	3	2	0	#2007
2659	30796	12514	5229	954	216	358	65	11	1	0	#2008
5604	18073	14644	3589	1914	475	140	107	24	2	0	#2009
525	50378	12909	7075	866	472	156	65	53	6	1	#2010

Table 7.4.5. (a) Mean landings weights-at-age. (b) Mean discard weights-at-age. (c) Mean stock weights-at-age (including discards). A 3-year running average was applied to the stock weights.

a) Haddock VIIbk - Landings weights at age

0	1	2	3	4	5	6	7	8	9	10	
0.141	0.187	0.320	0.556	0.851	1.402	1.693	2.130	2.593	2.325	0.000	#1993
0.000	0.321	0.537	0.869	1.167	1.428	1.990	2.399	2.673	0.000	0.000	#1994
0.156	0.285	0.735	0.932	0.964	1.052	1.284	2.040	2.495	0.000	0.000	#1995
0.000	0.207	0.339	0.689	1.137	1.389	1.450	1.850	2.105	1.835	1.415	#1996
0.000	0.321	0.442	0.863	1.237	1.417	1.453	0.965	1.451	0.706	1.570	#1997
0.101	0.291	0.341	0.664	1.024	1.325	1.558	1.915	2.106	1.544	2.044	#1998
0.000	0.360	0.444	0.661	1.094	1.406	2.267	2.594	2.559	1.575	0.000	#1999
0.160	0.437	0.918	1.392	1.709	1.826	2.308	2.486	2.213	2.449	0.000	#2000
0.442	0.345	0.541	1.104	1.865	1.783	1.705	2.297	1.669	1.386	0.000	#2001
0.114	0.373	0.513	0.825	1.032	1.732	1.671	1.504	1.532	1.589	1.840	#2002
0.282	0.347	0.520	0.883	1.242	1.429	1.800	1.705	1.589	2.143	3.045	#2003
0.197	0.432	0.523	0.758	1.192	1.380	1.855	1.806	1.876	3.092	1.950	#2004
0.104	0.429	0.546	0.719	1.027	1.256	1.946	2.667	1.881	2.185	2.708	#2005
0.000	0.349	0.482	0.545	0.938	1.486	2.118	2.619	4.022	4.019	0.000	#2006
0.000	0.330	0.467	0.640	0.886	1.199	1.630	1.487	3.427	1.448	5.779	#2007
0.000	0.377	0.519	0.673	0.875	1.139	1.267	1.654	1.745	2.553	2.878	#2008
0.000	0.349	0.553	0.701	0.999	1.310	1.544	1.646	2.449	2.204	0.000	#2009
0.000	0.385	0.547	0.774	1.185	1.773	1.862	1.739	1.702	1.541	1.012	#2010

b) Haddock VIIbk - Discard weights at age

0	1	2	3	4	5	6	7	8	9	10	
0.074	0.184	0.384	0.538	0.305	0.329	0.000	0.000	0.000	0.000	0.000	#1993
0.074	0.184	0.384	0.538	0.305	0.329	0.000	0.000	0.000	0.000	0.000	#1994
0.095	0.282	0.165	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	#1995
0.056	0.166	0.452	0.468	0.548	0.825	0.000	0.000	0.000	0.000	0.000	#1996
0.081	0.144	0.374	0.636	0.246	0.487	0.000	0.000	0.000	0.000	0.000	#1997
0.069	0.244	0.359	0.502	0.254	0.000	0.000	0.000	0.000	0.000	0.000	#1998
0.057	0.176	0.356	0.548	0.163	0.000	0.000	0.000	0.000	0.000	0.000	#1999
0.090	0.134	0.328	0.200	0.196	0.000	0.000	0.000	0.000	0.000	0.000	#2000
0.095	0.164	0.350	0.432	0.558	0.326	0.000	0.000	0.000	0.000	0.000	#2001
0.083	0.207	0.342	0.393	1.338	1.171	0.000	0.000	0.000	0.000	0.000	#2002
0.012	0.192	0.317	0.245	0.746	0.000	0.000	0.000	0.000	0.000	0.000	#2003
0.085	0.207	0.364	0.583	0.902	0.520	0.000	0.000	0.000	0.000	0.000	#2004
0.068	0.187	0.318	0.469	0.688	0.000	0.000	0.000	0.000	0.000	0.000	#2005
0.066	0.375	0.258	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	#2006
0.088	0.200	0.432	0.590	0.333	0.205	0.000	0.000	0.000	0.000	0.000	#2007
0.077	0.174	0.415	0.580	0.223	0.000	0.000	0.000	0.000	0.000	0.000	#2008
0.088	0.223	0.412	0.547	0.306	0.000	0.000	0.000	0.000	0.000	0.000	#2009
0.073	0.169	0.391	0.639	0.000	0.000	0.000	0.000	0.000	0.000	0.000	#2010

c) Haddock VIIbk - Stock weights at age (3-year running average)

0	1	2	3	4	5	6	7	8	9	10	
0.073	0.190	0.362	0.659	0.866	1.581	2.010	2.114	3.779	2.384	2.384	#1993
0.080	0.252	0.441	0.766	0.956	1.536	1.864	2.142	3.403	2.473	2.473	#1994
0.075	0.244	0.438	0.821	1.147	1.385	1.720	1.998	2.833	2.166	2.170	#1995
0.077	0.237	0.454	0.936	1.267	1.484	1.712	1.961	2.484	1.575	2.033	#1996
0.068	0.172	0.343	0.805	1.235	1.421	1.676	2.044	2.542	1.037	1.368	#1997
0.069	0.179	0.367	0.672	1.072	1.311	1.782	2.198	2.231	1.040	1.365	#1998
0.072	0.181	0.367	0.657	1.089	1.456	2.050	2.363	2.324	1.376	1.358	#1999
0.080	0.184	0.435	0.797	1.339	1.691	2.224	2.373	1.934	1.560	1.560	#2000
0.089	0.192	0.414	0.878	1.383	1.710	1.893	1.817	1.562	1.753	1.670	#2001
0.063	0.197	0.399	0.828	1.373	1.671	1.895	1.724	1.601	2.647	2.409	#2002
0.060	0.203	0.366	0.728	1.199	1.556	1.944	1.386	1.610	3.145	2.409	#2003
0.055	0.206	0.352	0.682	1.225	1.625	2.315	1.968	1.927	3.147	2.732	#2004
0.073	0.259	0.357	0.603	1.100	1.555	2.172	2.421	2.676	3.151	2.891	#2005
0.074	0.260	0.369	0.580	0.982	1.448	2.110	2.564	3.343	2.752	4.182	#2006
0.077	0.246	0.390	0.589	0.885	1.361	1.820	2.203	3.315	3.079	4.179	#2007
0.084	0.206	0.405	0.629	0.894	1.195	1.655	1.870	3.189	2.287	3.387	#2008
0.079	0.194	0.402	0.644	0.950	1.306	1.546	1.824	2.615	2.087	1.783	#2009
0.081	0.200	0.405	0.671	1.029	1.346	1.610	1.858	2.809	1.643	1.324	#2010

Table 7.4.6. Tuning data available for haddock in VIIB–k. The tuning data used in the final assessment is highlighted in grey.

HADDOCK VIIb–k, WGSSDS 2010, TUNING DATA												
113												
IRL-OTB (7b) : Irish Otter Trawl in 7B - effort, nos at age per 1000h												
1995	2010											
1	1	0	1									
0	10											
65.3	0	0	20.5	104.3	76.1	105.3	62	29.6	8.1	0	0	#1995
41.5	0	19.4	93.2	30.2	30	17.9	21.5	9.4	5.1	0.8	0.8	#1996
49.5	0	8.3	195.2	116.9	29.6	31.9	19.1	13.5	4.1	5.3	8.4	#1997
63.5	0	9.8	147.4	290.7	68.1	37.7	34.6	25	9.5	8.4	0.9	#1998
62	0	0.4	193.6	225.9	190.9	49.6	12.4	6	2.3	0.7	0	#1999
57.7	0	41.3	57.2	22.2	56.8	98.5	31.2	7.5	6.9	0.7	0	#2000
60.7	0	20.2	289.1	72.8	13.9	42.5	60.4	7.4	8.2	2	0	#2001
46.8	0.3	3.9	38.9	95.2	28.6	4.3	17.3	17.6	4.8	1.3	0.6	#2002
64	0	2.2	21.7	42.2	66.8	15.1	9	10.6	10.4	2.5	0.1	#2003
60.4	0	0.6	43.7	68.3	59.8	79.6	11	3.2	4.8	0.3	0.2	#2004
47.4	0	9.7	60.8	64.4	57.4	32.7	2	1.6	1	0.3	0	#2005
39.7	0	20.9	120.5	108.9	50.7	7.2	9.3	0	0	0	0	#2006
40.7	0	0	63.5	64.9	45.3	69.5	14.9	7.9	0	0	0	#2007
37.3	0	0	37.6	96.6	63.3	33.3	62.4	12.2	3.1	0.2	0	#2008
37.8	0	0.1	75.1	54.3	81.3	80.5	34.4	44.3	4.7	1.3	0	#2009
43.1	0	0	7.8	110.4	50.2	42.6	41.4	25.2	25.5	4.3	0.6	#2010
IRL-OTB (7j) : Irish Otter Trawl in 7J - effort, nos at age per 1000h												
1995	2010											
1	1	0	1									
0	10											
93.6	3.56	323.2	92.2	37.7	1.4	0.5	0	0	0	0	0	#1995
70.2	0	146.9	464.1	24	9.9	3.2	1.6	0	0	0	0	#1996
83.2	0	136.4	929	190.9	38.6	26.4	6.7	1.5	0	0	0	#1997
89.6	0.34	69	287.7	515.6	48	7.3	4.3	3	1.6	0	0	#1998
40.6	0	8.5	119.2	52.1	61.2	3.2	1.6	1.8	0.6	0	0	#1999
64.1	0	100.1	80.4	30.6	26.2	37	4.9	0	0	0	0	#2000
67.7	0.4	347.9	523	62.7	21.1	10.4	6.3	1.4	0.1	0	0	#2001
90.4	0.2	38.9	495.4	322.3	36	3.9	7.3	3.2	0.6	0	0	#2002
111.3	0.7	26.6	318.3	125.7	150.1	23	3.6	4.1	2.6	0	0	#2003
92	0	7.8	204.5	207.1	84.4	34.4	2.4	0.8	0.6	0.3	0	#2004
73.9	0.1	2.3	32.2	207.1	152.6	61.2	9.6	0	0	0	0	#2005
65.9	0	32.4	117.6	111.7	222.8	44.3	5.4	0.9	0	0	0	#2006
80.5	0	28.1	148.6	152.6	41.9	157.8	16.6	2.1	0.6	0	0.2	#2007
66.5	0	177.7	232.8	120.6	74.4	22.6	38.5	8.3	0.5	0	0.1	#2008
72.5	0	102	577.5	105.6	52.5	38.6	34.8	20.4	3.1	0	0	#2009
85.3	0	26.8	272.5	379.6	44.3	17.4	19.2	7.7	13.4	0.9	0	#2010
IRL-OTB (7bj) : Irish Otter Trawl in 7B&J - effort, nos at age per 1000h												
1995	2010											

HADDOCK VIIb–k, WGSSDS 2010, TUNING DATA												
1	1	0	1									
0	10											
158.9	3.56	323.2	112.7	142	77.6	105.8	62	29.6	8.1	0	0	#1995
111.7	0	166.3	557.4	54.1	39.9	21.1	23.1	9.4	5.1	0.8	0.8	#1996
132.7	0	144.7	1124.2	307.8	68.1	58.2	25.8	15	4.1	5.3	8.4	#1997
153.1	0.34	78.8	435.1	806.3	116.1	45.1	39	28	11.2	8.4	0.9	#1998
102.7	0	8.9	312.8	277.9	252.1	52.8	13.9	7.8	3	0.7	0	#1999
121.7	0	141.3	137.6	52.8	83	135.5	36.1	7.5	6.9	0.7	0	#2000
128.4	0.4	368.1	812	135.6	35	52.9	66.7	8.8	8.3	2	0	#2001
137.2	0.5	42.9	534.2	417.5	64.6	8.3	24.6	20.8	5.4	1.3	0.6	#2002
175.2	0.7	28.8	340	167.9	216.9	38.1	12.6	14.7	13	2.5	0.1	#2003
152.4	0	8.4	248.2	275.3	144.2	114	13.4	4	5.4	0.6	0.2	#2004
121.3	0.1	12.1	92.9	271.6	210.1	93.9	11.7	1.6	1	0.3	0	#2005
105.6	0	53.3	238.1	220.6	273.6	51.5	14.7	0.9	0	0	0	#2006
121.2	0	28.1	212	217.5	87.2	227.3	31.5	10	0.6	0	0.2	#2007
103.8	0	177.7	270.4	217.2	137.7	56	100.9	20.5	3.6	0.2	0.1	#2008
110.3	0	102.1	652.6	160	133.7	119.1	69.2	64.7	7.8	1.3	0	#2009
128.3	0	26.8	280.2	489.9	94.5	60	60.6	32.9	38.9	5.2	0.6	#2010
IRL-ISCSGFS (7g): Irish Sea Celtic Sea GFS (VIIg; Prime stations only) - effort, nos at age per 30min												
1997	2002											
1	1	0.8	0.9									
0	4											
1	18.9	11.7	15.2	2.4	2.4	#1997						
1	241.6	23.6	5.6	0.8	0.2	#1998						
1	2465.2	6.6	0.4	0.4	0.1	#1999						
1	1191.4	710.6	0.9	0	0	#2000						
1	1200.9	34.5	13.7	0	0	#2001						
1	560.9	119.9	8.5	2.8	0.2	#2002						
IRL-WCGFS : Irish Autumn WCGFS - effort, nos at age per min												
1993	2002											
1	1	0.75	0.79									
0	6											
1901	6647	1307	86	52	7	6	0	#1993				
2386	47261	727	111	68	5	7	0	#1994				
2210	239176	6136	17	6	2	3	0	#1995				
2248	37211	9305	333	141	28	22	0	#1996				
2396	661	8679	526	249	88	120	0	#1997				
2486	12340	601	685	451	50	31	0	#1998				
2304	53123	808	22	66	7	18	0	#1999				
2400	57484	14036	28	22	6	22	0	#2000				
1107	45261	10419	6230	209	173	364	302	#2001				
1301	141437	17366	2026	849	7	5	27	#2002				
UK-WCGFS 1gp : 7efghj Standardized no <= 26 cm as proxy for 1-gp												
1992	2001											
1	1	0.15	0.25									

HADDOCK VIIb-k, WGSSDS 2010, TUNING DATA									
1	1								
1	1.7	#1992							
1	19.8	#1993							
1	33.4	#1994							
1	20.8	#1995							
1	145.9	#1996							
1	26.7	#1997							
1	7.1	#1998							
1	9.3	#1999							
1	19.6	#2000							
1	15.6	#2001							
UK-WCGFS : 7efghj Aged component - effort, nos at age per min									
1998	2004								
1	1	0.15	0.25						
1	6								
3744	380.3	245.8	170.3	51	9.5	10.9	#1998	Cirolana	
3823	580.2	18.5	8	37.9	14.5	1	#1999	Cirolana	
4092	1639	33	1.5	1.5	11.2	1	#2000	Cirolana	
3700	949.9	335.5	33.1	0	1.5	4.5	#2001	Cirolana	
3387	3995.1	317.5	100.8	13.8	2.1	0	#2002	Cirolana	
2326	13655.1	947.1	75.3	45.7	4.6	0	#2003	Cirolana	
1689	3334.1	7174.4	410.7	56.4	18.7	4	#2004	Cefas Endeavour	
EVHOE-WIBTS-Q4: THALASSA - effort, nos at age per 30min									
1997	2010								
1	1	0.75	1						
0	7								
1	6.38	10.49	1.53	0.1	0.07	0	0	0	#1997
1	10.72	8.85	1.38	1.82	0.44	0.13	0	0	#1998
1	102.68	57.65	1.7	0.58	0.32	0.16	0	0	#1999
1	26.03	15.5	0.17	0.03	0.04	0.02	0	0	#2000
1	188.39	16.98	3.12	0.29	0.01	0	0	0	#2001
1	281.02	12.38	7.49	5.53	0.31	0	0	0	#2002
1	46.57	228.87	11.61	0.77	0.1	0.01	0	0	#2003
1	83.49	3.25	9.52	1.24	0.11	0.03	0	0	#2004
1	111.84	26.13	1.26	2.36	0.49	0.1	0	0	#2005
1	14.74	8.67	1.04	0.2	0.34	0.17	0	0.01	#2006
1	101.33	8.63	2.17	0.67	0.1	0.35	0.05	0.01	#2007
1	83.6	27.94	1.83	0.62	0.15	0.05	0.1	0.05	#2008
1	396.22	15.14	4.52	0.26	0.11	0.03	0	0	#2009
1	17.69	431.32	12.89	3.24	0.11	0.16	0	0.05	#2010
FR-GAD : French Gadoid Trawlers in VIIfgh FU05 - effort, nos at age per 1000h									
2002	2008								
1	1	0	1						
1	9								
178.7	267.5	1518.8	1435.8	17.3	5.1	3.9	1.2	0	0	#2002

HADDOCK VIIb–k, WGSSDS 2010, TUNING DATA

144.2	124.8	3434.6	787.5	313	9.3	2.3	0.8	0.1	0.3	#2003	
119.4	0	2901.3	1909.1	219.5	102	4.5	0.1	0.1	1	#2004	
101	284.2	256.4	1353.4	457.6	109	24.8	1	4.8	0	#2005	
79.2	212.5	808.2	212.2	534.1	79.3	4.9	0.1	0	0	#2006	
83.9	69.9	2260.4	772.9	93	124.4	24.9	1.8	0.9	1.1	#2007	
70	415.7	1137.3	1601.4	235.5	22.1	46.2	3.7	0.6	0	#2008	
IGFS-WIBTS-Q4 (7g) : Irish Sea Celtic Sea GFS +Irish Groundfish Survey (IBTS 4th Qtr) - standardized numbers per 10km²											
1999	2010										
1	1	0.8	0.9								
0	9										
10	4894	129	17	17	5	1	0	0	0	0	#1999 ISCSGFS
10	1549	3038	25	0	0	0	0	0	0	0	#2000 ISCSGFS
10	26150	1676	122	12	0	0	0	0	0	0	#2001 ISCSGFS
10	14484	2402	272	37	3	0	0	3	3	0	#2002 ISCSGFS
10	2819	6393	453	11	6	0	0	0	0	0	#2003 IBTS Q4
10	11248	1853	1302	78	6	3	0	0	0	0	#2004 IBTS Q4
10	12470	2204	140	106	16	1	0	0	0	0	#2005 IBTS Q4
10	3387	2102	240	21	6	2	1	0	0	0	#2006 IBTS Q4
10	9395	795	325	62	2	3	0	0	0	0	#2007 IBTS Q4
10	8871	3148	109	29	7	0	3	0	0	0	#2008 IBTS Q4
10	65717	1050	521	35	6	1	0	0	0	0	#2009 IBTS Q4
10	2817	30977	784	172	11	2	0	0	0	1	#2010 IBTS Q4
IGFS-WIBTS-Q4 (7g) : Irish Groundfish Survey in VIIg (IBTS 4th Qtr) - effort in minutes											
2003	2010										
1	1	0.79	0.92								
0	7										
832	3042	6975	489	11	6	0	0	0	#2003		
980	14567	2400	1687	101	7	4	0	0	#2004		
845	15997	2594	173	125	20	1	0	0	#2005		
1046	5098	3163	361	32	9	3	1	0	#2006		
1168	15557	1316	539	102	3	4	0	0	#2007		
1139	12644	4487	156	41	9	0	4	0	#2008		
1018	88424	1412	701	47	7	1	0	0	#2009		
1381	4538	49888	1263	277	17	3	0	1	#2010		
IGFS-WIBTS-Q4 (7j) : Irish Groundfish Survey in VIIj (IBTS 4th Qtr) - effort in minutes											
2003	2010										
1	1	0.79	0.92								
0	7										
780	4592	16281	640	74	20	1	0	0	#2003		
720	5175	1620	1395	44	7	4	1	0	#2004		
881	1474	1273	240	286	36	6	2	0	#2005		
901	2636	262	124	53	50	7	0	0	#2006		
874	22831	2116	192	71	20	36	1	0	#2007		
873	14056	4934	222	20	15	6	6	3	#2008		
747	56856	1476	205	2	1	2	2	1	#2009		

HADDOCK VIIb-k, WGSSDS 2010, TUNING DATA										
1021	1308	27870	1906	362	8	5	9	1	#2010	
IGFS-WIBTS-Q4 (7b) : Irish Groundfish Survey in VIIb (IBTS 4th Qtr) - effort in minutes										
2003	2010									
1	1	0.79	0.92							
0	8									
757	11834	34773	2793	874	313	6	1	2	7	#2003
728	31311	2960	6688	925	372	196	46	2	1	#2004
724	3737	7082	964	2299	188	37	5	0	0	#2005
700	8823	2303	2471	614	421	39	16	7	0	#2006
734	56350	2383	770	747	434	392	26	9	0	#2007
653	10948	11622	398	148	172	98	273	54	4	#2008
770	46145	6349	8264	258	272	122	165	110	4	#2009
861	10253	19311	2195	1754	36	144	123	50	55	#2010

Table 7.4.7. 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. Lpue in kg/hour and effort in hours fishing. No Effort data were available for the French fleet in 2009–2010.

	IRL OTB VIIb		IRL OTB VIIg		IRL OTB VIIj		FR OTB_DEF VIIfgh		UK Beam VIIe-k	UK Trawl 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

Table 7.4.8. (a) XSA diagnostics for haddock in VIIb–k, (b) Fishing mortalitiy-at-age and (c) stock numbers-at-age.

Lowestoft VPA Version 3.1

4/05/2011 14:13

Extended Survivors Analysis

HADDOCK VIIb-k WGCSE 2011 COMBSEX PLUSGROUP

Cpue data from file had7bktu.txt

Catch data for 18 years. 1993 to 2010. Ages 0 to 8.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
IRL-OTB (7bj)	1995	2010	2	7	0	1
EVHOE-WIBTS-Q4	1997	2010	0	5	0.75	1
FR-GAD	2002	2010	2	6	0	1
IGFS-WIBTS-Q4 (7g)	1999	2010	0	5	0.8	0.9

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 26 iterations

1

Regression weights

1 1 1 1 1 1 1 1 1 1

Fishing mortalities

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	0	0	0	0	0	0	0	0	0	0
1	0.432	0.486	0.514	0.373	0.262	0.204	0.262	0.542	0.44	0.157
2	0.765	1.1	0.928	0.706	0.644	0.424	0.65	1.013	0.541	0.657
3	0.671	0.922	0.718	0.882	0.653	0.528	0.63	0.844	0.952	0.551
4	0.91	1.425	0.832	0.71	0.893	0.495	0.359	0.44	0.897	0.633
5	0.607	0.308	0.76	1.585	0.87	0.412	0.369	0.254	0.409	0.575
6	0.574	0.361	0.563	0.969	1.763	0.286	0.283	0.268	0.26	0.227
7	0.373	0.264	0.342	0.307	0.174	0.449	0.202	0.192	0.119	0.184

1

XSA population numbers (Thousands)

	AGE							
YEAR	0	1	2	3	4	5	6	7
2001	8.11E+04	3.56E+04	2.05E+04	2.82E+03	5.44E+02	7.19E+02	7.54E+02	1.81E+02
2002	8.65E+04	6.64E+04	1.89E+04	7.81E+03	1.18E+03	1.79E+02	3.21E+02	3.48E+02
2003	1.94E+04	7.08E+04	3.34E+04	5.16E+03	2.54E+03	2.33E+02	1.08E+02	1.83E+02
2004	2.46E+04	1.59E+04	3.46E+04	1.08E+04	2.06E+03	9.06E+02	8.91E+01	5.02E+01
2005	4.34E+04	2.01E+04	8.97E+03	1.40E+04	3.67E+03	8.29E+02	1.52E+02	2.77E+01
2006	4.21E+04	3.55E+04	1.27E+04	3.85E+03	5.97E+03	1.23E+03	2.85E+02	2.14E+01
2007	9.94E+04	3.45E+04	2.37E+04	6.79E+03	1.86E+03	2.98E+03	6.68E+02	1.75E+02
2008	6.86E+04	8.14E+04	2.17E+04	1.01E+04	2.96E+03	1.06E+03	1.69E+03	4.12E+02
2009	4.69E+05	5.61E+04	3.87E+04	6.46E+03	3.57E+03	1.56E+03	6.76E+02	1.06E+03
2010	1.74E+04	3.84E+05	2.96E+04	1.85E+04	2.04E+03	1.19E+03	8.50E+02	4.26E+02

Estimated population abundance at 1st Jan 2011

0.00E+00	1.42E+04	2.69E+05	1.26E+04	8.72E+03	8.88E+02	5.49E+02	5.55E+02

Taper weighted geometric mean of the VPA populations:

4.22E+04	3.47E+04	1.61E+04	5.66E+03	2.16E+03	9.32E+02	4.19E+02	1.92E+02

Standard error of the weighted Log(VPA populations) :

0.9134	0.9078	0.6391	0.6389	0.52	0.6577	0.7664	0.9987

1

Log-catchability residuals.

Fleet : IRL-OTB (7bj) : Iris

Age	1995	1996	1997	1998	1999	2000
0	No data for this fleet at this age					
1	No data for this fleet at this age					
2	-0.31	0.63	0.64	0.79	1.48	-0.27
3	-0.36	-0.71	0.45	0.58	0.99	0.04
4	-0.59	-1.02	-0.16	0.08	0.51	0.09
5	0.13	-1.04	-0.06	0.2	0.5	0.53
6	0.42	-0.24	-0.43	0.41	0.24	0.64
7	0.01	-0.13	0.02	0.32	0.07	0

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	No data for this fleet at this age									
1	No data for this fleet at this age									
2	0.75	0.48	-0.86	-1.16	-0.59	0.05	-0.73	-0.1	-0.05	-0.73
3	0.27	0.42	-0.41	-0.45	-0.58	0.58	-0.09	-0.25	-0.12	-0.37
4	0.34	0.31	0.28	0.17	0.27	0.02	-0.16	0.03	-0.06	-0.11
5	0.35	-0.32	0.9	1.1	0.94	-0.11	0.33	0.07	0.45	-0.05
6	0.52	0.21	0.48	1.04	0.9	0.04	-0.19	0.2	0.67	0.14
7	-0.17	-0.08	0	0.12	-0.03	-0.09	-0.03	-0.02	0.09	0.2

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	-8.3858	-7.7598	-7.4341	-7.4341	-7.4341	-7.4341
S.E(Log q)	0.7343	0.494	0.3757	0.5847	0.5188	0.1256

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	1.86	-1.681	7.21	0.21	16	1.29	-8.39
3	1.24	-0.989	7.54	0.55	16	0.61	-7.76
4	1.03	-0.141	7.43	0.67	16	0.4	-7.43
5	1.06	-0.276	7.21	0.61	16	0.58	-7.19
6	1.36	-2.359	7.51	0.75	16	0.48	-7.12
7	0.97	1.067	7.35	0.99	16	0.12	-7.42
1							

Fleet : EVHOE-WIBTS-Q4: THAL

Age	1995	1996	1997	1998	1999	2000
0	99.99	99.99	-0.57	-0.96	-0.02	-0.7
1	99.99	99.99	0.18	0.56	1.55	-0.36
2	99.99	99.99	-1.03	0.05	1.03	-1.89
3	99.99	99.99	-1.53	0.66	0.47	-1.51
4	99.99	99.99	-0.32	1.38	0.29	-0.99
5	99.99	99.99	99.99	1.24	1.07	-1.73
6	No data for this fleet at this age					
7	No data for this fleet at this age					

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	0.66	1	0.69	1.04	0.76	-1.23	-0.16	0.01	-0.35	-0.16

1	-0.11	-1.01	1.87	-1.01	0.74	-0.98	-0.91	-0.35	-0.68	0.5
2	0.07	1.31	1.03	0.61	-0.12	-0.85	-0.54	-0.31	-0.39	1.02
3	0.01	2.16	0.42	0.3	0.49	-0.8	-0.07	-0.36	-0.68	0.44
4	-1.03	2.07	-0.34	-0.14	0.93	-0.26	-0.44	-0.43	-0.53	-0.2
5	99.99	99.99	-0.31	0.14	0.81	0.55	0.35	-0.67	-1.43	0.66
6	No data for this fleet at this age									
7	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	5
Mean Log q	-6.5496	-6.9831	-8.0164	-8.4316	-8.9028	-8.9028
S.E(Log q)	0.7337	0.9442	0.928	0.9555	0.8861	0.9902

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	0.95	0.236	6.76	0.66	14	0.72	-6.55
1	1.04	-0.149	6.82	0.48	14	1.03	-6.98
2	0.94	0.146	8.12	0.33	14	0.91	-8.02
3	0.6	1.825	8.57	0.64	14	0.53	-8.43
4	0.91	0.217	8.8	0.35	14	0.84	-8.9
5	1.55	-0.71	9.9	0.16	11	1.57	-8.84

1

Fleet : FR-GAD : French Gado

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	No data for this fleet at this age									
1	No data for this fleet at this age									
2	99.99	-0.22	0.17	0.06	-0.87	0.08	0.52	0.26	99.99	99.99
3	99.99	-0.06	-0.12	0.28	-0.25	-0.62	0.09	0.69	99.99	99.99
4	99.99	-1.82	0.29	0.28	0.68	0.43	-0.27	0.41	99.99	99.99
5	99.99	-1.62	-0.86	0.68	0.73	0.06	-0.45	-1.02	99.99	99.99
6	99.99	-2.44	-1.58	-0.35	1.28	-1.32	-0.6	-0.74	99.99	99.99
7	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
Mean Log q	-6.9073	-6.3059	-6.8851	-6.8851	-6.8851
S.E(Log q)	0.4438	0.4143	0.8532	0.9657	1.464

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	0.62	2.143	8.06	0.86	7	0.22	-6.91
3	0.67	1.444	7.19	0.79	7	0.25	-6.31
4	0.43	2.885	7.43	0.84	7	0.25	-6.89
5	0.69	1.258	7.04	0.77	7	0.59	-7.24
6	1.18	-0.303	8.07	0.37	7	1.49	-7.71
1							

Fleet : IGFS-WIBTS-Q4 (7g) :

Age	1995	1996	1997	1998	1999	2000
0	99.99	99.99	99.99	99.99	-0.9	-1.35
1	99.99	99.99	99.99	99.99	-2.02	0.52
2	99.99	99.99	99.99	99.99	-1.03	-1.26
3	99.99	99.99	99.99	99.99	-0.14	99.99
4	99.99	99.99	99.99	99.99	-0.54	99.99
5	99.99	99.99	99.99	99.99	-0.68	99.99
6	No data for this fleet at this age					
7	No data for this fleet at this age					

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	0.85	0.2	0.05	1.2	0.74	-0.54	-0.38	-0.06	0.02	0.16
1	0.1	-0.12	0.82	0.95	0.8	0.13	-0.76	0	-0.82	0.4
2	-0.62	0.55	0.34	1.18	0.25	0.25	0.12	-0.58	0.01	0.78
3	-0.26	0.06	-0.91	0.45	0.3	-0.13	0.47	-0.51	0.22	0.42
4	99.99	0.74	0.16	0.27	0.83	-0.97	-1.02	-0.17	-0.12	0.82
5	99.99	99.99	99.99	1.14	-0.47	-0.57	-1.08	99.99	-1.5	-0.39
6	No data for this fleet at this age									
7	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	5
Mean Log q	-4.1161	-4.9196	-5.9907	-6.7659	-7.6399	-7.6399
S.E(Log q)	0.7289	0.8546	0.7336	0.4397	0.6952	0.9897

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	1.15	-0.499	3.12	0.54	12	0.87	-4.12
1	0.84	0.595	5.83	0.6	12	0.74	-4.92
2	0.6	2.124	7.54	0.74	12	0.38	-5.99
3	0.73	1.706	7.33	0.82	11	0.29	-6.77
4	3.14	-1.422	7.08	0.05	10	2.07	-7.64
5	7.01	-1.28	14.47	0.01	7	5.49	-8.15

1

Terminal year survivor and F summaries :

Age 0 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
IRL-OTB (7bj)	1	0	0	0	0	0	0
EVHOE-WIBTS-Q4	12058	0.759	0	0	1	0.499	0
FR-GAD	1	0	0	0	0	0	0
IGFS-WIBTS-Q4 (7g)	16763	0.759	0	0	1	0.501	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
14220	0.54	0.16	2	0.307	0

Age 1 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
IRL-OTB (7bj)	1	0	0	0	0	0	0
EVHOE-WIBTS-Q4	260865	0.6	0.414	0.69	2	0.441	0.161
FR-GAD	1	0	0	0	0	0	0
IGFS-WIBTS-Q4 (7g)	321859	0.577	0.19	0.33	2	0.476	0.132
F shrinkage mean	111009	1.5				0.082	0.344

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F

268698	0.4	0.21	5	0.528	0.157

1

Age 2 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
IRL-OTB (7bj)	6050	0.757	0	0	1	0.191	1.075
EVHOE-WIBTS-Q4	15870	0.52	0.474	0.91	3	0.315	0.552
FR-GAD	1	0	0	0	0	0	0
IGFS-WIBTS-Q4 (7g)	14857	0.472	0.454	0.96	3	0.4	0.58
F shrinkage mean	12487	1.5				0.094	0.66

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12567	0.32	0.25	8	0.778	0.657

Age 3 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
IRL-OTB (7bj)	6422	0.433	0.13	0.3	2	0.325	0.692
EVHOE-WIBTS-Q4	8658	0.504	0.213	0.42	4	0.173	0.554
FR-GAD	1	0	0	0	0	0	0
IGFS-WIBTS-Q4 (7g)	11381	0.352	0.15	0.43	4	0.451	0.446
F shrinkage mean	5975	1.5				0.051	0.728

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8720	0.24	0.11	11	0.471	0.551

1

Age 4 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
IRL-OTB (7bj)	797	0.321	0.004	0.01	3	0.52	0.685
EVHOE-WIBTS-Q4	574	0.58	0.171	0.29	5	0.126	0.861
FR-GAD	1145	0.474	0	0	1	0.039	0.521
IGFS-WIBTS-Q4 (7g)	1294	0.381	0.238	0.62	5	0.264	0.473
F shrinkage mean	908	1.5				0.052	0.622

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
888	0.22	0.1	15	0.456	0.633

Age 5 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2005

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IRL-OTB (7bj)	502	0.317	0.07	0.22	4	0.479	0.615
EVHOE-WIBTS-Q4	632	0.572	0.273	0.48	6	0.145	0.516
FR-GAD	1038	0.339	0.077	0.23	2	0.099	0.345
IGFS-WIBTS-Q4 (7g)	425	0.409	0.131	0.32	6	0.218	0.696
F shrinkage mean	719	1.5				0.06	0.466

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
549	0.22	0.09	19	0.416	0.575

1

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IRL-OTB (7bj)	640	0.267	0.083	0.31	5	0.544	0.199
EVHOE-WIBTS-Q4	329	0.468	0.369	0.79	6	0.108	0.357
FR-GAD	649	0.327	0.094	0.29	3	0.137	0.197
IGFS-WIBTS-Q4 (7g)	538	0.335	0.36	1.07	6	0.18	0.233
F shrinkage mean	181	1.5				0.033	0.577

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
555	0.18	0.12	21	0.681	0.227

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IRL-OTB (7bj)	360	0.203	0.114	0.56	6	0.72	0.151
EVHOE-WIBTS-Q4	182	0.473	0.189	0.4	6	0.063	0.281

FR-GAD	146	0.333	0.141	0.42	4	0.107	0.339
IGFS-WIBTS-Q4 (7g)	210	0.335	0.269	0.8	5	0.091	0.246
F shrinkage mean	95	1.5				0.02	0.482
Weighted prediction :							
Survivors	Int	Ext	N	Var	F		
at end of year	s.e	s.e		Ratio			
290	0.16	0.1	22	0.647	0.184		

b) Haddock VIIbk – Fishing mortality (F) at age

	Age									
Year	0	1	2	3	4	5	6	7	8+	Fbar 2-5
1993	0.000	0.289	0.823	0.349	0.493	0.326	0.648	0.493	0.493	0.498
1994	0.000	0.571	0.703	0.376	0.258	0.333	0.128	0.241	0.241	0.418
1995	0.000	0.158	0.300	0.367	0.311	0.592	0.789	0.520	0.520	0.392
1996	0.000	0.177	1.035	0.548	0.403	0.296	0.628	0.791	0.791	0.570
1997	0.000	0.578	0.785	0.981	0.694	0.749	0.475	0.703	0.703	0.802
1998	0.000	0.196	0.678	0.919	0.723	0.750	0.894	0.811	0.811	0.768
1999	0.000	0.218	0.987	0.671	0.666	0.470	0.449	0.369	0.369	0.699
2000	0.000	1.050	1.292	0.870	0.524	0.534	0.513	0.222	0.222	0.805
2001	0.000	0.432	0.765	0.671	0.910	0.607	0.574	0.373	0.373	0.738
2002	0.000	0.486	1.100	0.922	1.425	0.308	0.361	0.264	0.264	0.939
2003	0.000	0.514	0.928	0.718	0.832	0.760	0.563	0.342	0.342	0.809
2004	0.000	0.373	0.706	0.882	0.710	1.585	0.969	0.307	0.307	0.971
2005	0.000	0.262	0.644	0.653	0.893	0.870	1.763	0.174	0.174	0.765
2006	0.000	0.204	0.424	0.528	0.495	0.412	0.286	0.450	0.450	0.465
2007	0.000	0.262	0.650	0.630	0.359	0.369	0.283	0.202	0.202	0.502
2008	0.000	0.542	1.013	0.844	0.440	0.254	0.268	0.192	0.192	0.638
2009	0.000	0.440	0.541	0.952	0.897	0.409	0.260	0.119	0.119	0.700
2010	0.000	0.157	0.657	0.551	0.633	0.575	0.227	0.185	0.185	0.604
Fbar Catch	0.000	0.379	0.737	0.782	0.656	0.413	0.251	0.165		
Fbar Land	0.000	0.038	0.400	0.667	0.638	0.407	0.251	0.165		
Fbar Disc	0.000	0.341	0.337	0.115	0.018	0.006	0.000	0.000		

c) Haddock VIIbk - Stock numbers-at-age (start of year) ('1000)

	Age									
Year	0	1	2	3	4	5	6	7	8+	Total
1993	14226	15782	9459	3936	2334	1030	301	369	127	47565
1994	35562	11647	9677	3402	2273	1167	609	129	324	64790
1995	54599	29116	5389	3921	1913	1438	685	439	119	97618
1996	22676	44702	20348	3268	2224	1148	651	255	181	95453
1997	9432	18566	30678	5919	1546	1218	699	285	210	68551
1998	23281	7722	8525	11455	1817	632	471	356	265	54524
1999	87316	19061	5198	3543	3740	722	244	158	60	120043
2000	43475	71488	12547	1586	1483	1572	369	128	88	132738

2001	81123	35594	20487	2822	544	719	754	181	127	142352
2002	86450	66418	18925	7808	1181	179	321	348	123	181753
2003	19426	70779	33447	5159	2543	233	108	183	193	132071
2004	24586	15904	34648	10831	2060	906	89	50	79	89153
2005	43402	20129	8966	13998	3672	829	152	28	110	91287
2006	42110	35535	12685	3854	5965	1231	285	21	0	101687
2007	99367	34477	23720	6795	1861	2978	668	175	30	170070
2008	68578	81355	21720	10142	2964	1064	1686	412	76	187996
2009	468851	56147	38742	6459	3572	1564	676	1056	256	577322
2010	17368	383862	29616	18469	2041	1193	850	426	392	454218
2011	0	14220	268698	12567	8720	888	549	555	557	306753
GM93-09	38338	28995	14651	5215	2100	889	389	164		

Table 7.4.9. Stock Summary for haddock in VIIb–k.

	Recruits					Yield/	Fbar 2–5
Year	age 0	TotBio	SSB	Landings	Discards	SSB	Lan+Dis
1993	14226	15555	11519	3348	1193	0.291	0.498
1994	35562	19131	13352	4131	1193	0.309	0.418
1995	54599	23440	12200	4470	470	0.366	0.392
1996	22676	31202	18860	6756	1398	0.358	0.570
1997	9432	24865	21029	10827	2104	0.515	0.802
1998	23281	18657	15670	7668	355	0.489	0.768
1999	87316	20091	10359	4882	620	0.471	0.699
2000	43475	29263	12646	7411	6984	0.586	0.805
2001	81123	28973	14911	8632	1941	0.579	0.738
2002	86450	35930	17387	6403	7506	0.368	0.939
2003	19426	35793	20251	8146	8194	0.402	0.809
2004	24586	28716	24081	8581	5350	0.356	0.971
2005	43402	26111	17711	6555	2546	0.370	0.765
2006	42110	27673	15271	5383	2083	0.352	0.465
2007	99367	36862	20695	6510	3243	0.315	0.502
2008	68578	45421	22897	7049	9277	0.308	0.638
2009	468851	76761	28810	9276	7276	0.322	0.700
2010	17368	109630	31343	9864	12369	0.315	0.604
GM93-08	38338						

Table 7.4.10. Input values for short-term forecast (.prd).

MFDP version 1a
Run: mfdp
Time and date: 09:41 05/05/2011
Fbar age range (Total) : 2-5
Fbar age range Fleet 1 : 2-5

2011

Age	N	M	Mat	PF	PM	SWt
0	38338	0.2	0	0	0	8.13E-02
1	14220	0.2	0	0	0	0.2
2	268698	0.2	1	0	0	0.405
3	12567	0.2	1	0	0	0.651
4	8720	0.2	1	0	0	0.954333
5	888	0.2	1	0	0	1.266667
6	549	0.2	1	0	0	1.578667
7	555	0.2	1	0	0	1.818333
8	557	0.2	1	0	0	2.756667

CATCH

Age	Sel	CWt	DSel	DCWt
0	0	0	0	7.93E-02
1	1.65E-02	0.195333	0.36299	0.188667
2	0.266362	0.457	0.47507	0.406
3	0.693101	0.697667	0.114892	0.588667
4	0.676601	1.006667	1.23E-02	0.176333
5	0.394884	1.407333	0	0
6	0.210039	1.557667	0	0
7	0.127029	1.679667	0	0
8	0.128635	1.983	0	0

2012

Age	N	M	Mat	PF	PM	SWt
0	38338	0.2	0	0	0	8.13E-02
1	.	0.2	0	0	0	0.2
2	.	0.2	1	0	0	0.405
3	.	0.2	1	0	0	0.651
4	.	0.2	1	0	0	0.954333
5	.	0.2	1	0	0	1.266667
6	.	0.2	1	0	0	1.578667
7	.	0.2	1	0	0	1.818333
8	.	0.2	1	0	0	2.756667

CATCH

Age	Sel	CWt	DSel	DCWt
0	0	0	0	7.93E-02
1	1.65E-02	0.195333	0.36299	0.188667
2	0.266362	0.457	0.47507	0.406
3	0.693101	0.697667	0.114892	0.588667
4	0.676601	1.006667	1.23E-02	0.176333
5	0.394884	1.407333	0	0
6	0.210039	1.557667	0	0
7	0.127029	1.679667	0	0
8	0.128635	1.983	0	0

2013

Age	N	M	Mat	PF	PM	SWt
0	38338	0.2	0	0	0	8.13E-02
1	.	0.2	0	0	0	0.2
2	.	0.2	1	0	0	0.405
3	.	0.2	1	0	0	0.651
4	.	0.2	1	0	0	0.954333
5	.	0.2	1	0	0	1.266667
6	.	0.2	1	0	0	1.578667
7	.	0.2	1	0	0	1.818333
8	.	0.2	1	0	0	2.756667

CATCH

Age	Sel	CWt	DSel	DCWt
0	0	0	0	7.93E-02
1	1.65E-02	0.195333	0.36299	0.188667
2	0.266362	0.457	0.47507	0.406
3	0.693101	0.697667	0.114892	0.588667
4	0.676601	1.006667	1.23E-02	0.176333
5	0.394884	1.407333	0	0
6	0.210039	1.557667	0	0
7	0.127029	1.679667	0	0
8	0.128635	1.983	0	0

Input units are thousands and kg - output in tonnes

Table 7.4.11. Management options table (.prm).

MFDP version 1a
Run: mfdp
Time and date: 09:41 05/05/2011
Fbar age range (Total) : 2-5
Fbar age range Fleet 1 : 2-5

2011								
		"CATCH"	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield		
135824	129862	1	0.5077	29730	0.1506	34864		

2012							2013	
		"CATCH"	Landings		Discards			
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	Biomass	SSB
93416	84020	0	0	0	0	0	118692	109296
.	84020	0.1	0.0508	5003	0.0151	945	111100	101704
.	84020	0.2	0.1015	9644	0.0301	1827	104065	94670
.	84020	0.3	0.1523	13950	0.0452	2650	97548	88152
.	84020	0.4	0.2031	17945	0.0602	3420	91507	82111
.	84020	0.5	0.2539	21652	0.0753	4140	85908	76512
.	84020	0.6	0.3046	25094	0.0903	4813	80718	71322
.	84020	0.7	0.3554	28290	0.1054	5442	75904	66509
.	84020	0.8	0.4062	31259	0.1205	6031	71441	62045
.	84020	0.9	0.457	34016	0.1355	6583	67300	57904
.	84020	1	0.5077	36578	0.1506	7099	63459	54063
.	84020	1.1	0.5585	38960	0.1656	7583	59894	50498
.	84020	1.2	0.6093	41174	0.1807	8037	56585	47189
.	84020	1.3	0.6601	43234	0.1957	8463	53513	44117
.	84020	1.4	0.7108	45149	0.2108	8862	50661	41265
.	84020	1.5	0.7616	46932	0.2259	9237	48011	38615
.	84020	1.6	0.8124	48592	0.2409	9589	45550	36154
.	84020	1.7	0.8632	50137	0.256	9920	43262	33867
.	84020	1.8	0.9139	51577	0.271	10231	41136	31740
.	84020	1.9	0.9647	52919	0.2861	10523	39159	29763
.	84020	2	1.0155	54169	0.3011	10798	37321	27925

Input units are thousands and kg - output in tonnes

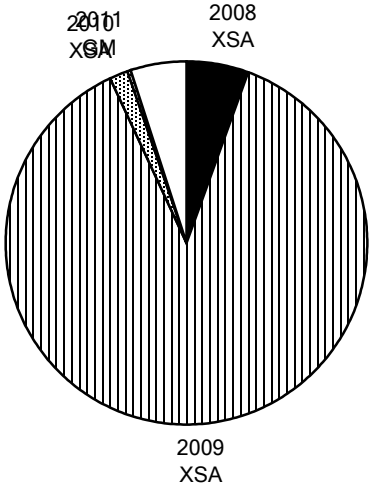
Table 7.4.12. Haddock VIIb–k. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.

Year-class			2008	2009	2010	2011	2012
Stock No. (thousands) of 0 year-olds			68578	468851	17368	38338	38338
Source			XSA	XSA	XSA	GM	GM
Status Quo F:							
% in	2011	landings	12.9	71.3	0.1	0.0	-
% in	2012		5.7	87.3	1.7	0.2	0.0
% in	2011	SSB	6.3	83.8	0.0	0.0	-
% in	2012	SSB	3.7	85.5	6.5	0.0	0.0
% in	2013	SSB	2.9	59.8	4.9	27.5	0.0

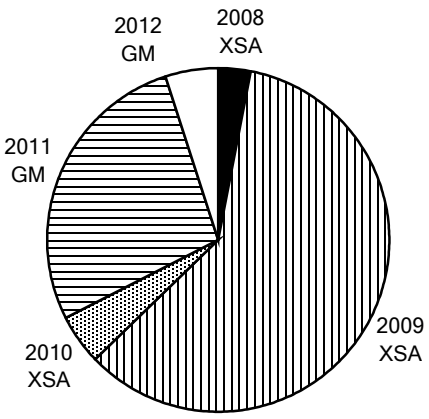
MR : mean recruitment

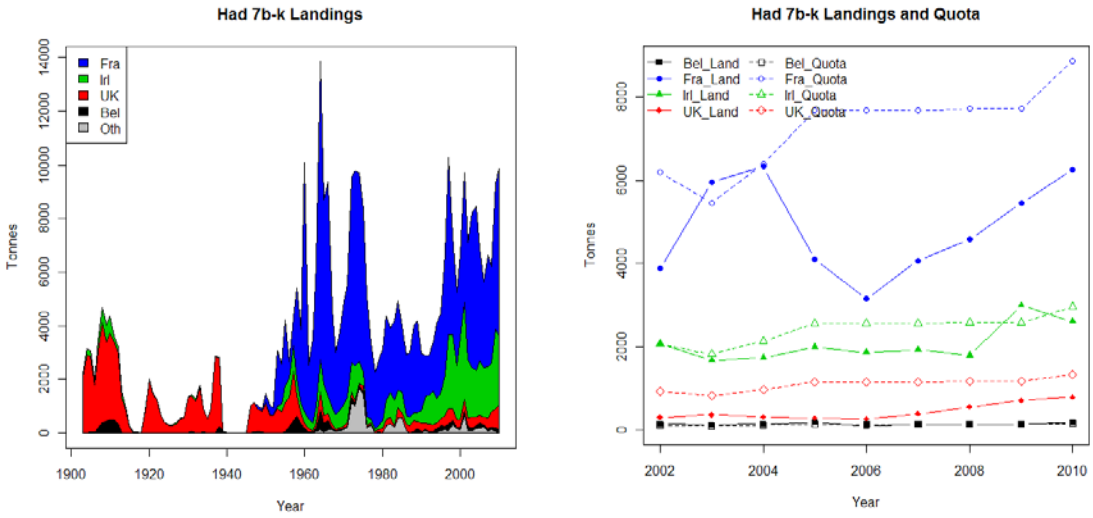
Haddock in VIIb-k : Year-class % contribution to

a) 2012 landings



b) 2013 SSB





(a) **(b)**

Figure 7.4.1. a) Official ICES landings of haddock in VIIb–k by country and the TAC. Historical data may not be complete for all countries. b) Recent working group landings and quota by country.

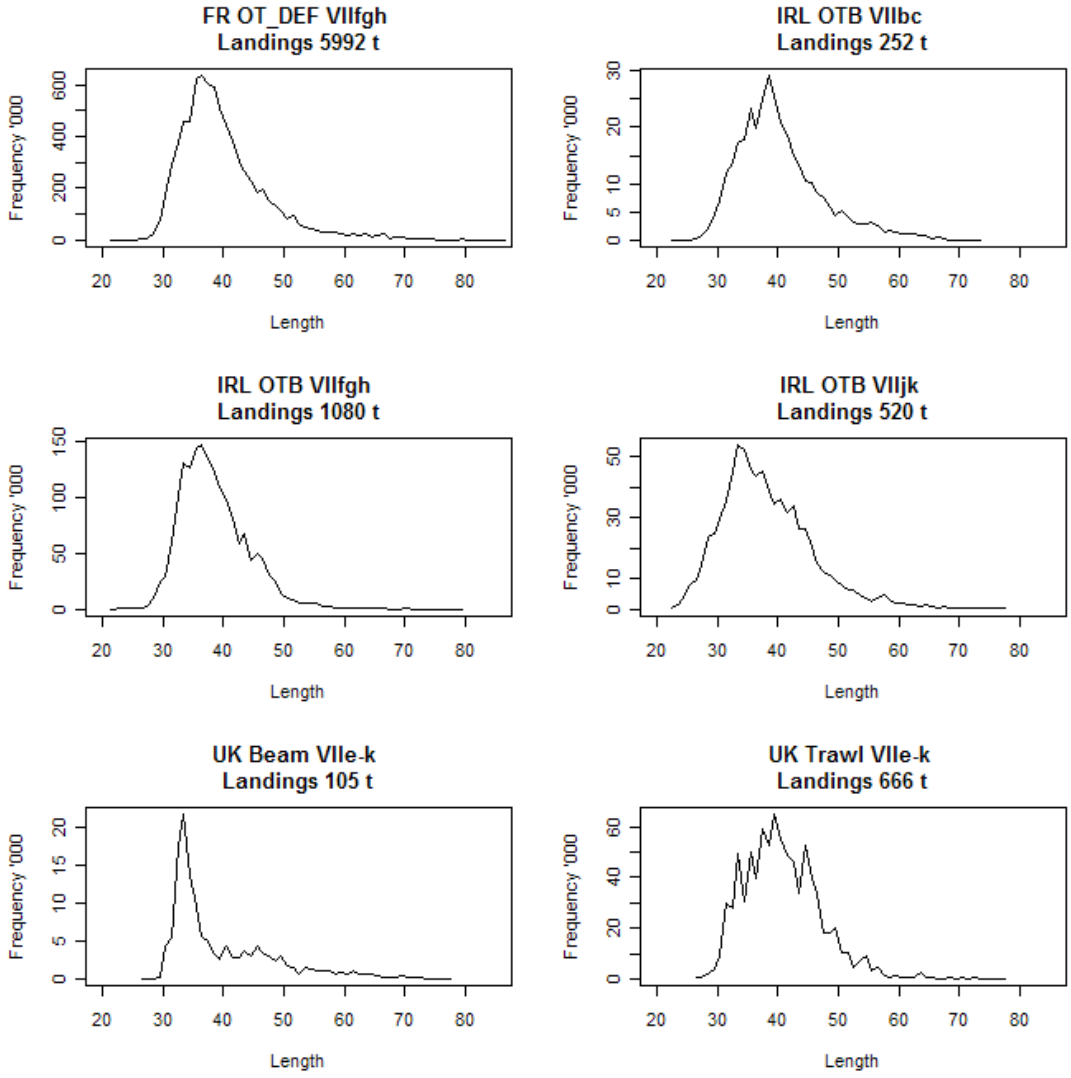


Figure 7.4.2a. Length distributions of the landings of haddock in VIIb–k in 2010. FR OT_DEF is the French demersal fleet; IRL OTB is the Irish otter trawl fleet; UK beam is the UK beam trawl fleet and UK trawl consists of all other UK trawls.

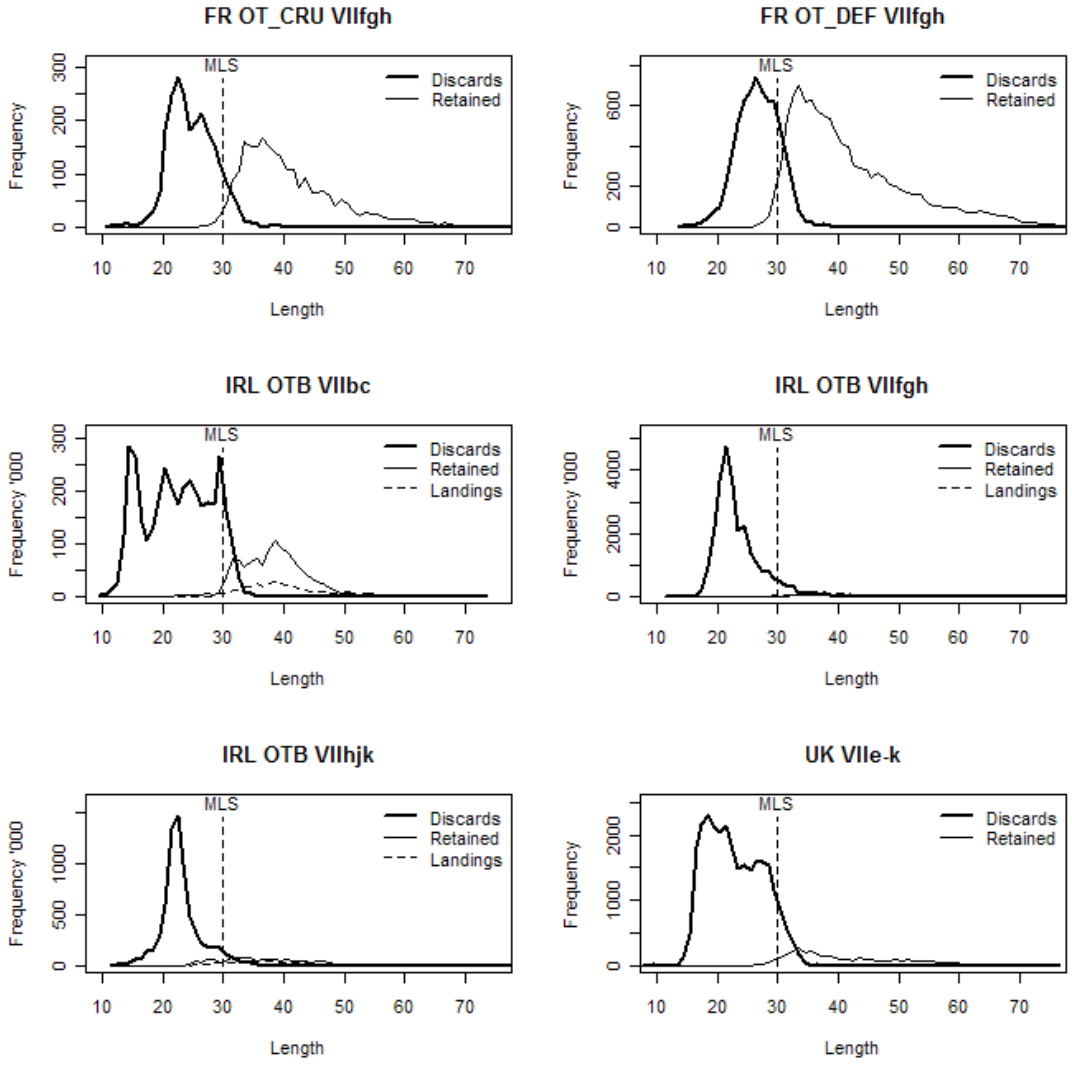


Figure 7.4.2b. Length distributions of discards and the retained catch of haddock in VIIb–k in 2010. FR OT_CRU is the French otter trawl *Nephrops* fleet; FR OT_DEF is the French otter trawl demersal fleet; IRL OTB is the Irish otter trawl fleet; all UK fleets were combined. Irish data were raised to total numbers, the length distributions of the landings (from port sampling) is given for comparison.

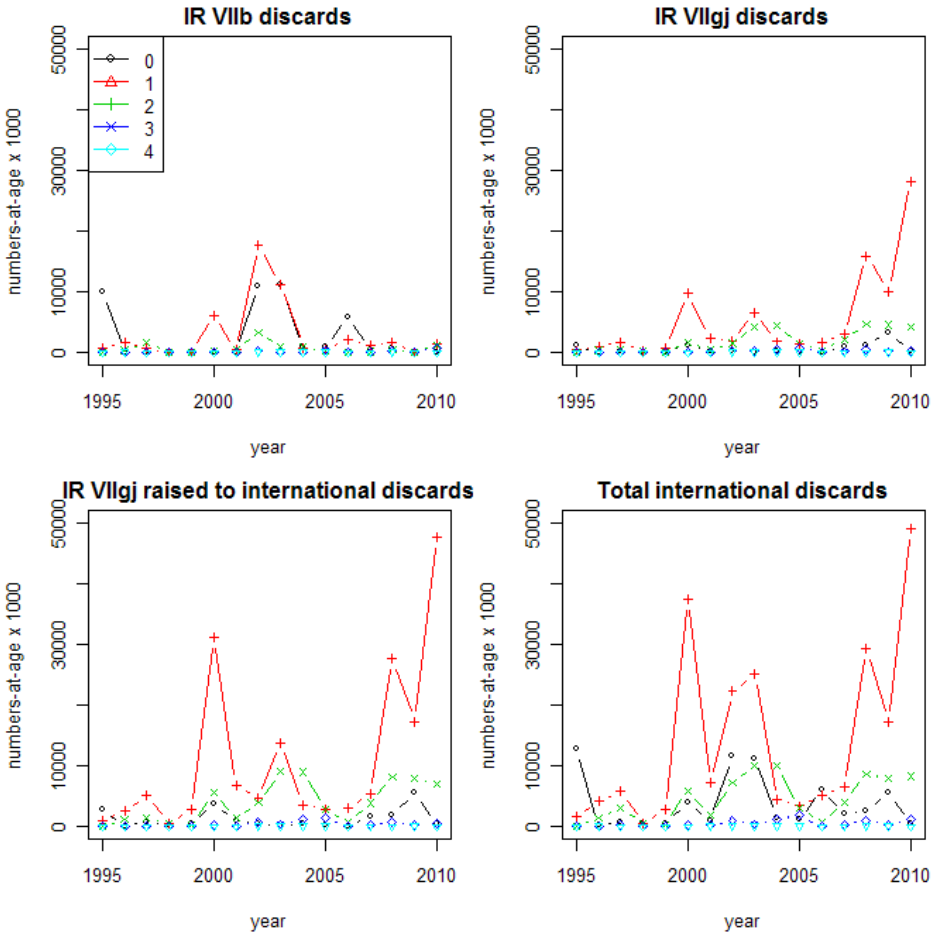


Figure7.4.3a. Numbers-at-age of Irish Discards of haddock in VIIb and VIIgj. The Irish discards in VIIgj were raised to international levels using effort as auxiliary variable.

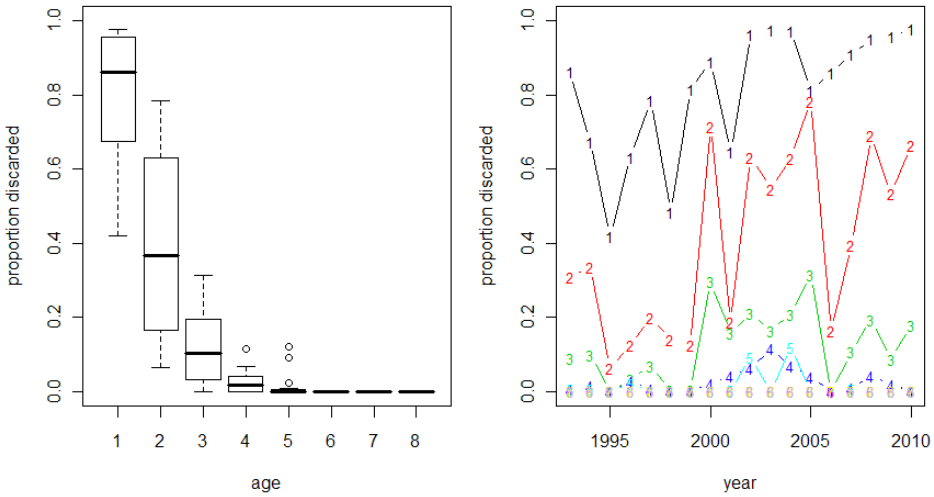


Figure7.4.3b. Proportion of discards of haddock in VIIb–k by age (left) and year (right).

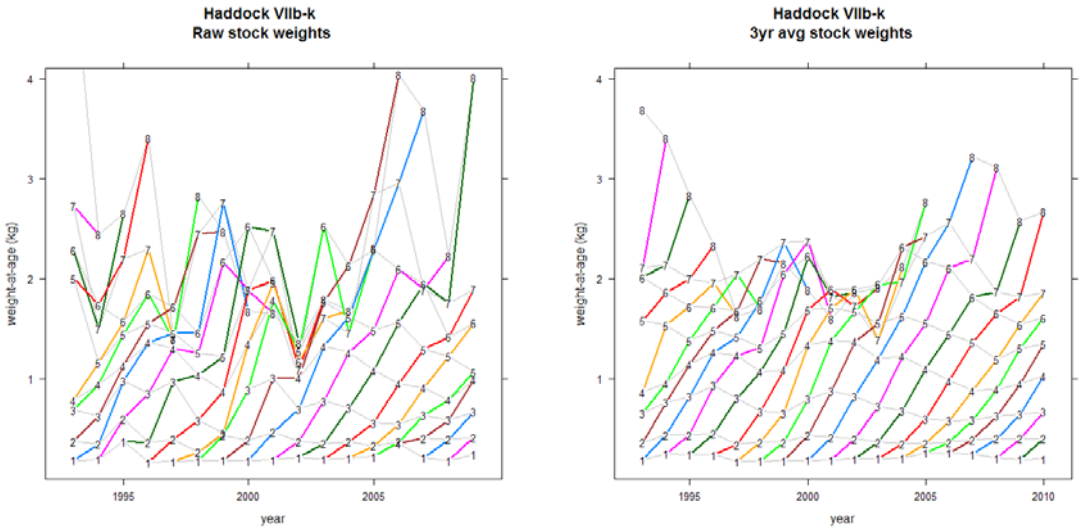


Figure7.4.4. Raw stock weights-at-age (left) and the tree-year running average stock weights (left).



Figure 7.4.5a. Log standardized indices of tuning fleets by year. The IGFSWIBTSQ4(7b) and IGFSWIBTSQ4(7j) fleets were not used in the assessment. See Stock Annex for a description of the fleets.

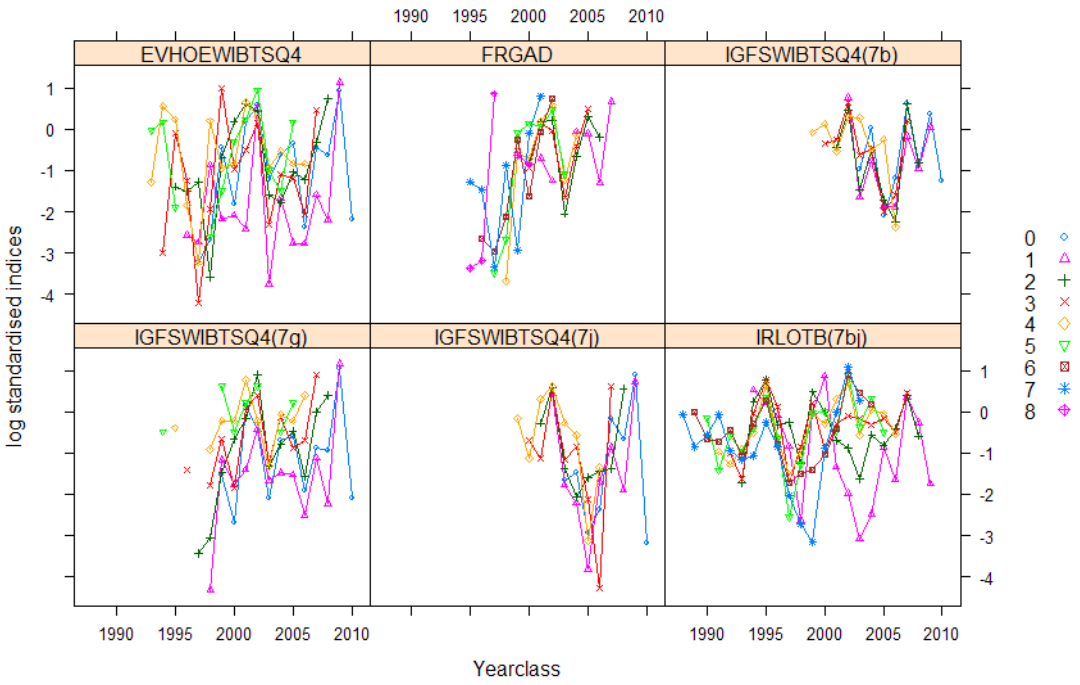


Figure 7.4.5b. Log standardized indices of tuning fleets by year class. The IGFSWIBTSQ4(7b) and IGFSWIBTSQ4(7j) fleets were not used in the assessment. See Stock Annex for a description of the fleets.

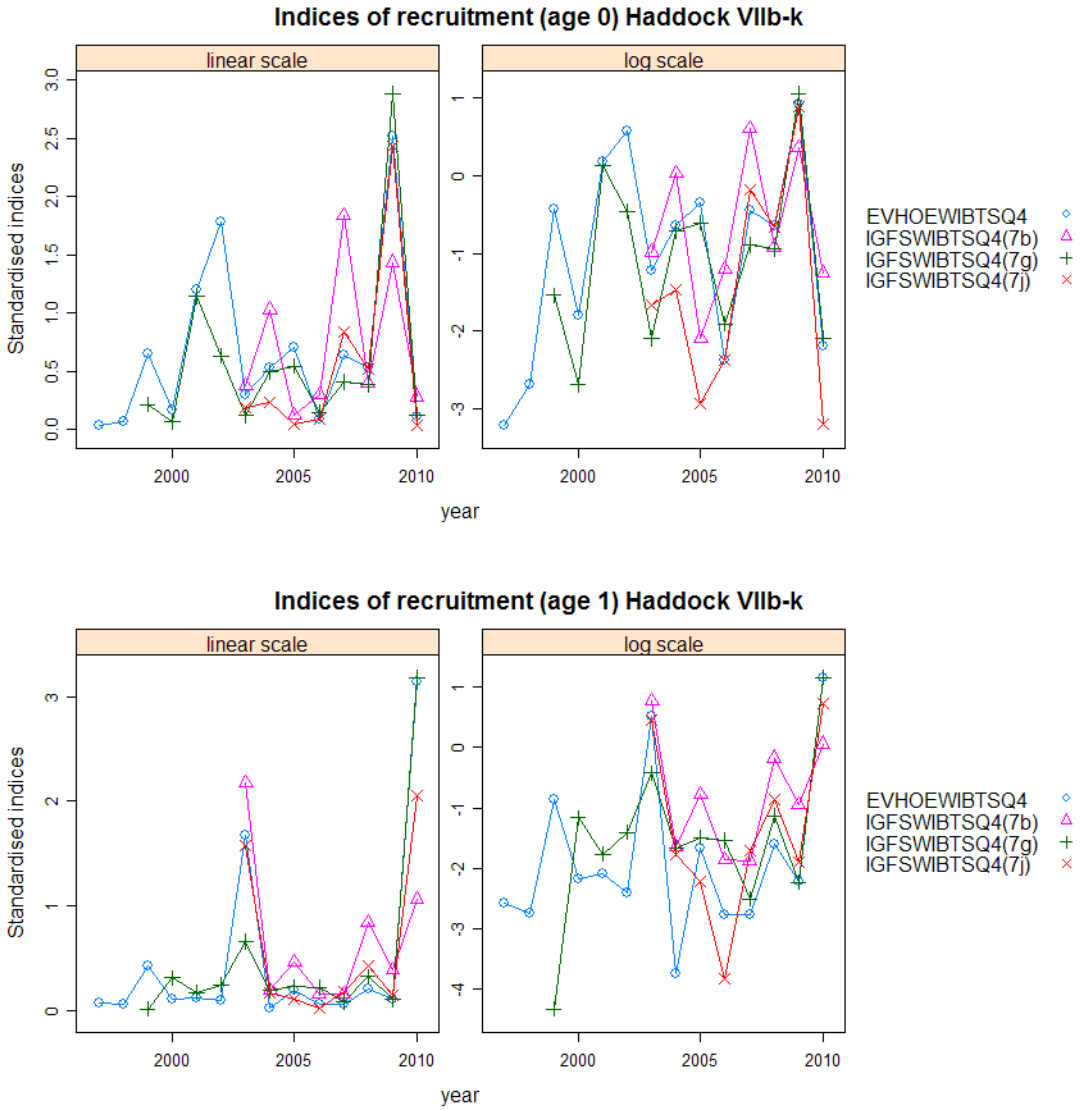


Figure 7.4.6. Survey indices of recruitment-at-age 0 and 1, presented on a linear and log scale. The EVHOE-WIBTS-Q4 and IGFS-WIBTS-Q4-(7g) were used as tuning fleets. The other fleets are currently not used.

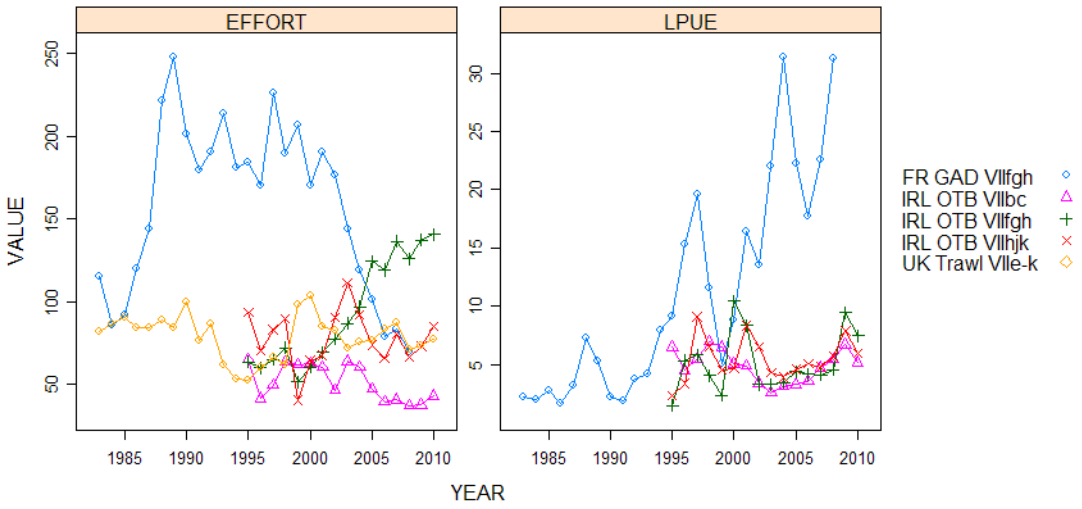


Figure 7.4.7. Effort ('1000h) of the Irish otter trawl fleets, the French gadoid fleet and for UK trawl fleet and lpue (kg/h) for the Irish and French fleets.

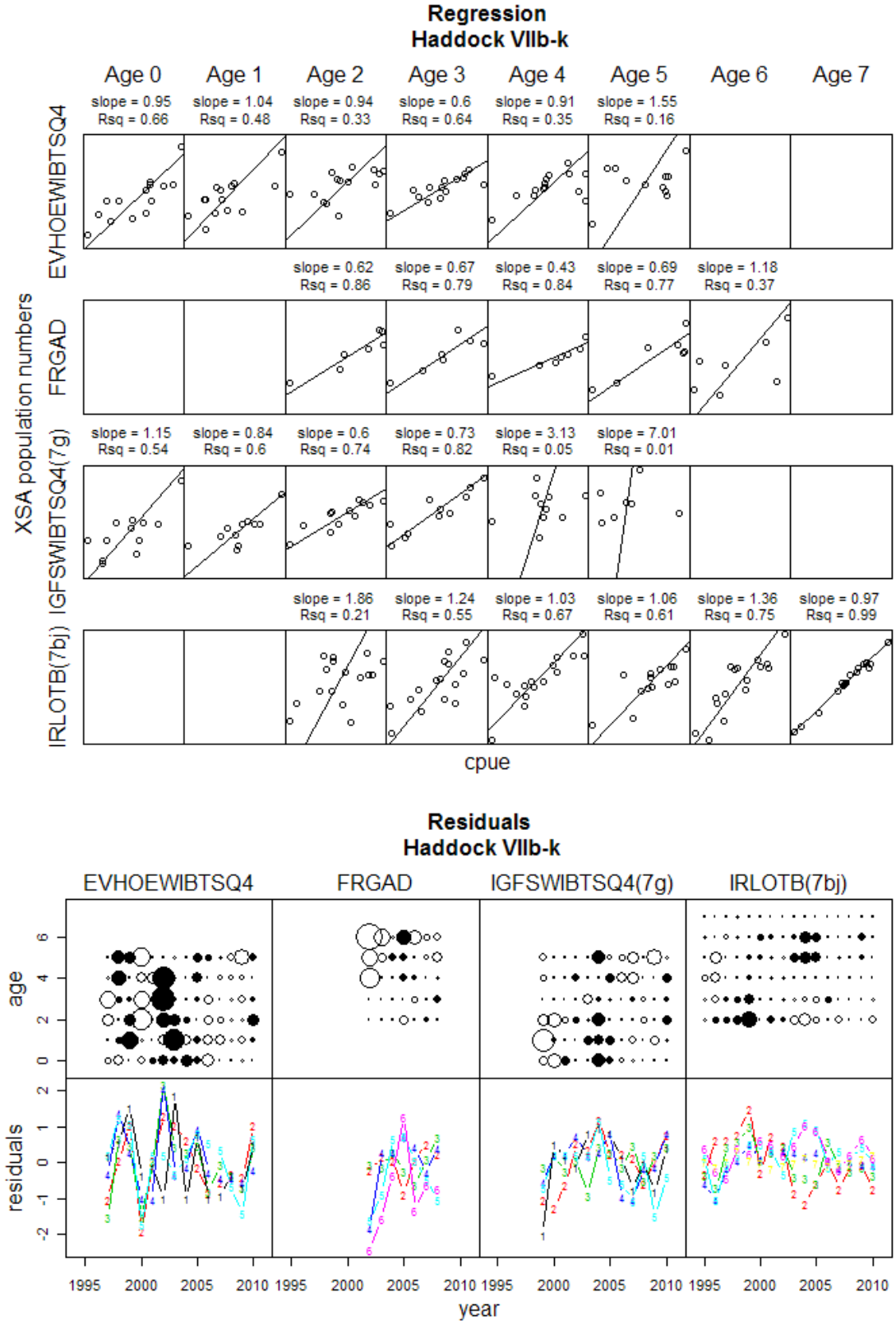


Figure 7.4.8. Log-catchability regressions and residual plots of the tuning fleets used in the assessment.

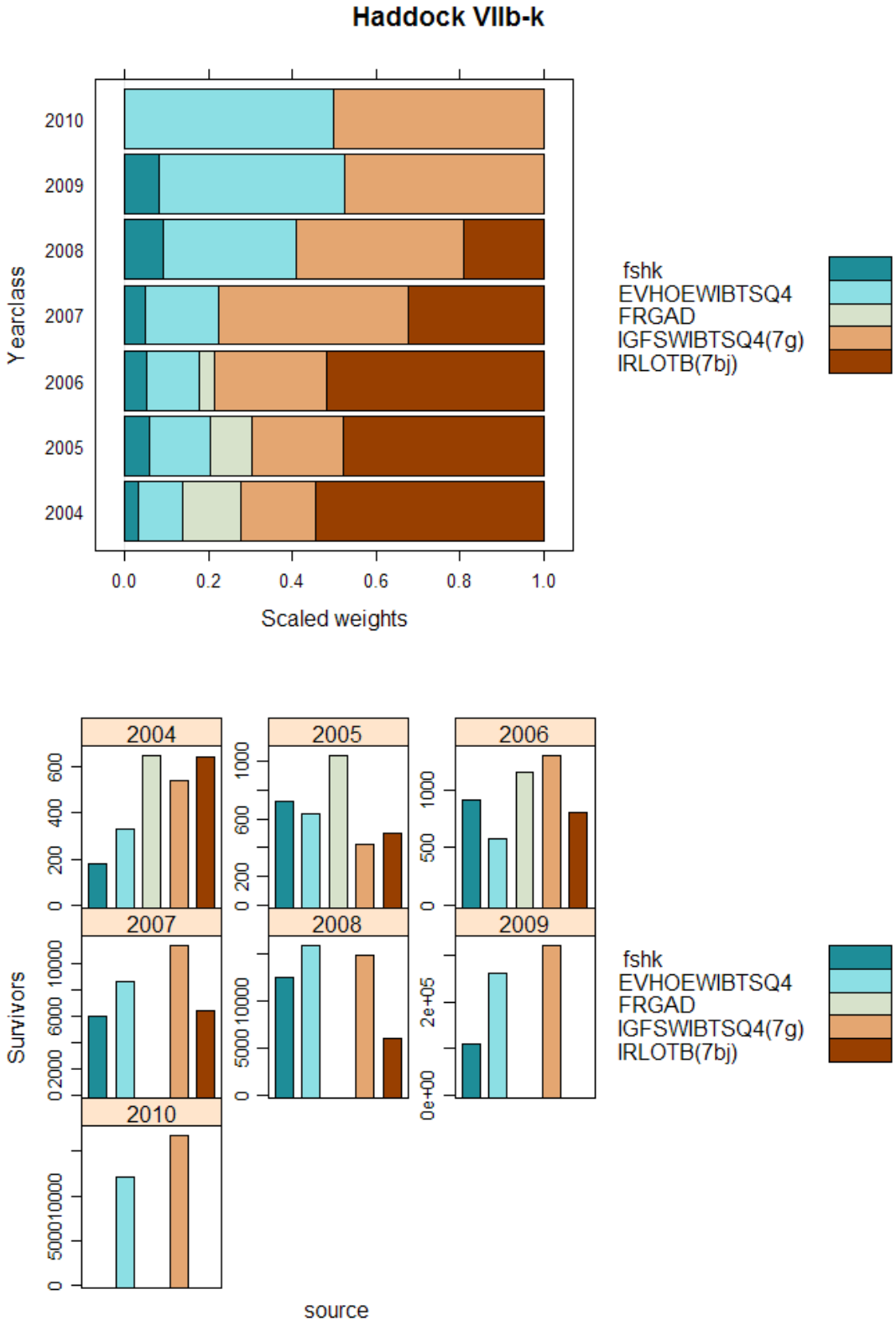


Figure 7.4.9. Scaled weights and survivor estimates (by year class) of the tuning fleets used in the assessment.

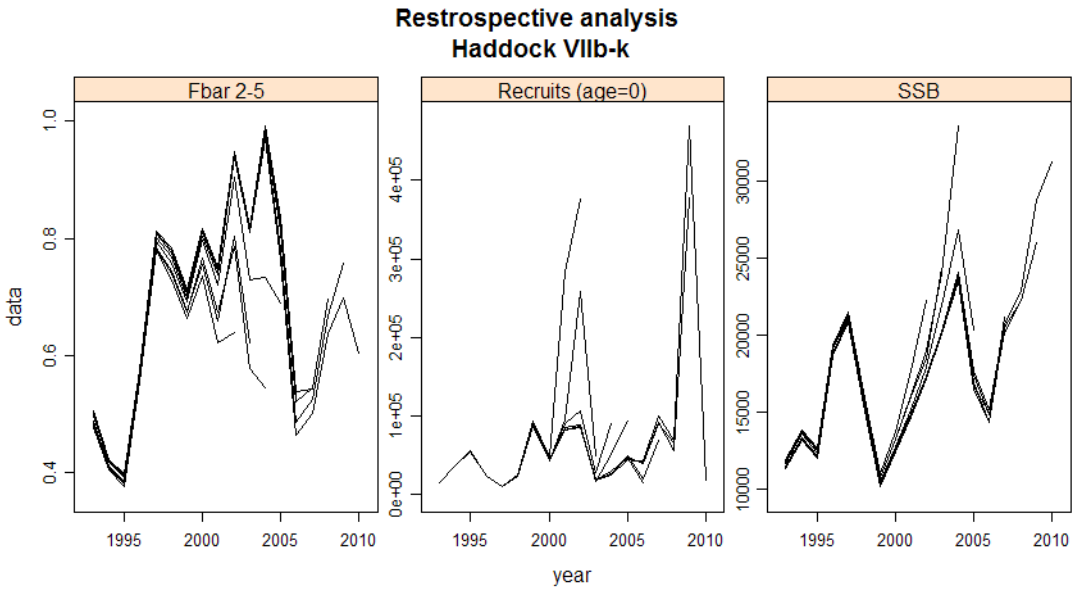


Figure 7.4.10. Retrospective XSA analysis.

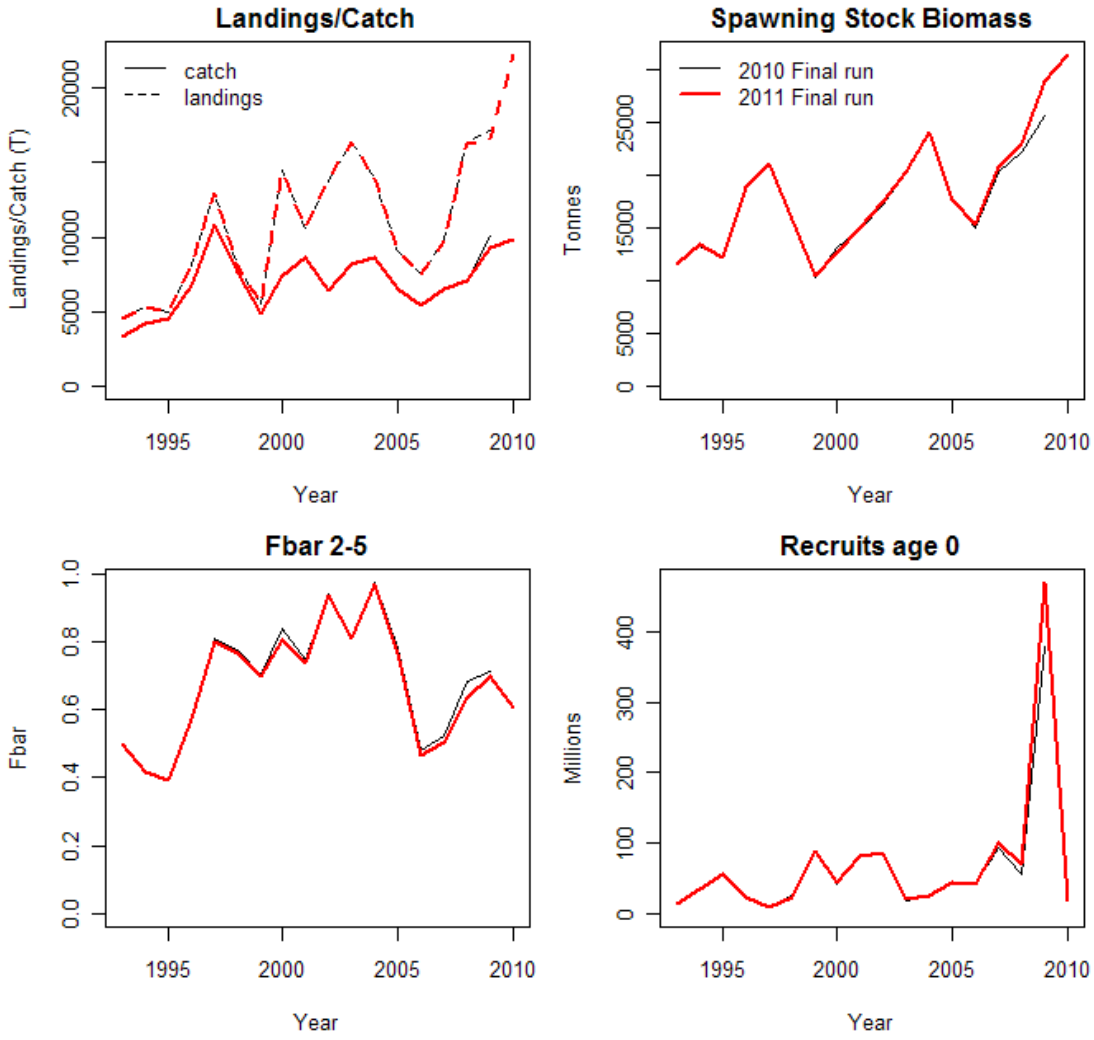


Figure 7.4.11. Stock summary plot. The thin black line represents last year's assessment, the thick red line represents the current assessment.

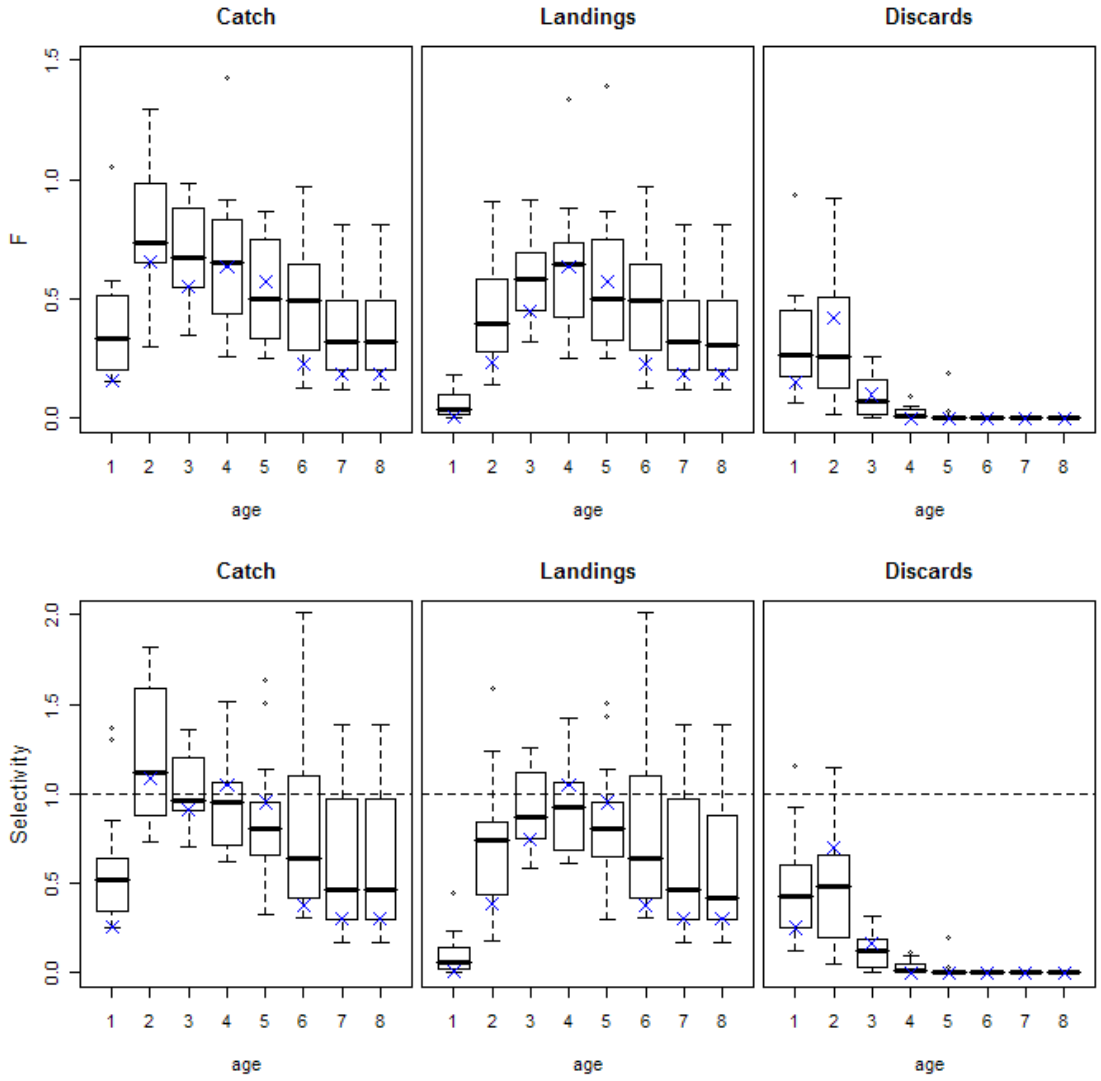


Figure 7.4.12. Fishing mortality and selectivity-at-age, the blue crosses represent the most recent year. F was separated into a landings and discards component using the proportion of the catch numbers that were discarded for each age and year. Selectivity was estimated by dividing the F matrix by the catch F_{bar} 2–5 for each year.

7.5 *Nephrops* in Division VIIb (Aran Grounds, FU17)

Type of assessment in 2011

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 2010

June 2009

"Advises on the basis of exploitation boundaries in relation to high long-term yield and low risk of depletion of production potential that the Harvest Ratio for Nephrops fisheries should be less than the lower bound of $F_{0.1}$ ranges for similar stocks (8%).This corresponds to landings of no more than 505 t for the Aran Grounds stock."

Advice was reopened in November after the 2009 UWTV survey results were available.

November 2009

"ICES recommends that on the basis of exploitation boundaries in relation to high long-term yield and low risk of depletion of production potential that the Harvest Ratio for Nephrops fisheries should be less than the lower bound of $F_{0.1}$ ranges for similar stocks (8%). This corresponds to landings of no more than 704 t for the Aran Grounds stock."

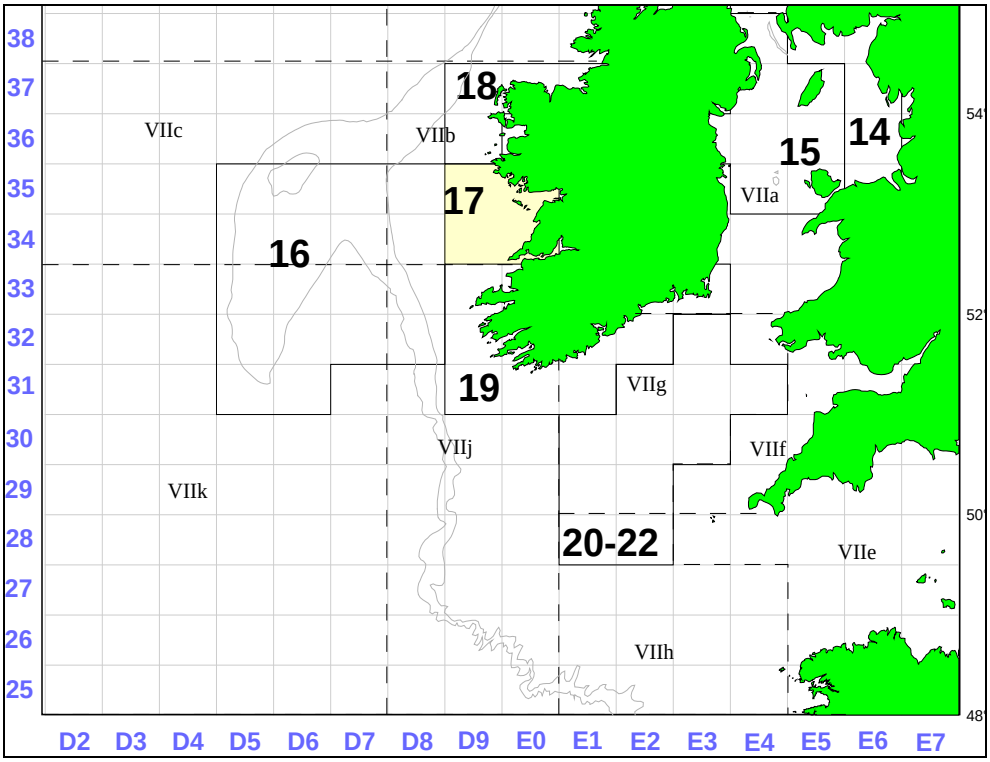
ICES advice applicable to 2011

"Following the ICES MSY framework implies harvest ratio of 10.5%, resulting in landings of 950 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 2011 TAC is 21 759 t, 3% less than the 2010 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 2010 and 2011

TAC in 2010

Species:	Norway lobster *Nephrops norvegicus*	Zone:	VII (NEP/07.)
Spain	1 346		
France	5 455		
Ireland	8 273		
United Kingdom	7 358		
EU	22 432		
TAC	22 432		Analytical TAC

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

Species:	Norway lobster *Nephrops norvegicus*	Zone:	VIIa, VIIb, VIId and VIIe (NEP/5ABDE.)
Spain	234		
France	3 665		
EU	3 899		
TAC	3 899		Analytical TAC

Species:	Norway lobster *Nephrops norvegicus*	Zone:	VIIc (NEP/08C.)
Spain	87		
France	4		
EU	91		
TAC	91		Analytical TAC

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. 53 Irish trawlers reported landings from this FU in 2010. This is about a 43% increase compared with the number of vessels reporting in 2009. In addition, 28 of these vessels reported landings in excess of 10 t. The majority of these vessels are based in the port of Ros-a-Mhíl. 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 2010

The 2010 landings increased by 60% from those made in 2009 and amounted to 1000 t. The increase is mainly attributable to an increase in fishing effort relative to 2009. 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 2010 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 is concern 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. The TAC was increased in 2007 and 2008 this has led to an increase in reported landings and lpue.

Commercial cpue

Effort data for this FU is available from 1995 for the Irish otter trawl *Nephrops* directed fleet. In 2010 this fleet accounted for ~90% 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 has declined between 2003–2006 then increased in 2007 to 2008, dropped again in 2009 then increased in 2010 to levels similar to 2008. (Table 7.5.2.). Landings per unit of effort (lpues) have been fluctuating around an average of 42 kg/hr. Lpue in 2010 was above average at 54 kg/hr (Figure 7.5.2).

Discarding

Before 2001 there was no discard sampling and it was thought 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 14–24% of total catch by weight and 25–40% 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.

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 7.5.4). The mean size of *Nephrops* in the catch has remained relatively stable since 2001.

The sex ratio in the landings is slightly male biased (Figure 7.5.4). The proportion of males is high in 2009 due an increased proportion of the landings taken in autumn (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

Prior to 2011 there were minor revisions to 2006 to 2008 UWTV data due to the amalgamation of survey data into a SQL server. This amalgamation resulted in some changes to historical abundance estimates although it did not change the overall perception in the trend in the time-series (See Lordan and Doyle, WD05). 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). 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 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	species 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 rather and there is a notable trend towards lower densities towards 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 2010 is approx 15% increase on 2009 and remains just below the average of the time-series.

The summary statistics from this geostatistical analysis are given in Table 7.5.5 and plotted in Figure 7.5.6. The 2010 estimate of 827 million burrows are around average but the estimates have fluctuated fairly widely since the survey commenced. The estimation variance of the survey as calculated by EVA is very low (CVs in the order <5%). Random stratified estimates are given for the smaller Slyne Head and Galway Bay grounds. Currently the spatial extent of these other grounds not well estimated. The size and contribution to landings of these grounds is small relative to the Aran grounds and these have not been taken into account in the overall abundance estimate or catch options.

7.5.3 Assessment

Summary of Review Group comments on the 2010 assessment

"The assessment was carried out in accordance with the description in the Stock Annex and the RG found no errors in the assessment.

The assessment approach used by WGCSE 2010 was said to be consistent with that set out in the Stock Annex and WKNEPH (2009). Exploratory SCAs (Separable cohort analysis) were carried out to derive suitable reference points for this stock. The RG could not evaluate the SCA as the input files were not available.

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."

1) The combined-sex F_{MSY} proxy harvest-ratios for the *Nephrops* stocks in VIa and VII other than FU17, all tend to be very similar despite the variations in growth rates and discard rates (see table below). The much lower value for FU17 appears to be due to a low value for females (similar to FU15) and a very low value for males (50% lower than FU15). The same growth data are used for FU15 and FU17. The RG asked for the FU17 model inputs to be checked as the $L_{infinity}$ for mature females in the Stock Annex table is given as 50 mm but is claimed to be derived from FU15 and FU16 values which are 56–60 mm. The RG was advised that the LCA was run using the same parameters as for the Irish Sea. A source of the large difference between FU17 and other FUs could therefore be a very different length composition and selectivity pattern for males in the 2008–2009 FU17 data than is obtained for the other stocks. The WG should further explore the reasons for the different F_{MSY} values in FU17, including the quality of the LFDs for landings and discards and the effect of the shift in timing of the fishery in recent years.

Harvest ratios for different (combined sex) FMSY proxies				Harvest ratios for F35%spr for males and females		Males and imm. females		Mature females		Burrow densities
FU	F0.1	Fmax	F35%spr	Male	Female	Linf	K	Linf	K	(per m2)
11	9.8	16.9	13.3	10.5	19.2	70	0.16	60	0.06	0.55
12	9.7	16.9	13.1	9.8	21.1	66	0.16	59	0.06	0.43
13	9.3	16.9	13.1	9.7	22.2	73	0.16	60	0.06	0.8–1.0
14	9.8	16.4	13.0	14.1	12.7	Same as FU15				0.25–0.38
15	10.6	17.1	13.4	12.5	13.5	60	0.16	56	0.10	~1.0
16						75	0.14	60	0.16	
17	7.2	11.1	10.5	8.4	12.8	60	0.15	56*	0.1	0.6–1.4
20–22						68	0.17	49	0.10	0.23–0.4

2) The Stock Annex and WKNEPH 2009 should be amended to show the correct Linf of mature females in FU17 (56 mm if derived from FU15). The RG/ADG was advised that the F_{MSY} calculations were done for FU17 using "the same growth inputs as for the Irish Sea".

Conclusions

"The RG agrees that the UWTV survey and associated F_{MSY} values represent an appropriate means of providing quantitative management advice. The UWTV is a method susceptible to bias but the WG concludes that the survey estimates are considered fairly precise. The RG agrees that $F_{35\%spr}/F_{max}$ (both giving harvest ratio of 9.7% combined between sexes) is consistent with the approach adopted by WGCSE for choosing F_{msy} proxies for *Nephrops*. This is predicted to deliver an SPR for males of 23% virgin SPR. However the RG still has concerns about the different harvest ratios for males compared to other stocks which should be investigated further. The mean weight in landings and discard rates should also be examined further as they are also key sources of uncertainty.

The bias correction factor needs further investigation including, as suggested by the WG, a precision estimate.

The RG agrees with the WG that management on a FU level would be beneficial."

Approach in 2011

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 weighs in the landings and proportions retained in the fishery have been used. This is in line with the procedure for other stocks.

Last year the final SCAs (Separable cohort analysis) used landings and discard length distributions by sex derived from 2008–2009 sampling. Different selection patterns between sexes were included in the model to take into account differences in selection observed in the fishery. Despite this the SCA model fit was not as good as those observed for other stocks with relatively high residuals at length (Figure 7.5.7, ICES, 2010). In response to the RG comments above WGCSE 2011 explored further the SCA inputs for FU17. In order to obtain a more parsimonious model fit to the data the assumed growth and natural mortality parameters needed to be altered. Despite the explorations WGCSE was not in a position to conclude on an alternative SCA analysis for this stock. WGCSE recommend that this is something that should be explored at the next benchmark or through an inter-benchmark process.

Comparison with previous assessments

The assessment is based on the same methods and similar data as used in 2010. The stock size is estimated to have increased and harvest ratio has also increased 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 2010 estimate is close to average of the series (geomean: 842 million). Table 7.5.6 summarizes recent harvest ratios for the stock along with other stock parameters. Figure 7.5.6 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 7.5.6. A three year average (2008–2010) of mean weight in landings and proportion of removals retained was used. Since 2002 mean

weight in the landings has varied between 18–27 grs. The estimate harvest ratio has also varied a lot, 3–13% with 2008 being the highest observed.

A prediction of landings for 2012 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 7.5.7 shows landings predictions at various harvest ratios, including those equivalent to fishing within the range of $F_{0.1}$ to F_{max}. The F_{2010} (mean F 2008–2010) for the Aran grounds is estimated to close to the $F_{msy\ proxy}$ proposed by ICES.

7.5.5 MSY explorations

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.

		Fbar 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. In 2009 a larger proportion of the landings were taken in autumn leading to a change in sex ratio and size compared with 2008. 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 6.5.9. 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. For FU17 deterministic estimates of the mean weight in the landings and discard rates for 2008 and 2009 have been used since sampling data were not available for the previous two years. Historical data suggest parameters have been variable in the past (Table 7.5.6). 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 have any additional catches for the smaller Slyne or Galway Bay Grounds. This is likely to cause a small (<3%) 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. Currently there is no recommended time frame for another benchmark but this stock should be benchmarked with other *Nephrops* stocks.

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 three 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 June 2011 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 the Aran and other *Nephrops* grounds where effort control has not been put in place. This did not happen in 2009 as effort declined by 37% due to the decommissioning of several vessels that actively participated in the fishery. Effort increased again in 2010 but harvest rates remained below the F_{msy} target.

7.5.11 References

ICES. 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM: 14.

ICES. 2008. Report of the Workshop and training course on *Nephrops* burrow identification (WKNEPHBID). ICES CM 2008/LRC:03.

ICES. 2009. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2009/LRC: 15, pp 52.

ICES. 2009. Report of the Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM 2009/ACOM:33.

ICES. 2010. Report of the Working Group on the Celtic Seas Region (WGCSE) ICES CM 2009/ACOM:09.

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

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

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	726	134	24%
2010	408	126	593	73	17%
	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	16,894	8,000	24,075	5,336	25%

Table 7.5.4. ***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

Table 7.5.5. *Nephrops* in FU17 (Aran Grounds). Results summary table for geostatistical analysis of UWTV survey.

Ground	Year	Number of stations	Mean Density (No./M2)	Domain Area (km2)	Geostatistical abundance estimate (million burrows)	CV on Burrow Estimate
Aran	2002	49	0.84	943	818	4%
	2003	41	1.01	943	989	5%
	2004	64	1.43	943	1397	3%
	2005	70	1.09	936	1063	3%
	2006*	67	0.64	932	**616**	3%
	2007	71	0.93	942	906	3%
	2008*	63	0.56	906	**536**	3%
	2009	82	0.73	940	718	2%
	2010	91	0.85	937	827	2%

* Minor data revision due to transfer of data to SQL server

Results summary table for empirical statistical analysis of UWTV survey

Ground	Year	Number of stations	Mean Density (No./M2)	Area Surveyed (m2)	Burrow count	Standard Deviation	95%CI	CV
Galway Bay	2002	7	1.58	1,299	2,017	0.37	0.34	9%
	2003	3	1.60	591	941	0.29	0.73	11%
	2004	9	0.73	2,312	1,625	0.42	0.32	19%
	2005	4	1.67	661	1,107	0.20	0.32	6%
	2006	3	0.98	540	522	0.27	0.67	16%
	2007	5	1.14	890	992	0.24	0.29	9%
	2008	10	0.42	1,907	859	0.31	0.22	23%
	2009	8	0.93	1,207	1,116	0.16	0.14	6%
	2010	10	1.61	1,284	1,757	0.43	0.31	9%
Slyne Grounds	2002	5	0.85	1,216	1,027	0.19	0.23	10%
	2003	0	-	-	-	-	-	-
	2004	3	0.68	827	531	0.27	0.66	23%
	2005	3	0.55	531	294	0.05	0.13	6%
	2006	3	0.41	526	210	0.20	0.49	28%
	2007	4	0.63	838	547	0.31	0.49	24%
	2008	0	-	-	-	-	-	-
	2009	6	0.40	531	144	0.22	0.23	22%
	2010	9	0.74	1,117	928	0.43	0.33	20%

*random stratified estimates are given for the Slyne Head and Galway Bay grounds

Table 7.5.6. *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
Avg 08-10				**0.70**					**24.46**

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 7.5.7. *Nephrops* in FU 17 (Aran Grounds). Catch option table for 2012.

			Implied fishery	
	Harvest rate	Survey Index (millions)	Retained number (millions)	Landings (tonnes)
MSY framework	10.5%	636	47	1,146
F_{2010}	10.4%	636	46	1,134
$F_{0.1\ Combined}$	7.2%	636	32	786
$F_{max\ Combined}$	11.1%	636	50	1,212
	0%	636	0	0
	2%	636	9	218
	4%	636	18	437
	6%	636	27	655
	8%	636	36	873
	10%	636	45	1,092
	12%	636	54	1,310

		Basis
Landings Mean Weight (Kg)	0.0245	Sampling 2008–2010
Survey Overestimate Bias	1.30	WKNEPH 2009
Survey Numbers (Millions)	827	UWTV Survey 2010
Prop. Retained by the Fishery	0.70	Sampling 2008–2010

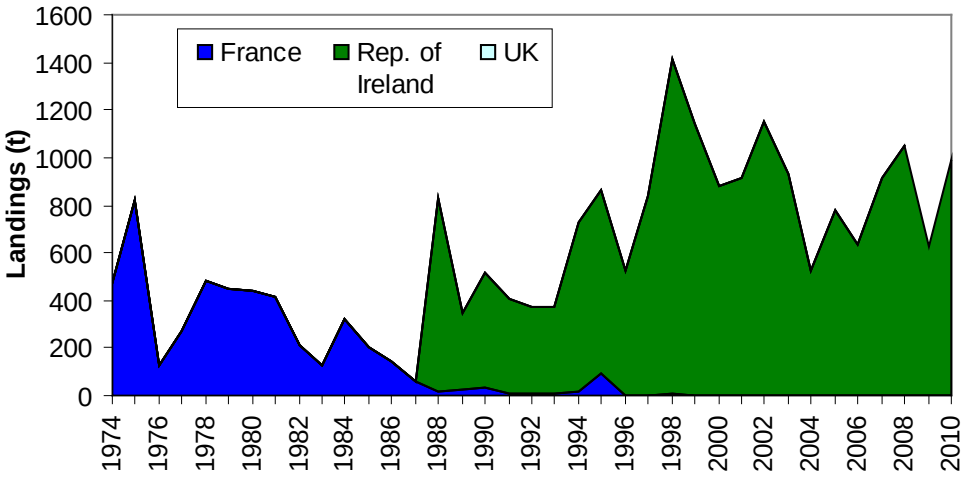


Figure 7.5.1. ***Nephrops*** **in FU17 (Aran Grounds). Landings in tonnes by country.**

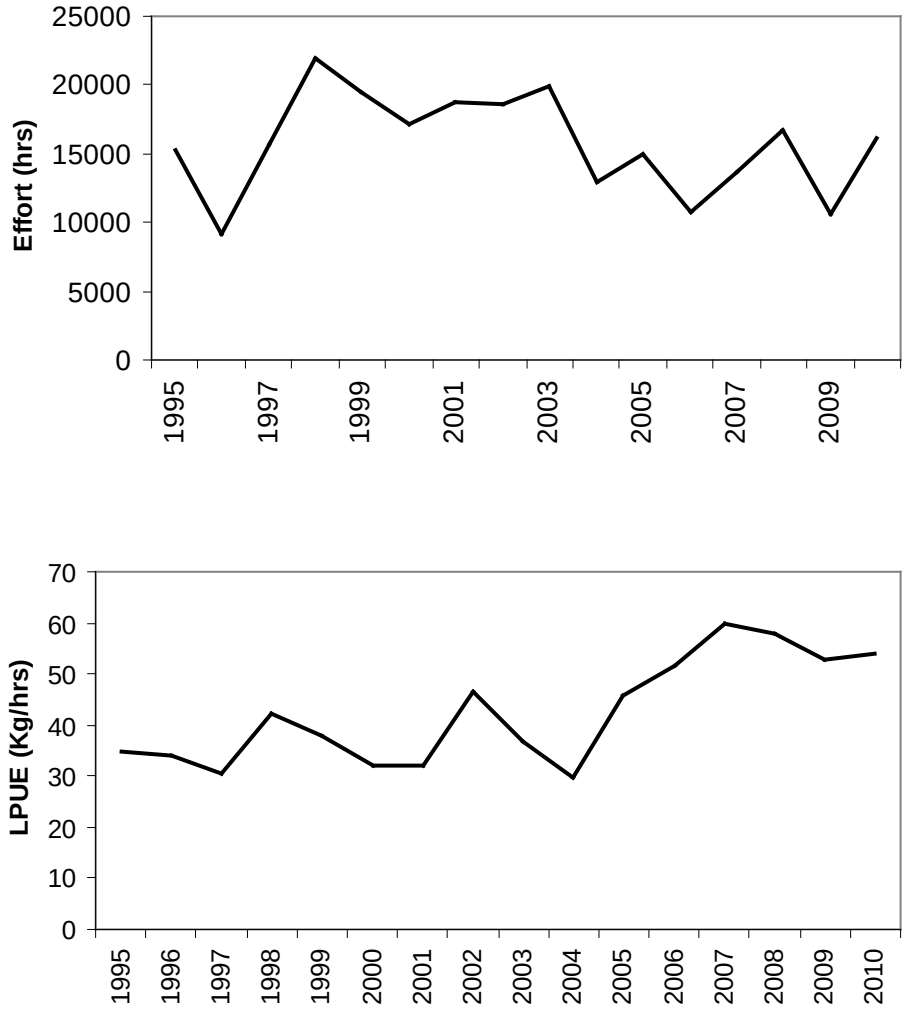


Figure 7.5.2. ***Nephrops*** **FU17 Aran Grounds. Irish effort and lpue for** ***Nephrops*** **directed fleet.**

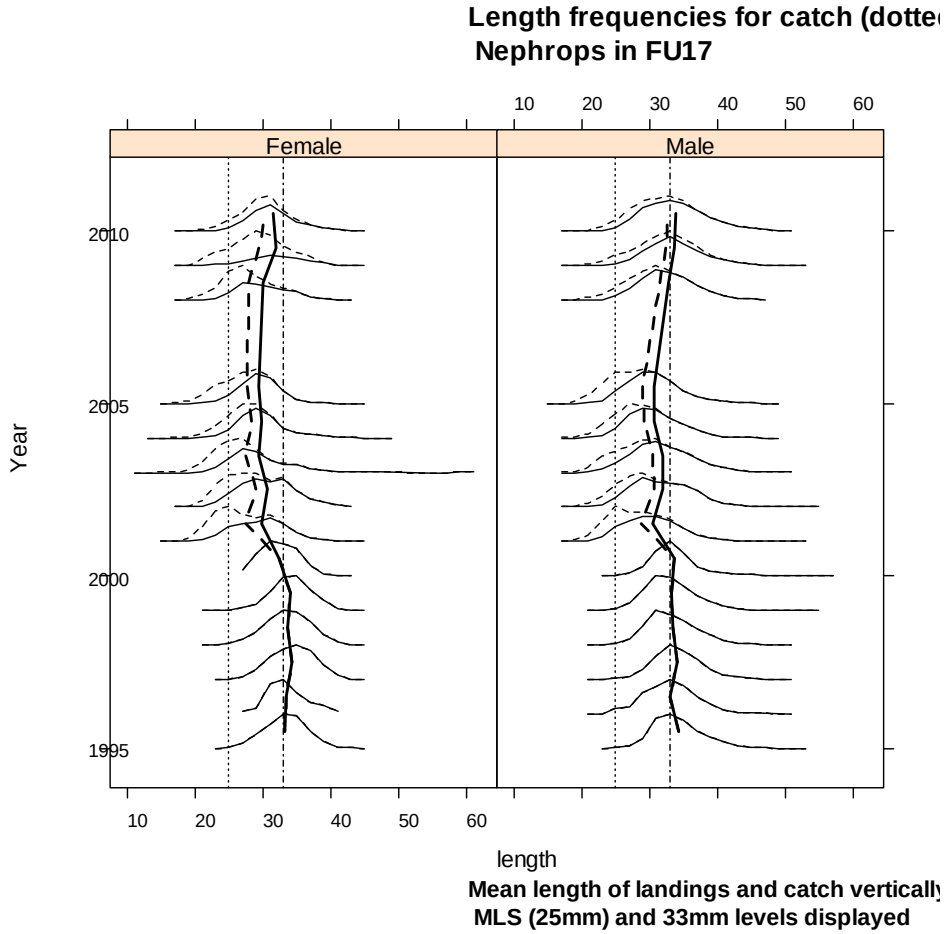


Figure 7.5.3. ***Nephrops*** **FU17 Aran Grounds. Length distributions in the catches 2001–2005, 2008–2010 and in the landings 1995–2001.**

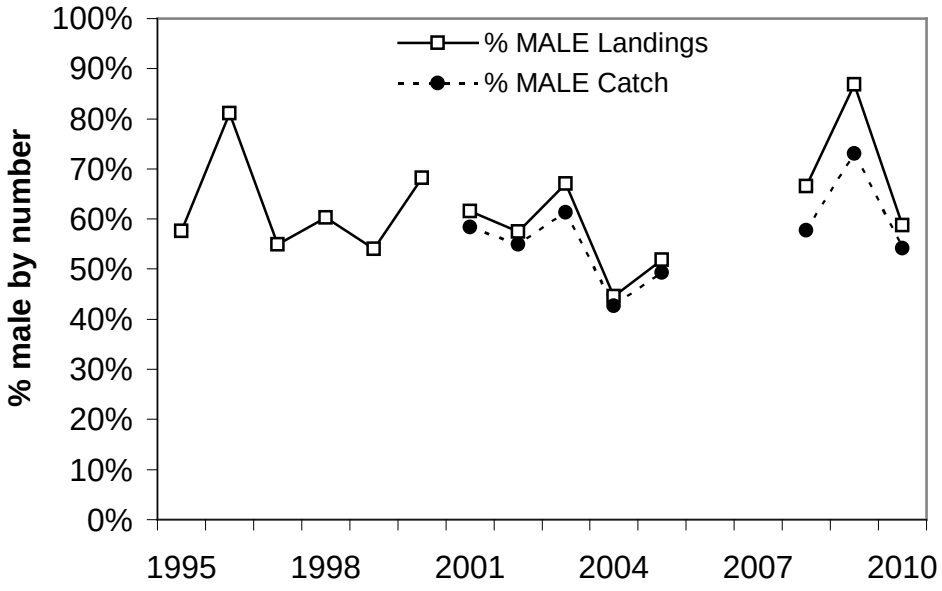


Figure 7.5.4. ***Nephrops*** **in FU17 (Aran Grounds). Sex ratio of whole landings (1995–2000), landings (2001–2010) and catch (2001–2010).**

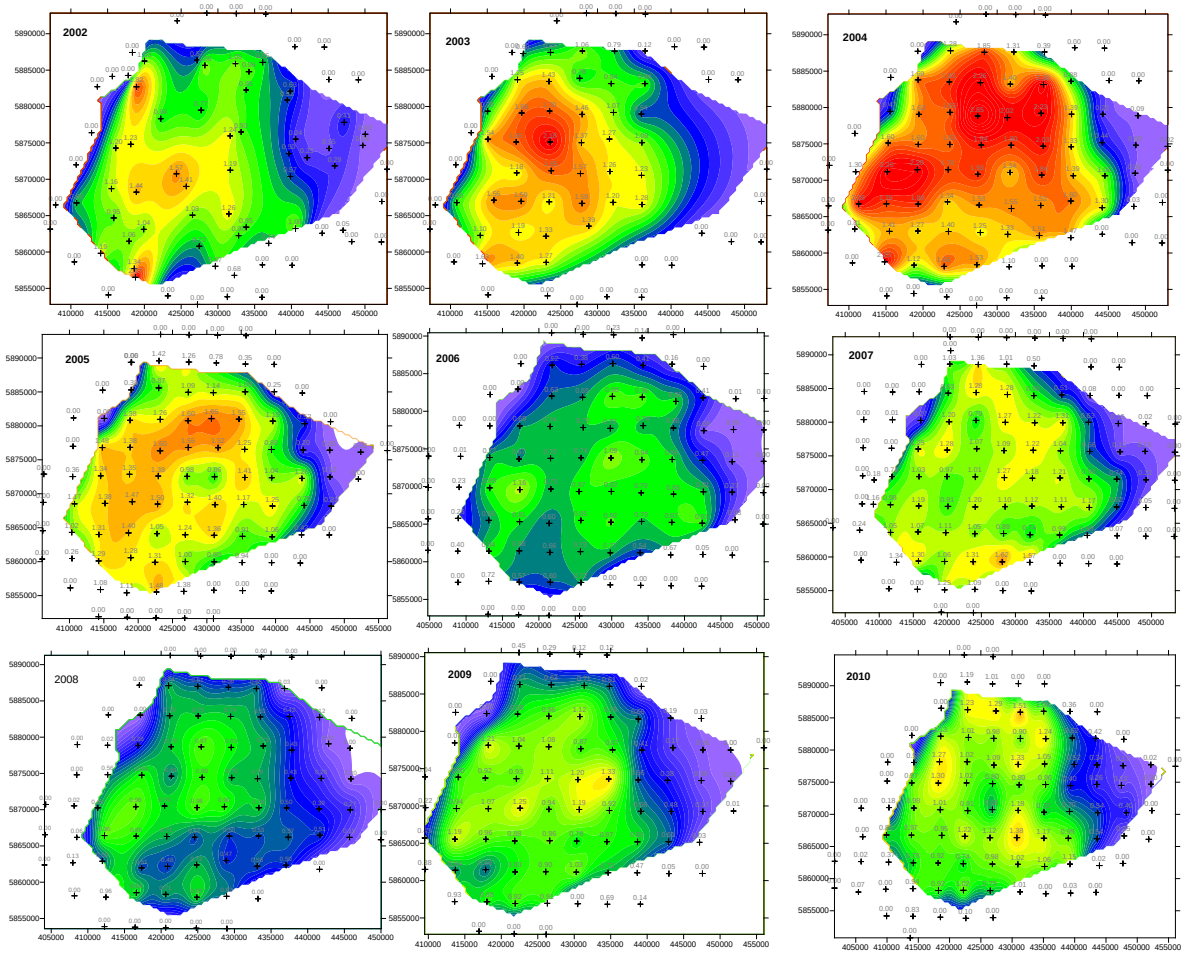


Figure 7.5.5. ***Nephrops*** **in FU17 (Aran Grounds). Contour plots of the krigged density estimates for the Aran Ground UWTV surveys from 2002–2010.**

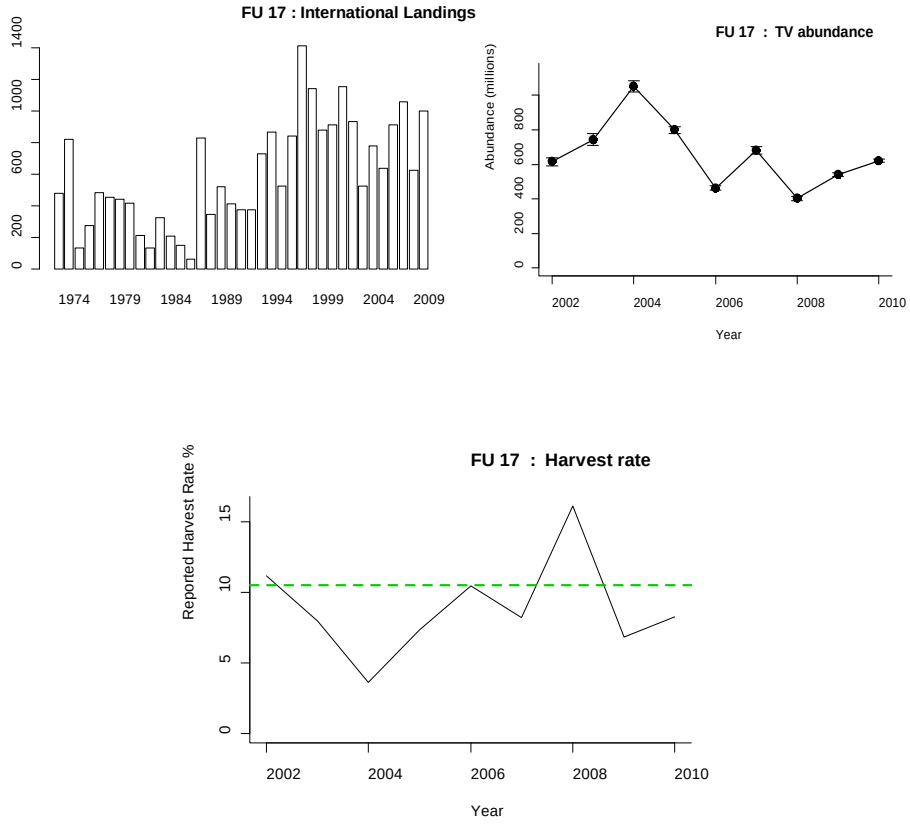


Figure 7.5.6. ***Nephrops*** **FU17 Aran Grounds. Stock Summary plots: Landings (tonnes), UWTV abundance (millions) and Harvest Ratio (% dead removed/UWTV abundance).**

7.6 *Nephrops* in Division VIIb,c,j,k (Porcupine Bank, FU16)

Type of assessment in 2011

This year the Working Group updated the fishery information, survey data and other indicators for *Nephrops* in Division VIIbcjk. There has been a deterioration in the sampling information from the landings in recent years due larger proportions of the catches landed in frozen grades. There have been significant changes in fishing practices. The recruit observed in the survey and commercial catches last year has been confirmed by the 2010 survey. The switch towards larger proportions of females in the landings has been reversed in 2010. Mean size in the landings remains high. The stock was over exploited and declining but the new recruitment offers an opportunity to rebuild the stock if exploitation rates can be kept low.

ICES advice applicable to 2010

"ICES advises on the basis of exploitation boundaries in relation to precautionary considerations that catches in 2010 should be reduced to the lowest possible level."

ICES advice applicable to 2011

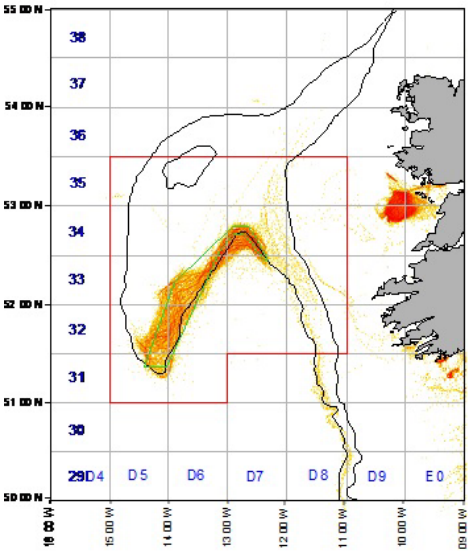
" MSY approach

Catches in 2011 should be reduced to the lowest possible level to allow the incoming recruitment to rebuild the stock."

7.6.1 General

Stock description and management units

The TAC area is Subarea VII in 2011 and 'of which' clause has been introduced specifically for the Porcupine Bank. The quota share by country was determined by relative stability for the TAC but discussions are ongoing to develop an alternative allocation scheme. 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 01/05/10–31/07/10 and 01/05/11–31/07/11 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 2010 and 2011

TAC in 2010

Species:	Norway lobster *Nephrops norvegicus*	Zone:	VII (NEP/07.)
Spain	1 346		
France	5 455		
Ireland	8 273		
United Kingdom	7 358		
EU	22 432		
TAC	22 432		Analytical TAC

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

Closed area restrictions

A seasonal closed area was introduced in 2010 and is also in place in 2011. The closed area is shown in the map above. The specific coordinates and conditions of the closed area are given below (EC 57/2011).

Article 13

Restrictions on the use of certain fishing opportunities

1. The fishing opportunities fixed in Annex I for tusk, cod, megrim, anglerfish, haddock, whiting, hake, blue ling, ling, Norway lobster, plaice, pollack, saithe, skates and rays, sole and spurdog in ICES subarea VII or relevant divisions thereof, shall be restricted by the prohibition to fish or retain onboard any such species during the period from 1 May to 31 July 2011 in the Porcupine Bank. The relevant Annex I entries are identified by cross-reference to this Article.

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

3. By way of derogation from paragraph 1 of this Article, transit through the Porcupine Bank, carrying onboard 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 2010

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 ~10% in 2010 to 917 t (Figure 7.6.1 and Table 7.6.1).

Effect of regulations

Landings for the TAC area (Subarea VII) are undershot (Table 7.8.4). UK and Irish national quotas are usually restrictive but uptake by France and Spain is well below their quotas due to changes in relative landings from different FUs within this TAC area (Section 7.1). In the past TACs and quotas applied to the whole of VII. This has not restricted the FU16 fishery. A closed implemented in 2010 and again in 2011 is coincident with a time period where the majority of annual international landings have been taken in recent years (see text table below). The closure is therefore expected to be quite effective at reducing fishing mortality within the closed area. An analysis of VMS effort data in 2010 illustrates that considerable effort was displaced to the part of the *Nephrops* ground not fully covered by the closure (Figure 7.6.2). The closure therefore afforded some protection to the majority of the stock area (~75%). 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 ~25% of the stock area not covered by the closure. In August 2010 fishing resumed in the closed part of the ground and catch rates were reported to be high.

	2003	2004	2005	2006	2007	2008	2003–2008
% of annual Int. landings taken May–July	60%	53%	64%	54%	67%	68%	61%

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 2008–2010). No sampling was possible in 2006 and 2007 for Ireland due to the withdrawal of cooperation with scientific sampling programmes by the fishing industry. Sampling in Ireland resumed in 2008 but sampling levels have been low (only three samples in 2010). There was no sampling in France in 2008 and 2009 due to low landings. Sampling intensity in Spain was extremely low in 2008 and 2009 (two and five samples) with no sampling in 2010.

Sampling of *Nephrops* in this area is hampered by several factors:

- The remote nature of the fishery.
- Trips are long duration 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.

These issues need to be resolved as current sampling intensity is insufficient to get precise and accurate length structure data of the catches. In 2010 data on the grade composition of the landings have been provide for some Irish vessels and this has been used to reconstruct the size distribution of the landings for around 25% of the

total landings (see information form industry). Despite the low sampling intensity in recent years, the recent trends in indicators such as length and sex ratio are consistent across all countries and in the survey (Figure 7.6.3).

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 7.6.3). 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. Since 2002 there has been an increasing trend in the mean size in the landings. Mean *Nephrops* sizes in French landings also show an increasing trend in both sexes. Mean sizes in the landings of Irish trawlers are more variable but clearly show increasing trend over the last number of years.

Raised frequency distributions of the sampled landings by sex are given in Figure 7.6.4. This also shows significant shift towards larger individuals in the landings since 2002 and few individuals at smaller sizes. The 2009 data for males shows a recruiting year class entering the landings at ~35 mm CL this year class is also apparent in the 2010 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).

It is difficult to extract other useful signals in the length frequency distributions plot, so for males a number of indicators were calculated (Figure 7.6.5). These included a recruitment proxy (% of males <32 mm CL), and percentage of larger individuals (>50 mm CL) in the sampled landings. An exploitation proxy was 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 7.6.6).

These indicators suggest the following: recruitment has fluctuated in the past and recruitment in the last five years (2004 to 2008) has probably been very weak. The recruitment proxy in 2009 and 2010 was around average (note: this conclusion is relatively insensitive to length threshold). The fishery in recent years has exploited a larger proportion of larger individuals than ever before in the time-series. The exploitation proxy shows an increasing trend (i.e. steepness) since the early 2000s. The exploitation proxy in 2010 declined from the highest in the series observed in 2009.

Discards

There are few historical estimates of discards for this stock. Recent Irish sampling has shown discarding to be minimal mainly limited to small and damaged individuals <5% by number. This situation may well change due to restrictive vessel quotas in 2011.

Biological

Previous working groups have highlighted stability in sex ratio as an important indicator for *Nephrops* stocks. In the most recent years the sex ratio in the landings and survey catches has been unstable (Figure 7.6.7). The change in sex ratio in the landings is strongly influenced by the re-availability of Irish sampling data since 2007. In the past Irish vessels have tended to land a greater proportion of female *Nephrops* than either the French or Spanish fleet so the situation may be exaggerated somewhat. The fishery-independent survey catches also show larger proportions of females in the catches between 2007–2009. Both the commercial and survey data

indicate that sex ratio switched back to a more usual situation in 2010 with males accounting for larger proportions of the catch.

Nephrops moult once a year shortly after hatching of eggs in April or May. There is a 24 horr period after moulting when the male *Nephrops* can mate with the female (Farmer, 1974). It has been suggested that insufficient males in the population to mate with the recently moulted females can result in a change in female behaviour whereby unmated females concentrated on feeding and growth instead of reproduction. This so called "sperm limitation" 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 2010 (WD 03) 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 main fishery-independent source of data is from the Spanish Porcupine trawl survey (SpPGFS-WIBTS-Q4). Further information on this survey is provided in the IBTS report (ICES, 2009) and in previous IBTS reports. Catchability of *Nephrops* in trawl surveys is typically an issue due to variable emergence patterns of *Nephrops* from their burrows (ICES, 2007). However, this stock is found in deep water where animals are known to emerge mainly during the day. Survey hauls are only conducted during the day and the survey is scheduled for the same time each year, thus minimizing variability due to seasonal emergence patterns.

Distribution of *Nephrops* catches and biomass in Porcupine surveys between 2001 and 2010 are shown in Figure 7.6.8. There may well be a year effect in 2008 when unusual gear parameters were observed other than that the survey gives consistent a fairly consistent information. The recruitment in 2009 in one particular area of the ground appears to be more widespread (Figure 7.6.8). The stratified abundance estimate and biomass increased significantly in 2010 and are now the highest on the short series (Figure 7.6.9).

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 7.6.10, WD 03). 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. 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).

An Irish Fisheries Science Research Partnership (IFSRP) survey was developed in consultation the Irish fishing industry to obtain data from the closed area in 2010 (see WD 03). Altogether 46 hauls were carried out and the results indicate high cpue for the survey relative to recent observations at that time of year for the Irish fleet. 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. The male biased sex ratio and size-at-maturity observed in July 2010 was

similar to historical observation for the stock. The size distributions of the catches are very different from the September Spanish survey in the area indicating selectivity differences between the surveys.

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 *Nephrops* in lower volumes. Fishing effort has fluctuated considerably in the recent past in response to availability of *Nephrops*.

Effort and lpue 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 and abundance trends over the longer term. These data are presented by country in Table 7.6.3 and Figure 7.6.11. Note: Irish and French effort is in hours and Spanish effort is power adjusted and is reported in thousands of day*BHP/100.

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, probably due to increased targeting of *Nephrops*, before declining again 2006.

Fishing effort for French *Nephrops* vessels[1] has fluctuated widely with peaks in the mid 1980s and through the late 1990s. Effort in 2009 was the lowest in the series. Lpue data for the French fleet in FU16 were high in the 1980s but declined with fluctuations to a series low in 2008.

Fishing effort data for the Irish otter trawl *Nephrops* directed fleet[2]. Increased rapidly over the period 2003–2007 due to increase targeting. Effort remains higher in 2010 than at the start of the series. Lpue has increased a little in 2010.

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 (WD 12). The main conclusion of the analysis was as follows: It remains possible that the long lpue trend is biased in the past and not reflective of stock abundance given the observed differences in size structure throughout the ground. While targeting behaviour and fleet composition has changed significantly over time including vessel, spatial and temporal explanatory variables in the lpue models does not significantly alter the long-term trends. There is an upturn in lpues in 2010 despite the closure of the majority of the area during months with relatively high lpues suggesting that without the closure the lpue increase in 2010 may have been higher.

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[1] where *Nephrops* constituted 10% of the landed value.

[2] A threshold of 30% of *Nephrops* in reported landings by trip is used to identify the landing and effort of this fleet.

Information from the fishing industry

A meeting was held prior to WGCSE with some of the main Irish vessels operating in the fishery. The industry view is that the Irish lpue data is biased by changing fishing practices. This was explored by WD 12 and summarized above. The industry opinion was that the size and sex ratio trends in landings data would also be affected by targeting behaviour. The industry expressed a view that the drop in sex ratio in 2009 was exaggerated in ICES statistics compared with their observations. Recent sampling data have been sparse as discussed in Section 7.6.2. In response some vessels gave a detailed breakdown of size grade and sex composition of their landings in 2010 and the first few months of 2011. These data were used to reconstruct size composition of ~25% if the Irish landings in 2010.

These reconstructions proved sensitive to the choice of mean and standard deviation parameters for the normal distributions at each grade. Three different modelling approaches were investigated at WGCSE:

1) Using the observed means and standard deviation based on 2011 grade sampling.

2) Using the observed means and adjusting standard deviations of the grades to model observed LFD distribution on the 2010 IFSRP survey (WD 03) from grade compositions.

3) Using grade midpoints and modelled standard deviations.

Figure 7.6.12 illustrates the differences in different resulting length frequency distributions from the three approaches. The text table below summarizes the impact of these on the stock indicators currently used by WGCSE. All three methods result in a very similar estimate of mean CL and % >= 50 mm. These are significantly different from other samples in 2010. The exploitation and recruitment proxies are slightly more variable but similar to 2010 sampling.

Method	Mean Carapace Length (mm)	% >=50mm	Recruit Proxy %<32mm	Exploitation Proxy
1	36.6	4%	13%	0.12
2	36.6	4%	10%	0.11
3	36.3	4%	14%	0.14
2010 Sampling	48.9	20%	10%	0.15

WGCSE concluded 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 sizedgrade carried out in parallel. If the industry can provided a breakdown of grades landed in future this will address a key data deficiency for this stock.

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 (2001–2010,) along with lpue and effort data for the main fleets.

Comparison with previous assessments

The assessment is based on similar indicators to those used in 2010. The additional data shows some improvement in stock status due to a new recruitment to the fishery

and survey in 2009 and 2010. 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) has proven increasingly important for this stock. The survey indices in abundance and biomass are the highest observed in the series (from 2001).

State of the stock

The main state of the stock indicators are shown in Figure 7.6.13. Effort, landings and size distribution indicate that exploitation rate has been high in the last seven years. 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 survey abundance and biomass in 2010. The marked decline in the proportion of males (observed in the catches between 2007–2009) may impair future recruitment in the short term.

Landings per unit of effort (lpue) show a generally declining trend in most fleets over the time-series available and reached their lowest levels in the early 2000s. Since then lpue have been fluctuating. This may reflect longer term declines in stock abundance.

7.6.4 Short-term projections

There is no possibility to forecast catches in the short term using the available stock indicators. Recruitment may be impaired in the near future if sperm limitation occurred during 2008 and 2009.

7.6.5 MSY explorations

It has not been possible to carry out explorations of MSY targets for this stock but given the recent stock indicators the stock is probably exploited well above MSY levels.

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

Despite the poor recent sampling all size data from the commercial fleets show similar trend towards increasing mean size as does the fishery-independent survey. All information points to poor recruitment prior to 2009 and an increasing reliance of the fishery up to 2009 on larger individuals with a high female component. The situation changed in 2010 with new recruitment entering the fishery.

7.6.9 Recommendation for next benchmark

There needs to be improved sampling of catches for this stock. Sampling levels are currently low and several factors complicate sampling (see Section 7.6.2).

In the short term the survey may be the most appropriate method of monitoring stock status. The development of full analytical assessment would require better growth information and an improvement in sampling of catches. Spatially explicit landings

and effort data, either by rectangle or at finer resolution by gear from all countries would also be useful.

Currently there are no plans to benchmark this stock before 2013.

7.6.10 Management considerations

Nephrops on the Porcupine Bank are fished in relatively deep waters over a widespread area where they occur at low abundance. Given the sedentary nature of *Nephrops* populations the closed area as introduced in 2010 can be an appropriate management tool to substantially reduce catches and fishing mortality allowing the stock to recover. An analysis of the spatial dynamics if the fleet during the closure in 2010 shows that the closure was respected and is expected to have been quite effective at reducing fishing mortality for ~70% of the stock area. Some fishing effort during May–July was displaced to the remaining 30% of the stock area not covered by the closure in 2010 in advertently resulting in increased fishing mortality on that component of the stock. The overall impact of the closure is difficult to quantitatively assess.

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 mechanizms. 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.

7.6.11 References

González Herraiz, I. and Fariña A.C. 2005. Approach to the realized fecundity of *Nephrops norvegicus* in the Porcupine Bank. ICES CM 2005/Q:24.

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.

ICES. 2010. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), 5–11 May 2010, ICES Headquarters, Copenhagen. ICES CM 2010/ACOM:13. 1048 pp.

Table 7.6.1. Porcupine Bank (FU 16): Landings (tonnes) by country, 1965–2010.

Year	France	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

Table 7.6.2. 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 1981–2010.

Year	Spain		Rep. of Ireland		France		Porcupine Survey	
	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	48.9	40.4	na	na	35.8	31.3

Table 7.6.3. Porcupine Bank (FU 16): Landings and effort for the various different fleets exploiting the stock 1971–2010.

	Spanish fleet			French Nep fleet1			Irish Nep Fleet2		
	Landings	Effort	Standardized Lpue	Landings	Effort	Lpue (>10%)	Landings	Effort	Lpue
Year	Tonnes	day*BHP/100 (x1000)	Kg/day*BHP/100	Tonnes	('000's Hrs)	(kg/hr)	Tonnes	('000's Hrs)	(kg/hr)
1971	1444	159	9						
1972	1738	188	9						
1973	2135	181	12						
1974	1894	192	10						
1975	2150	229	9						
1976	1321	187	7						
1977	1545	196	8						
1978	1742	166	11						
1979	2255	157	14						
1980	2904	163	18						
1981	3315	143	23						
1982	3931	138	29						
1983	2811	108	26	615	18	35			
1984	2504	114	22	1067	30	35			
1985	2738	115	24	1181	33	36			
1986	1462	95	15	1060	28	38			
1987	1677	105	16	609	24	26			
1988	1555	109	14	600	22	27			
1989	1417	105	14	324	14	23			
1990	1349	96	14	336	15	23			
1991	1021	85	12	348	19	18			
1992	822	59	14	665	32	21			
1993	752	49	15	799	36	22	206		
1994	809	50	16	1088	38	28	512		
1995	579	48	12	1234	42	30	971	15	41
1996	471	43	11	1069	41	26	508	8	42
1997	473	42	11	1028	41	25	653	11	35
1998	405	43	10	879	40	22	598	10	42
1999	448	37	12	889	43	21	609	9	35
2000	213	30	7	313	23	16	227	2	31
2001	270	29	9	366	24	17	369	8	30
2002	276	31	9	324	18	22	543	10	38
2003	333	38	9	130	7	19	296	7	26
2004	588	32	18	232	9	25	494	16	21
2005	799	30	27	380	15	26	628	24	30
2006	571	39	15	446	22	21	683	28	25
2007	496	35	14	297	17	20	977	36	27
2008	234	24	10	25	4	7	534	20	26
2009	294	26	11	na	na	na	327	12	27
2010	235	23	10	na	na	na	555	19	29

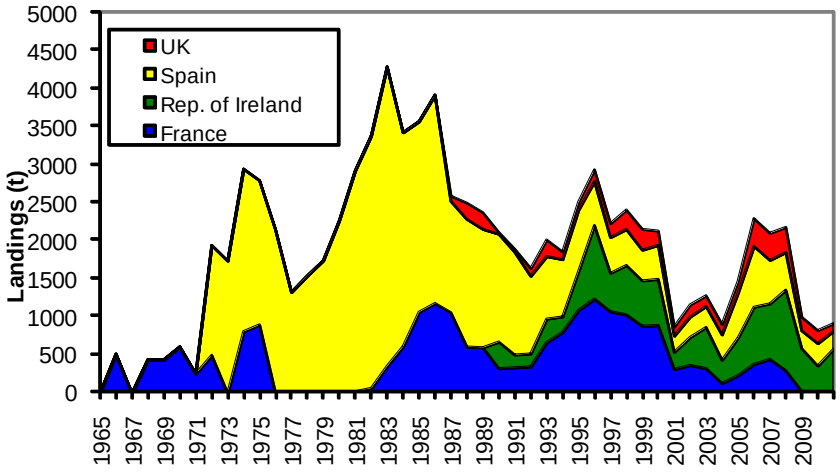


Figure 7.6.1. ***Nephrops*** **in FU16 (Porcupine Bank). Landings in tonnes by country.**

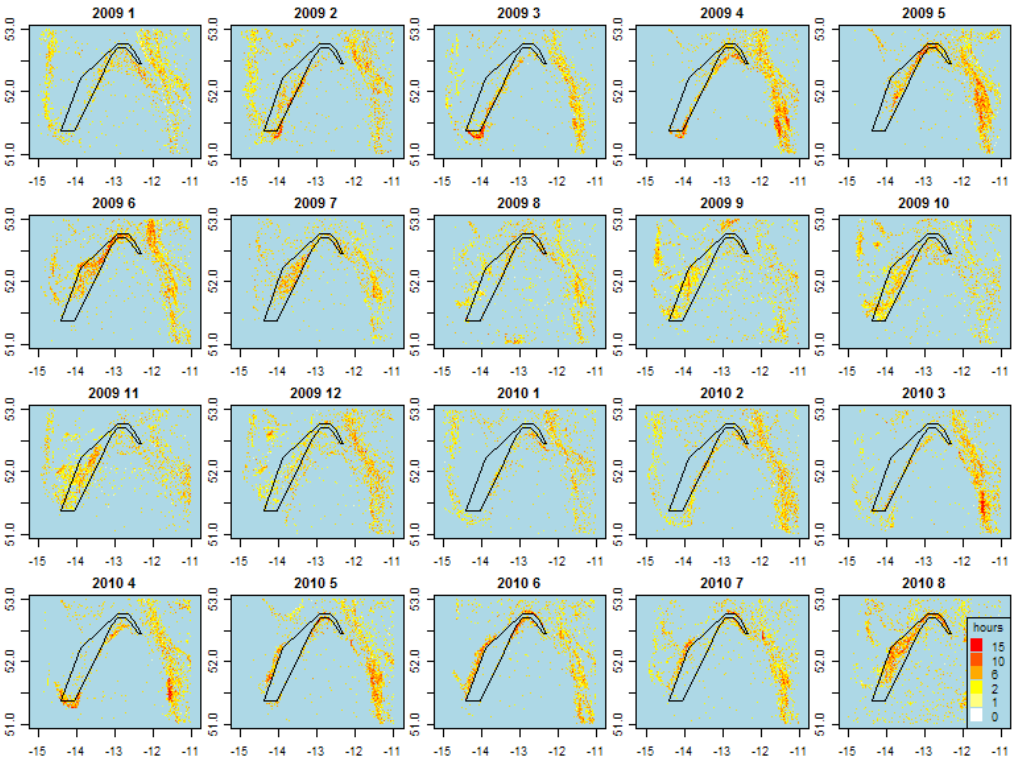


Figure 7.6.2. ***Nephrops*** **in FU16 (Porcupine Bank). Fishing activity from VMS by month for all vessels between Jan 2009 and August 2010. The black polygon indicates the closed area a square root effort scale has be used to enhance contrast.**

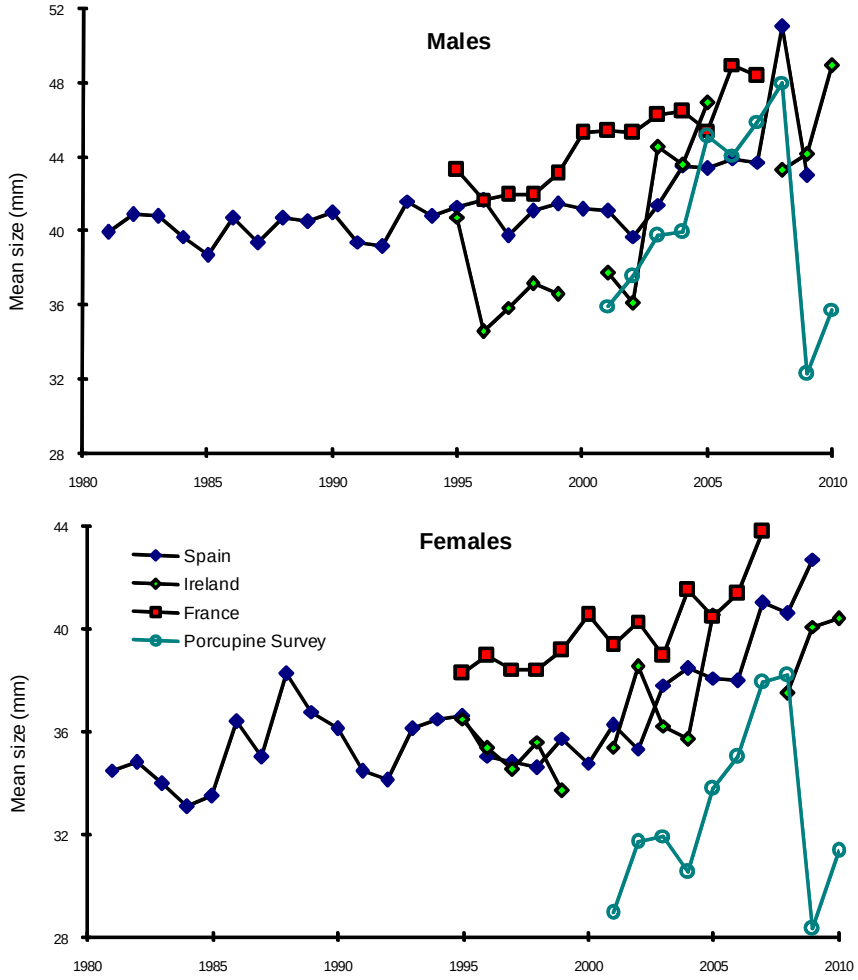


Figure 7.6.3. ***Nephrops*** **in FU16 (Porcupine Bank). Landings mean sizes by sex and country and mean size in the catch for the Porcupine survey.**

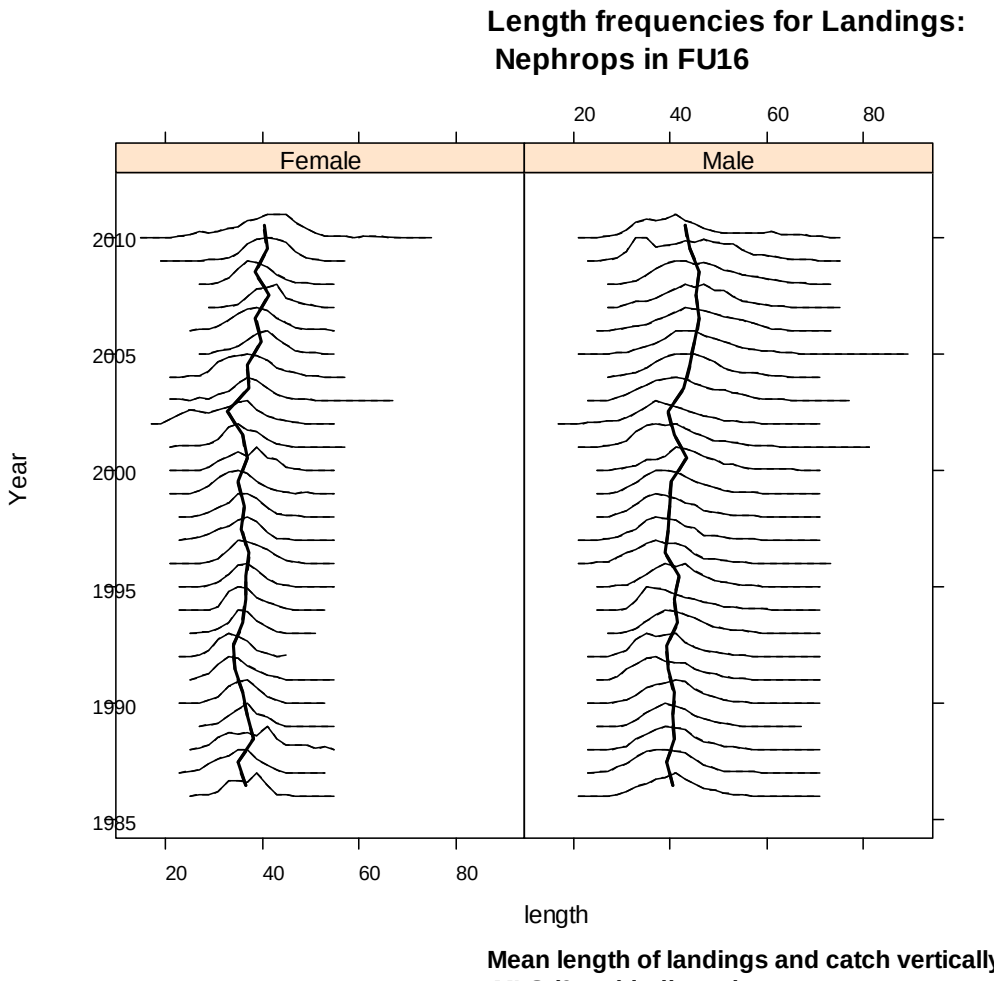


Figure 7.6.4. ***Nephrops*** **in FU16 (Porcupine Bank). Female and male landings length distributions.**

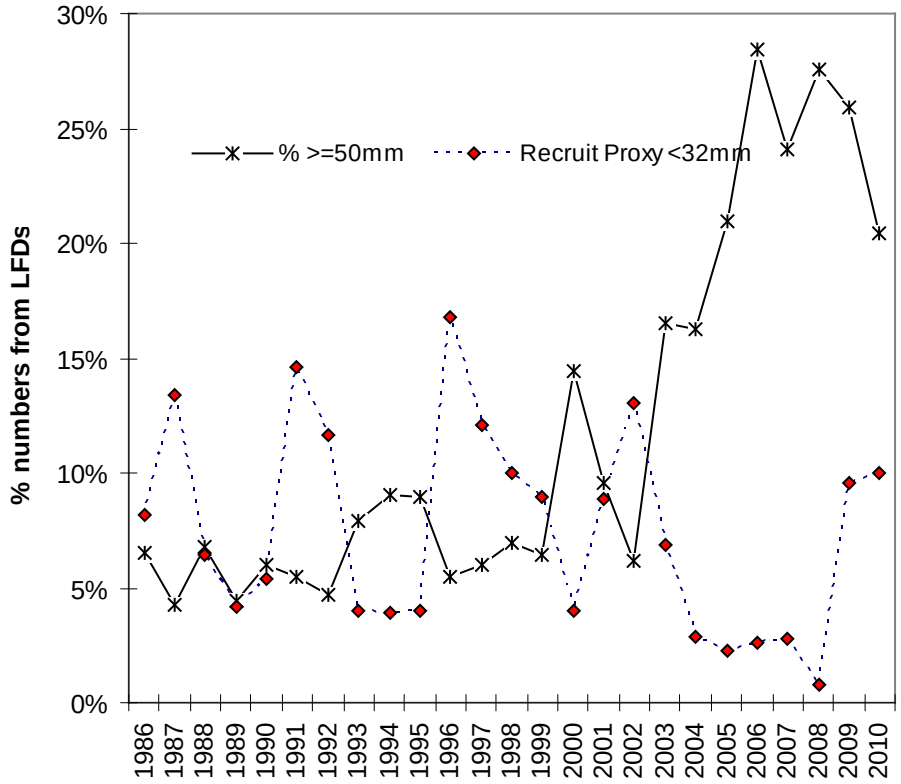


Figure 7.6.5. ***Nephrops*** **in FU16 (Porcupine Bank). Trends in the percentages of the sampled male** ***Nephrops*** **landings <32 mm carapace length (a possible recruitment proxy) and >50 mm carapace length.**

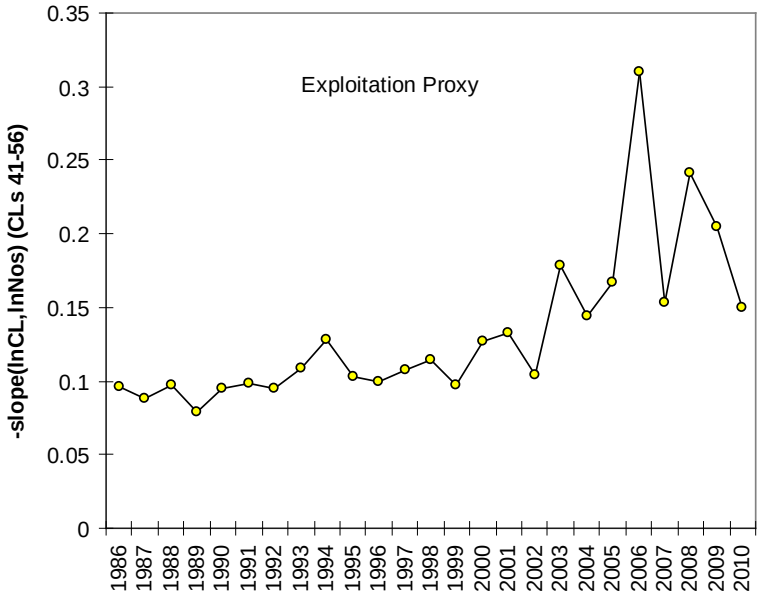


Figure 7.6.6. ***Nephrops*** **in FU16 (Porcupine Bank). Trends in an exploitation proxy for this stock. This is derived from the slope of the length frequency for male** ***Nephrops*** **between carapace lengths of 41–56 mm which are considered fully selected in the fishery.**

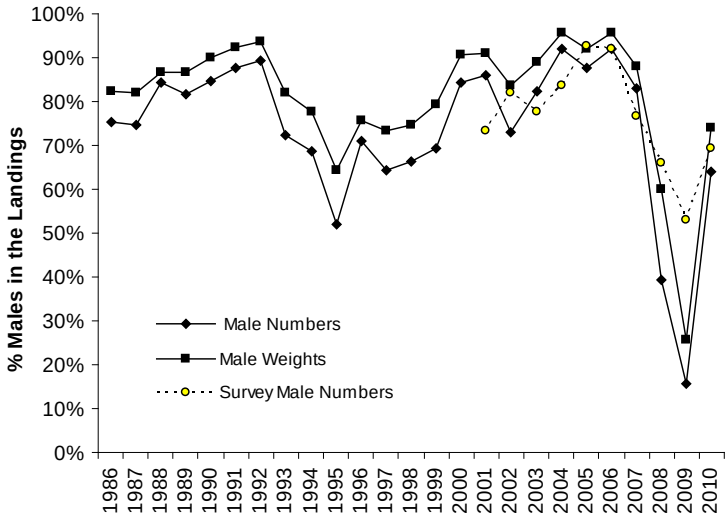


Figure 7.6.7. ***Nephrops*** **in FU16 (Porcupine Bank). Sex ratio of landings and survey catches.**

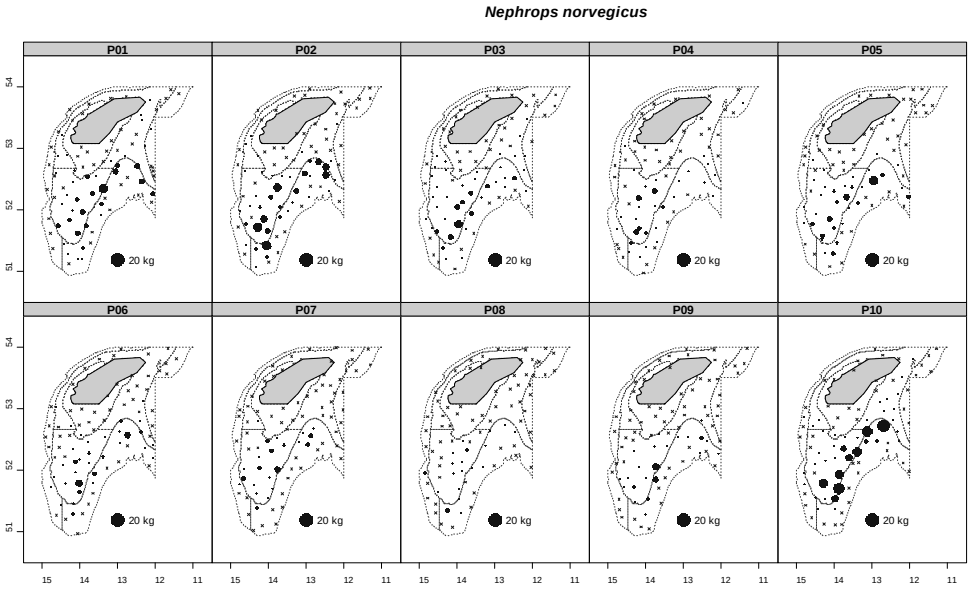


Figure 7.6.8. ***Nephrops*** **in FU16 (Porcupine Bank). Distribution of** ***Nephrops norvegicus*** **catches in Porcupine surveys between 2001 and 2009.**

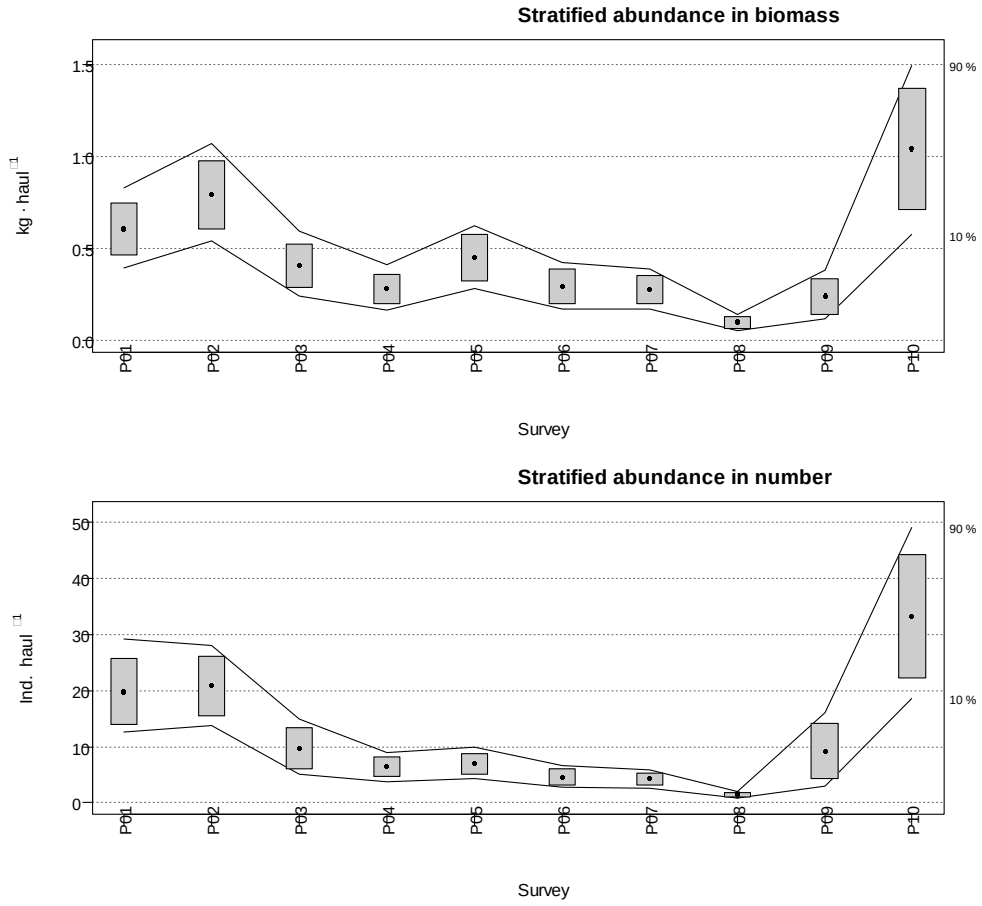


Figure 7.6.9. ***Nephrops*** **in FU16 (Porcupine Bank). Changes in** ***Nephrops norvegicus*** **biomass and number stratified indices during Porcupine Survey time-series (2001–2009). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (α=0.80, bootstrap iterations=1000).**

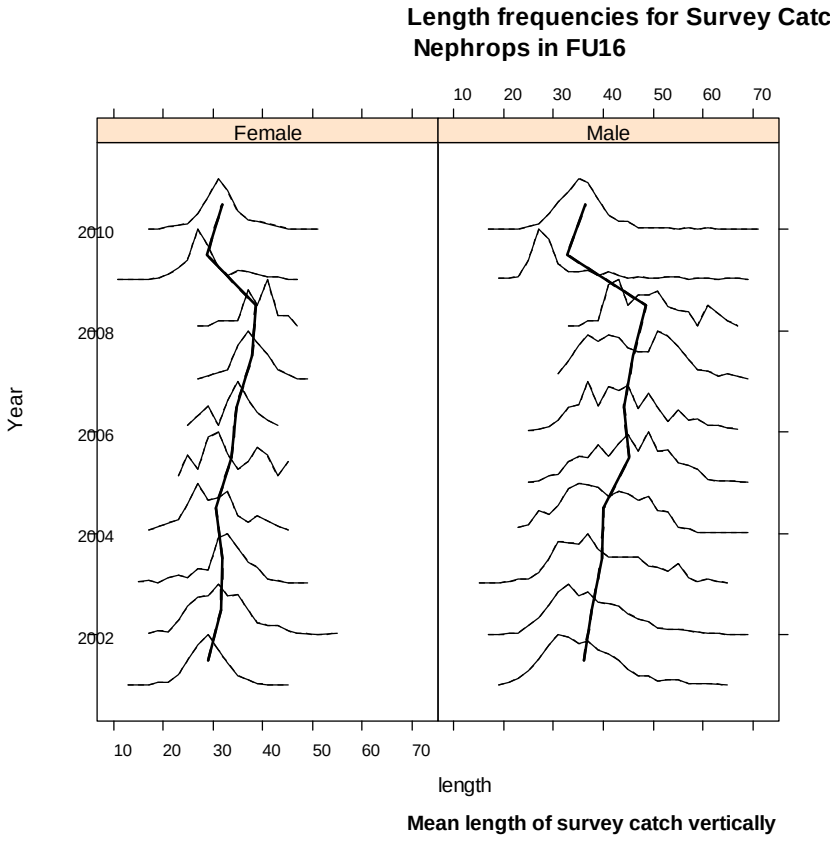


Figure 7.6.10. ***Nephrops*** **in FU16 (Porcupine Bank). Female and male Porcupine Survey length distributions.**

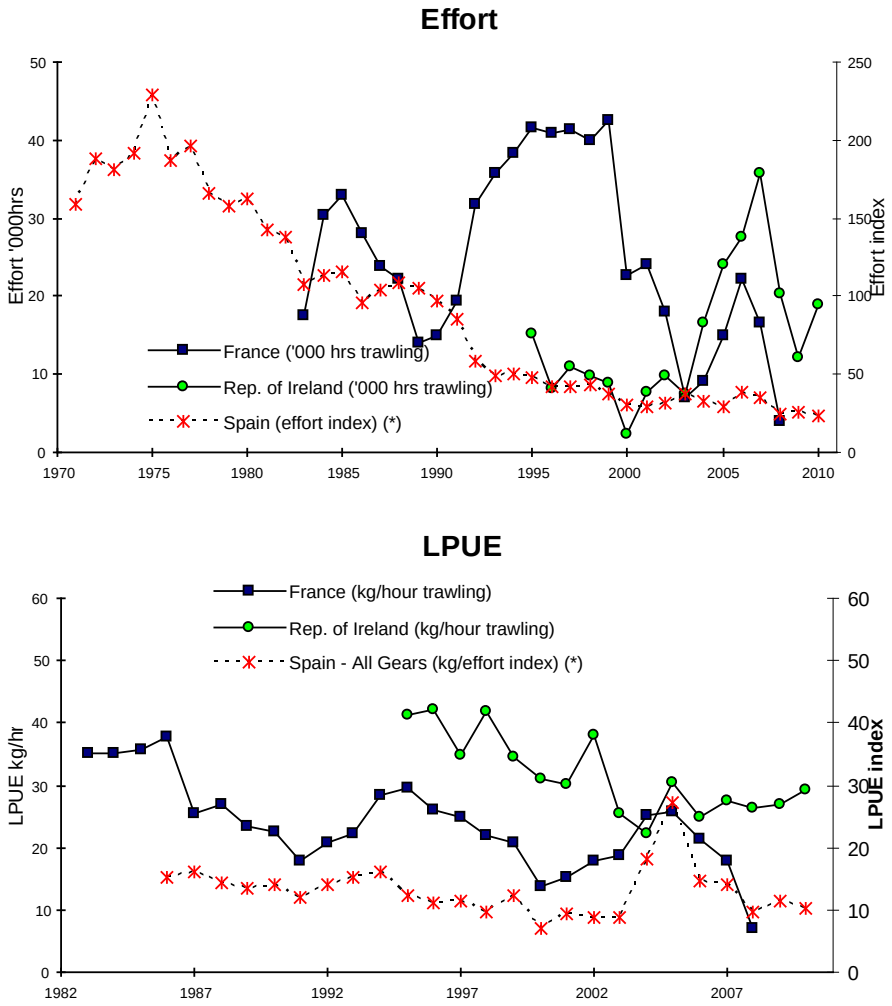


Figure 7.6.11. ***Nephrops*** **in FU16 (Porcupine Bank). Effort and lpue trends for fleets. (*) The Spanish effort index is based on a combination of hours at sea and average engine power. Irish and French effort and lpue is unstandardized.**

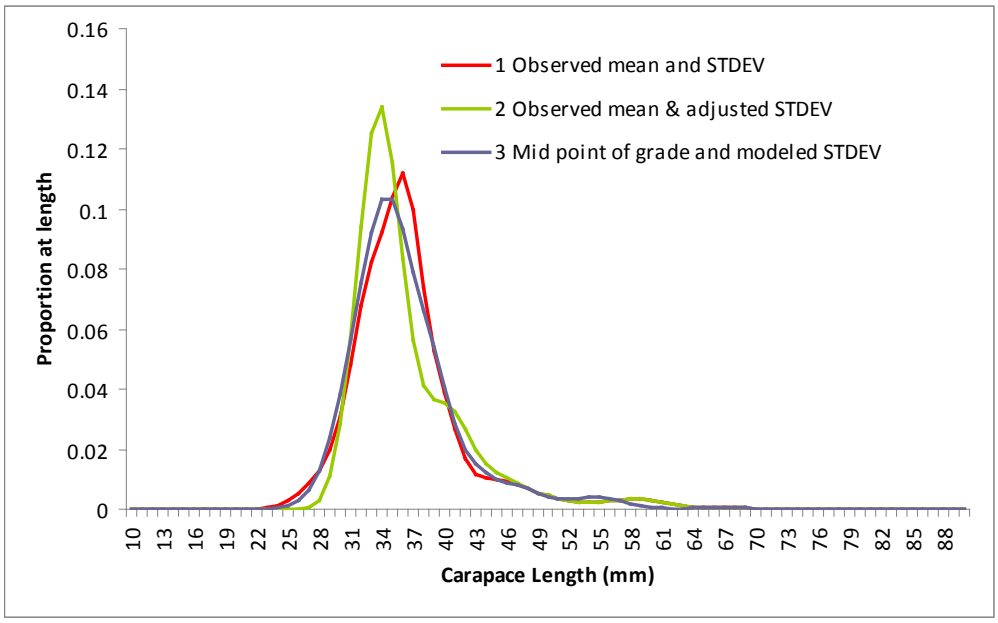


Figure 7.6.12. ***Nephrops*** **in FU16 (Porcupine Bank). Using commercial grade information from the fishing industry to reconstruct the size distribution of male** ***Nephrops*** **landings in 2010 using three alternative methods.**

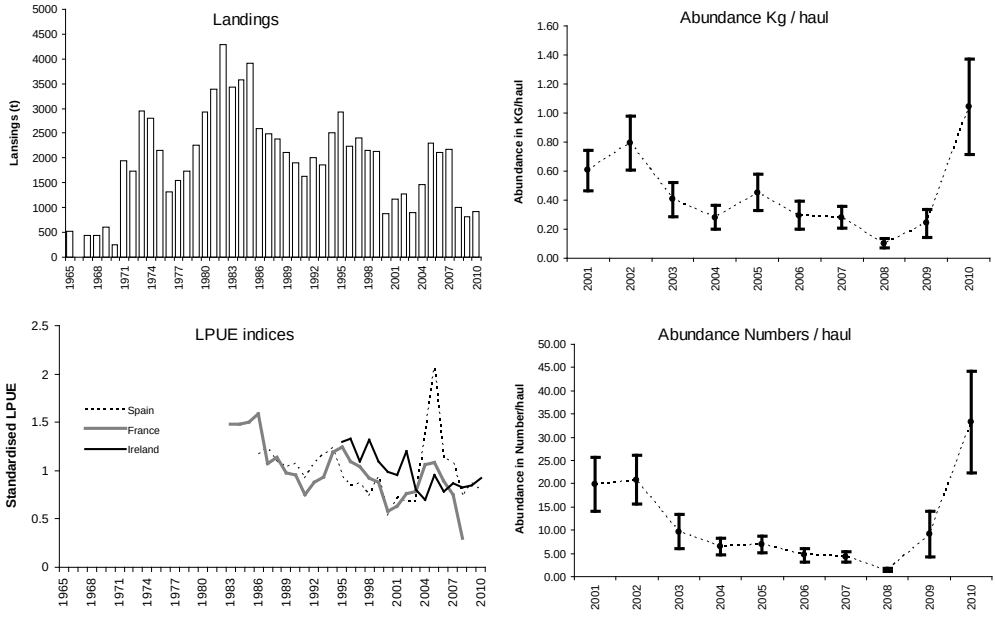


Figure 7.6.13. ***Nephrops*** **in FU16 (Porcupine Bank). Left: ICES landings over the years (top), standardized lpues by fleet (bottom). Right: Trends over the years in biomass (top, in kg/haul) and abundance (bottom, individuals/haul) from the Spanish Porcupine survey (LHS).**

7.7 *Nephrops* in the Celtic Sea (FU20–22)

ICES description VIIfgh

Functional Units Celtic Sea, VIIfgh (FU20–22)

Type of assessment in 2011: This year there was an update of stock trends for FU20–22 in addition the UWTV survey for the Smalls component of the stock are (FU22) was used to evaluate recent harvest rates and provide catch options for that component of the stock.

Overall upwards trend mainly since the early 2000s. Suggested very strong recruitment in 2007, but impossibility to indicate the actual state of the more recent year classes.

ICES advice in 2010 applicable to 2011 and 2012

Advice Summary for 2011 and 2012

Management Objective (s)	**Landings in 2011 and 2012**
Transition to an **MSY approach** with caution at low stock size	Reduce landings from recent level
Cautiously avoid impaired recruitment (**Precautionary Approach**)	Less than 5 300 t
Cautiously avoid impaired recruitment and achieve other objective(s) of a **management plan** (e.g., catch stability)	

To protect the stock in this Functional Unit, management should be implemented at the Functional Unit level.

MSY approach

Considering the stable lpue trend and unknown exploitation status, catches should be reduced from the recent level.

PA considerations

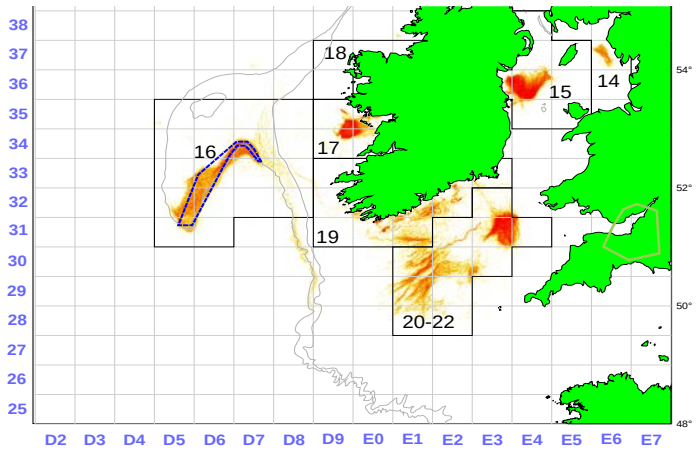
ICES considers that the current fishery does not appear to be detrimental to the stock and recommends that *Nephrops* fisheries should not be allowed to increase relative to recent landings. This corresponds to landings of no more than 5300 t.

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 southeest 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; FU20 NW Labadie, Baltimore and Galley, FU21 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.



The FUs with TAC VII are shown above together with Irish *Nephrops* directed VMS effort between 2005–2009. The 'Smalls' FU22 covered by the Irish UWTV survey is shown with a green line.

Management applicable in 2010 and 2011

Currently the TAC is set for Subarea VII .The 2011 TAC is 21 759 t, 3% less than the 2009 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) is applied by the French trawlers.

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 2010

Species:	Norway lobster *Nephrops norvegicus*	Zone:	VII (NEP/07.)
Spain	1 346		
France	5 455		
Ireland	8 273		
United Kingdom	7 358		
EU	22 432		
TAC	22 432		Analytical TAC

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

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 2010 49 French trawlers landed *Nephrops* from FU20–22 (74 in 2009 and 88 in 2008). Of these, 25 exceeded landings of 10 t representing around 92% of French landings; among them, seven vessels exceeded 50 t and accounted for 42% of the total. In 2010, 65 Irish vessels reported landings from FU20–22 (79 in 2009). Of these, 60 vessels (54 in 2009) reported landings in excess of 10 t accounting for 99% of the total Irish landings.

A decommissioning programme was in operation in Ireland during 2007 and 2008. Twelve vessels active in the FU20 fishery were decommissioned. These vessels accounted for approximately 18% of the landings in the 2007–2008 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.

Landings

In 2010, total landings were 4622 tonnes (-14% compared to 2009). Slight revisions of the French and of Irish landings data have been done and presented in the Table below.

Country	Year	Previous landings (t)	Revised landings (WGCSE 2011) (t)
France	2009	2156	2165
Ireland	2003	1388	1389
	2004	1627	1629
	2005	2391	2387
	2006	1864	1848
	2007	3213	3214

Landings are reported mainly by France and the Republic of Ireland (Figure 7.7.1; Table 7.7.1). The contribution of French landings has gradually decreased from 80–90% at the end of 1980s to 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 2010, French contribution in the total landings reached the historically lowest level, whereas Irish landings increased by 9%. 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 2010, 5455 t were allocated to France whereas actual French landings were 2217 t almost exclusively i.e. 98% coming from the Celtic Sea. In 2010, 8273 t were allocated to the Republic of Ireland and the uptake of quota was of 98% (38% of the national landings coming from the Celtic Sea). For 2010 there was no advice and ICES recommended as for 2009 to not exceed 5300 t of landings coming: the total harvested quantity was 4622 t (3110 t Ireland, 1112 t France, 343 t England/Wales/Northern Ireland, 57 t Scotland).

Discards

The increasing practice of tailing *Nephrops* by the French trawlers may affect the total discard rate of this fleet. Hence, method for discard derivation applied since 2006 on LFD French dataset for years with no sampling on board is not currently used for the assessment. The Irish discard rate seems to have decreased for the last three years after some higher values in the second half of 2000s mainly explained by positive signal of recruitments as for 2007.

7.7.2 Data

Landings

Landings information by country (France and Ireland) is given in the Stock Annex. All data are presented in Figures 7.7.2 and 7.7.3, Tables 7.7.3 to 7.7.11, 7.7.12, 7.7.13 and 7.7.14a. The Table 7.7.15 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 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.

In recent years, the decline in mean sizes observed in 2007 and 2008 may be due to a strong year class which was also apparent in the 2006 Irish UWTV survey.

Since 2009, the WGCSE has pointed out a significantly increasing proportion of tailed individuals present in French landings (Figure 7.7.4) whereas this proportion was already high for Irish trawlers. For 2005–2010, 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 larger 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 on board 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 fitting CL vs. 2nd abdominal segment of tail by sex.

The length distribution of *Nephrops* tailed in the French landings for years 2008–2010 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 (Table 7.7.13; Figures 7.7.5 to 7.7.7). Results for 2009 are respectively 48 and 39 million *Nephrops*. It should be noted that 19% of individuals are smaller than the French Producers' Organization MLS (11.5 cm/35 mm CL) and the sex ratios are respectively 10% and 3%. In 2010, this method provides respectively 23 and 18 million individuals (+23%), 20% of them were smaller than the French Producers' Organization MLS and the sex ratios are respectively 14.5% and 3.5%. As indicated in the Table 7.7.15, the mean size of French landings for years 2008–2010 decreases at around 2.5–5.5 mm CL by sex when tails are involved by sampling. However, the mean CL remains larger than the Irish one. Before WGCSE 2009, the size composition was overestimated when raised to the composition of entire individuals and, therefore, the total number of landed *Nephrops* was underestimated.

Discards

Sampling

The available dataset is detailed in the Stock Annex. Additional French dataset was also acquired in 2005, but it involves in only two quarters (Q3 and Q4; Stock Annex). 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 no common dataset on discards between French and Irish fleets (lack of information of the Irish sampling programme for 2005-Q3, 2005-Q4, 2006-Q4, 2007-Q2). Available information on complete yearly sets (1997-FR, 2010-FR, 2003-IRL, 2008-IRL, 2009-IRL, 2010-IRL) is given by Figures 7.7.8 to 7.7.10, Tables 7.7.16 and 7.7.17. Tables 7.7.14b,c,d provide discard estimates, total catches and removals for Irish trawlers (using mortality rate of discards equal to 75%: Charuau *et al.*, 1982).

The notable contrast between the retained proportions on board and the spatial heterogeneity of the exploited area prevents direct comparisons of the main fleets. It is not yet possible to estimate if the inter-fleet variability of the discard rate is larger than the interannual one.

Changes in discard rate are 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

As for the main *Nephrops* stocks, the lack of estimation of discards hampers quantitative analysis of recruitment indices, therefore, possibilities of back-calculation for discards were investigated. For a long period, a "proportional derivation" of discards was processed on the FU20–22 *Nephrops* by WGNEPH, but was considered as unreliable because it induces lack of contrast in interannual variations of recruitment (see reports of WGSSDS 2005–2008; WGCSE 2009). An alternative probabilistic approach developed since 2006 on other *Nephrops* stocks (VIIIab; Bay of Biscay; FU23–24) was also applied to the FU20–22. The main concepts of the back-calculation are detailed in 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

A fishery-independent UWTV survey has been conducted by Ireland since 2006. This survey indicates a stable density of burrow density over the “Smalls” ground FU22 during the last three years (WD10). Figure 7.7.11 shows a consistency between the highest survey indicators in 2006 and the strong lpue values obtained by commercial vessels in the same area in 2007. Around 50% of the recent landings from FU20–22 are caught on the Smalls annually although this percentage does vary (Table 7.7.18).

In FU20–22, the French groundfish survey EVHOE while not focusing on *Nephrops per se* it does provide some indication of the length distributions and the strength of recruitment (Stock Annex). The Irish groundfish survey has been carried out since 2003 giving some information on the length compositions of *Nephrops* catches. The UK bottom-trawl survey 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 are available from 1983 to 2008 for the French *Nephrops* fleet (Table 7.7.19; Figure 7.7.12). In 2009 and 2010, the new registration system of official French statistics 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, the WG tested new allocation method 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 7.7.19). 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 for 2009 and 2010 (Table 7.7.19; Figure 7.7.12) were calculated in this way.

The WGCSE 2011 investigated the disaggregated lpue series for FU20–21 and FU22 separately in order to evaluate trends between the two areas. The French trawlers represented in Figure 7.7.12 are essentially operating in FU20–21 and are showing very similar patterns as the Irish trawlers in FU20–22. Highest lpues for both series were observed in 2008 and 2009 with a decline in lpue evident in 2010. Recent lpues for 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 2010. 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, remained stable in 2009 (+22%: 22.6 kg/h in 2008 and 22.7 kg/h in 2009 against 18.5 kg/h for 2007). In 2010, lpue decreased (-27%: 16.9 kg/h).

Effort data, aggregated and spatially separated (FU20–21 and FU22: Smalls ground), are available from 1995 for the Irish otter trawl *Nephrops* directed fleet. These data have not been standardized 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 global fishing effort remained stable in 2010, increasing steeply in FU22 (+36%) and dropping in FU20–21 (-36%). The lpue reached a maximum value in 2008 (60.5 kg/h) in the Smalls ground, decreased by -10% in 2009 and remained stable in 2010 (47.3 kg/h against 48.2). Outside Smalls the lpue was maximized in 2008 and 2009, but decreased by -21% in 2010 (34.4 kg/h against 43.6 kg/h). (Table 7.7.19; Figure 7.7.12). The increase of the Irish fishing effort involves either in the number of fishing vessels or in the number of trips by vessel.

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. 1999–2008; 40 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 on board on discarded fraction of catches was initiated in the 2nd quarter 2011 with the aim of providing additional information to the DCF sampling dataset.

7.7.3 Historical stock development

The stock is considered to be stable at a high level 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

New approach : UWTV survey on FU22, trends only on FU20–21

The previous assessment was based on global indicators for the stock e.g. lpue, mean size. Even if 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 and cpue series both have indicated a rise in stock abundance since the early 2000s suggesting that recent fishing activity has not been detrimental to the stock. It is noticeable that the French groundfish survey EVHOE, while not focusing on *Nephrops*, had provided in 2007 the highest indices for this species since the beginning of the survey ten years ago is in agreement with observations made by the Irish UWTV survey (WD 10). Trenkel and Rochet (2003) examining indicators in the French EVHOE Celtic Sea survey suggested that *Nephrops* population was increasing during 2000s.

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 of mean sizes for some sampling reference stations: see WGSSDS 2006) could be induced either by stronger recruitment abundance than previously or by overfishing.

As detailed in the Stock Annex, independent sources of information (EVHOE survey's indices, logistically derived discards for no sampled years) agree that some recent recruiting classes (mainly 2001 and probably 2002 and 2003, mostly 2007) should be of a good level whereas it is still impossible to indicate the actual state of the more recent year classes.

Little or no change in the perception of the state of the stock has to be taken into consideration for the moment.

7.7.4 MSY explorations

MSY explorations were carried out for the Smalls component FU22 which represents around ~50% of the total landings from FU20–22 (Table 7.7.18).

In response to the recommendations of WKFRAME (2010), the Bell/Dobby combined sex–length cohort analysis (LCA) model (WKNEPH, 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 FU22 (Smalls) from 2003–2010.

The length frequency distributions reference period 2008–2010 were used as input to the LCA model. There has been some variations in the LFDs particularly when an apparently strong recruitment entered the fishery in 2007 (Figure 7.7.13). The length distributions in the reference period were very stable. Other LCA 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 22 mm was based on Irish sampling in FU22 and reported to WKNEPH 2006 (ICES, 2006). Figure 7.7.14 shows the estimated selection pattern and residuals and YPR curves, from the model. The LCA 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 7.7.20 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 estimate harvest rates are very close to those estimated for several other stocks in VI and VII.

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 FU22 is the moderate ~0.5/m². These moderate densities have been

fairly consistent throughout time and space (Figure 7.7.11) with the exception of 2006 when strong recruitment was observed. The time-series of UWTV estimates is short.

- The biological parameters in the Celtic Sea are rather old indicating slightly faster growth in males than in other areas. 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 observed harvest rate has fluctuated over the time-series but is relatively stable over the most recent years.
- Overall the indicators suggest that the adult stock has been relatively stable or increasing for more than a decade.

Given the above considerations the **WG concluded default proxy of combined sex $F_{35\%Spr}$ is appropriate as an F_{msy} proxy**. **This corresponds to a harvest rate of 10.9%,** in line with several other stocks in the remit of this WG (FU11, 12, 15, 17). 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 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 high level it is likely to be above $B_{trigger}$.

7.7.5 Short-term projections

No short-term projection is performed for the whole area of this stock. Projections are only carried out for the Smalls (FU22) component using the method agreed at WKNEPH 2009 and applied for all other stocks with UWTV estimates in VI and VII by WGCSE.

Catch option for 2011 at various harvest rations were calculated using the approach agreed at the Benchmark Workshop (WKNEPH, 2009). Catch options are calculated by applying a bias correction factor to the UWTV survey estimate, using 3 year mean weight in the landings, 3 year mean proportions of the catch retained and harvest ratios at different reference points from an SCA analysis to calculate landings options.

Previously a bias correction factor has not been estimated for FU22 but WD 10 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 FU22. The FOV is smaller than that used for Scottish stocks (FOV ~1 m) resulting an edge effect bias correction factor of around 1.35 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 FU22 and misidentification is assumed to be in the order of 1.05. Fishing activity in FU22 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 bias estimates appropriate to the survey are shown below.

FU	Area	Edge effect	detection rate	species identification	Occupancy	Cumulative bias
20–22	Smalls	1.35	0.9	1.05	1	1.3

The inputs to the catch option table are given in Table 7.7.21. Table 7.7.22 shows landings predicted at a range of harvest ratios including those equivalent to fishing at F_{MSY} proxies for the fishery as well as $F_{current} = F_{2010}$. 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.

Table 7.7.18 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 last decade were ~2.6 kT. In the provision of catch options for the whole of the area landings of that order could be added to catch advice for FU22.

7.7.6 Biological reference points

There are no biological reference points for FU20–22 *Nephrops* stock.

7.7.7 Management plans

No specific management plan exists for this stock.

7.7.8 Uncertainties and bias in assessment and forecast

The revision of French landings, fishing effort and lpue over the recent years, underlines the heterogeneous composition of the standard pool of vessels. Currently, misreporting does not seem to be a problem for the stock.

There are several key uncertainties and bias sources in the method used here (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). 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 (WKNEPH 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 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 FU22 deterministic estimates of the mean weight in the landings and discard rates for 2008–2010 are used although there is some variability of these over time. Particularly 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 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 improving over the time-series.

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 7.7.18, French and Irish trawlers cover different areas and have presented contrasting features over the last decade. 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 the contribution of this rectangle became minor less than 10% at the end of 2000s. 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 on board 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 on board 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 on board provided a high discard rate of 54% [65% in 1997] even if data from the 3rd and 4th quarter seem to be unlikely: Figure 7.7.9). 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.

7.7.9 Recommendation for next benchmark

Many quantitative explorations attempted in recent years for the FU20–22 *Nephrops* stock (e.g. sampling on board, maturity ogive, discard derivation) were handicapped by the overall spatial heterogeneity, by the divergence of exploitation pattern for the two main fleets and by other factors as commercial trip duration.

Biological sampling

Auction

As the French sampling of tailed *Nephrops* on landings at auction has recently been standardized, updated information for LFD and sex ratio was provided in 2010 and should be benchmarked.

On board

The Irish plan of sampling on board under DCF will continue to provide information on discarded amounts and LFD. For the French trawlers, self-sampling on board is more realistic than during the 1980s–1990s (concentration of a huge proportion of total landings from a small number of vessels; see above § 7.7.1).

Maturity

Re-estimation of maturity parameters requires a specifically designed experiment which should be commonly organized by France and Ireland under DCF. This point should be discussed during the next RCM North Atlantic at La Rochelle.

Back-calculation for missing biological data

Tails

The modification of LFD for tailed individuals was extended on the overall period since the tailed fraction became significant by applying probabilistic concepts combined with s-shaped quarterly curves of tailing *Nephrops* vs. size. This has to be validated.

Discards

After re-calculating LFD for French landings on recent years, LFD of discards for French trawlers should be carried out for the whole time-series integrating the change of relative selectivity for trawls in 2000 (100 mm replacing 80 mm).

Dataset on LFD of Irish landings before 2002

For the years 1995–2002, available series on Irish landings on quarterly basis was not associated to samples on LFD. Despite spatial variability affecting size composition by fleet, the possibility to extrapolate French LFD for this period has to be investigated: before 2000, the same selectivity parameters for trawls should be used (the difference involved in MLS; § 7.7.1).

Surveys

UWTV Irish survey

The UWTV Irish survey initiated in 2006 can already form the basis for catch options and management advice on the Smalls component of the stock.

Commercial fleets

Stratification of the French fleet

The existence of official French statistics by vessel and trip (at least for the recent ten years), allows to stratify the whole fleet in order to propose homogeneous pools for commercial tuning fleets. Spatio-temporal variability of fishing power should also be performed aiming to evaluate the effect of different decommissioning plans throughout the time-series. See also general comments on mixed fisheries and allocation of trips to métier.

7.7.10 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.

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.

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.

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 substratum 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.

The average landings during 2000s have been stable or ascending up to 2008, and declining more recently. . However, various additional information such as mean sizes in landings, discard rate, abundances provided by UWTV survey suggest that there is little evidence of significant changes in the status of this stock.

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.**

Year	France	Rep. of Ireland	UK	Other Countries[1]	Total reported	Unallocated	Total
1983	3667		65				
1984	3653		36				
1985	3599		3				
1986	2638						
1987	3080	329					
1988	2926	239	1				
1989	3221	784	13				
1990	3762	528	14				
1991	2651	644	13				
1992	3415	750	84				
1993	3815	770	47	0	4632	-274	4358
1994	3658	1415	42	2	5117	-274	4843
1995	3803	1575	100	2	5480	-282	5198
1996	3363	1377	77	2	4819	-217	4602
1997	2589	1552	59	4	4204	-213	3991
1998	2241	1619	48	1	3909	-90	3819
1999	2078	824	38	0	2940	-78	2862
2000	2848	1793	44	1	4686	-44	4642
2001	2626	2123	19	1	4769	-33	4736
2002	3154	1496	15	8	4673	-50	4623
2003	3595	1389	19	N/A	5003	0	5003
2004	2605	1629	36	N/A	4270	0	4270
2005	2502	2387	53	N/A	4942	0	4942
2006	2368	1848	32	N/A	4248	0	4248
2007	2033	3214	47	6	5300	0	5300
2008	2348	3411	242	N/A	6001	0	6001
2009	2165	2844	378	N/A	5387	0	5387
2010	1112	3110	400	N/A	4565	0	4622

[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

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.

- The French data are presented by 2 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).

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

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	32	29		72	73		120	100	18	94	74		318	276	18
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	10 126	7774	21 703	23 884	17 600	14 293	16 297	13 821	12 732	14 516	19 184	57 783	64 823	58 378

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.

The French data are presented by 2 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).

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
52	42	44		119	123	10	90	91		57	59	14	308	317	24

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	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	12 492	22 977	25 366	23 767	22 978	25 977	22 516	8581	9438	9258	62 959	69 688	68 034

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.

- The French data are presented by 2 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).

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	10 029	9048	15 381	17 020	24 434	12 354	15 106	13 409	7892	8850	15 412	44 565	51 005	62 303

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.

The French data are presented by 2 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).

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	
52	179	171		349	278		215	165		21	22		764	636	

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	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	10 828	18 072	11 307	14 310	65 334	7474	9276	10 511	9190	10 123	18 409	37 491	44 537	112 326

Table 7.7.7. *Nephrops* in VIIfgh. Length distribution of landings by country in 2006. 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.

The French data are presented by 2 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).

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	
52	68	68		156	127	14	70	63		19	18		313	276	14

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	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	23	545	17 796	20 408	49 887	10 060	12 597	13 515	6249	6918	20 179	42 315	49 167	107	126

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.

The French data are presented by 2 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).

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	
52	34	31		70	62		19	20		20	19		142	132	

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	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	33	532	18 354	21 584	84 288	8897	10 287	27 541	6256	7289	56 252	38 803	45 339	201 614

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.

The French data are presented by 2 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).

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
52	28	25		47	40	41	30	30		17	14		120	109	41

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	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	10 387	21 914	16 039	20 836	73 086	13 516	17 380	26 900	8676	9763	34 056	46 348	58 365	155 956

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.

The French data are presented by 2 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).

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
52	33	33		51	51	57	22	22	11	10	10		115	115	68

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	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	11 195	49 557	16 360	19 967	42 590	9010	11 410	25 263	4538	5438	10 505	39 633	48 010	127 915

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.

The French data are presented by 2 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).

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
52	30	30	74	34	34	35	24	28		13	17		100	109	109

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	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	52 839	6120	8033	57 994	5303	6392	19 450	2145	2647	17 384	18 420	22 571	147 667

Table 7.7.12. Nephrops in FUs 20-22 Celtic Sea (VIIfgh) landings length distributions in 1987-1998. French trawlers.

Landings CL mm/	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21		57		7								
22							38					
23		53		36					43			
24		106		57		30			43			
25	24	289			14		85		86			
26	88	309		29	53	60	19	12	109	15		
27	149	490		143	34	111	84	23	644	20	15	
28	684	1177	110	465	448	669	111	78	601	60	28	59
29	1104	3180	710	728	922	966	213	309	610	62	45	93
30	2030	4373	958	1241	1719	2139	393	631	1113	246	236	294
31	2317	7579	1804	2146	3047	3212	935	1113	1074	696	542	475
32	3640	8076	3103	2521	4057	4393	2253	2650	2486	1803	1220	1043
33	4449	8059	4294	4456	6036	6608	2468	3177	3203	2699	2144	1396
34	4312	8452	5210	5034	5804	6509	3757	4532	3129	4239	2186	2308
35	6179	6948	6479	6677	5721	7896	5213	6666	4870	6136	3608	3354
36	5691	5137	5914	5800	4591	8225	5941	5440	4339	5583	3827	3587
37	5479	5084	5281	5077	3959	8066	6026	6653	7127	6995	4262	4465
38	4940	3623	5931	6143	3797	7579	6784	6950	7141	7410	4804	4525
39	3870	2383	4832	5402	3091	5528	5667	4853	5497	5691	3619	3127
40	4622	2590	4843	4796	2772	3386	7263	5497	6493	5277	4918	4453
41	2482	2302	3636	3702	2216	2745	5349	4396	4044	4225	3062	2875
42	2695	2462	3675	4147	2218	2919	5485	4473	4433	4096	3414	2996
43	1994	1645	2371	3271	2110	2429	3652	3222	3257	3205	2725	2267
44	1275	1274	2165	3235	1793	1680	2415	2580	3403	2115	1849	2109
45	1590	1231	1999	2366	1550	1636	2732	2183	2142	2086	2288	1474
46	1265	988	1415	2066	1229	1222	1653	1348	1747	1183	1428	1014
47	1184	806	1151	1446	865	939	1604	1323	1635	1247	1021	1012
48	1182	778	858	1787	1057	966	1134	1204	1338	877	970	789
49	767	525	708	1277	766	738	950	898	816	747	603	433
50	834	437	565	809	527	576	981	969	972	702	733	420
51	571	307	511	692	437	406	489	639	743	504	353	274
52	668	353	447	786	403	278	612	571	770	510	372	253
53	526	260	315	477	303	303	365	395	635	389	286	157
54	268	205	253	387	236	191	344	462	448	294	198	110
55	391	111	148	204	128	171	276	364	262	197	110	109
56	150	107	156	95	121	96	162	191	152	141	54	76
57	129	85	118	90	48	74	93	110	176	116	81	41
58	55	49	96	91	73	68	83	154	124	56	36	28
59	92	33	74	31	12	48	93	68	49	22	8	7
60	52	4	26	26	17	24	47	71	69	17	23	13
61	7	4	22	8		11	19	22	22	5	8	
62	11	10	7	21	7	9	25	9	29	20	3	
63	6		12		1		5	12	13	2		2
64			5									
65	16	4	5				6	2	3			
66						2		2				
67	6											
68			5									
69												
70												
71												
72								2				
73												
74												
75												
Total	**67794**	**81948**	**70215**	**77770**	**62182**	**82908**	**75824**	**74255**	**75892**	**69686**	**51080**	**45637**
Weights	**3080**	**2926**	**3221**	**3762**	**2652**	**3415**	**3815**	**3658**	**3803**	**3363**	**2589**	**2241**

Table 7.7.13. Nephrops in FUs 20-22 Celtic Sea (VIIfgh) landings length distributions in 1999-2010. French trawlers.
Years 2008-2010: DLFs including tails are provided by sampling at auction. For previous years sampling involved only in entire Nephrops; DLF including tails are estimated by simulation (see Stock Annex).

Landings																										
CL mm/Year		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010	
		no tails	tails	no tails	tails	no tails	tails	no tails	tails	no tails	tails	no tails	tails	no tails	tails	no tails	tails	no tails	tails	no tails	tails	no tails	tails	no tails	tails
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	19	0	1	0	2	0	1	0	2	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
	20	0	1	0	3	0	1	0	3	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
	21	0	2	0	5	0	2	0	5	0	1	0	2	0	2	0	1	0	0	0	0	0	0	0	0	0
	22	0	4	0	9	0	3	0	8	0	1	0	3	0	2	0	1	0	1	0	0	0	0	0	0	0
	23	0	7	0	15	0	6	0	13	0	2	0	6	1	4	0	3	0	1	0	0	0	0	0	0	0
	24	0	11	0	26	0	10	81	81	0	4	0	11	0	5	0	5	0	2	0	0	0	0	0	0	0
	25	0	20	0	43	0	18	0	35	0	6	0	19	0	9	0	8	0	4	0	0	0	0	0	0	0
	26	0	35	45	110	0	32	0	57	0	11	0	35	8	20	0	15	0	7	0	49	0	0	0	0	24
	27	34	90	23	141	26	76	0	94	0	19	0	64	10	33	0	28	21	25	0	104	0	4	0	36	
	28	18	123	45	330	0	102	83	213	0	35	0	117	2	45	15	62	22	37	0	343	0	35	0	69	
	29	15	208	90	420	0	184	21	369	0	63	0	215	1	73	0	99	5	50	22	582	0	151	0	136	
	30	255	867	150	463	258	674	283	763	0	115	0	397	13	136	34	205	47	113	18	1256	0	490	0	350	
	31	469	1754	155	520	606	1529	289	1125	50	250	73	1063	21	228	20	359	10	170	50	1951	5	1251	2	590	
	32	1171	2570	324	719	1990	3594	375	1260	357	767	398	1805	148	509	146	972	125	378	174	3567	31	1808	8	962	
	33	1801	3142	739	1558	3095	4960	664	1676	146	1653	748	2047	233	1045	229	1662	307	1986	544	4140	132	2251	31	1109	
	34	2441	3493	1113	2461	3766	5975	927	2822	1191	3975	838	2442	660	2119	877	2809	731	3354	1236	5198	434	3058	93	1165	
	35	3034	3685	2115	3366	6159	7334	1985	4332	2778	5457	1792	3352	1323	3366	1283	3791	1768	4509	2253	5332	1063	3627	322	1432	
	36	3102	3437	2554	3729	5506	6564	3223	5217	3083	5345	2785	4414	2069	4294	2468	4789	2616	5286	3697	6254	1859	4228	562	1557	
	37	3457	3472	3881	4092	5602	5618	3718	5288	3591	5169	3723	4749	2656	4408	3558	5440	4053	5525	4645	5001	2828	4334	1058	1524	
	38	3483	3248	3354	3862	3324	3517	5150	5821	4979	5649	3664	4346	2728	4004	4509	5314	4290	4883	5231	4690	3895	4305	1340	1561	
	39	2646	2453	4471	4403	3500	3217	5364	5584	5297	5415	3675	3628	3106	3634	4281	4435	4063	3993	5159	4071	4414	4059	1674	1635	
	40	3819	3272	4316	4064	4325	3629	7063	6361	5168	5027	3074	2916	2700	2867	4237	3747	4238	3429	4528	3306	4482	3761	1807	1573	
	41	2365	2057	4108	3622	3404	2759	5978	5163	6683	5771	3745	3109	2487	2377	3957	3130	3312	2513	4226	2886	4322	3153	1717	1362	
	42	2898	2440	3889	3343	2180	1762	5334	4391	5535	4703	3852	2998	2432	2087	3829	2474	2848	1967	3383	2215	3826	2592	1822	1328	
	43	1828	1557	3223	2692	2723	2065	4196	3332	5535	4490	2653	2054	2021	1647	3061	2131	2510	1620	2845	1720	3367	2264	1695	1180	
	44	1938	1639	3006	2516	2231	1701	3454	2749	4467	3570	2706	2069	1775	1401	2181	1495	1784	1156	2480	1493	2888	1957	1701	1208	
	45	1459	1262	2688	2261	1346	1044	2727	2174	3971	3206	2571	1912	1812	1371	1781	1202	1777	1107	1876	1190	1667	1129	1201	863	
	46	1045	923	2280	1943	1073	849	1811	1466	3659	2954	1530	1130	1563	1183	1629	1093	1282	844	1225	835	1430	1039	851	680	
	47	921	844	1858	1211	934	767	1241	1061	1941	1679	1264	1004	1486	1109	1198	844	747	537	812	593	1035	796	703	559	
	48	825	766	1115	1014	652	577	1147	949	1498	1329	1299	1099	1248	938	913	687	774	555	600	456	581	483	567	483	
	49	530	505	846	794	466	451	477	420	958	919	935	816	1174	886	619	497	421	350	395	298	523	434	474	409	
	50	461	450	801	808	438	417	560	490	676	663	739	698	1275	973	443	381	352	275	308	247	320	267	261	248	
	51	330	321	650	658	335	330	435	371	450	465	541	548	1051	835	313	286	196	181	229	192	191	194	224	200	
	52	270	263	458	466	347	327	318	276	308	317	516	528	764	636	313	276	142	132	120	109	115	115	100	109	
	53	220	219	439	451	251	241	175	172	199	204	479	478	707	570	231	228	98	93	102	92	80	80	76	80	
	54	197	196	277	284	194	190	176	165	126	129	287	293	543	448	166	161	76	67	55	65	50	55	54	54	
	55	144	142	243	249	137	135	192	175	94	97	209	214	502	421	134	133	50	50	46	43	51	45	37	43	
	56	80	80	155	159	182	178	85	85	82	84	164	167	276	238	105	108	51	46	28	28	20	20	14	14	
	57	53	52	82	84	103	101	77	78	75	77	134	137	280	228	85	87	24	22	27	24	11	11	9	9	
	58	24	24	104	107	111	109	42	42	25	26	66	68	169	141	71	74	21	20	20	17	4	4	3	3	
	59	15	14	64	66	94	93	25	26	25	25	48	49	133	113	49	50	10	10	8	8	3	3	2	2	
	60	14	14	55	57	71	69	34	34	0	0	23	24	39	41	36	37	13	13	4	4	4	4	0	0	
	61	11	11	57	58	39	38	28	28	7	7	17	17	43	39	21	22	8	9	2	2	2	2	2	2	
	62	5	5	11	11	27	27	26	26	5	5	11	12	11	15	10	11	7	7	1	1	0	0	0	0	
	63	0	0	15	16	0	0	11	11	0	0	4	4	17	15	3	3	3	4	1	1	0	0	2	2	
	64	0	0	0	0	3	3	2	2	0	0	0	0	1	2	7	7	2	2	0	0	0	0	1	1	
	65	0	0	10	10	0	0	3	3	0	0	2	2	2	3	2	2	1	1	0	0	0	0	1	1	
	66	0	0	5	5	0	0	0	0	0	0	0	0	3	4	0	0	0	0	0	0	0	0	0	0	
	67	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	
	68	0	0	0	0	0	0	2	2	0	0	2	2	1	2	0	0	0	0	0	0	0	0	1	1	
	69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	
	70	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	1	1	
	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	72	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	
	73	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
	74	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
	75	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	1	1	
Numbers		41375	45030	48813	53226	55495	61252	57783	64324	62959	69688	44565	51005	37491	44537	42215	49168	38303	45340	46348	58305	39033	48010	18420	22571	
Weights		2078		2848		2626		3154		3595		2005		2502		2368		2033		2348		2105		1112		

Table 7.7.14.a Nephrops in FUs 20-22 Celtic Sea (VIIfgh)

landings length distributions in 2002-2010. Irish trawlers.

Landings

CL mm/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
17	0	0	1	0	0	0	0	0	0
18	0	2	6	0	4	0	0	0	0
19	33	10	20	0	15	29	0	0	0
20	145	270	40	102	235	468	0	127	0
21	213	1071	77	459	497	601	28	167	169
22	653	1333	134	553	1113	2360	296	566	564
23	1340	2578	245	1164	2312	8021	1258	1643	1526
24	2243	2141	480	2730	4529	13135	3621	4207	2564
25	2245	2474	807	4313	6403	18144	6981	7405	6346
26	2459	5827	1416	6634	10050	22708	12397	11525	11047
27	2417	4372	2053	8554	12454	22225	9779	12331	15188
28	3459	6654	2938	8913	13349	24486	14738	11744	14745
29	3104	5578	4037	9930	12415	24021	13502	12619	15938
30	3483	5106	5255	10418	10950	19509	14588	10865	15399
31	4632	5247	6063	11816	8115	12783	12680	8630	12355
32	4325	5915	6424	10966	6849	9018	12436	8234	10875
33	4624	4380	6459	7954	5053	6395	10817	6731	8603
34	4281	3845	6264	7116	3755	4009	10013	5694	7333
35	3913	2639	4829	5597	2693	3309	9194	4647	4861
36	2742	1809	3905	4134	1907	2573	6725	4032	4504
37	2705	1441	3138	2726	1343	1757	4337	3397	3778
38	2460	1374	2426	2745	897	1474	3548	3106	3115
39	1628	1026	1618	2045	668	1148	2294	2569	2079
40	1606	495	1072	1255	405	909	1713	1627	1375
41	847	592	894	809	393	938	1606	1831	929
42	825	549	554	488	189	447	1192	864	1352
43	474	415	366	380	151	481	726	797	800
44	438	203	234	230	133	143	470	517	665
45	300	110	156	38	80	148	297	240	530
46	183	131	72	201	32	138	123	293	255
47	126	167	107	19	69	64	40	137	152
48	195	70	61	11	19	50	81	169	164
49	121	77	51	0	17	89	207	40	146
50	29	40	14	24	6	0	165	51	35
51	18	60	10	0	0	0	61	29	79
52	18	24	7	0	14	0	41	68	109
53	0	0	12	0	0	24	0	43	0
54	18	0	6	1	0	0	0	171	0
55	18	0	6	0	0	0	0	86	17
56	0	0	3	0	0	0	0	171	53
57	18	10	19	0	0	0	0	57	0
58	18	0	3	0	0	14	0	86	0
59	0	0	8	0	14	0	0	57	0
60	18	0	1	0	0	0	0	86	0
61	0	0	1	0	0	0	0	71	0
62	0	0	0	0	0	0	0	43	0
63	0	0	0	0	0	0	0	29	0
64	0	0	0	0	0	0	0	57	0
65	0	0	0	0	0	0	0	14	0
66	0	0	3	0	0	0	0	0	0
67	0	0	1	0	0	0	0	0	0
68	0	0	1	0	0	0	0	14	0
69	0	0	3	0	0	0	0	14	0
70	0	0	1	0	0	0	0	14	17
71	0	0	1	0	0	0	0	0	0
72	0	0	3	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0
Total	**58378**	**68034**	**62303**	**112326**	**107126**	**201614**	**155956**	**127915**	**147667**
Weights	**1496**	**1389**	**1629**	**2387**	**1848**	**3214**	**3411**	**2844**	**3110**

Table 7.7.14.b Nephrops in FUs 20-22 Celtic Sea (VIIfgh)

discards length distributions in 2002-2010. Irish trawlers.

Total Discards

CL mm/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
10	0	0	0	0	0	0	0	0	0
11	0	0	1	0	0	0	0	0	0
12	0	0	1	0	0	0	0	0	0
13	0	0	1	0	19	0	0	0	0
14	0	19	2	20	38	40	0	0	0
15	0	84	3	0	202	0	35	25	0
16	0	68	5	61	136	153	70	0	12
17	0	171	15	40	237	200	181	178	29
18	0	261	16	132	359	772	320	300	21
19	0	614	77	496	556	1784	744	644	102
20	0	1489	49	1094	868	3919	1372	1266	82
21	1	3118	94	1554	1656	7572	1854	1273	615
22	2	4657	125	2461	2940	11791	2848	3018	1384
23	7	5158	215	3753	3343	15300	4324	3688	2006
24	27	4482	358	6116	4735	17670	6275	5080	2304
25	112	4164	498	7164	5329	17336	9561	5596	3911
26	420	4026	748	8360	5522	13463	9047	4877	3783
27	685	2926	787	9873	6342	10636	8600	4447	4169
28	502	2227	751	8638	5130	10963	6591	2991	3436
29	243	1556	762	7511	2563	5085	4500	2335	3100
30	164	890	708	5773	1040	1772	3580	1650	2223
31	174	511	636	3893	586	546	2652	1150	2120
32	162	275	421	2731	332	153	1626	749	1446
33	103	67	304	1568	159	18	905	461	1035
34	61	0	107	807	60	5	617	236	671
35	34	0	92	554	0	1	55	68	330
36	19	0	9	201	0	0	27	0	152
37	10	0	5	50	0	0	0	0	63
38	5	0	3	0	0	0	0	0	24
39	3	0	2	0	0	0	0	0	0
40	1	0	1	0	0	0	0	0	0
41	1	0	1	0	0	0	0	0	0
42	0	0	1	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0
Total	**2738**	**36762**	**6800**	**72851**	**42153**	**119180**	**65784**	**40032**	**33018**
Weights	**42**	**333**	**99**	**946**	**437**	**1101**	**765**	**426**	**445**

Table 7.7.14.c Nephrops in FUs 20-22 Celtic Sea (VIIfgh)

catches length distributions in 2002-2010. Irish trawlers.

Total catches

CL mm/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
10	0	0	0	0	0	0	0	0	0
11	0	0	1	0	0	0	0	0	0
12	0	0	1	0	0	0	0	0	0
13	0	0	1	0	19	0	0	0	0
14	0	19	2	20	38	40	0	0	0
15	0	84	3	0	202	0	35	25	0
16	0	68	5	61	136	153	70	0	12
17	0	171	15	40	237	200	181	178	29
18	0	263	21	132	363	772	320	300	21
19	33	624	97	496	571	1813	744	644	102
20	145	1759	89	1196	1103	4387	1372	1393	82
21	214	4189	172	2013	2153	8173	1882	1440	784
22	655	5989	259	3014	4053	14151	3144	3584	1948
23	1347	7736	460	4917	5654	23321	5582	5331	3532
24	2270	6624	838	8846	9264	30805	9896	9287	4868
25	2357	6638	1305	11478	11732	35480	16542	13001	10257
26	2879	9854	2163	14994	15572	36171	21444	16402	14830
27	3102	7299	2840	18427	18797	32861	18379	16778	19357
28	3961	8881	3689	17551	18480	35449	21329	14735	18181
29	3348	7134	4799	17442	14978	29106	18002	14954	19038
30	3647	5996	5963	16191	11990	21280	18168	12515	17622
31	4806	5758	6699	15708	8701	13329	15332	9780	14475
32	4487	6190	6845	13698	7181	9171	14062	8983	12321
33	4728	4446	6763	9522	5212	6413	11722	7192	9638
34	4343	3845	6370	7923	3815	4014	10630	5930	8004
35	3948	2639	4921	6151	2693	3310	9249	4715	5191
36	2760	1809	3914	4336	1907	2573	6752	4032	4656
37	2715	1441	3144	2776	1343	1758	4337	3397	3841
38	2465	1374	2429	2745	897	1474	3548	3106	3139
39	1631	1026	1620	2045	668	1148	2294	2569	2079
40	1608	495	1074	1255	405	909	1713	1627	1375
41	848	592	895	809	393	938	1606	1831	929
42	826	549	555	488	189	447	1192	864	1352
43	475	415	366	380	151	481	726	797	800
44	438	203	234	230	133	143	470	517	665
45	300	110	156	38	80	148	297	240	530
46	183	131	72	201	32	138	123	293	255
47	126	167	107	19	69	64	40	137	152
48	195	70	61	11	19	50	81	169	164
49	121	77	51	0	17	89	207	40	146
50	29	40	14	24	6	0	165	51	35
51	18	60	10	0	0	0	61	29	79
52	18	24	7	0	14	0	41	68	109
53	0	0	12	0	0	24	0	43	0
54	18	0	6	1	0	0	0	171	0
55	18	0	6	0	0	0	0	86	17
56	0	0	3	0	0	0	0	171	53
57	18	10	19	0	0	0	0	57	0
58	18	0	3	0	0	14	0	86	0
59	0	0	8	0	14	0	0	57	0
60	18	0	1	0	0	0	0	86	0
61	0	0	1	0	0	0	0	71	0
62	0	0	0	0	0	0	0	43	0
63	0	0	0	0	0	0	0	29	0
64	0	0	0	0	0	0	0	57	0
65	0	0	0	0	0	0	0	14	0
66	0	0	3	0	0	0	0	0	0
67	0	0	1	0	0	0	0	0	0
68	0	0	1	0	0	0	0	14	0
69	0	0	3	0	0	0	0	14	0
70	0	0	1	0	0	0	0	14	17
71	0	0	1	0	0	0	0	0	0
72	0	0	3	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0
Total	**61116**	**104795**	**69103**	**185177**	**149279**	**320793**	**221740**	**167947**	**180685**
Weights	**1538**	**1723**	**1728**	**3333**	**2285**	**4315**	**4176**	**3271**	**3554**

Table 7.7.14.d Nephrops in FUs 20-22 Celtic Sea (VIIfgh)

removals length distributions in 2002-2010. Irish trawlers.

Removals=Landings+dead catches (discard survival rate : 25%)

CL mm/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	0	1	0	0	0	0	0	0
13	0	0	1	0	14	0	0	0	0
14	0	14	2	15	29	30	0	0	0
15	0	63	2	0	152	0	26	19	0
16	0	51	4	46	102	115	53	0	9
17	0	128	12	30	178	150	136	134	22
18	0	197	18	99	273	579	240	225	16
19	33	471	77	372	432	1367	558	483	77
20	145	1387	77	922	886	3407	1029	1076	62
21	214	3410	148	1624	1739	6280	1419	1122	630
22	654	4825	228	2398	3318	11203	2432	2830	1602
23	1345	6446	406	3979	4818	19496	4501	4409	3031
24	2263	5503	749	7317	8080	26387	8327	8017	4292
25	2329	5597	1180	9686	10399	31146	14152	11602	9280
26	2774	8847	1976	12904	14191	32805	19183	15183	13884
27	2931	6567	2644	15959	17211	30202	16229	15666	18314
28	3836	8324	3501	15391	17197	32708	19681	13988	17322
29	3287	6745	4609	15564	14338	27835	16877	14370	18263
30	3606	5773	5786	14748	11730	20837	17273	12102	17067
31	4763	5630	6540	14735	8554	13192	14669	9492	13945
32	4446	6121	6740	13015	7098	9133	13656	8796	11959
33	4702	4430	6687	9130	5172	6409	11496	7077	9379
34	4327	3845	6344	7721	3800	4012	10476	5871	7836
35	3939	2639	4898	6012	2693	3310	9236	4698	5108
36	2756	1809	3912	4285	1907	2573	6745	4032	4618
37	2712	1441	3142	2764	1343	1758	4337	3397	3825
38	2464	1374	2428	2745	897	1474	3548	3106	3133
39	1630	1026	1619	2045	668	1148	2294	2569	2079
40	1607	495	1073	1255	405	909	1713	1627	1375
41	847	592	895	809	393	938	1606	1831	929
42	825	549	555	488	189	447	1192	864	1352
43	475	415	366	380	151	481	726	797	800
44	438	203	234	230	133	143	470	517	665
45	300	110	156	38	80	148	297	240	530
46	183	131	72	201	32	138	123	293	255
47	126	167	107	19	69	64	40	137	152
48	195	70	61	11	19	50	81	169	164
49	121	77	51	0	17	89	207	40	146
50	29	40	14	24	6	0	165	51	35
51	18	60	10	0	0	0	61	29	79
52	18	24	7	0	14	0	41	68	109
53	0	0	12	0	0	24	0	43	0
54	18	0	6	1	0	0	0	171	0
55	18	0	6	0	0	0	0	86	17
56	0	0	3	0	0	0	0	171	53
57	18	10	19	0	0	0	0	57	0
58	18	0	3	0	0	14	0	86	0
59	0	0	8	0	14	0	0	57	0
60	18	0	1	0	0	0	0	86	0
61	0	0	1	0	0	0	0	71	0
62	0	0	0	0	0	0	0	43	0
63	0	0	0	0	0	0	0	29	0
64	0	0	0	0	0	0	0	57	0
65	0	0	0	0	0	0	0	14	0
66	0	0	3	0	0	0	0	0	0
67	0	0	1	0	0	0	0	0	0
68	0	0	1	0	0	0	0	14	0
69	0	0	3	0	0	0	0	14	0
70	0	0	1	0	0	0	0	14	17
71	0	0	1	0	0	0	0	0	0
72	0	0	3	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0
Total	**60432**	**95605**	**67403**	**166965**	**138741**	**290998**	**205294**	**157939**	**172430**
Weights	**1527**	**1639**	**1704**	**3097**	**2176**	**4039**	**3984**	**3164**	**3443**

Table 7.7.15. ***Nephrops*** **in VIIfgh. Mean sizes (carapace length, CL in mm) of French and Irish landings. For the period 1999–2010, 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*			

Table 7.7.16. *Nephrops* in VIIfgh. 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.

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 7.7.17. *Nephrops* in VIIfgh. Irish program of discard sampling onboard (years 2003, 2008-2010). 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.

CL	2003						2008						2009						2010					
		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
14				10		10																		
15		10		74		84				35		35		25				25						
16		10		58		68		35		35		70												
17		30		141		171				181		181		42		136		178						
18	1	134	1	127	2	261		83		237		320		77		223		300						
19	3	242	7	372	10	614		166		578		744		239		405		644						
20	53	452	215	1038	269	1489		370		1002		1372		247	127	1019	127	1266				12		12
21	164	902	904	2216	1068	3118		988	28	866	28	1854	111	679	56	594	167	1273		29				29
22	472	1963	858	2693	1330	4657	98	1127	198	1721	296	2848	220	1182	346	1836	566	3018				21		21
23	1469	2503	1101	2655	2570	5158	195	1431	1063	2893	1258	4324	756	1610	887	2078	1643	3688		54		48		102
24	1251	2392	888	2091	2139	4482	1491	2022	2130	4253	3621	6275	2015	2235	2192	2845	4207	5080		41		41		82
25	1209	2056	1264	2109	2473	4164	3058	2931	3923	6630	6981	9561	4121	2814	3284	2782	7405	5596	21	164	148	451	169	615
26	3132	1631	2683	2396	5815	4026	5878	2971	6519	6076	12397	9047	5814	2316	5711	2561	11525	4877	280	666	284	718	564	1384
27	1978	1304	2392	1622	4370	2926	4798	3416	4981	5184	9779	8600	6595	2292	5735	2155	12331	4447	633	834	893	1172	1526	2006
28	3591	1030	3053	1196	6644	2227	8319	3258	6419	3333	14738	6591	6508	1644	5236	1347	11744	2991	1147	1097	1417	1207	2564	2304
29	2568	723	3006	833	5574	1556	8292	2362	5209	2138	13502	4500	7532	1311	5087	1024	12619	2335	2512	1614	3835	2297	6346	3911
30	2327	433	2775	457	5102	890	9274	1926	5314	1654	14588	3580	6985	1076	3879	574	10865	1650	4972	1601	6075	2182	11047	3783
31	2977	300	2265	211	5241	511	7186	1431	5495	1221	12680	2652	5539	751	3091	399	8630	1150	7992	2143	7196	2026	15188	4169
32	3570	166	2338	109	5908	275	7137	914	5299	712	12436	1626	5748	580	2486	169	8234	749	7087	1401	7658	2035	14745	3436
33	2313	57	2063	9	4376	67	7181	585	3636	320	10817	905	4680	388	2051	73	6731	461	8438	1236	7500	1864	15938	3100
34	2371		1470		3841		7008	332	3005	285	10013	617	4353	220	1341	16	5694	236	8153	666	7246	1557	15399	2223
35	1468		1168		2637		6570	55	2624		9194	55	3721	68	926		4647	68	6784	631	5570	1489	12355	2120
36	1108		700		1808		5201	27	1524		6725	27	3236		797		4032		5954	428	4921	1018	10875	1446
37	1056		384		1440		3430		906		4337		2864		533		3397		4960	424	3643	611	8603	1035
38	1140		232		1372		2993		556		3548		2785		321		3106		4623	264	2710	407	7333	671
39	891		134		1025		1928		366		2294		2334		235		2569		3181	152	1680	178	4861	330
40	404		91		495		1526		187		1713		1411		216		1627		3315	76	1189	76	4504	152
41	572		20		592		1459		148		1606		1667		163		1831		2873	38	904	25	3778	63
42	492		57		549		1114		78		1192		827		37		864		2595	12	520	12	3115	24
43	386		29		414		650		76		726		766		32		797		1871		208		2079	
44	155		48		203		431		40		470		503		14		517		1219		156		1375	
45	110				110		297				297		226		15		240		820		109		929	
46	131				131		123				123		270		23		293		1213		139		1352	
47	167				167		40				40		137				137		702		98		800	
48	70				70		81				81		169				169		569		96		665	
49	77				77		207				207		40				40		482		48		530	
50	40				40		165				165		51				51		255				255	
51	60				60		61				61		29				29		137		15		152	
52	24				24		41				41		57		11		68		164				164	
53													43				43		146				146	
54													171				171		35				35	
55													86				86		64		15		79	
56													171				171		109				109	
57	10				10								57				57							
58													86				86							
59													57				57		17				17	
60													86				86		53				53	
61													71				71							
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																								
	37807	**16335**	**30146**	**20427**	**67953**	**36762**	**96232**	**26430**	**59724**	**39354**	**155956**	**65784**	**83082**	**19796**	**44833**	**20236**	**127915**	**40032**	**83395**	**13571**	**64271**	**19447**	**147667**	**33018**
%D		*30*		*40*		*35*		*22*		*40*		*30*		*19*		*31*		***24***		*14*		*23*		*18*

Table 7.7.18. ***Nephrops*** **in the Celtic Sea (FU20–22). Production by rectangle for French and Irish trawlers. The total by rectangle and the % involve in years 1999–2010 (excluding 2009) for French fleet and in years 1999–2010 for Irish fleet. Landings by FU20 and 21 and by FU22 have been disaggregated for the time-series.**

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total	%
	French trawlers													
28E1	78	75	127	207	246	164	191	212	375	362		159	2197	8.1%
28E2	146	350	331	287	363	259	296	214	189	252		174	2861	10.5%
29E1	105	182	302	535	653	353	277	258	398	354		123	3540	13.0%
29E2	129	287	205	204	249	261	371	423	240	223		139	2732	10.0%
30E1	121	170	205	437	374	205	179	104	106	146		34	2081	7.6%
30E2	293	424	434	741	806	781	577	773	437	661	Not	294	6222	22.8%
31E3	847	1016	763	489	679	396	423	249	193	230	available	125	5410	19.8%
all FR	2078	2848	2626	3154	3595	2605	2502	2368	2033	2348	2156	1112	27269	
	Irish trawlers													
28E1	0	0	0	0	6	4	10	2	10	18	64	102	215	0.8%
28E2	0	3	1	1	2	23	15	6	2	6	72	16	147	0.6%
29E1	15	22	0	9	34	38	105	91	194	374	476	255	1613	6.2%
29E2	1	2	0	0	1	11	19	24	31	23	67	52	231	0.9%
30E1	5	10	10	37	62	104	133	141	154	292	297	116	1361	5.3%
30E2	4	5	3	2	5	36	52	99	69	147	151	105	676	2.6%
30E3	15	11	0	5	2	27	55	39	40	15	16	16	241	0.9%
31E2	44	55	54	50	37	56	68	49	101	61	59	52	684	2.6%
31E3	616	1424	1679	1124	941	1101	1571	1168	2392	2257	1549	2096	17918	69.2%
31E4	27	25	146	134	115	17	129	85	96	61	40	104	980	3.8%
32E3	97	238	229	134	185	211	231	145	126	156	53	21	1828	7.1%
all IRL	824	1793	2123	1496	1389	1629	2387	1848	3214	3411	2844	3110	26069	
														Average 99–10
FU20-22	2902	4641	4749	4650	4984	4234	4889	4216	5247	5759	5000	4222	53338	4624
FU20&21	1314	1939	1932	2769	3064	2508	2534	2569	2440	3055	3143	1876	27202	2429
FU22	1588	2702	2817	1881	1921	1726	2355	1647	2807	2704	1857	2345	26136	2196
FU22 %of total	55%	58%	59%	40%	39%	41%	48%	39%	54%	47%	37%	56%	49%	

Table 7.7.19. Division VIIfgh. *Nephrops* effort and lpue data by country.

French data: otter trawlers getting at least 10% of their landings by targeting this species (period 1983–2008). For years 2009 and 2010, these data were not 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: otter trawlers 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		
	Otter	Otter			Total otter	Single Otter[1 3]	Twin otter[1 3]	Otter		
Year		total	FU22	FU20–21				total	FU22	FU20–21
1983	231440				14.2	14.2				
1984	204600				15.8	15.8				
1985	202830				16.0	16.0				
1986	162510				14.9	14.9				
1987	189580				15.2	15.2				
1988	170840				16.4	16.4				
1989	179060				16.8	16.8				
1990	229470				15.6	15.6				
1991	224710				11.3	11.3				
1992	276450				11.7	11.7				
1993	268410				13.2	13.2				
1994	258490				13.5	13.5				
1995	239240	26681	25028	2296	14.6	14.6		46.9	48.6	41.8
1996	220120	20579	18688	2319	14.2	14.2	14.2	50.0	46.6	30.4
1997	187180	23255	21824	1811	12.6	12.5	14.4	49.2	48.2	31.8
1998	155340	25380	24840	2654	13.0	12.9	14.9	53.1	53.6	32.4
1999	150770	15491	13899	2102	10.9	10.2	10.0	41.5	44.3	22.7
2000	194150	28267	26035	2530	13.8	11.5	11.4	47.8	50.6	23.6
2001	170320	36205	34166	1786	14.6	11.4	13.3	54.6	56.0	23.6
2002	165670	29990	27336	1727	18.7	15.4	16.7	44.3	47.0	33.4
2003	191600	28532	28334	2963	18.2	16.3	15.0	33.9	34.4	25.9
2004	152700	31309	28317	5658	15.8	13.5	12.9	32.8	34.4	26.5
2005	146880	51031	43502	10374	16.0	13.0	13.2	41.3	43.1	32.9
2006	136650	45383	35557	13476	16.3	14.4	12.8	34.9	38.6	26.0
2007	101980	59899	48111	16393	18.5	15.9	14.3	48.1	55.4	30.9
2008	99789	59875	41208	20880	22.6	18.4	16.4	53.8	60.5	44.4
2009	92116	55454	29096	27899	22.7	na[4]	na[4]	48.2	54.3	43.6
2010	66685	55417	39713	17780	16.9	na[4]	na[4]	47.3	54.6	34.4

[1]The single and twin otter French lpue can be compared with the total otter indices until 1999 when the definition of the fishing effort of trawlers was changed (see note 2).

[2]For the period 1999–2008, the French statistics differentiate fishing effort calculated on the basis of the "number of fishing hours" from that deduced from the "number of hours of use of a fishing gear".

[3]Information for single and twin trawl lpue involve in the total fishing fleet whereas aggregated indices are calculated for the otter trawlers getting at least 10% of their landings by targeting this species.

[4] Not available.

Table 7.7.20. ***Nephrops*** **of the Celtic Sea. Output of the SCA model applied on the Smalls component (FU22) of the stock.**

		Fbar 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%

Table 7.7.21. ***Nephrops*** **in the Smalls FU22. Short-term catch option prediction inputs (Bold) and recent estimates of mean weight in landings and harvest ratio (shaded area: years 2008–2010 are used as input for the SCA model).**

Year	Landings (number 106) scaled	Discards (number 106) scaled	Removals (number 106) 25%discard survival	Prop Removals Retained	Adjusted Survey(106)	HarvestRatio	FU22 Landings (t)	FU22 Discards (t)	MeanWt landings(g)
2003	89.69	50.81	127.8	0.70	Na		1,921	502	21.4
2004	67.67	8.06	73.7	0.92	Na		1,726	112	25.5
2005	111.40	88.19	177.5	0.63	Na		2,355	1,115	21.1
2006	91.37	51.40	129.9	0.70	1503	8.6%	1,647	544	18.0
2007	160.64	146.11	270.2	0.59	1136	23.8%	2,807	1,449	17.5
2008	114.55	52.56	154.0	0.74	1114	13.8%	2,704	644	23.6
2009	76.72	25.71	96.0	0.80	1093	8.8%	1,857	295	24.2
2010	107.13	23.42	124.7	0.86	1141	10.9%	2,345	331	21.9
Avg 08–10				0.80					23.24

Table 7.7.22. ***Nephrops*** **in the Smalls FU22. Short-term catch options table giving landings options for 2012.**

	Harvest rate	Adjusted Survey (millions)	Retained number (millions)	Landings (tonnes)
MSY framework	10.9%		99	2,303
$F_{35\% \text{ combined}}$		1,141		
F_{2010}	10.9%	1,141	100	2,320
$F_{0.1 \text{ Combined}}$	7.5%	1,141	68	1,581
$F_{max \text{ Combined}}$	12.3%	1,141	112	2,604
	0%	1,141	0	0
	2%	1,141	18	424
	4%	1,141	37	849
	6%	1,141	55	1,273
	8%	1,141	73	1,698
	10%	1,141	91	2,122
	12%	1,141	110	2,547

		Basis
Landings Mean Weight (Kg)	0.0232	Sampling 2008–10
Survey Overestimate Bias	1.30	WGCSE 2011
Survey Numbers (Millions)	1483	UWTV Survey 2010
Prop. Retained by the Fishery	0.80	Sampling 2008–10

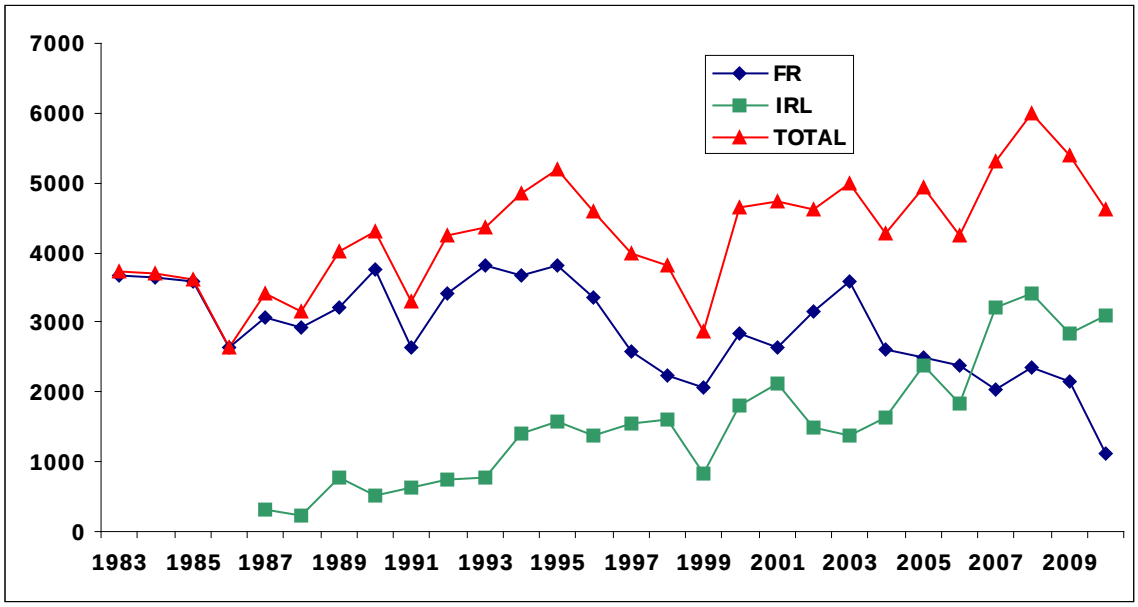


Figure 7.7.1. ***Nephrops*** **in VIIfgh. Evolution of nominal landings (t).**

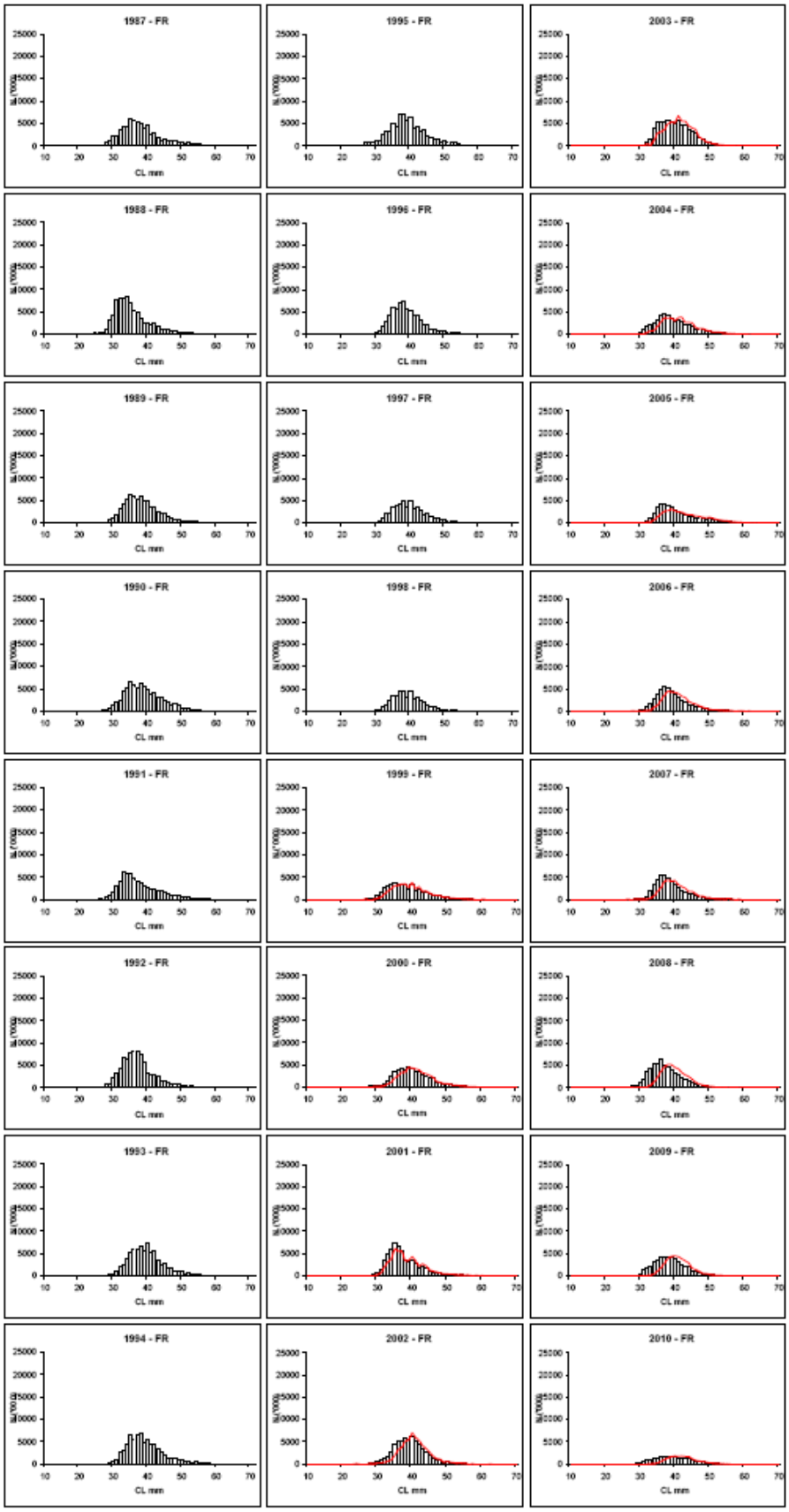


Figure 7.7.2. Nephrops in FU 20-22 Celtic Sea (VIIfgh) landings of French trawlers.

Landings since 1999 are presented by two ways: (1) Lines: previous method (tails not sampled and systematically apportioned in the smallest category of entire Nephrops at auction).(2) Bars: tails are included (years 1999-2007: simulation; since 2008: sampled data).

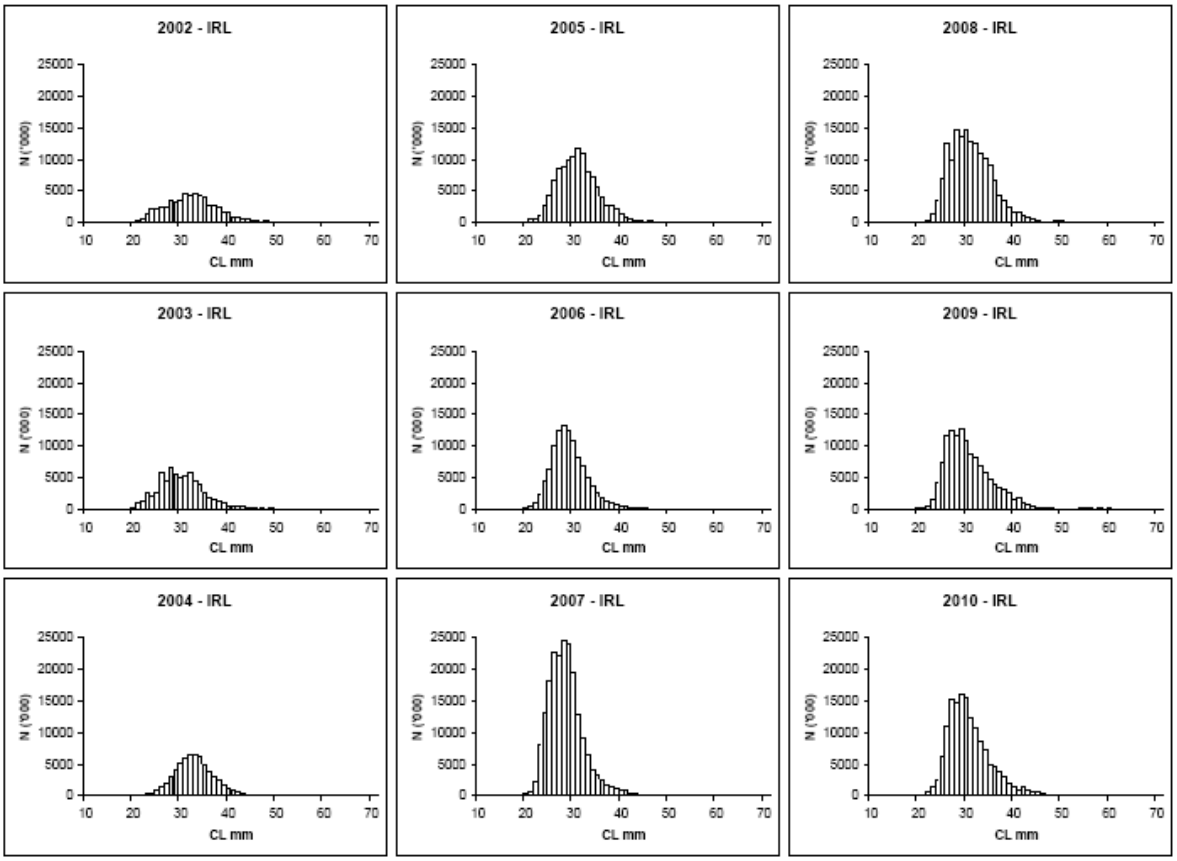


Figure 7.7.3. Nephrops in FU 20-22 Celtic Sea (VIIfgh) landings of Irish trawlers.

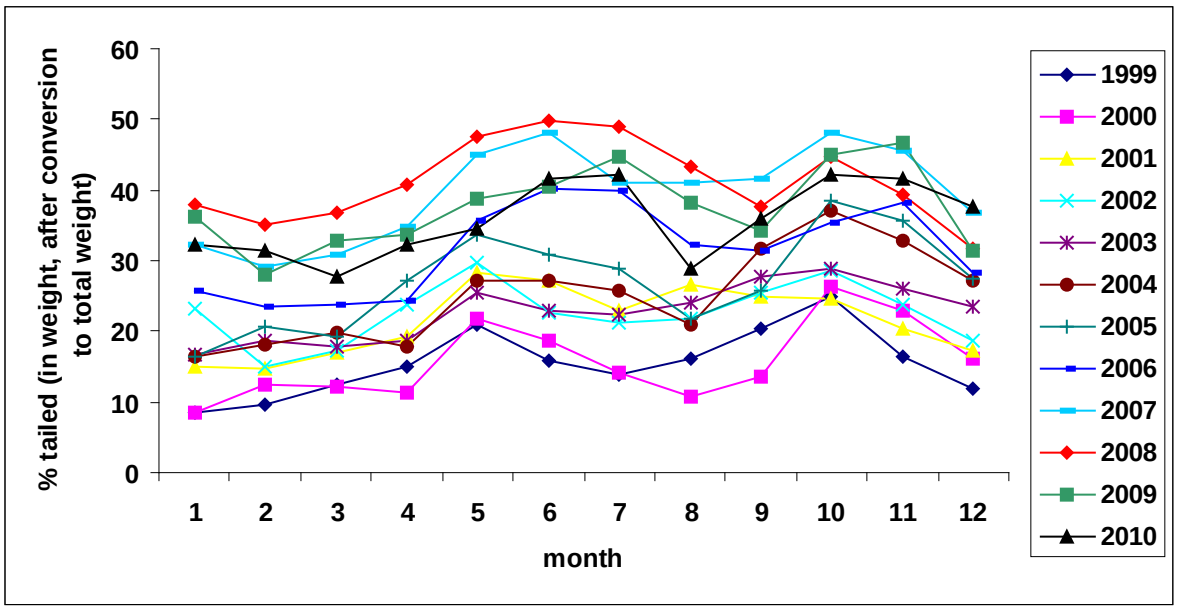


Figure 7.7.4. *Nephrops* **of the Celtic Sea (VIIfgh, FU20–22). Years 1999–2010. Monthly percentages of tailed individuals in the French landings (after conversion to total weight).**

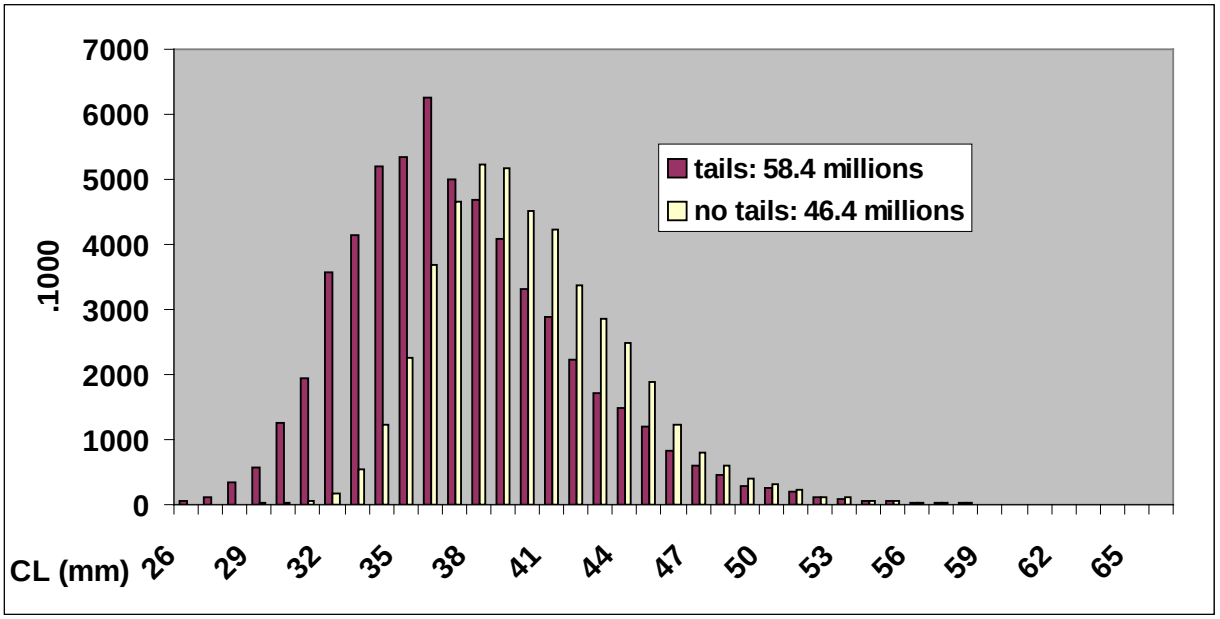


Figure 7.7.5. *Nephrops* **of the Celtic Sea (VIIfgh, FU20–22). French landings for 2008. Length distributions (1) including the data on tails and (2) using the previous method (no sampling of tails; the total tailed proportion was apportioned in the smallest category of entire** *Nephrops* **at auction).**

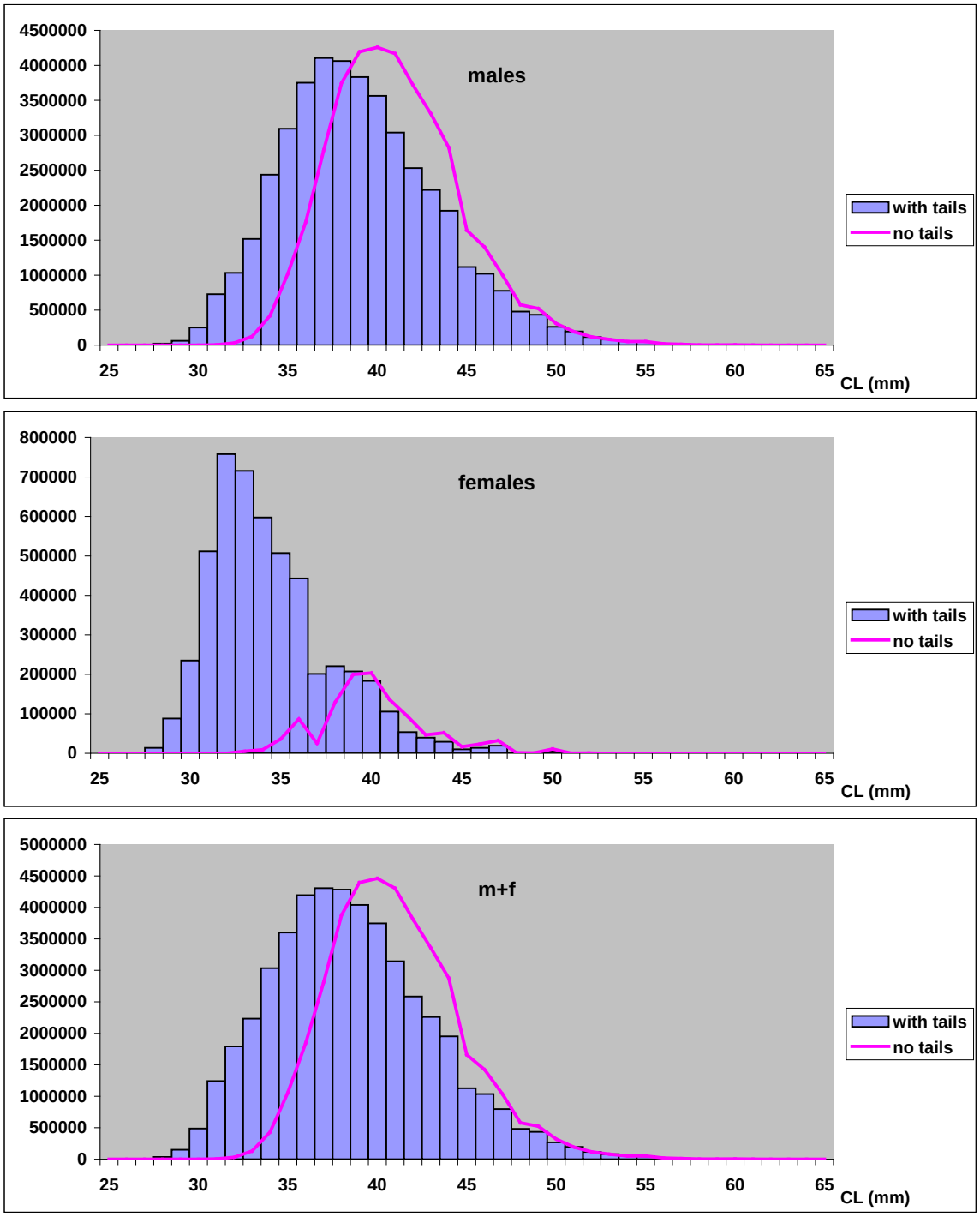


Figure 7.7.6. *Nephrops* **of the Celtic Sea (VIIfgh, FU20–22). French landings for 2009 by sex. Length distributions (1) including the data on tails and (2) using the previous method (no sampling of tails; the total tailed proportion was apportioned in the smallest category of entire** *Nephrops* **at auction).**

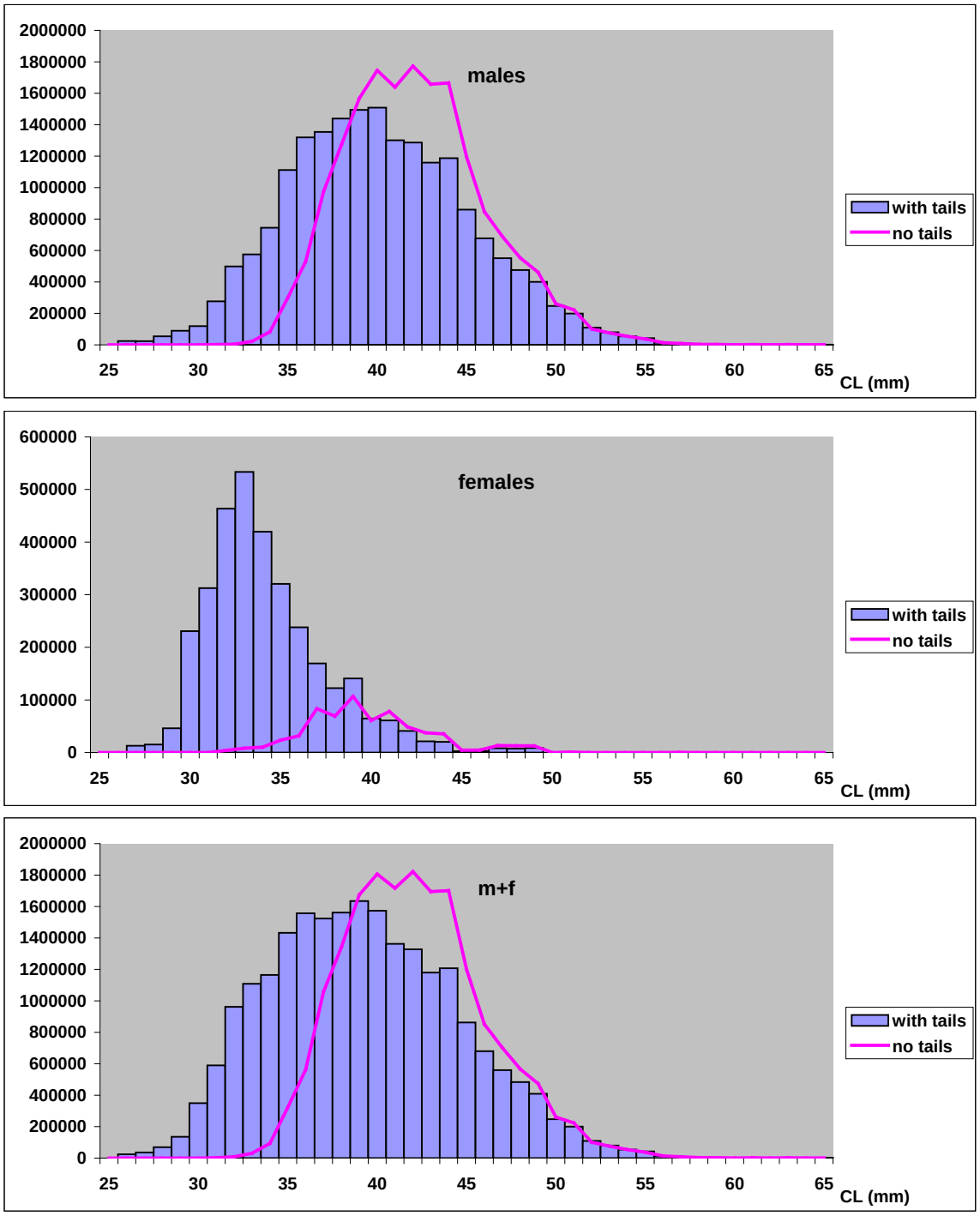


Figure 7.7.7. *Nephrops* **of the Celtic Sea (VIIfgh, FU20–22). French landings for 2010 by sex. Length distributions (1) including the data on tails and (2) using the previous method (no sampling of tails; the total tailed proportion was apportioned in the smallest category of entire** *Nephrops* **at auction).**

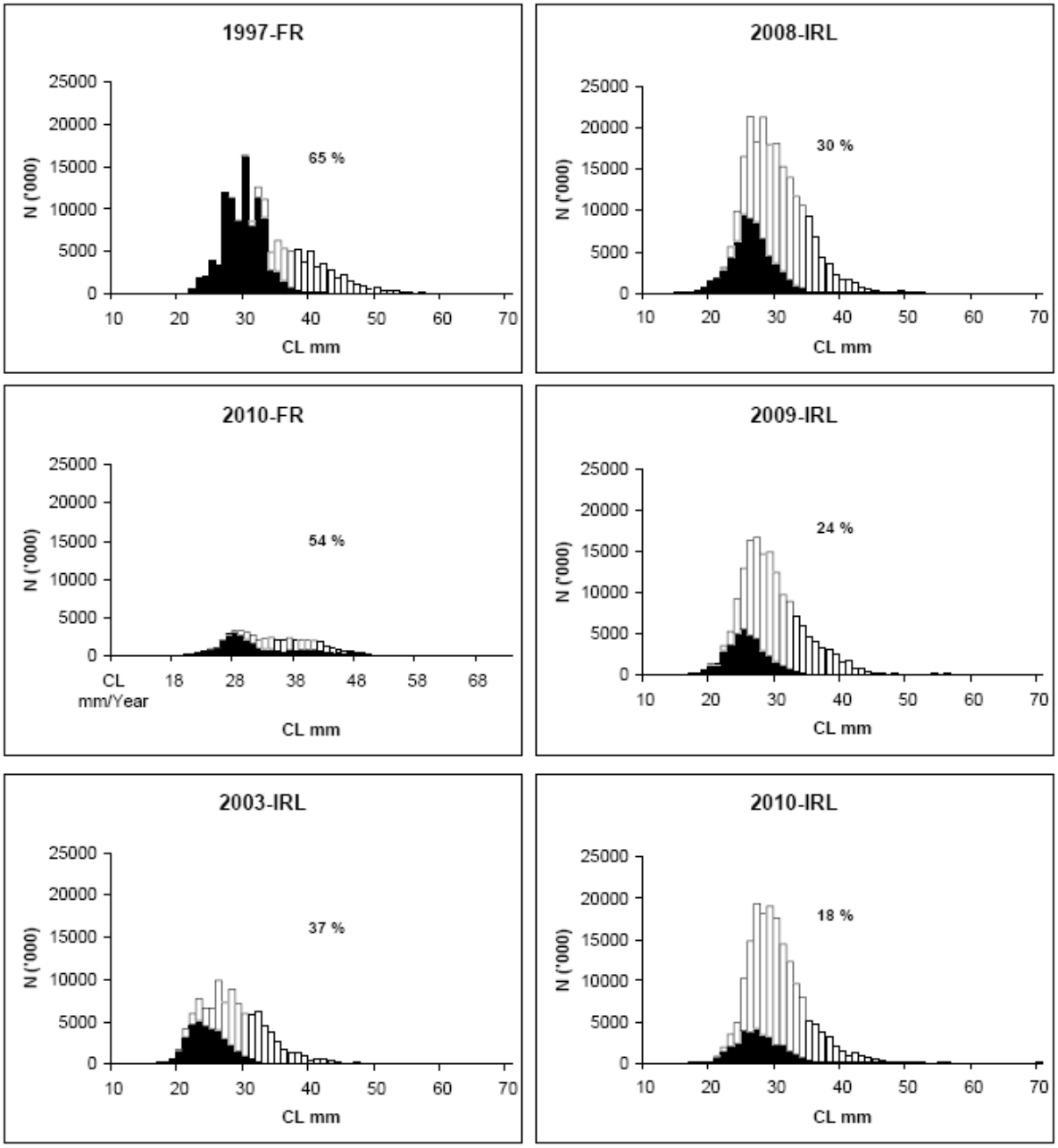


Figure 7.7.8. Nephrops in FU 20-22 Celtic Sea (VIIfgh).
Years with complete set of discard samples:
French data (1997 and 2010), Irish data (2003, 2008-2010).
Landings in white, discards in black.

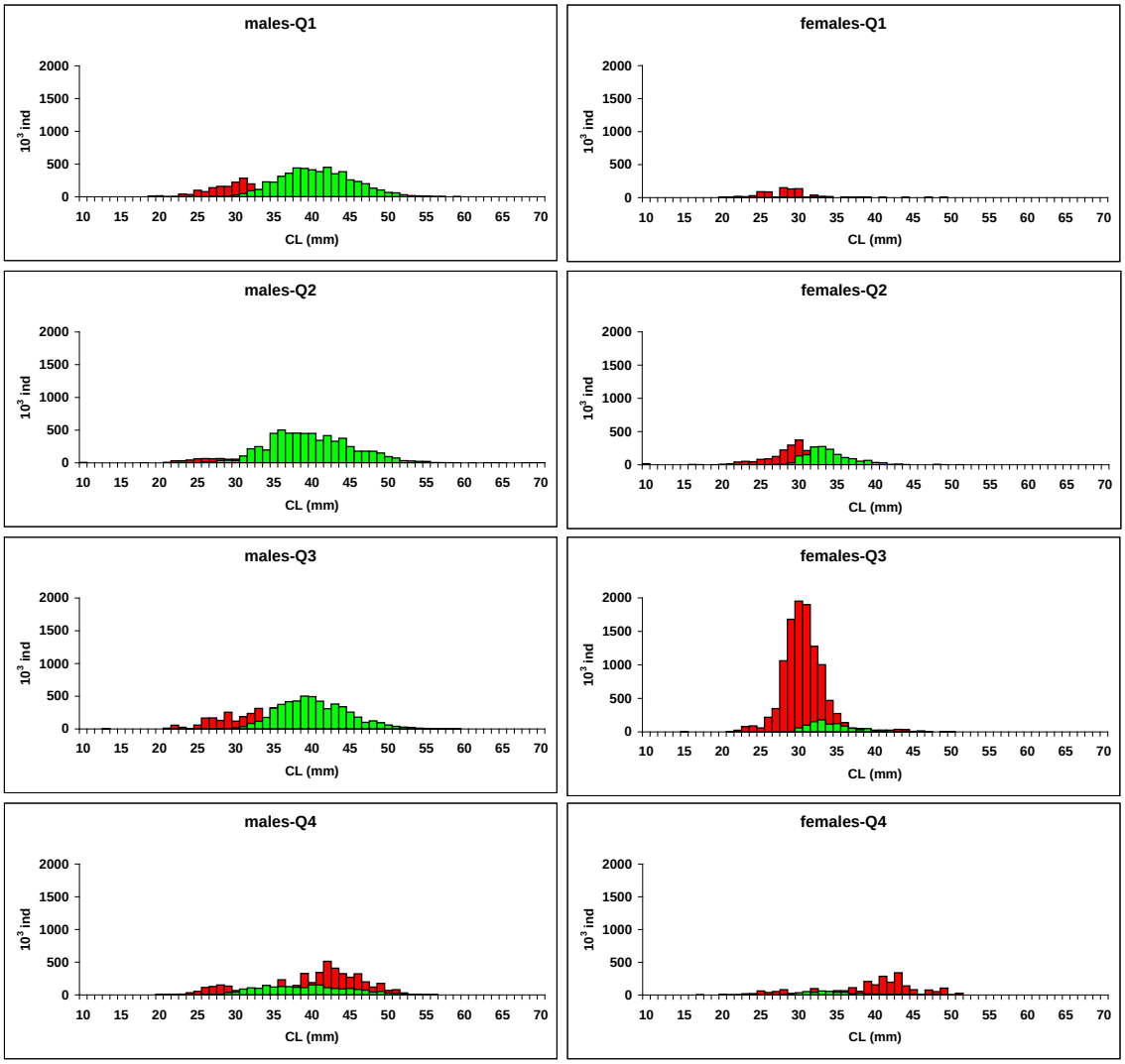


Figure 7.7.9. *Nephrops* **of the Celtic Sea (VIIfgh, FU20–22). Distribution of length frequencies (carapace length, CL in mm) by sex and by quarter for landings and discards of the French trawlers in 2010.**

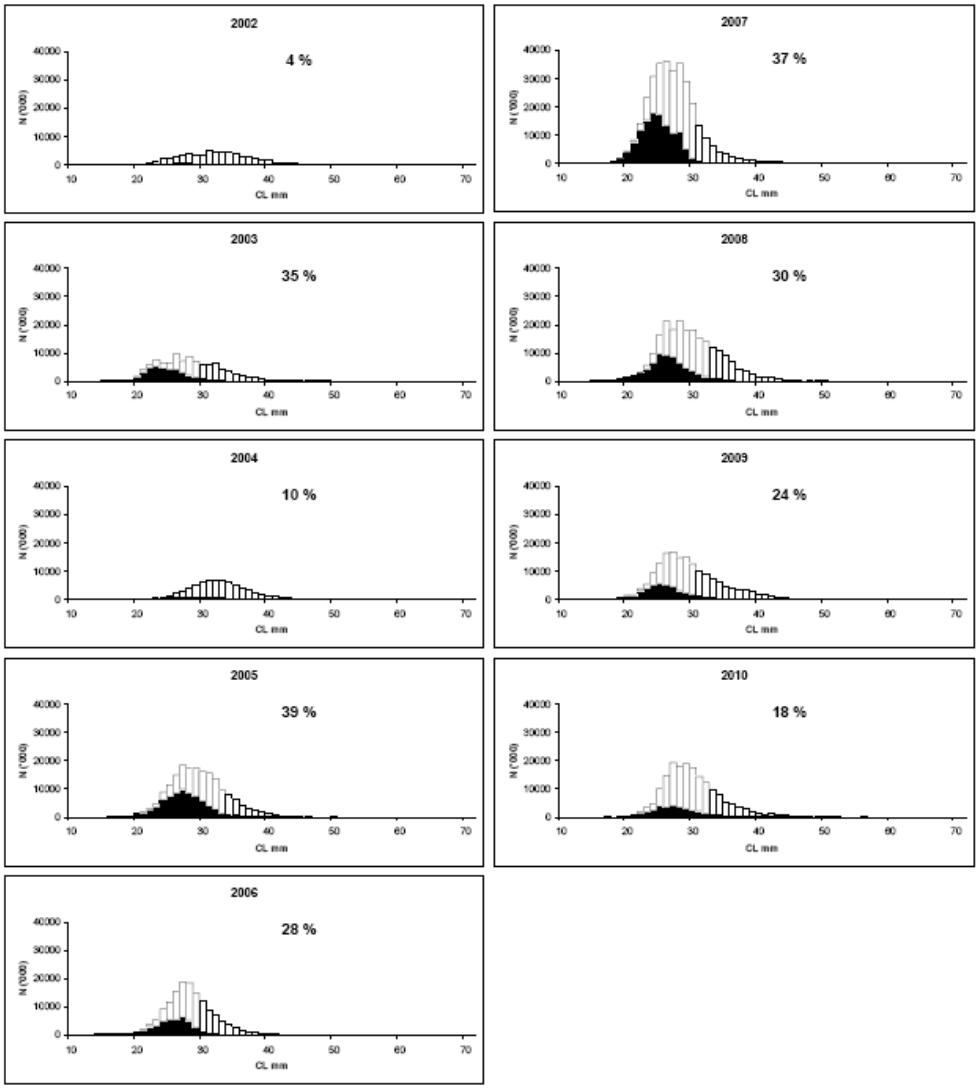


Figure 7.7.10. Nephrops in FU 20-22 Celtic Sea (VIIfgh).
Catches (landings in white and discards in black) of the Irish fleet.
Length distributions in 2002-2010.

Ground	Year	Number of stations	Mean Density (no./m_2)	Domain Area (km_2)	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%
Smalls	2010	90	0.49	2861	1483	4%

*Minor data revision due to transfer of survey data to SQL server.

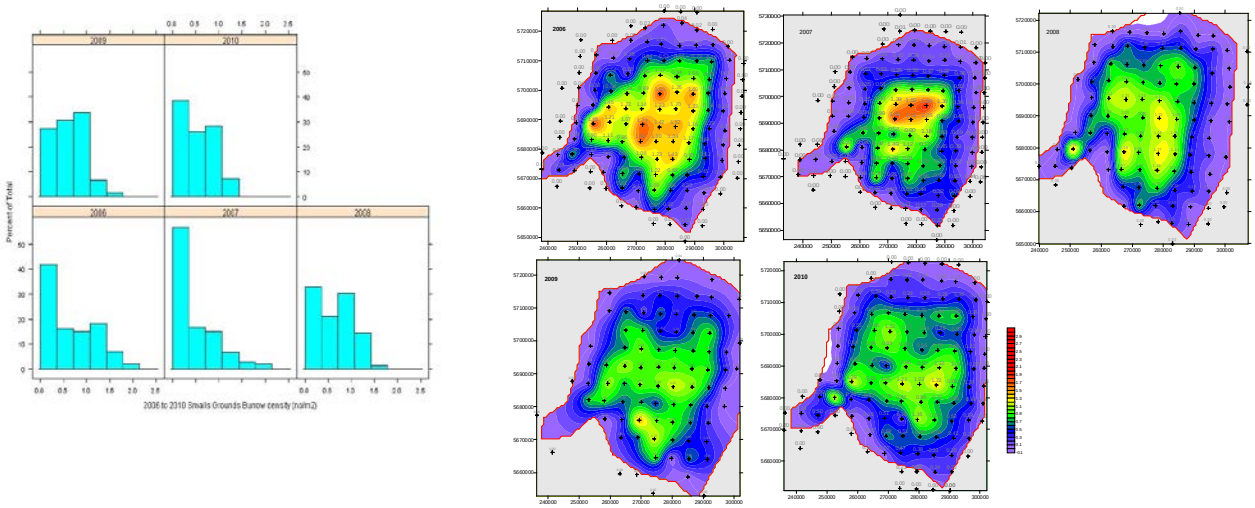


Figure 7.7.11. ***Nephrops*** **in the Celtic Sea (FU 20–22).Summary of geostatistics results 2006–2010 of the Irish UWTV survey carried out on the Smalls ground (FU22) and contour plots of burrow densities.**

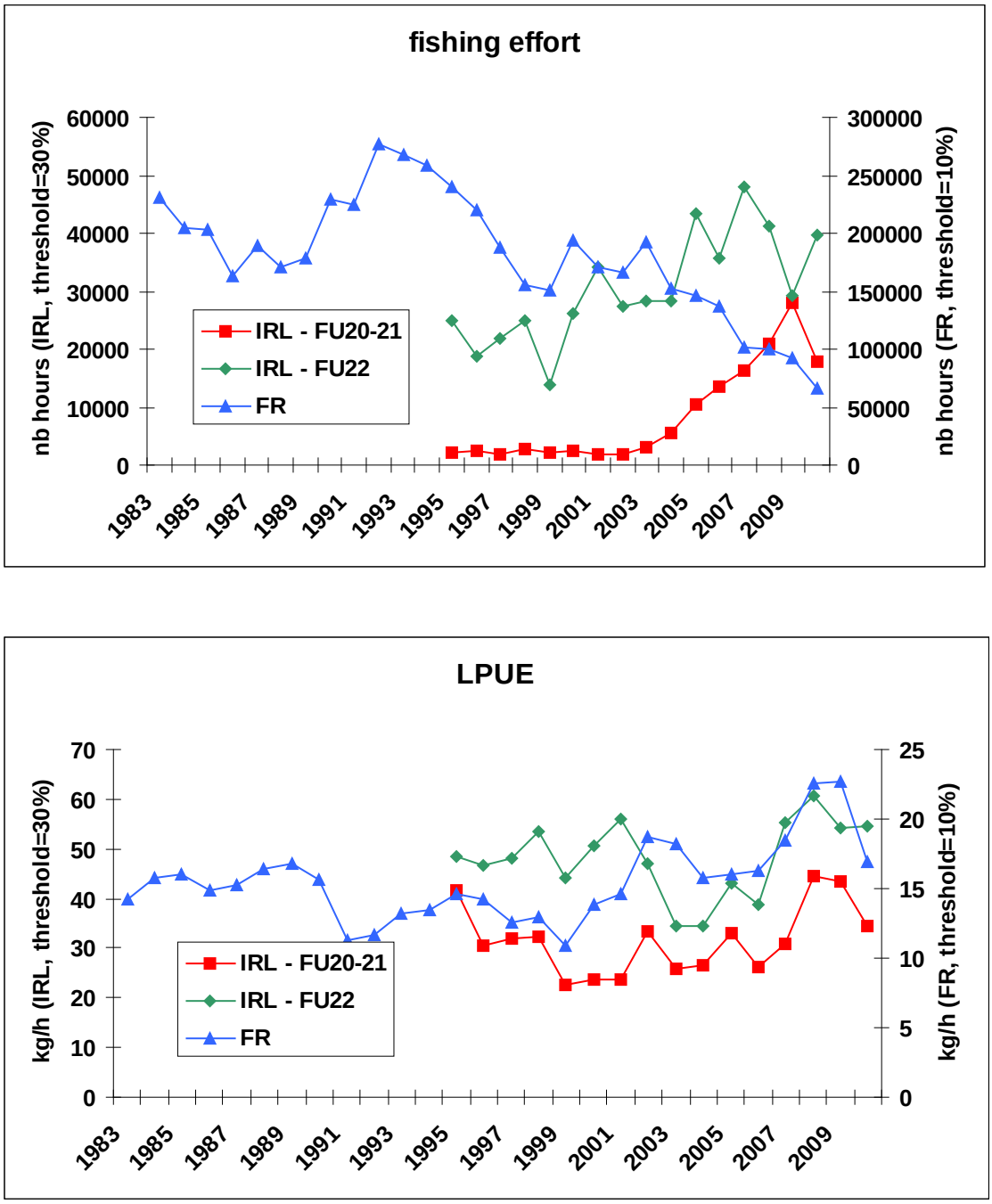


Figure 7.7.12. *Nephrops* **in VIIfgh (Celtic Sea, FU20–22). Lpue and fishing effort-series for French and Irish (inside and outside Smalls ground, FU22) fleets.**

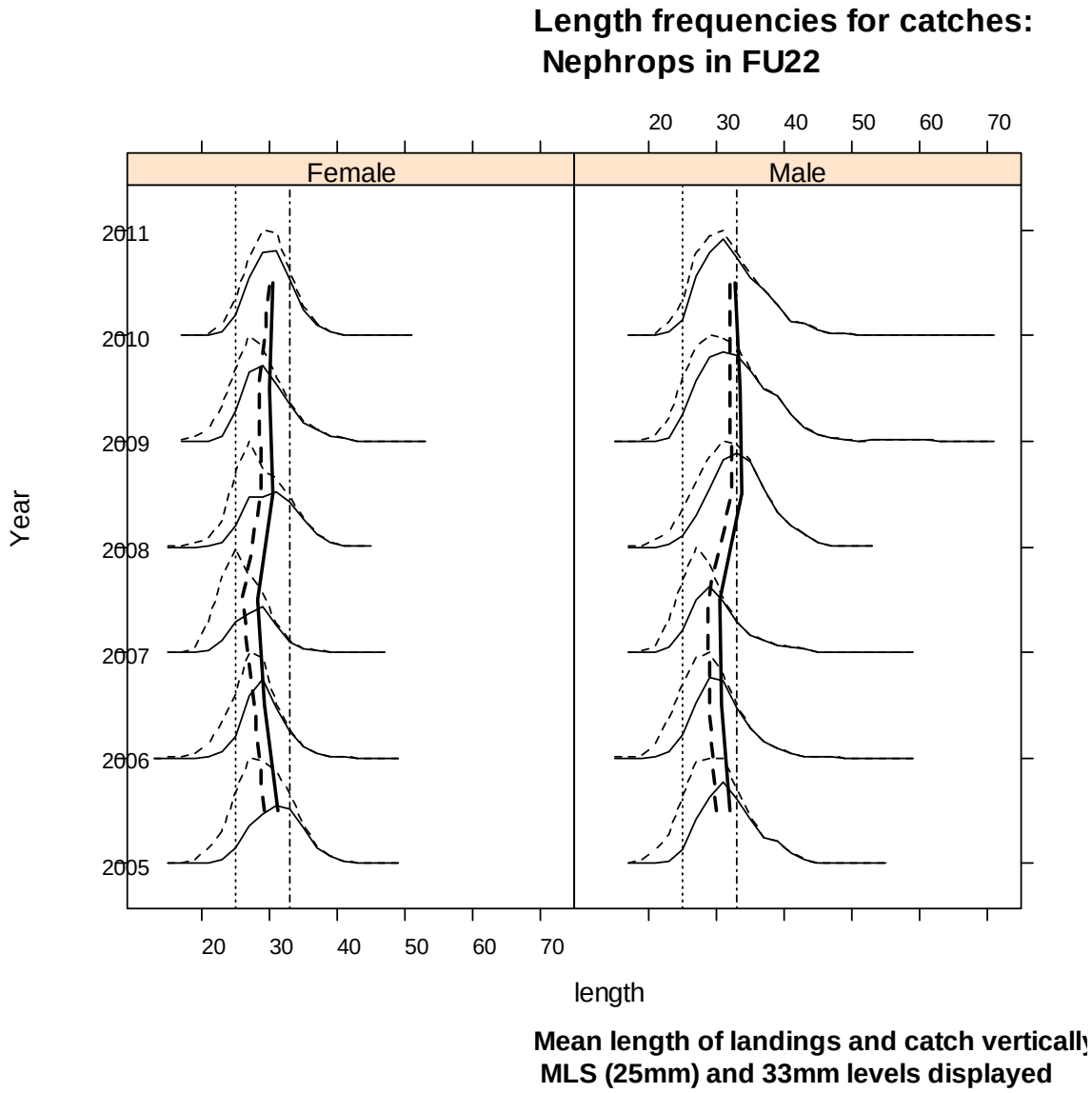


Figure 7.7.13. ***Nephrops*** **in the Smalls FU22. Female and Male landings length distributions for landings (solid line) and discards (dotted line) base on Irish sampling.**

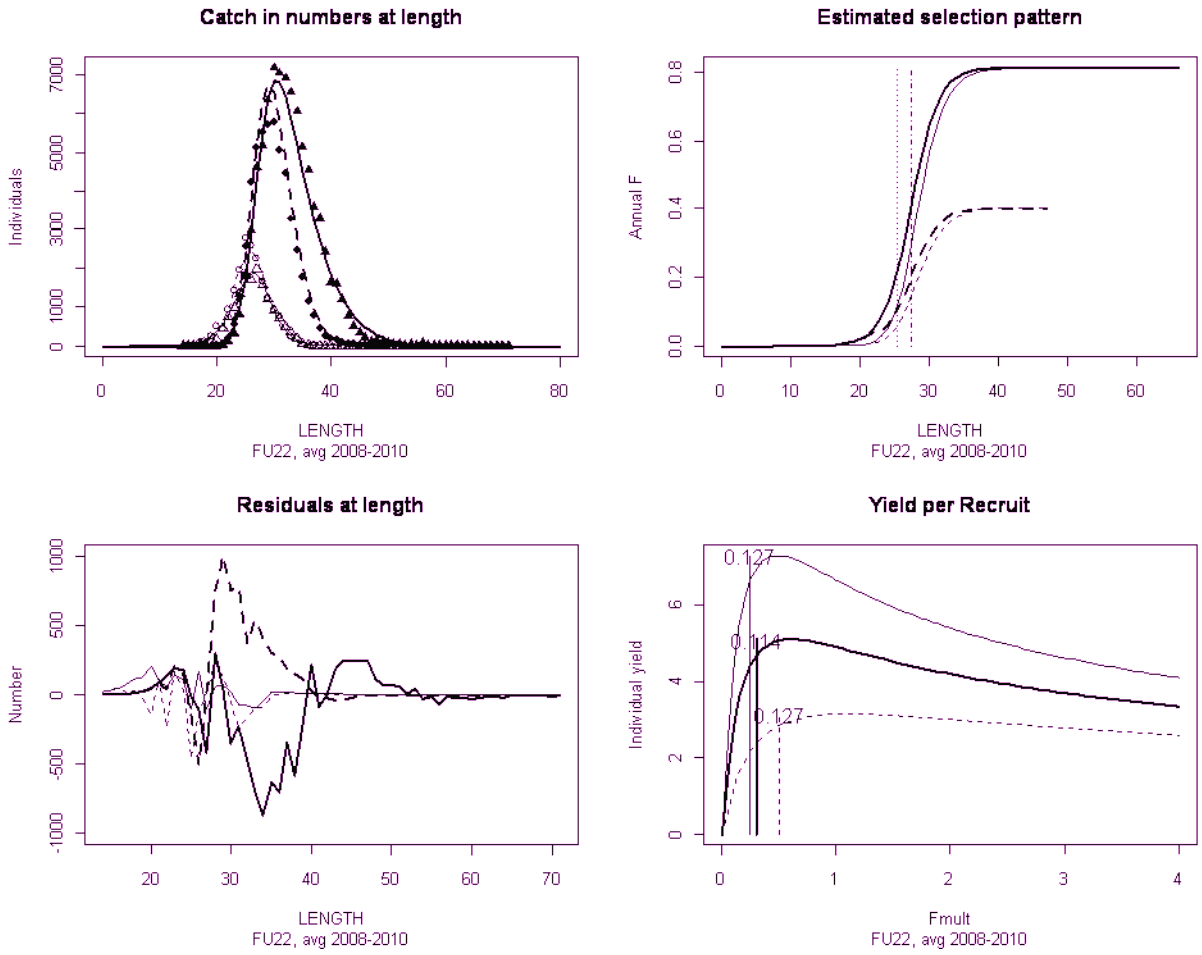


Figure 7.7.14. ***Nephrops*** **in the Smalls FU22. Separable Cohort Analysis model fit. Solid lines are for males, dashed lines are females, thick lines represent the landings component, the thin lines represent the discarded component. The top left panel gives observed and predicted numbers-at-length 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.**

7.8 *Nephrops* in Divisions VIIjg (South and SW Ireland, FU19)

Type of assessment in 2011

ICES is providing new advice for this stock this year so the Report consists of an update to available data.

ICES advice applicable to 2010

Exploitation boundaries in relation to precautionary limits/considerations

The current fishery appears sustainable. Therefore, ICES recommends that Nephrops fisheries should not be allowed to increase relative to 2007. This corresponds to landings of no more than 800 tonnes for the Ireland SW and SE Coast (FU 19).

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.

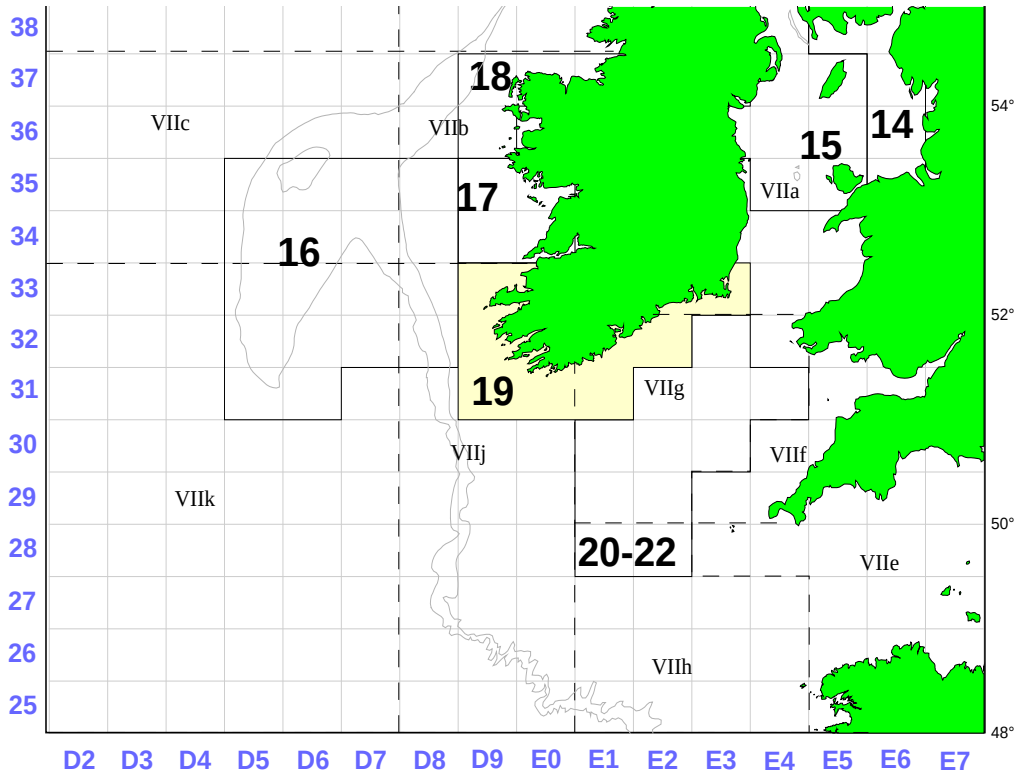
Policy paper

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.

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', around the Kinsale Gas Rigs and south of Cork appear to be the most important.



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.

7.8.2 Fishery description

The number of Irish vessels reporting landings in this area has increased from 28 in 2000 to 76 in 2010. Of these, only 16 reported landings in excess of 10 t and these 16 vessels accounted for 66% of the total landings. Fleet segmentation data shows that the *Nephrops* métiers in this area also have important catches of megrim and monk-fish. There are also some catches of hake and 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) 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) may shift DLF for *Nephrops* to smaller sizes compared with previous years. In 2010, twelve French trawlers reported landings from FU19, but only one exceeded 5 tonnes (20 in 2009, 24 in 2008, 31 in 2007, 30 in 2006 and 35 in 2005).

7.8.3 Data

The sampling level for the species is given in Table 2.1.

7.8.4 Commercial catches and discards

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 (Fig-

ure 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 2010 landings decreased by approx. 13% 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 5 t in 2010. Landings from the UK are minor.

Effort and lpue data are available for the Irish *Nephrops* directed fleet in FU19 from 1995–2010 (Table 7.8.2, Figure 7.8.3). The effort increases substantially in 2002 this is in part due to the inclusion of smaller vessels (10–18 m) in the dataset. These vessels did not record logbook operations prior 2002. The lpue and effort-series is based on the same criteria for FU16 and 17 (30% landings threshold) and will be contingent on the accuracy of landings data reported in logbooks. The lpues have fluctuated between 15–30 kg/hr with a slightly declining trend. The lpues are lower than that of other FUs reflecting the smaller size of the vessels and generally more mixed nature of this fishery.

For FU18 landings information from 1993 was available to the WG only. 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 (7 t in 2010).

7.8.5 Biological sampling

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.

The dataseries of the mean sizes of *Nephrops* in the landings of Irish trawlers is too short and inconsistent to draw definite conclusions (Table 7.8.3; Figure 7.8.4). The mean size of males varied between 29 and 41 mm CL, and for females between 26 and 40 mm CL. There is a decrease in mean size for males in 2010. However, the dataseries are too short to provide useful information on the state of the stock.

It should be noted that due to the change in sampling methodology from 2001 onwards the profile of the length frequencies has changed as a result of inclusion of smaller individuals from the discard component.

7.8.6 Information from surveys

The UK March groundfish survey has been carried between 1984 and 2004. This survey was examined in 2006 and there is a slight indication of a decline in mean sizes of *Nephrops* compared with those observed in the late 1980s. In 2006 some UWTV stations were carried out within FU19 as part of the Celtic Sea UWTV survey (which mainly targets FU20–22). The heterogeneous distribution of *Nephrops* and sediment in FU19 will make accurate UWTV survey abundance estimate difficult to obtain on a regular basis.

7.8.7 Assessment

A much improved and longer historical time-series of data is needed to carry out analytical assessment of this stock. Although sampling of this stock is required under the EU data collection regulation it is difficult to obtain precise length frequency data at

the spatial resolution required to assess *Nephrops* in such a heterogeneous area where several small discrete fisheries occur. Future assessments would benefit from a higher spatial resolution of landings and effort data (possibly from VMS as in Figure 7.8.1). Fishery-independent methods such as UWTV surveys may also be useful for this FU in future.

7.8.8 Management considerations

The time-series of lpue data based on logbook data for FU19 is short and variable but is without an obvious trend. Reported landings in 2010 have been around 18% below series average.

Nephrops fisheries in this area are fairly mixed also catching megrim, anglerfish and other demersal species. There are also some catches of hake, and 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).

ICES has repeatedly advised that management should be at a smaller scale than 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. A time-series of landings by all FUs in ICES Subarea VII together with the overall TAC is shown in Table 7.8.4. (Note that national quotas for Ireland and the UK are restrictive in most of the recent years).

7.8.9 References

ICES. 2009. Review of the Biologically Sensitive Area/Irish Box. http://www.ices.dk/committe/acom/comwork/report/2009/Special%20Requests/EC%20Irish%20box.pdf.

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

Table 7.8.2. *Nephrops* in FU19 (SW and SE Ireland). Irish *Nephrops* directed effort hrs and lpue, 1993–2010.

Year	Irish Fleet		
	Nephrops trawlers (>30% landings weight)		
	Effort hrs	Landings Tonnes	LPUE Kg/hr
1995	9126	206	22.5
1996	9295	220	23.7
1997	9604	248	25.8
1998	15775	386	24.5
1999	13345	206	15.4
2000	9329	178	19.1
2001	9701	309	31.8
2002	25565	764	29.9
2003	28887	621	21.5
2004	26554	529	19.9
2005	23848	455	19.1
2006	24272	460	19.0
2007	30361	665	21.9
2008	25101	573	22.8
2009	22797	527	23.1
2010	23650	467	19.7

Table 7.8.3. *Nephrops* in FU19 (SW and SE Ireland). Mean time-series for catches and landings.

Year	Catches		Landings <35mm CL		Landings >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

na = not available

Table 7.8.4. ***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
Average	611	8241	2191	631	24	846	4322	270	16 171	

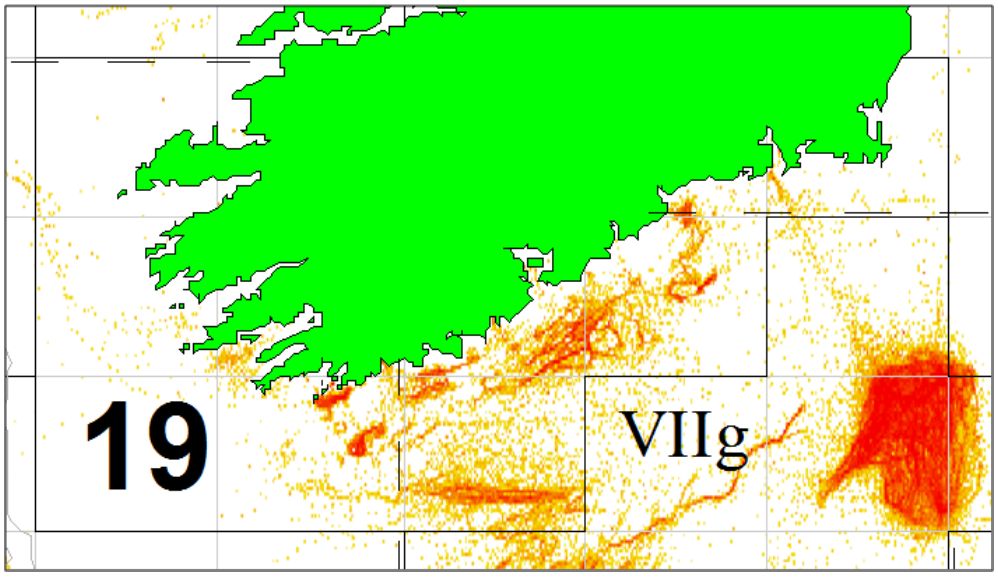


Figure 7.8.1. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). The spatial distribution of the fishery of the Irish Fishery from VMS data.**

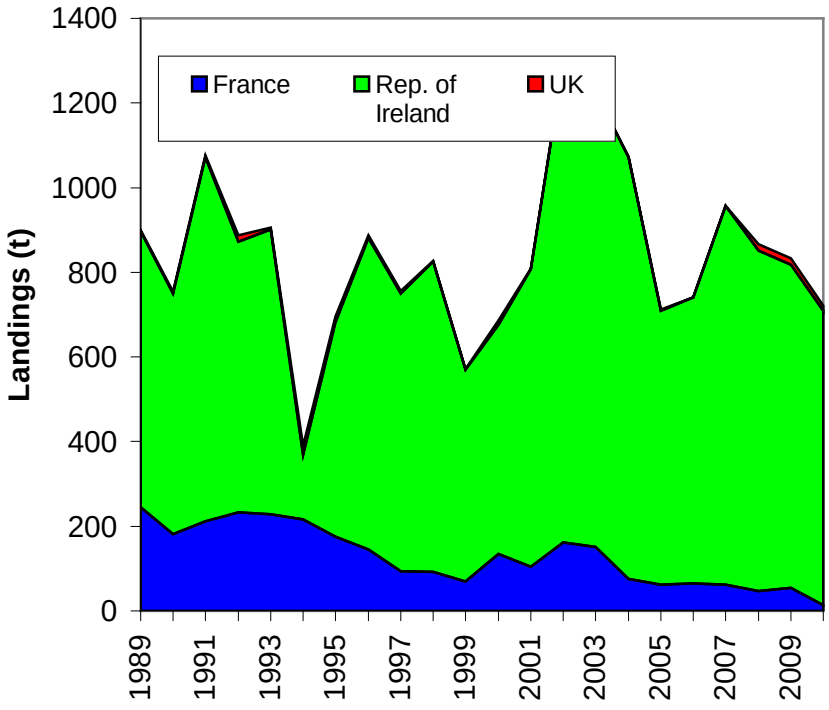


Figure 7.8.2. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Landings in tonnes by country.**

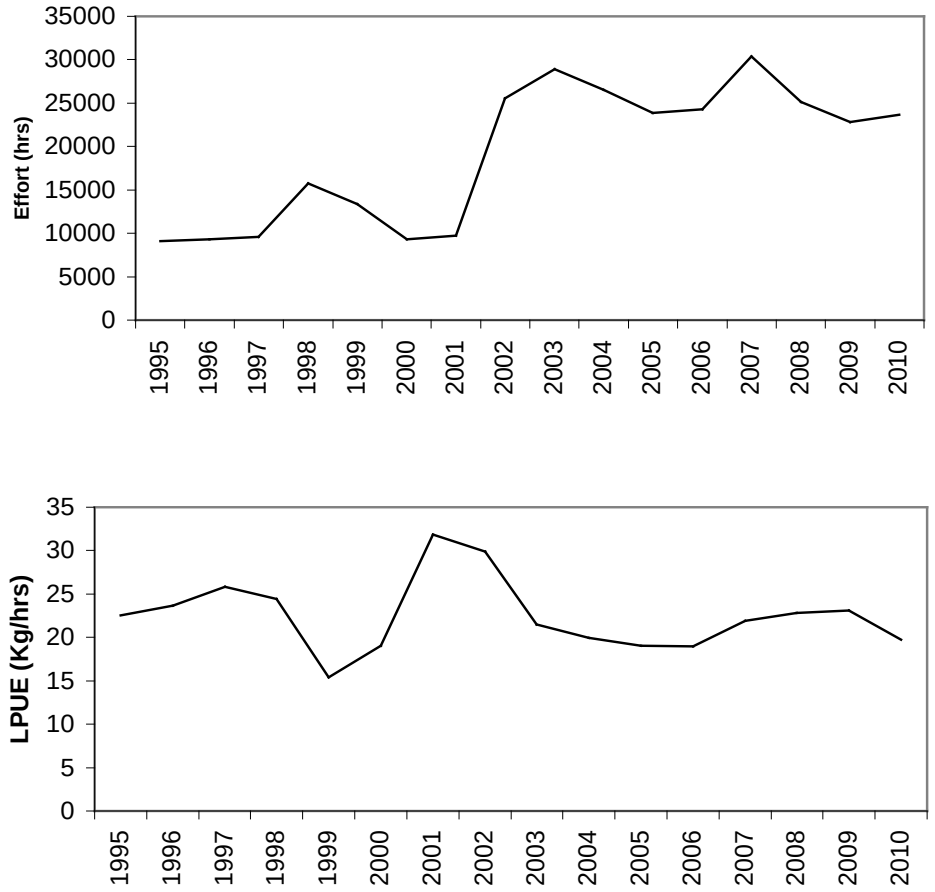


Figure 7.8.3. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Trawl effort for Irish OTB vessels where >30% of landed weight was** ***Nephrops*****. Trawl lpue for Irish OTB vessels where >30% of landed weight was** ***Nephrops*****.**

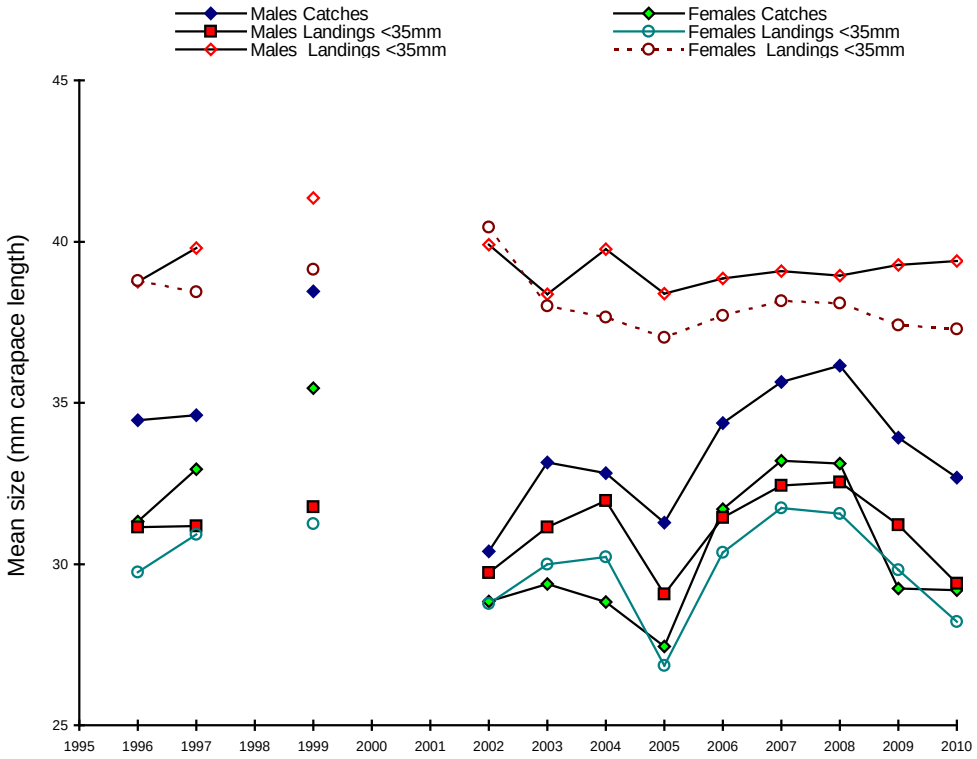


Figure 7.8.4. ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean size trends for catches and whole landings by sex.**

7.9 Plaice in west of Ireland Division VII b, c

Type of assessment in 2011

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 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. 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.

7.9.2 Data

The nominal landings are given in Table 7.9.1.

Table 7.9.1. Landings of plaice in VIIbc as officially reported to ICES.

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Denmark	-	-	-	-	-	-	2	-	-	-	-	-	-
France	60	45	10	9	4	16	6	12	9	8.00	37	2	10
Ireland	124	106	153	133	135	122	117	142	135	122	108	110	150
Spain	-	-	-	-	-	-	-	65	58	22	7	-	-
UK - Eng+Wales+N.Irl.	.	.	.	.	.	.	.	.	.	.	.	.	.
UK - England & Wales	1	1	-	-	-	-	-	-	4	4	-	3	7
UK - Scotland	-	-	-	-	-	-	-	-	-	-	-	3	-
Total	185	152	163	142	139	138	125	219	206	156	152	118	167

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	-	-	-	-	-	-	-	-	-	-	-	-	-
France	11	13	9	1	11	9	3	2	1	5	1	3	-
Ireland	114	153	157	159	130	179	180	191	200	239	248	206	160
Spain	-	-	-	-	-	-	-	-	-	-	-	-	-
UK - Eng+Wales+N.Irl.	.	.	.	1	2	-	6	1	2	1	2	-	1
UK - England & Wales	5	1	2	.	.	.	.	.	.	.	.	.	.
UK - Scotland	-	-	-	13	90	3	3	2	3	1	-	-	-
Total	130	167	168	174	233	191	192	196	206	246	251	209	161

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Denmark	-	-	-	-								
France	.	31	8	17	7	14	12	11	12	9	7	6
Ireland	157	99	70	51	56	39	25	20	23	21	45	27
Spain	-	-	-	2				1		1		
UK - Eng+Wales+N.Irl.	-	-	-	2		0	0	0				
UK - England & Wales	.	.	.	.								
UK - Scotland	2	-	-	-	0							
Total	159	130	78	72	63	53	37	31.6	35.3	31	52	33

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 ICES WKFLAT (2011) benchmark meeting to a revised assessment data structure which includes estimates of discards-at-age.

ICES advice applicable to 2010

ICES advises on the basis of exploitation boundaries in relation to precautionary considerations that a 50% reduction in F is needed to increase SSB to around Bpa in 2011. This corresponds to landings of less than 330 t in 2010.

ICES advice applicable to 2011

In the advice for 2011, the stock status was presented as follows:

Fishing mortality	2007	2008	2009
F_{MSY}	Above	Above	Above
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}	Below	Below	Between

MSY approach

Following the ICES MSY framework implies fishing mortality to be reduced to 0.14 (25% lower than F_{MSY} because SSB is 25% below $B_{trigger}$), resulting in landings of 210 t in 2011. This is expected to lead to an SSB of 1700 t in 2012.

*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.*

PA approach

Fishing mortality in 2011 should be no more than 0.10 corresponding to landings of less than 150 t in 2011. This is expected to bring SSB above B_{pa} 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 2010 and 2011

TACs and quotas set for 2010 (source COUNCIL REGULATION (EU) No 23/2010).

Species: Plaice *Pleuronectes platessa,* Zone: VIIf and VIIg (PLE/7FG.)

Belgium	67
France	120
Ireland	201

UK	63
Total EU	451
Total TAC	451

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
UK	53
Total EU	410
Total TAC	410

Fishery in 2010

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 2009 official statistics from France were not available; of the landings reported Belgium reported 58%, the UK 15% and Ireland 17%. In 2010 France reported 31% of the landings, Belgium 43%, the UK 12% and Ireland 14%. The WG estimated total international landings for 2010 were 433 t, below the TAC of 451 t.

Discards are a significant component of the catch and have been raised for the international fishery for the first time in this year's assessment of the stock status; the time-series is available from 2004–2010. In recent years the proportion that discards contribute to the total catch has been increasing and since 2006 they have exceeded the landings. Although the current assessment indicates a gradual decline in fishing mortality in recent years, it is unclear as to whether this is linked to the Trevose Head spring fishery closure.

7.10.2 Data

Landings

National landings data and estimates of total landings used by the WG are given in Table 7.10.1. Revisions to French landings (previously estimated) were reported for 2009.

Discards

Prior to 2010 indications were that discard rates, although variable, were substantial in some fleets/periods. At ICES WKFLAT (2010) meeting discard data from the countries participating in the fishery was raised and collated to the total international level for the years 2004–2010.

Discard information was available for Belgium and UK(E+W). The UK estimates were raised to incorporate equivalent levels of discards for the 'un-sampled' 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. The total estimates (Table 7.10.1) confirm the perception of the significant level of discarding; discards have therefore been 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, 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. Data from national discard sampling programmes are summarized in Figures 7.10.3a–c.

Biological information

Following minor revisions to landings data for previous years (described previously), the international age compositions and landings weights-at-age have been amended.

Quarterly age compositions for 2010 were available for Belgium, Ireland and UK(E+W), representing approximately 69% 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 (2004–2010) 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 were available for Belgium and UK(E+W). UK weight-at-age data were derived from data collected for each year from 2002–2010. Belgian weight-at-age data were derived using estimates of total catch biomass and total numbers-at-age for years 2004–2010; the values were used to derive a weight-at-age matrix in grammes for an individual fish. The two national weight-at-age matrices were averaged to a total international estimates 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 2004–2010 for which discard estimates were 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) are 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 (BTS-Q3) beam trawl survey in VIIf and the Irish Celtic Explorer IBTS survey (IBTS-EA-4Q) are presented in Table 7.10.10. The UK(E&W) data indicate relatively strong 1994 and 1999 year classes. There is and indication at age 1 of a stronger year class entering the fishery but survey data at this age tend to be noisy.

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 cpue

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 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 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, 3, 4 and Figures 7.10.1 and 7.10.2).

Commercial lpue data show a general pattern of steep decline since the high levels in the early 1990s, with a further more gradual decline in recent years. There was an increase in 2007 and 2008 for beam trawlers in VIIf and a smaller increase in 2007 and 2008 for otter trawlers in VIIg east but the levels returned to the recent low levels in 2009 and 2010.

UK(E&W) beam trawl effort levels have declined in both VIIf and VIIg from the high levels observed in 1999–2001; effort in VIIf in 2008 was at the lowest level since 1984. 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 trend since 2003.

Other relevant data

Other than the rectangle closures, there were no early closures of the fishery for plaice in 2010. There is relatively little information on the level of landings misreport-

ing 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

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).

The AP statistical catch-at-age model allows for four types of discard selectivity pattern. Discard selectivity can be modelled as a linear function of age and or as a more flexible function of age. Two functions allow the landings and discard proportions to change in time. Although a good start, the AP model is not considered the definitive assessment structure for the Celtic 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 as time invariant (having similar rates to those estimated for the period for which discard data are available) or using a time variant spline. Given that the spline extrapolates beyond the range of the recent data to which it is fitted it can potentially result in spurious estimates of historic discarding, which may change markedly as new discard data are added to the short time-series. In addition, it is highly likely that the discard patterns currently observed differ from those that would have been observed historically as a result of substantial changes in the composition of the gear types that have been used to prosecute the fisheries in which plaice is caught. A model which incorporates estimates of historic discards that are derived from the proportional allocation of the effort deployed by the dominant gear types is considered more appropriate in the long term.

Ideally the model with the lowest AIC would be retained for further analysis and inference of the population and fishery trends, however, the different model structures resulted in very similar fits to the data and therefore selection between the models was made on the basis of residual patterns and the perceived realism of estimated time-series of the changes in discard and landings selectivity-at-age and through time.

Models which consider the discard selection pattern to be constant in time were rejected. Discarding patterns are known to have changed as the types of gear used in the fishery have evolved. The TV_TVS model which fits a time variant selection pattern to the landings and a time variant spline for the discard selection resulted in the lowest AIC value for all of the model fits. However, examination of the fitted selection patterns established that the improvement in the fit resulted from estimates of selection at age seven that increased historically in time, independent of the adjacent ages; consequently this model was rejected as a plausible fit to the data. The remaining three models (TI_PTVS, TI_TVS and TV_PTVS), all had very similar fits in terms of the residual patterns in the fits to the data and therefore WKFLAT (2011) agreed 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.

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 remaining 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	191.85	561.71	89	488
TI	TVS	196.15	562.29	85	488
TV	PTVS	190.42	566.83	93	488

Consistent with the WKFLAT (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. 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 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 reasonable fits. 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 model. In all model fits SSB has increased to the level at the start of the assessment time-series and total fishing mortality is gradually decreasing. The management advice that would be derived from all model fits would be similar.

Final assessment

The settings and data for the model fits are set out in the table below:

Assessment year		2011
Assessment model		AP
Catch data		Including discards 1990–2010
Tuning fleets	UK(E&W)-BTSurvey	1990–2010 ages 1–6
	UK commercial beam trawl	1990–2010 ages 4–8
	UK commercial otter trawl	1990–2010 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		2004–2010, ages 1–7

Model diagnostics are given in Table 7.10.12. 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 (Figure a); the estimated relative selection pattern (Figure b), the log survey (Figure c) and commercial fleet catchability residuals (Figures d and e) and the log residuals for the discard-at-age and landings-at-age data (Figure f). Figure 7.10.11 presents the time-series of stock and fishery metrics for the years 1997–2010 to which the model can be fitted. 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 and total fishing mortality is gradually decreasing. 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 (~60% by weight). There are indications that the most recent recruitment is strong, possibly the strongest in the short time-series.

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 2.1.

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 were available in a suitable form for the raising of the data to the international level.

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 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 7.10.12) 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 are 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 decreasing and is likely to be above the levels that would lead to high levels of biomass and yield.

The high level of discarding indicated for some fleets in this fishery indicates 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.

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 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						
Belgium	214	196	171	372						
UK (Engl. & Wales)	150	152	176	227						
France	365	527	467	706						
Ireland	28	0	49	61						
Scotland	0	0	0	7			N/A	Not available		
Total	757	875	863	1373						
Discards	N/A	N/A	N/A	N/A						
Unallocated	0	0	0	0						
Landings used by WG	757	875	863	1373						
Catch as used by WG	N/A	N/A	N/A	N/A						

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Belgium	365	341	314	283	357	665	581	617	843	794
UK (Engl. & Wales)	251	196	279	366	466	529	496	629	471	497
France	697	568	532	558	493	878	708	721	1089	767
Ireland	64	198	48	72	91	302	127	226	180	160
N. Ireland								1		
Netherlands						9				
Scotland	0	0	0	0	0	1				1
Total	1377	1303	1173	1279	1407	2384	1912	2194	2583	2219
Discards	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Unallocated	0	0	-27	-69	345	-693	-11	-78	-432	-137
Landings used by WG	1377	1303	1146	1210	1752	1691	1901	2116	2151	2082
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

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Belgium	836	371	542	350	346	410	594	540	371	224
UK (Engl. & Wales)	392	302	290	251	284	239	258	176	170	134
France	444	504	373	298	254	246	329	298		287
Ireland	155	180	89	82	70	83	78	135	115	76
Scotland		5	9	1	2					
Total reported	1827	1362	1303	982	956	978	1259	1149	656	721
Discards	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Unallocated	-326	-174	-189	88	72	-26	-42	-82	312	-3
Landings used by WG	1501	1188	1114	1070	1028	952	1217	1067	968	718
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

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	241	248	221	212	168	172	194	187	216	188
UK (Engl. & Wales)	136	105	127	87	55	88	61	63	55	54
France	262	186	165	145	132	106	104	62	N/A	136
Ireland	45	79	51	45	44	48	58	63	63	63
Total reported	684	618	564	489	399	414	417	375	N/A	442
Discards	N/A	N/A	N/A	247	309	451	1283	580	604	700
Unallocated	30	24	30	21	-13	-10	-7	62	N/A	-9
Landings used by WG	714	642	594	510	386	404	410	437	463	433
Catch as used by WG	N/A	N/A	N/A	757	695	855	1693	1017	1067	1133

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 VIIf (grp 1)		RECT. GROUP VIIg EAST (grp 2)		RECT. GROUP VIIg WEST (grp 3)		RECT GROUP VIIf (grp1)				VIIg (East)		VIIg (West)	
							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	7.62	19.63	14.44	1.19	4.47	7.43	1.62

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

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

	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

Table 7.10.5. Plaice in Divisions VIIf&g: Landings numbers-at-age.

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

Landings numbers at age Numbers*10**-3

AGE\YEAR	1977	1978	1979	1980
1	0	0	0	0
2	989	851	877	1921
3	426	903	673	1207
4	411	291	638	658
5	105	136	72	146
6	72	76	70	21
7	37	47	34	16
8	59	23	8	16
+gp	75	98	46	32
TOTALNUM	2175	2426	2419	4018

AGE\YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0	0	0	0	0	0	0	0	0	0
2	822	300	750	704	1461	703	434	967	797	164
3	2111	1180	560	918	2503	2595	1883	2099	3550	2078
4	681	955	827	343	393	1332	1812	1568	1807	2427
5	109	443	372	373	102	156	772	612	741	655
6	54	86	92	209	177	59	156	413	160	242
7	53	51	44	70	62	48	22	65	98	86
8	11	14	27	41	25	32	125	16	24	70
+gp	44	60	23	42	38	24	76	73	23	46
TOTALNUM	3886	3090	2696	2701	4762	4950	5281	5814	7201	5769

AGE\YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0	0	25	100	43	0	8	17	22	19
2	279	800	1019	428	488	812	420	426	243	320
3	1072	526	1179	936	572	734	1318	921	982	606
4	1193	357	284	730	743	515	929	849	802	482
5	578	471	139	164	334	219	272	287	372	203
6	179	275	185	117	117	137	121	96	116	145
7	94	80	115	86	57	59	60	82	45	53
8	78	21	62	92	48	37	20	39	27	22
+gp	79	96	59	65	132	96	82	56	69	32
TOTALNUM	3553	2627	3066	2716	2534	2609	3231	2773	2678	1881

AGE\YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	75	3	15	6	24	12	8	15	2	0
2	651	170	239	126	201	331	130	270	127	134
3	371	661	571	578	327	458	513	341	626	224
4	323	543	465	428	265	140	340	443	345	428
5	199	183	150	261	134	134	104	145	273	189
6	108	113	85	46	73	76	76	47	68	150
7	62	65	34	27	24	50	46	29	20	44
8	23	24	26	15	14	12	26	11	10	8
+gp	28	28	24	17	16	15	13	15	12	8
TOTALNUM	1838	1789	1608	1504	1078	1229	1257	1315	1485	1187

Table 7.10.6. Plaice in Divisions VIIf&g: Landings weights-at-age.

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

Landings weights at age (kg)

AGE\YEAR	1977	1978	1979	1980
1	0.078	0.194	0.076	0.118
2	0.205	0.258	0.203	0.238
3	0.323	0.323	0.325	0.354
4	0.43	0.389	0.44	0.467
5	0.528	0.457	0.55	0.576
6	0.615	0.525	0.652	0.682
7	0.693	0.595	0.749	0.784
8	0.76	0.666	0.839	0.882
+gp	0.8762	0.8435	1.0653	1.1812
SOPCOFAC	1.0052	1.0262	1.0225	1.0135

AGE\YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.185	0.151	0.178	0.276	0.135	0	0.129	0.26	0.102	0.24
2	0.255	0.245	0.274	0.324	0.251	0.16	0.208	0.288	0.176	0.27
3	0.33	0.339	0.369	0.384	0.363	0.301	0.288	0.325	0.255	0.309
4	0.412	0.433	0.464	0.455	0.47	0.434	0.368	0.37	0.337	0.358
5	0.5	0.526	0.559	0.538	0.572	0.559	0.449	0.423	0.423	0.416
6	0.595	0.62	0.654	0.633	0.67	0.677	0.53	0.484	0.514	0.483
7	0.695	0.714	0.749	0.739	0.763	0.787	0.612	0.554	0.608	0.56
8	0.802	0.808	0.844	0.857	0.851	0.889	0.694	0.633	0.706	0.646
+gp	1.1824	1.0948	1.1579	1.2661	1.0036	1.1033	0.8632	0.8887	0.9932	0.9097
SOPCOFAC	1.0042	1.0125	0.9995	1	1.0047	0.9997	1.0034	1.0024	1.0006	1.0009

AGE\YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.2	0.148	0.171	0.236	0.219	0	0.249	0.213	0.213	0.245
2	0.26	0.257	0.263	0.296	0.254	0.247	0.291	0.256	0.268	0.26
3	0.327	0.362	0.314	0.308	0.304	0.295	0.304	0.317	0.278	0.302
4	0.4	0.464	0.405	0.397	0.364	0.349	0.357	0.38	0.332	0.37
5	0.481	0.563	0.5	0.455	0.485	0.512	0.466	0.463	0.44	0.479
6	0.567	0.658	0.598	0.598	0.603	0.553	0.663	0.604	0.538	0.539
7	0.661	0.75	0.643	0.801	0.714	0.523	0.745	0.661	0.618	0.672
8	0.761	0.839	0.728	0.728	0.752	0.947	0.877	0.69	0.839	0.875
+gp	1.0465	1.0399	0.9886	0.9585	1.0655	1.0667	1.1007	1.1886	1.1906	1.2018
SOPCOFAC	1.0113	1.0022	0.9997	1.0001	1.0004	0.9998	1.0002	1.0009	1	1.0007

AGE\YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.268	0.246	0.205	0.221	0.237	0.238	0.278	0.26	0.279	0.233
2	0.305	0.284	0.295	0.258	0.26	0.246	0.271	0.273	0.267	0.292
3	0.34	0.281	0.321	0.287	0.295	0.291	0.277	0.298	0.275	0.331
4	0.398	0.343	0.353	0.33	0.356	0.339	0.303	0.329	0.329	0.329
5	0.466	0.433	0.439	0.382	0.425	0.385	0.389	0.386	0.376	0.376
6	0.556	0.484	0.502	0.514	0.525	0.513	0.457	0.433	0.469	0.459
7	0.675	0.541	0.651	0.649	0.631	0.549	0.537	0.511	0.499	0.599
8	0.695	0.859	0.681	0.75	0.714	0.638	0.547	0.719	0.605	0.472
+gp	1.0905	1.1262	1.0389	0.9919	1.0163	0.8369	0.9862	0.9042	0.7197	1.0441
SOPCOFAC	1.0007	1.0004	0.9994	1.0007	1.0011	1.0008	1.0005	1.0001	0.9993	1.0002

Table 7.10.7. Plaice in Divisions VIIf&g: Discard numbers-at-age.

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

Discard numbers at age Numbers*10**-3

AGE\YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0	0	0	448	536	542	1828	72	668	1504
2	0	0	0	327	1141	2584	3330	3580	982	2544
3	0	0	0	548	423	750	3408	630	2035	301
4	0	0	0	155	111	74	814	391	758	486
5	0	0	0	63	38	47	81	69	398	231
6	0	0	0	3	11	12	32	4	44	30
7	0	0	0	3	4	1	11	1	4	1
8	0	0	0	1	22	1	9	1	5	1
+gp	0	0	0	0	0	0	0	0	0	0
TOTALNUM	0	0	0	1548	2286	4011	9513	4748	4894	5098
TONSLAND	0	0	0	247	309	451	1283	580	604	700
SOPCOF %	0	0	0	100	100	100	100	100	100	100

Table 7.10.8. Plaice in Divisions VIIf&g: Discard weights-at-age.

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

Discardss weights at age (kg)

AGE\YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0	0	0	0.123	0.094	0.065	0.088	0.083	0.088	0.1
2	0	0	0	0.152	0.128	0.107	0.126	0.11	0.127	0.144
3	0	0	0	0.177	0.157	0.152	0.158	0.155	0.127	0.174
4	0	0	0	0.195	0.19	0.172	0.162	0.169	0.127	0.172
5	0	0	0	0.214	0.231	0.179	0.21	0.221	0.14	0.174
6	0	0	0	0.253	0.433	0.35	0.21	0.247	0.186	0.206
7	0	0	0	0.133	0.634	0.35	0.414	0.2	0.182	0.267
8	0	0	0	0	0.418	0	0.437	0.217	0.2	0.221
+gp	0	0	0	0	0	0	0	0	0	0

Table 7.10.9. Plaice in Divisions VIIf&g: Stock weights-at-age.

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

Stock weights at age (kg)

YEAR	1977	1978	1979	1980
1	0.112	0.086	0.107	0.109
2	0.216	0.170	0.212	0.217
3	0.315	0.252	0.313	0.322
4	0.406	0.334	0.412	0.426
5	0.492	0.414	0.507	0.528
6	0.570	0.493	0.599	0.628
7	0.642	0.570	0.689	0.727
8	0.707	0.646	0.775	0.823
+gp	0.839	0.822	1.015	1.132

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.082	0.096	0.103	0.256	0.075	0.000	0.089	0.249	0.066	0.228
2	0.167	0.192	0.206	0.298	0.193	0.087	0.168	0.273	0.139	0.254
3	0.257	0.288	0.307	0.352	0.307	0.232	0.248	0.305	0.215	0.288
4	0.350	0.383	0.408	0.418	0.417	0.369	0.328	0.346	0.295	0.332
5	0.447	0.479	0.507	0.495	0.521	0.498	0.408	0.395	0.380	0.386
6	0.548	0.574	0.606	0.584	0.621	0.619	0.489	0.453	0.468	0.448
7	0.653	0.668	0.704	0.685	0.717	0.733	0.571	0.518	0.560	0.520
8	0.762	0.763	0.801	0.797	0.808	0.839	0.653	0.593	0.657	0.602
+gp	1.129	1.049	1.114	1.190	0.965	1.064	0.822	0.837	0.938	0.854

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.173	0.092	0.171	0.236	0.219	0.000	0.249	0.213	0.213	0.245
2	0.229	0.203	0.263	0.296	0.254	0.247	0.291	0.256	0.268	0.260
3	0.293	0.310	0.314	0.308	0.304	0.295	0.304	0.317	0.278	0.302
4	0.363	0.414	0.405	0.397	0.364	0.349	0.357	0.380	0.332	0.370
5	0.440	0.514	0.500	0.455	0.485	0.512	0.466	0.463	0.440	0.479
6	0.523	0.611	0.598	0.598	0.603	0.553	0.663	0.604	0.538	0.539
7	0.613	0.705	0.643	0.801	0.714	0.523	0.745	0.661	0.618	0.672
8	0.710	0.795	0.728	0.728	0.752	0.947	0.877	0.690	0.839	0.875
+gp	0.987	1.000	0.989	0.959	1.066	1.067	1.101	1.189	1.191	1.202

YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.268	0.246	0.205	0.221	0.237	0.238	0.278	0.260	0.279	0.233
2	0.305	0.284	0.295	0.258	0.260	0.246	0.271	0.273	0.267	0.292
3	0.340	0.281	0.321	0.287	0.295	0.291	0.277	0.298	0.275	0.331
4	0.398	0.343	0.353	0.330	0.356	0.339	0.303	0.329	0.329	0.329
5	0.466	0.433	0.439	0.382	0.425	0.385	0.389	0.386	0.376	0.376
6	0.556	0.484	0.502	0.514	0.525	0.513	0.457	0.433	0.469	0.459
7	0.675	0.541	0.651	0.649	0.631	0.549	0.537	0.511	0.499	0.599
8	0.695	0.859	0.681	0.750	0.714	0.638	0.547	0.719	0.605	0.472
+gp	1.091	1.126	1.039	0.992	1.016	0.837	0.986	0.904	0.720	1.044

Table 7.10.10. Plaice in Divisions VIIf&g: Survey abundance indices (figures used in the assessment shown in bold).

```
IRGFS
2003 2010
1 1 0.79 0.92
2 7
832   45    84    37    8     3     1
980   6     31    51    20    13    1
845   63    83    19    9     3     3
1046  105   80    22    18    11    12
1168  51    166   68    22    9     8
1139  113   106   72    19    8     5
1018  199   548   247   100   21    16
1381  871   304   479   197   84    23
```

E+W BT Survey

1990 2010

1 1 0.75 0.85

0 10

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

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 2010
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

UK(E+W) OTTER TRAWL VIIF
1989 2010
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
```

Table 7.10.12. Plaice in Divisions VIIf&g: AP Model Diagnostics.

Sun May 15 18:52:11 2011	
SEL_MODEL	TV
DISC_MODEL	PTVS
firstoptMETHOD	SANN
mainMETHOD	BFGS
BFGS_MAXIT	1000
BFGS_RELTOL	1.00E-20
n.tries for uncertainty	1000
eigenvalues Hessian positive?	FALSE
negative log.likelihood	190.4164
AIC	566.8328
Nparameters	93
Nobservations	488
Final parameter values	
Ftrend 1	0.538249
Ftrend 2	0.675755
Ftrend 3	0.759486
Ftrend 4	0.734489
Ftrend 5	0.880095
Ftrend 6	0.830547
Ftrend 7	0.854852
Ftrend 8	0.785874
Ftrend 9	0.731393
Ftrend 10	0.857853
Ftrend 11	0.813121
Ftrend 12	0.825369
Ftrend 13	0.629245
Ftrend 14	0.620637
Ftrend 15	0.768152
Ftrend 16	0.524305
Ftrend 17	0.613731
Ftrend 18	0.626754
sel.C 1	-2.45892
sel.C 2	6.213888
sel.C 3	-1.77793
sel.C 4	1.478122
sel.C 5	0.058086
sel.C 6	-0.15398
sel.C 7	0.385898
sel.C 8	-0.25302

Table 7.10.12. Plaice in Divisions VIIf&g: AP Model Diagnostics.

logrecruitment 1	19.55866

logrecruitment 2	17.87203
logrecruitment 3	16.17875
logrecruitment 4	13.92387
logrecruitment 5	11.75304
logrecruitment 6	10.17994
logrecruitment 7	8.743988
logrecruitment 8	8.345533
logrecruitment 9	8.917262
logrecruitment 10	9.340562
logrecruitment 11	9.166612
logrecruitment 12	8.98295
logrecruitment 13	8.709882
logrecruitment 14	8.566078
logrecruitment 15	9.153922
logrecruitment 16	8.958794
logrecruitment 17	8.643788
logrecruitment 18	8.179628
logrecruitment 19	8.733661
logrecruitment 20	9.245807
logrecruitment 21	8.912797
logrecruitment 22	9.214311
logrecruitment 23	8.297601
logrecruitment 24	8.817198
logrecruitment 25	9.505879
Catchability1	-6.77021
Catchability2	-5.08736
Catchability3	-2.79867
sel.U 1	0.955221
sel.U 2	1.361871
sel.U 3	3.403979
sel.U 4	7.114822
sel.U 5	-1.70321
sel.U 6	-1.8111
sel.U 7	-1.67159
sel.U 8	-1.70573
sel.U 9	-5.36597
sel.U 10	-5.13736
sel.U 11	-6.60006
sel.U 12	-6.31946

Table 7.10.12. Plaice in Divisions VIIf&g: AP Model Diagnostics.

b1	3.677171
b2	0.358522
b3	-3.06563
b4	-2.68955
b5	0.19585
b6	-0.24288
b7	0.772269
b8	-0.09655
b9	-0.00304
b10	-0.00842
b11	-0.01607
b12	0.012851
sds.land1	-2.04448
sds.land2	-1.55056
sds.land3	2.55275
sds.disc1	-0.75546
sds.disc2	0.38436
sds.disc3	0.634873
sds.tun1	-2.02773
sds.tun2	0.765797
sds.tun3	1.195124
sds.tun4	-1.08616
sds.tun5	0.108301
sds.tun6	-0.07763
sds.tun7	-0.87227
sds.tun8	1.190155
sds.tun9	-0.00773

Table 7.10.13. Plaice in Divisions VIIf&g: Fishing Mortalities.

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

Total Fishing mortality at age

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.032	0.041	0.047	0.052	0.064	0.06	0.072	0.068	0.063	0.085	0.083	0.084	0.074	0.075	0.092	0.071	0.086
2	0.377	0.454	0.486	0.521	0.602	0.539	0.614	0.547	0.483	0.624	0.576	0.553	0.464	0.448	0.523	0.391	0.448
3	0.537	0.643	0.69	0.741	0.851	0.765	0.873	0.773	0.683	0.886	0.813	0.782	0.657	0.631	0.738	0.553	0.634
4	0.521	0.626	0.752	0.734	0.845	0.765	0.88	0.78	0.694	0.907	0.832	0.805	0.681	0.653	0.768	0.58	0.663
5	0.437	0.53	0.656	0.64	0.742	0.755	0.792	0.705	0.635	0.838	0.771	0.753	0.643	0.617	0.732	0.557	0.636
6	0.386	0.465	0.583	0.561	0.647	0.669	0.692	0.614	0.615	0.733	0.671	0.658	0.564	0.539	0.642	0.491	0.559
7	0.493	0.577	0.702	0.654	0.728	0.741	0.734	0.628	0.619	0.707	0.625	0.661	0.496	0.458	0.529	0.393	0.432
8	0.489	0.573	0.7	0.649	0.723	0.739	0.732	0.624	0.625	0.705	0.621	0.667	0.494	0.454	0.585	0.392	0.429
+gp	0.489	0.573	0.7	0.649	0.723	0.739	0.732	0.624	0.625	0.705	0.621	0.667	0.494	0.454	0.585	0.392	0.429
FBAR 3- 6	0.470	0.566	0.670	0.669	0.771	0.739	0.809	0.718	0.657	0.841	0.772	0.750	0.636	0.610	0.720	0.545	0.623

Discard Fishing mortality at age

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.027	0.036	0.042	0.048	0.060	0.057	0.069	0.066	0.061	0.083	0.081	0.083	0.073	0.074	0.091	0.070	0.085
2	0.262	0.332	0.371	0.412	0.490	0.449	0.521	0.472	0.422	0.551	0.513	0.496	0.419	0.406	0.475	0.356	0.408
3	0.122	0.176	0.223	0.276	0.359	0.358	0.446	0.425	0.399	0.545	0.521	0.518	0.447	0.438	0.519	0.393	0.453
4	0.016	0.027	0.045	0.059	0.088	0.103	0.149	0.161	0.172	0.263	0.278	0.304	0.285	0.298	0.377	0.303	0.364
5	0.002	0.006	0.011	0.015	0.023	0.032	0.046	0.054	0.063	0.106	0.123	0.146	0.150	0.172	0.236	0.206	0.266
6	0.005	0.009	0.012	0.015	0.016	0.026	0.025	0.031	0.038	0.049	0.059	0.069	0.071	0.079	0.113	0.100	0.134
7	0.154	0.145	0.140	0.109	0.096	0.084	0.061	0.055	0.046	0.047	0.041	0.038	0.020	0.021	0.024	0.027	0.018
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
+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
FBAR 3- 6	0.036	0.055	0.073	0.091	0.122	0.130	0.167	0.168	0.168	0.241	0.245	0.259	0.238	0.247	0.311	0.250	0.304

Landings Fishing mortality at age

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.005	0.005	0.005	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
2	0.115	0.122	0.115	0.109	0.112	0.090	0.093	0.075	0.061	0.073	0.063	0.057	0.045	0.042	0.048	0.035	0.040
3	0.415	0.467	0.467	0.465	0.492	0.407	0.427	0.348	0.284	0.341	0.292	0.264	0.210	0.193	0.219	0.160	0.181
4	0.505	0.599	0.707	0.675	0.757	0.662	0.731	0.619	0.522	0.644	0.554	0.501	0.396	0.355	0.391	0.277	0.299
5	0.435	0.524	0.645	0.625	0.719	0.723	0.746	0.651	0.572	0.732	0.648	0.607	0.493	0.445	0.496	0.351	0.370

Table 7.10.14. Plaice in Divisions VIIf&g: Population numbers.

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

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
1	4211	7460	11391	9572	7966	6063	5250	9451	7776	5675	3568	6208	10361	7426	10040	4014	6749
2	4836	3616	6348	9644	8056	6627	5062	4333	7833	6477	4622	2912	5064	8538	6113	8123	3316
3	3255	2942	2037	3464	5080	3915	3427	2429	2224	4288	3077	2304	1485	2825	4839	3214	4872
4	862	1688	1372	907	1464	1923	1616	1270	995	996	1568	1211	935	683	1334	2052	1639
5	528	454	801	573	386	558	793	594	516	441	357	606	480	420	315	549	1019
6	536	302	237	369	268	163	232	319	260	243	169	146	253	224	201	135	279
7	452	323	168	117	187	125	74	103	153	125	103	77	67	128	116	94	73
8	203	245	161	74	54	80	53	32	49	73	55	49	35	36	72	60	56
+gp	161	156	276	212	168	114	140	73	64	57	55	36	44	44	31	48	37
TOTAL	17037	19180	24786	26928	25626	21566	18646	20604	21871	20377	15577	15553	20729	22330	25068	20297	20049

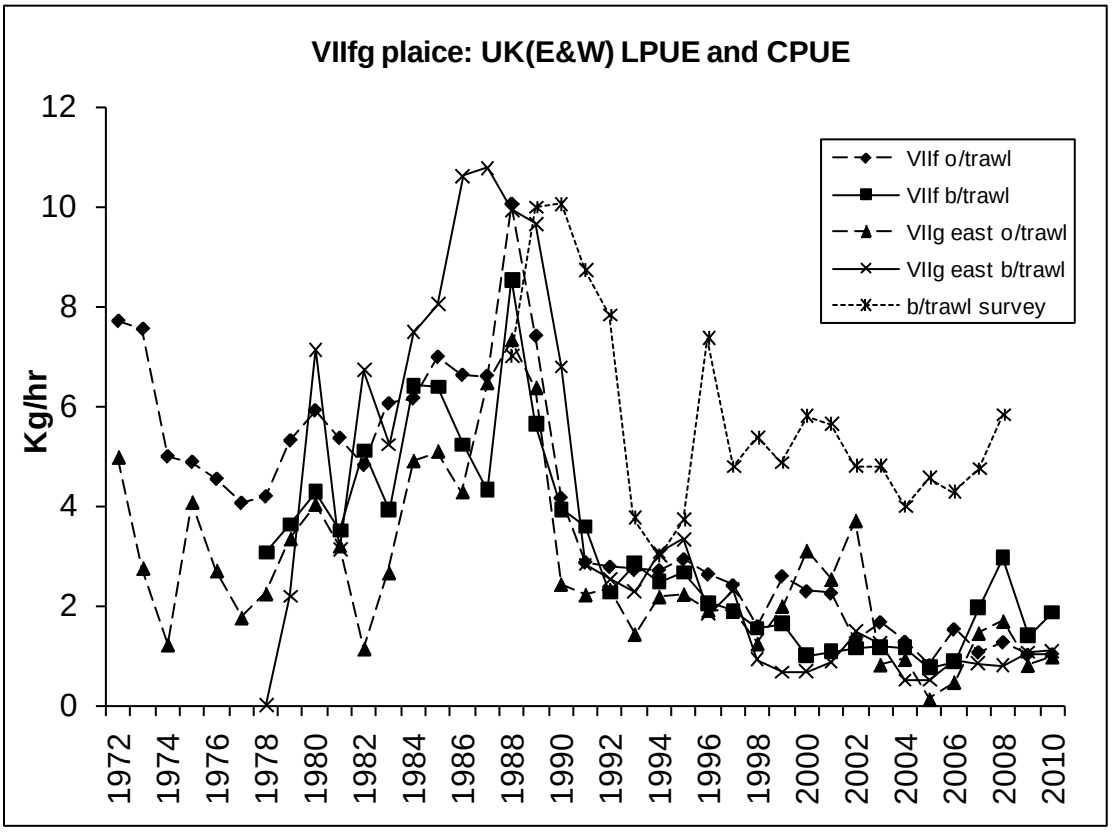
Table 7.10.15. Plaice in Divisions VIIf&g: Summary table.

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

Stock Summary

	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	1980.39	2181.33	2396.43	3568	4196	5032	740.14	861.97	985.61	134.59	204.20	292.58	0.413	0.472	0.530	0.434	0.036
1994	1947.14	2143.23	2334.54	6298	7437	8813	851.37	966.16	1099.67	146.12	214.64	312.07	0.501	0.565	0.636	0.511	0.055
1995	1775.97	1932.88	2098.32	9670	11447	13360	795.60	906.58	1025.53	235.08	328.31	456.29	0.593	0.669	0.752	0.598	0.073
1996	1866.62	2042.13	2231.41	8054	9578	11314	793.75	910.16	1029.43	391.70	530.26	693.73	0.598	0.667	0.750	0.578	0.091
1997	2161.93	2401.77	2642.64	6718	7942	9438	1013.77	1172.21	1328.67	443.73	607.29	796.11	0.691	0.771	0.855	0.650	0.122
1998	1986.95	2204.55	2416.43	5060	6075	7249	871.72	995.15	1123.91	363.45	478.77	631.10	0.668	0.741	0.821	0.609	0.130
1999	1691.68	1871.83	2045.99	4434	5248	6206	759.91	858.15	971.04	343.30	457.97	592.96	0.738	0.812	0.893	0.643	0.167
2000	1477.30	1624.08	1766.27	7923	9496	11196	580.04	657.14	737.43	289.85	383.33	497.49	0.640	0.719	0.804	0.550	0.168
2001	1686.40	1869.56	2065.22	6618	7807	9225	533.17	607.85	687.00	370.55	480.23	615.98	0.580	0.657	0.738	0.489	0.168
2002	1643.73	1831.06	2025.01	4858	5685	6691	607.60	690.78	783.77	496.01	635.10	795.54	0.761	0.843	0.933	0.600	0.241
2003	1525.00	1682.98	1858.90	3096	3567	4140	516.54	590.74	665.69	369.14	464.43	581.13	0.688	0.774	0.866	0.526	0.245
2004	1173.13	1266.77	1384.42	5422	6194	7044	386.68	439.07	496.05	343.87	419.40	522.80	0.672	0.752	0.846	0.490	0.259
2005	1164.56	1251.07	1346.91	9119	10368	11776	304.53	340.68	383.35	327.51	394.65	480.15	0.570	0.637	0.718	0.398	0.238
2006	1412.91	1532.56	1666.71	6438	7453	8651	314.59	355.37	402.09	415.06	486.11	579.14	0.547	0.611	0.690	0.363	0.247
2007	1633.52	1779.23	1956.86	8550	10073	12155	413.47	472.54	535.54	572.63	679.78	811.39	0.641	0.721	0.804	0.409	0.311
2008	1828.64	2013.01	2211.63	3160	4039	5195	355.52	404.27	461.00	422.12	510.12	621.41	0.487	0.546	0.622	0.295	0.250
2009	1779.19	1972.76	2194.49	4877	6715	9324	413.51	469.68	528.92	375.97	461.47	570.82	0.546	0.620	0.717	0.319	0.304
2010	1740.06	1997.21	2287.32	8185	13425	21451	375.47	428.39	485.36	463.16	590.44	758.70	0.491	0.600	0.749	0.293	0.311
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	0.486	0.190



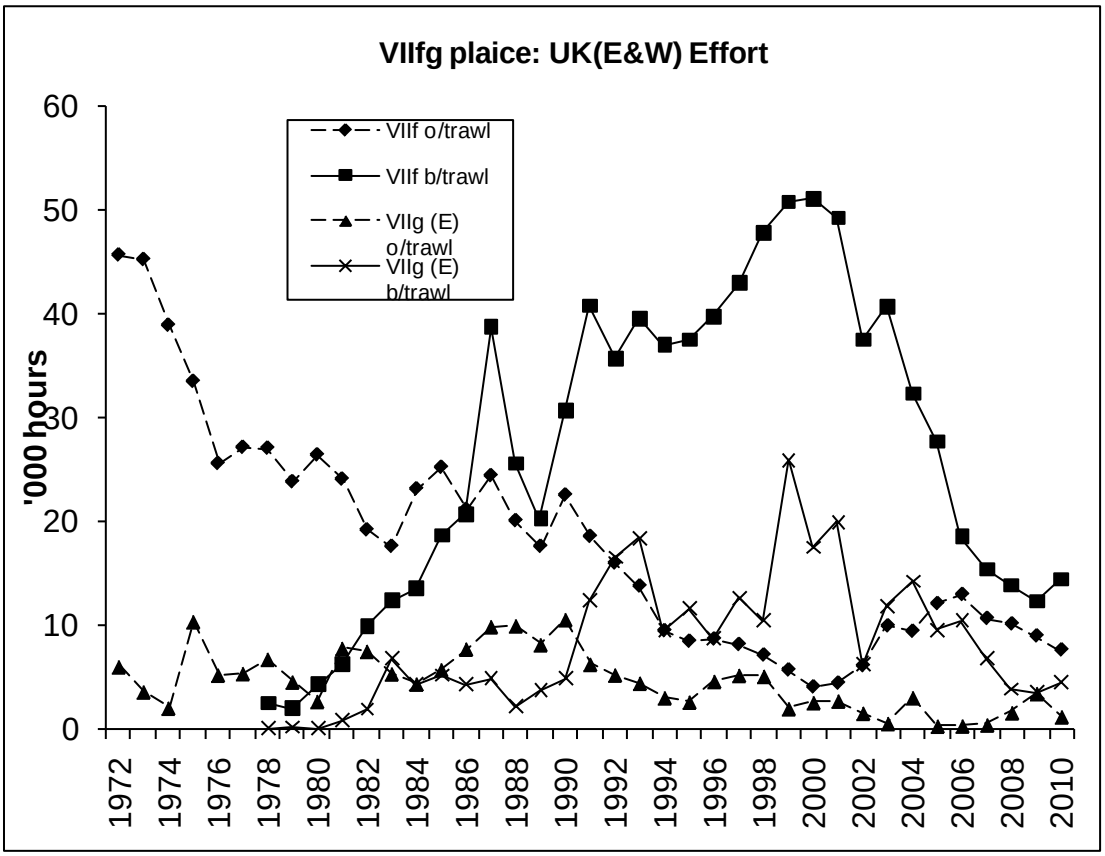


Figure 7.10.1. Plaice in Division VIIf&g: UK(E&W) lpue and effort by fleet.

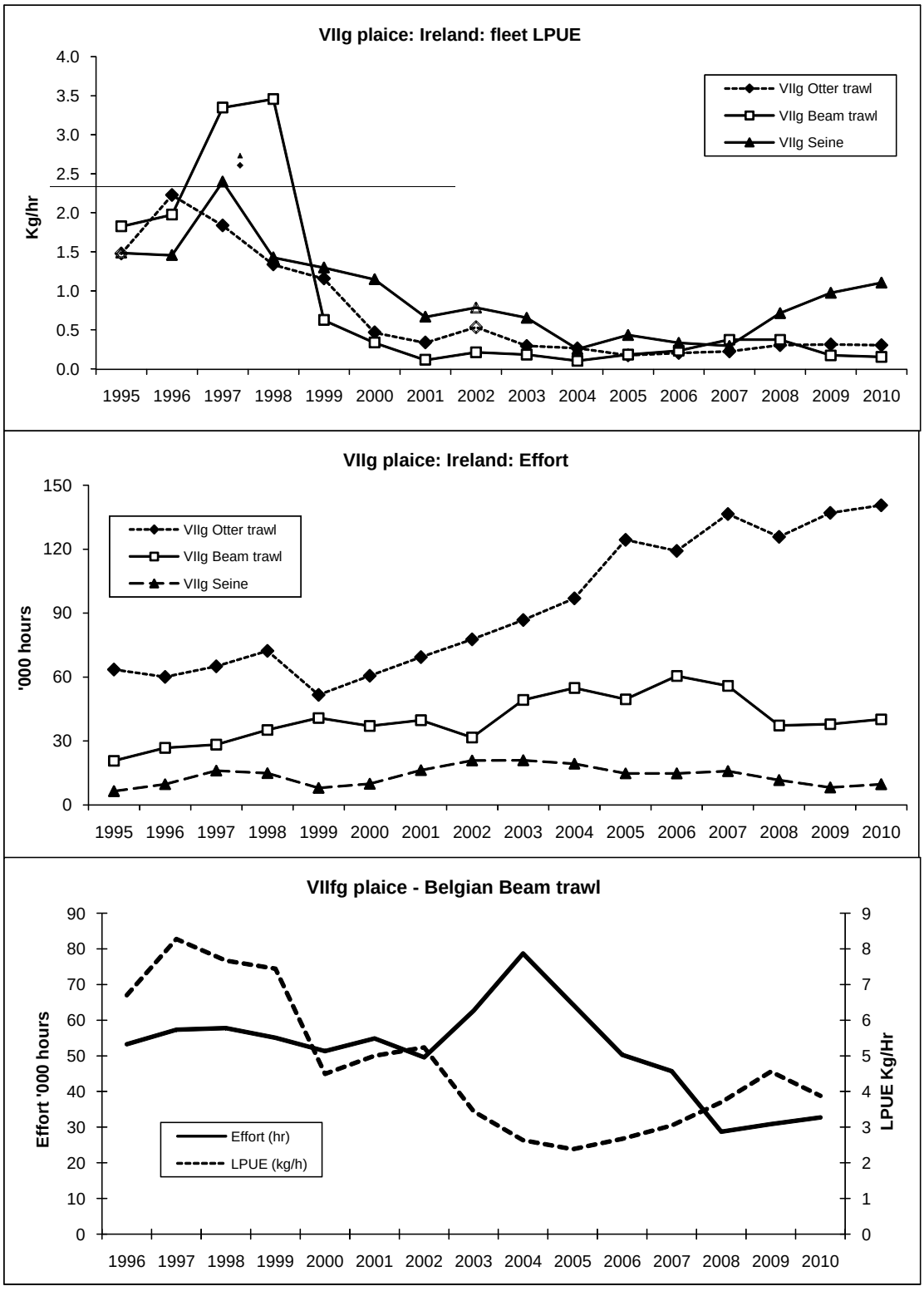


Figure 7.10.2. Plaice in Division VIIf&g: Ireland and Belgium: lpue and effort by fleet.

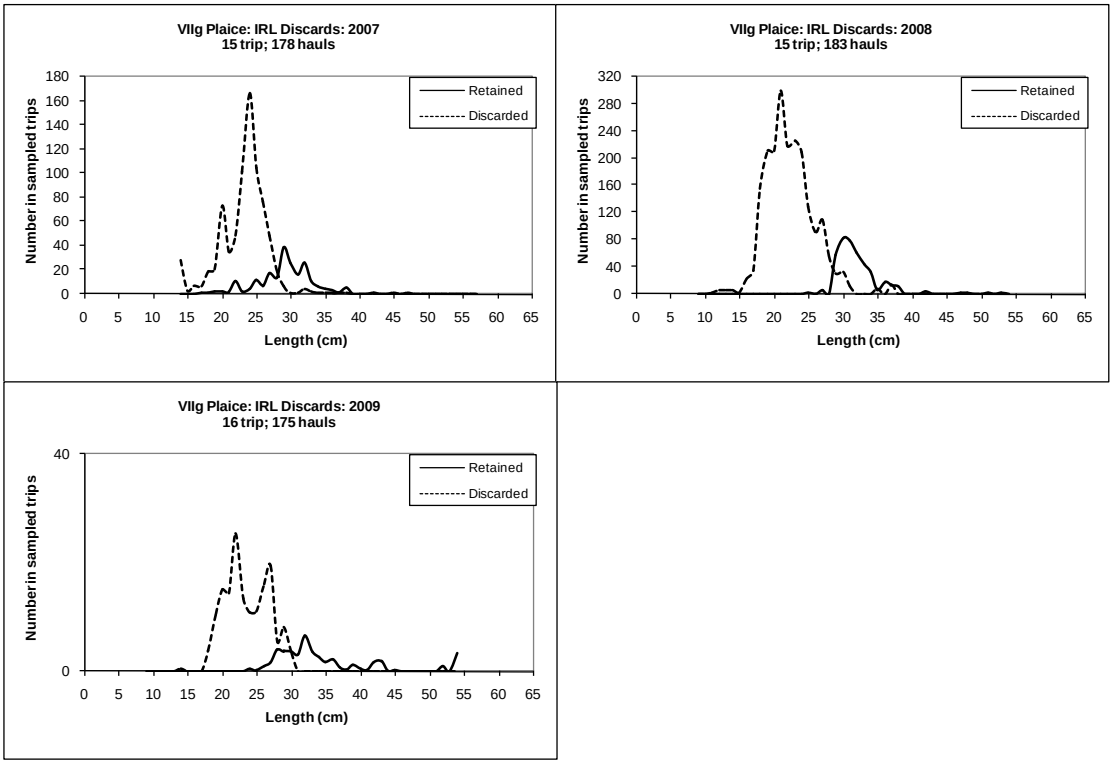


Figure 7.10.3a. Plaice in Division VIIf&g: Ireland otter trawl discard sampling results in 2007–2009: raised to sampled trips.

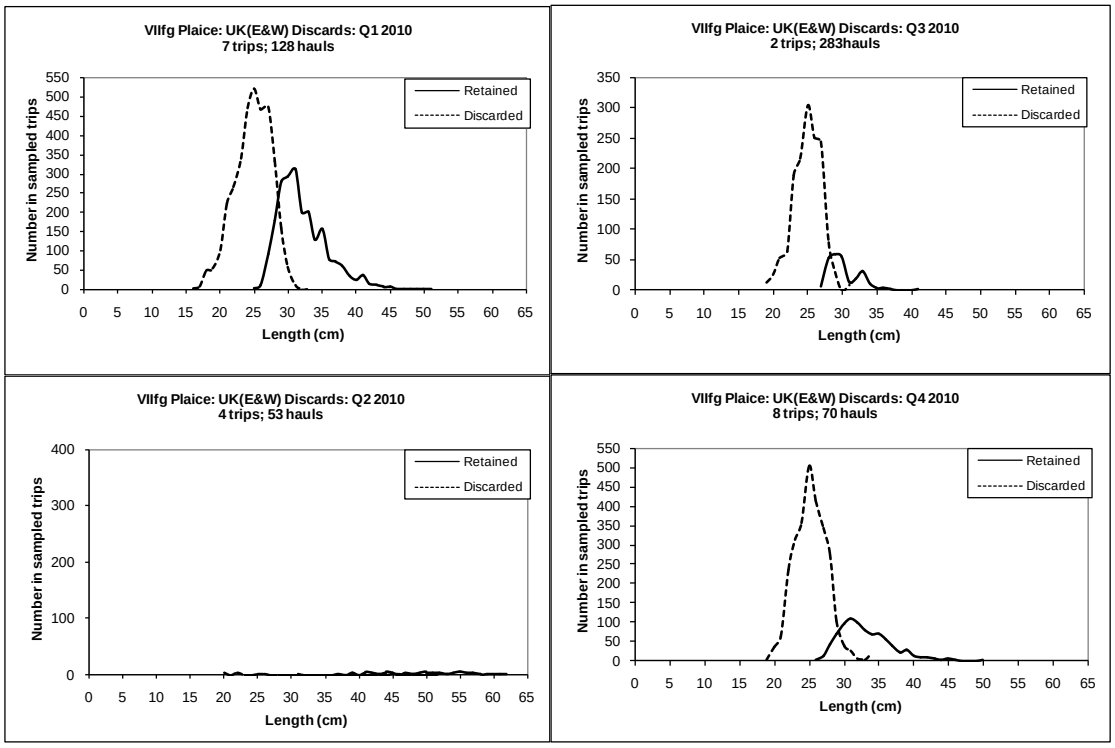


Figure 7.10.3b. Plaice in Division VIIf&g: UK(E&W) Discard sampling results in 2010: raised to sampled trips. All gears.

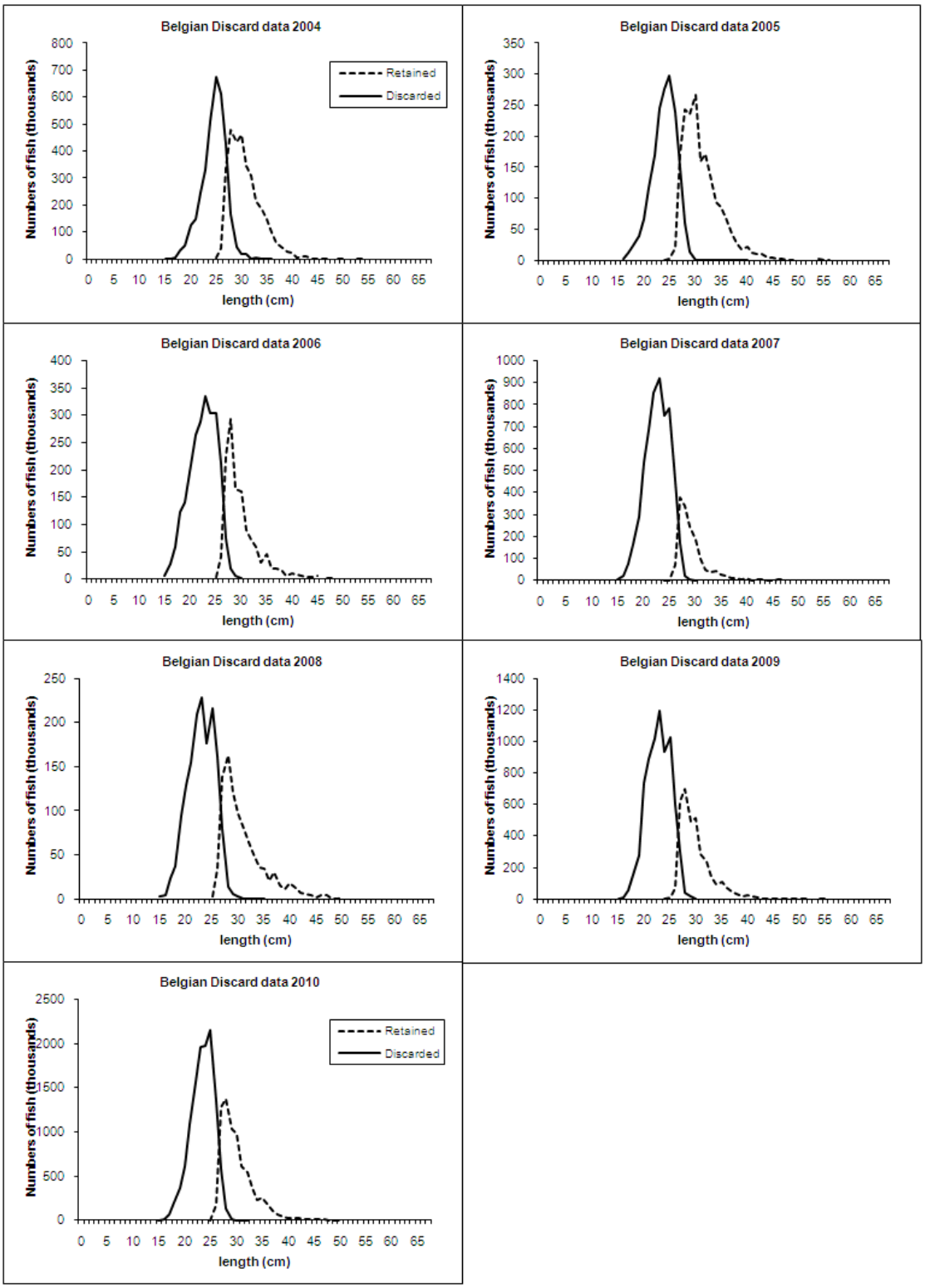


Figure 7.10.3c. Plaice in Division VIIf&g: Belgian Discard sampling length distributions: raised to sampled trips. Beam trawl.

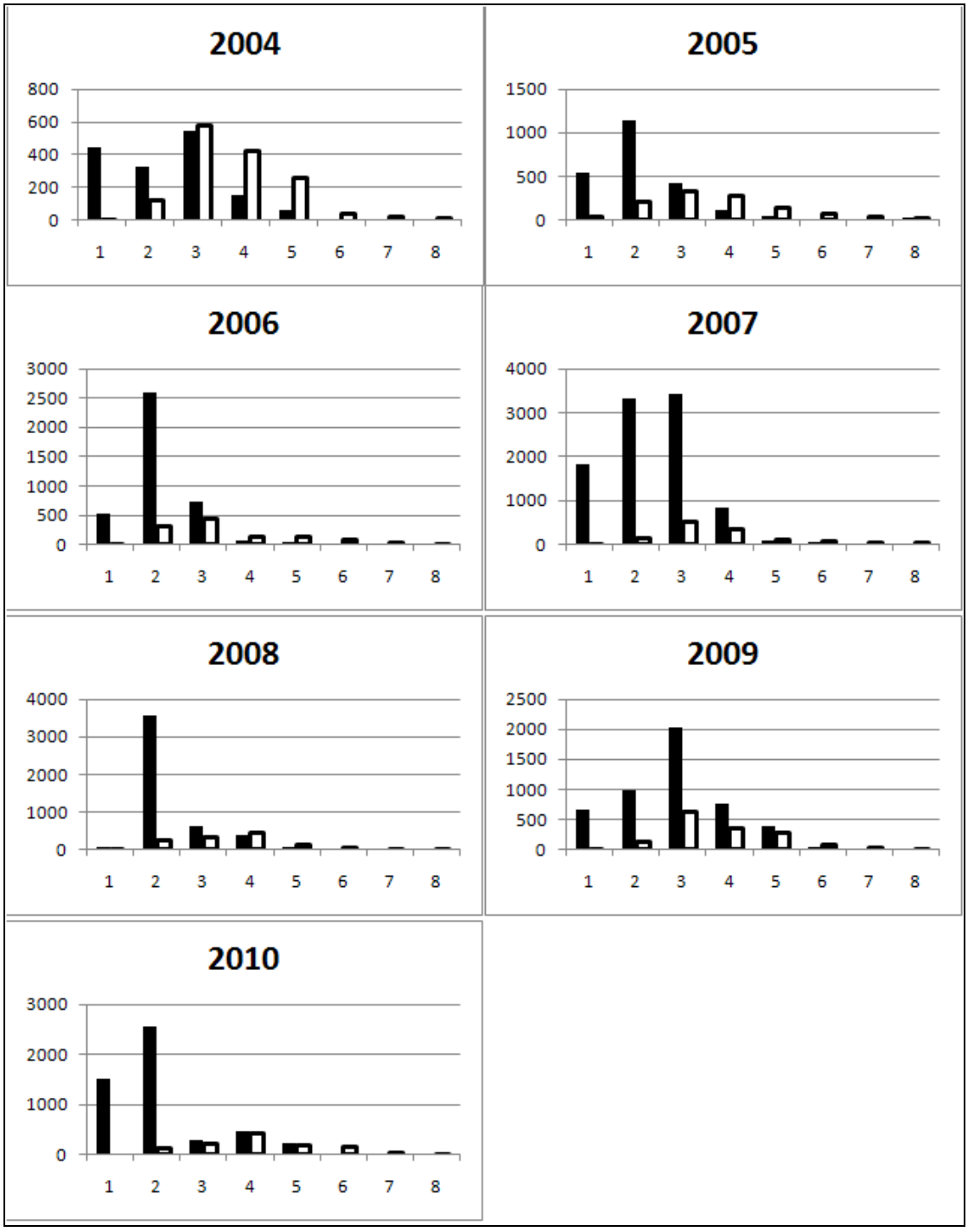


Figure 7.10.4. Plaice in Division VIIf&g: Age composition of International landings and discards from 2000 to 2010.

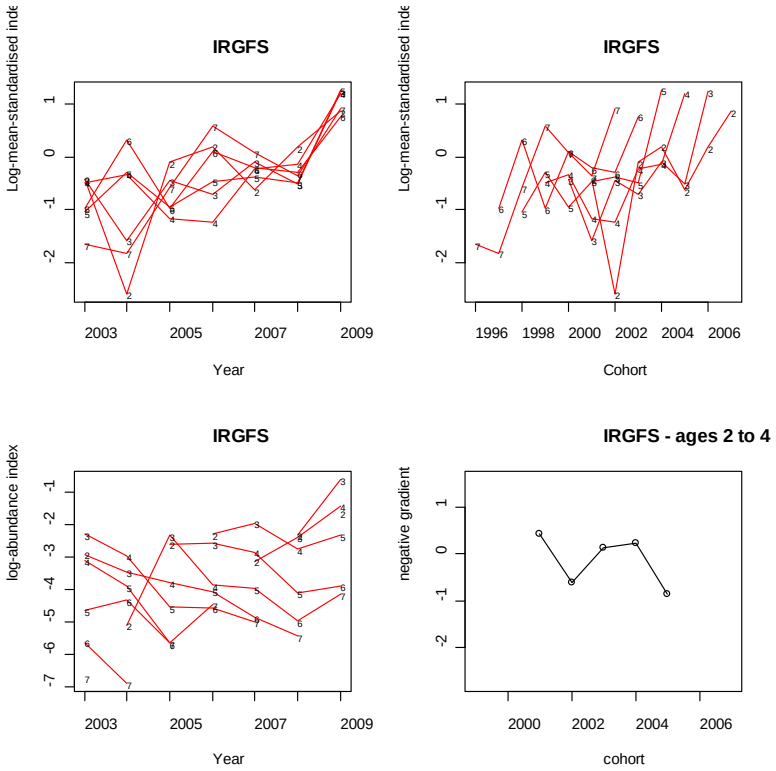


Figure 7.10.5. Plaice in Division VIIf&g: Irish groundfish survey log cpue-at-age; by year and year class (top row), with log catch curves and the negative slope of the catch curves; ~Z (bottom row).

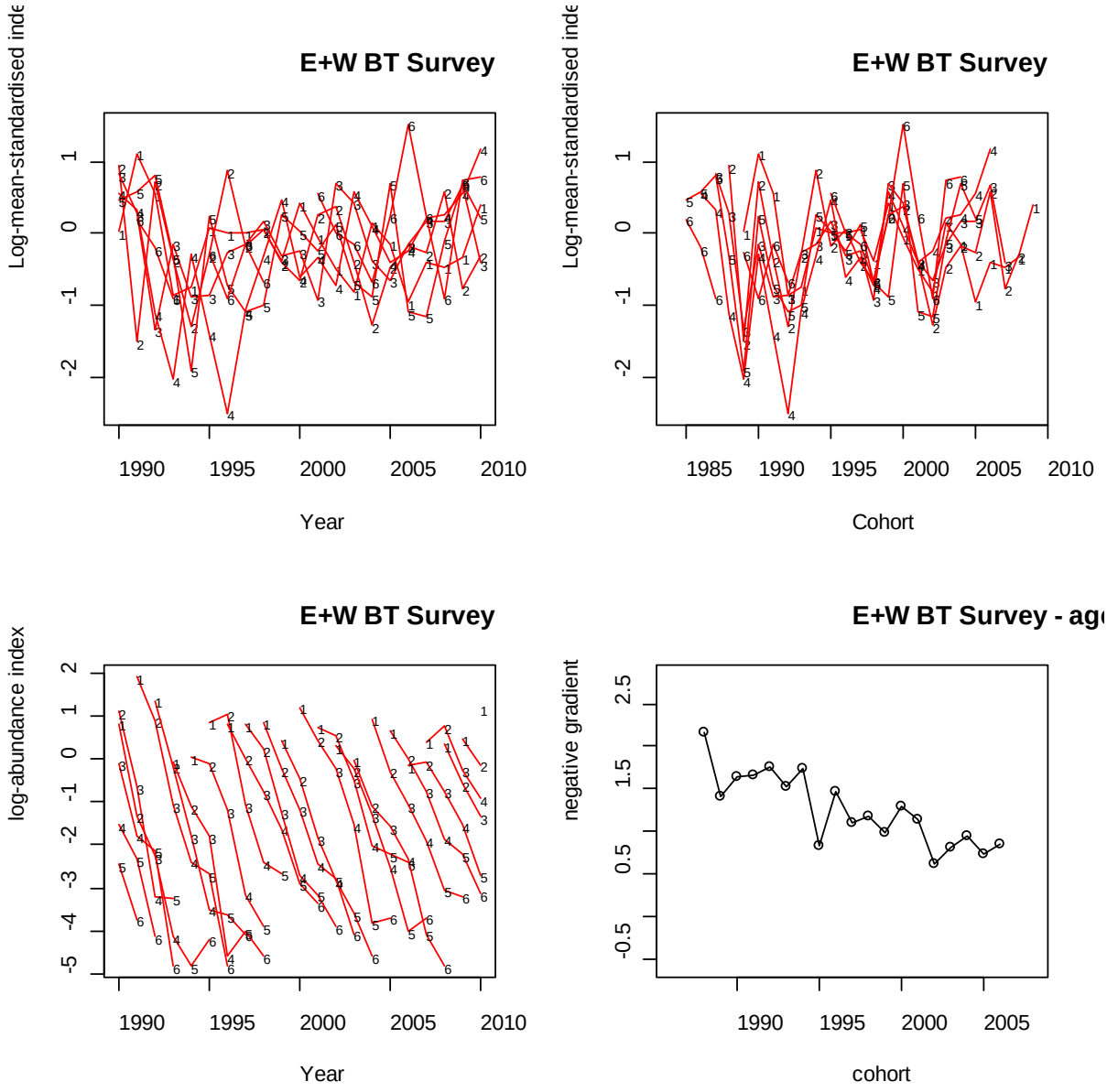


Figure 7.10.6. Plaice in Division VIIf&g: UK (BTS-Q3) Beam trawl survey log cpue by year, year class, log catch curves and the negative slope of the catch curves (~Z).

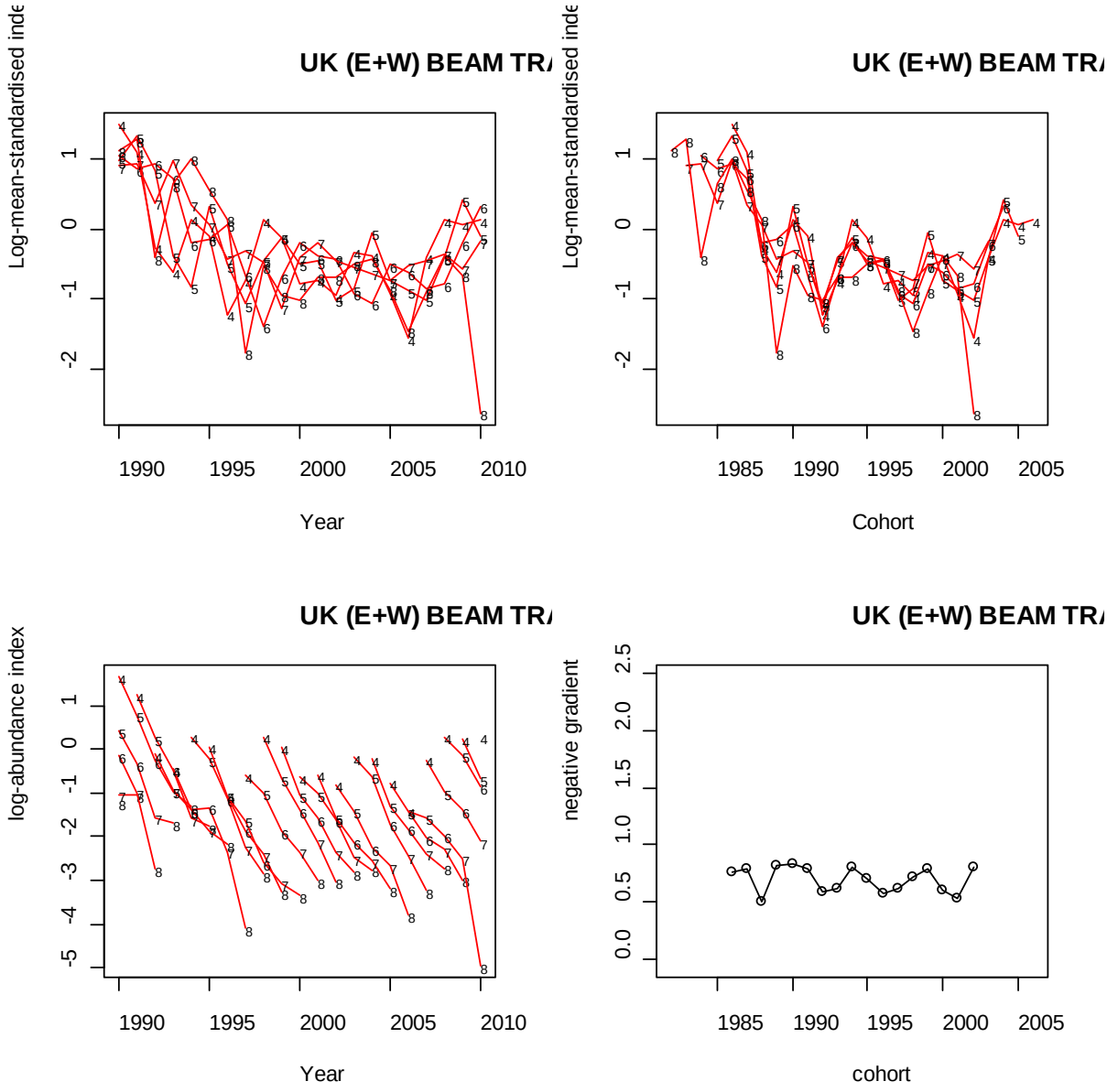


Figure 7.10.7a. Plaice in Division VIIf&g: UK EW Beam trawl fleet log cpue by year, year class, log catch curves and the negative slope of the catch curves (~Z).

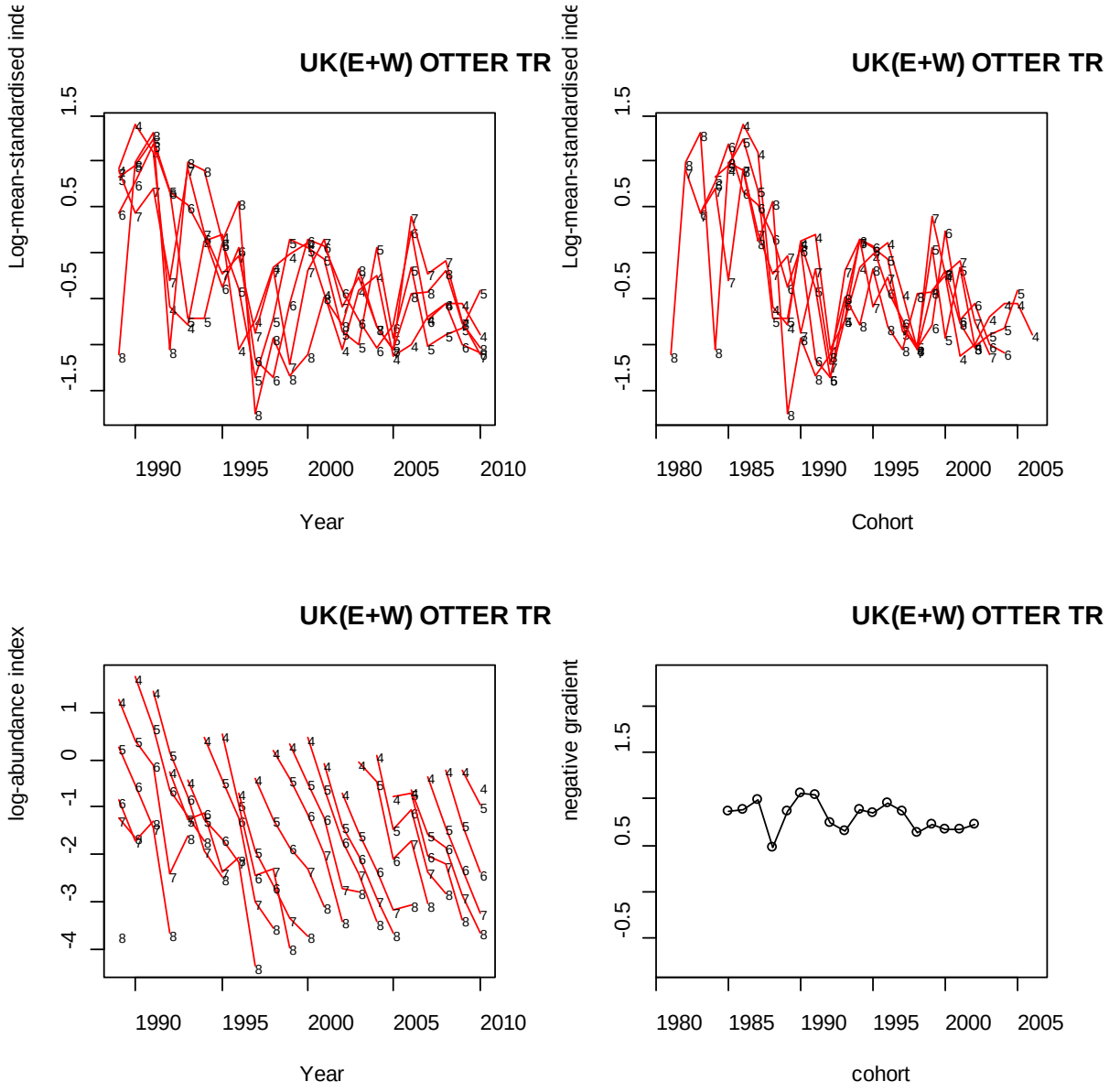


Figure 7.10.7b. Plaice in Division VIIf&g: UK EW Otter trawl fleet log cpue by year, year class, log catch curves and the negative slope of the catch curves (~Z).

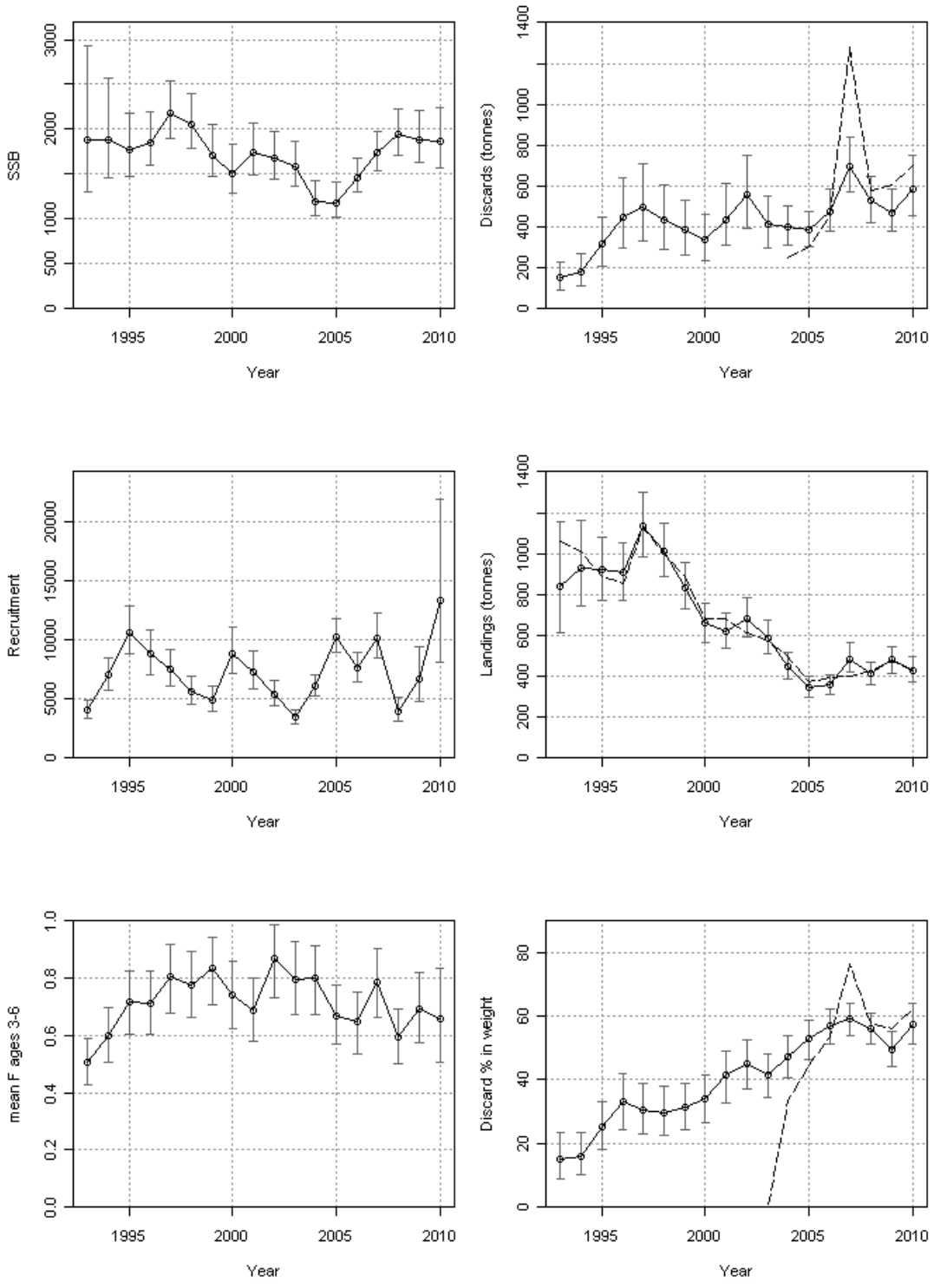


Figure 7.10.8. Plaice in Division VIIf&g: The estimated time-series of spawning–stock biomass, recruitment, average fishing mortality-at-ages 3–6, total discard weight, total landings weight and the discard percentage in weight with standard error bars derived from bootstrapping the hessian matrix, for the fit of the TI_PTVS model.

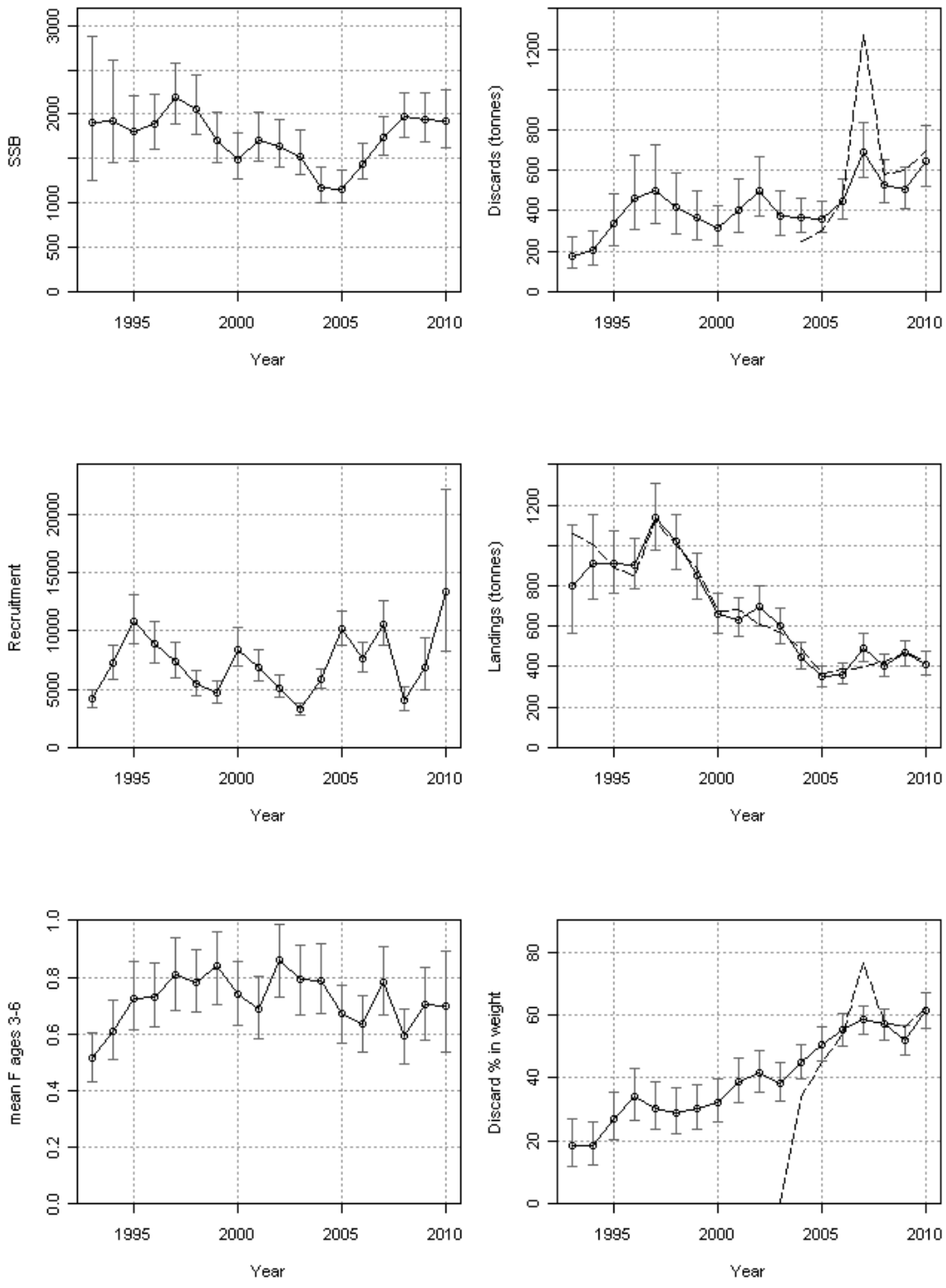


Figure 7.10.9. Plaice in Division VIIf&g: The estimated time-series of spawning–stock biomass, recruitment, average fishing mortality-at-ages 3–6, total discard weight, total landings weight and the discard percentage in weight with standard error bars derived from bootstrapping the hessian matrix, for the fit of the TI_TVS model.

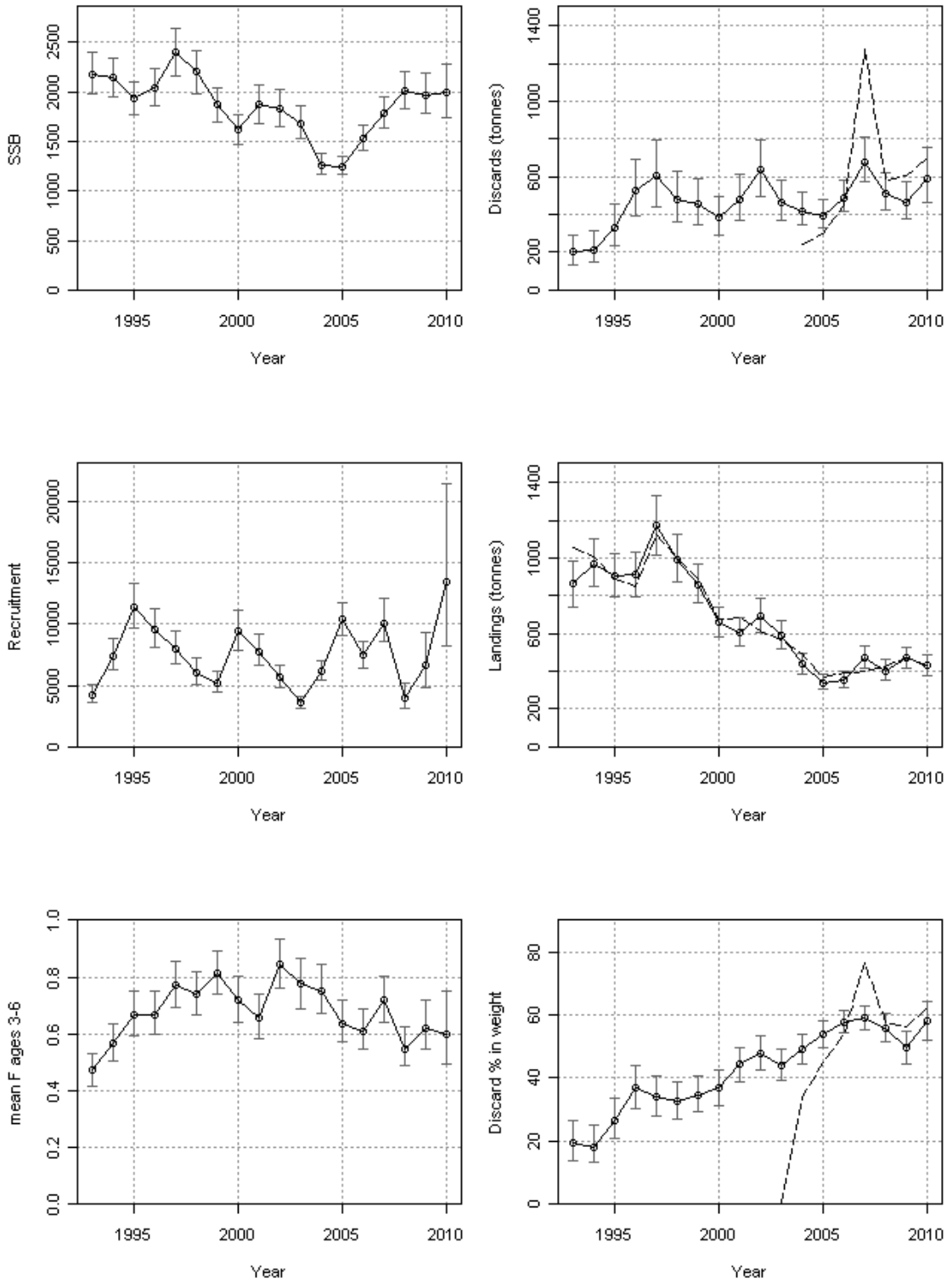


Figure 7.10.10a. Plaice in Division VIIf&g: The estimated time-series of spawning–stock biomass, recruitment, average fishing mortality-at-ages 3–6, total discard weight, total landings weight and the discard percentage in weight with standard error bars derived from bootstrapping the hessian matrix, for the fit of the TV_PTVS model.

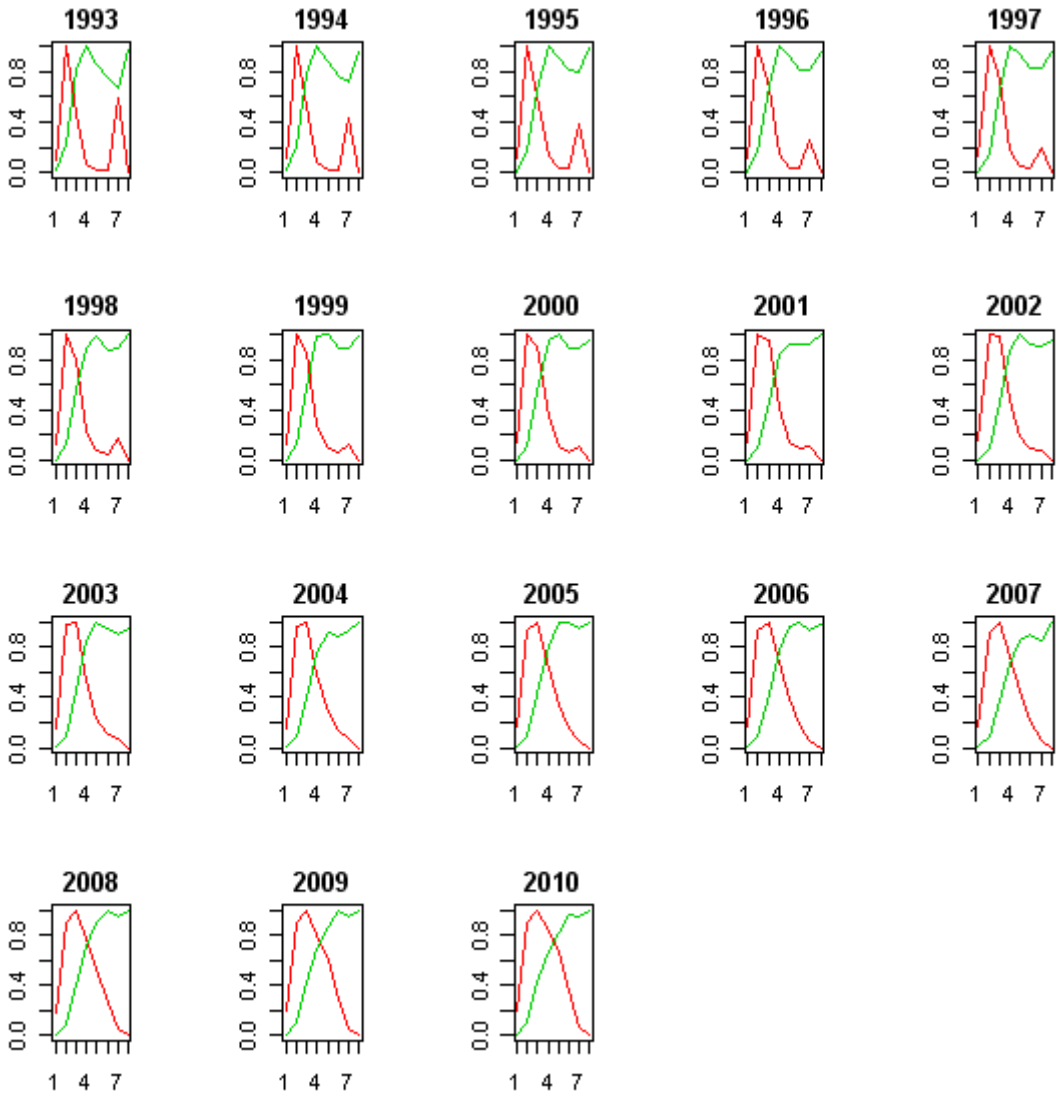


Figure 7.10.10b. Plaice in Division VIIf&g: The estimated selection pattern-at-age for landings (green) and discards (red) scaled to a highest value = 1.0 for the TV_PTVS model which fits a time variant selection pattern to the landings and a polynomial time variant spline for the discard selection.

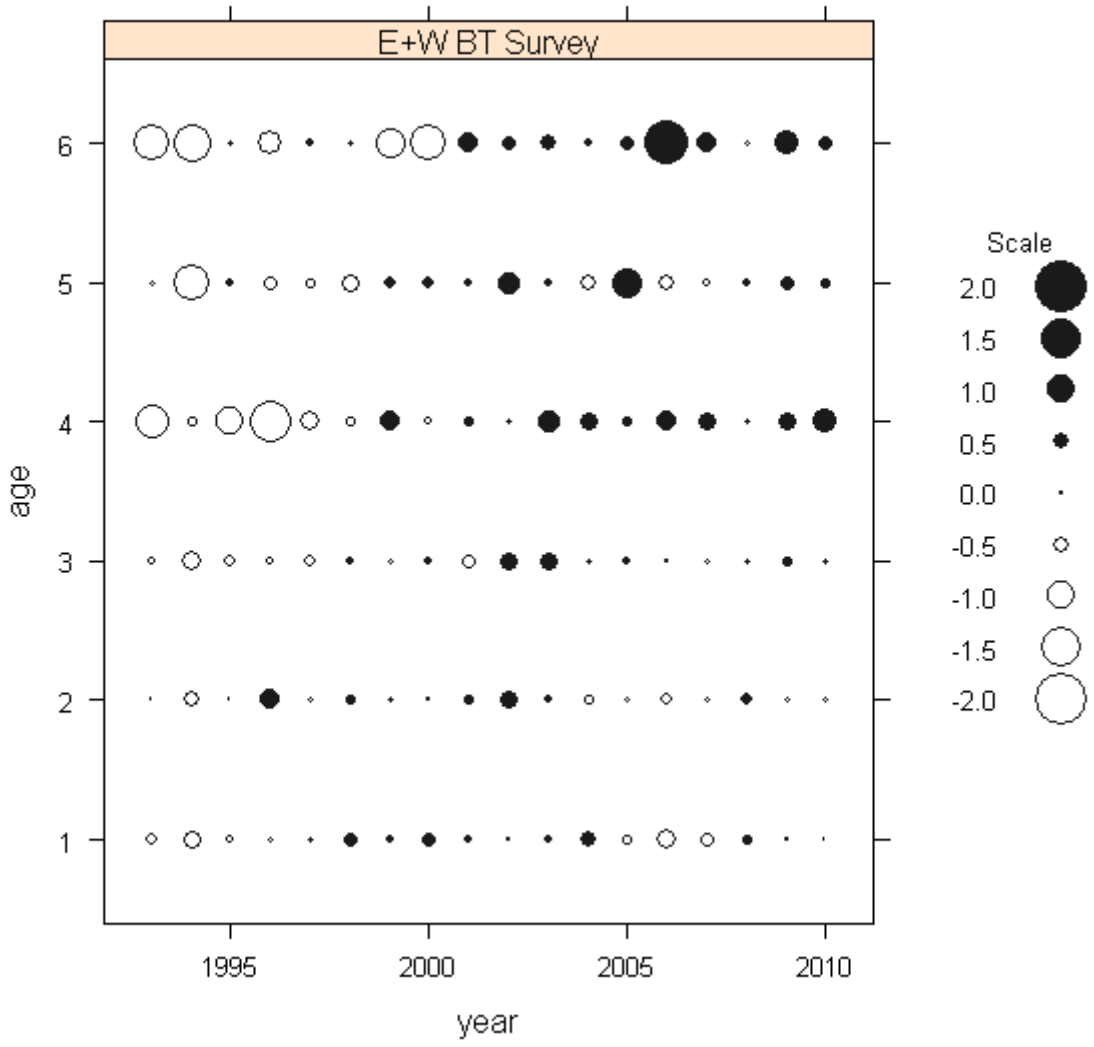


Figure 7.10.10c. Plaice in Division VIIf&g: The Log-catchability residuals for the fit TV_PTVS model fit to the UKBT survey.

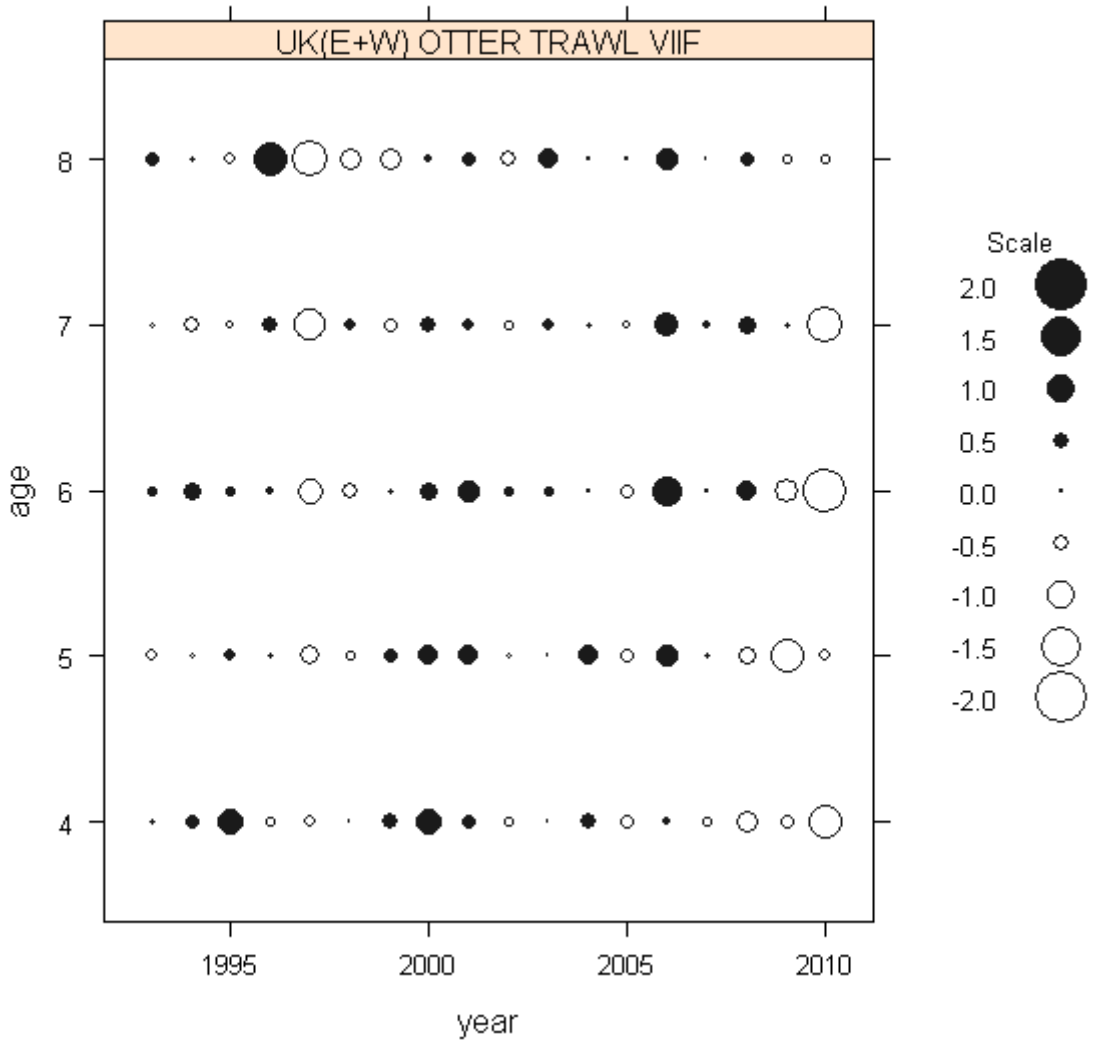


Figure 7.10.10d. Plaice in Division VIIf&g: The Log-catchability residuals for the fit TV_PTVS model fit to the UK commercial otter trawl data.

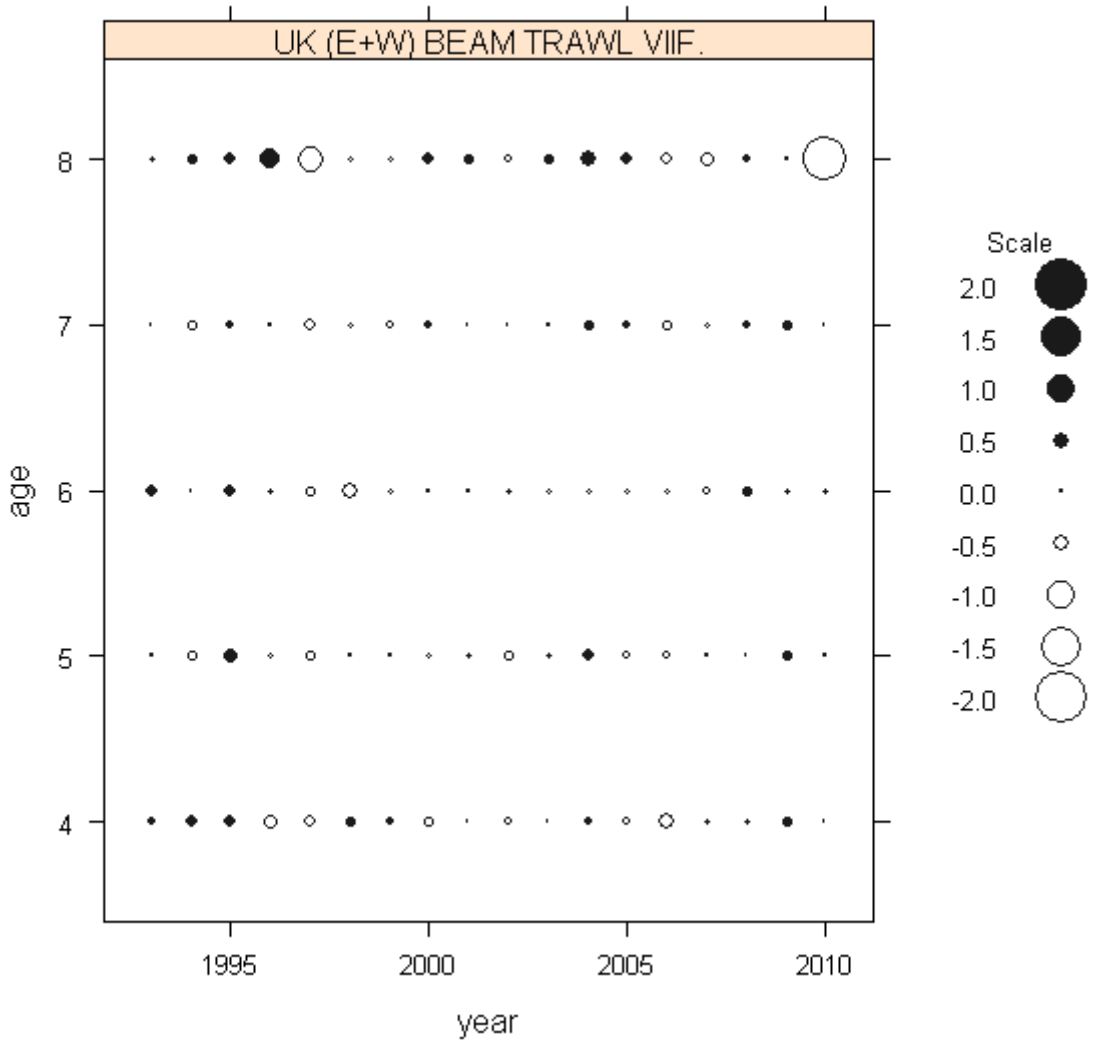


Figure 7.10.10e. Plaice in Division VIIf&g: The Log-catchability residuals for the fit TV_PTVS model fit to the UK commercial beam trawl data.

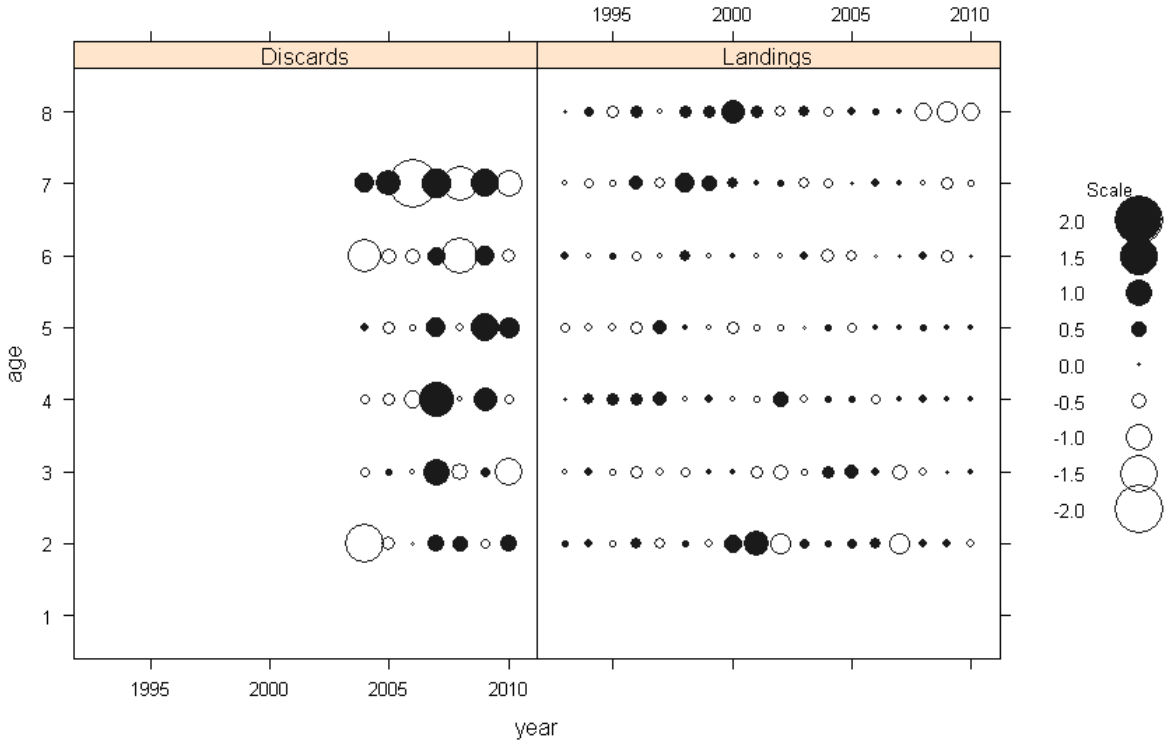


Figure 7.10.10f. Plaice in Division VIIf&g: The Log residuals for the fit TV_PTVS model fit to the discard and landings numbers-at-age data.

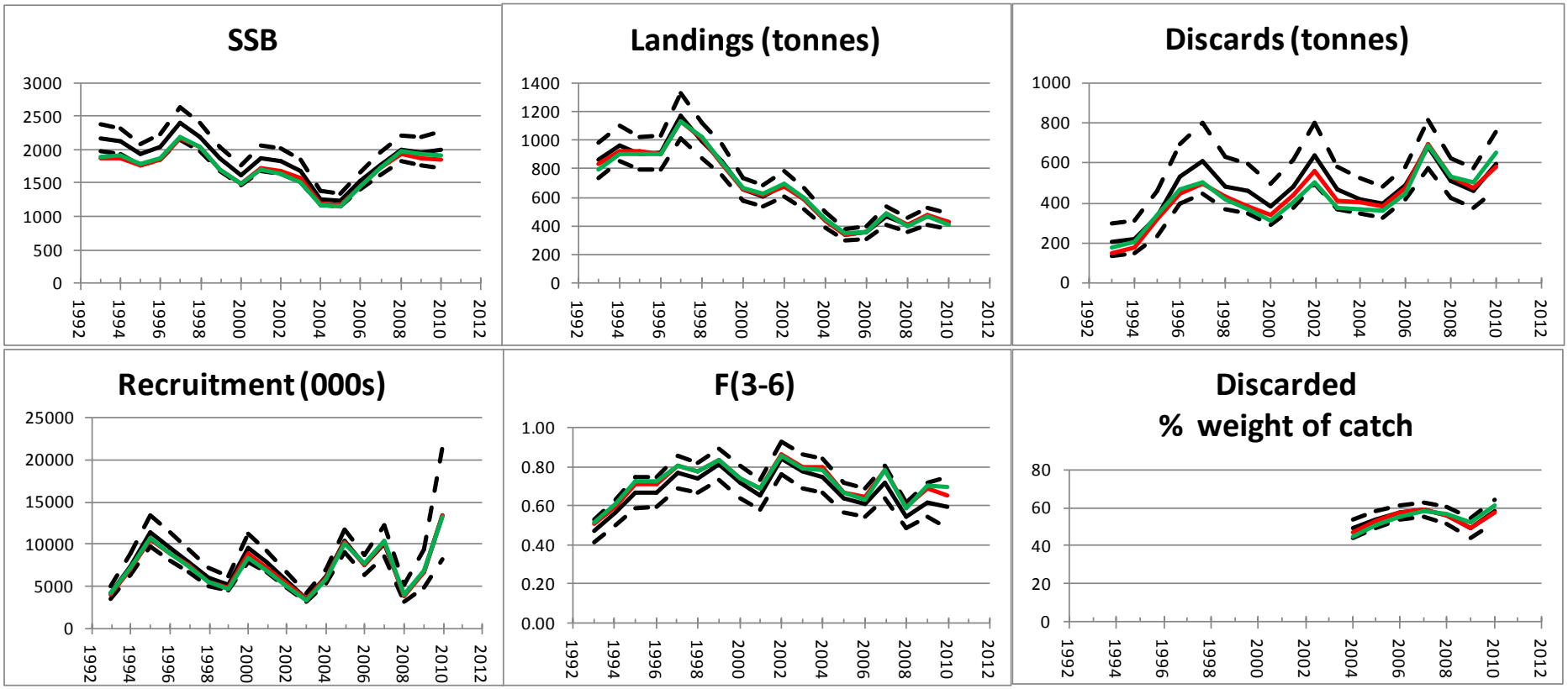


Figure 7.10.11. Plaice in Division VIIf&g: The time-series of stock and fishery trends from fits the three WKFLAT models; black lines preferred TV_PTVS model with 5 and 95% C.L. red lines TI_PTVS model, green lines TI_TVS model.

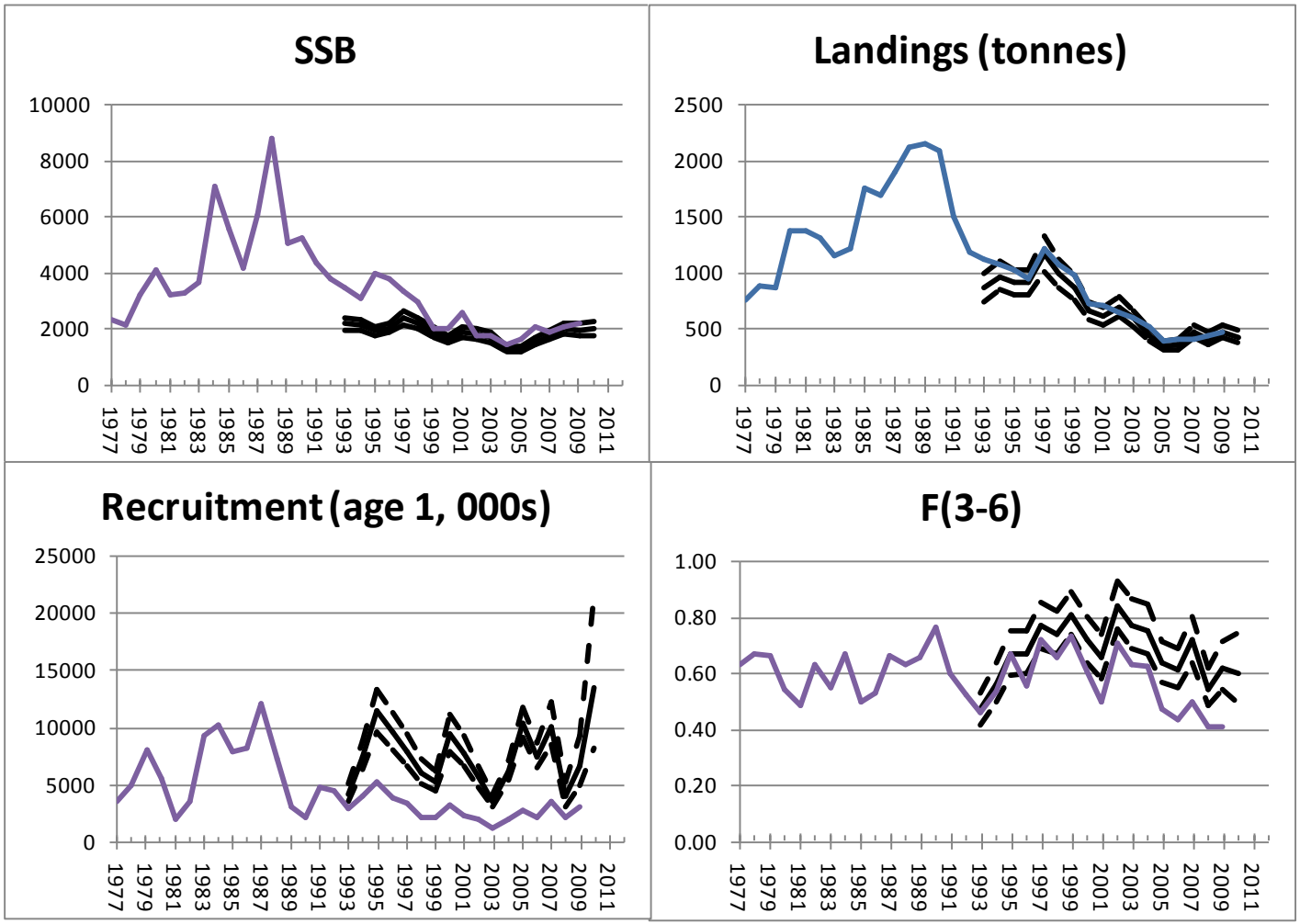


Figure 7.10.12. Plaice in Division VIIf&g: The time-series of stock and fishery trends from the preferred TV_PTVS model with 5 and 95% C.L. compared to the 2010 assessment estimates based on the landings only assessment.

7.11 Plaice in the Southwest of Ireland (ICES Divisions VIIh–k)

Type of assessment in 2011

No assessment was performed, however catch numbers and weights were aggregated for the Irish landings for the years 1993–2010 and these were used to perform a yield-per-recruit analysis.

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.

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 2010 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 2010. 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 2010.

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 standardized 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 logcatch numbers (Z). Figure 7.11.6 shows the catch curve; 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 logcatch numbers was estimated over ages 4 to 7 (Figure 7.11.7). It appears that Z 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 standardized 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 standardized 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 0.25. $F_{0.1}$ is estimated as 0.15. Recent values of Z ranged from 0.6 to 1.2, with M=0.12 this would result in an F of between 0.48 and 1.08. This is well above F_{max} and $F_{0.1}$

7.11.4 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 7.11.1. Plaice in Divisions VII h–k (Southwest Ireland). Nominal landings (t), 1987–2010, 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
Belgium	32	22	7	25	1	0
Denmark						0
France	20	37	30	12	43	53
Ireland	90	65	72	72	71	66
Netherlands	.					
Spain	.	1	13	1		
UK - Eng+Wales+N	28	18	20	12	32	35
UK - England & Wa	.					
UK - Scotland	.					
Total	170	143	142	122	147	154

* Belgian Landings up to 1998 include VIIg

Table 7.11.2. Official landings of plaice in VIIjk.

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	-	6	71	-	2	79
2010*	-	10	66	-	1	77

*** 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	92	624	479	115	45	23	10	6	2	0	1
1994	68	104	340	260	82	46	18	8	5	1	1	0
1995	10	208	634	348	107	36	16	7	4	1	2	0
1996	1	77	316	229	127	37	23	5	1	0	0	0
1997	0	164	277	269	120	42	20	5	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	21	2	7	0	0	0
2002	0	54	155	172	54	42	44	12	4	2	0	1
2003	0	74	165	65	29	6	15	11	2	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	58	43	60	43	18	4	1	1	1	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		0.197	0.256	0.306	0.417	0.582	0.750	0.933	1.159	1.534		1.969
1994	0.046	0.222	0.302	0.368	0.460	0.563	0.708	0.871	1.031	1.307	1.373	
1995	0.100	0.228	0.272	0.325	0.390	0.519	0.645	0.818	1.197	1.475	1.558	
1996	0.029	0.298	0.379	0.431	0.463	0.512	0.528	0.494	0.595	2.322		
1997	1.111	0.285	0.338	0.431	0.485	0.653	0.807	0.928				1.314
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	0.881	1.170	1.731	2.121	1.135
2000	0.119	0.274	0.348	0.420	0.486	0.610	0.805	1.113	1.437	1.088		1.737
2001	0.214	0.243	0.325	0.405	0.536	0.648	0.798	0.561	1.119			
2002		0.211	0.296	0.328	0.415	0.498	0.567	0.701	1.014	1.098		1.532
2003		0.274	0.356	0.402	0.482	0.575	0.737	0.881	1.048	1.872	1.257	
2004	0.128	0.258	0.309	0.341	0.448	0.550	0.633	0.635	0.900	1.137	1.328	1.803
2005	0.174	0.238	0.276	0.324	0.381	0.459	0.731	0.949		1.222	1.534	2.020
2006		0.272	0.319	0.370	0.438	0.520	0.794	0.895	0.792		1.880	
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	0.530	0.756	0.399	1.106	1.576		
2009		0.224	0.255	0.335	0.403	0.462	0.520		1.080		1.393	1.138
2009	0.213	0.257	0.308	0.339	0.364	0.451	0.532	0.734	0.698	0.730	0.155	

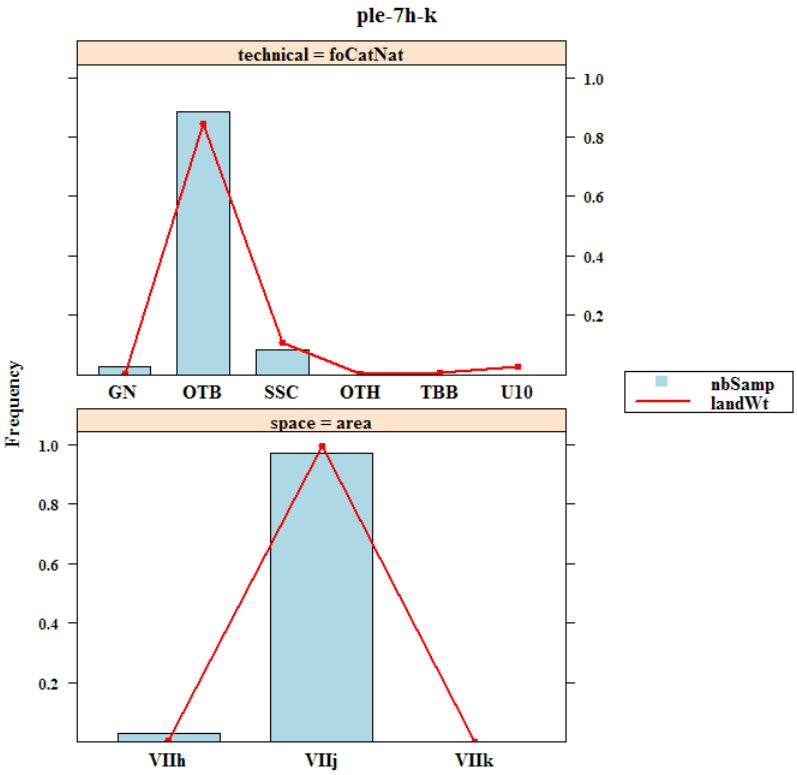


Figure 7.11.1. Irish Operational landings and sampling levels (number of samples) for plaice in VIIjk by gear type (top) and ICES Division (bottom). The sampling appears to be representative of the landings.

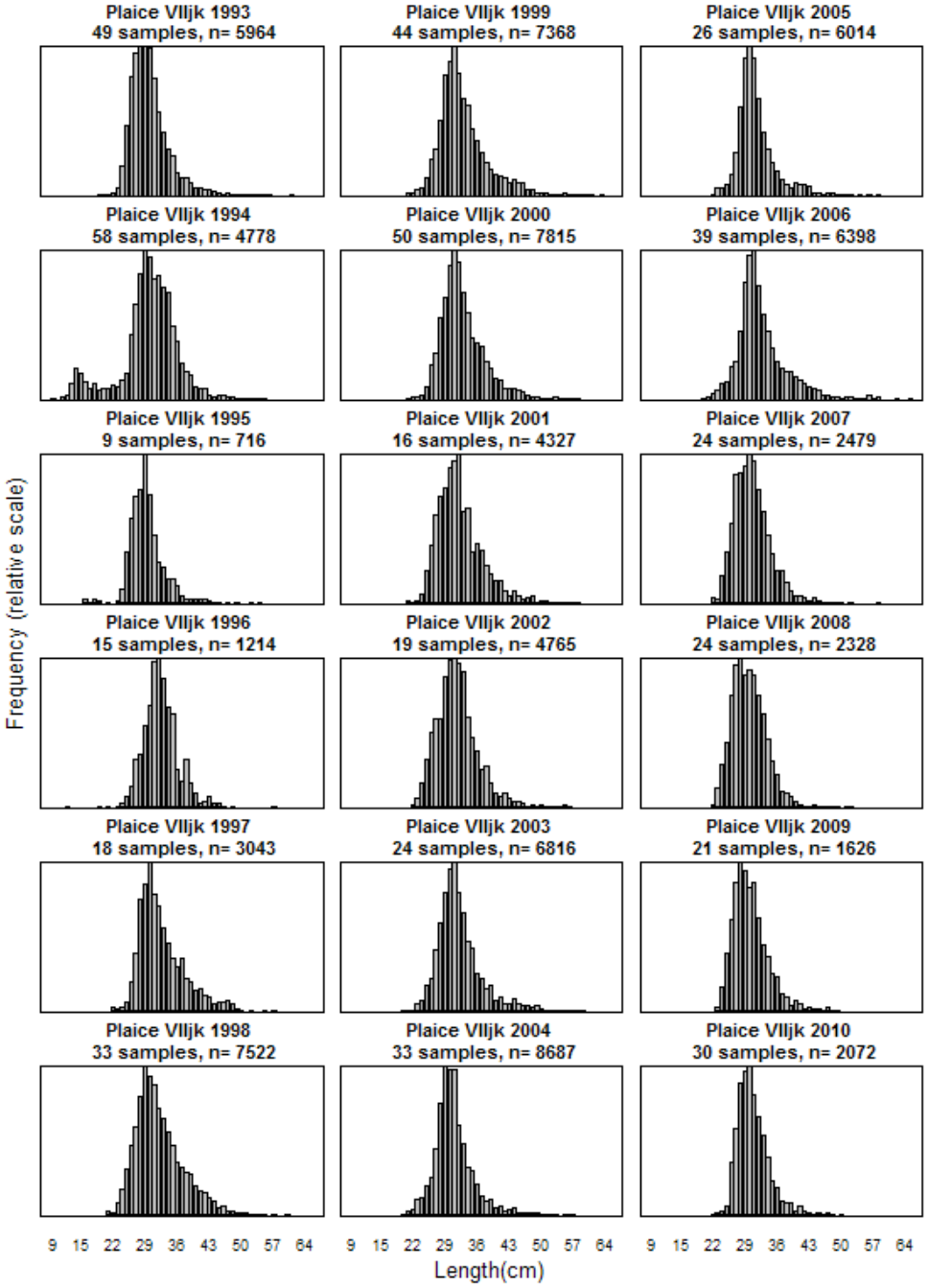


Figure 7.11.2. Length frequency distribution of the Irish landings of plaice in VIIjk between 1993 and 2010. All gears and quarters combined.

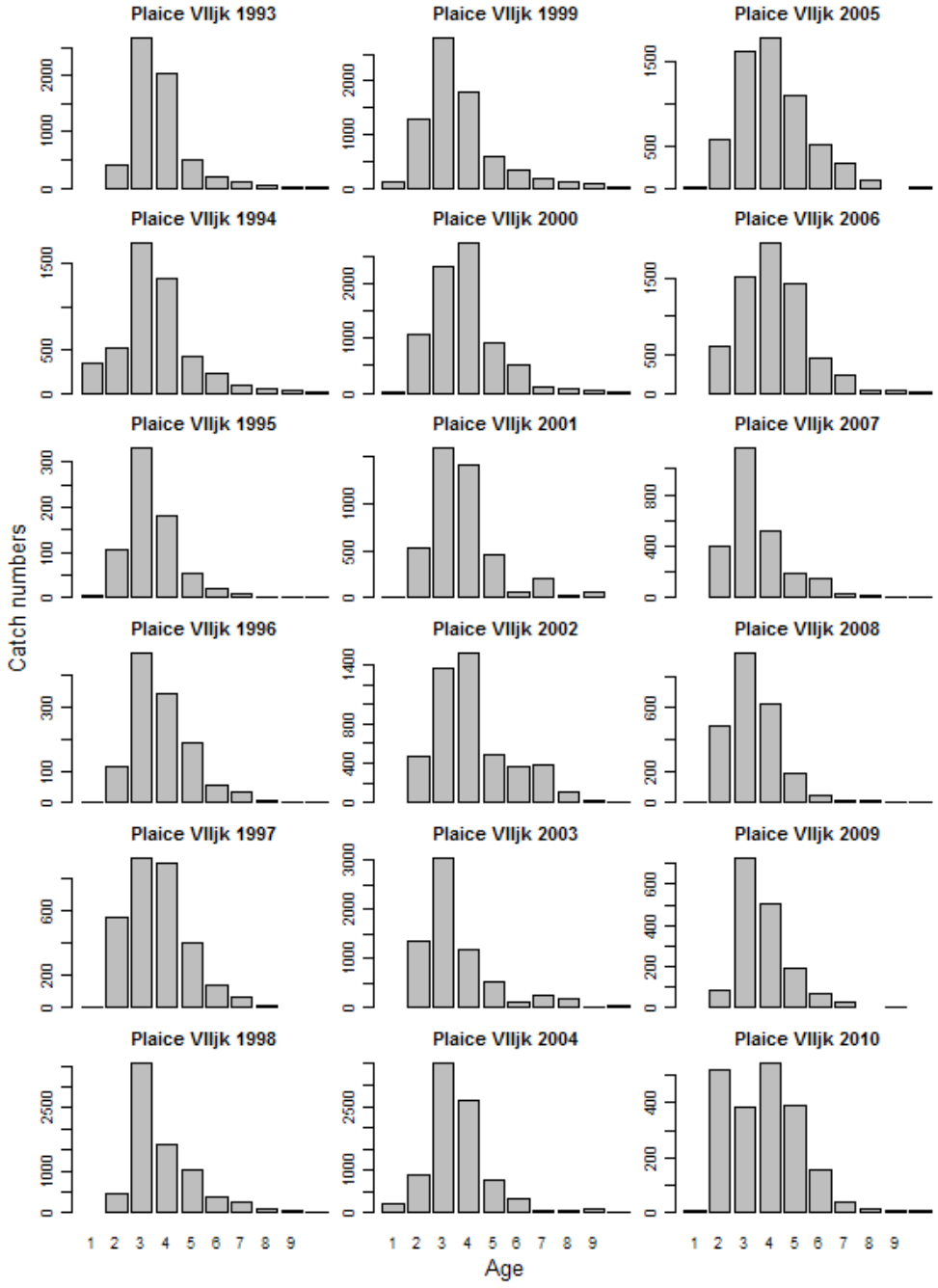


Figure 7.11.3. Age distribution of plaice in VIIjk between 1993 and 2010. All gears and quarters combined. The age data for 1995 were considered insufficient and for this year the combined age data for 1993–1996 were used.

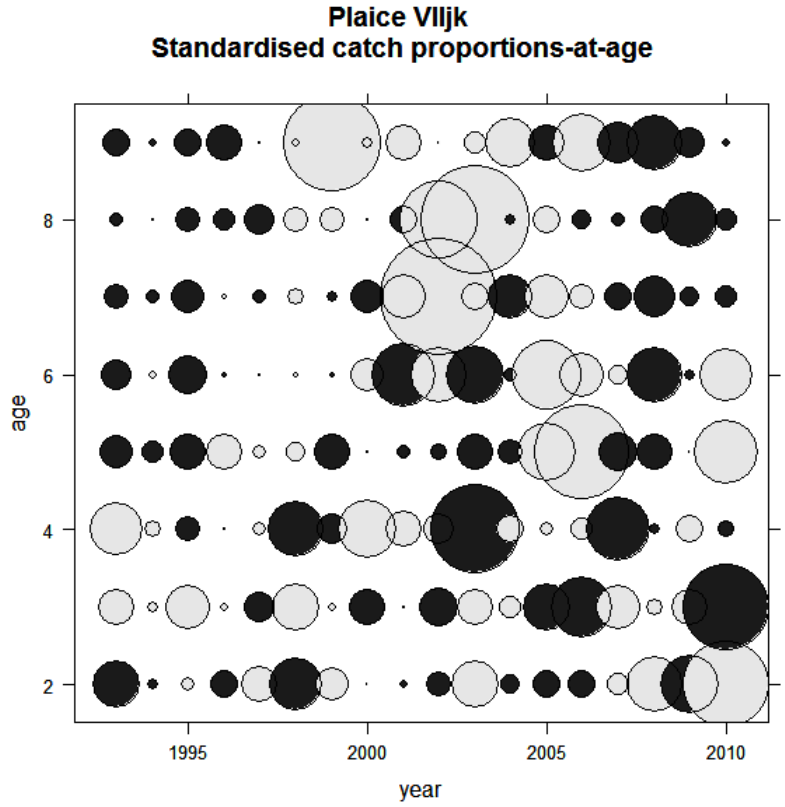


Figure 7.11.4. Standardized catch proportions-at-age for plaice in VIIjk. Grey bubbles represent higher than average catch-at-age and black bubbles represent lower than average catch-at-age.

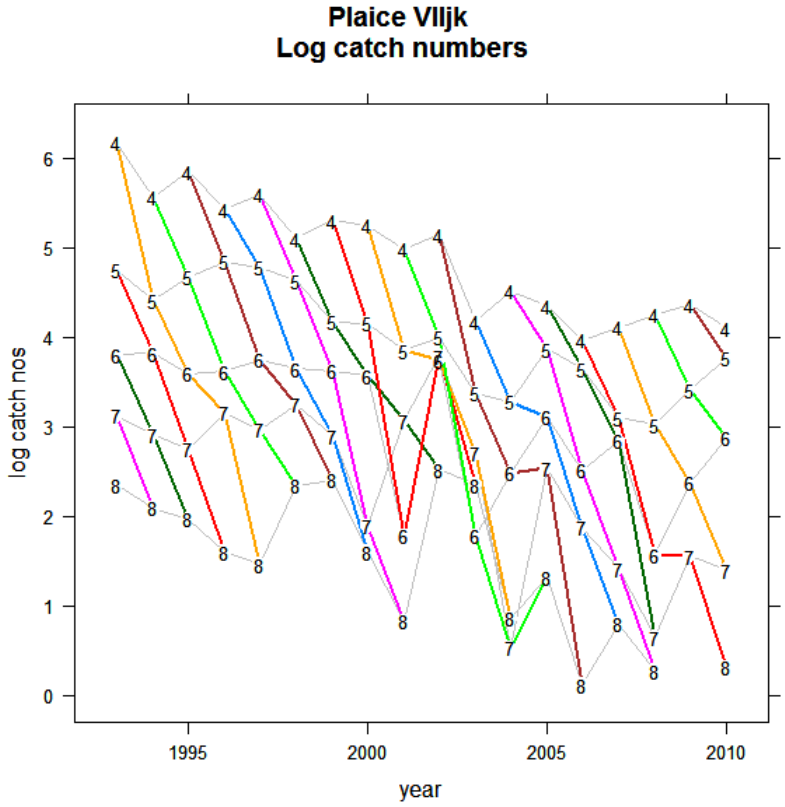


Figure 7.11.5. Log catch numbers-at-age (ages 4–8).

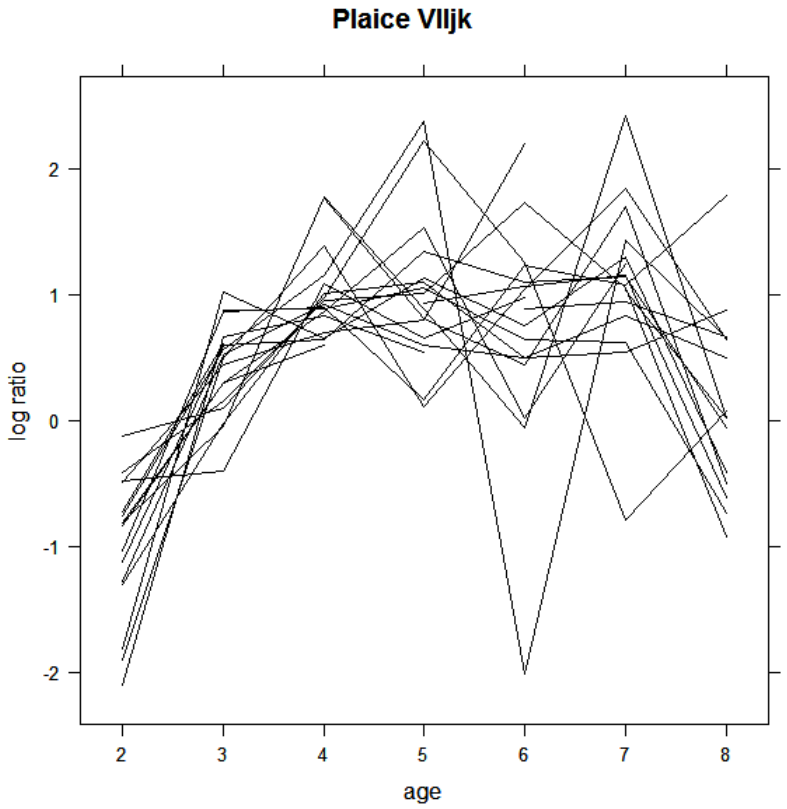


Figure 7.11.6. Catch curve of plaice in VIIjk. Plaice from the age of 4 appear to be fully selected; the data get quite noisy from the age of 7 onwards.

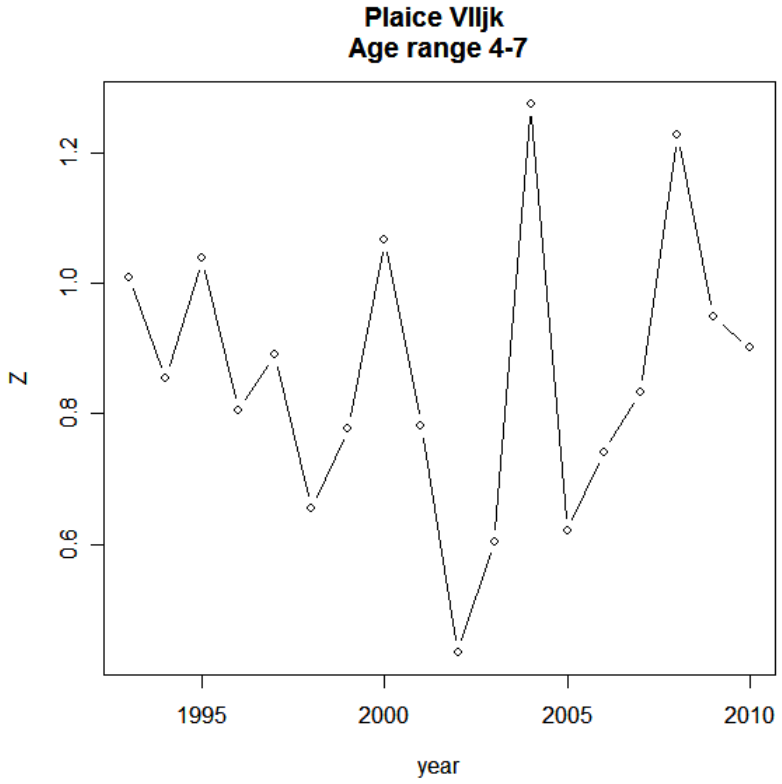


Figure 7.11.7. Z estimated over pseudo-cohorts as the slope of the log catch numbers.

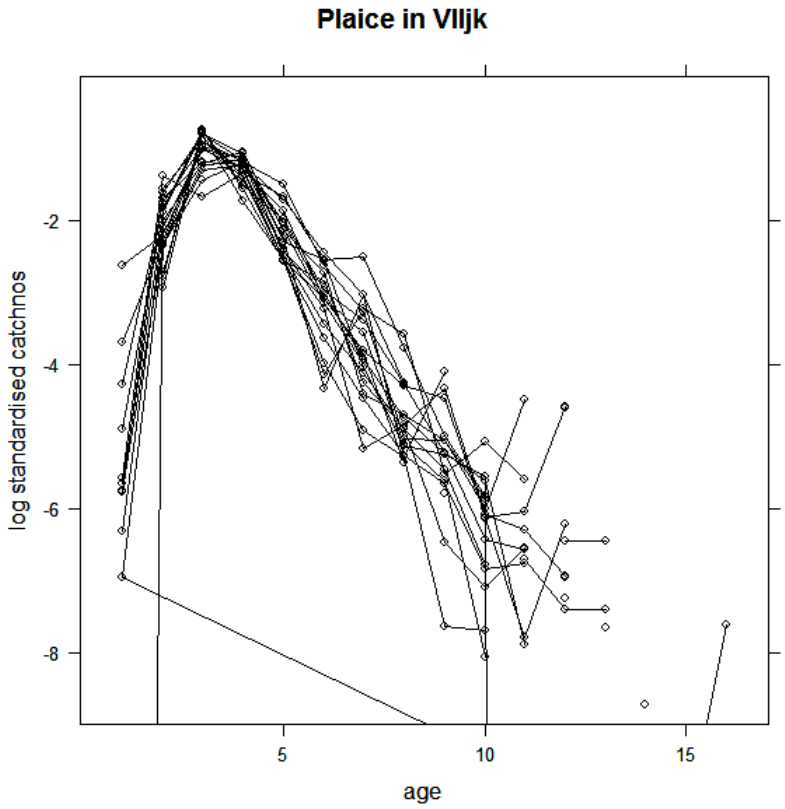


Figure 7.11.8. Log catch numbers (standardized by year). Fish appear to be fully selected from the age of 4.

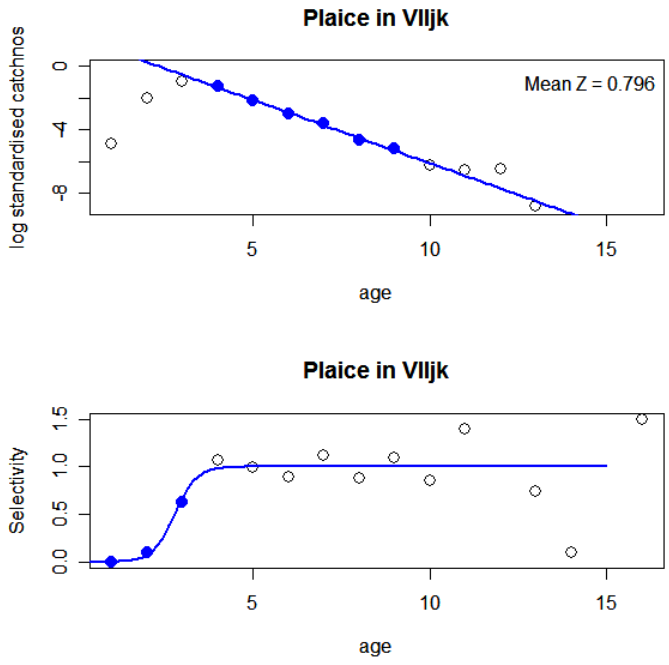


Figure 7.11.9. Selectivity was modelled by fitting a line through the mean log standardized catch numbers of ages 4 to 9 to predict the expected catch numbers for ages 1 to 3 if these were fully selected. The proportions of observed divided by expected catch number were taken as the 'observed' selectivity. This was then modelled using a logit transformation.

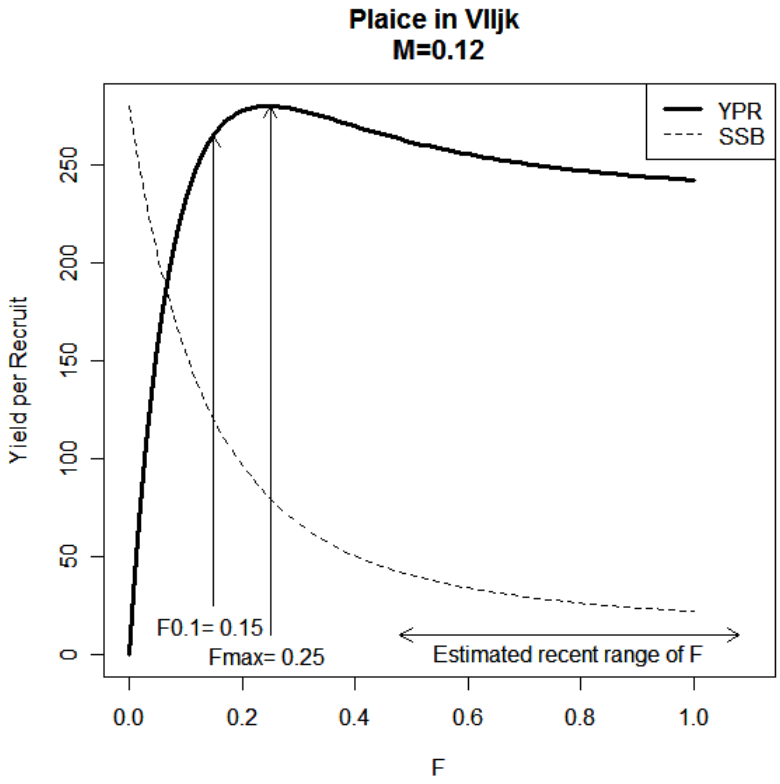


Figure 7.11.10. YPR analysis using the Thompson-Bell approach. Recent estimates of Z were between 0.6 to 1.2 which translates to an F of 0.48 to 1.08.

7.12 Sole in West of Ireland Division VIIb, c

Type of assessment in 2011

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 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). 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.

Table 7.12.1. Landings of Sole in VIIbc as officially reported to ICES.

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
France	-	25	7	6	3	3	6	9	6	5	9	3	6
Ireland	12	12	19	44	14	16	13	24	47	55	40	17	44
Spain	19	16	30	25	1	-	11	1	-	-	-	-	-
UK - Eng+\	.	.	.	.	.	.	.	.	.	.	.	.	.
UK - Engla	-	-	-	-	-	-	-	-	-	1	-	-	-
Total	31	53	56	75	18	19	30	34	53	61	49	20	50

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
France	8	2	2	-	-	5	2	1	1	2	2	3	-
Ireland	29	39	34	38	41	46	43	59	60	59	52	51	49
Spain	-	-	-	-	-	-	-	-	-	-	-	-	-
UK - Eng+\	.	.	.	-	-	-	-	-	-	-	-	1	-
UK - Engla	-	-	1	.	.	.	.	.	.	.	.	.	.
Total	37	41	37	38	41	51	45	60	61	61	54	55	49

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
France	.	12	7	14	19	18	7	12	7	6	4	8
Ireland	68	65	53	50	50	49	38	31	34	31	46	35
Spain	-	-	-	-	-	-	.	.				
UK - Eng+\	-	-	-	-	0	-	.	.				
UK - Engla	.	.	.	.	.	.	.	.				0
Total	68	77	60	64	69	67	45	43	41	37	50	43

7.13 Sole in Divisions VIIfg

Type of assessment in 2011: Update

ICES advice applicable to 2010

In the advice for 2010 ICES considered the stock as having full reproductive capacity and being harvested sustainably.

Single-stock exploitation boundaries

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects.

The current fishing mortality (2008) is estimated to be 0.27, which is slightly above the rate expected to lead to high long-term yields and low risk of stock depletion.

Exploitation boundaries in relation to precautionary limits

F should be kept below F_{pa}, corresponding to landings of less than 1185 tonnes in 2010. This is expected to keep the stock above B_{pa}.

Conclusion on exploitation boundaries

ICES advises that there is no long-term gain in yield to increase fishing mortality. ICES therefore recommends limiting landings in 2010 to no more than 920 t.

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

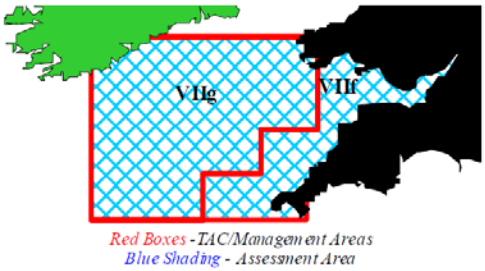
Following the ICES MSY framework implies fishing mortality to be 0.31, resulting in landings of 1400 t in 2011. This is expected to lead to an SSB of 4900 t in 2012.

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.

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.

2010 TAC

Species:	Common sole *Solea solea*	Zone:	VIIf and VIIg (SOL/7FG.)
Belgium	621		
France	62		
Ireland	31		
United Kingdom	279		
EU	993		
TAC	993		Analytical TAC

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

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 2011. 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 2010

The Working Group estimated the total international landings at 862 t in 2010 (Table 7.13.1), which is 13% below the 2010 TAC (993 t) and less than 1% different from last year's forecast of 866 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

French landings submitted to the Working Group for 2009 were revised upward by 26% to 73 t. There were also minor revisions (<1%) from UK (E&W). The 2009 values for the numbers-at-age were therefore also updated. Total landings now amount to 805 t (Table 7.13.1).

Annual length compositions for 2010 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 (approx. 95% of the total landings). Catch weights-at-age were calculated, weighted by national catch numbers-at-age, then quadratically smoothed in year (using age = 1.5, 2.5, etc.) and SOP-corrected. For 2010, the quadratic fit used was:

$$W(t) = +0.073 + (0.0569*(AGE)) - (0.0007*(AGE)^2) \qquad R2 = 0.97$$

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:

$$W(t) = -0.0505 + (0.0819*(AGE)) - (0.0023*(AGE)^2) \qquad R2 = 0.92$$

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 7.13.4-5. Age compositions over the last twelve years are plotted in Figure 7.13.2. The standardized catch proportion-at-age is presented in Figure 7.13.3.

All 2010 data has been uploaded into InterCatch. The aggregated data outside Intercatch has been compared with the Intercatch results and were almost identical apart from some minor differences of 1%.

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 and 2010, discarding of sole in the UK fleet was estimated at about 3%, 1%, 6% 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 2008–2010 accounting for about 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 2010 are presented in Figures 7.13.4a,b. The UK length distributions for 2007–2010 from samples of UK static gear are given in Figure 7.13.4c. The Irish length distributions from the otter trawl fleet for 2010 are shown in Figure 7.13.4d. 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 (See also stock annex).

The proportion of M and F before spawning was set to zero (see stock annex).

Surveys

Standardized 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. Effort stayed at the same level in 2009 and 2010. 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 2010 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 a similar value for 2010.

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 groundfish 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 2010 data to the time-series, together with the French and UK landings revisions for 2009 did not cause any additional anomalies compared to previous years. The "single fleet runs", "separable VPA", etc. that are usually used to screen the data of this stock are therefore 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 French and UK 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. There is a year effect in 2007, 2008 and 2009 for the UK beam trawl fleet (UK-CBT, positive residuals) and for the UK beam trawl survey (UK(E&W)-BTS-Q3), negative residuals), indicating a conflicting signal between these two fleets (see also Section 7.13.9. recommendation for next Benchmark).

In this year's assessment the estimates for the recruiting year class 2009 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 from each other for most of the ages. 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 of 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-series (see also Section 7.13.9 recommendation for next Benchmark).

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:

	2011 assessment		
Fleets	Years	Ages	α–β
BEL-CBT commercial	1971–2003	2–9	0–1
UK-CBT commercial	1991–2009	2–9	0–1
UK(E&W)-BTS-Q3 survey	1988–2009	1–9	0.75–0.85

-First data year	1971
-Last data year	2010
-First age	1
-Last age	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
F_{bar} (4–8)	

Retrospective patterns for the final run are shown in Figure 7.13.12. SSB is generally underestimated and fishing mortality overestimated.

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 2010 data, estimates of fishing mortality and SSB for the most recent years were revised slightly. For example, last year fishing mortality and SSB in 2009 were estimated to be 0.19 and 4180 t. In this year's assessment, the 2009 estimates have been revised upwards by 20% (fishing mortality) and downwards by 10% (SSB). The estimated recruitment by XSA in 2009 (year class 2008) was revised downwards by 26% 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 2006. Fishing mortality in 2010 is estimated to be 0.26.

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 incoming recruitment (year class 2009) is estimated to be by far the weakest in the time-series.

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 2008 is predicted to keep SSB well above $B_{pa}/B_{trigger}$.

7.13.4 Short-term projections

The 2008 year class was estimated to be around 5.4 million fish at age 1, which is about average and 26% lower than estimated last year. The XSA survivor estimate for this year class was used for further prediction.

The 2009 year class in 2010 was estimated by XSA to be 1.2 million one year olds which is by far the lowest in the time-series. 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_{71-08} recruitment (5.0 million) was assumed for the 2010 and subsequent year classes.

The working group estimates of year-class strength used for prediction can be summarized as follows:

Year class	At age in 2011	XSA		Source
2008	3	4206		XSA
2009	2	1069		XSA
2010	1	-	5025	GM 1971–2008
2011 & 2012	recruits	-	5025	GM 1971–2008

Population numbers at the start of 2011, 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 2008–2010. 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 2011 of around 960 t (the agreed TAC is 1241 t) and a catch of 880 t in 2012. Assuming *status quo* F will result in a SSB of 4060 t in 2012 and 3800 t in 2013.

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 2012 and about 12% of the 2013 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 2012 are 650 t and 1150 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 2013.

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 2010, are given in Table 7.13.18 and Figure 7.13.15. F_{max} is estimated to be 0.32. 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 910 t and 4100 t respectively.

Investigations for possible F_{msy} candidates for this stock were done in last year's 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}, while 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 last year's 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 (approx. 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–d) 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 the very strong year classes may cause bias in the forecast. This year's assessment estimates the incoming recruitment (year class 2009) the lowest of 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 (see stock annex).

7.13.9 Recommendation for next benchmark

Year	Candidate Stock	Supporting Justification	Suggested time	Indicate expertise necessary at benchmark meeting
2011	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.	2014	Expert group members

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, increased subsequently due to the strong 1998 year class, to above the long-term average. The good recruitment in 2007 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).

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
1986	1039 *	2	146	188	611	-	3	1989	-389	1600
1987	701 *	-	117	9	437	-	-	1264	-42	1222
1988	705 *	-	110	72	317	-	-	1204	-58	1146
1989	684 *	-	87	18	203	-	-	992	0	992
1990	716 *	-	130	40	353	0	-	1239	-50	1189
1991	982 *	-	80	32	402	0	-	1496	-389	1107
1992	543 *	-	141	45	325	6	-	1060	-79	981
1993	575 *	-	108	51	285	11	-	1030	-102	928
1994	619 *	-	90	37	264	8	-	1018	-9	1009
1995	763 *	-	88	20	294	-	-	1165	-8	1157
1996	695 *	-	102	19	265	0	-	1081	-86	995
1997	660 *	-	99	28	251	0	-	1038	-111	927
1998	675 *	-	98	42	198	-	-	1013	-138	875
1999	604	-	61	51	231	0	-	947	65	1012
2000	694	-	74	29	243	-	-	1040	51	1091
2001	720	-	77	35	288	-	-	1120	48	1168
2002	703	-	65	32	318	+	-	1118	227	1345
2003	715	-	124	26	342	+	-	1207	185	1392
2004	735	-	79	33	283	-	-	1130	119	1249
2005	645	-	101	34	217	-	-	997	47	1044
2006	576	-	75	38	232	-	-	921	25	946
2007	582	-	85	32	244	-	-	943	2	945
2008	466	-	68	28	218	-	-	780	20	800
2009	513	-	74	26	194	-	-	807	-2	805
2010 [1]	620	-	45	27	179	-	-	871	-9	862

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	62	189	61
22	1851	3743	210
23	1163	58842	657
24	10443	298836	1994
25	28050	393734	2880
26	40925	378233	4140
27	40343	346443	6103
28	44327	273845	5395
29	31067	187686	6268
30	29863	148949	5196
31	22994	107339	6275
32	26096	86778	5432
33	22690	67185	4629
34	22975	51023	4278
35	19108	54385	3714
36	19282	41765	2716
37	13266	31920	2967
38	14107	25279	1941
39	14509	21888	1655
40	11437	15140	1220
41	10292	11516	676
42	6378	6047	529
43	4784	5712	476
44	4018	2221	119
45	1810	2050	211
46	1679	642	16
47	949	487	43
48	330	788	0
49	13	278	16
50	123	28	
51	0	39	
52	42	101	
53			
54			
55			
56			
57			
58			
59			
60			
Total	444977	2623111	69817

* Distributions from sample only

Table 7.13.3 - Sole in VIIfg. Catch numbers at age (in thousands)

Run title : CELTIC SEA SOLE - 2011WG
At 1/05/2011 12:35

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	386	541	364	155	119	312	314	318	328	657
3	270	902	1882	438	287	834	438	741	560	972
4	1341	314	748	863	336	560	349	339	747	876
5	625	670	305	411	638	611	271	154	208	584
6	433	329	352	209	304	559	244	159	154	180
7	537	213	119	239	110	261	404	99	197	62
8	763	232	110	97	102	131	120	198	124	96
9	376	314	116	109	67	197	28	71	153	100
+gp	1220	730	644	541	372	463	365	174	169	352
0 TOTALNUM	5951	4245	4640	3062	2335	3928	2533	2253	2640	3879
TONSLAND	1861	1278	1391	1105	919	1350	961	780	954	1314
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	602	342	647	672	196	494	318	526	479	277
3	675	831	1078	846	1473	1296	957	464	1164	994
4	792	309	729	606	766	1173	797	879	601	1176
5	399	467	284	542	565	526	577	441	621	399
6	377	280	349	184	296	358	273	387	237	452
7	150	207	225	277	100	193	205	127	188	138
8	120	92	192	106	140	87	100	78	82	115
9	94	111	52	47	73	103	61	67	24	50
+gp	380	326	320	274	240	328	179	268	102	129
0 TOTALNUM	3589	2965	3876	3554	3849	4558	3467	3237	3498	3730
TONSLAND	1212	1128	1373	1266	1328	1600	1222	1146	992	1189
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	1458	433	354	295	129	177	245	197	608	1721
3	690	1700	863	790	1156	1035	890	932	1718	1480
4	658	644	1104	739	1098	904	599	724	834	683
5	496	409	332	864	420	424	400	297	282	241
6	151	253	186	283	483	229	252	171	143	60
7	156	61	161	149	133	192	127	108	80	56
8	55	59	63	65	112	57	126	51	31	43
9	46	28	83	42	65	43	45	52	23	19
+gp	162	89	99	146	109	106	106	87	44	51
0 TOTALNUM	3872	3676	3245	3373	3705	3167	2790	2619	3763	4354
TONSLAND	1107	981	928	1009	1157	995	927	875	1012	1091
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	704	29	119	425	271	685	335	211	612	264
3	1918	1465	697	1721	855	1330	865	447	468	1260
4	860	2202	1134	792	837	715	743	552	430	715
5	436	660	1860	794	473	576	474	558	349	333
6	242	249	402	721	398	163	325	274	295	247
7	65	95	223	114	348	148	157	196	175	157
8	39	54	80	60	48	178	145	75	104	114
9	26	36	26	34	41	44	184	108	44	64
+gp	81	51	75	49	43	51	70	171	194	112
0 TOTALNUM	4371	4841	4616	4710	3314	3890	3298	2592	2671	3266
TONSLAND	1168	1345	1392	1249	1044	946	945	800	805	862
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 - 2011WG
At 1/05/2011 12:35

Table 2 Catch weights at age (kg)

	YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	AGE										
1		0.039	0.106	0.081	0.063	0.046	0.114	0.098	0.068	0.023	0.048
2		0.106	0.147	0.143	0.137	0.132	0.167	0.169	0.154	0.132	0.144
3		0.167	0.186	0.202	0.205	0.212	0.218	0.235	0.234	0.232	0.234
4		0.222	0.226	0.258	0.270	0.286	0.268	0.297	0.309	0.321	0.316
5		0.272	0.264	0.311	0.329	0.355	0.316	0.355	0.378	0.401	0.392
6		0.315	0.302	0.361	0.385	0.417	0.363	0.409	0.441	0.471	0.461
7		0.352	0.340	0.408	0.436	0.473	0.409	0.460	0.499	0.531	0.523
8		0.383	0.376	0.452	0.483	0.523	0.453	0.506	0.551	0.581	0.579
9		0.408	0.413	0.493	0.525	0.567	0.496	0.548	0.598	0.622	0.627
	+gp	0.4397	0.5384	0.6021	0.6239	0.6715	0.6649	0.6681	0.7196	0.6636	0.720
0	SOPCOFA(	1.000	1.001	1.001	1.000	1.000	0.999	1.000	0.998	1.001	0.999

Table 2 Catch weights at age (kg)

	YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
	AGE										
	1	0.078	0.061	0.085	0.019	0.089	0.046	0.048	0.074	0.013	0.049
	2	0.154	0.156	0.173	0.131	0.17	0.144	0.146	0.157	0.109	0.134
	3	0.225	0.243	0.255	0.235	0.246	0.236	0.236	0.235	0.198	0.214
	4	0.292	0.324	0.33	0.33	0.317	0.321	0.32	0.309	0.28	0.291
	5	0.355	0.397	0.398	0.416	0.383	0.4	0.396	0.378	0.355	0.363
	6	0.414	0.462	0.459	0.494	0.444	0.471	0.466	0.442	0.424	0.43
	7	0.469	0.521	0.514	0.562	0.5	0.536	0.528	0.502	0.487	0.494
	8	0.519	0.572	0.561	0.622	0.552	0.594	0.584	0.557	0.543	0.553
	9	0.565	0.617	0.602	0.673	0.598	0.645	0.632	0.608	0.592	0.609
	+gp	0.6654	0.7043	0.6786	0.7716	0.7026	0.7479	0.7404	0.7385	0.6909	0.7474
0	SOPCOFA(	0.9999	0.9994	1.0004	0.9985	1.0016	1.0004	1.001	0.9993	0.9993	0.9993

Table 2 Catch weights at age (kg)

	YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	AGE										
	1	0.054	0.073	0.057	0.081	0.068	0.027	0.074	0.079	0.015	0.078
	2	0.15	0.147	0.134	0.151	0.147	0.124	0.156	0.163	0.122	0.166
	3	0.239	0.216	0.207	0.216	0.22	0.214	0.234	0.244	0.222	0.248
	4	0.32	0.281	0.275	0.276	0.288	0.296	0.307	0.32	0.315	0.322
	5	0.393	0.342	0.338	0.331	0.351	0.372	0.376	0.393	0.4	0.39
	6	0.459	0.398	0.396	0.38	0.409	0.439	0.44	0.462	0.478	0.451
	7	0.516	0.451	0.45	0.425	0.462	0.5	0.5	0.528	0.549	0.506
	8	0.566	0.499	0.5	0.465	0.51	0.552	0.555	0.589	0.613	0.553
	9	0.608	0.543	0.545	0.5	0.553	0.598	0.605	0.647	0.67	0.594
	+gp	0.674	0.6402	0.6445	0.5626	0.6429	0.6773	0.7071	0.7809	0.7655	0.6649
0	SOPCOFA(	0.9998	0.9995	0.9994	0.9996	0.9982	1.0008	0.9997	0.9994	1.0005	1

Table 2 Catch weights at age (kg)

	YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	AGE										
	1	0.066	0.054	0.123	0.066	0.068	0.085	0.075	0.098	0.132	0.091
	2	0.148	0.13	0.171	0.13	0.145	0.139	0.139	0.155	0.178	0.145
	3	0.225	0.202	0.218	0.194	0.219	0.192	0.2	0.209	0.225	0.198
	4	0.296	0.271	0.266	0.256	0.288	0.245	0.258	0.26	0.271	0.249
	5	0.363	0.336	0.313	0.317	0.354	0.297	0.313	0.31	0.317	0.299
	6	0.425	0.399	0.361	0.377	0.415	0.349	0.365	0.356	0.362	0.348
	7	0.482	0.457	0.408	0.435	0.473	0.4	0.414	0.401	0.408	0.395
	8	0.533	0.513	0.454	0.493	0.528	0.451	0.46	0.443	0.453	0.44
	9	0.579	0.564	0.501	0.549	0.578	0.501	0.503	0.482	0.498	0.485
	+gp	0.6773	0.7045	0.6379	0.7217	0.6918	0.6177	0.6087	0.5448	0.6024	0.593
0	SOPCOFA(	0.9954	1.0001	1.0019	1.0003	1.0004	0.9992	0.9999	1.0035	0.9994	1.0012

Table 7.13.5 - Sole in VIIfg. Stock weights at age (kg)

Run title : CELTIC SEA SOLE - 2011WG
At 1/05/2011 12:35

Table 3 Stock weights at age (kg)

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
AGE										
1	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
2	0.076	0.113	0.113	0.113	0.113	0.113	0.145	0.113	0.113	0.113
3	0.136	0.157	0.142	0.159	0.141	0.16	0.174	0.167	0.163	0.157
4	0.19	0.222	0.203	0.221	0.215	0.21	0.236	0.257	0.255	0.238
5	0.239	0.298	0.263	0.305	0.295	0.269	0.366	0.36	0.392	0.354
6	0.406	0.351	0.334	0.45	0.353	0.354	0.392	0.413	0.437	0.394
7	0.472	0.352	0.322	0.448	0.593	0.432	0.454	0.521	0.485	0.622
8	0.389	0.593	0.4	0.464	0.423	0.462	0.505	0.508	0.595	0.556
9	0.346	0.417	0.539	0.624	0.465	0.425	0.907	0.56	0.657	0.704
+gp	0.5826	0.6005	0.5822	0.6707	0.7112	0.728	0.7006	0.7826	0.6963	0.7714

Table 3 Stock weights at age (kg)

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
2	0.113	0.113	0.113	0.118	0.113	0.113	0.113	0.113	0.113	0.113
3	0.159	0.164	0.175	0.173	0.175	0.18	0.153	0.158	0.152	0.164
4	0.232	0.255	0.262	0.274	0.268	0.273	0.242	0.233	0.227	0.247
5	0.306	0.356	0.37	0.429	0.472	0.398	0.361	0.363	0.308	0.369
6	0.385	0.487	0.488	0.517	0.433	0.462	0.473	0.466	0.465	0.476
7	0.462	0.543	0.633	0.641	0.462	0.546	0.468	0.687	0.546	0.523
8	0.551	0.61	0.606	0.613	0.48	0.636	0.587	0.687	0.526	0.753
9	0.737	0.766	0.464	0.836	0.944	0.89	0.82	0.676	0.542	0.847
+gp	0.6627	0.8561	0.823	0.9784	0.7983	0.8435	0.8378	0.818	0.7522	0.9732

Table 3 Stock weights at age (kg)

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
2	0.113	0.113	0.148	0.113	0.113	0.104	0.113	0.113	0.11	0.062
3	0.179	0.184	0.196	0.135	0.143	0.186	0.178	0.195	0.204	0.169
4	0.23	0.265	0.267	0.227	0.233	0.284	0.276	0.282	0.317	0.306
5	0.356	0.388	0.392	0.329	0.335	0.387	0.386	0.371	0.433	0.434
6	0.536	0.498	0.47	0.43	0.441	0.486	0.495	0.454	0.541	0.534
7	0.376	0.751	0.492	0.521	0.54	0.573	0.598	0.529	0.635	0.603
8	0.859	0.754	0.576	0.599	0.629	0.647	0.689	0.593	0.712	0.648
9	0.735	0.475	0.636	0.661	0.705	0.708	0.766	0.644	0.772	0.677
+gp	0.6789	0.8963	0.7272	0.7572	0.8447	0.808	0.8923	0.7318	0.8525	0.707

Table 3 Stock weights at age (kg)

YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE										
1	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
2	0.113	0.113	0.158	0.116	0.149	0.143	0.117	0.151	0.147	0.14
3	0.187	0.189	0.205	0.176	0.213	0.188	0.177	0.2	0.21	0.208
4	0.312	0.289	0.258	0.248	0.275	0.235	0.236	0.249	0.271	0.271
5	0.434	0.403	0.317	0.329	0.337	0.284	0.294	0.298	0.33	0.33
6	0.538	0.512	0.381	0.415	0.399	0.334	0.35	0.349	0.386	0.385
7	0.619	0.609	0.449	0.502	0.459	0.386	0.406	0.4	0.439	0.434
8	0.68	0.691	0.521	0.587	0.52	0.441	0.46	0.453	0.491	0.479
9	0.725	0.757	0.594	0.667	0.579	0.496	0.513	0.506	0.54	0.52
+gp	0.7835	0.873	0.8113	0.869	0.7401	0.6414	0.6622	0.6027	0.6414	0.5988

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
Geomean	15	359	306	55	17	8	6	3	2	2
Mean	30	499	359	72	20	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	7.62	14.44		32.22	140.82	9.69	40.98

[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	1.00	0.63	5.92		16.00	0.13	0.01	0.21

[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	2010													
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**

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	**2010**									
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**

IR - GFS : Irish Groundfish Survey (IBTS 4th Qtr) - VIIb Sole number at age (Interim indices for new Celtic Explorer series)

2003	2010									
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

UK (E+W) TRAWL 107F. (Processed as unsexed - from 2001WG)

1991	2010									
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

Table 7.13.10 - Sole VIIfg - XSA diagnostics

Lowestoft VPA Version 3.1

1/05/2011 12:34

Extended Survivors Analysis

CELTIC SEA SOLE - 2011WG

CPUE data from file s7fgtun.txt

Catch data for 40 years. 1971 to 2010. Ages 1 to 10.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BE-CBT	1971	2010	2	9	0	1
UK(E&W)-CBT	1991	2010	2	9	0	1
UK(E&W)-BTS-Q3	1988	2010	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	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0	0	0	0	0	0	0	0	0	0
2	0.11	0.008	0.021	0.098	0.052	0.153	0.113	0.061	0.077	0.058
3	0.207	0.311	0.244	0.403	0.261	0.345	0.263	0.195	0.167	0.202
4	0.402	0.345	0.374	0.425	0.311	0.322	0.294	0.238	0.26	0.366
5	0.4	0.545	0.486	0.433	0.43	0.325	0.327	0.333	0.208	0.293
6	0.536	0.372	0.668	0.312	0.356	0.229	0.273	0.284	0.263	0.2
7	0.376	0.368	0.59	0.354	0.218	0.194	0.321	0.235	0.263	0.194
8	0.38	0.543	0.534	0.273	0.22	0.148	0.263	0.223	0.169	0.244
9	0.522	0.638	0.485	0.402	0.271	0.287	0.201	0.285	0.176	0.134

1

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
2001	4.17E+03	7.11E+03	1.08E+04	2.73E+03	1.39E+03	6.13E+02	2.18E+02	1.30E+02	6.72E+01
2002	6.80E+03	3.78E+03	5.76E+03	7.93E+03	1.65E+03	8.43E+02	3.25E+02	1.35E+02	8.03E+01
2003	5.27E+03	6.15E+03	3.39E+03	3.82E+03	5.08E+03	8.67E+02	5.26E+02	2.03E+02	7.12E+01
2004	6.17E+03	4.77E+03	5.45E+03	2.40E+03	2.38E+03	2.83E+03	4.02E+02	2.64E+02	1.08E+02
2005	5.60E+03	5.58E+03	3.91E+03	3.29E+03	1.42E+03	1.40E+03	1.87E+03	2.56E+02	1.82E+02
2006	3.63E+03	5.07E+03	4.79E+03	2.73E+03	2.19E+03	8.36E+02	8.84E+02	1.36E+03	1.86E+02
2007	4.15E+03	3.28E+03	3.93E+03	3.07E+03	1.79E+03	1.43E+03	6.02E+02	6.59E+02	1.06E+03
2008	9.56E+03	3.76E+03	2.65E+03	2.74E+03	2.07E+03	1.17E+03	9.84E+02	3.95E+02	4.58E+02
2009	5.44E+03	8.65E+03	3.20E+03	1.97E+03	1.95E+03	1.34E+03	7.95E+02	7.04E+02	2.86E+02
2010	1.18E+03	4.93E+03	7.25E+03	2.45E+03	1.38E+03	1.43E+03	9.34E+02	5.53E+02	5.38E+02

Estimated population abundance at 1st Jan 2010

0.00E+00	1.07E+03	4.21E+03	5.36E+03	1.54E+03	9.29E+02	1.06E+03	6.96E+02	3.92E+02

Taper weighted geometric mean of the VPA populations:

4.86E+03	4.57E+03	3.69E+03	2.44E+03	1.49E+03	9.05E+02	5.54E+02	3.52E+02	2.27E+02

Standard error of the weighted Log(VPA populations) :

0.4117	0.3424	0.3517	0.3545	0.4169	0.4917	0.6	0.7788	0.9558

Table 7.13.10 - Sole VIIfg - XSA diagnostics - continued

Log catchability residuals.

Fleet : BE-CBT

Age	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	No data for this fleet at this age									
2	0.23	0.13	0.54	0.11	-0.15	0.55	0.21	0.38	0.41	1.18
3	-0.48	0.18	0.38	-0.1	-0.34	0.4	0.15	0.08	0.08	0.05
4	0.26	-0.16	0.13	-0.05	-0.31	-0.01	-0.02	0.07	0.41	0.27
5	0.32	0.14	0.2	0.14	0	0.26	-0.08	-0.46	0.13	0.21
6	0.13	0.3	-0.09	0.51	0.27	-0.18	0.08	-0.21	0.05	-0.04
7	0.5	-0.01	-0.3	0.12	0.38	0.15	0.19	-0.38	0.63	-0.87
8	0.32	0.21	-0.42	-0.01	-0.45	0.57	-0.01	-0.17	0.3	-0.16
9	0.02	-0.1	-0.18	0.15	-0.1	0.07	-0.27	-0.23	0.02	-0.01

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	No data for this fleet at this age									
2	0.55	0.22	0.45	0.17	-1.66	-0.09	0.42	0.05	-0.31	0.09
3	0.22	0.12	-0.02	-0.19	-0.06	0.01	-0.16	-0.54	-0.48	0.18
4	-0.09	-0.15	-0.25	-0.34	-0.12	-0.09	0	-0.19	-0.15	0.13
5	-0.13	0.05	-0.24	0.02	0.12	-0.04	0	-0.05	-0.1	-0.04
6	0.21	0.21	-0.18	-0.1	0.07	0.11	0.38	-0.02	0.09	0.22
7	0.17	0.41	0.14	0.22	-0.06	0.05	0.69	0.02	0.18	0.19
8	-0.14	0.36	0.5	-0.08	0.19	-0.27	-0.13	0.57	0.17	0.24
9	0.08	0.42	-0.22	-0.29	-0.06	-0.08	0.15	0.03	-0.31	-0.16

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	No data for this fleet at this age									
2	1.61	0.79	0.42	-0.16	-1.11	-0.77	-0.44	-0.91	0.03	0.26
3	0.42	0.42	0.29	-0.2	0.1	0.25	0.07	0	0.2	-0.03
4	0.08	0.31	-0.03	0.23	0.42	0.19	-0.08	0.45	0.1	-0.55
5	0	0.24	-0.18	0.19	0.05	0.04	0.02	-0.07	0.05	-0.92
6	-0.35	0.02	-0.33	0.36	-0.03	0.03	0.21	-0.09	-0.47	-1.6
7	-0.45	-0.85	0.23	-0.07	0.1	-0.32	0.21	0.66	-0.45	-1.28
8	-0.41	-0.96	0.44	-0.74	-0.02	-0.27	-0.26	0.16	-0.64	-0.82
9	-0.41	-0.48	0.29	-0.02	-0.29	-0.32	0.07	-0.43	-0.09	-0.61

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	No data for this fleet at this age									
2	0.09	99.99	-3.28	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	-0.71	0.04	-0.32	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	-0.17	-0.2	-0.06	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	-0.31	0.39	0.06	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6	0.07	-0.2	0.57	99.99	99.99	99.99	99.99	99.99	99.99	99.99
7	-0.4	-0.23	0.45	99.99	99.99	99.99	99.99	99.99	99.99	99.99
8	-0.74	0	0.21	99.99	99.99	99.99	99.99	99.99	99.99	99.99
9	-0.4	-0.03	0.27	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	-6.3727	-5.1056	-4.8867	-4.9172	-4.9827	-5.0711	-5.0711	-5.0711
S.E(Log q)	0.8642	0.2857	0.2321	0.2421	0.3733	0.4505	0.4199	0.2593

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	0.065	6.43	0.15	32	0.85	-6.37
3	1.06	-0.419	4.91	0.58	33	0.31	-5.11
4	1.07	-0.603	4.68	0.71	33	0.25	-4.89
5	0.85	1.926	5.28	0.84	33	0.2	-4.92
6	0.76	2.375	5.4	0.76	33	0.27	-4.98
7	0.81	1.753	5.29	0.74	33	0.36	-5.07
8	0.89	1.315	5.21	0.83	33	0.36	-5.15
9	0.92	2.109	5.19	0.96	33	0.21	-5.18
1							

Table 7.13.10 - Sole VIIfg - XSA diagnostics - continued

Fleet : UK(E&W)-CBT

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	No data for this fleet at this age									
2	0.43	0.17	-1.1	0.31	0.17	0.47	-0.59	-0.74	-0.05	-0.08
3	0.04	0.3	-0.16	-0.25	-0.12	0.18	-0.35	-0.15	0.22	-0.2
4	0.52	0.11	0	-0.48	-0.35	0.29	0.06	-0.15	-0.16	-0.1
5	0.54	0.06	-0.07	-0.2	-0.23	0	0.04	0.21	-0.08	-0.25
6	0.4	0.16	-0.22	-0.36	0.18	-0.01	0.24	0.15	0.17	-0.38
7	0.37	-0.05	0.08	-0.18	-0.15	0.02	0.09	-0.16	0.07	0.06
8	0.4	-0.21	-0.35	-0.07	0.45	-0.06	0.28	0.01	0.29	0.26
9	0.51	0.23	0.34	0.4	0.73	0.28	0.21	0.13	-0.17	0.57

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	No data for this fleet at this age									
2	-0.06	-0.42	-0.49	0.08	0.41	0.43	1.16	0.69	0.64	-1.41
3	-0.53	-0.18	-0.16	-0.43	-0.17	0.17	0.41	0.86	0.44	0.07
4	-0.66	-0.15	-0.24	-0.52	-0.07	0.23	0.23	0.54	0.67	0.24
5	-0.4	-0.23	-0.05	-0.27	-0.32	0.23	0.33	0.15	0.34	0.17
6	-0.33	-0.17	0.05	-0.22	-0.43	-0.21	0.41	0.27	0.43	-0.14
7	-0.35	-0.09	-0.08	0.03	-0.2	-0.14	0.3	0.39	0.04	-0.08
8	0.06	0.42	-0.07	0.18	-0.24	-0.02	0.43	0.26	0.19	-0.11
9	0.35	0.74	-0.14	0.55	0.05	0.37	0.54	0.66	0.21	-0.19

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	-8.9887	-6.8971	-6.3151	-6.0034	-5.8191	-5.7614	-5.7614	-5.7614
S.E(Log q)	0.6362	0.3359	0.3613	0.2545	0.2809	0.1896	0.2655	0.4324

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.07	-0.164	9.02	0.24	20	0.7	-8.99
3	1.4	-1.43	6.34	0.42	20	0.46	-6.9
4	1.14	-0.548	6.11	0.47	20	0.42	-6.32
5	0.98	0.144	6.03	0.79	20	0.26	-6
6	1.01	-0.044	5.81	0.8	20	0.29	-5.82
7	0.96	0.642	5.78	0.92	20	0.18	-5.76
8	1.02	-0.236	5.66	0.89	20	0.25	-5.66
9	0.99	0.159	5.44	0.89	20	0.29	-5.44
1							

Fleet : UK(E&W)-BTS-Q3

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-1.39	-0.19	-0.48
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.01	0.28	0.39
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.32	1.09	0.13
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.11	0.57	-0.06
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.13	0.42	-0.05
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.5	0.19
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.52	0.58
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.66	99.99
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	1.72	99.99

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.23	0.2	-0.68	0.36	-0.66	-0.67	0.09	0.53	0.81	0.48
2	0.15	0.11	0.3	0.33	0.09	0.09	-0.27	0.23	-0.34	0.49
3	0.5	0.58	-0.04	0.81	0.18	0.5	-0.59	0.16	-0.48	-0.67
4	0.19	0.81	-0.16	0.4	-0.12	0.7	0.22	0.16	0.14	0.27
5	0.69	1.02	-1.02	-0.22	0.1	0.15	1.02	0.71	0.62	-0.17
6	0.29	0.65	-1.16	0.61	0.59	-0.28	0.5	0.48	0.3	99.99
7	99.99	-0.7	-0.34	99.99	-0.65	0.12	0.74	0.7	1.26	0.29
8	1	-0.13	-0.15	99.99	-0.24	-0.11	1.22	0.36	0.65	0.23
9	0.86	0.4	-0.21	1.74	0.31	1.51	99.99	1.61	99.99	1.34

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.23	0.3	0.03	0.52	-0.16	0.04	0.18	0.41	0.26	0
2	0.3	-0.07	0.25	0.23	-0.48	-0.42	-0.64	-0.85	-0.56	0.38
3	0.42	0.42	-0.11	0.16	-0.61	-0.54	-0.32	-1.21	-0.76	0.06
4	-0.03	0.52	-0.12	-0.28	-0.66	-0.46	-0.6	-0.41	-0.88	-0.09
5	-0.1	0.28	0.5	0.31	-0.35	-0.73	-0.05	-0.81	-0.49	-1.68
6	0.23	-0.07	0.39	0.5	-0.92	99.99	-0.67	-0.21	-1.18	-0.74
7	0.24	-0.16	-0.06	0.34	0.11	-1.3	-0.41	-0.68	-0.74	0.15
8	99.99	1.26	0.84	0.41	-0.73	0.02	-0.26	-0.07	-0.69	-0.1
9	1.54	99.99	99.99	99.99	0.34	99.99	0.47	0.34	-0.19	-0.85

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	-7.1547	-7.2118	-8.508	-9.1195	-9.3122	-9.122	-9.3297	-9.3297	-9.3297
S.E(Log q)	0.5063	0.3785	0.5674	0.4365	0.6609	0.6171	0.6269	0.6321	1.1095

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	0.72	1.783	7.53	0.67	23	0.35	-7.15
2	0.87	0.659	7.37	0.56	23	0.33	-7.21
3	0.78	0.845	8.46	0.42	23	0.45	-8.51
4	1.34	-1.015	9.57	0.29	23	0.59	-9.12
5	1.38	-0.894	10.09	0.21	23	0.91	-9.31
6	1.72	-1.598	10.85	0.22	20	1.02	-9.12
7	1.87	-2.22	12.16	0.27	20	1.07	-9.33
8	1.61	-2.129	11.3	0.41	19	0.87	-9.11
9	2.65	-3.22	14.43	0.23	15	1.67	-8.6

1

Terminal year survivor and F summaries :

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2009

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
UK(E&W)-CBT	1	0	0	0	0	0	0
UK(E&W)-BTS-Q3	1069	0.517	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
1069	0.52	0	1	0	0

1

Age 2 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	1024	0.652	0	0	1	0.178	0.219
UK(E&W)-BTS-Q3	5910	0.31	0.06	0.19	2	0.787	0.042
F shrinkage mean	2619	1.5				0.036	0.092

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4206	0.27	0.39	4	1.418	0.058

Table 7.13.10 - Sole VIIfg - XSA diagnostics - continued

Age 3 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	6459	0.305	0.228	0.75	2	0.446	0.17
UK(E&W)-BTS-Q3	4626	0.273	0.297	1.09	3	0.531	0.23
F shrinkage mean	4283	1.5				0.023	0.247

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5360	0.2	0.17	6	0.844	0.202

1

Age 4 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	2242	0.236	0.104	0.44	3	0.497	0.265
UK(E&W)-BTS-Q3	1029	0.234	0.245	1.05	4	0.483	0.507
F shrinkage mean	2056	1.5				0.02	0.286

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1536	0.17	0.19	8	1.136	0.366

Age 5 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	1536	0.189	0.195	1.03	4	0.618	0.187
UK(E&W)-BTS-Q3	400	0.225	0.256	1.14	5	0.366	0.583
F shrinkage mean	823	1.5				0.016	0.325

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
929	0.14	0.25	10	1.756	0.293

1

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 2004

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	1305	0.163	0.138	0.85	5	0.683	0.166
UK(E&W)-BTS-Q3	681	0.219	0.074	0.34	6	0.305	0.297
F shrinkage mean	722	1.5				0.012	0.282

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1062	0.13	0.12	12	0.894	0.2

Table 7.13.10 - Sole VIIfg - XSA diagnostics - continued

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	1	0	0	0	0	0	0
UK(E&W)-CBT	817	0.151	0.09	0.6	6	0.728	0.168
UK(E&W)-BTS-Q3	451	0.224	0.212	0.95	7	0.26	0.286
F shrinkage mean	534	1.5				0.012	0.247

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
696	0.13	0.11	14	0.904	0.194

1

Age 8 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	422	0.14	0.072	0.52	7	0.753	0.229
UK(E&W)-BTS-Q3	306	0.224	0.118	0.53	8	0.235	0.303
F shrinkage mean	477	1.5				0.012	0.205

Weighted prediction :

Survivors **at end of year**	Int s.e	Ext s.e	N	Var Ratio	F
392	0.12	0.07	16	0.554	0.244

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BE-CBT	16	0.878	0	0	1	0.005	1.565
UK(E&W)-CBT	505	0.136	0.095	0.7	8	0.765	0.114
UK(E&W)-BTS-Q3	263	0.225	0.142	0.63	9	0.219	0.208
F shrinkage mean	205	1.5				0.011	0.26

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
426	0.12	0.11	19	0.941	0.134

Table 7.13.11 - Sole in VIIfg. Fishing mortality

Run title : CELTIC SEA SOLE - 2011WG
At 1/05/2011 12:35

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.000
2	0.0825	0.0676	0.1042	0.0546	0.0415	0.1300	0.0728	0.0831	0.0719	0.243
3	0.1455	0.2513	0.3134	0.1578	0.1221	0.3974	0.2426	0.2195	0.1846	0.280
4	0.3793	0.2248	0.3035	0.2065	0.1566	0.3284	0.2557	0.2677	0.3194	0.431
5	0.3888	0.2940	0.3156	0.2425	0.2075	0.4164	0.2331	0.1533	0.2334	0.393
6	0.3037	0.3236	0.2212	0.3300	0.2540	0.2527	0.2587	0.1866	0.2022	0.290
7	0.4001	0.2143	0.1658	0.2055	0.2580	0.3208	0.2608	0.1420	0.3297	0.105
8	0.3343	0.2678	0.1467	0.1772	0.1138	0.4899	0.2134	0.1761	0.2373	0.236
9	0.2478	0.1991	0.1859	0.1899	0.1602	0.2975	0.1617	0.1691	0.1796	0.273
+gp	0.2478	0.1991	0.1859	0.1899	0.1602	0.2975	0.1617	0.1691	0.1796	0.273
FBAR 4-8	0.3613	0.2649	0.2305	0.2323	0.1980	0.3616	0.2444	0.1851	0.2644	0.291

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.1465	0.0853	0.1669	0.1221	0.0496	0.1070	0.1244	0.1126	0.1323	0.0905
3	0.3751	0.2754	0.3714	0.3046	0.3778	0.4646	0.2767	0.2404	0.3445	0.3923
4	0.3437	0.2617	0.3674	0.3278	0.4405	0.5176	0.5140	0.3910	0.4925	0.6147
5	0.3169	0.3110	0.3622	0.4538	0.5103	0.5448	0.4598	0.5292	0.4678	0.6292
6	0.4212	0.3413	0.3585	0.3748	0.4255	0.6277	0.5368	0.5669	0.5350	0.6535
7	0.3702	0.3825	0.4482	0.4752	0.3190	0.4816	0.8045	0.4546	0.5268	0.6075
8	0.2704	0.3619	0.6495	0.3487	0.4153	0.4482	0.4373	0.7330	0.5288	0.6326
9	0.3401	0.3818	0.3180	0.2843	0.3821	0.5422	0.5767	0.5212	0.4584	0.6342
+gp	0.3401	0.3818	0.3180	0.2843	0.3821	0.5422	0.5767	0.5212	0.4584	0.6342
FBAR 4-8	0.3445	0.3317	0.4372	0.3961	0.4221	0.5240	0.5505	0.5349	0.5102	0.6275

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.2191	0.1276	0.0968	0.0806	0.0449	0.0640	0.0728	0.0427	0.1191	0.1414
3	0.3021	0.3793	0.3564	0.2888	0.4516	0.5234	0.4573	0.3820	0.5451	0.4158
4	0.4330	0.4523	0.4021	0.5195	0.7220	0.6799	0.5797	0.7367	0.6163	0.3834
5	0.5039	0.4655	0.3943	0.5587	0.5583	0.6011	0.6465	0.5629	0.6325	0.3176
6	0.4564	0.4610	0.3538	0.6076	0.6207	0.5989	0.7793	0.5611	0.5144	0.2325
7	0.4336	0.2987	0.5308	0.4713	0.5695	0.4746	0.6984	0.8184	0.4929	0.3441
8	0.4591	0.2573	0.5064	0.3746	0.6934	0.4517	0.5808	0.5950	0.5140	0.4755
9	0.4945	0.3972	0.6092	0.6651	0.6977	0.5525	0.6895	0.4450	0.5196	0.6073
+gp	0.4945	0.3972	0.6092	0.6651	0.6977	0.5525	0.6895	0.4450	0.5196	0.6073
FBAR 4-8	0.4572	0.3870	0.4375	0.5063	0.6328	0.5612	0.6569	0.6548	0.5540	0.3506

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	FBAR 08-10
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.1100	0.0081	0.0206	0.0983	0.0524	0.1533	0.1135	0.0608	0.0773	0.0580	0.0654
3	0.2072	0.3111	0.2436	0.4034	0.2610	0.3451	0.2629	0.1951	0.1670	0.2018	0.1880
4	0.4022	0.3454	0.3742	0.4252	0.3107	0.3224	0.2937	0.2383	0.2601	0.3665	0.2883
5	0.4000	0.5446	0.4863	0.4326	0.4304	0.3245	0.3268	0.3331	0.2083	0.2933	0.2782
6	0.5360	0.3716	0.6680	0.3124	0.3565	0.2292	0.2732	0.2836	0.2626	0.1998	0.2487
7	0.3761	0.3677	0.5896	0.3536	0.2176	0.1936	0.3206	0.2350	0.2632	0.1943	0.2308
8	0.3799	0.5433	0.5336	0.2729	0.2199	0.1479	0.2630	0.2225	0.1688	0.2443	0.2119
9	0.5223	0.6376	0.4846	0.4023	0.2705	0.2866	0.2009	0.2846	0.1763	0.1336	0.1981
+gp	0.5223	0.6376	0.4846	0.4023	0.2705	0.2866	0.2009	0.2846	0.1763	0.1336	
FBAR 4-8	0.4188	0.4345	0.5304	0.3594	0.3070	0.2435	0.2954	0.2625	0.2326	0.2597	

Table 4.3.12 - Sole in VIIfg. Stock numbers at age (start of year, in thousand)

Run title : CELTIC SEA SOLE - 2011WG
At 1/05/2011 12:35

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	9610	4276	3387	3404	2973	5193	4636	5493	3534	5131
2	5123	8695	3869	3065	3080	2690	4699	4195	4970	3198
3	2096	4268	7353	3154	2626	2674	2137	3953	3493	4185
4	4466	1639	3004	4863	2438	2103	1626	1517	2872	2628
5	2040	2766	1185	2006	3580	1886	1370	1139	1050	1888
6	1738	1251	1865	782	1425	2632	1125	982	884	753
7	1712	1161	819	1353	509	1000	1850	786	737	654
8	2823	1038	848	628	997	356	656	1289	617	480
9	1801	1828	719	662	476	805	197	480	978	440
+gp	5830	4241	3982	3281	2637	1886	2565	1174	1079	1546
TOTAL	37237	31163	27031	23199	20739	21224	20861	21008	20216	20903

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	4859	4889	6792	4706	5657	3158	5740	4490	3720	8609
2	4643	4396	4424	6145	4258	5119	2858	5194	4063	3366
3	2269	3629	3653	3387	4921	3666	4162	2283	4199	3220
4	2862	1411	2493	2280	2260	3052	2085	2855	1625	2692
5	1545	1837	982	1562	1486	1317	1646	1128	1747	898
6	1153	1018	1218	619	898	807	691	940	601	990
7	510	685	655	770	385	531	390	365	483	319
8	532	319	423	378	433	253	297	158	210	258
9	343	368	201	200	242	259	146	173	69	112
+gp	1381	1076	1231	1161	792	820	427	690	290	287
TOTAL	20096	19626	22070	21208	21332	18981	18440	18277	17006	20751

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	4200	4456	4427	3411	3319	4054	5478	6292	15162	7854
2	7790	3800	4032	4006	3086	3003	3668	4957	5693	13719
3	2782	5661	3026	3311	3344	2670	2549	3086	4298	4573
4	1968	1861	3506	1917	2245	1926	1431	1460	1906	2255
5	1317	1155	1071	2122	1032	987	883	725	632	931
6	433	720	656	653	1098	534	489	419	374	304
7	466	248	411	417	322	534	266	203	216	202
8	157	273	167	219	235	165	301	120	81	119
9	124	90	191	91	136	106	95	152	60	44
+gp	435	284	227	314	227	261	222	254	114	117
TOTAL	19672	18549	17714	16462	15045	14241	15383	17668	28536	30119

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	GMST 71-08	AMST 71-08
1	4173	6795	5273	6166	5601	3628	4153	9563	5444	1181	0*	5025	5375
2	7107	3776	6149	4771	5579	5068	3283	3758	8653	4926	1069	4484	4771
3	10777	5761	3389	5450	3913	4791	3934	2652	3199	7248	4206	3639	3876
4	2730	7927	3819	2404	3295	2727	3070	2737	1974	2450	5360	2449	2630
5	1390	1652	5078	2377	1422	2185	1788	2071	1951	1377	1536	1480	1628
6	613	843	867	2825	1395	836	1429	1167	1343	1433	929	885	1001
7	218	325	526	402	1870	884	602	984	795	934	1062	541	652
8	130	135	203	264	256	1361	659	395	704	553	696	342	480
9	67	80	71	108	182	186	1063	458	286	538	392	220	363
+gp	208	113	204	155	190	215	403	724	1260	940	1170		
TOTAL	27414	27408	25580	24923	23703	21880	20382	24508	25609	21580	16420		

* Replaced with GM (5025)

Table 7.13.13 - Sole in VIIfg. Summary

Run title : CELTIC SEA SOLE - 2011WG
At 1/05/2011 12:35

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 8
1971	9610	9506	8038	1861	0.2315	0.3613
1972	4276	7998	6339	1278	0.2016	0.2649
1973	3387	6639	5304	1391	0.2622	0.2305
1974	3404	6704	5683	1105	0.1945	0.2323
1975	2973	5889	5034	919	0.1826	0.1980
1976	5193	5391	4364	1350	0.3094	0.3616
1977	4636	5944	4680	961	0.2053	0.2444
1978	5493	5086	3766	780	0.2071	0.1851
1979	3534	5098	3888	954	0.2454	0.2644
1980	5131	5247	4024	1314	0.3265	0.2911
1981	4859	4600	3424	1212	0.3540	0.3445
1982	4889	4810	3559	1128	0.3169	0.3317
1983	6792	5138	3660	1373	0.3752	0.4372
1984	4706	5378	3920	1266	0.3230	0.3961
1985	5657	4793	3310	1328	0.4012	0.4221
1986	3158	4625	3370	1600	0.4747	0.5240
1987	5740	3736	2519	1222	0.4851	0.5505
1988	4490	3906	2711	1146	0.4227	0.5349
1989	3720	3248	2113	992	0.4696	0.5102
1990	8609	3886	2407	1189	0.4939	0.6275
1991	4200	3606	2134	1107	0.5188	0.4572
1992	4456	3862	2451	981	0.4003	0.3870
1993	4427	3837	2479	928	0.3744	0.4375
1994	3411	3267	2259	1009	0.4467	0.5063
1995	3319	3088	2157	1157	0.5364	0.6328
1996	4054	3062	2082	995	0.4780	0.5612
1997	5478	2977	1823	927	0.5084	0.6569
1998	6292	3061	1627	875	0.5377	0.6548
1999	15162	4286	1822	1012	0.5553	0.5540
2000	7854	3899	1944	1091	0.5612	0.3506
2001	4173	5414	3125	1168	0.3737	0.4188
2002	6795	5966	4101	1345	0.3280	0.4345
2003	5273	5617	3774	1392	0.3688	0.5304
2004	6166	5182	3536	1249	0.3532	0.3594
2005	5601	5348	3553	1044	0.2939	0.3070
2006	3628	4664	3130	946	0.3023	0.2435
2007	4153	4564	3380	945	0.2796	0.2954
2008	9563	4905	3170	800	0.2523	0.2625
2009	5444	5788	3758	805	0.2142	0.2326
2010	1181	5487	3869	862	0.2228	0.2597
2011	5025[1]	5429[2]	4187[2]			0.2516[3]
Arith. Mean	5272	4888	3457	1125	0.3597	0.3964
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

[1] Geometric mean 1971-2008
[2] From forecast
[3] Mean $F_{(2008-2010)}$

Table 7.13.14 - Sole in VIIfg
Input for catch forecast and Fmsy analysis

Input: F mean 08-10 not rescaled to F2010
Catch and stock weights are mean 08-10
Recruits age 1 in 2011,12 and 13 GM (71-08)

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	5025	0.43	WS1	0.090	0.00
N2	1069	0.52	WS2	0.146	0.04
N3	4206	0.39	WS3	0.206	0.03
N4	5360	0.20	WS4	0.264	0.05
N5	1536	0.19	WS5	0.319	0.06
N6	929	0.25	WS6	0.373	0.06
N7	1062	0.13	WS7	0.424	0.05
N8	696	0.13	WS8	0.474	0.04
N9	392	0.12	WS9	0.522	0.03
N10	1170	0.12	WS10	0.614	0.04
H.cons selectivity			Weight in the HC catch		
sH1	0.0000	0.00	WH1	0.107	0.20
sH2	0.0654	0.16	WH2	0.159	0.11
sH3	0.1880	0.10	WH3	0.211	0.06
sH4	0.2883	0.24	WH4	0.260	0.04
sH5	0.2782	0.23	WH5	0.309	0.03
sH6	0.2487	0.18	WH6	0.355	0.02
sH7	0.2308	0.15	WH7	0.401	0.02
sH8	0.2119	0.18	WH8	0.445	0.02
sH9	0.1982	0.39	WH9	0.488	0.02
sH10	0.1982	0.39	WH10	0.580	0.05
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		
HF11	1	0.1	K10	1	0.1
HF12	1	0.1	K11	1	0.1
HF13	1	0.1	K12	1	0.1
Recruitment in 2012 and 2013					
R12	5025	0.43			
R13	5025	0.43			

Table 7.13.15 Sole in VIIfg - Management option table

MFDP version 1a
Run: S7fg_fin
Sole in VIId
Time and date: 18:34 1/05/2011
Fbar age range: 4-8

2011 Biomass	SSB	FMult	FBar	Landings
5429	4187	1.0000	0.2516	956

2012 Biomass	SSB	FMult	FBar	Landings	2013 Biomass	SSB
5306	4057	0.0000	0.0000	0	6292	4759
.	4057	0.1000	0.0252	98	6181	4652
.	4057	0.2000	0.0503	193	6072	4547
.	4057	0.3000	0.0755	287	5967	4445
.	4057	0.4000	0.1006	378	5863	4346
.	4057	0.5000	0.1258	466	5762	4249
.	4057	0.6000	0.1509	553	5664	4154
.	4057	0.7000	0.1761	638	5568	4061
.	4057	0.8000	0.2013	721	5474	3971
.	4057	0.9000	0.2264	802	5382	3883
.	4057	1.0000	0.2516	881	5293	3798
.	4057	1.1000	0.2767	958	5205	3714
.	4057	1.2000	0.3019	1033	5120	3632
.	4057	1.3000	0.3271	1107	5037	3553
.	4057	1.4000	0.3522	1178	4956	3475
.	4057	1.5000	0.3774	1249	4876	3399
.	4057	1.6000	0.4025	1317	4799	3325
.	4057	1.7000	0.4277	1384	4723	3253
.	4057	1.8000	0.4528	1449	4649	3183
.	4057	1.9000	0.4780	1513	4577	3114
.	4057	2.0000	0.5032	1576	4507	3047

Input units are thousands and kg - output in tonnes

Fmult corresponding to Fpa = 1.47						
.	4057	1.47	0.3698	1228	4900	3422
Fmult corresponding to Fmsy = 1.23						
.	4057	1.23	0.3094	1055	5095	3608

Bpa = 2 200 t

Table 7.13.16 - Sole in VIIfg. Detailed results

MFDP version 1a
Run: S7fg_fin
Time and date: 18:34 1/05/2011
Fbar age range: 4-8

Year:	**2011**	F multiplier:	1	Fbar:	0.252				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.000	0	0	5025	452	0	0	0	0
2	0.065	64	10	1069	156	150	22	150	22
3	0.188	687	145	4206	866	1893	390	1893	390
4	0.288	1281	333	5360	1413	4717	1244	4717	1244
5	0.278	356	110	1536	490	1505	481	1505	481
6	0.249	195	69	929	347	929	347	929	347
7	0.231	209	84	1062	451	1062	451	1062	451
8	0.212	127	56	696	330	696	330	696	330
9	0.198	67	33	392	205	392	205	392	205
10	0.198	200	116	1170	719	1170	719	1170	719
Total		3186	956	21445	5429	12513	4187	12513	4187

Year:	**2012**	F multiplier:	1	Fbar:	0.252				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.000	0	0	5025	452	0	0	0	0
2	0.065	274	44	4547	664	637	93	637	93
3	0.188	148	31	906	187	408	84	408	84
4	0.288	753	196	3154	831	2775	732	2775	732
5	0.278	842	260	3635	1161	3562	1138	3562	1138
6	0.249	221	78	1052	393	1052	393	1052	393
7	0.231	129	52	656	278	656	278	656	278
8	0.212	139	62	763	362	763	362	763	362
9	0.198	87	43	510	266	510	266	510	266
10	0.198	199	115	1159	712	1159	712	1159	712
Total		2792	881	21406	5306	11521	4057	11521	4057

Year:	**2013**	F multiplier:	1	Fbar:	0.252				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.000	0	0	5025	452	0	0	0	0
2	0.065	274	44	4547	664	637	93	637	93
3	0.188	629	133	3854	794	1734	357	1734	357
4	0.288	162	42	679	179	598	158	598	158
5	0.278	495	153	2139	683	2096	669	2096	669
6	0.249	523	186	2490	930	2490	930	2490	930
7	0.231	146	59	743	315	743	315	743	315
8	0.212	86	38	471	223	471	223	471	223
9	0.198	96	47	558	292	558	292	558	292
10	0.198	212	123	1239	761	1239	761	1239	761
Total		2624	824	21745	5293	10565	3798	10565	3798

Input units are thousands and kg - output in tonnes

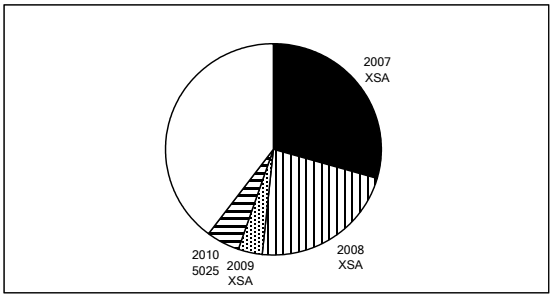
Table 7.13.17 **Sole VIIf,g**
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class			2007	2008	2009	2010	2011
Stock No. (thousands) of 1 year-olds			9563	5444	1181	5025	5025
Source			XSA	XSA	XSA	5025	GM71-08
Status Quo F:							
% in	2011	landings	34.8	15.2	1.0	0.0	-
% in	2012	landings	29.5	22.2	3.5	5.0	0.0
% in	2011	SSB	29.7	9.3	0.5	0.0	-
% in	2012	SSB	28.0	18.0	2.1	2.3	0.0
% in	2013	SSB	24.5	17.6	4.2	9.4	2.4

GM : geometric mean recruitment

Sole VIIf,g : Year-class % contribution to

a) 2012 landings



b) 2013 SSB

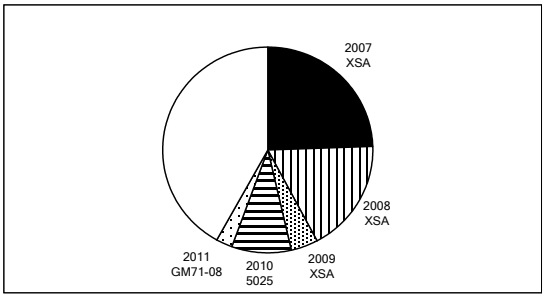


Table 7.13.18 - Sole in VIIfg Yield per recruit summary table

MFYPR version 2a
Run: S7fg_yield_fin
Time and date: 18:41 1/05/2011
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	10.5083	4.3541	8.1776	4.0300	8.1776	4.0300
0.1000	0.0252	0.1525	0.0633	8.9847	3.4736	6.6598	3.1509	6.6598	3.1509
0.2000	0.0503	0.2603	0.1035	7.9081	2.8631	5.5889	2.5418	5.5889	2.5418
0.3000	0.0755	0.3403	0.1298	7.1103	2.4198	4.7968	2.0999	4.7968	2.0999
0.4000	0.1006	0.4017	0.1475	6.4976	2.0866	4.1897	1.7680	4.1897	1.7680
0.5000	0.1258	0.4502	0.1595	6.0139	1.8292	3.7114	1.5119	3.7114	1.5119
0.6000	0.1509	0.4895	0.1677	5.6234	1.6261	3.3262	1.3101	3.3262	1.3101
0.7000	0.1761	0.5217	0.1733	5.3022	1.4628	3.0103	1.1481	3.0103	1.1481
0.8000	0.2013	0.5487	0.1771	5.0339	1.3296	2.7471	1.0160	2.7471	1.0160
0.9000	0.2264	0.5716	0.1796	4.8069	1.2194	2.5251	0.9071	2.5251	0.9071
1.0000	0.2516	0.5912	0.1811	4.6124	1.1273	2.3356	0.8161	2.3356	0.8161
1.1000	0.2767	0.6082	0.1820	4.4442	1.0494	2.1723	0.7394	2.1723	0.7394
1.2000	0.3019	0.6230	0.1824	4.2974	0.9830	2.0304	0.6741	2.0304	0.6741
1.3000	0.3271	0.6361	0.1825	4.1683	0.9259	1.9059	0.6181	1.9059	0.6181
1.4000	0.3522	0.6477	0.1824	4.0539	0.8764	1.7961	0.5697	1.7961	0.5697
1.5000	0.3774	0.6580	0.1820	3.9518	0.8332	1.6986	0.5275	1.6986	0.5275
1.6000	0.4025	0.6673	0.1815	3.8602	0.7952	1.6115	0.4906	1.6115	0.4906
1.7000	0.4277	0.6757	0.1810	3.7775	0.7617	1.5333	0.4582	1.5333	0.4582
1.8000	0.4528	0.6834	0.1804	3.7025	0.7320	1.4627	0.4294	1.4627	0.4294
1.9000	0.4780	0.6903	0.1797	3.6342	0.7054	1.3986	0.4038	1.3986	0.4038
2.0000	0.5032	0.6967	0.1791	3.5718	0.6815	1.3404	0.3809	1.3404	0.3809

Reference point	F multiplier	Absolute F
Fbar(4-8)	1.0000	0.2516
FMax	1.2772	0.3213
F0.1	0.5553	0.1397
F35%SPR	0.5474	0.1377

Figure 7.13.1 - Sole in VIIfg. Dotted lines give the length distributions of UK (England and Wales) landings; solid lines of Belgian landings

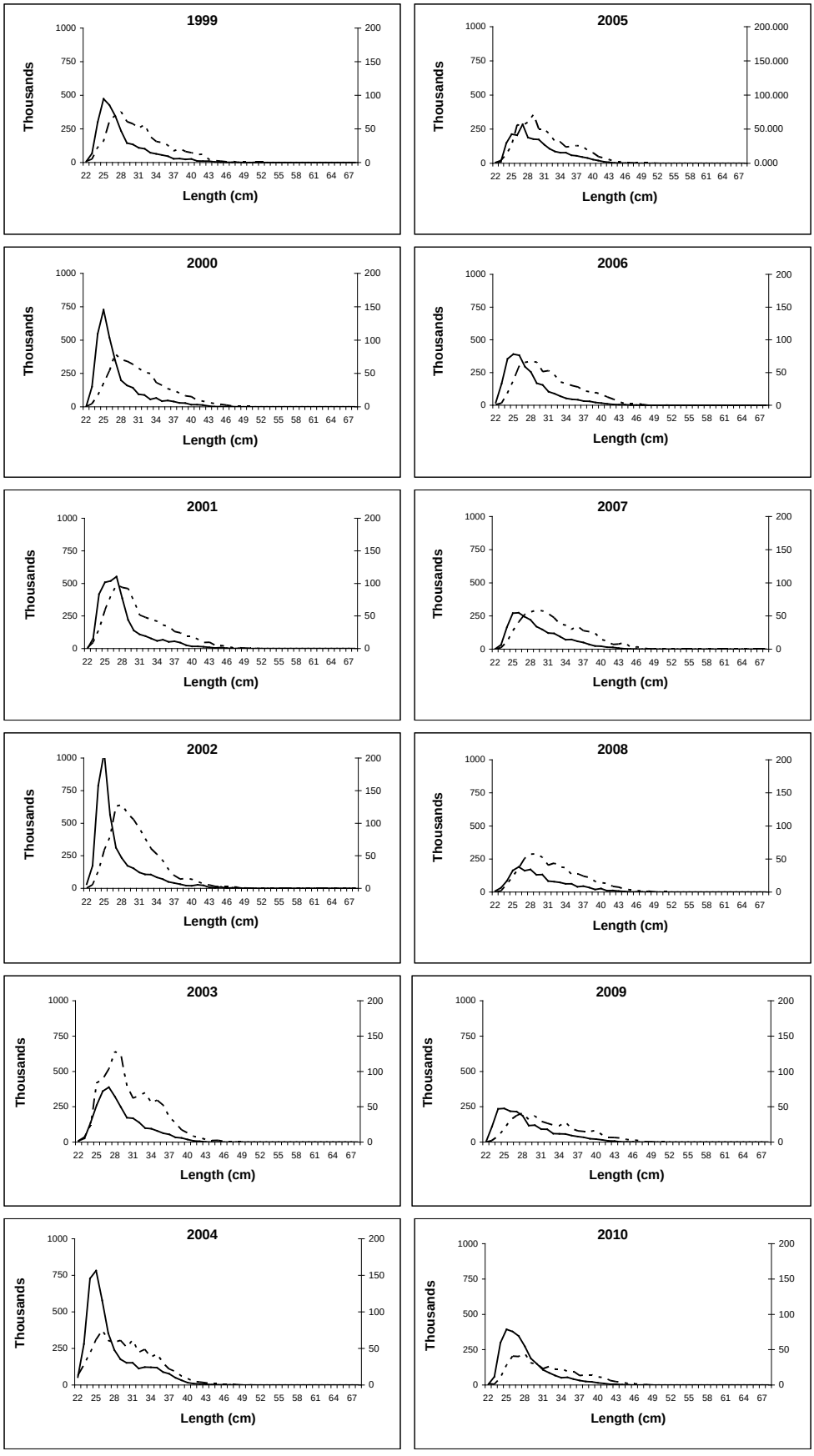


Figure 7.13.2 - Sole in VIIfg. Age composition of landings

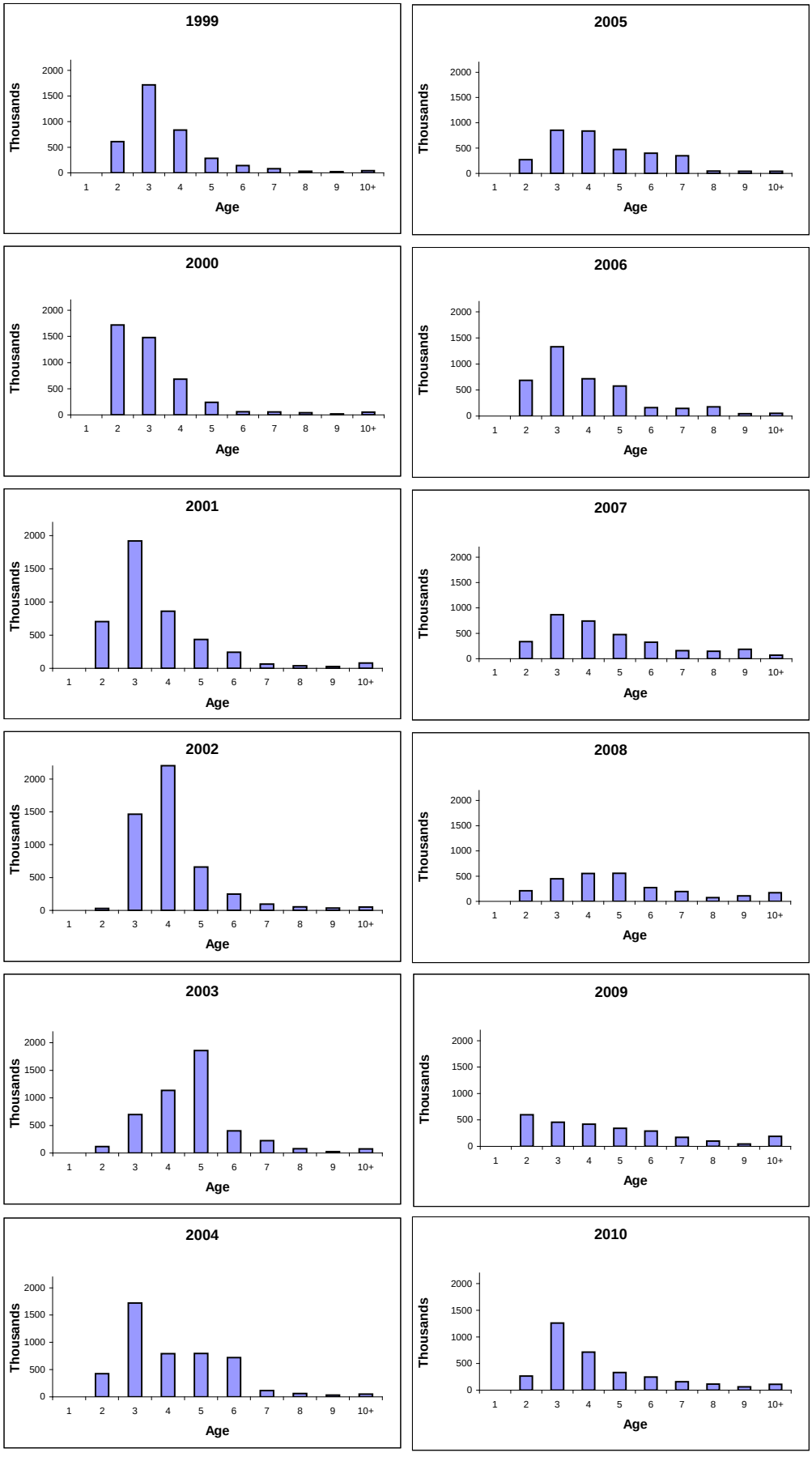


Figure 7.13.3 - Sole VIIfg - Standardized catch proportion

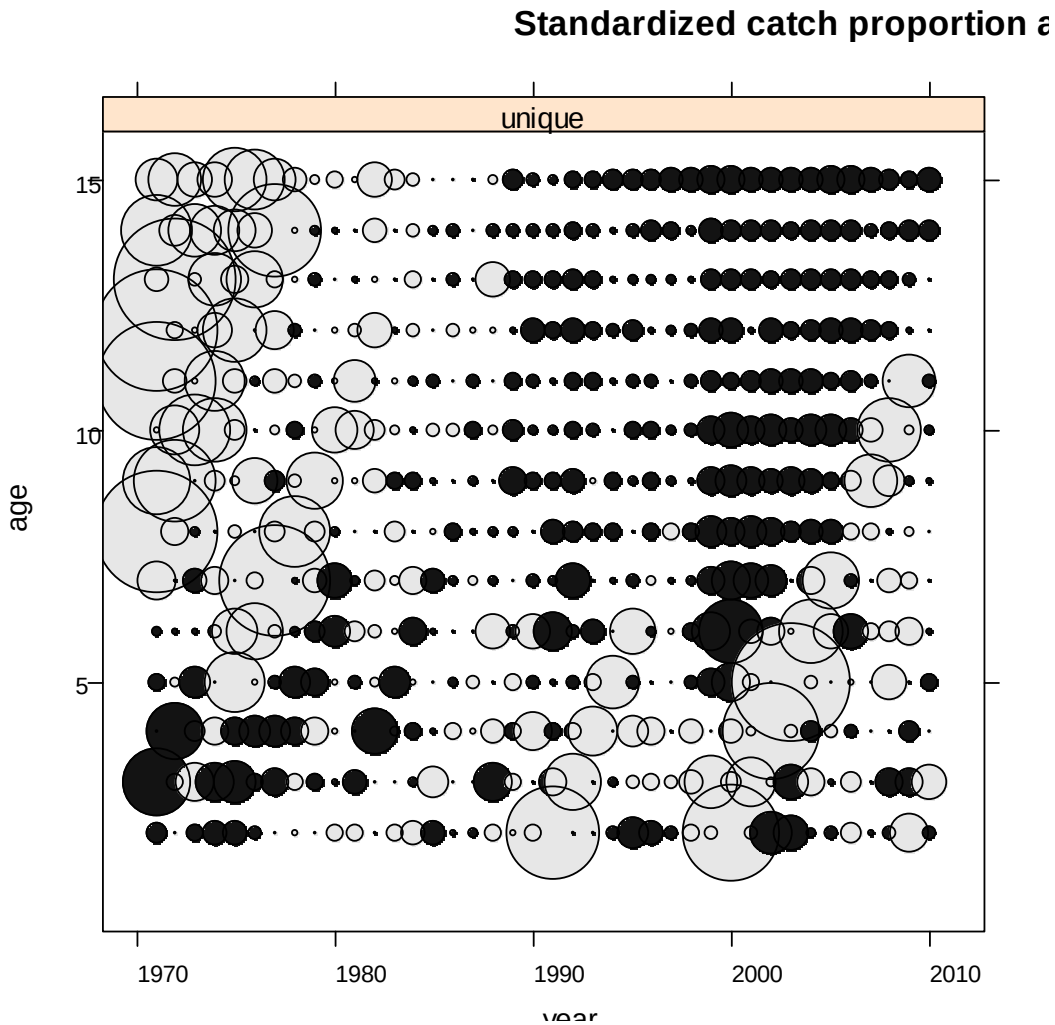


Figure 7.13.4a - Sole VIIf - Length distributions of discarded and retained fish from Belgium bream trawls

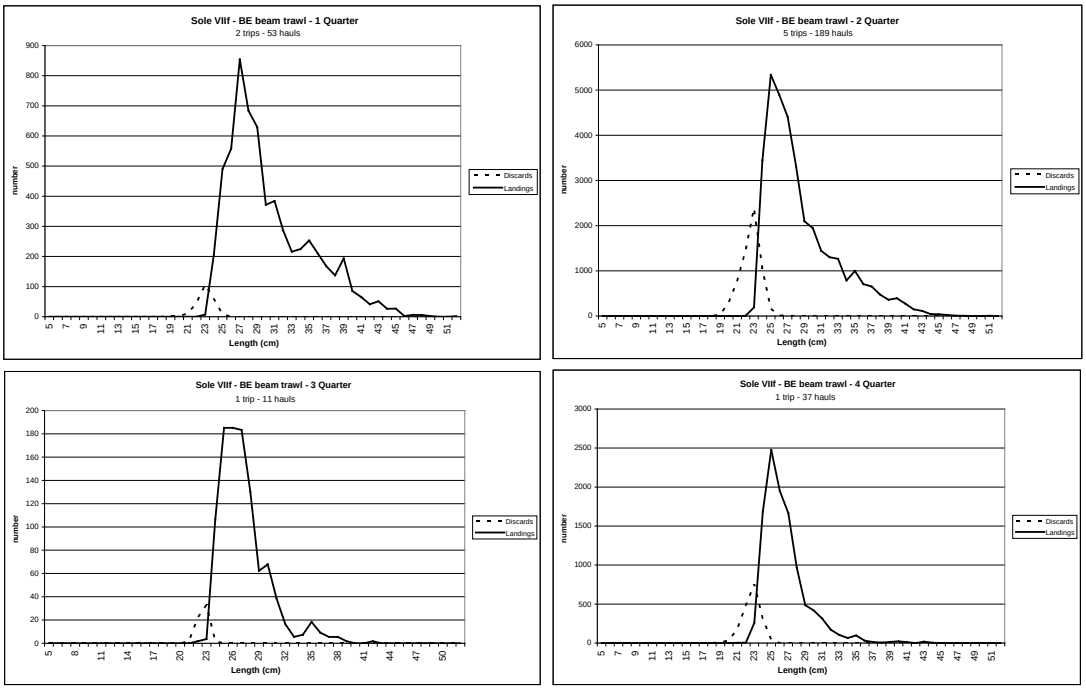


Figure 7.13.4b - Sole VIIg - Length distributions of discarded and retained fish from Belgium bream trawls

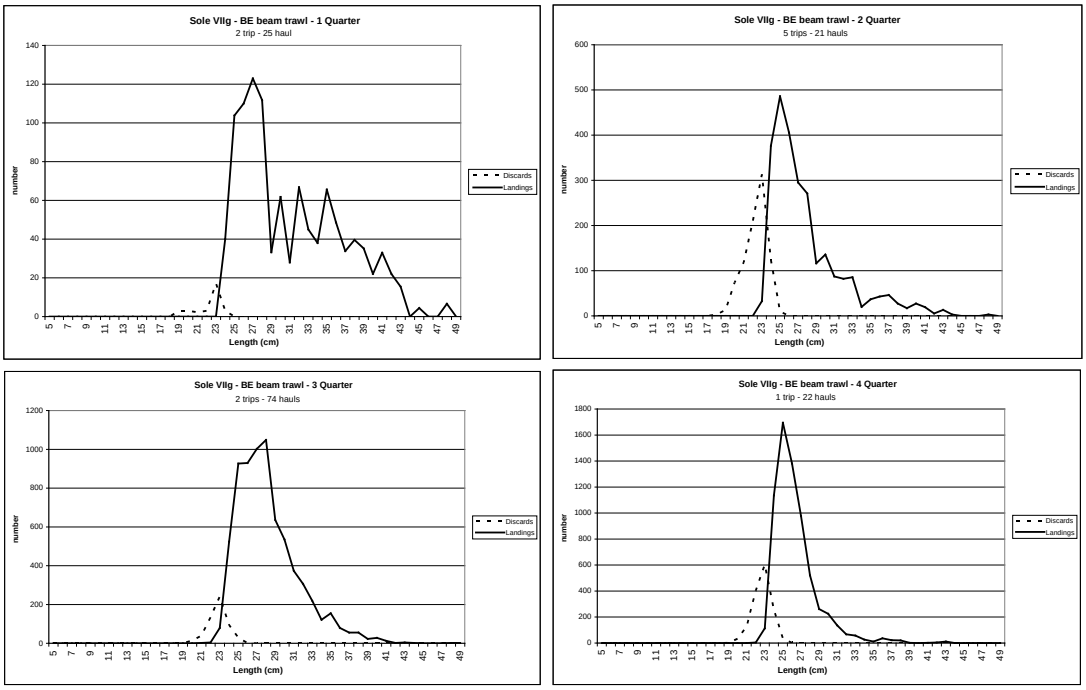


Figure 7.13.4c - Sole VIIfg - Length distributions of discarded and retained fish from UK static gear

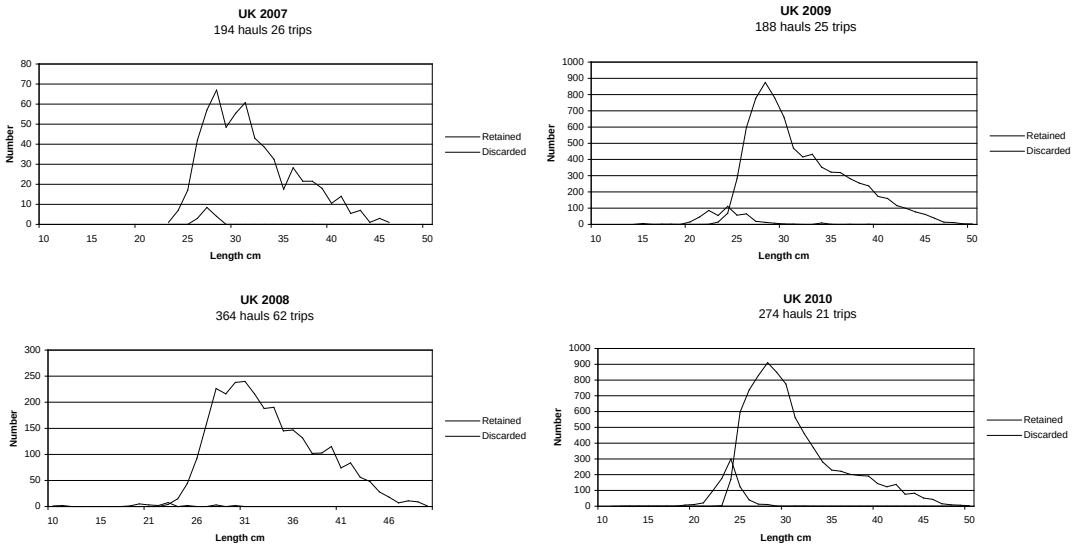


Figure 7.13.4d - Sole VIIfg - Length distributions of discarded and retained fish from Irish otter trawl

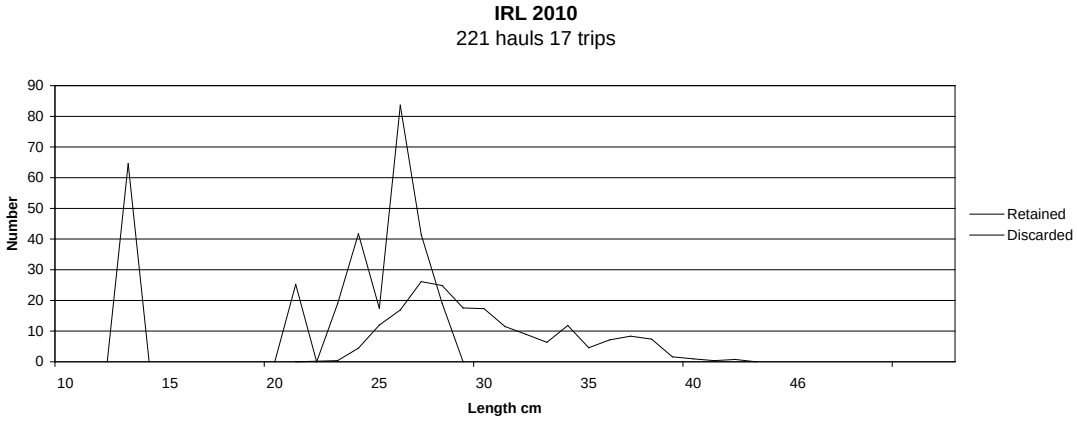
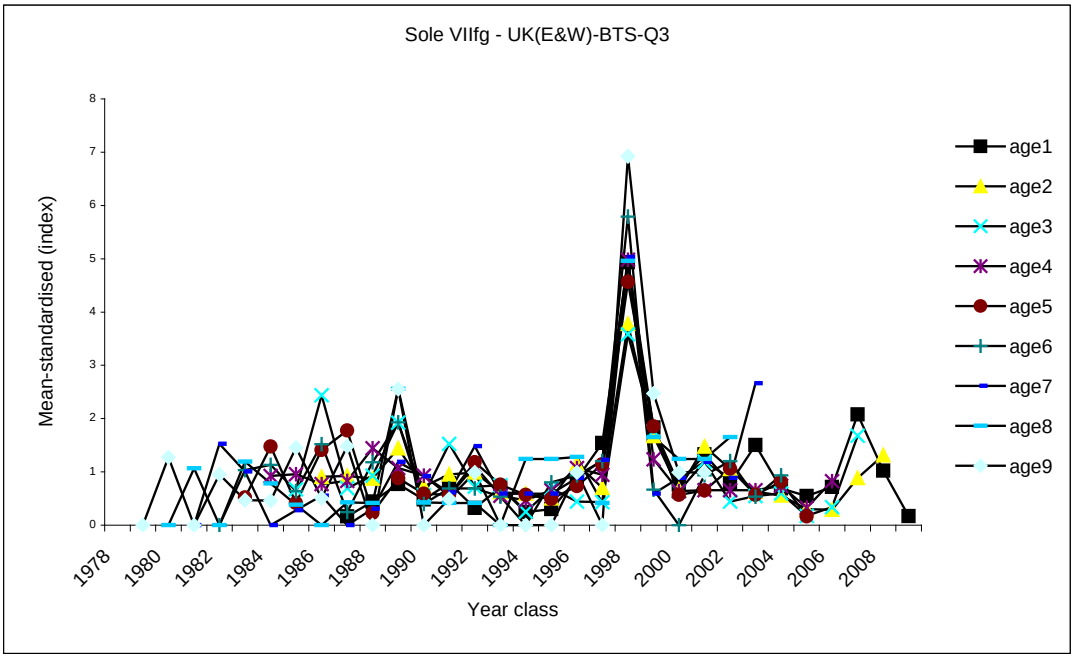


Figure 7.13.5 - Sole VIIfg - Mean-standardised index of UK(E&W) VIIfg Corystes survey



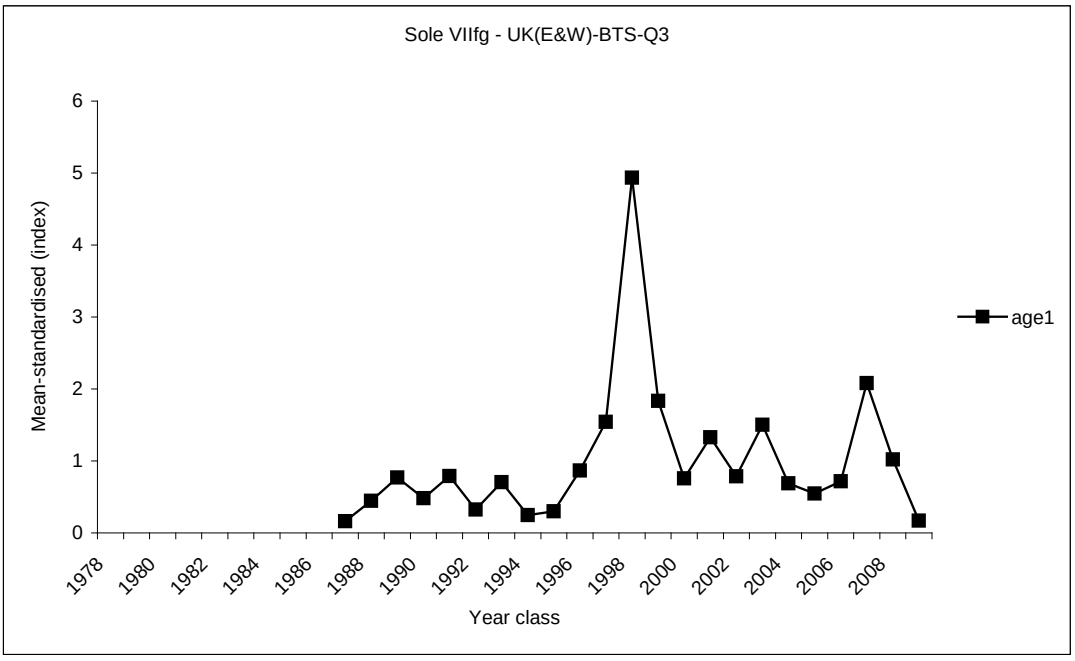
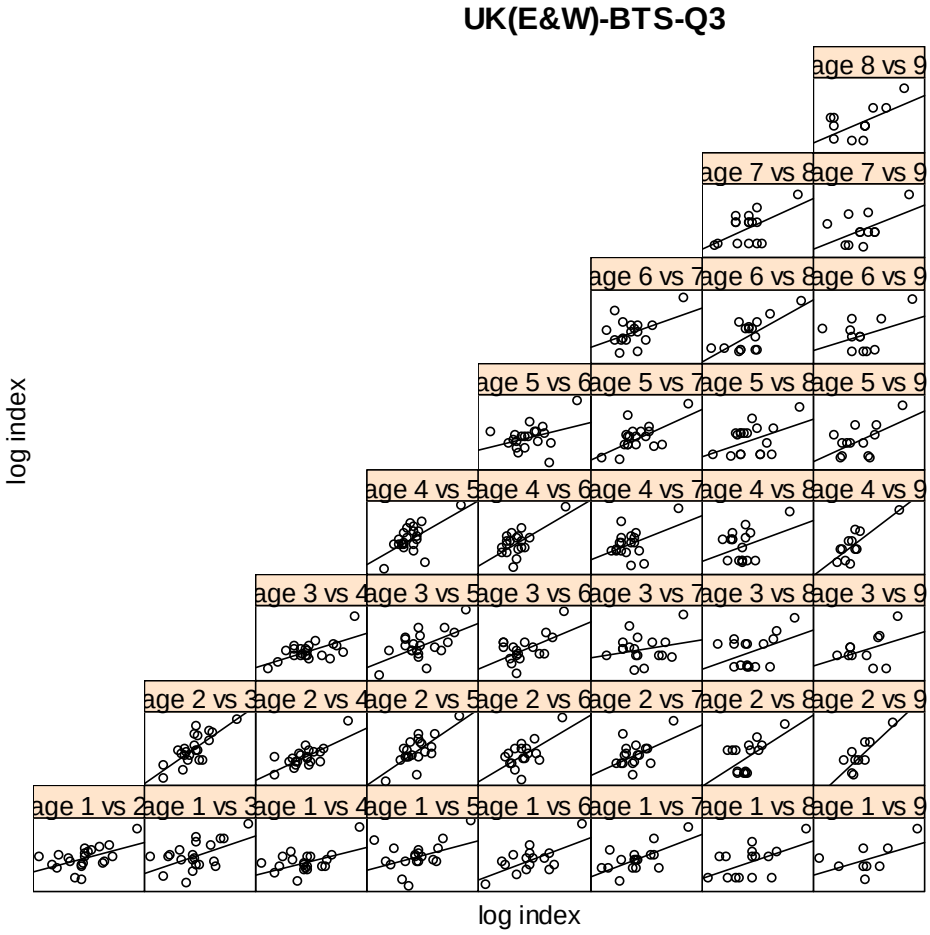


Figure 7.13.6 - Sole in VIIfg - Consistency plot UK(E&W)-BTS-Q3 survey



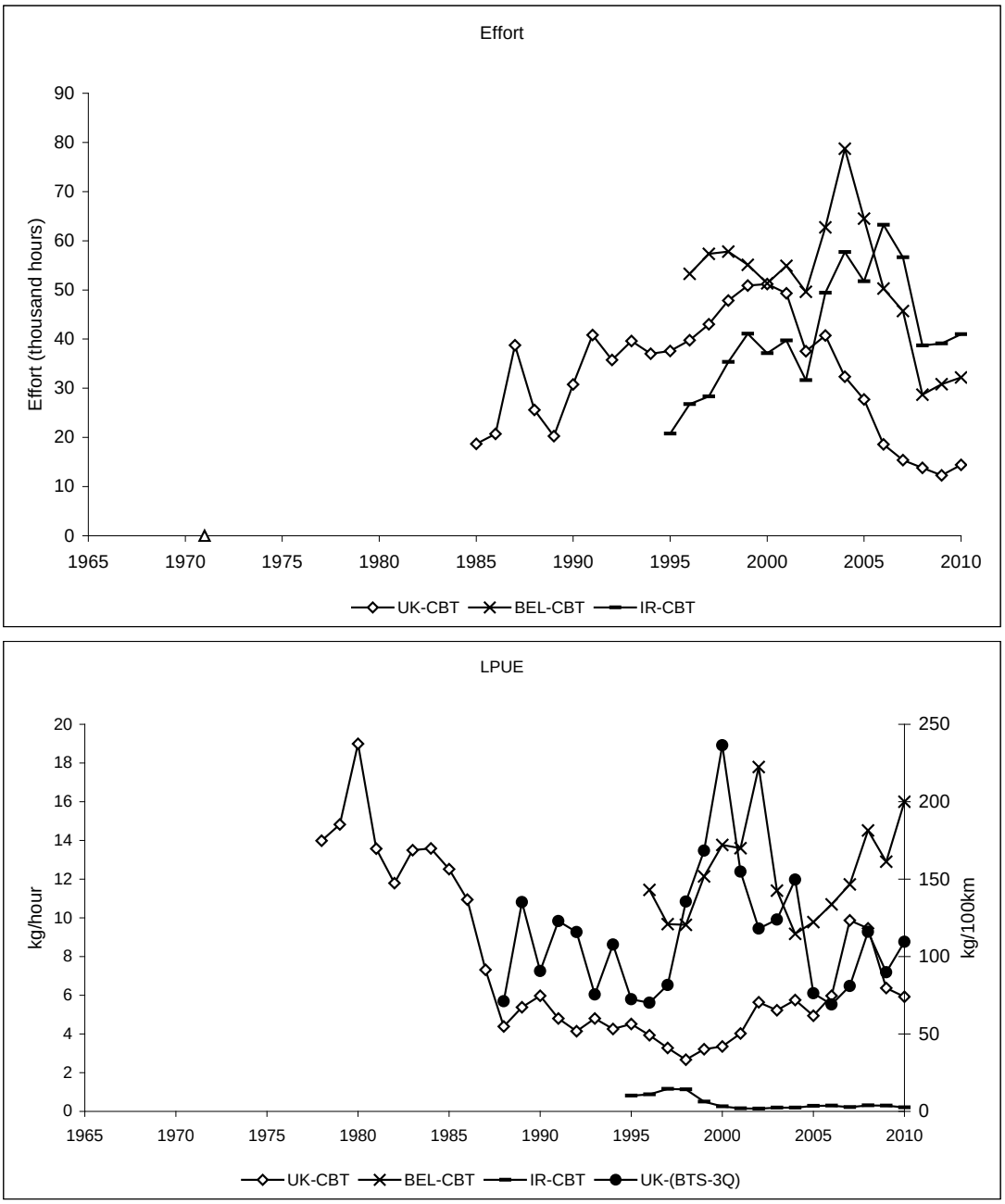


Figure 7.13.7. Sole in VIIfg. Effort (in thousand hours, GRT corrected in case of E&W beam trawl fleet) and lpue (in kg/hour; or in kg/100km in case of UK(BTS-3Q) survey) for three beam trawl fleets and one survey.

Figure 7.13.8 - Sole in VIIfg - Consistency plot Uk(E&W) beam trawl

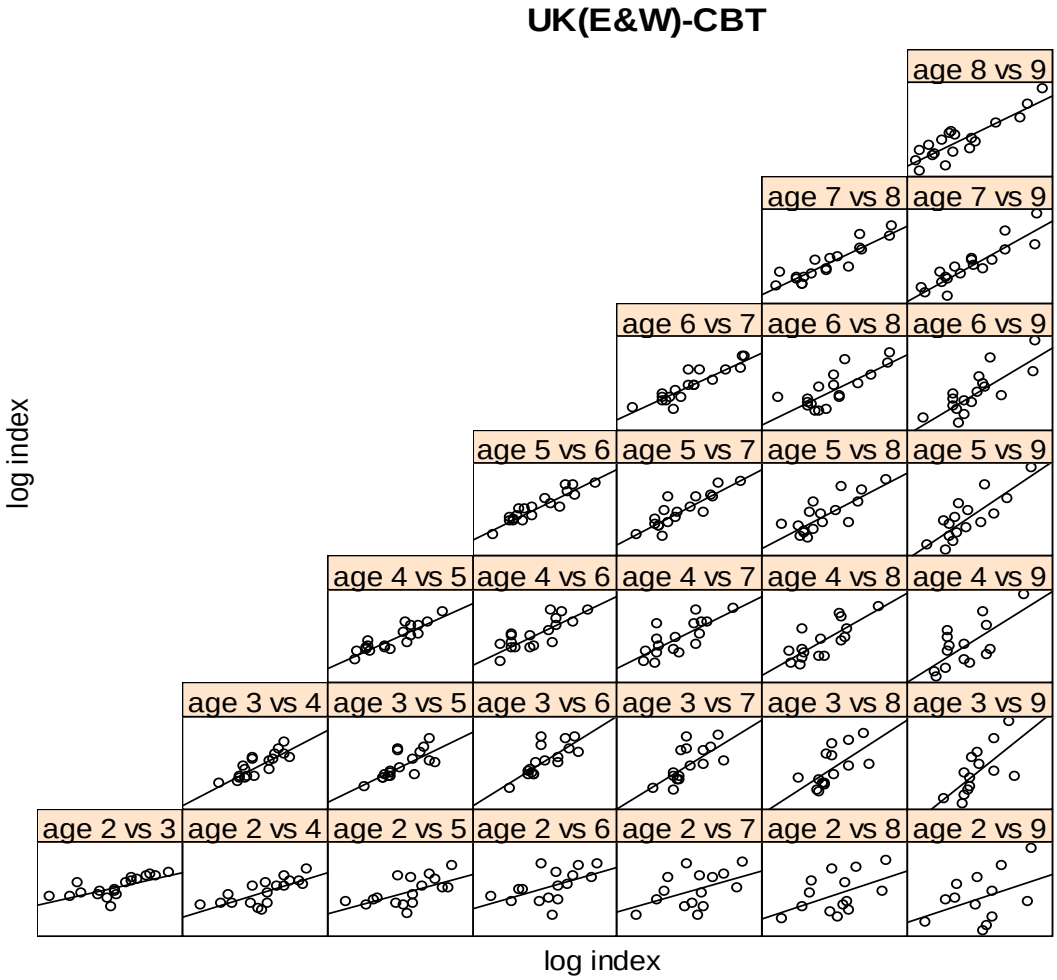


Figure 7.13.9 - Sole in VIIfg - Consistency plot Belgian beam trawl

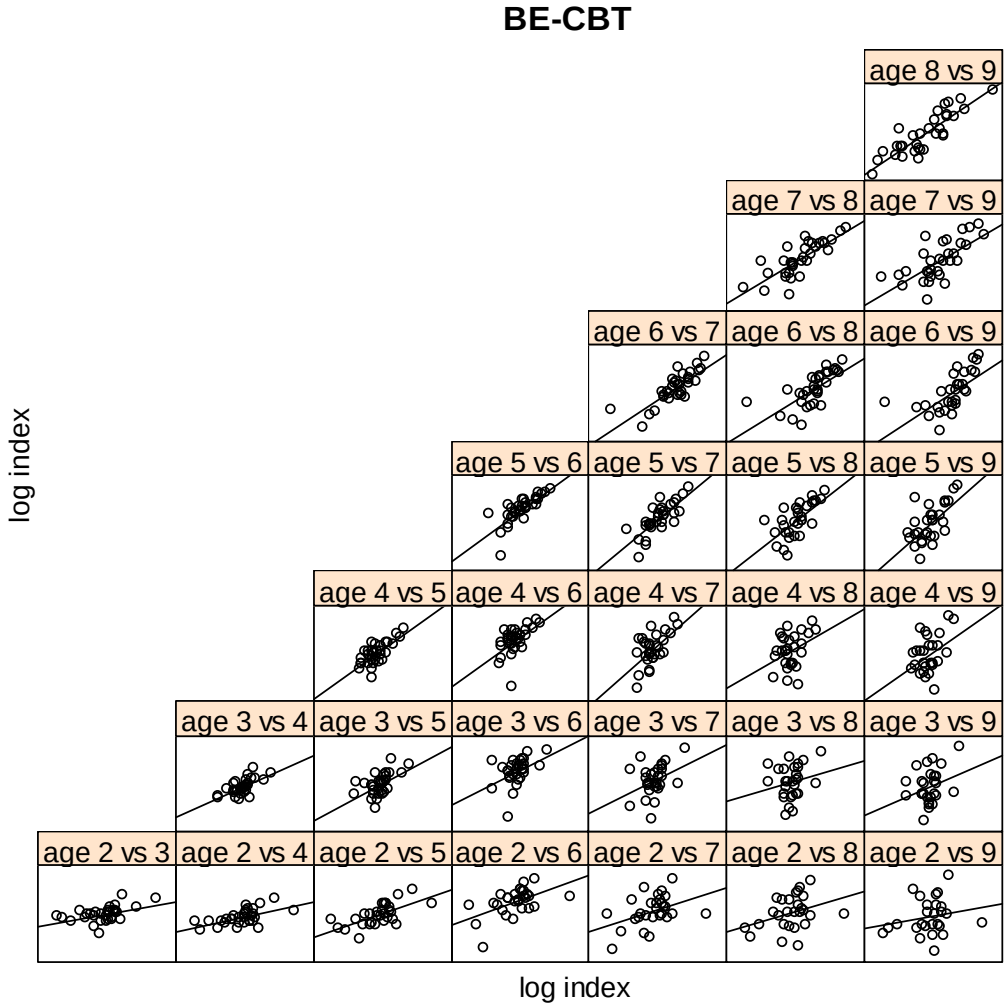
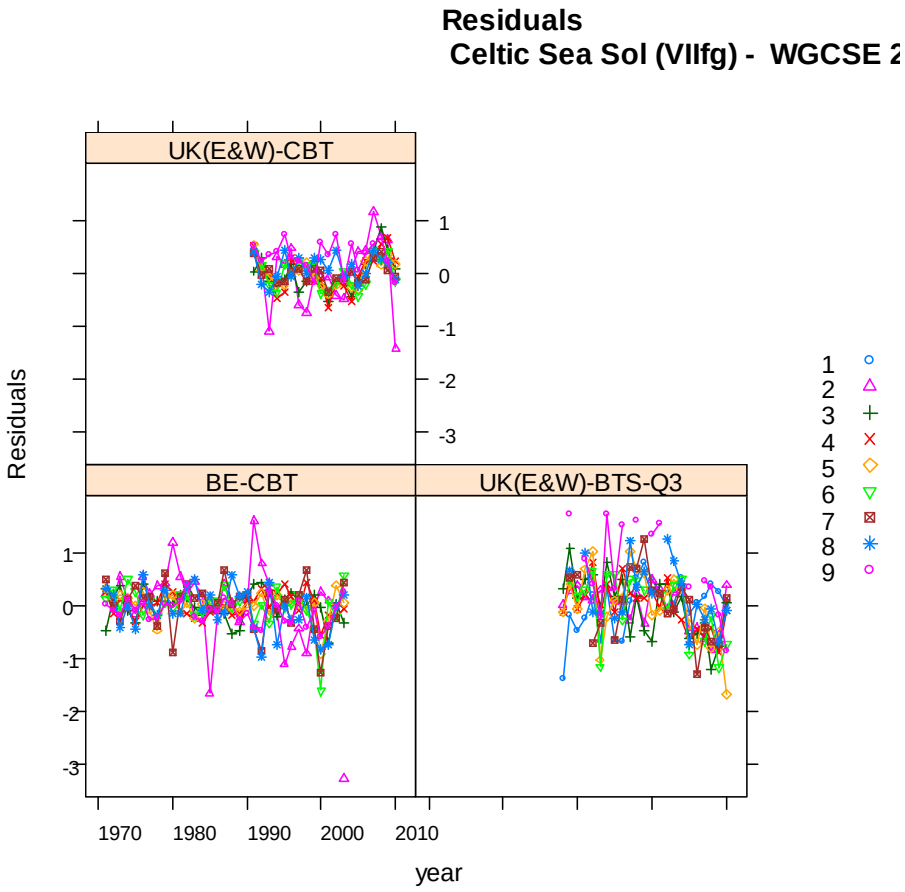


Figure 7.13.10 - Sole in VIIfg. Catchability residuals for final XSA run



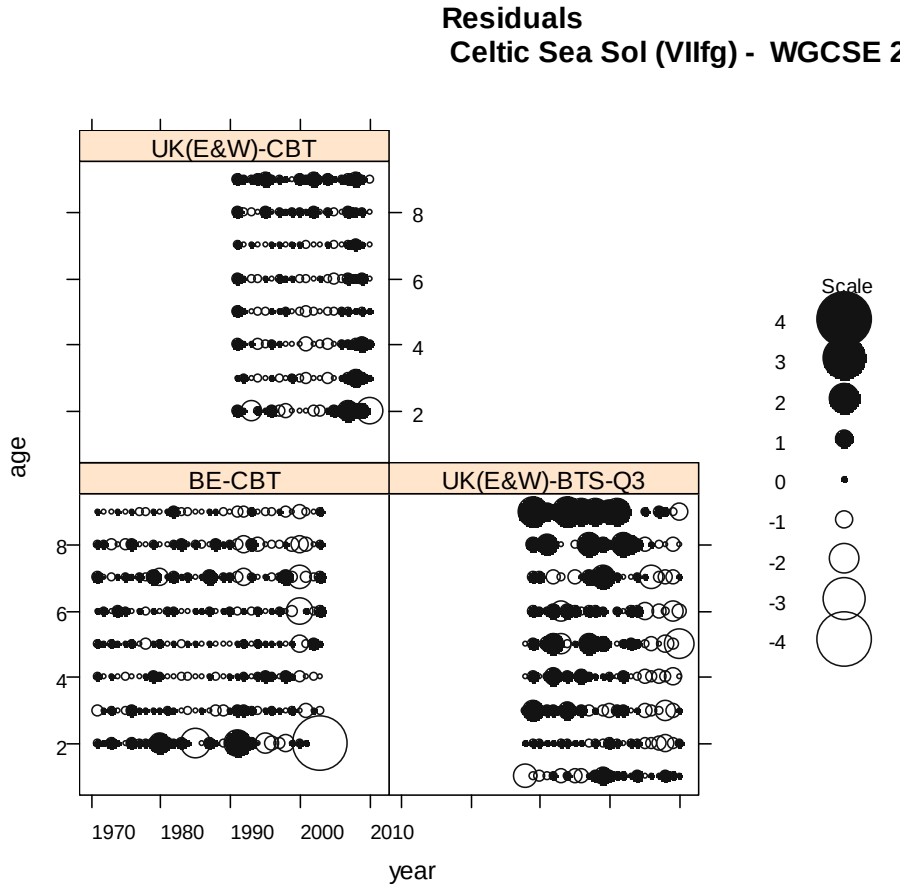


Figure 7.13.11 - Sole in VIIfg. Estimates of survivors from different fleets and shrinkage, as well as their different weighting in the final XSA-run

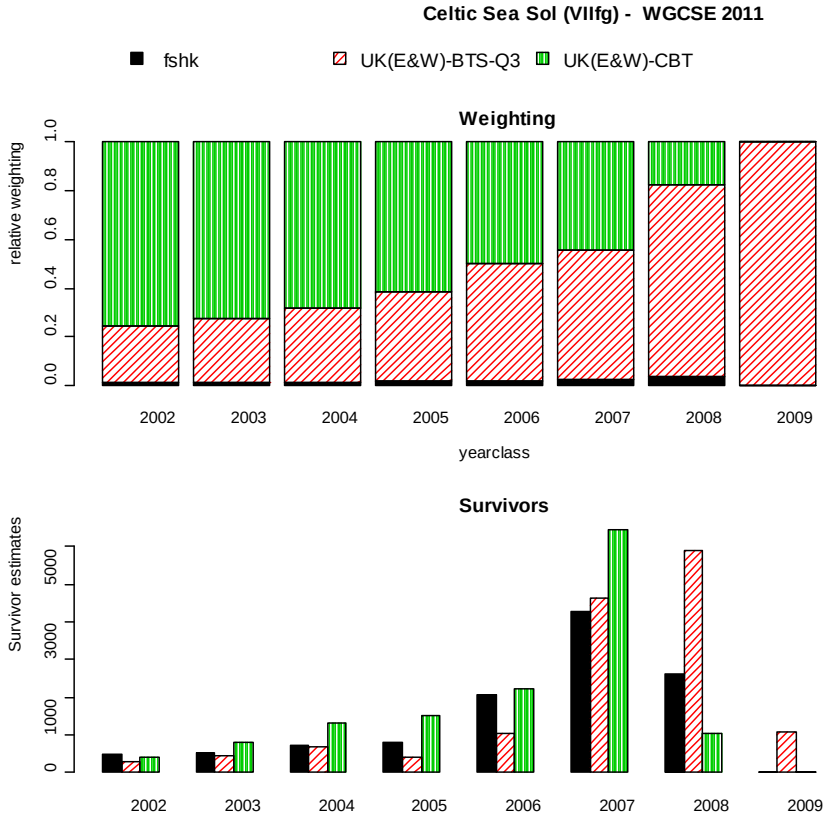


Figure 7.13.12 - Sole VIIf,g retrospective XSA analysys (shinkage SE=1.5)

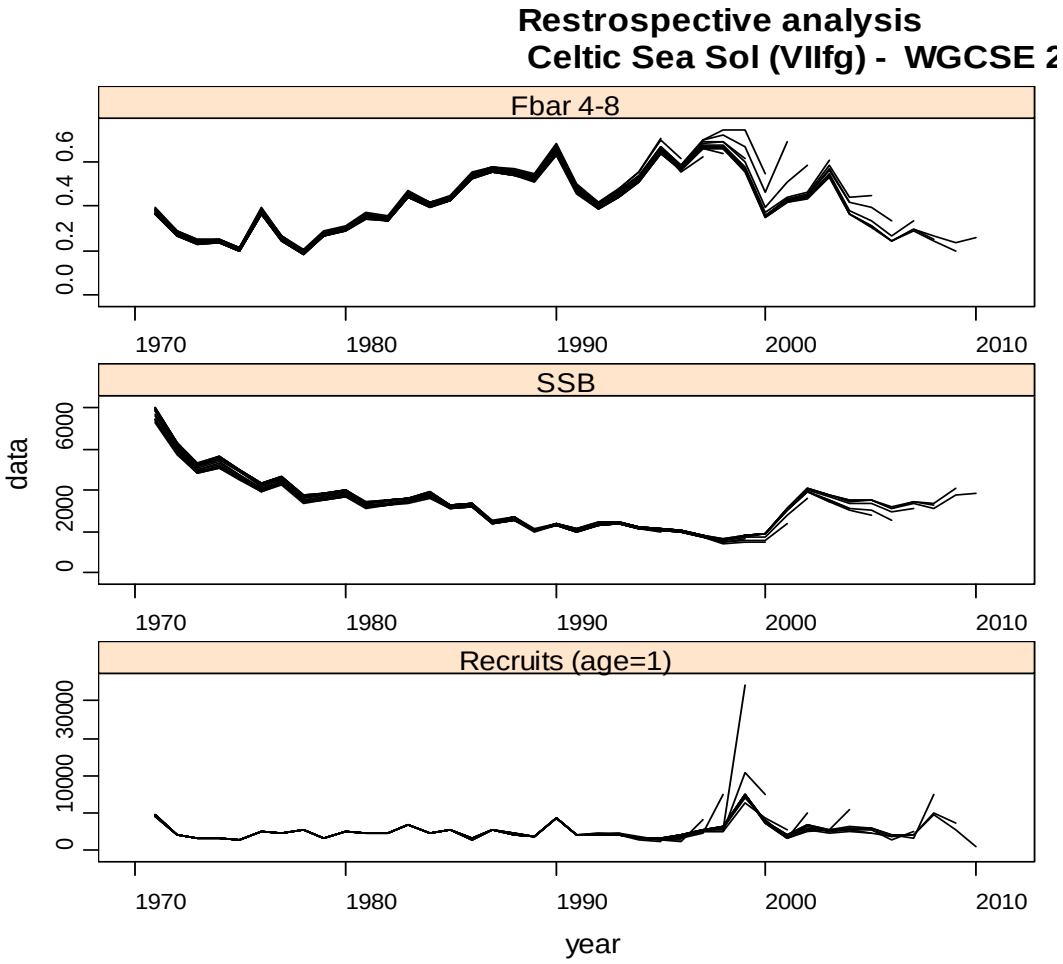
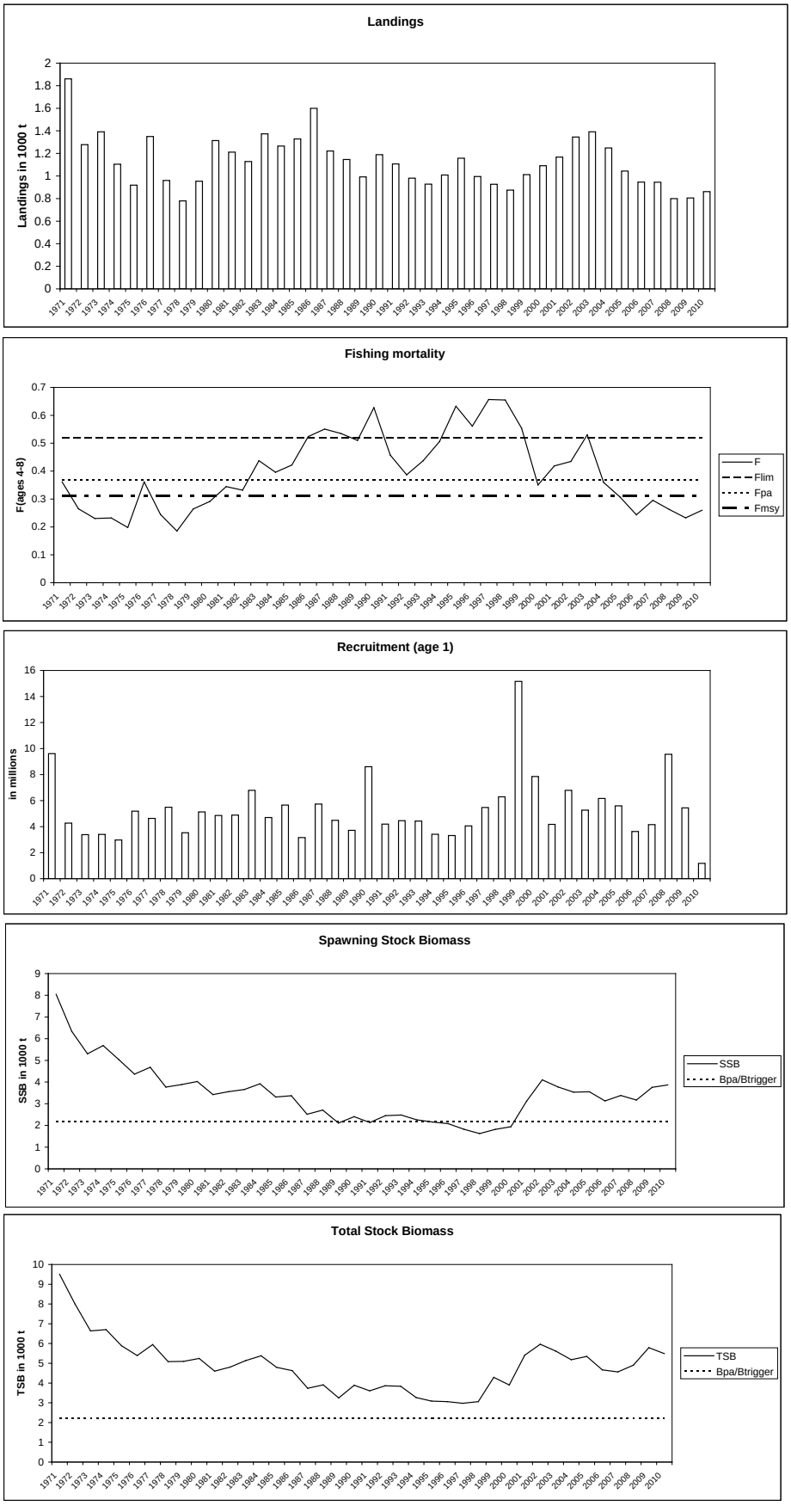
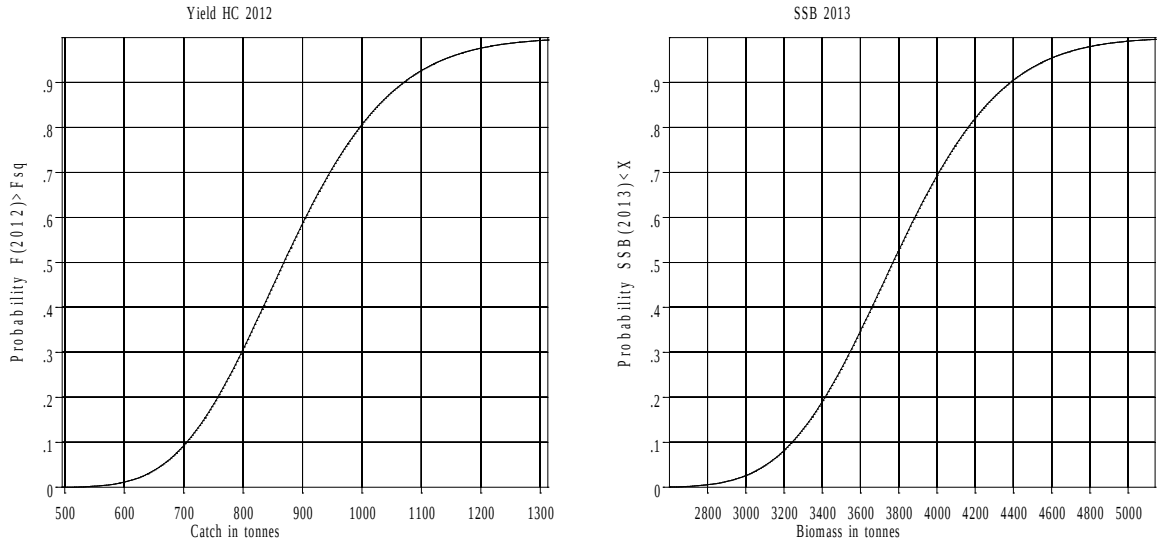


Figure 7.13.13 Sole in VIIfg. Summary plots



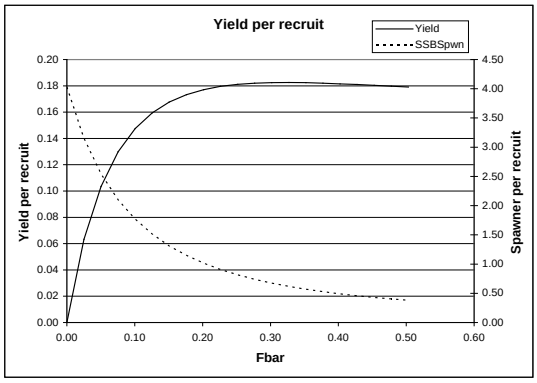
Sole VIIfg - Probability profiles for short term forecast.

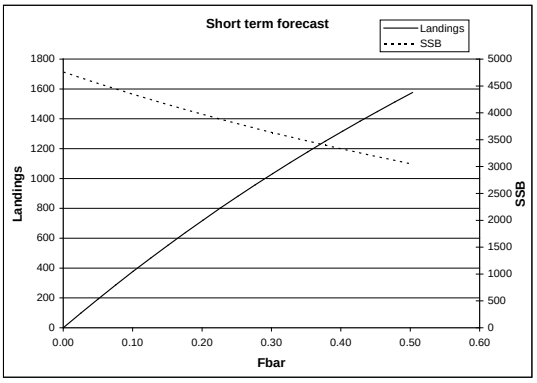


Data from file:D:\Probability_SoleVIIfg\SOLVIIfg.SEN on 11/05/2011 at 14:29:53

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: S7fg_yield_fin
Time and date: 18:41 1/05/2011

Reference point	F multiplier	Absolute F
Fbar(4-8)	1.0000	0.2516
FMax	1.2772	0.3213
F0.1	0.5553	0.1397
F35%SPR	0.5474	0.1377

MFDP version 1a
Run: S7fg_fin
Sole in VIId
Time and date: 18:34 1/05/2011
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)

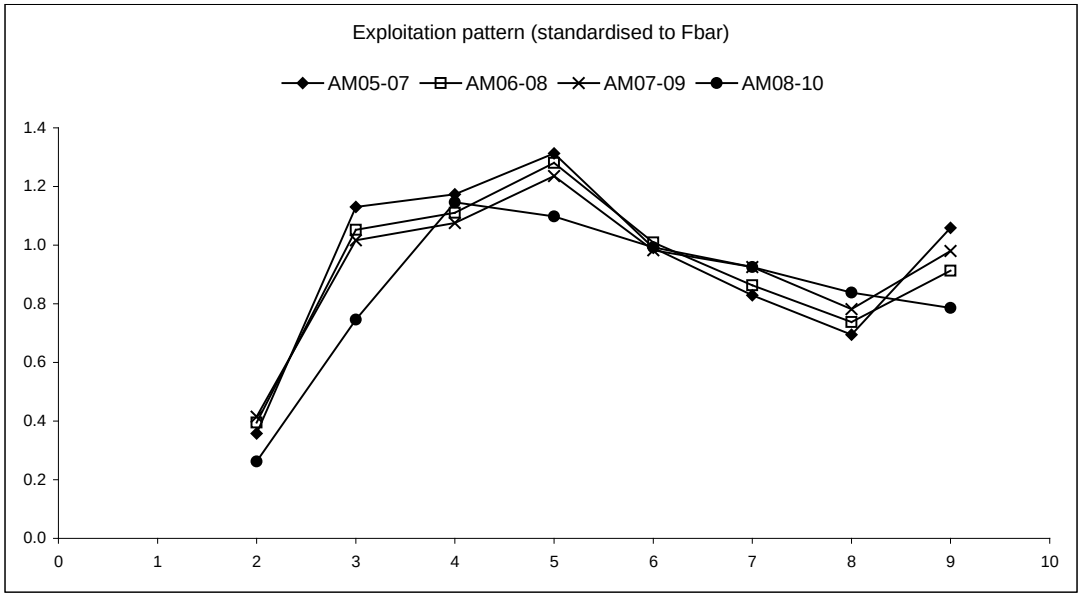




Figure 7.13.17. Sole VIIfg. Stock–recruitment plot.

7.14 Sole in the Southwest of Ireland (ICES Divisions VIIh–k)

Type of assessment in 2011

No assessment was performed, however catch numbers and weighs were aggregated for the Irish landings for the years 1993–2010 and these were used to perform a yield-per-recruit analyis.

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

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 2010. 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 standardized 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 logcatch 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 standardized 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 standardized 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 0.32. $F_{0.1}$ is estimated as 0.15. Recent (2006–2010) values of Z ranged between 0.15 and 0.45, with M=1.0 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 W.F. and Bell F.H. 1934. 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 VIIh–k (Southwest Ireland). Nominal landings (t), 1973–2010, 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.I	.	.	.	.	.	.	.	.	.	.
UK - England & Wale	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.I	.	.	.	.	.	.	177	144	234	215
UK - England & Wale	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.I	209	172	192	148	113	111	97	95	111	124
UK - England & Wale	.	.	.	.	.	.	.	.	.	.
UK - Scotland	5	2	-	-	-	-	-	-	-	-
Total	812	738	915	826	742	759	406	303	352	517

Country	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	170	157	90	36	31	10	11	20
Denmark	-	-						
France	133	103	93	92	78	57	77	83
Ireland	105	111	98	63	78	72	60	71
Netherlands	-	-		1				
Spain	-	-	2					
UK - Eng+Wales+N.I	78	79	112	87	91	80	58	51
UK - England & Wale	.	.						
UK - Scotland	-	-						
Total	486	450	395	279	278	219	206	225

Table 7.14.2. Official landings of sole in VIIjk.

Year	Bel	Fra	Ire	Esp	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	7	60	-	0	67
2010*	0	13	68	-	0	81

*** 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	1	25	90	42	21	20	25	11	8	5	3	3	7
2009	0	14	37	74	30	16	16	15	6	6	5	1	4
2010	5	48	49	54	47	14	9	9	9	6	6	3	8

Table 7.14.4. Weight-at-age for sole in VIIjk.

	2	3	4	5	6	7	8	9	10	11	12	2	14+
1993	0.154	0.221	0.275	0.342	0.412	0.455	0.511	0.496	0.628	0.567	0.761	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	0.592
1996	0.138	0.169	0.230	0.307	0.435	0.421	0.505	0.587	0.613	0.711	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		0.692	0.846	0.922
1998	0.137	0.223	0.281	0.357	0.379	0.448	0.515	0.554	0.455	0.646	0.497	0.641	0.805
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	
2000	0.180	0.210	0.255	0.396	0.416	0.472	0.502	0.489	0.505	0.452	0.554		0.641
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	0.727
2002	0.203	0.198	0.255	0.305	0.470	0.490	0.473	0.655	0.732	0.724	0.627	0.616	0.895
2003	0.168	0.191	0.296	0.323	0.329	0.378	0.371	0.575	0.503	0.548	0.477		0.600
2004	0.095	0.200	0.198	0.294	0.313	0.353	0.287	0.581	0.632	0.498	0.595	0.498	0.724
2005	0.128	0.168	0.198	0.249	0.383	0.318	0.340	0.445	0.525	0.468		0.489	0.614
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	0.143	0.205	0.236	0.275	0.305	0.339	0.339	0.395	0.389	0.448	0.559	0.450	0.631
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	0.505

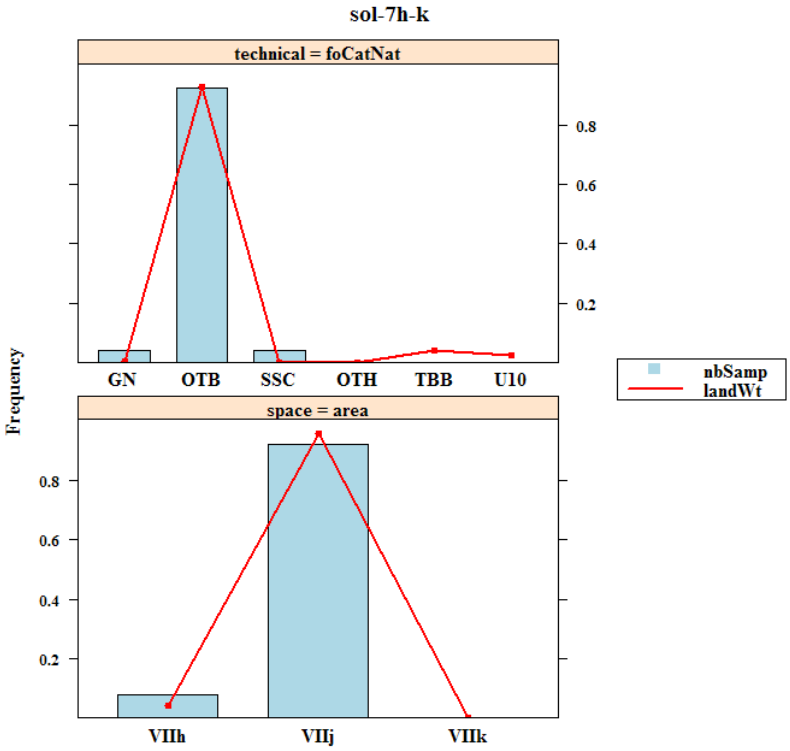


Figure 7.14.1. Irish Operational landings and sampling levels (number of samples) for sole in VIIjk by quarter (top), geartype (middle) and ICES division (bottom). The sampling appears to be representative of the landings.

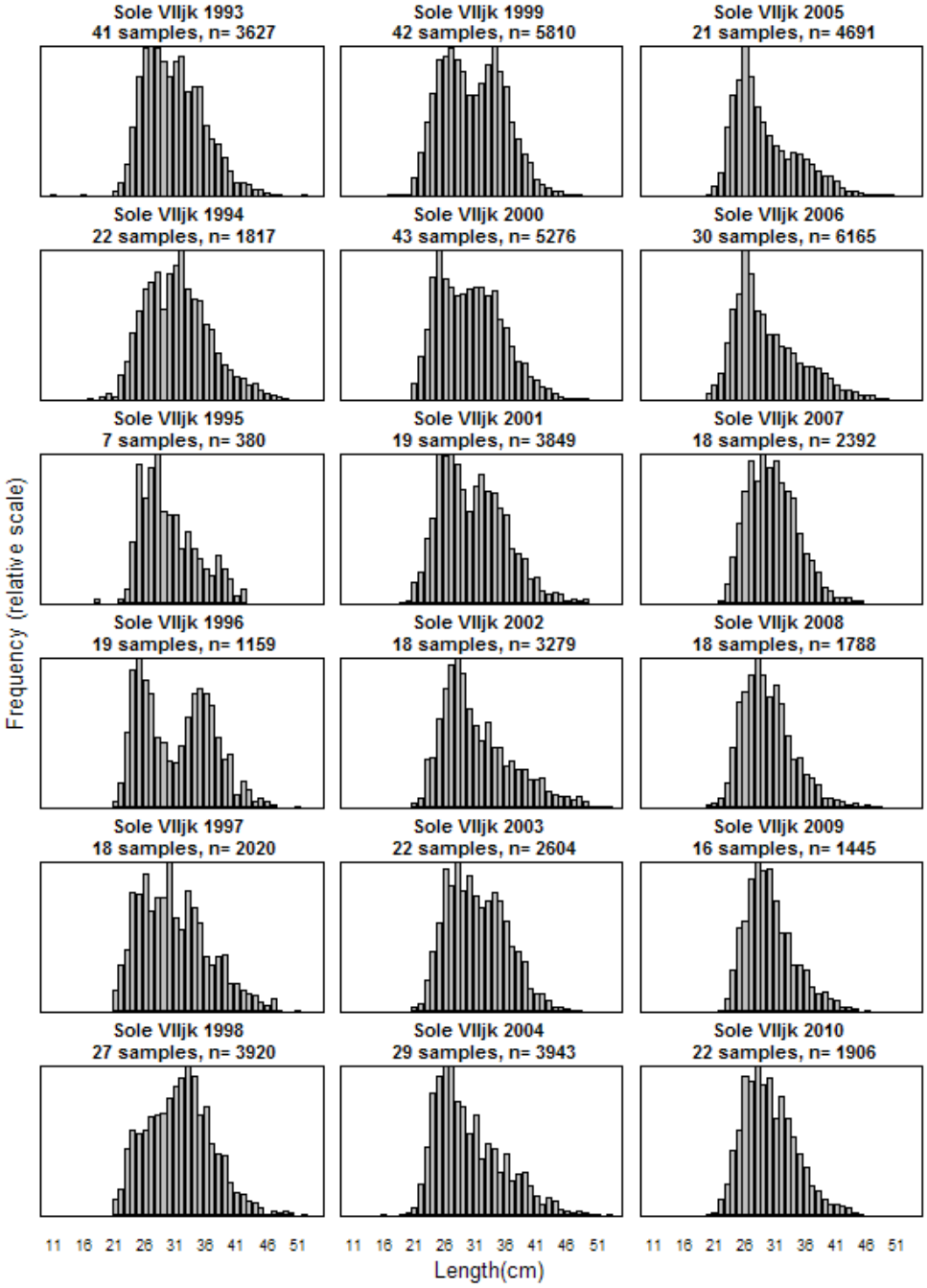


Figure 7.14.2. Length frequency distribution of the Irish landings of sole in VIIjk between 1993 and 2010. All gears and quarters combined.

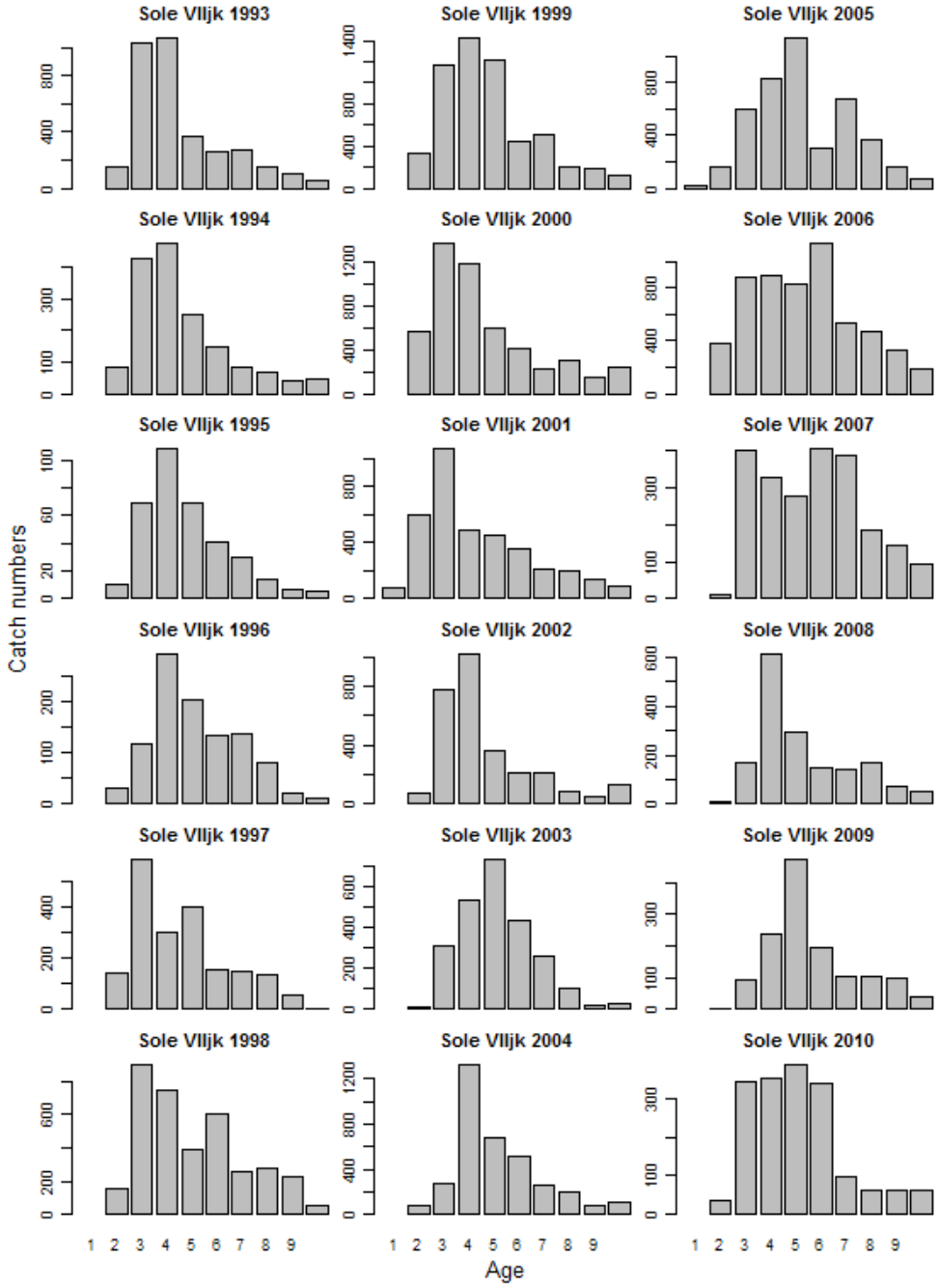


Figure 7.14.3. Age distribution of sole in VIIjk between 1993 and 2010. All gears and quarters combined.

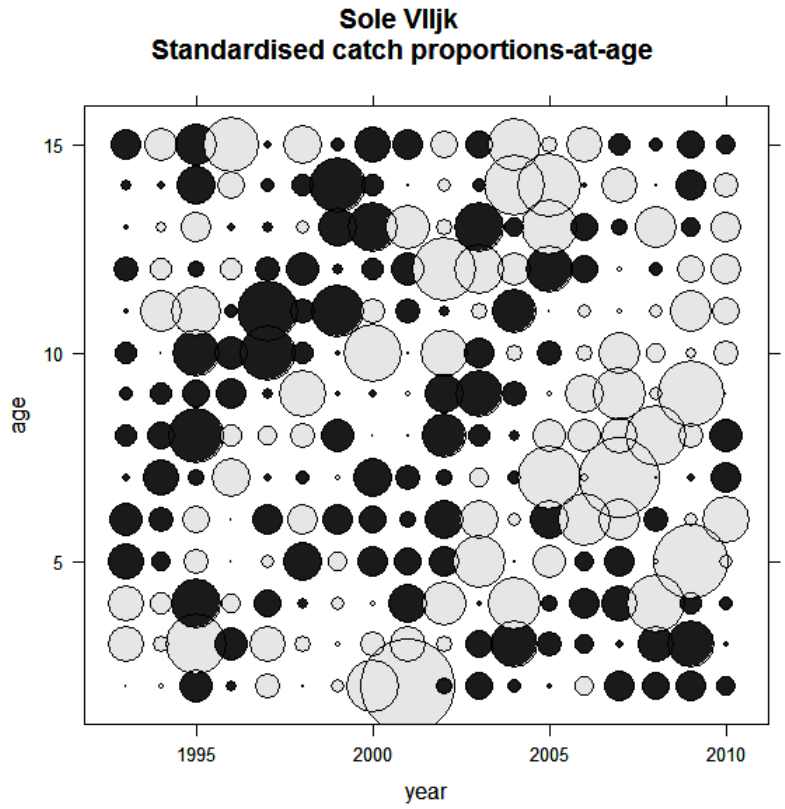


Figure 7.14.4. Standardized catch proportions-at-age for sole in VIIjk. Grey bubbles represent higher-than-average catch-at-age and black bubbles represent lower-than-average catch-at-age.

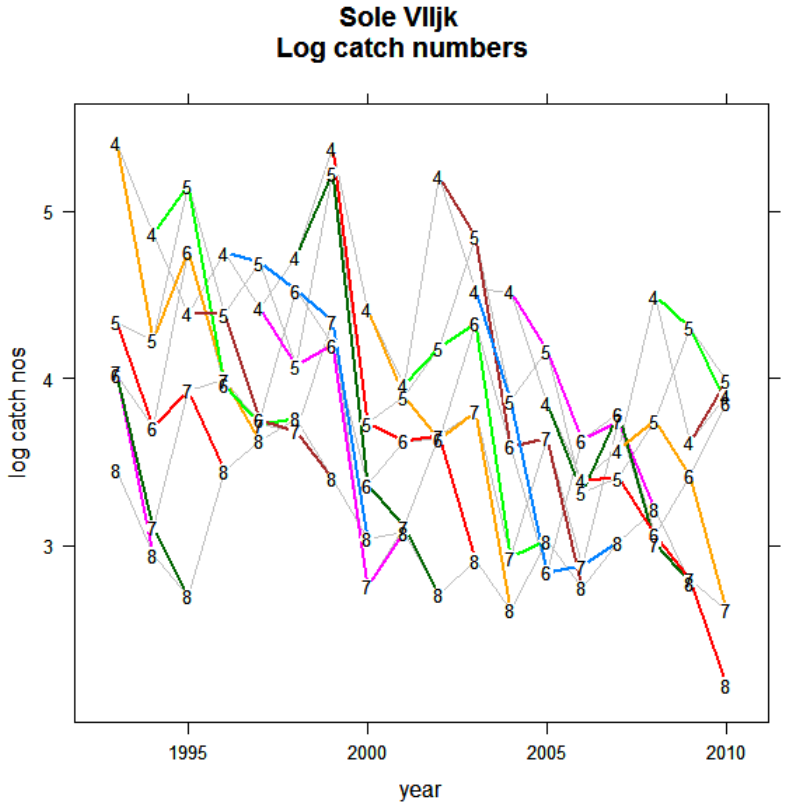


Figure 7.14.5. Log catch numbers-at-age (ages 4–8).

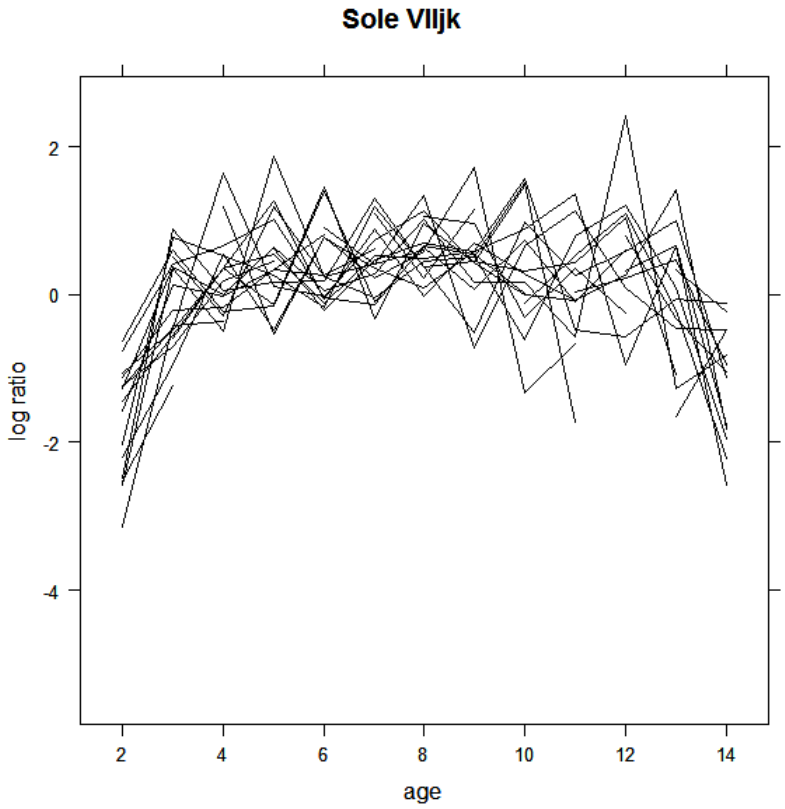


Figure 7.14.6. Catch curve of plaice in VIIbc. Sole from the age of 4 appear to be fully selected; the data get quite noisy from the age of 10 onwards.

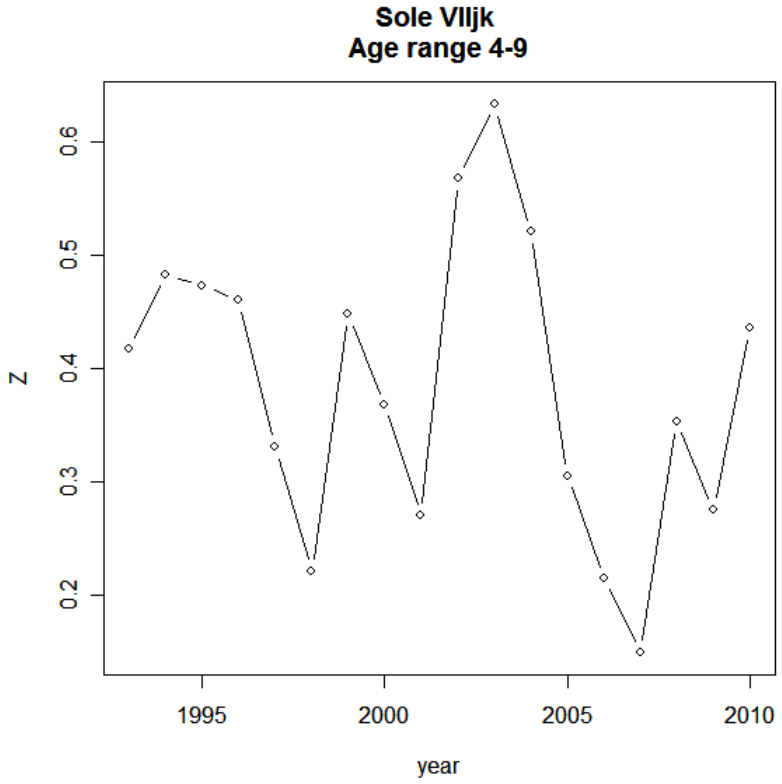


Figure 7.14.7. Z estimated over pseudo-cohorts as the slope of the log catch numbers.

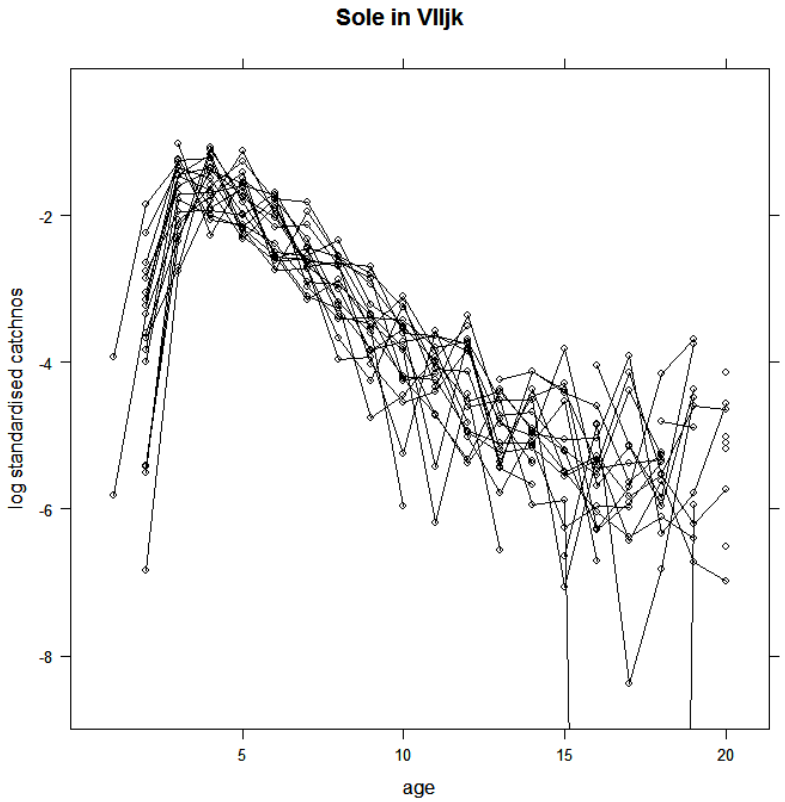


Figure 7.14.8. Log catch numbers (standardized by year). Fish appear to be fully selected from the age of 4.

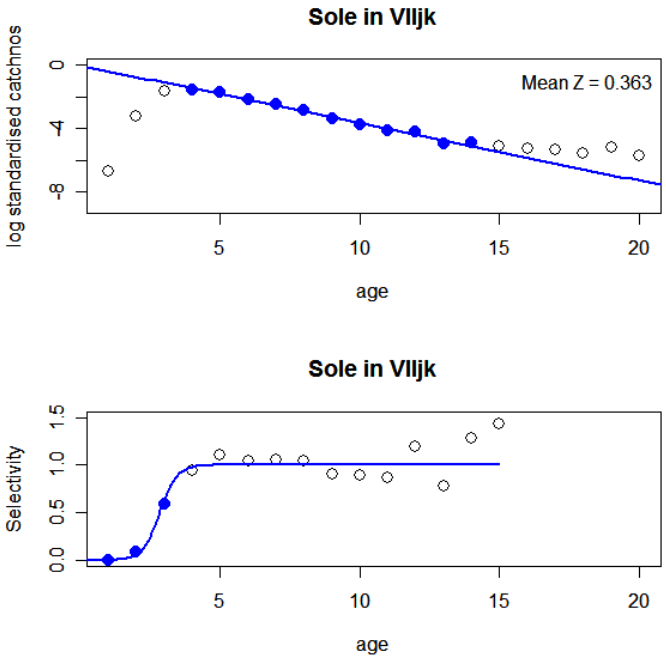


Figure 7.14.9. Selectivity was modelled by fitting a line through the mean log standardized catch numbers of ages 4 to 14 to predict the expected catch numbers for ages 1 to 3 if these were fully selected. The proportions of observed divided by expected catch number were taken as the 'observed' selectivity. This was then modelled using a logit transformation.

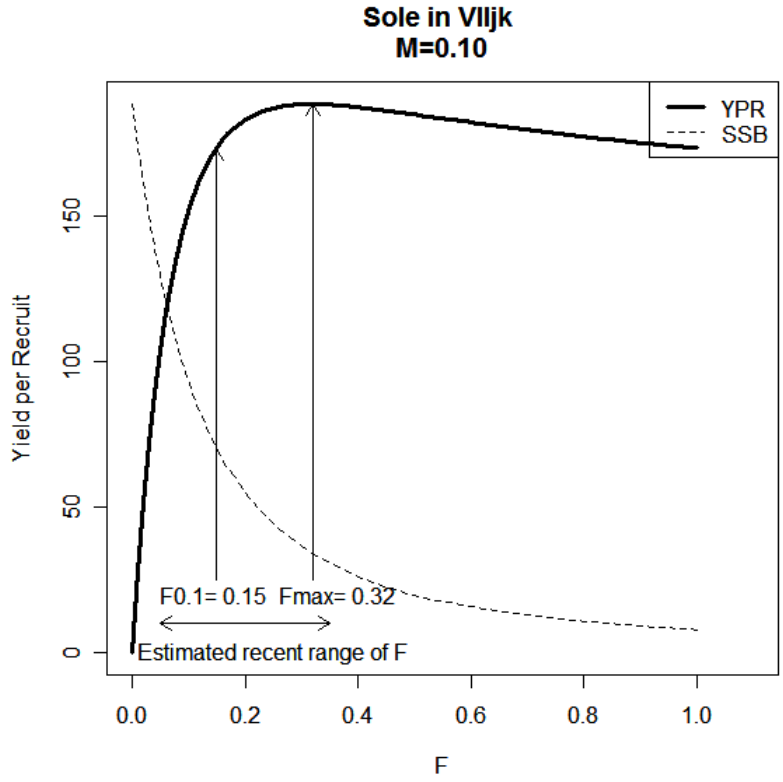


Figure 7.14.10. YPR analysis using the Thompson–Bell approach. Recent estimates of Z were between 0.15 to 0.45 which translates to an F of 0.05 to 0.35.

7.15 Whiting in Division VIIe–k

Type of assessment in 2011

Update assessment. Same Advice as Last Year.

ICES advice applicable to 2010

Exploitation boundaries in relation to precautionary limits: *The current estimates of fishing mortality and SSB are uncertain, but SSB shows a decreasing trend while recruitment has been low in recent years although the 2007 year class is above average, and the 2008 year class may be very strong. In order to reverse the trend in SSB, ICES considers that fishing mortality should be reduced. However, ICES cannot quantify the required reduction in fishing mortality.*

In addition, ICES offers the following consideration: surveys indicate that the 2007 year class is above average, and the 2008 year class may be very strong. Management measures should be introduced in the Celtic Sea to reduce discarding of these year classes in order to maximize their contribution to future yield and SSB.

ICES advice applicable to 2011

Stock status

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

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 to 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 minimize 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.

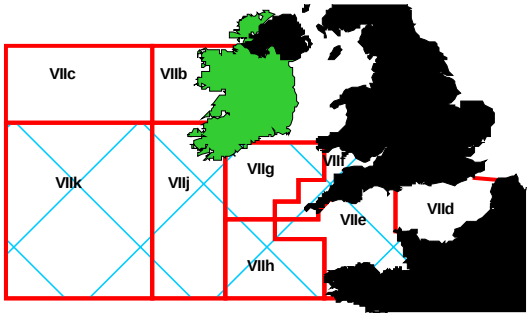
Policy paper

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 2 years are 70% higher than the SSB in the previous 3 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 $F_{MSY.}$

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 WDNSSK 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 2011 TAC for whiting VIIb–h and k has been increased from 14 407 t to 16 658 t (2010). This TAC has not been considered restrictive, with officially reported VIIe–k landings totalling 8540 t in 2010,. 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 2010

Species:	Whiting *Merlangius merlangus*	Zone:	VIIb, VIIc, VIId, VIIe, VIIf, VIIg, VIIh and VIIk (WHG/7X7A.)
Belgium	133		
France	8 180		
Ireland	4 565		
The Netherlands	66		
United Kingdom	1 463		
EU	14 407		
TAC	14 407		Analytical TAC

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.

Fishery in 2010

ICES officially reported landings for Divisions VIIe–k and landings as used by the Working Group are given in Table 7.15.1. Previously absent landings for France for 2009 of 2779 t were submitted to the WG, with official landings of 2739 t updated to the table also. ICES Official landings increased by ~3112 t, primarily resulting from French revisions. Landings from Spain, UK Scotland and the Channel Islands have also now been reported (combined 64 t). The 2009 reported landings were 674 t higher than those used by the WG. International landings in 2010 used by the Working Group are substantially higher than those for 2009 (+48%), but 166 t lower than the officially reported landings for 2010.

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 to 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 country in 2010 are given in Figure 7.15.1. Irish catches are primarily from within VIIg particularly within 31E2 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 2010. 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 2010 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, peaking around 32–36 cm. 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 significantly higher in the 2010 landings than in the preceeding two years. 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 as 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 2005–2010, and for the UK (E&W) fisheries from

2001–2010. 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 2010 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 2010. This equates to a reduction from 2009 of 30%; 8% by weight for the gadoid fleet, and 42%; 9% for the French crustacean fleet. Overall discarding is up for the UK and Irish fleets. Sampling trips are down by 7% while sampled hauls increased by 87% from the previous year.

Discarded whiting length distributions from 2010 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 some fish being discarded up to 50 cm in some fleets. The discard L_{50}'s for most countries/fleets is around 30 cm in 2010 up from previous years.

Age compositions for Irish discard data were provided for otter trawlers in VIIg and VIIj for 2004–2010 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 2010 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).

The internal consistency of the surveys 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 three surveys included in the assessment are provided in Figure 7.15.7b. Year effects were examined with mean log standardized plots of indices by age and year (Figure 7.15.8a). Cohort tracking was examined with mean log standardized plots of indices by age and cohort (Figure 7.15.8b).

The EVHOE-WIBTS-Q4 survey log indices scatterplots display reasonable 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 (Fig 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 2010, 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 7.15.10). 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 the 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 2010 data. 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 assessment was carried out with FLXSA 1.4–2 under R version 2.4.1. The assessment uses the same settings as last year (detailed below), with the exception of the French commercial tuning fleets which were not updated for 2009–2010 due to data non-availability. The tuning data available, and the subset used in the assessment, are given in Table 7.15.8. No exploratory runs were carried out for this assessment.

		2010	2011
Catch date range:	Years	82–08	82–10
	Ages	0–7+	0–7+
F_{bar} Age Range:		2–5	2–5
Assessment Method:		XSA	XSA
Commercial Tuning Fleets:			
FR-Gadoid Late	Yrs	93–08	93–08
	Ages	3–6	3–6
FR-*Nephrops*	Yrs	93–08	93–08
	Ages	3–6	3–6
Survey Tuning-series:			
FR-EVHOE	Yrs	97–09??	97–10
	Ages	0–4	0–4
UK-WCGFS	Yrs	87–01	87–01
	Ages	1–6	1–6
IR-IGFS Swept-area	Yrs	99–09	99–010
	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. Higher survivor estimates are given by the FR-EVHOE swept-area survey than the IR-IGFS Swept-area survey for the 2010 year class (age 0), although weighting between the two is almost equal. This situation is reversed from the previous year where IR-WIBTS-Q4 gave a significantly higher estimate. The IR-IGFS Swept-area survey estimated substantially higher survivors for both the 2008 year class (age 1) and the FR-EVHOE is higher for 2007 year class (age 2). The two estimates of survivors converge from the 2005 year class (age 4). Figure 7.15.11 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 7.15.12. There are strong year effects apparent in the French commercial fleets and survey, with the UKWCGFS estimated to be noisy even in the short time-series of data.

The retrospective pattern is shown in Figure 7.15.13. The retrospective bias in recruitment around the 1999 year class remains. The trend is a result of the non-inclusion of discards in the assessment while discarding rates are high. The large 2008 recruitment given by the assessment has been revised downwards, most likely for the same reason. In addition, F is underestimated when F is increasing and usually overestimated when decreasing although this pattern has not been observed in the last two years because of the loss of French commercial tuning information from the assessment (last data point in 2008). SSB retrospective patterns are opposite in sign to those observed for F.

Estimates of fishing mortality and stock numbers from the final XSA are given in Tables 7.15.11 and 7.15.12. These are summarized in Table 7.15.13 and Figure 7.15.14. The assessment this year reveals a slight increase in fishing mortality. Although the last two years of recruitment have been revised downward they remain above average of recent years. Recruitment of 2010 is below the time-series average.

Comparison with previous assessments

This assessment is an update of the assessment settings carried out since 2007, with the exception of the French commercial tuning fleet for which 2009/2010 data were not available. Minor revisions to landings and landings numbers-at-age have been included. The current assessment estimates of F agree with those estimated last year, as do SSB with a slight reduction in 2008.

State of the stock

Trends in landings, F(2–5), SSB, and recruitment are presented in Table 7.15.13 and Figure 7.15.14. SSB displays peak biomass in the mid-1990s following a series of good recruitment in preceding years. Subsequently SSB has shown a declining trend, which was temporarily halted by the strong 1999 year class. SSB for the last three years shows an increase. This is particularly noticeable in 2010 when SSB is estimated to be 41 905 t, well above B_{pa} (21 000 t) in response to two consecutive larger than the recent average recruitments (2008–2009). Fishing mortality (F_{bar}) is estimated to have been stable in the last three years following at low levels compared to the time-series average, following a recent peak in 2007.

Recruitment estimates of 2007–2009 year classes are above those of the six preceding year classes, however 2010 is the lowest in the time-series. The very large estimate of the 2008 year was revised downward by 25% in the 2010 assessment. The WG believed this to be an above average year class, although the size is still considered to be uncertain. The current assessment shows a 30% reduction in the estimate of the 2008 year class from 118 975 t down to 84 026 t. 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

No projections were undertaken given no change from last year where projections were rejected by the working group.

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)

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 2010 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 may explain a large proportion of the retrospective bias problems and changing catchabilities in commercial fleets observed throughout the assessment period. The availability of discard data has improved in the most recent years since the implementation of the DCF sampling programmes, but is has not been possible to compile a sufficient time-series of raised discard information.

Surveys

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). These surveys have given very different estimates of the 2009, 2008, 2007, and 2006 year classes, while the survivor estimates for the 2010 year class seems more comparable 23 557 (FR-EVHOE) vs. 17 462 (IR-IGFS Swept-area). The estimation of younger year classes is one of the most important factors in the short-term development of the stock.

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.

Consistency

Interannual comparison between the results of this year's and last year's assessments shows consistent estimates up until 2005 inclusive. Estimated recruitment for the 2008 and 2009 year class have been revised downward, by 29% and up by 44% respectively. Recent estimates of F are consistent between assessments with only a slight upward revision is observed in 2008 (4%) and 2009 (12%). SSB estimates exhibit a small downward revision for the last two years (11–13%). Part of this improved consistency is the result of the recent termination of the French commercial information and thus the result of a bias variance trade-off rather than a decrease in the uncertainty in the assessment.

SSB has been rescaled upwards slightly in the past when the full time-series of commercial tuning data was included in the assessment. Consistency between more recent assessments showed some problems with recruitment and SSB estimates as strong year classes during the 1990s passed through the fishery and were heavily discarded. Assessments for the last few years have been reasonably consistent for SSB with some downward revisions, while F is revised upwards. Estimates of recruitment in the most recent assessment, remains problematic.

7.15.8 Recommendation for next benchmark

The 2010 assessment was accepted for trends only by the Celtic Sea Review Group which had no specific comments on the assessment of whiting VIIe–k. The RG commented that the WG should provide potential management actions that can be taken to protect the 2008 year class.

A benchmark assessment of whiting is necessary.

Problem: The assessment of this stock has not been accepted for a number of years and considered to be indicative of trends only. 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.

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.

Solution: The available discard data has improved in the most recent years since the implementation of the DCR sampling programmes. Data are now available for the main fleets, operating within VIIe–k. Work is now required to compile a complete time-series

of discard data, and evaluate raising options and uncertainty levels. 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. Exploratory analyses were carried out in the WGSSDS up until 2007.

WGCSE 2011 should review the time-series of discard data and options for inclusion of into this assessment. Until this happens WGCSE will not propose a time frame for the next benchmark.

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.

7.15.9 Management considerations

Catches and SSB in VIIe–k whiting fluctuate considerably depending on year-class strength. Indications are that the 2008 and 2009 year classes were strong, but 2010 is quite weak. Management measures should be considered to reduce discarding such that yield and SSB contributions can be maximized. This could be achieved through 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.

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 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. The current assessment doesn't include discard estimates. Recent selection data from FTFB should be investigated at the next benchmark workshop.

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. The impact of this on whiting remains unclear but spatial distribution of landings in 2010 suggest that landings from the closed rectangles are lower than those of adjacent rectangles. Irish quarterly landings by rectangle indicate little or no landings from within these closed rectangles during the first quarter.

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 ves-

sels 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 occuring.

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
Belgium	130	158	160	107	112	159	295	317	304	111	145	228	205	268
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
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
Netherlands		398		124										8
Spain													4	31
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
UK(Scotland)						1	33	32	20	41	16	23	23	34
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
Unallocated	1,376	3,192	-135	-263	149	353	-6,535	-9,184	-248	-690	-532	-429	1,165	144
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

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010a
Belgium	449	479	448	194	171	149	129	180	218	128	127	122	87	102
Denmark														
France	11,370	11,711	16,418b	9,077	7,203	7,435	5,897	4,811	5,784	4,649	3,543	3,046	2,739	3,390
Germany														
Ireland	6,893	5,226	5,807	4,795	5,008	5,332	4,093	4,215	5,709	4,521	4,764	2,330	2,704	4,186
Netherlands		1			5	4	9	18	60	40	64	23	24	75
Spain	24	53	21	11	9	12	-	76	56	70	21	8	1	
UK (E/W/NI)	1,742	1,706	1,344	1,249	943	843	758	586	471	402	569	610	764	
UK(Scotland)	42	68	3	2	11	12	5	7	-	6	4	7	63	
United Kingdom														785
Channel Islands		3	2	3	3	1	4	0	0	0	1	1	-	2
Total	20,520	19,247	24,043	15,331	13,353	13,788	10,895	9,893	12,298	9,816	9,093	6,147	6,382	8,540
Unallocated	12	-2	-4,128	-466	-583	-642	-312	61	-269	-283	-146	-410	-674	-116
Total as used by Working Group	20,532	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

a: Preliminary.

b: Preliminary, Reported as VIIb–k.

Table 7.15.2. Whiting in Divisions VIIe–k. Raised length distributions for 2010 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
20									
21				0.3					0.2
22				0.3					0.2
23	0.4			1.8				0.3	1.3
24	4.4			1.2				1.0	0.9
25	1.9			1.3				3.1	1.1
26	4.9	0.0	0.2	4.4	2.7			8.4	1.8
27	6.4	0.0	3.3	9.0	25.7			15.7	3.3
28	24.2	0.0	13.4	23.6	74.6			22.4	9.5
29	43.8	0.1	31.1	49.1	88.4		0.1	37.6	21.9
30	76.7	0.8	54.6	79.7	148.8		0.4	50.5	44.1
31	184.0	0.5	75.5	91.6	191.3		0.9	75.7	45.9
32	343.4	2.4	140.3	125.2	247.5		0.8	77.6	59.9
33	449.3	3.9	142.9	163.3	315.7	0.0	2.4	86.8	82.5
34	480.5	4.7	175.3	154.8	383.1	0.1	1.1	91.5	80.7
35	578.9	5.7	180.2	169.1	454.8	0.2	2.3	82.2	84.5
36	581.7	6.9	167.2	190.4	487.2	0.3	2.5	71.6	98.2
37	558.6	7.8	130.0	151.9	454.0	0.4	2.1	68.7	75.0
38	457.9	6.1	106.4	128.7	383.9	0.6	1.9	57.1	67.0
39	376.6	6.1	104.7	102.1	321.2	0.8	1.1	47.9	49.0
40	401.3	5.1	73.6	93.8	254.0	0.5	0.4	47.9	53.3
41	275.8	4.1	57.6	72.7	210.1	0.7	1.3	34.1	35.4
42	257.1	3.8	33.2	82.5	170.7	0.5	1.0	29.5	37.2
43	183.4	3.5	35.1	66.7	124.6	0.3	0.4	12.8	34.8
44	145.5	1.9	22.6	50.5	108.6	0.3	0.5	19.1	26.1
45	107.7	1.7	17.8	48.8	84.1	0.3	0.5	11.4	23.2
46	95.5	1.4	18.0	41.8	61.1	0.2	0.1	13.3	19.1
47	96.9	1.4	17.1	31.3	49.0	0.1	0.4	5.4	16.1
48	64.9	1.2	8.0	29.1	21.8	0.1	0.4	5.9	13.0
49	54.8	0.8	7.3	19.3	27.1	0.1	0.1	4.7	9.1
50	31.2	0.8	7.9	16.2	19.8	0.1	0.1	4.3	6.7
51	23.7	0.4	2.7	9.2	10.0	0.1	0.2	1.9	3.5
52	21.9	0.5	2.3	3.3	9.3	0.0	0.2	1.0	1.9
53	20.6	0.2	1.8	5.6	10.2	0.0	0.2	2.9	2.1
54	16.6	0.7	1.9	3.2	4.7	0.0	0.1	0.4	1.2
55	12.1	0.5	0.4	1.9	3.9	0.0	0.1	0.8	0.8

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
56	8.3	0.2	3.0	3.9	3.7	0.0	0.1	0.3	2.7
57	10.0	0.2	0.8	2.6	3.2	0.0	0.1	0.2	1.1
58	10.2	0.2	0.6	0.8	0.6	0.0		0.2	0.3
59	2.8	0.0	0.0		0.9	0.0		0.2	
60	4.8	0.0	0.0		0.7	0.0			
61	0.0	0.1	0.0		0.9				
62	0.6	0.0	0.4						
63	0.6								
64	1.0								
65									
66	0.0								
67	1.2								
68									
69									
Total N.	6022.2	73.5	1637.3	2030.6	4757.7	6.1	22.1	994.1	1014.6
Total (t)	3222.1	40.3	691.0	1041.4	2162.1	4.1	11.5	416.6	518.2

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

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

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

Table 7.15.6. Whiting in Divisions VIIe–k. Summary of discard data in 2010 provided to the Working Group.

				Sampling							Discard Rates	
Country	Year	Quarter	Gear/Fleet	Trips	Hauls	Numbers Retained	Weight Retained	Number Discarded	Weight Discarded	Units	Number	Weight
France	2010	Q1-3	OT VIIe-k Crustacean	14	551	1422	751	332	71	No. & KG Sampled	19%	9%
France	2010	Q2-4	OT VIIe-k Demersal fish	31	1771	4544	2524	987	209	No. & KG Sampled	18%	8%
UK	2010	1	All Gears	32	366	3622	1490	2253	411	Raised No. & KG Sampled	38%	22%
UK	2010	2	All Gears	26	237	1213	490	6684	667	Raised No. & KG Sampled	85%	58%
UK	2010	3	All Gears	13	117	423	140	1702	313	Raised No. & KG Sampled	80%	69%
UK	2010	4	All Gears	22	219	622	354	5751	1240	Raised No. & KG Sampled	90%	78%
Ireland	2010	All	Otter Trawls VIIg	17	221	1551	554	12 194	2568	No. '000s & tonnes raised to Fleet	89%	82%
Ireland	2010	All	Otter Trawls VIIj	23	252	1804	713	3073	340	No. '000s & tonnes raised to Fleet	63%	32%

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.

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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    2010

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
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    2010
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
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
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    2010
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   1506.6 t
        12.03
137086  91      2224    1538    1046    #       412     125     48      #2001   2227.9 t
        16.25
168134  291     1140    2615    613     #       86      13      6       #2002   1761.4 t
        10.48
198059  147     878     1640    1195    #       155     8       0       #2003   1544.6 t
        7.80
188948  132     628     1763    1002    #       428     42      2       #2004   2243.9 t
        11.88
198315  96      1743    2848    1226    #       1162    745     31      #2005   3730.4 t
        18.81
185083  188     1900    2070    950     #       427     283     127     #2006   3008.2 t
        16.25
217009  78      1063    3112    2305    #       614     141     70      #2007   3597.2 t
        16.58
192317  131     860     1038    677     #       173     55      7       #2008   1269.3 t
        6.60
209568  216     894     1471    675     #       283     69      17      #2009   1576.6 t
        7.52
225900  133     1078    2008    1339    #       379     94      12      #2010   2631.5 t
        11.65
IR-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    2010
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
```

IR-GFS-7J : Irish Groundfish Survey in VIIj (IBTS 4th Qtr) - Whiting no. @ age (Interim indices: New Celtic Explorer series)

```
2003    2010
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
```

IR-GFS-7G&J : Irish Groundfish Survey in VIIg&j (IBTS 4th Qtr) - Whiting no. @ age (Interim indices: New Celtic Explorer series)

```
2003    2010
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
```

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

	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

[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

10/05/2011 12:19

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 29 years. 1982 to 2010. Ages 0 to 7.

Fleet	First year	Last year	First age	Last age	Alpha	Beta		
"FR-GADOID-late: Fre			1993	2010	3	6	0	1
"FR-NEPHROPS-Late: F	1993	2010	3	6	0	1		
"FR-EVHOE: Thalassa			1997	2010	0	4	0.75	1
"UK-WCGFS: UK (E+W)	1987	2010	1	6	0.15	0.25		
IR-GFS-7G-SweptArea:			1999	2010	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 23 iterations

1

Regression weights

1 1 1 1 1 1 1 1 1 1

Fishing mortalities

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	0	0	0	0	0	0	0	0	0	0
1	0.007	0.038	0.016	0.039	0.027	0.054	0.032	0.029	0.005	0.009
2	0.161	0.168	0.173	0.199	0.285	0.316	0.328	0.163	0.125	0.066
3	0.685	0.445	0.371	0.481	0.755	0.69	0.934	0.7	0.404	0.389
4	1.272	0.973	0.513	0.594	1.006	0.97	1.57	1.051	0.859	0.606
5	1.377	1.05	0.886	0.553	1.101	1.377	1.808	1.06	0.777	1.444
6	1.011	0.656	0.827	0.725	0.736	0.964	1.86	1.21	0.782	0.595

1

XSA population numbers (Thousands)

	AGE						
YEAR	0	1	2	3	4	5	6
2001	**3.88E+04**	**5.24E+04**	**8.68E+04**	**2.47E+04**	**7.88E+03**	**3.05E+03**	**1.29E+03**
2002	3.84E+04	3.18E+04	4.26E+04	6.05E+04	1.02E+04	1.81E+03	6.30E+02
2003	4.26E+04	3.14E+04	2.50E+04	2.95E+04	3.17E+04	3.15E+03	5.18E+02
2004	3.96E+04	3.49E+04	2.53E+04	1.72E+04	1.67E+04	1.56E+04	1.06E+03
2005	3.49E+04	3.24E+04	2.75E+04	1.70E+04	8.72E+03	7.54E+03	7.33E+03
2006	4.19E+04	2.85E+04	2.59E+04	1.69E+04	6.54E+03	2.61E+03	2.05E+03
2007	6.07E+04	3.43E+04	2.21E+04	1.54E+04	6.95E+03	2.03E+03	5.39E+02
2008	8.40E+04	4.97E+04	2.72E+04	1.31E+04	4.97E+03	1.18E+03	2.72E+02
2009	8.07E+04	6.88E+04	3.95E+04	1.89E+04	5.31E+03	1.42E+03	3.36E+02
2010	2.41E+04	6.61E+04	5.60E+04	2.86E+04	1.03E+04	1.84E+03	5.35E+02

Estimated population abundance at 1st Jan 2011

0.00E+00 1.98E+04 5.36E+04 4.29E+04 1.58E+04 4.62E+03 3.56E+02

Taper weighted geometric mean of the VPA populations:

6.65E+04 5.51E+04 4.22E+04 2.34E+04 8.72E+03 2.43E+03 5.83E+02

Standard error of the weighted Log(VPA populations):

0.5256 0.5038 0.5132 0.6305 0.8658 1.1205 1.418

1

Log-catchability residuals.

Fleet : "FR-GADOID-late: Fre

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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	99.99	0.24	0.09	-0.36	-1.02	-1.1	0.16	0.31	0.51
4	99.99	99.99	-0.32	0.12	-0.21	-0.48	-0.67	-0.61	0.27	0.21
5	99.99	99.99	-0.33	-0.03	0.1	-0.43	-0.63	-0.45	0.31	0.1
6	99.99	99.99	-0.07	0.01	0.18	-0.4	-0.63	0.68	0.11	0.14

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
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	0.18	-0.19	-0.67	-0.47	0.51	0.88	0.69	0.26	99.99	99.99
4	0.06	0.03	-0.36	-0.26	0.39	0.64	0.63	0.57	99.99	99.99
5	-0.11	-0.08	-0.24	-0.29	0.51	0.87	0.13	0.56	99.99	99.99
6	-0.25	-0.26	-0.4	-0.03	0.28	0.57	-0.22	0.47	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	-6.6398	-6.1555	-5.9887	-5.9887
S.E(Log q)	0.5859	0.4332	0.4096	0.3702

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	2.72	-3.263	0.31	0.2	16	1.24	-6.64
4	1.83	-4.908	3.36	0.71	16	0.5	-6.16
5	1.16	-1.463	5.59	0.85	16	0.46	-5.99
6	0.95	0.67	6.04	0.93	16	0.36	-5.98

1

Fleet : "FR-NEPHROPS-Late: F

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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	99.99	0.7	0.32	0.19	-0.55	-0.42	-0.08	0.79	0.56
4	99.99	99.99	0.22	0.03	0.01	-0.11	0.06	-0.17	0.67	0.5
5	99.99	99.99	0.23	-0.48	-0.12	-0.01	0.31	0.09	0.52	0.28
6	99.99	99.99	-0.22	-0.64	-0.34	0.06	0.29	-0.01	0.57	0.18

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
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	0.38	-0.38	-0.54	-0.41	0.3	-0.12	-0.04	-0.69	99.99	99.99
4	0.47	0.04	-0.29	-0.27	-0.04	-0.42	-0.23	-0.48	99.99	99.99
5	0.25	0.46	0.05	-0.13	0.06	-0.22	-0.59	-0.69	99.99	99.99
6	0	0.35	0.03	0.17	-0.05	-0.61	-0.91	-0.78	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	-8.9402	-8.3659	-8.1672	-8.1672
S.E(Log q)	0.4756	0.3299	0.3572	0.4469

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	1.05	-0.231	8.87	0.6	16	0.52	-8.94
4	1.01	-0.093	8.35	0.84	16	0.35	-8.37
5	0.89	1.419	8.19	0.93	16	0.31	-8.17

6	0.82	2.948	8.1	0.95	16	0.29	-8.29
1							

Fleet : "FR-EVHOE: Thalassa

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	99.99	99.99	99.99	99.99	99.99	99.99	-0.54	-0.25	0.73	-0.67
1	99.99	99.99	99.99	99.99	99.99	99.99	-0.45	-0.86	0.45	-0.1
2	99.99	99.99	99.99	99.99	99.99	99.99	-0.64	-0.63	0.35	0.48
3	99.99	99.99	99.99	99.99	99.99	99.99	-0.39	-1.56	0.22	-0.15
4	99.99	99.99	99.99	99.99	99.99	99.99	-0.13	-1.27	0.05	-0.12
5	No data for this fleet at this age									
6	No data for this fleet at this age									

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	-0.47	0.07	0.16	-0.27	0.3	-0.99	1.15	1.54	-0.93	0.18
1	-0.15	-0.46	0.87	1.4	-0.46	-0.82	0.56	0.15	0.23	-0.36
2	0.34	-0.43	1.01	1.16	-0.64	-0.96	-0.57	-0.07	0.63	-0.01
3	0.66	-0.28	1.1	1.41	-0.37	-0.89	-1.14	0.4	0.45	0.55
4	-0.03	-0.51	0.85	0.81	0.02	-1.07	-0.43	0.84	0.54	0.44
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	-6.7998	-6.9673	-7.5084	-7.9027	-7.8986
S.E(Log q)	0.7486	0.6506	0.6721	0.8428	0.6672

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	0.7	0.888		8		0.43	14	0.53	-6.8

1	1.15	-0.267	6.4	0.21	14	0.78	-6.97
2	0.89	0.242	7.84	0.28	14	0.62	-7.51
3	1.18	-0.279	7.51	0.17	14	1.03	-7.9
4	1.09	-0.318	7.76	0.51	14	0.75	-7.9

1

Fleet : "UK-WCGFS: UK (E+W)

Age	1987	1988	1989	1990
0	No data for this fleet at this age			
1	-1.22	-1.4	-0.18	-3.2
2	1.34	-1.28	0.05	-1.28
3	0.56	-0.86	0.4	-0.21
4	0.06	-1.11	0.2	0.08
5	1.13	0.16	0.63	0.73
6	1.74	99.99	1.12	0.62

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	No data for this fleet at this age									
1	-1.56	-0.14	1.29	1.62	-0.52	-0.1	0.31	0.83	0.34	2.49
2	-3.28	-0.21	-0.16	0.29	1.41	0.69	0.26	0.65	0.31	0.81
3	-2.38	-0.12	0.04	0.55	0.98	0.58	-0.86	0.8	-0.24	0.57
4	-1.37	0.64	-0.09	0.44	0.73	0.07	-0.02	0.51	-0.49	0.56
5	-0.44	0.39	-0.31	0.68	0.53	-0.07	0.08	-0.75	-0.76	0.3
6	0.24	0.12	0.6	0.14	0.88	-0.58	-0.09	-1.34	0.04	0.41

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	No data for this fleet at this age									
1	1.44	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	0.4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	0.2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	-0.21	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	-2.3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6	-0.18	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		-11.3524	-11.3958	-11.5835	-11.6823	-11.4955	-11.4955
S.E(Log q)		1.4621	1.1905	0.8605	0.6082	0.8429	0.7952

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	0.856	11.29	0.26	15	0.88	-11.35
2	0.55	1.314	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	0.551	11.48	0.76	15	0.57	-11.68
5	1.38	-1.658	12.81	0.6	15	1.1	-11.5
6	1.44	-2.745	13.18	0.76	14	0.88	-11.23

1

Fleet : IR-GFS-7G-SweptArea:

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.31	-0.33
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.06	0.08
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.02	0.38
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.21	-0.78
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.7	-1.09
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.4	0.13
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.2	-1.16

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	-0.1	-0.72	0.07	0.63	-1.39	1.01	0.22	0.39	0.04	-0.12
1	-0.93	-0.14	-0.65	-0.3	-0.32	0.45	0.57	-0.18	0.14	1.23
2	1	-0.38	-0.35	-0.79	0.07	0.48	0.87	0.33	-0.11	-1.52
3	1.25	-0.24	-0.69	-0.31	0.21	0.67	0.52	0.54	0.14	-1.52
4	1.23	0.17	99.99	-0.5	0.63	-0.02	0.62	0.28	0.58	-2.6
5	0.37	-1.17	-0.65	-0.02	0.99	99.99	1.38	-1.14	0.97	-1.26
6	1.13	0.66	99.99	-2.01	1.17	0.87	1	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	0	1	2	3	4	5	6
Mean Log q		-4.16	-4.1199	-4.8307	-5.4064	-5.8743	-6.4953	-6.4953
S.E(Log q)		0.6256	0.5723	0.7043	0.7525	1.069	0.9403	1.209

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	0.72	0.968	6.02	0.55	12	0.45	-4.16
1	0.77	0.693	5.63	0.48	12	0.45	-4.12
2	1.07	-0.115	4.45	0.22	12	0.79	-4.83
3	3.25	-1.28	-4.91	0.03	12	2.38	-5.41
4	6.15	-0.935	-10.57	0	11	6.62	-5.87
5	0.76	0.945	6.89	0.63	11	0.72	-6.5
6	1.03	-0.065	6.22	0.46	8	1.31	-6.26

1

Terminal year survivor and F summaries:

Age 0 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
"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	23557	0.775	0	0	1	0.414	0
"UK-WCGFS: UK (E+W)	1	0	0	0	0	0	0
IR-GFS-7G-SweptArea:	17462	0.651	0	0	1	0.586	0
F shrinkage mean	0	1			0	0	

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
19766	0.5	0.15	2	0.296	0

Age 1 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
"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	29270	0.508	0.278	0.55	2	0.385	0.016
"UK-WCGFS: UK (E+W)	1	0	0	0	0	0	0
IR-GFS-7G-SweptArea:	106727	0.44	0.597	1.36	2	0.515	0.004
F shrinkage mean	16002	1				0.1	0.03

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
53622	0.32	0.44	5	1.384	0.009

1

Age 2 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
"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	71495	0.41	0.458	1.12	3	0.423	0.04
"UK-WCGFS: UK (E+W)	1	0	0	0	0	0	0
IR-GFS-7G-SweptArea:	34506	0.377	0.558	1.48	3	0.501	0.082

F shrinkage mean	10636	1		0.076	0.245

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
42914	0.27	0.36	7	1.352	0.066

Age 3 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
"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	28450	0.372	0.205	0.55	4	0.413	0.235
"UK-WCGFS: UK (E+W)	1	0	0	0	0	0	0
IR-GFS-7G-SweptArea:	11225	0.34	0.362	1.06	4	0.493	0.514
F shrinkage mean	7393	1				0.094	0.703

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
15840	0.25	0.25	9	1.022	0.389

1

Age 4 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	5432	0.339	0.26	0.77	5	0.451	0.535
"UK-WCGFS: UK (E+W)	1	0	0	0	0	0	0
IR-GFS-7G-SweptArea:	5123	0.332	0.563	1.7	5	0.417	0.56
F shrinkage mean	1906	1				0.132	1.104

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4617	0.24	0.28	11	1.147	0.606

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

"FR-GADOID-late: Fre	463	0.604	0	0	1	0.055	1.249
"FR-NEPHROPS-Late: F	178	0.5	0	0	1	0.081	2.011
"FR-EVHOE: Thalassa	397	0.369	0.274	0.74	5	0.195	1.361
"UK-WCGFS: UK (E+W)	1	0	0	0	0	0	0
IR-GFS-7G-SweptArea:	250	0.431	0.425	0.98	6	0.263	1.725
F shrinkage mean	469	1				0.406	1.24

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
356	0.43	0.18	14	0.427	1.444

1

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
"FR-GADOID-late: Fre	439	0.414	0.047	0.11	2	0.156	0.369
"FR-NEPHROPS-Late: F	169	0.386	0.197	0.51	2	0.171	0.77
"FR-EVHOE: Thalassa	253	0.388	0.407	1.05	5	0.131	0.575
"UK-WCGFS: UK (E+W)	1	0	0	0	0	0	0
IR-GFS-7G-SweptArea:	441	0.497	0.19	0.38	6	0.196	0.368

F shrinkage mean	154	1	0.346	0.822

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
242	0.37	0.16	16	0.439	0.595

Table 7.15.11. Whiting in Divisions VIIe–k. Fishing mortality (F)-at-age. F_{bar} range is 2–5.

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990
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
2	0.6227	0.7307	0.8392	0.8031	0.7132	0.6564	0.4359	0.3215	0.64
3	1.048	1.441	0.9644	1.1689	0.9843	1.347	1.0988	0.9266	0.7543
4	1.2366	1.5064	1.5566	0.8735	1.2303	1.5192	1.4821	1.3525	1.0945
5	1.3855	1.985	1.5183	1.3016	1.1488	1.7752	1.2823	1.2656	1.4198
6	1.2385	1.6665	1.3637	1.1279	1.1343	0.7612	1.2515	0.6736	0.8407
+gp	1.2385	1.6665	1.3637	1.1279	1.1343	0.7612	1.2515	0.6736	0.8407
FBAR 2–5	1.0732	1.4158	1.2196	1.0368	1.0191	1.3245	1.0748	0.9665	0.9772

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0	0	0	0	0	0	0	0	0	0
1	0.1097	0.0419	0.0216	0.0089	0.0068	0.0291	0.0141	0.0285	0.089	0.0366
2	0.4959	0.4281	0.2672	0.178	0.1386	0.1228	0.1273	0.2114	0.3643	0.295
3	1.0798	0.9191	0.8456	0.5557	0.4598	0.2414	0.2883	0.5233	0.7669	0.7817
4	1.7591	0.9275	0.835	0.8166	0.7045	0.5434	0.5069	0.5867	1.0368	0.9647
5	1.4168	1.0148	1.1755	0.8534	0.823	0.6629	0.6979	0.6999	1.1003	0.9722
6	1.3144	0.9538	1.0318	1.2112	0.6947	0.7749	0.876	0.6587	0.931	0.8185
+gp	1.3144	0.9538	1.0318	1.2112	0.6947	0.7749	0.876	0.6587	0.931	0.8185
FBAR 2–5	1.1879	0.8224	0.7809	0.6009	0.5315	0.3926	0.4051	0.5053	0.8171	0.7534

AGE	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	0	0	0	0	0	0	0	0	0	0
1	0.0071	0.0378	0.0164	0.039	0.0265	0.0543	0.0323	0.0286	0.0055	0.0089
2	0.1606	0.168	0.173	0.1994	0.285	0.3161	0.3278	0.1634	0.1248	0.0664
3	0.6852	0.4448	0.3706	0.4815	0.7547	0.6896	0.934	0.7001	0.4045	0.3894
4	1.2721	0.9732	0.5131	0.594	1.0062	0.9698	1.5705	1.051	0.8588	0.6056
5	1.3767	1.0498	0.8859	0.5526	1.1011	1.3775	1.8079	1.0596	0.7771	1.4445
6	1.0112	0.6557	0.8273	0.7246	0.736	0.9636	1.8601	1.2097	0.7825	0.5946
+gp	1.0112	0.6557	0.8273	0.7246	0.736	0.9636	1.8601	1.2097	0.7825	0.5946
FBAR 2–5	0.8737	0.659	0.4856	0.4569	0.7867	0.8382	1.1601	0.7435	0.5413	0.6265

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

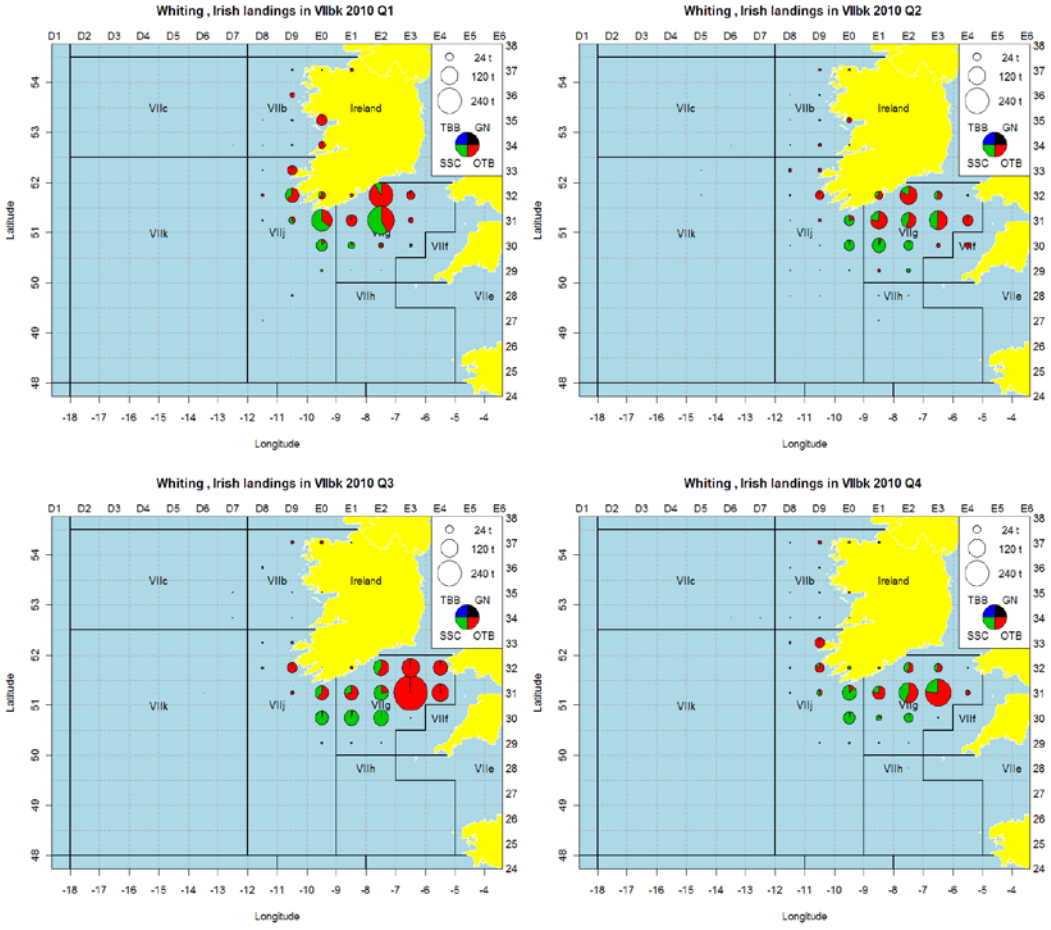
AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	163335	145774	193541	107379	63215	58626	56796	66012	134277	64022
1	88729	133727	119349	158458	87914	51756	47999	46501	54046	109936
2	33914	65100	104995	95630	128584	71489	41157	38747	37002	40482
3	9336	16911	34738	65806	65528	91647	51769	29669	25679	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	22648	18983	11225	0.5913	1.0732
1983	50257	22821	16988	11781	0.6935	1.4158
1984	53997	23398	17511	9985	0.5702	1.2196
1985	71465	23313	17576	10838	0.6166	1.0368
1986	133034	26073	18631	9952	0.5342	1.0191
1987	105422	37568	25014	12652	0.5058	1.3245
1988	33073	45762	33779	15128	0.4479	1.0748
1989	55007	39533	34797	16541	0.4754	0.9665
1990	108374	32753	27468	14106	0.5135	0.9772
1991	163335	33336	24231	13508	0.5575	1.1879
1992	145774	48233	32326	12364	0.3825	0.8224
1993	193541	61919	47054	16320	0.3468	0.7809
1994	107379	82229	62601	20034	0.32	0.6009
1995	63215	84112	74617	22678	0.3039	0.5315
1996	58626	79265	72727	18260	0.2511	0.3926
1997	56796	67573	62951	20532	0.3262	0.4051
1998	66012	55303	49975	19245	0.3851	0.5053
1999	134277	44137	39394	19915	0.5055	0.8171
2000	64022	45413	34611	14865	0.4295	0.7534
2001	38799	48124	39927	12770	0.3198	0.8737
2002	38393	45207	40143	13146	0.3275	0.659
2003	42647	37875	33442	10583	0.3165	0.4856
2004	39621	34706	30376	9953	0.3277	0.4569
2005	34864	30958	26927	12030	0.4468	0.7867
2006	41910	26317	22408	9533	0.4254	0.8382
2007	60665	25482	20479	8947	0.4369	1.1601
2008	84026	28309	20542	5737	0.2793	0.7435
2009	80709	41479	29198	6386	0.2187	0.5413
2010	24142	55327	41905	8451	0.2017	0.6265
GeoMean	66471.06					
ArithMean	76256					

Irish landings for the main gear types by quarter in 2010:



UK (E&W) whiting landings for all gears 2010:

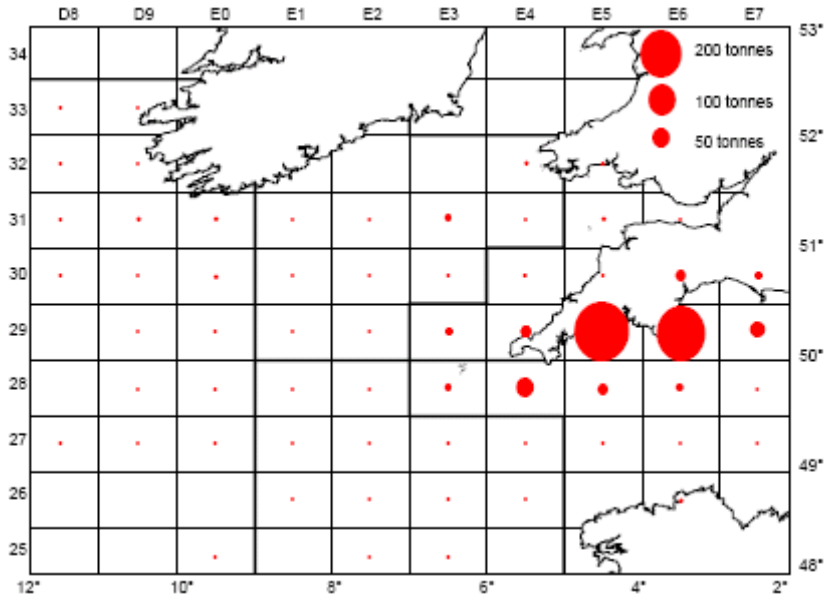


Figure 7.15.1. Whiting in VIIe–k (Celtic Sea). The spatial and temporal distribution of UK landings data in 2010 available to the WG.

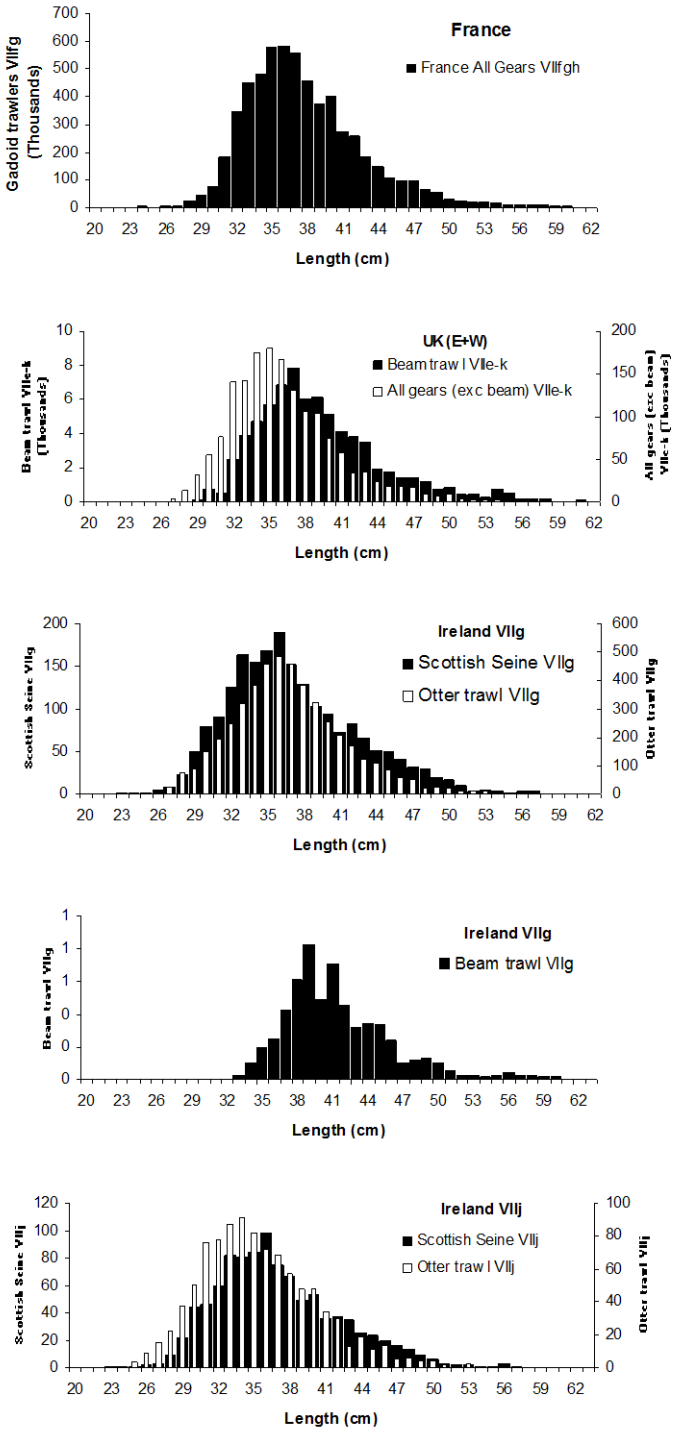
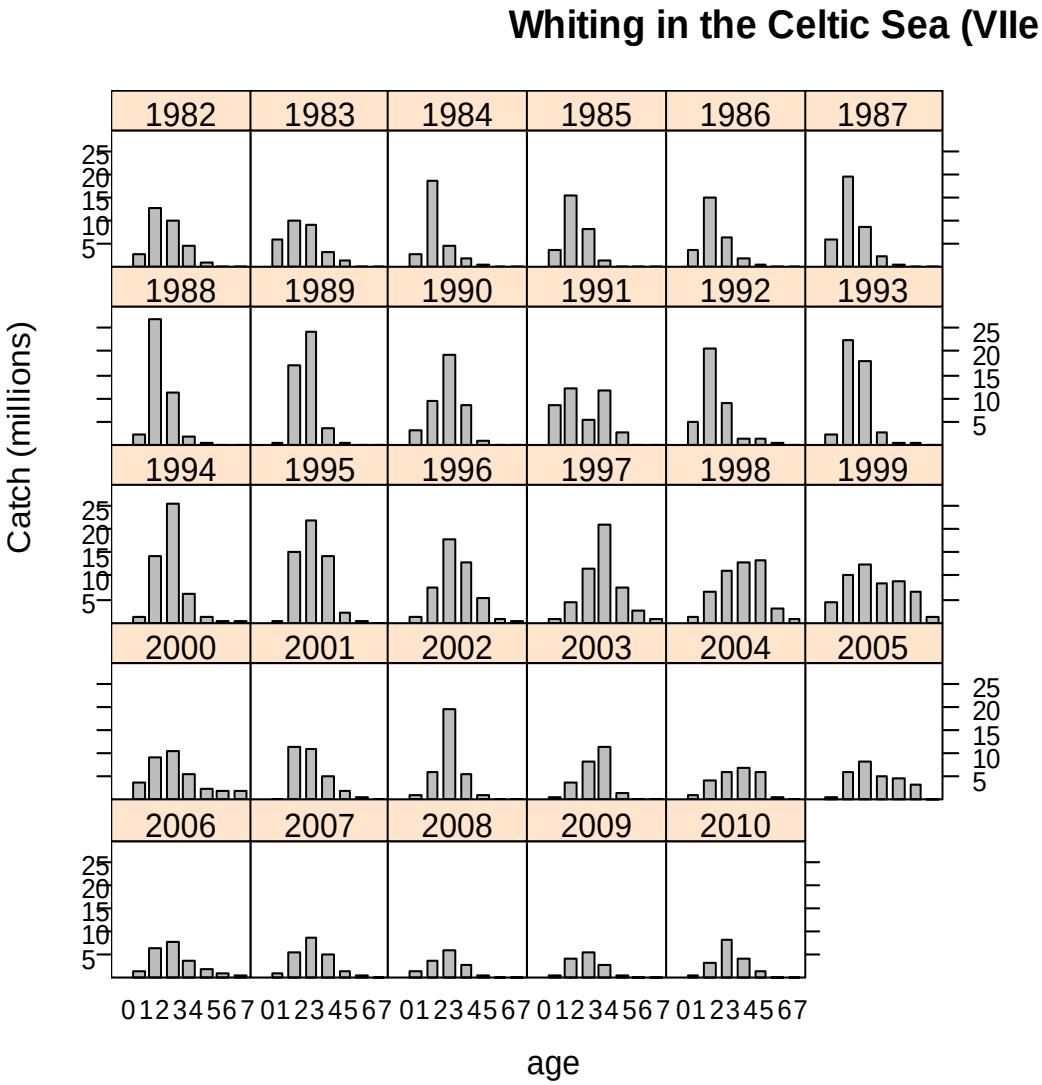


Figure 7.15.2. Whiting in VIIe–k (Celtic Sea). 2010 length compositions (raised numbers) of French, UK and Irish fleets.

(a)


Whiting in the Celtic Sea (VIIe
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Catch (millions)
age
0 1 2 3 4 5 6 7
5
10
15
20
25

(b)

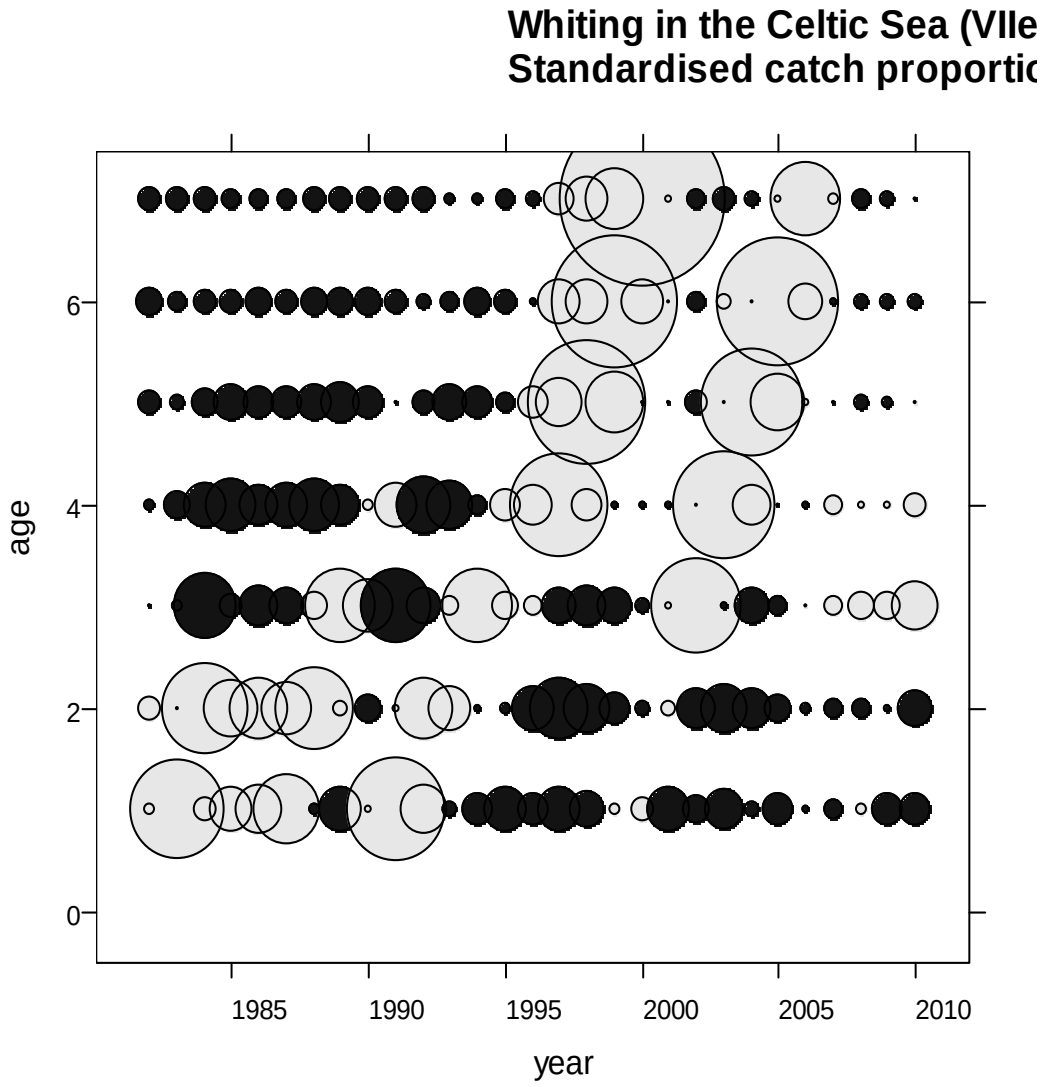


Figure 7.15.3. Whiting in VIIe–k (Celtic Sea). Annual landings age composition (a) and standardized catch proportions-at-age (b).

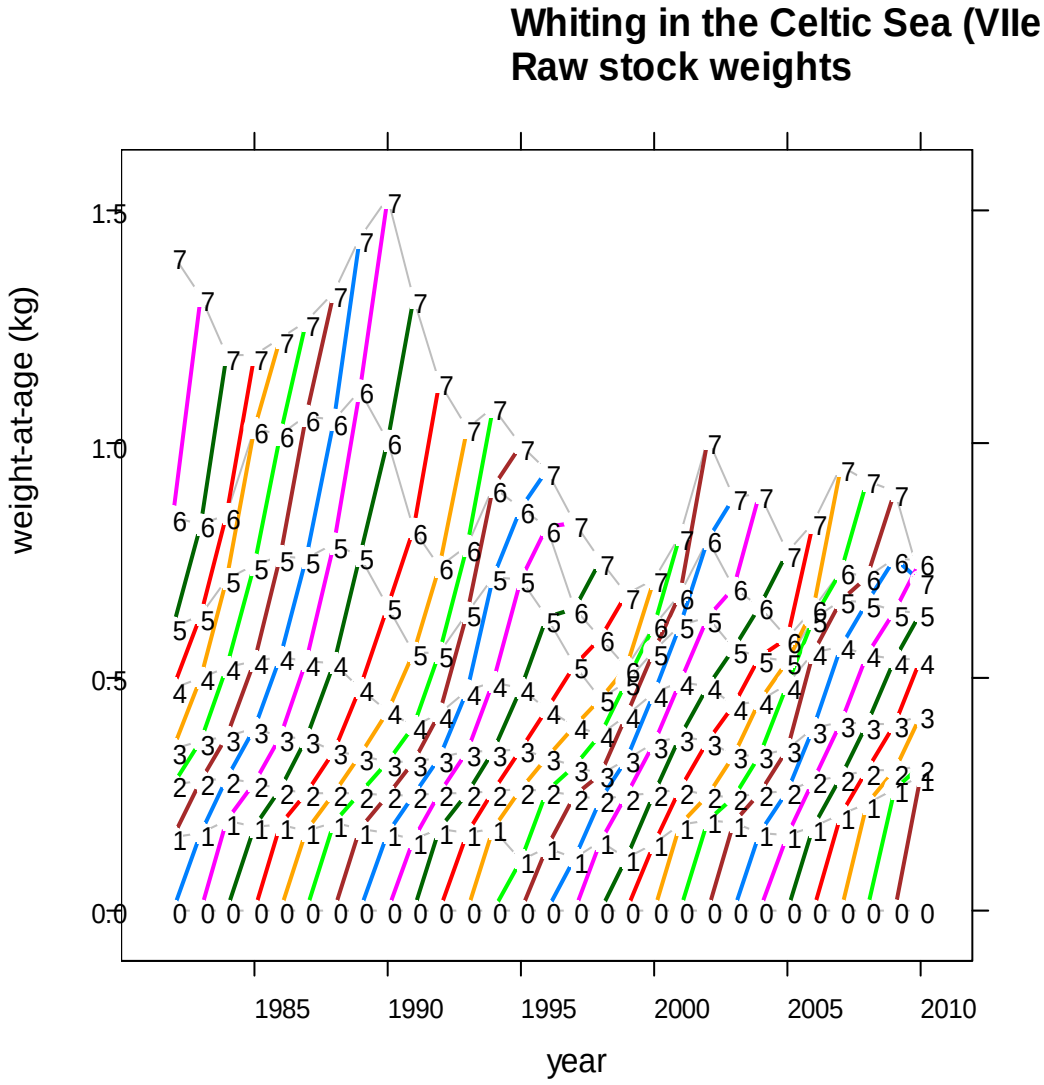


Figure 7.15.4. Whiting in VIIe–k (Celtic Sea). Stock weights-at-age.

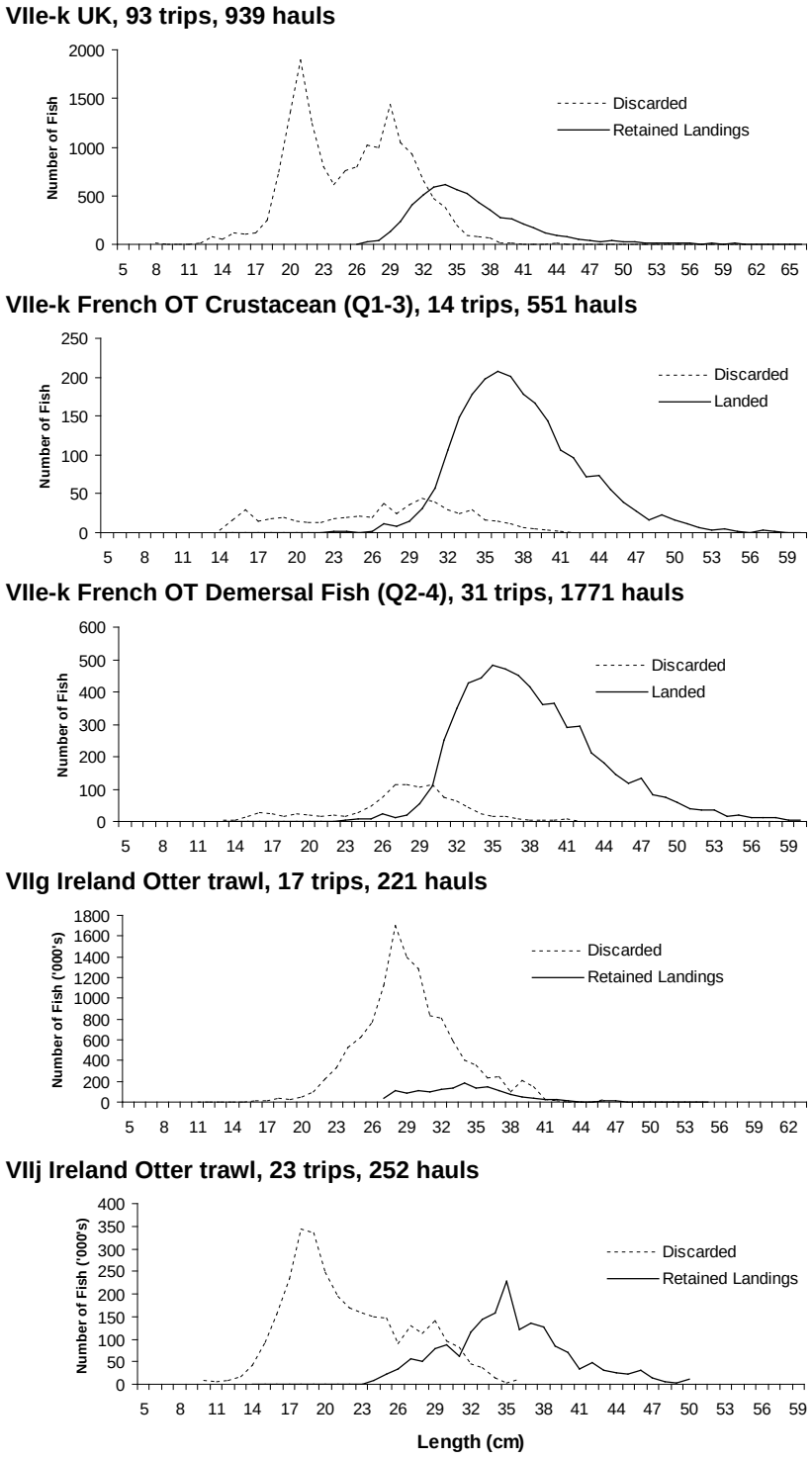


Figure 7.15.5. Whiting in VIIe–k (Celtic Sea). 2010 Annual length compositions of Irish, UK and French discards. Numbers are raised to the sampled catch for the UK and are raised by trip to the fleet for Ireland and are unraised sampled lengths for France.

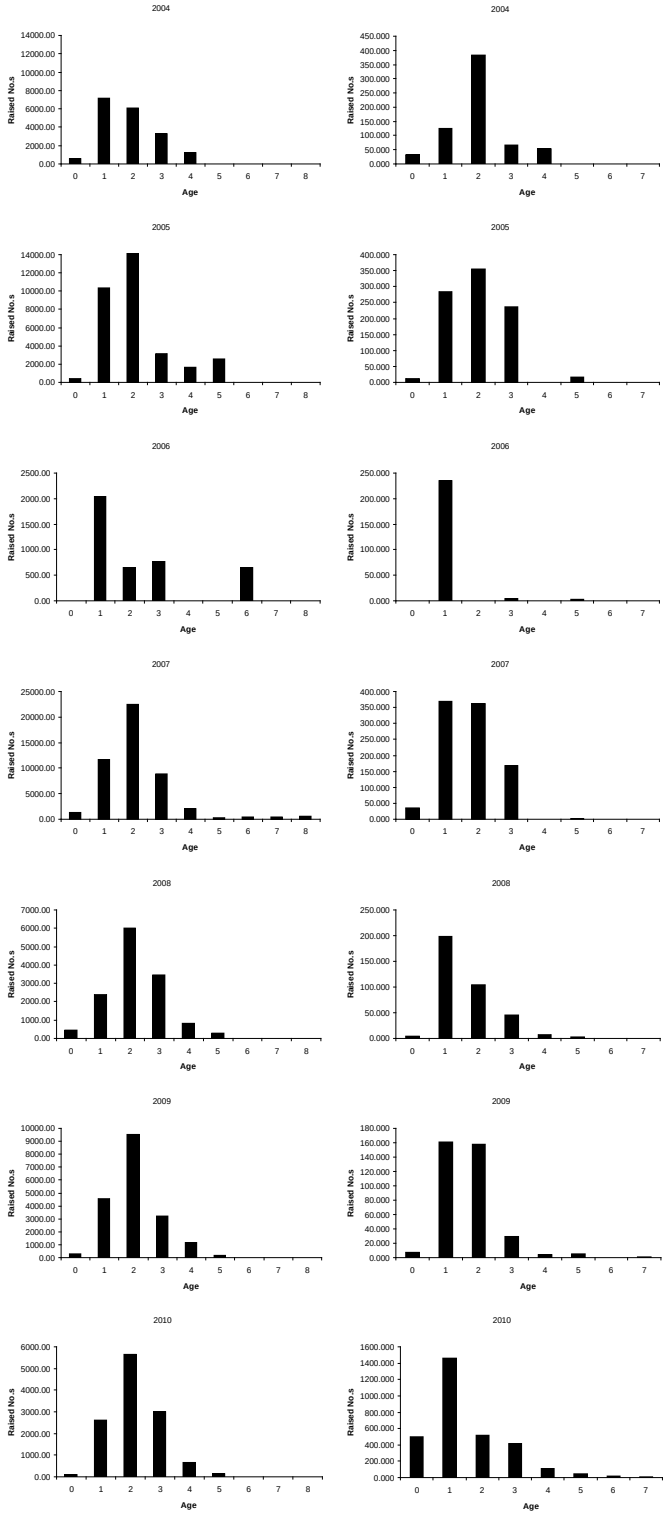
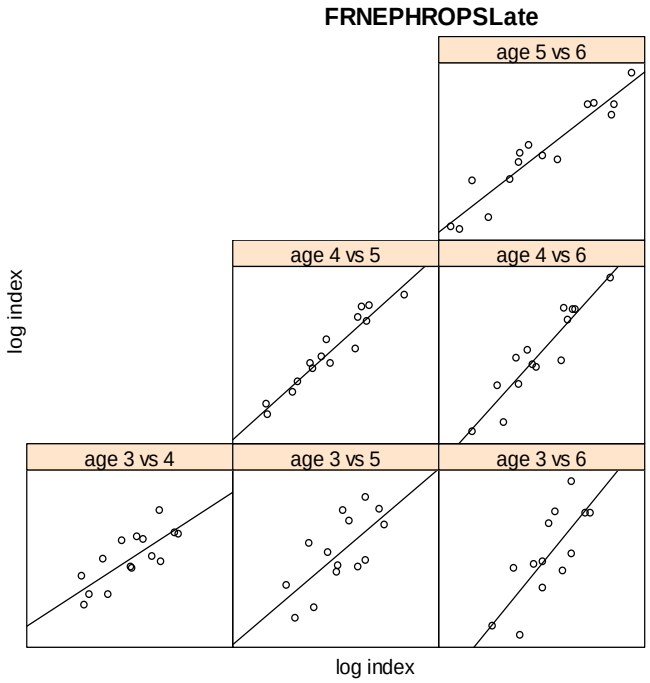
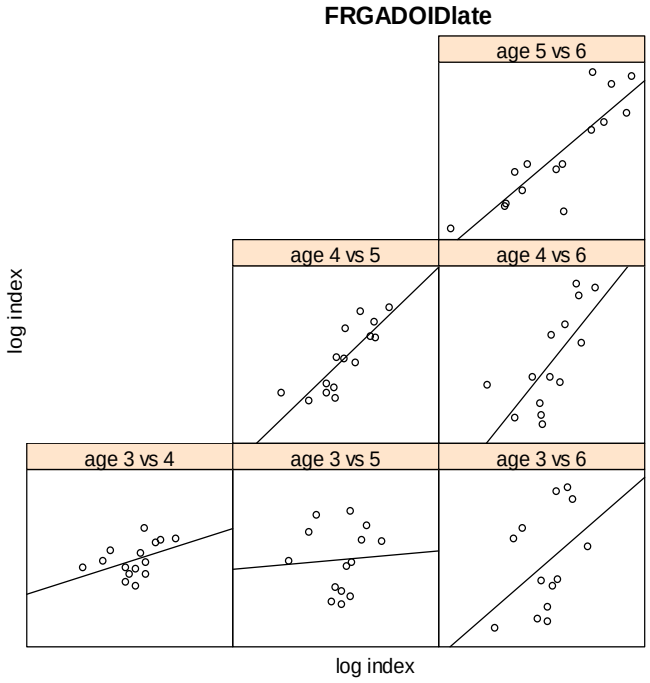


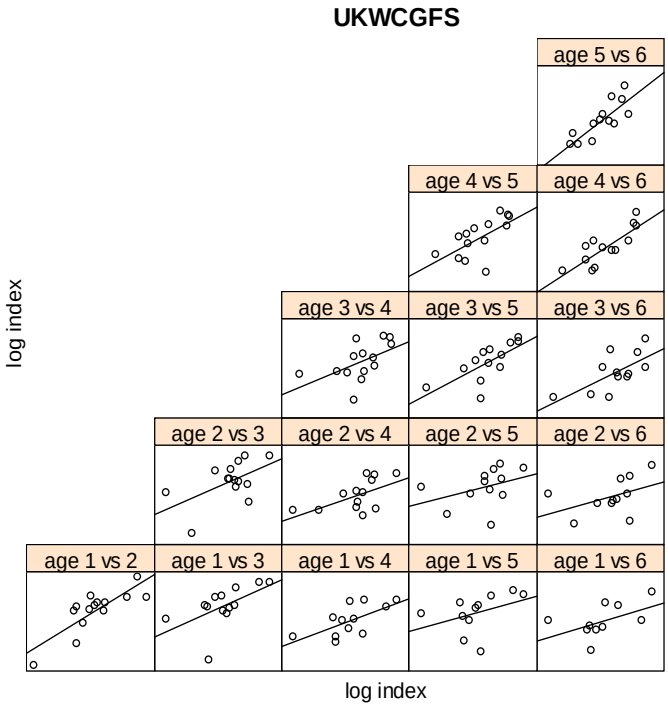
Figure 7.15.6. Whiting in VIIe–k (Celtic Sea). Age Composition of Discards from Irish otter board trawlers 2004–2010 in VIIg (left) and VIIj (right).

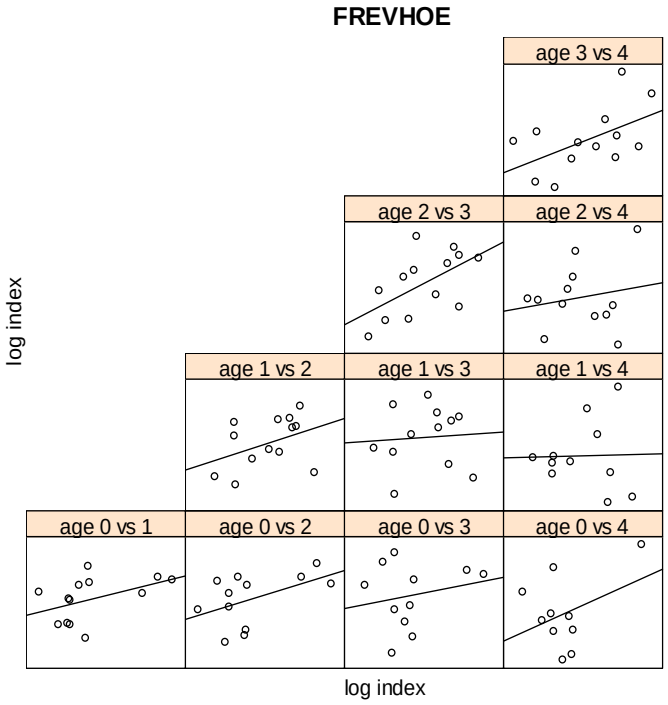
(A)


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

(B)


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


UKWCGFS
age 5 vs 6
age 4 vs 5
age 4 vs 6
age 3 vs 4
age 3 vs 5
age 3 vs 6
age 2 vs 3
age 2 vs 4
age 2 vs 5
age 2 vs 6
age 1 vs 2
age 1 vs 3
age 1 vs 4
age 1 vs 5
age 1 vs 6
log index
log index


FREVHOE
age 3 vs 4
age 2 vs 3
age 2 vs 4
age 1 vs 2
age 1 vs 3
age 1 vs 4
age 0 vs 1
age 0 vs 2
age 0 vs 3
age 0 vs 4
log index
log index

(b) Cont.

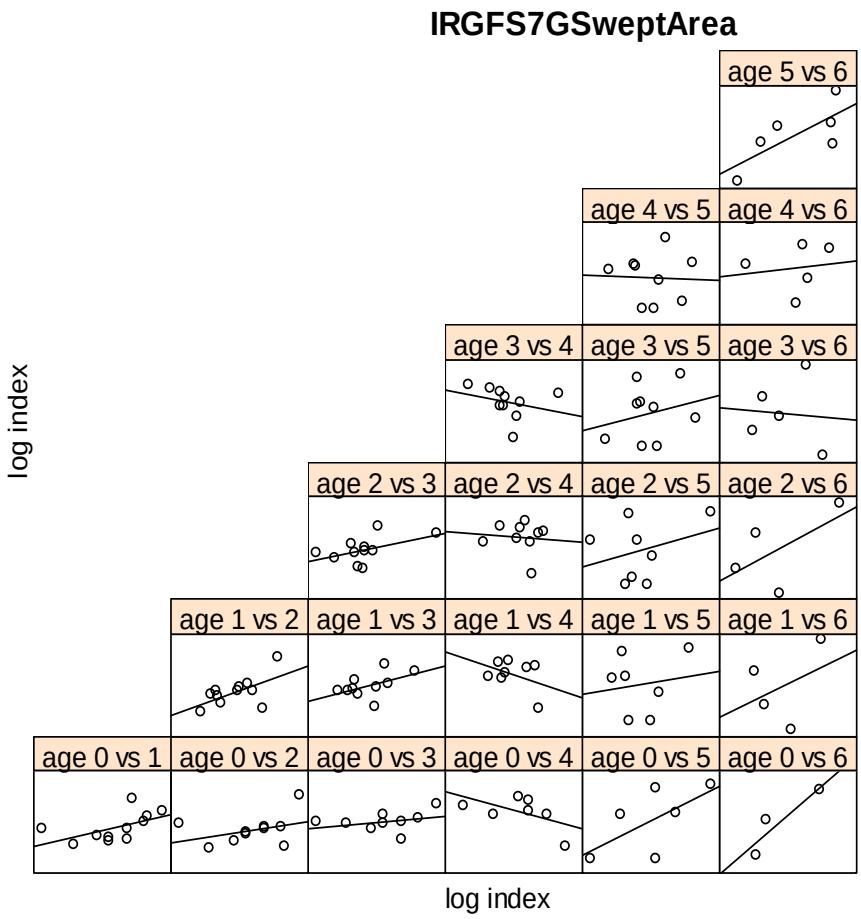
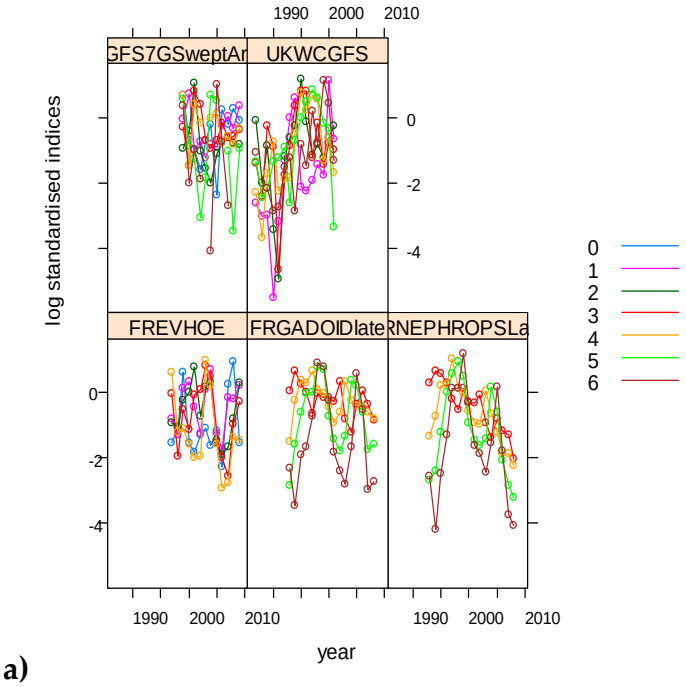
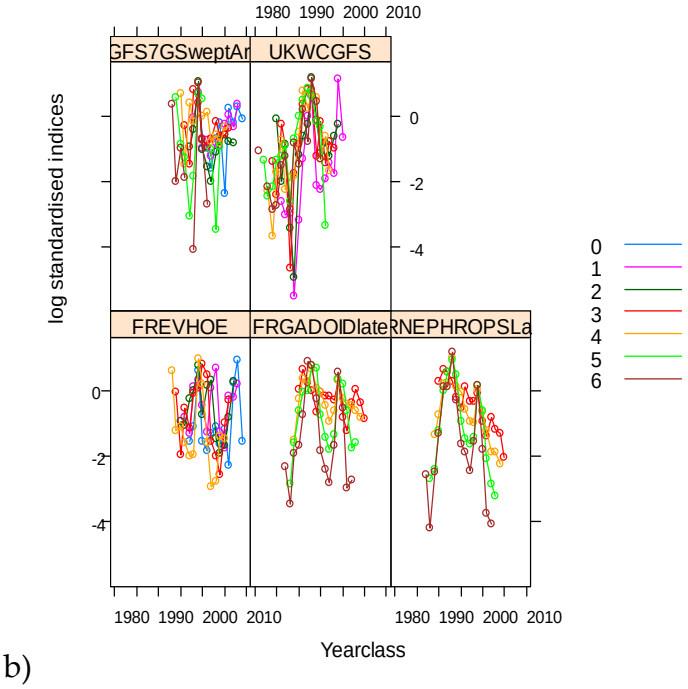


Figure 7.15.7. Whiting in VIIe–k (Celtic Sea). Pairwise scatterplots for the log numbers-at-age for the main tuning fleets to examine internal constancy of the indices (a) commercial fleets and (b) surveys.



a)



b)

Figure 7.15.8. Whiting in VIIe–k (Celtic Sea). Mean log standardized plots of indices by (a) age and year, and (b) age and cohort.

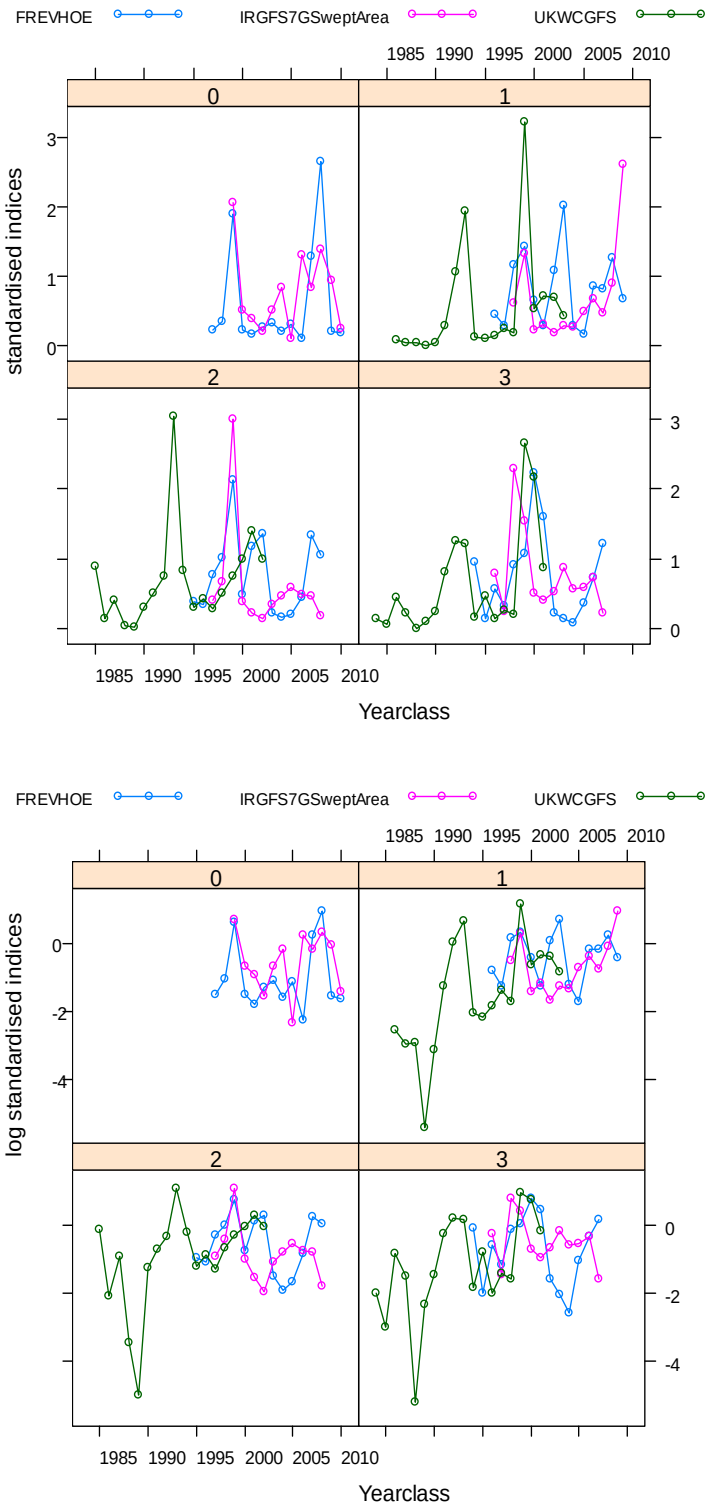


Figure 7.15.9. Whiting in VIIe–k (Celtic Sea). (a) standardized and (b) log standardized plots of survey indices used within the assessment for younger ages (0–2) by cohort.

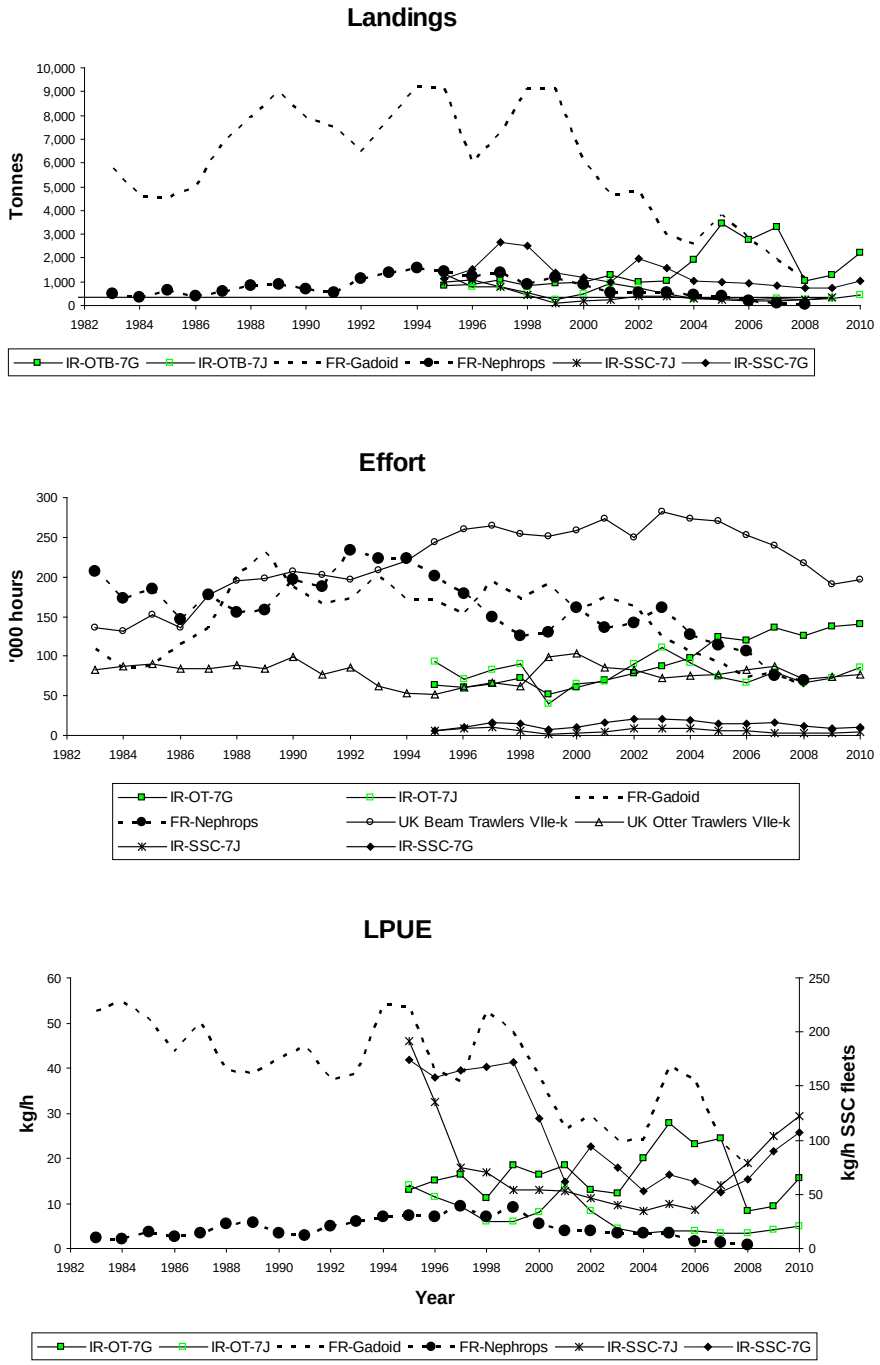


Figure 7.15.10. Whiting in VIIe–k (Celtic Sea). Landings, Effort and Landings per Unit Effort (lpue) for some fleets landing whiting. For the UK fleets Effort is GRT corrected.

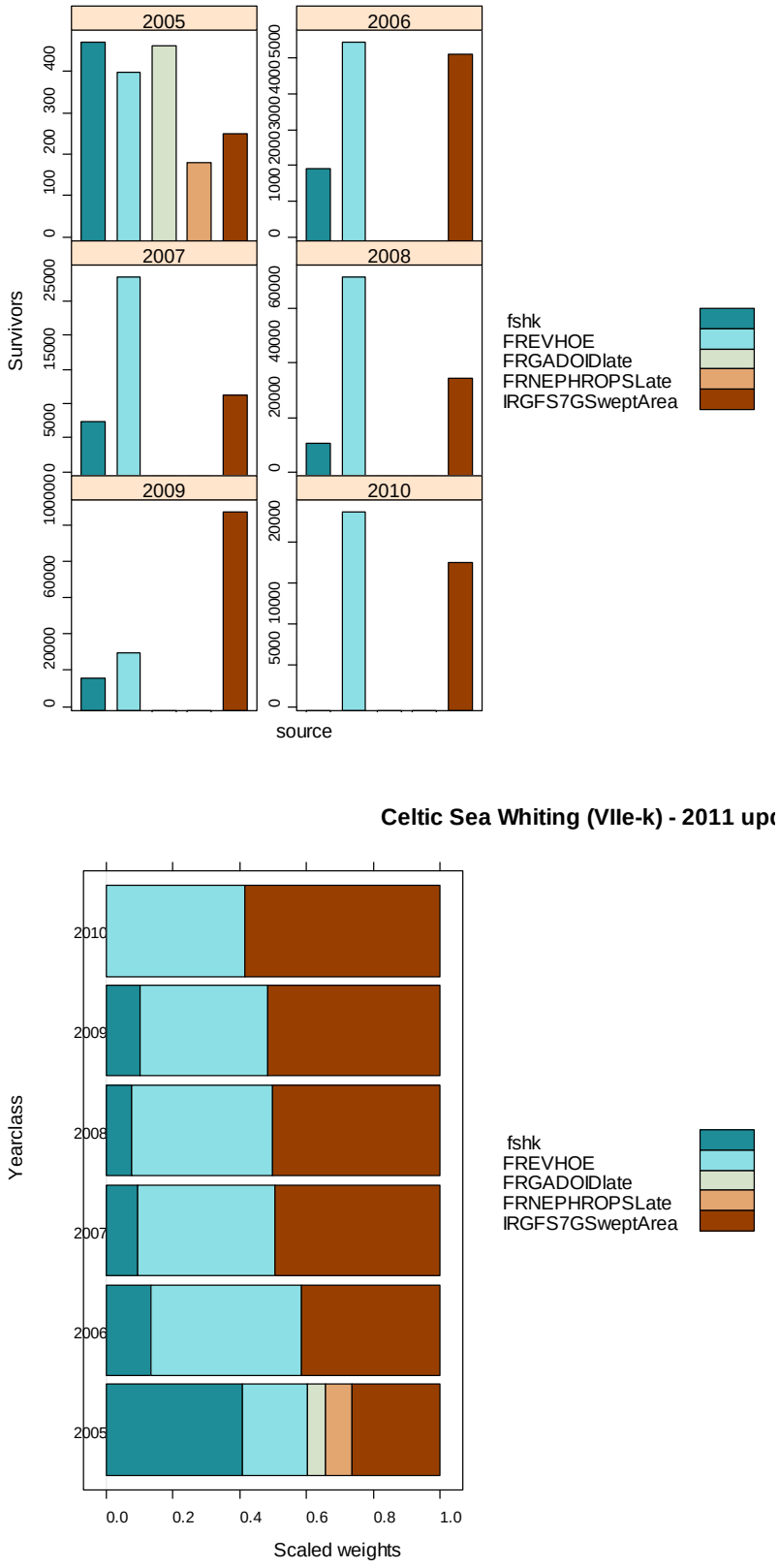
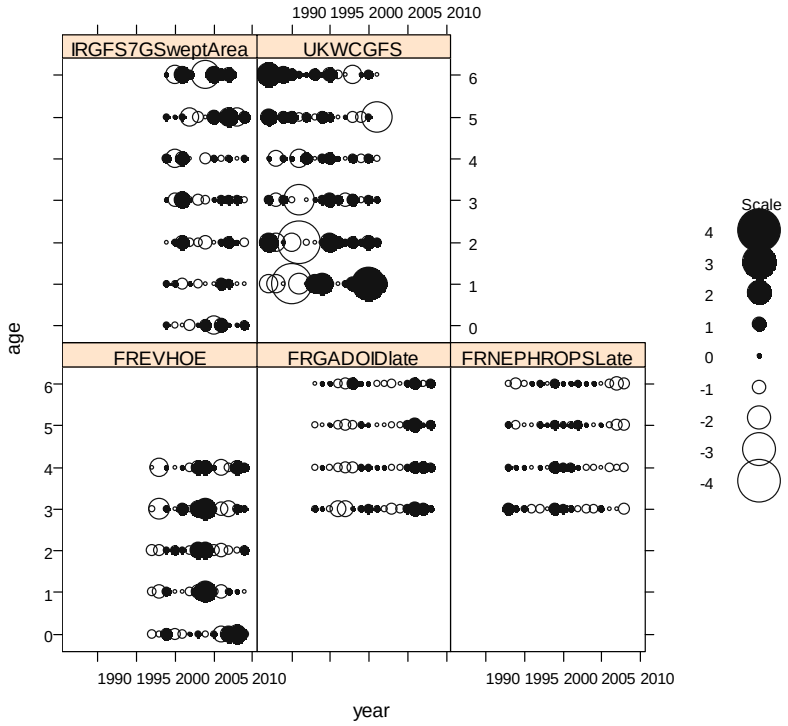


Figure 7.15.11. Whiting in VIIe–k (Celtic Sea). The survivor estimate weightings given by all fleets.

(a)



(b)

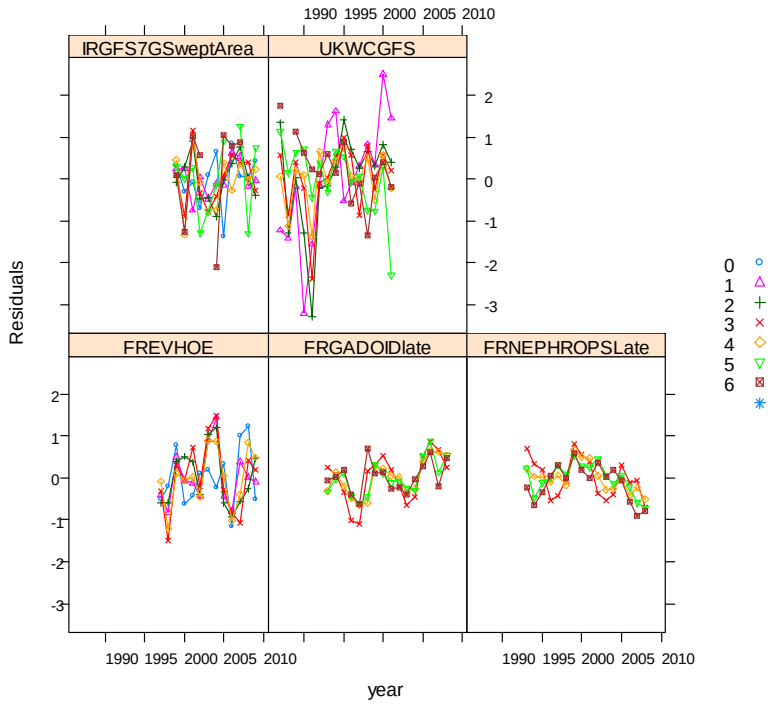


Figure 7.15.12. Whiting in VIIe–k (Celtic Sea). Log fleet catchability residuals bubble (a) and line (b) plots.

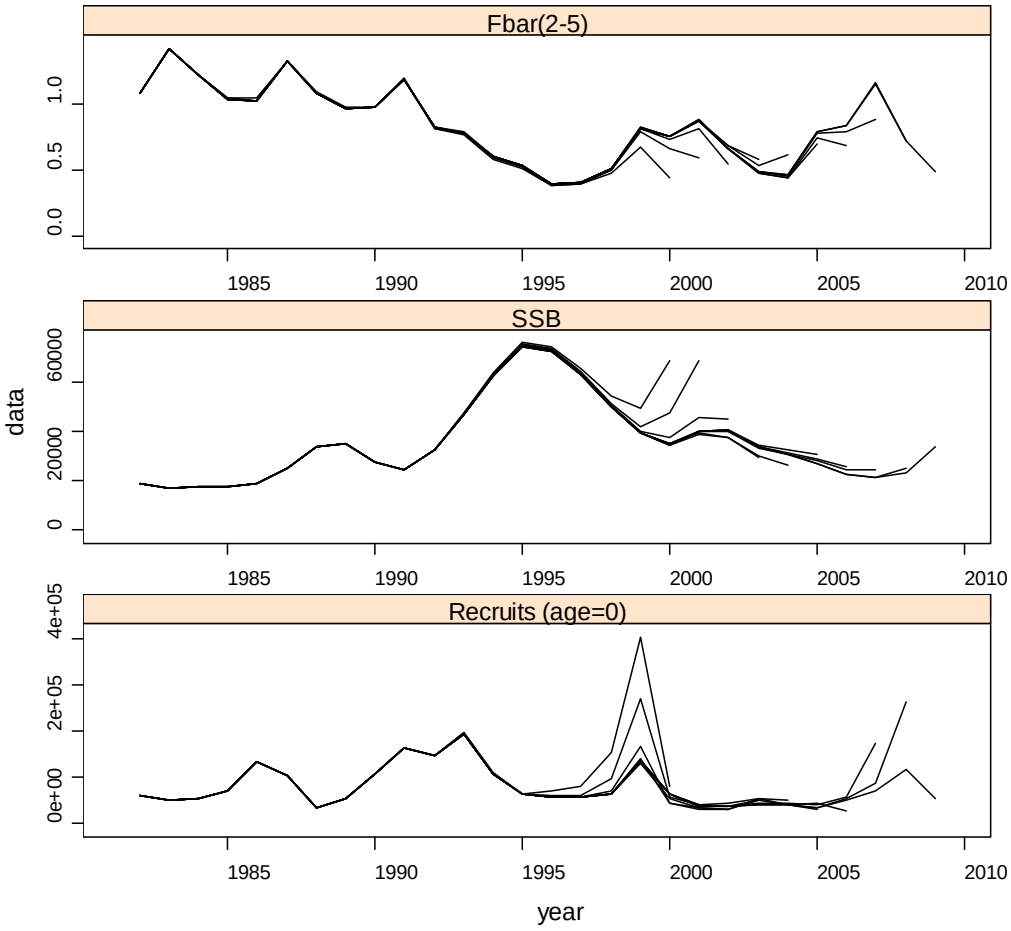


Figure 7.15.13. Whiting in VIIe–k (Celtic Sea). Retrospective analysis.

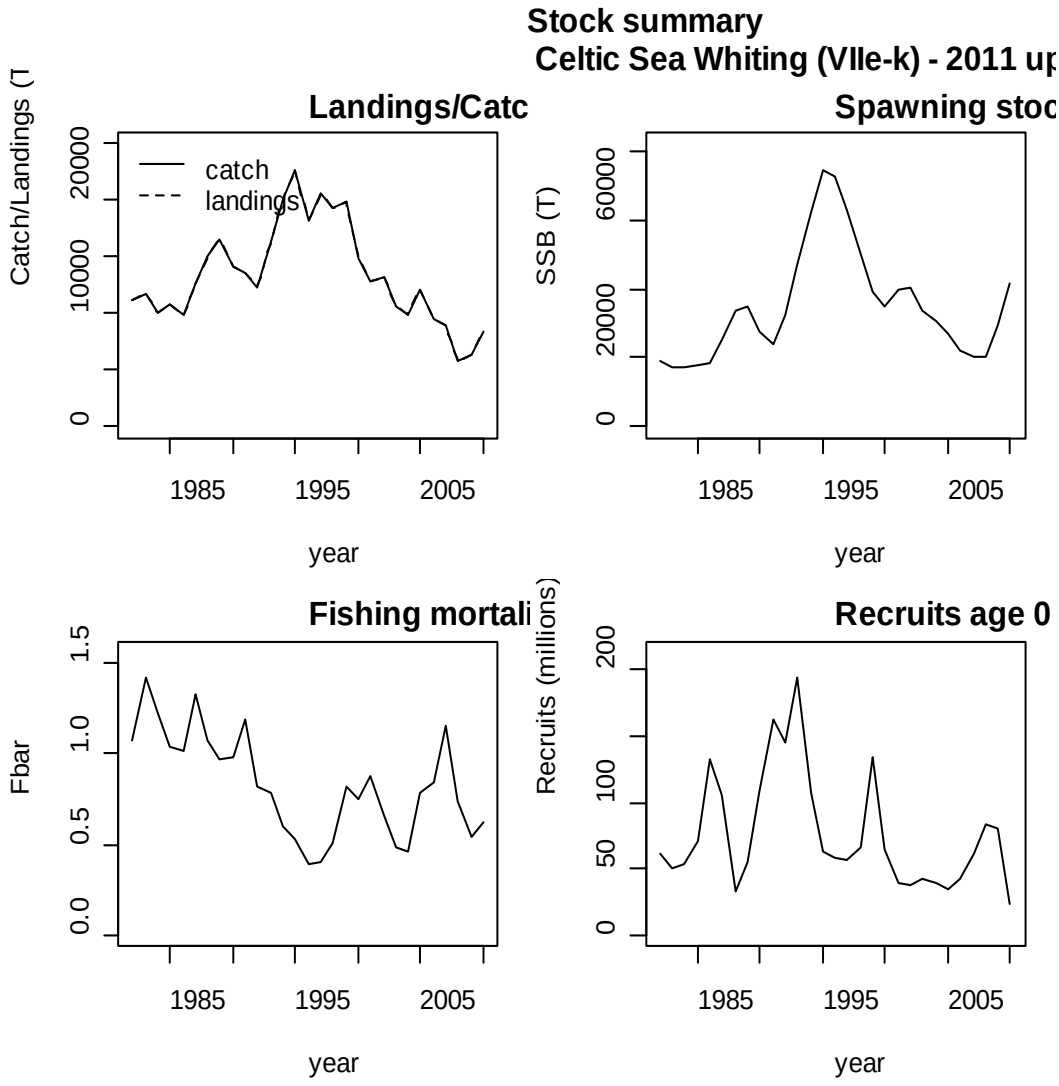


Figure 7.15.14. Whiting in VIIe–k (Celtic Sea). Stock summary.

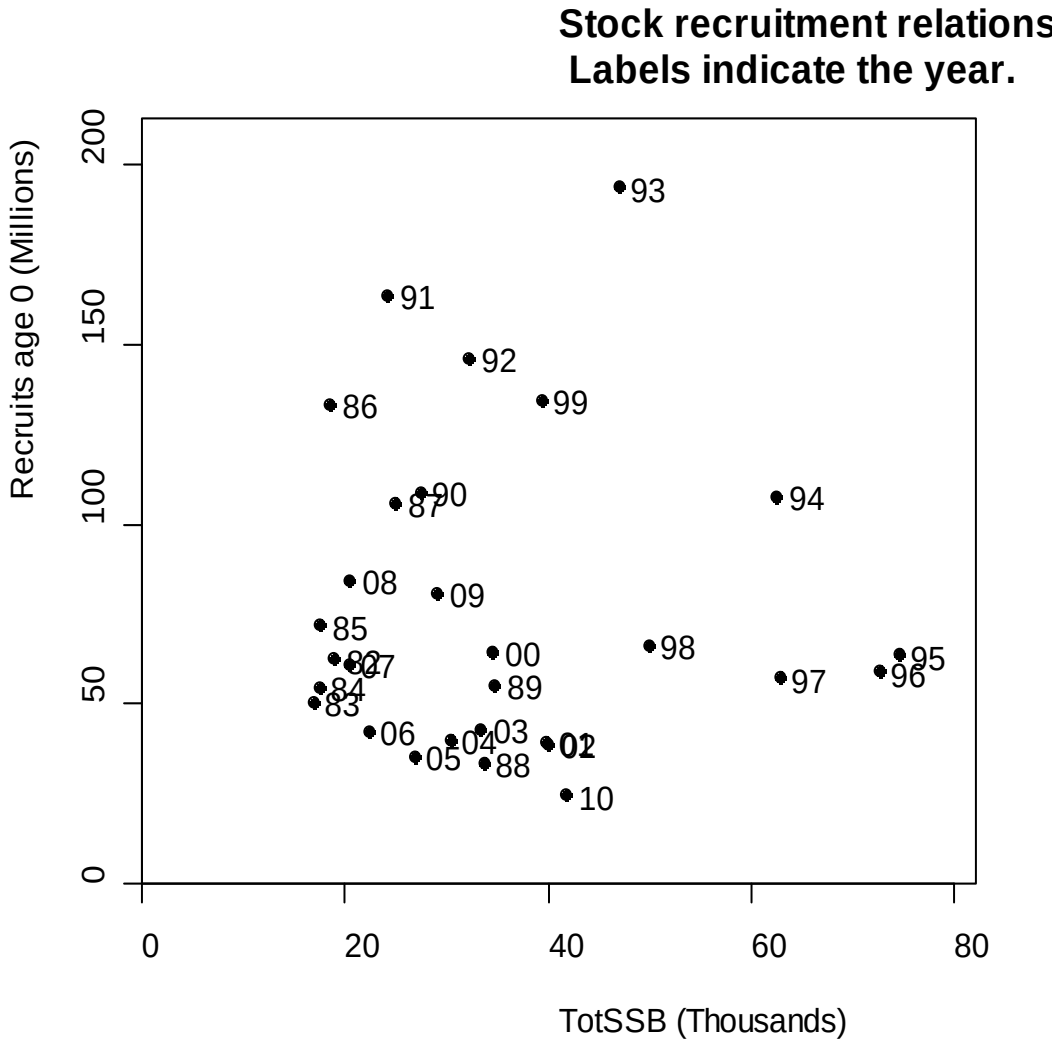


Figure 7.15.16. Whiting in VIIe–k (Celtic Sea). Stock–recruitment relationship.

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 1995–2010.

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010[a]
France	57	76	65	37*	…1*	107	114	111	92	59	102	62	32	26	32	70
Ireland	1894	1233	403	323	206	563	357	386	423	135	65	49	100	76.0	94	143
Netherlands	-	-	-	-	-	-	2	-	3	-	2	-	-	-	-	-
Spain	+	+	-	27	1	4	-	6	-	31	18	19	1	4	-	-
UK(E/W/NI)	24	96	75	49	10	6	5	4	5	1	11	5	1	1	2	0.4
UK(Scotland)	71	17	4	27	-	19	1	+	-	-	-	-	-	-	-	-
Total	2046	1422	547	463	217	699	479	507	523	226	198	135	134	107	128	214

*** See VIIg–k.**

[a] provisional.

8.2 Plaice in the Western Channel (ICES Divisions VIIe)

Type of assessment in 2011

Update assessment with no changes to the assessment settings as agreed at the Benchmark assessment meeting (WKFLAT 2010) held in February 2010.

ICES advice applicable to 2010

Exploitation boundaries in relation to precautionary limits: Given the low stock size, recent poor recruitment, high fishing mortality, the uncertainty in the assessment, and the inability to reliably forecast catch, ICES recommends a substantial reduction in catch until the estimate of SSB is above B_{pa} or other strong evidence of rebuilding is observed.

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

Technical comments made by the Review Group (RGCS)

The upward adjustment of SSB throughout the series caused by the addition of VIId data means that the basis for the previous B_{lim} and B_{pa} is no longer valid. A revision to the precautionary reference points is needed if these are to be retained for the stock. The B_{lim} value now lies below all historic SSB values in the assessment (see Figure 8.2.11). Alternative reference points are considered in the Stock Annex but the old values continue to be added to the biomass and stock–recruit plots which are misleading.

WKFLAT 2010 examined the stock dynamics provided by the migration model to determine appropriate biological reference points for this stock on the basis of the new assessment. It concluded that the historical 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. The Group could not come to a consensus with regards to suitable precautionary reference points but clearly stated that F_{sq} is currently too high and should be reduced, while biomass dynamics below the reasonably well estimated SSB levels of 2200 t are poorly under-stood.

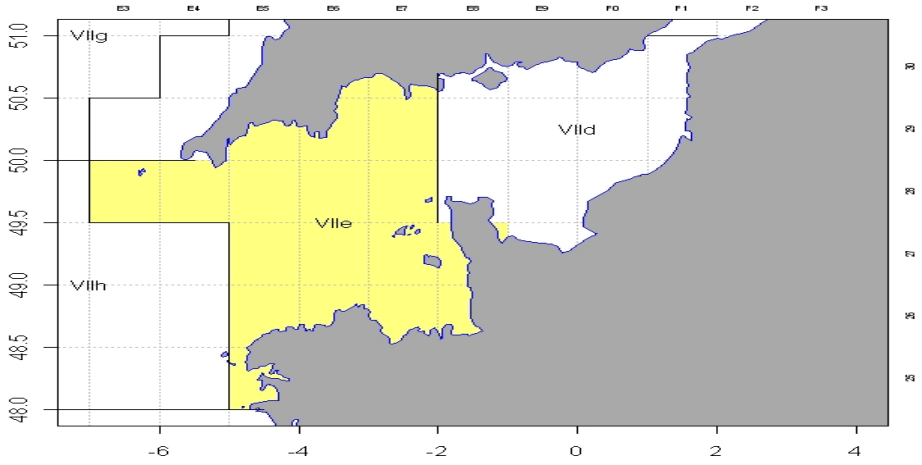
The Working Group agreed with these points, and given that the advice for this stock is now given on the basis of the ICES Maximum Sustainable Yield (MSY) framework,

deemed it inappropriate to propose alternate PA reference points at this time. These MSY reference levels have been added to the biomass and stock–recruits plots in this assessment report to remove the potential misinterpretation.

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 2010 and 2011

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 2010

Species:	Plaice *Pleuronectes platessa*	Zone:	VIId and VIIe (PLE/7DE.)
Belgium	699		
France	2 332		
United Kingdom	1 243		
EU	4 274		
TAC	4 274		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 twelve 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 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 twelve days for the UK beam trawl fleet due to a reduction in capacity of the fleet.

The fishery in 2010

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 2010, the UK beam trawl fleet took around 51% 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 5%).

UK otter trawl effort has increased in 2010 following a steady decline and is now at the highest level observed since 2002. The UK beam trawl effort has increased slightly in 2010 following the sharp fall seen the previous year but is still only just above the level observed in 2000.

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 25% of the TAC in 2010 and only 20% of the TAC in 2009.

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 2010 were 1111 t with Working Group estimates of VIIe plaice landings 3% lower at 1078 t. The Working Group estimate of the 2009 landings was revised upwards due to minor revisions to the landings by UK (E&W), France and UK (Guernsey) and the addition of Netherlands landings data not available last year. These combined additional landings totalled just 7 t making the revised total international landings in 2009 to be 923 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 in 2010 landings increased for the first time since 2006 and is now just under 1100 t. Unallocated landings in recent years, are generally the additional French landings derived from sales note information.

In addition to the estimated 2010 landings for VIIe an extra 149 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 2009 migration adjustment was increased to 142 t, as a result of an increase in the French 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 Section 2 (Table 2.1).

Annual length compositions of the 2010 UK (E&W) landings (two fleets) and France (five fleets) are provided (Table 8.2.3). Length distributions of UK (E&W) landings from 2001 to 2010 as used by the WG are illustrated in Figure 8.2.3.

Quarterly age compositions for landings in 2010 were available from UK (E&W) only, which accounted for almost 80% of the total reported international landings. Additional age compositions representing the migration adjustment (15% of quarter 1 landings for VIId) were available from UK (E&W), Belgium and France and a small landing (only) for the Netherlands. 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 migration element) are given in Table 8.2.4 and plotted for 2001 to 2010 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 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 2002–2010 (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. This year, in addition to these data, Belgian quarterly discard length frequency data were also available and showed similar discarding ratios to both the UK and France. Quarterly profiles of numbers landed and discarded-at-length, in 2010, are given in Figure 8.2.2.

Biological

Natural mortality and the maturity ogive 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 coverage 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 two years have seen a large increase in this survey's cpue as a result of large increases in numbers of recent year classes caught. This may be an 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 in 2008 that had a significant impact on the survivor estimates and the 2009 and 2010 Working Groups both excluded these data. These data were excluded once again at the 2011 Working Group.

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 is now at stable but low levels.

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 shows slow declining trend since 1997 in the west, but shows much more variation throughout the time-series in both the north and south areas.

All lpue time-series show an increase in 2010 with the exception of commercial otter trawlers in the south of the area.

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 level observed in 2000. 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 2009 and 2010.

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). Four 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) indices continues to show a large year effect in the 2008 data. 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, these data were excluded from the final assessment.

These data remain excluded from the assessment despite its impact being greatly reduced with the effect mostly now seen in the fleet residuals. 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 WKFLAT	2010 XSA	2011 XSA
Catch-at-age data		1980–2008, 1–10+ add catch from 7d	1980–2009, 1–10+ add catch from 7d	1980–2010, 1–10+ add catch from 7d
Fleets	UK-WECBTS – Survey	1986–2008, 1–8	1986–2009, 1–8	1986–2010, 1–8
	UK WECOT – Commercial	1988–2008, 3–9	1988–2009, 3–9	1988–2010, 3–9
	UK WECOT– Commercial historic	1980–1987, 2–9	1980–1987, 2–9	1980–1987, 2–9
	UK WECBT – Commercial	1989–2008, 3–9	1989–2009, 3–9	1989–2010, 3–9
	FSP-7e (UK E+W)	2003–2007, 2–8	2003–2009, 2–8 (exc 08)	2003–2010, 2–8 (exc 08)
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 fleets (UK-WECBT; UK-WECOT) and a year effect can be seen in the survey results (UK-WEC-BTS) for 2004 probably associated with a change in vessel effect.

Estimates for the youngest age are almost entirely determined by the UK beam trawl 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 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 2006–2008 above average year classes have led to a further increase in SSB in 2010. The 2009 year class appears to be the highest in the time-series. In last year's assessment, the 2008 year class was estimated to be weak but is now being estimated to be above average given the age 2 catches in this survey.

A retrospective analysis (Figure 8.2.7) was run without the short FSP-7e UK (E&W) tuning-series, and indicates a strong downward revision of the 2001 year-class strength, going from the second strongest year class in history to a value much closer to long-term GM. However, this year there has been strong upward revision to the estimate of the 2008 year class from a level well below the GM average last year to around double the GM this year. This assessment shows no retrospective bias in either SSB or F estimation.

Comparison with previous assessments

Fishing mortality has increased slightly in 2010 (0.45) and SSB is estimated to have increased to 2629 t. Last year, fishing mortality and SSB in 2009 were estimated to be 0.44 and 1833 t; this year's estimates for 2008 are 0.43 and 1868 t, a downward revision in F of 2% and an upward revision in SSB of 2%.

There is no major bias in the retrospective analysis and historical stock trends are strongly converged. Other recent estimates of F show a slight underestimation with a slight overestimation 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, 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 1650 t in 2008. Above average recruitments in the 2006–2008 year classes has led to an increase in the SSB estimate for 2010 to over 2600 t.

Fishing mortality showed a gradually increasing trend up until the mid 1990s, then a slight decline followed by a sharp increase up to 2007. This assessment shows a small reduction in F in 2008 and a much larger reduction in 2009, followed by a small increase again in 2010. These changes in F are corroborated by corresponding changes in the effort observed for the UK beam trawl fleet and the F for sole, the target species for this fishery.

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 five year classes have been above the long-term GM80-08 (5007) since 2000. The above average estimates of recruitment for the 2006–2008 year classes have led the significant increase in SSB in 2010.

8.2.3 Short-term projections

At last year's Working Group, a short-term forecast was run with F scaled to the last year due to the large fall in F observed in the penultimate year of the assessment.

Estimating year–class abundance

The 2009 year class is estimated to be highest value in the time-series at around 21.0 million with 91% of the weight coming from the UK-WEC-BTS. However, given that other year classes have been significantly revised in following assessments, the Working Group considered this estimate to be highly uncertain and replaced it with the GM recruitment (GM89-08).

Working Group estimates of year-class strength used for prediction can be summarized as follows:

Recruitment at-age 1:

Year class	Thousands	Basis	Surveys	Commercial	Shrinkage
2008	10 062	XSA	98%	-	2%
2009	5007	GM (89-08)	-	-	-
2010	5007	GM (89-08)	-	-	-
2011	5007	GM (89-08)	-	-	-

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 2008–2010, scaled to 2010. Catch and stock weights-at-age were also the mean of the period 2008–2010. Stock numbers-at-age in 2011 for ages 3 and older were obtained from the XSA, with the values for age 2 being set at 4438, the GM(89-08) less a reduction for natural mortality (0.12) and fishing mortality (0.0007) at age 1. Recruitment for 2011 onwards are taken to be 5007, the GM (89-08).

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} = 0.45) implies landings of 1755 t in 2011 and 1733 t in 2012. (The TAC for 2011 is 4665 t. for VIId,e). SSB is predicted to rise from 3371 t in 2011 to 3751 t in 2012 and 3710 t in 2013. 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 GM1989-08 recruitment are predicted to contribute 30% to the landings in 2012 and 41% to SSB in 2013.

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. No further work was carried out this year.

8.2.5 Biological reference points

	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 ($SSB_{MT}< B_{pa}$).

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}, and then this reference point is also rejected.

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 8.2.10. F_{max} is given by a reference F of 0.25, around 55% of F_{sq}. Long-term yield and SSB (at F_{sq} and assuming GM89-08 recruitment = 5.007 million) are given as 1510 t and 3210 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 utilizes 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 20% of the landings for this stock is 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 to 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 relatively low compared to other plaice stocks. As the time-series of data expands, the WG will be able to better determine how to include these data in the assessment appropriately.

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.

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. The large 2010 recruits estimate as suggested by the assessment may lead to increased discarding in 2012.

8.2.8 Recommendation for next benchmark

A benchmark assessment was carried out for this stock in February 2010.

8.2.9 Management considerations

The stock unit (Division VIIe) does not correspond to 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 mainly targeting sole, and as part of a mixed demersal fishery by otter trawlers. Therefore 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 long-term targets with some certainty.

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	-	1111	-33	1078	149	1227

[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 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, CPUE data are kg/hr for commercial fleets, in kg/10 km towed for Carhelmar beam survey and Kg/hour/ Metre beam length for FSP survey .

Year	(CPUE) (kg/hr).						Effort (000 hours)		Landings (tonnes)		(CPUE) (kg/10 km)	(CPUE) (Kg h^{-1} m^{-1} beam)
	West Sector		North Sector		South Sector							
	Otter	Beam	Otter	Beam	Otter	Beam	Otter	Beam	Otter	Beam	Carhelmar Survey (UK-WEC-BTS)	FSP survey (FSP-7e)
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	0.48
2004	0.88	3.38	2.01	6.16	0.19	2.80	25.58	158.68	37.98	701.17	4.53	0.57
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

Table 8.2.3. Plaice in VIIe. Annual length distribution by fleet (2010)

	UK (England & Wales)		France				
Length (cm)	Beam trawl	All gears (excl. beam trawl)	Trammel & Gill nets	Otter (inc twin) targetting Dem	Otter (inc twin) targetting Mol	Beam Trawl	Other Gears
24		543		713		56	161
25	3178	2660		1663	873	199	574
26	13112	11364		4254	3346	597	1721
27	25110	36151	342	8066	15710	1895	5461
28	49921	71338	1254	14544	16582	2544	7331
29	92926	93959	1505	23502	15564	3188	9186
30	104262	101408	593	18557	11055	2373	6839
31	113419	97501	684	28092	4800	2638	7602
32	106815	88272	1368	28096	3346	2578	7429
33	104246	65901	1961	17819	1455	1669	4808
34	92292	54996	935	21129	2327	1917	5523
35	91240	43279	684	13866	1746	1280	3690
36	70410	31952	2121	8107	0	804	2316
37	68448	21710	479	5823	727	552	1592
38	54467	15042	502	11383		934	2691
39	43322	14065	1459	3751		409	1180
40	32819	8952	935	5675		519	1497
41	26036	5266	1551	3660		409	1180
42	24724	4272	844	5524		500	1442
43	21583	6994	502	1900		189	544
44	15200	1885	844	1068		150	433
45	12953	1680	1163	452		127	366
46	7138	1208	0	0		0	0
47	4686	817	297	1557		146	420
48	4534	934	228	1685		150	433
49	4216	501	456	973		112	324
50	4026	484	0	1022		80	231
51	2414	307	1687	0		133	382
52	1956	2060	0	238		19	54
53	1835	326	639	951		125	360
54	1932	135	0			0	0
55	1555	65	776			61	176
56	1055	43	228			18	52
57	1134	53	0			0	0
58	624	110	228			18	52
59	252	18	0			0	0
60	436	0	342			27	77
61	12	44	456			36	103
62	313	0					
63	11	9					
64	0						
65	0						
66	11						
Total	1204624	786303	25063	234071	77530	26455	76226

Table 8.2.4 Plaice in VIIe. Catch numbers-at-age.

Table 1 Catch numbers at age		Numbers*10**-3
YEAR	1980	
AGE		
1	19	
2	814	
3	800	
4	252	
5	230	
6	62	
7	63	
8	23	
9	13	
+gp	138	
TOTALNUM	2415	
TONSLAND	1215	
SOPCOF %	100	

Table 1 Catch numbers at age					Numbers*10**-3					
YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	41	72	3	77	3	10	74	12	10	57
2	723	310	790	970	727	1025	1258	1932	352	391
3	2268	2131	893	1864	1605	2532	2303	5179	2960	3408
4	591	1420	1702	702	1399	963	1407	1160	3014	2757
5	120	263	593	531	157	488	657	464	843	1222
6	103	89	104	197	255	116	233	155	274	272
7	21	83	41	92	142	129	90	116	121	135
8	47	17	50	30	28	68	52	40	97	80
9	19	28	2	33	16	29	45	25	32	57
+gp	95	122	100	51	52	62	52	53	101	73
TOTALNUM	4027	4534	4276	4546	4383	5421	6170	9136	7805	8451
TONSLAND	1746	1938	1754	1813	1751	2161	2388	2994	2808	3058
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age					Numbers*10**-3					
YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	41	90	36	84	6	15	7	7	19	46
2	691	841	844	409	421	1160	963	636	678	399
3	1352	1430	1488	1707	818	774	2443	1732	2480	1331
4	1943	760	650	878	986	403	486	1158	1219	2069
5	973	654	266	256	269	392	185	159	414	496
6	528	452	272	111	120	127	155	66	94	181
7	106	264	219	119	58	60	80	61	38	38
8	46	72	171	83	84	41	34	23	40	14
9	33	33	40	86	69	48	18	21	17	22
+gp	51	50	86	65	90	107	101	63	46	52
TOTALNUM	5764	4646	4071	3797	2920	3127	4472	3926	5046	4648
TONSLAND	2250	1950	1691	1471	1295	1321	1654	1430	1616	1678
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age					Numbers*10**-3					
YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE										
1	6	188	23	21	22	18	3	5	5	18
2	585	1400	1004	600	831	1089	428	1015	742	844
3	946	1251	1208	1644	1034	1448	1168	781	1359	1024
4	795	597	622	600	858	543	723	563	295	761
5	950	428	207	349	282	388	287	252	147	202
6	145	511	172	102	146	121	196	107	76	108
7	79	116	224	75	52	60	70	83	30	41
8	19	49	54	96	50	29	30	32	21	15
9	12	13	41	44	53	22	10	15	7	19
+gp	37	42	39	38	44	45	49	28	16	25
TOTALNUM	3574	4595	3594	3569	3372	3764	2962	2882	2698	3057
TONSLAND	1379	1608	1478	1402	1370	1466	1184	1144	1065	1227
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
AGE	
1	0.248
2	0.337
3	0.428
4	0.519
5	0.612
6	0.706
7	0.801
8	0.898
9	0.996
+gp	1.404
SOPCOFAC	0.9999

Table 2 Catch weights at age (kg)

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	0.144	0.186	0.106	0.136	0.098	0.171	0.252	0.134	0.156	0.236
2	0.268	0.273	0.221	0.238	0.214	0.257	0.288	0.215	0.217	0.267
3	0.389	0.360	0.330	0.343	0.328	0.346	0.337	0.303	0.285	0.308
4	0.507	0.447	0.432	0.447	0.437	0.438	0.403	0.399	0.360	0.359
5	0.622	0.532	0.529	0.550	0.543	0.533	0.480	0.504	0.440	0.421
6	0.733	0.619	0.617	0.654	0.644	0.632	0.572	0.618	0.528	0.493
7	0.841	0.702	0.699	0.757	0.743	0.734	0.679	0.740	0.622	0.577
8	0.946	0.786	0.775	0.861	0.837	0.840	0.799	0.870	0.723	0.670
9	1.047	0.869	0.844	0.965	0.928	0.950	0.933	1.009	0.830	0.775
+gp	1.387	1.217	1.027	1.390	1.253	1.427	1.388	1.357	1.122	1.078
SOPCOFAC	1.0007	0.9999	1.0003	1.0000	0.9996	0.9993	0.9997	0.9991	1.0001	0.9996

Table 2 Catch weights at age (kg)

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	0.194	0.242	0.212	0.201	0.213	0.173	0.188	0.179	0.107	0.117
2	0.245	0.282	0.269	0.258	0.281	0.266	0.259	0.239	0.196	0.204
3	0.306	0.335	0.332	0.322	0.353	0.360	0.334	0.294	0.282	0.290
4	0.377	0.401	0.405	0.391	0.429	0.455	0.412	0.411	0.364	0.375
5	0.456	0.481	0.484	0.464	0.507	0.551	0.494	0.526	0.444	0.459
6	0.545	0.574	0.571	0.543	0.588	0.647	0.580	0.638	0.521	0.542
7	0.643	0.680	0.667	0.628	0.674	0.743	0.669	0.747	0.596	0.624
8	0.750	0.799	0.769	0.717	0.763	0.840	0.762	0.853	0.667	0.705
9	0.866	0.933	0.880	0.812	0.855	0.938	0.860	0.958	0.735	0.784
+gp	1.221	1.317	1.202	1.117	1.055	1.170	1.110	1.274	0.950	1.029
SOPCOFAC	1.0004	0.9996	1.0000	1.0002	0.9998	1.0006	0.9992	1.0004	1.0000	0.9997

Table 2 Catch weights at age (kg)

YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE										
1	0.167	0.193	0.147	0.254	0.226	0.206	0.186	0.208	0.098	0.180
2	0.231	0.246	0.250	0.293	0.287	0.276	0.259	0.279	0.239	0.268
3	0.305	0.306	0.352	0.342	0.354	0.352	0.334	0.356	0.376	0.361
4	0.384	0.372	0.450	0.400	0.426	0.434	0.412	0.438	0.507	0.458
5	0.468	0.446	0.548	0.468	0.504	0.521	0.493	0.526	0.634	0.559
6	0.558	0.525	0.641	0.545	0.586	0.614	0.577	0.619	0.757	0.665
7	0.654	0.612	0.734	0.632	0.674	0.712	0.663	0.718	0.874	0.775
8	0.754	0.706	0.822	0.728	0.766	0.814	0.752	0.822	0.987	0.890
9	0.861	0.806	0.910	0.833	0.864	0.923	0.844	0.932	1.096	1.009
+gp	1.272	1.137	1.231	1.189	1.106	1.165	1.095	1.270	1.336	1.260
SOPCOFAC	1.0001	0.9998	1.0003	1.0005	1.0002	1.0003	1.0001	1.0002	1.0000	0.9996

Table 8.2.6 Plaice in VIIe. Stock weights-at-age.

Table 3 Stock weights at age (kg)

YEAR	1980
AGE	
1	0.114
2	0.227
3	0.338
4	0.447
5	0.554
6	0.66
7	0.764
8	0.867
9	0.967
+gp	1.351

Table 3 Stock weights at age (kg)

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	0.126	0.108	0.116	0.111	0.112	0.096	0.068	0.103	0.138	0.236
2	0.25	0.214	0.228	0.222	0.222	0.195	0.145	0.184	0.2	0.262
3	0.373	0.318	0.335	0.334	0.331	0.297	0.232	0.275	0.27	0.3
4	0.492	0.419	0.436	0.446	0.438	0.401	0.326	0.373	0.347	0.349
5	0.609	0.517	0.532	0.56	0.543	0.507	0.429	0.481	0.431	0.408
6	0.725	0.615	0.623	0.673	0.647	0.615	0.539	0.598	0.522	0.479
7	0.838	0.71	0.71	0.788	0.749	0.727	0.659	0.723	0.62	0.561
8	0.949	0.802	0.791	0.903	0.849	0.84	0.788	0.858	0.725	0.654
9	1.057	0.893	0.867	1.018	0.948	0.955	0.924	1.002	0.837	0.758
+gp	1.435	1.255	1.094	1.498	1.329	1.442	1.347	1.363	1.143	1.064

Table 3 Stock weights at age (kg)

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	0.182	0.235	0.188	0.188	0.191	0.134	0.171	0.169	0.069	0.082
2	0.232	0.269	0.241	0.248	0.262	0.233	0.248	0.225	0.171	0.181
3	0.292	0.317	0.302	0.314	0.336	0.333	0.329	0.254	0.27	0.279
4	0.362	0.378	0.371	0.385	0.413	0.434	0.414	0.382	0.365	0.376
5	0.442	0.454	0.447	0.462	0.495	0.535	0.503	0.507	0.457	0.472
6	0.531	0.543	0.531	0.545	0.58	0.637	0.596	0.629	0.545	0.567
7	0.631	0.646	0.623	0.633	0.668	0.739	0.694	0.749	0.631	0.66
8	0.74	0.763	0.723	0.728	0.76	0.842	0.795	0.866	0.712	0.752
9	0.858	0.893	0.83	0.828	0.856	0.945	0.901	0.98	0.791	0.842
+gp	1.223	1.274	1.145	1.15	1.064	1.191	1.176	1.326	1.04	1.122

Table 3 Stock weights at age (kg)

YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE										
1	0.139	0.18	0.1	0.246	0.205	0.177	0.156	0.175	0.026	0.138
2	0.204	0.233	0.211	0.282	0.266	0.248	0.229	0.243	0.169	0.223
3	0.277	0.293	0.319	0.327	0.334	0.323	0.305	0.317	0.308	0.314
4	0.356	0.36	0.425	0.383	0.406	0.405	0.385	0.396	0.442	0.409
5	0.441	0.435	0.529	0.448	0.484	0.492	0.467	0.481	0.571	0.508
6	0.531	0.516	0.63	0.523	0.567	0.584	0.551	0.572	0.696	0.611
7	0.627	0.605	0.728	0.608	0.656	0.682	0.639	0.668	0.816	0.72
8	0.729	0.701	0.824	0.702	0.749	0.786	0.73	0.769	0.931	0.832
9	0.836	0.805	0.918	0.807	0.849	0.895	0.823	0.876	1.042	0.949
+gp	1.253	1.148	1.263	1.16	1.095	1.139	1.078	1.207	1.288	1.195

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	5.56	103.60	194.03	126.03	62.13	18.23	7.92	9.75	0.56	1.85	2.22

Table 8.2.8 Plaice in VIIe. Tuning fleet data available (data in bold have been used for tuning)

W.CHANNEL PLAICE 2011 WGCSE

105	**idh**	**09/05/2011**							
UK-WEC-BTS									
1986	**2010**								
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	**186**	**349**	**227**	**112**	**33**	**14**	**18**	**1**	3
UK-WECOT									
1988	**2010**								
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**	**1.1**	**0.4**	**0.3**		

Table 8.2.8 (Cont.) Plaice in VIIe. Tuning fleet data available (data in bold have been used for tuning)

UK-WECBT

1989	**2010**							
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**	

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	**2010**							
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

Table 8.2.9. Plaice in VIIe Diagnostics.

```
Lowestoft VPA Version 3.1

  11/05/2011  14:28

Extended Survivors Analysis

W.CHANNEL PLAICE 2011 WGCSE

cpue data from file c:\vpa\PLE7ETU5.dat

Catch data for  31 years. 1980 to 2010. Ages  1 to  10.

     Fleet             First  Last  First  Last  Alpha   Beta
                        year  year   age    age
UK-WEC-BTS              1986  2010    1      8    .750    .800
UK WECOT                1988  2010    3      9    .000   1.000
UK WECBT                1989  2010    3      9    .000   1.000
UK WECOT historic       1980  2010    2      9    .000   1.000
FSP-7e   UK(E+W)        2003  2010    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   2001   2002   2003   2004   2005   2006   2007   2008   2009   2010

     1   .001   .032   .006   .005   .005   .007   .000   .001   .001   .001
     2   .169   .387   .219   .208   .228   .343   .195   .209   .174   .106
     3   .562   .587   .615   .602   .597   .697   .682   .584   .432   .351
     4   .599   .769   .593   .647   .666   .661   .838   .758   .413   .418
     5   .580   .689   .601   .719   .656   .658   .817   .726   .405   .503
     6   .363   .649   .597   .615   .687   .594   .753   .761   .449   .536
     7   .420   .501   .598   .509   .663   .614   .750   .767   .439   .422
     8   .483   .458   .421   .503   .700   .907   .654   .868   .393   .377
     9   .645   .628   .802   .650   .518   .700   .786   .717   .449   .672


  XSA population numbers (Thousands)

                              AGE
 YEAR             1         2         3         4         5         6         7         8
9

 2001      5.23E+03  3.99E+03  2.34E+03  1.87E+03  2.29E+03  5.07E+02  2.44E+02  5.20E+01
2.57E+01
 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
2.84E+01
 2003      3.85E+03  5.42E+03  2.79E+03  1.48E+03  4.86E+02  4.07E+02  5.27E+02  1.68E+02
7.98E+01
 2004      4.91E+03  3.39E+03  3.86E+03  1.34E+03  7.23E+02  2.36E+02  1.99E+02  2.57E+02
9.80E+01
 2005      4.52E+03  4.34E+03  2.44E+03  1.88E+03  6.21E+02  3.12E+02  1.13E+02  1.06E+02
1.38E+02
 2006      2.91E+03  3.99E+03  3.06E+03  1.19E+03  8.55E+02  2.86E+02  1.39E+02  5.17E+01
4.66E+01
 2007      6.45E+03  2.57E+03  2.51E+03  1.35E+03  5.47E+02  3.93E+02  1.40E+02  6.69E+01
1.85E+01
```

```
 2008      5.56E+03  5.71E+03  1.87E+03  1.13E+03  5.19E+02  2.14E+02  1.64E+02  5.87E+01
3.08E+01
 2009      1.01E+04  4.93E+03  4.11E+03  9.26E+02  4.68E+02  2.23E+02  8.88E+01  6.76E+01
2.18E+01
 2010      2.12E+04  8.92E+03  3.67E+03  2.37E+03  5.43E+02  2.77E+02  1.26E+02  5.08E+01
4.05E+01
```

Table 8.2.9 Plaice in VIIe Diagnostics (continued).

```
Estimated population abundance at 1st Jan 2011

          0.00E+00  1.88E+04  7.12E+03  2.29E+03  1.38E+03  2.91E+02  1.44E+02  7.34E+01
3.09E+01

 Taper weighted geometric mean of the VPA populations:

          6.33E+03  5.41E+03  3.91E+03  1.92E+03  8.49E+02  4.03E+02  2.12E+02  1.12E+02
5.87E+01

 Standard error of the weighted Log(VPA populations) :

             .5050     .4593     .4900     .5580     .5501     .5785     .6187     .6592
.7501

 Log-catchability residuals.


 Fleet : UK-WEC-BTS

  Age     1981   1982   1983   1984   1985   1986   1987   1988   1989   1990
     1   99.99  99.99  99.99  99.99  99.99   -.24   1.86    .87   -.04   -.38
     2   99.99  99.99  99.99  99.99  99.99    .16   -.36    .91   -.81   -.57
     3   99.99  99.99  99.99  99.99  99.99    .59    .05    .24   -.01    .02
     4   99.99  99.99  99.99  99.99  99.99    .42    .27    .36    .15   -.45
     5   99.99  99.99  99.99  99.99  99.99    .14    .49   -.10   -.40   -.01
     6   99.99  99.99  99.99  99.99  99.99   -.61    .83    .10   -.14  -1.96
     7   99.99  99.99  99.99  99.99  99.99    .79   1.05   -.04    .31   -.43
     8   99.99  99.99  99.99  99.99  99.99   -.92    .63    .47    .07  -1.72
     9   No data for this fleet at this age


  Age     1991   1992   1993   1994   1995   1996   1997   1998   1999   2000
     1    -.61   1.05   -.11    .24   -.27   -.55   -.51    .64    .29    .30
     2    -.90   -.66   -.31   -.39    .02   -.12    .12   -.37   -.63    .19
     3    -.28   -.22   -.53   -.30   -.16   -.65    .33   -.17   -.42    .15
     4    -.11   -.53   -.48   -.41   -.10   -.34   -.06    .34   -.27    .28
     5     .08   -.05   -.23   -.61   -.37    .19   -.46   -.23    .15    .33
     6     .25   -.28    .40  -1.31   -.54   -.33    .39    .43   -.39    .77
     7    -.22   -.54   -.37   -.51   -.01  -1.61    .49    .09   -.32  -1.12
     8   99.99   -.88   -.34    .04   -.22    .30   -.92    .57    .53    .30
     9   No data for this fleet at this age


  Age     2001   2002   2003   2004   2005   2006   2007   2008   2009   2010
     1    -.24   1.05   -.05  -1.16   -.20    .86   -.32  -1.04  -1.55    .11
     2    -.03    .44    .44   -.42    .04    .53    .76    .48    .68    .80
     3    -.28    .02   -.28   -.52    .23    .22    .59    .27    .52    .59
     4     .74   -.25    .15   -.38    .28   -.11    .05    .12   -.01    .36
     5     .49    .05   -.93   -.44   -.20    .36    .81    .02    .11    .78
     6     .70    .57    .75   -.38   -.74   -.71   -.19    .75    .80    .84
     7     .48   -.67    .55  -1.73   -.08   -.03    .50    .90   1.05   1.45
     8   99.99   -.83    .21    .31    .53  99.99   -.63   1.09    .82   -.56
     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    -9.9458    -9.0569    -8.1984    -8.1893    -8.2942    -8.5133    -8.1737    -
8.1737
 S.E(Log q)      .7652      .5329      .3689      .3357      .4180      .7334      .7962
.7142


 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      .96      .155       9.89      .35      25      .75    -9.95
  2      .95      .226       9.03      .48      25      .52    -9.06
  3      .90      .711       8.20      .71      25      .34    -8.20
  4      .86     1.293       8.11      .80      25      .29    -8.19
```

5	.85	1.206	8.06	.73	25	.35	-8.29
6	.94	.235	8.37	.41	25	.70	-8.51
7	1.18	-.565	8.68	.30	25	.95	-8.17
8	1.46	-1.333	9.77	.30	22	1.02	-8.23

Table 8.2.9 Plaice in VIIe Diagnostics (continued).

Fleet : UK WECOT

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
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	.59	.39	.34
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.10	.53	.46
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.39	.58	.05
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.08	.56	.18
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.14	-.01	.63
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.45	.12	.50
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.12	-.27	.07

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	.17	.01	-.06	-.09	.22	.11	.59	.09	-.47	-.30
4	.45	.31	.04	.04	.19	.04	-.24	.44	-.16	-.32
5	.30	.27	-.01	-.23	-.08	.14	-.14	.01	.05	-.23
6	.13	.27	-.02	-.35	.20	-.04	-.21	.07	.15	.05
7	.15	.05	.17	-.26	-.44	.13	-.10	-.28	.23	.17
8	.06	.24	.13	-.67	-.10	.18	-.49	-.63	-.19	-.02
9	.25	-.13	.01	-.31	-.14	-.13	-.22	.23	-.18	.21

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	-.37	.11	-.22	-.15	-.25	-.13	.12	-.15	-.26	-.27
4	-.22	-.06	-.36	-.12	-.29	-.41	.11	-.04	-.42	-.11
5	-.18	-.01	-.20	.16	-.14	-.32	-.07	.08	-.47	.02
6	-.54	.16	-.21	.10	-.03	-.29	-.21	.13	-.18	-.01
7	-.13	.01	-.08	-.28	-.02	-.02	-.03	.12	-.02	-.13
8	-.20	-.07	-.29	-.14	.06	.18	-.54	.50	-.11	-.25
9	.06	.58	-.07	.24	-.28	-.09	-.29	.38	-.56	-.18

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	-7.0830	-7.0640	-7.2422	-7.4345	-7.6159	-7.6159	-7.6159
S.E(Log q)	.2911	.2920	.2389	.2364	.2185	.3376	.2672

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	.82	2.004	7.29	.85	23	.22	-7.08
4	.79	2.824	7.17	.89	23	.20	-7.06
5	.84	2.398	7.16	.91	23	.18	-7.24
6	.90	1.370	7.29	.89	23	.21	-7.43
7	.96	.564	7.52	.90	23	.21	-7.62
8	.96	.416	7.55	.82	23	.32	-7.67
9	1.03	-.388	7.77	.88	23	.28	-7.66

Table 8.2.9. Plaice in VIIe Diagnostics (continued).

Fleet : UK WECBT

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
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	99.99	-.31	.18
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.15	.19
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.07	-.20
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.03	-.15
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.01	.31
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-.03	-.02
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	.03	-.28

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	.23	.54	.52	.36	.33	-.14	.11	-.39	-.31	-.23
4	.53	.74	.53	.46	.33	-.10	-.52	-.06	-.17	-.33
5	.33	.60	.42	.23	.16	.01	-.20	-.24	.02	-.41
6	-.05	.35	.34	.09	.23	-.17	-.12	.02	.37	-.30
7	-.07	.04	.38	.04	-.05	-.07	.04	-.02	.24	-.30
8	-.47	.19	.29	-.19	.15	.13	-.14	-.10	.12	-.25
9	-.25	-.07	.14	.14	.29	.06	.24	.53	.53	-.25

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	-.43	.05	.00	.00	.07	.12	-.03	-.25	.01	-.42
4	-.21	-.20	-.17	.10	-.06	-.19	-.02	-.15	-.17	-.39
5	-.11	-.09	-.08	.15	.07	-.11	-.04	-.09	-.27	-.08
6	-.54	-.02	-.03	.04	.15	-.13	-.10	.01	-.08	.06
7	-.28	-.17	.12	.01	.16	.01	.08	-.14	-.22	-.10
8	-.25	-.29	-.28	.00	.17	.23	.05	.34	-.06	-.18
9	-.09	-.06	.48	.30	-.01	-.05	.27	.11	.14	.38

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	-6.4536	-6.3026	-6.2864	-6.3127	-6.3739	-6.3739	-6.3739
S.E(Log q)	.2907	.3301	.2387	.2129	.1741	.2161	.2714

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	1.10	-.652	6.28	.67	22	.32	-6.45
4	.95	.426	6.37	.77	22	.32	-6.30
5	.94	.745	6.31	.88	22	.23	-6.29
6	1.01	-.065	6.31	.89	22	.22	-6.31
7	.92	1.549	6.29	.95	22	.15	-6.37
8	.97	.429	6.35	.92	22	.21	-6.40
9	1.06	-.784	6.38	.89	22	.26	-6.26

Table 8.2.9. Plaice in VIIe Diagnostics (continued).

Fleet : UK WECOT historic

Age	1980
1	No data for this fleet at this age
2	-.16
3	-.25
4	-.37
5	-.34
6	.38
7	-.41
8	-.39
9	.00

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	No data for this fleet at this age									
2	.08	-.06	.25	.54	-.30	.09	-.44	99.99	99.99	99.99
3	.26	.02	.08	-.06	-.18	.12	.03	99.99	99.99	99.99
4	-.02	.22	.35	.11	-.05	-.40	.17	99.99	99.99	99.99
5	-.03	.05	.50	.08	-.50	-.18	.42	99.99	99.99	99.99
6	-.12	.29	.00	-.08	.11	-.53	-.05	99.99	99.99	99.99
7	.14	-.02	.19	.23	.11	.02	-.26	99.99	99.99	99.99
8	.16	.54	-.05	.34	-.57	-.03	-.36	99.99	99.99	99.99
9	.23	.11	-.24	.17	-.41	.30	.17	99.99	99.99	99.99

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
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	-7.2670	-5.9585	-5.8030	-5.9634	-6.0641	-5.9756	-5.9756	-5.9756
S.E(Log q)	.3115	.1647	.2705	.3447	.2798	.2255	.3850	.2512

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	-1.131	6.58	.54	8	.44	-7.27
3	.83	1.323	6.37	.91	8	.13	-5.96
4	.79	1.596	6.18	.91	8	.19	-5.80
5	.73	1.525	6.18	.84	8	.23	-5.96
6	1.32	-1.450	6.10	.77	8	.34	-6.06
7	1.12	-.741	6.06	.87	8	.26	-5.98
8	1.47	-1.576	6.69	.65	8	.51	-6.02
9	.81	2.931	5.53	.98	8	.14	-5.93

Table 8.2.9. Plaice in VIIe Diagnostics (continued).

Fleet : FSP-7e UK(E+W)

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	No data for this fleet at this age									
2	99.99	99.99	-.29	.14	-.06	.62	-.37	99.99	-.03	.00
3	99.99	99.99	-.06	.18	.18	.07	.02	99.99	-.43	.04
4	99.99	99.99	-.27	.20	-.06	.09	-.12	99.99	.02	.13
5	99.99	99.99	.02	.47	.16	-.04	.17	99.99	-.32	-.45
6	99.99	99.99	.00	-.20	.27	.09	-.16	99.99	-.03	.02
7	99.99	99.99	.23	.28	-.37	.37	-.52	99.99	.34	-.33
8	99.99	99.99	.38	.23	.19	.09	-.37	99.99	-.58	.21
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	-9.2604	-8.4468	-8.3170	-8.4399	-8.5152	-8.3539	-8.3539
S.E(Log q)	.3247	.2099	.1614	.3112	.1573	.3887	.3535

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	.96	.109	9.23	.61	7	.34	-9.26
3	1.80	-1.119	8.76	.28	7	.37	-8.45
4	.98	.078	8.30	.79	7	.17	-8.32
5	.61	1.119	7.64	.62	7	.19	-8.44
6	.95	.181	8.37	.71	7	.16	-8.52
7	.85	.629	7.85	.77	7	.35	-8.35
8	.79	1.175	7.54	.86	7	.27	-8.33

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 = 2009

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
UK-WEC-BTS	20990.	.780	.000	.00	1	.911	.001
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	6059.	2.50				.089	.003

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
18796.	.74	.37	2	.497	.001

Age 2 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	7339.	.446	1.102	2.47	2	.546	.103
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)	7105.	.500	.000	.00	1	.435	.106
F shrinkage mean	3072.	2.50				.019	.230

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7115.	.33	.48	4	1.441	.106

Age 3 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	3247.	.334	.441	1.32	3	.345	.260
UK WECOT	1754.	.500	.000	.00	1	.168	.438
UK WECBT	1502.	.500	.000	.00	1	.168	.496
UK WECOT historic	1.	.000	.000	.00	0	.000	.000
FSP-7e UK(E+W)	2305.	.355	.033	.09	2	.309	.349
F shrinkage mean	1169.	2.50				.010	.601

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2291.	.20	.18	8	.892	.351

Table 8.2.9. Plaice in VIIe Diagnostics (continued).

```
Age  4   Catchability constant w.r.t. time and dependent on age

 Year class = 2006


 Fleet                 Estimated     Int        Ext     Var     N  Scaled   Estimated
                       Survivors     s.e        s.e    Ratio       Weights     F
 UK-WEC-BTS                1995.    .288        .133     .46    4   .316      .307
 UK WECOT                  1167.    .361        .075     .21    2   .225      .479
 UK WECBT                  1096.    .361        .198     .55    2   .225      .503
 UK WECOT historic            1.    .000        .000     .00    0   .000      .000
 FSP-7e   UK(E+W)          1265.    .361        .277     .77    2   .225      .449

   F shrinkage mean         750.    2.50                            .008      .671

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e           Ratio
      1383.        .17       .11    11     .621    .418


 Age  5   Catchability constant w.r.t. time and dependent on age

 Year class = 2005

 Fleet                 Estimated     Int        Ext     Var     N  Scaled   Estimated
                       Survivors     s.e        s.e    Ratio       Weights     F
 UK-WEC-BTS                 475.    .270        .178     .66    5   .284      .337
 UK WECOT                   249.    .309        .139     .45    3   .239      .568
 UK WECBT                   253.    .309        .047     .15    3   .239      .561
 UK WECOT historic            1.    .000        .000     .00    0   .000      .000
 FSP-7e   UK(E+W)           220.    .315        .154     .49    3   .231      .624

   F shrinkage mean         206.    2.50                            .008      .656

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e           Ratio
       291.        .15       .11    15     .702    .503


 Age  6   Catchability constant w.r.t. time and dependent on age

 Year class = 2004

 Fleet                 Estimated     Int        Ext     Var     N  Scaled   Estimated
                       Survivors     s.e        s.e    Ratio       Weights     F
 UK-WEC-BTS                 206.    .294        .148     .50    6   .216      .401
 UK WECOT                   124.    .293        .126     .43    4   .267      .599
 UK WECBT                   133.    .293        .085     .29    4   .267      .570
 UK WECOT historic            1.    .000        .000     .00    0   .000      .000
 FSP-7e   UK(E+W)           135.    .314        .133     .42    4   .242      .562

   F shrinkage mean         111.    2.50                            .009      .652

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e           Ratio
       144.        .15       .07    19     .477    .536
```

Table 8.2.9. Plaice in VIIe Diagnostics (continued).

```
Age  7   Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet                 Estimated     Int        Ext     Var     N  Scaled   Estimated
                      Survivors     s.e        s.e    Ratio       Weights     F
UK-WEC-BTS                 138.    .333        .265     .79    7   .166      .246
UK WECOT                    67.    .288        .049     .17    5   .287      .456
UK WECBT                    68.    .288        .020     .07    5   .287      .450
UK WECOT historic            1.    .000        .000     .00    0   .000      .000
FSP-7e   UK(E+W)            61.    .316        .076     .24    5   .253      .492

  F shrinkage mean          42.    2.50                            .008      .650

Weighted prediction :

Survivors         Int       Ext     N     Var      F
at end of year    s.e       s.e           Ratio
       73.        .15       .09    23     .559    .422


Age  8   Catchability constant w.r.t. time and age (fixed at the value for age)  7

Year class = 2002

Fleet                 Estimated     Int        Ext     Var     N  Scaled   Estimated
                      Survivors     s.e        s.e    Ratio       Weights     F
UK-WEC-BTS                  37.    .369        .265     .72    8   .151      .327
UK WECOT                    27.    .283        .066     .23    6   .293      .418
UK WECBT                    26.    .283        .038     .13    6   .293      .428
UK WECOT historic            1.    .000        .000     .00    0   .000      .000
FSP-7e   UK(E+W)            39.    .313        .032     .10    6   .256      .307

  F shrinkage mean          14.    2.50                            .008      .708

Weighted prediction :

Survivors         Int       Ext     N     Var      F
at end of year    s.e       s.e           Ratio
       31.        .15       .07    27     .443    .377


Age  9   Catchability constant w.r.t. time and age (fixed at the value for age)  7

Year class = 2001

Fleet                 Estimated     Int        Ext     Var     N  Scaled   Estimated
                      Survivors     s.e        s.e    Ratio       Weights     F
UK-WEC-BTS                  33.    .393        .150     .38    8   .105      .423
UK WECOT                    16.    .277        .045     .16    7   .363      .735
UK WECBT                    21.    .277        .096     .35    7   .363      .615
UK WECOT historic            1.    .000        .000     .00    0   .000      .000
FSP-7e   UK(E+W)            12.    .357        .102     .29    6   .156      .905

  F shrinkage mean          30.    2.50                            .012      .461

Weighted prediction :

Survivors         Int       Ext     N     Var      F
at end of year    s.e       s.e           Ratio
       18.        .16       .07    29     .423    .672
```

Table 8.2.10 Plaice in VIIe. Fishing mortality-at-age.

Run title : W.CHANNEL PLAICE 2011 WGCSE

At 11/05/2011 14:29

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1980
AGE	
1	0.0024
2	0.1242
3	0.433
4	0.4919
5	0.4282
6	0.7305
7	0.3466
8	0.3914
9	0.4644
+gp	0.4644
FBAR 3- 6	0.5209

Table 8 Fishing mortality (F) at age

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	0.0121	0.0098	0.0005	0.0097	0.0004	0.0006	0.0055	0.0012	0.0024	0.0127
2	0.1087	0.1092	0.1304	0.1834	0.1091	0.1505	0.0881	0.1773	0.0413	0.1114
3	0.5365	0.4804	0.4689	0.4632	0.4708	0.6029	0.5301	0.5576	0.4082	0.6165
4	0.5999	0.6958	0.8103	0.7552	0.69	0.5218	0.7305	0.5059	0.673	0.7535
5	0.4157	0.5307	0.641	0.5781	0.3348	0.4953	0.7479	0.5106	0.7759	0.5781
6	0.3151	0.5654	0.374	0.4094	0.5504	0.4034	0.4229	0.3519	0.5881	0.556
7	0.5128	0.4086	0.5063	0.6077	0.5301	0.5442	0.5708	0.3505	0.4642	0.5873
8	0.4286	0.9872	0.4186	0.7736	0.3427	0.4711	0.3968	0.4882	0.506	0.574
9	0.5758	0.4379	0.2938	0.49	1.1751	0.6192	0.6008	0.3075	0.8236	0.5714
+gp	0.5758	0.4379	0.2938	0.49	1.1751	0.6192	0.6008	0.3075	0.8236	0.5714
FBAR 3- 6	0.4668	0.5681	0.5735	0.5515	0.5115	0.5058	0.6078	0.4815	0.6113	0.626

Table 8 Fishing mortality (F) at age

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	0.008	0.0154	0.0134	0.0299	0.0008	0.0022	0.0007	0.0014	0.0059	0.0109
2	0.1916	0.2067	0.1787	0.1894	0.1877	0.1904	0.1766	0.072	0.1664	0.1491
3	0.6152	0.6793	0.6133	0.5916	0.6357	0.5586	0.689	0.497	0.3978	0.5122
4	0.7945	0.7739	0.6902	0.8272	0.7456	0.6796	0.7542	0.7551	0.7156	0.6152
5	0.5929	0.6164	0.6178	0.5818	0.5888	0.6849	0.6991	0.5358	0.6068	0.6528
6	0.4799	0.5522	0.5105	0.5123	0.5399	0.5547	0.5777	0.5232	0.637	0.5299
7	0.3953	0.4274	0.5157	0.3998	0.5059	0.521	0.7499	0.4297	0.5965	0.5233
8	0.3623	0.4673	0.4908	0.3387	0.4926	0.743	0.5799	0.4519	0.503	0.4203
9	0.4586	0.4368	0.4597	0.4482	0.4778	0.5291	0.806	0.7824	0.6478	0.5044
+gp	0.4586	0.4368	0.4597	0.4482	0.4778	0.5291	0.806	0.7824	0.6478	0.5044
FBAR 3- 6	0.6206	0.6555	0.6079	0.6282	0.6275	0.6194	0.68	0.5778	0.5893	0.5775

Table 8 Fishing mortality (F) at age

YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	FBAR 08-10
AGE											
1	0.0012	0.0321	0.0064	0.0046	0.0053	0.0067	0.0004	0.001	0.0006	0.0009	0.0008
2	0.1689	0.3869	0.219	0.208	0.2275	0.3426	0.1948	0.209	0.1743	0.106	0.1631
3	0.5619	0.5869	0.6153	0.6019	0.5967	0.6971	0.682	0.5844	0.4322	0.3512	0.4559
4	0.599	0.769	0.5934	0.6471	0.6656	0.6608	0.8378	0.758	0.4132	0.4177	0.5296
5	0.5804	0.6888	0.6014	0.7188	0.6561	0.6579	0.817	0.7262	0.4046	0.5032	0.5447
6	0.3626	0.6487	0.5967	0.6152	0.6875	0.5937	0.7525	0.7606	0.4489	0.5357	0.5818
7	0.4201	0.5006	0.598	0.5093	0.6633	0.6138	0.7502	0.7673	0.4387	0.4215	0.5425
8	0.4829	0.4577	0.4209	0.503	0.7003	0.9069	0.6542	0.8678	0.3926	0.3773	0.5459
9	0.6449	0.6284	0.8017	0.65	0.5183	0.7001	0.7863	0.7171	0.4488	0.6716	0.6125
+gp	0.6449	0.6284	0.8017	0.65	0.5183	0.7001	0.7863	0.7171	0.4488	0.6716	
FBAR 3- 6	0.526	0.6734	0.6017	0.6458	0.6515	0.6524	0.7723	0.7073	0.4247	0.4520	

Table 8.2.11 Plaice in VIIe. Stock numbers-at-age.

Run title : W.CHANNEL PLAICE 2011 WGCSE

At 11/05/2011 14:29

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1980
AGE	
1	8426
2	7403
3	2418
4	689
5	700
6	128
7	229
8	76
9	38
+gp	392
TOTAL	20499

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	3635	7808	6936	8502	8787	17872	14314	10429	4450	4802
2	7455	3185	6858	6149	7468	7790	15841	12626	9238	3937
3	5799	5931	2532	5339	4540	5939	5944	12865	9379	7862
4	1391	3008	3254	1405	2979	2515	2882	3103	6534	5531
5	374	677	1330	1283	586	1325	1324	1231	1659	2956
6	404	219	353	622	639	372	716	556	655	677
7	55	262	110	216	366	327	220	416	347	323
8	143	29	154	59	104	191	168	110	260	193
9	46	83	10	90	24	66	106	100	60	139
+gp	230	362	414	138	79	141	121	212	189	176
TOTAL	19532	21565	21952	23802	25571	36536	41637	41649	32772	26597

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
1	5433	6267	2874	3033	8019	7137	10969	5302	3470	4553
2	4206	4780	5473	2515	2611	7107	6316	9722	4696	3060
3	3124	3080	3447	4060	1846	1919	5210	4695	8024	3526
4	3764	1498	1385	1656	1993	867	974	2320	2533	4781
5	2309	1508	613	616	642	839	390	406	967	1098
6	1471	1132	722	293	305	316	375	172	211	468
7	345	807	578	385	156	158	161	187	90	99
8	159	206	467	306	229	83	83	67	108	44
9	97	98	114	254	193	124	35	41	38	58
+gp	148	149	245	189	249	276	192	121	101	139
TOTAL	21054	19525	15919	13306	16242	18825	24705	23034	20238	17825

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	GMST 80-08	AMST 80-08
AGE													
1	5230	6307	3849	4912	4517	2913	6445	5560	10062	21212	0	5974	6647
2	3994	4633	5417	3392	4337	3985	2566	5714	4927	8919	18796	5335	5947
3	2338	2992	2791	3860	2444	3064	2509	1873	4112	3670	7115	3911	4460
4	1874	1182	1475	1338	1875	1193	1353	1125	926	2367	2291	1958	2292
5	2292	913	486	723	621	855	547	519	468	543	1383	880	1027
6	507	1138	407	236	312	286	393	214	223	277	291	417	493
7	244	313	527	199	113	139	140	164	89	126	144	222	265
8	52	142	168	257	106	52	67	59	68	51	73	117	143
9	26	28	80	98	138	47	19	31	22	40	31	62	79
+gp	83	94	75	84	114	94	94	58	47	53	42		
TOTAL	16639	17743	15275	15099	14577	12628	14133	15318	20943	37259	30168		

Table 8.2.12 Plaice in VIIe. Summary

Run title : W.CHANNEL PLAICE 2011 WGCSE

At 11/05/2011 14:29

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	5046	2406	1215	0.5050	0.5209
1981	3635	6250	3279	1746	0.5326	0.4668
1982	7808	5894	3464	1938	0.5595	0.5681
1983	6936	6225	3657	1754	0.4797	0.5735
1984	8502	6377	3479	1813	0.5210	0.5515
1985	8787	6671	3556	1751	0.4923	0.5115
1986	17872	7571	3743	2161	0.5774	0.5058
1987	14314	7081	3615	2388	0.6607	0.6078
1988	10429	9802	5149	2994	0.5815	0.4815
1989	4450	8989	5475	2808	0.5130	0.6113
1990	4802	8585	5285	3058	0.5786	0.6260
1991	5433	6640	4300	2250	0.5232	0.6206
1992	6267	6557	3585	1950	0.5440	0.6555
1993	2874	5145	3057	1691	0.5532	0.6079
1994	3033	4444	2711	1471	0.5425	0.6282
1995	8019	4862	2411	1295	0.5369	0.6275
1996	7137	4910	2368	1321	0.5579	0.6194
1997	10969	6414	2500	1654	0.6616	0.6800
1998	5302	5876	2665	1430	0.5366	0.5778
1999	3470	4959	2956	1616	0.5468	0.5893
2000	4553	4795	3288	1678	0.5104	0.5775
2001	5230	4452	2718	1379	0.5073	0.5260
2002	6307	4922	2507	1608	0.6414	0.6734
2003	3849	4249	2503	1478	0.5906	0.6017
2004	4912	4865	2271	1402	0.6174	0.6458
2005	4517	4530	2252	1370	0.6083	0.6515
2006	2913	3849	2059	1466	0.7118	0.6524
2007	6445	3606	1725	1184	0.6863	0.7723
2008	5560	4025	1677	1144	0.6820	0.7073
2009	10062	3411	1868	1065	0.5701	0.4247
2010	5007*	7717	2629	1227	0.4667	0.4520
Arith. Mean	7227	5765	3070	1720	0.5676	0.5908
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

* replaced with GM89-08 recruitment (21212)

Table 8.2.13 VIIe plaice : Catch forecast input data

MFDP version 1a
Run: p7e2011wg
Time and date: 18:31 14/05/2011
Fbar age range: 3-6

2011

Age	*N*	*M*	*Mat*	*PF*	*PM*	*SWt*	*Sel*	*CWt*
1	5007	0.12	0	0	0	0.113	0.001	0.162
2	4438	0.12	0.26	0	0	0.212	0.140	0.262
3	7115	0.12	0.52	0	0	0.313	0.390	0.364
4	2291	0.12	0.86	0	0	0.416	0.453	0.468
5	1383	0.12	1	0	0	0.520	0.466	0.573
6	291	0.12	1	0	0	0.626	0.498	0.680
7	144	0.12	1	0	0	0.735	0.464	0.789
8	73	0.12	1	0	0	0.844	0.467	0.900
9	31	0.12	1	0	0	0.956	0.524	1.012
10	42	0.12	1	0	0	1.230	0.524	1.289

2012

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	5007	0.12	0	0	0	0.113	0.001	0.162
2	.	0.12	0.26	0	0	0.212	0.140	0.262
3	.	0.12	0.52	0	0	0.313	0.390	0.364
4	.	0.12	0.86	0	0	0.416	0.453	0.468
5	.	0.12	1	0	0	0.520	0.466	0.573
6	.	0.12	1	0	0	0.626	0.498	0.680
7	.	0.12	1	0	0	0.735	0.464	0.789
8	.	0.12	1	0	0	0.844	0.467	0.900
9	.	0.12	1	0	0	0.956	0.524	1.012
10	.	*0.12*	*1*	*0*	*0*	*1.230*	*0.524*	*1.289*

2013

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	5007	0.12	0	0	0	0.113	0.001	0.162
2	.	0.12	0.26	0	0	0.212	0.140	0.262
3	.	0.12	0.52	0	0	0.313	0.390	0.364
4	.	0.12	0.86	0	0	0.416	0.453	0.468
5	.	0.12	1	0	0	0.520	0.466	0.573
6	.	0.12	1	0	0	0.626	0.498	0.680
7	.	0.12	1	0	0	0.735	0.464	0.789
8	.	0.12	1	0	0	0.844	0.467	0.900
9	.	0.12	1	0	0	0.956	0.524	1.012
10	.	0.12	1	0	0	1.230	0.524	1.289

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: p7e2011wg
W.CHANNEL PLAICE 2011 WGCSE forecast inputs
Time and date: 18:31 14/05/2011
Fbar age range: 3-6

2011				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
5835	3371	1.0000	0.4520	1755

2012					2013	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
5774	3751	0.0000	0.0000	0	7460	5431
.	3751	0.1000	0.0452	212	7237	5223
.	3751	0.2000	0.0904	416	7024	5024
.	3751	0.3000	0.1356	611	6819	4834
.	3751	0.4000	0.1808	798	6623	4652
.	3751	0.5000	0.2260	978	6435	4477
.	3751	0.6000	0.2712	1151	6255	4310
.	3751	0.7000	0.3164	1316	6082	4150
.	3751	0.8000	0.3616	1475	5916	3997
.	3751	0.9000	0.4068	1627	5757	3851
.	3751	1.0000	0.4520	1773	5605	3710
.	3751	1.1000	0.4971	1914	5458	3575
.	3751	1.2000	0.5423	2049	5318	3447
.	3751	1.3000	0.5875	2178	5183	3323
.	3751	1.4000	0.6327	2303	5054	3205
.	3751	1.5000	0.6779	2422	4930	3092
.	3751	1.6000	0.7231	2537	4811	2983
.	3751	1.7000	0.7683	2647	4697	2879
.	3751	1.8000	0.8135	2753	4587	2779
.	3751	1.9000	0.8587	2855	4482	2684
.	3751	2.0000	0.9039	2952	4381	2592

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: p7e2011wg
Time and date: 18:31 14/05/2011
Fbar age range: 3-6

Year:	2011	F multiplier:	1	Fbar:	0.452				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.1332	3	1	5007	566	0	0	0	0
2	0.1396	546	143	4438	939	1154	244	1154	244
3	0.3903	2175	792	7115	2227	3700	1158	3700	1158
4	0.4534	790	370	2291	952	1970	819	1970	819
5	0.4662	488	280	1383	719	1383	719	1383	719
6	0.498	108	74	291	182	291	182	291	182
7	0.4644	51	40	144	106	144	106	144	106
8	0.4673	26	23	73	62	73	62	73	62
9	0.5243	12	12	31	30	31	30	31	30
10	0.5243	16	21	42	52	42	52	42	52
Total		4215	1755	20815	5835	8788	3371	8788	3371

Year:	2012	F multiplier:	1	Fbar:	0.452				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.1332	3	1	5007	566	0	0	0	0
2	0.1396	546	143	4438	939	1154	244	1154	244
3	0.3903	1046	381	3423	1071	1780	557	1780	557
4	0.4534	1474	689	4271	1775	3673	1527	3673	1527
5	0.4662	456	261	1291	671	1291	671	1291	671
6	0.498	286	194	770	482	770	482	770	482
7	0.4644	55	44	157	115	157	115	157	115
8	0.4673	28	26	80	68	80	68	80	68
9	0.5243	16	16	41	39	41	39	41	39
10	0.5243	15	19	38	47	38	47	38	47
Total		3925	1773	19516	5774	8984	3751	8984	3751

Year:	2013	F multiplier:	1	Fbar:	0.452				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.1332	3	1	5007	566	0	0	0	0
2	0.1396	546	143	4438	939	1154	244	1154	244
3	0.3903	1046	381	3423	1071	1780	557	1780	557
4	0.4534	709	332	2055	854	1767	735	1767	735
5	0.4662	849	487	2407	1252	2407	1252	2407	1252
6	0.498	267	182	718	450	718	450	718	450
7	0.4644	146	115	415	305	415	305	415	305
8	0.4673	31	28	87	74	87	74	87	74
9	0.5243	17	17	45	43	45	43	45	43
10	0.5243	16	21	41	51	41	51	41	51
Total		3631	1706	18637	5605	8415	3710	8415	3710

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	2007	2008	2009	2010	2011
Stock No. (thousands) of 1 year-olds	5560	10062	5007	5007	5007
Source	XSA	XSA	GM89-08	GM89-08	GM89-08
Status Quo F:					
% in 2011 landings	21.1	45.1	8.1	0.1	-
% in 2012	14.7	38.8	21.5	8.1	0.1
% in 2011 SSB	24.3	34.3	7.2	0.0	-
% in 2012 SSB	17.9	40.7	14.9	6.5	0.0
% in 2013 SSB	12.1	33.7	19.8	15.0	6.6

GM : geometric mean recruitment

Plaice in VIIe : Year-class % contribution to

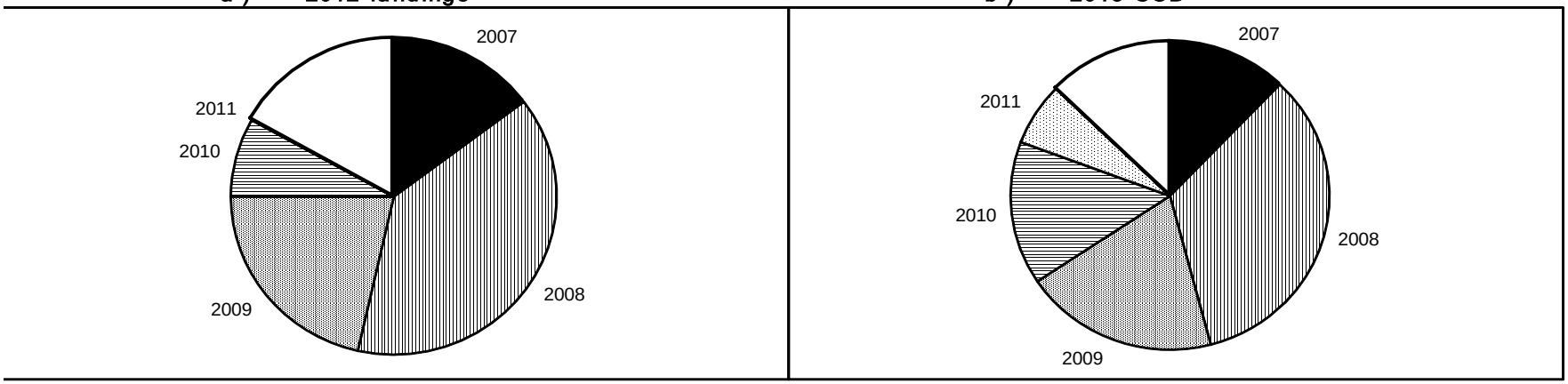


Table 8.2.17 VIIe plaice : Yield per recruit

MFYPR version 2a
Run: p7e2011
Time and date: 08:49 15/05/2011
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	8.8433	6.2842	6.7118	5.8735	6.7118	5.8735
0.1000	0.0452	0.2321	0.1901	6.9120	4.1388	4.7908	3.7318	4.7908	3.7318
0.2000	0.0904	0.3584	0.2649	5.8631	3.0452	3.7519	2.6419	3.7519	2.6419
0.3000	0.1356	0.4384	0.2966	5.1989	2.3976	3.0974	1.9977	3.0974	1.9977
0.4000	0.1808	0.4941	0.3095	4.7379	1.9771	2.6458	1.5807	2.6458	1.5807
0.5000	0.2260	0.5352	0.3137	4.3978	1.6864	2.3148	1.2932	2.3148	1.2932
0.6000	0.2712	0.5670	0.3137	4.1357	1.4757	2.0615	1.0857	2.0615	1.0857
0.7000	0.3164	0.5924	0.3117	3.9269	1.3175	1.8613	0.9305	1.8613	0.9305
0.8000	0.3616	0.6131	0.3087	3.7563	1.1951	1.6990	0.8110	1.6990	0.8110
0.9000	0.4068	0.6305	0.3054	3.6142	1.0980	1.5649	0.7168	1.5649	0.7168
1.0000	0.4520	0.6452	0.3021	3.4937	1.0195	1.4522	0.6411	1.4522	0.6411
1.1000	0.4971	0.6579	0.2989	3.3901	0.9548	1.3563	0.5791	1.3563	0.5791
1.2000	0.5423	0.6690	0.2958	3.3001	0.9007	1.2736	0.5276	1.2736	0.5276
1.3000	0.5875	0.6787	0.2929	3.2209	0.8549	1.2016	0.4843	1.2016	0.4843
1.4000	0.6327	0.6874	0.2902	3.1508	0.8156	1.1384	0.4474	1.1384	0.4474
1.5000	0.6779	0.6952	0.2877	3.0882	0.7816	1.0826	0.4157	1.0826	0.4157
1.6000	0.7231	0.7022	0.2853	3.0318	0.7518	1.0328	0.3883	1.0328	0.3883
1.7000	0.7683	0.7085	0.2831	2.9808	0.7256	0.9882	0.3642	0.9882	0.3642
1.8000	0.8135	0.7143	0.2811	2.9344	0.7023	0.9480	0.3431	0.9480	0.3431
1.9000	0.8587	0.7196	0.2792	2.8920	0.6814	0.9117	0.3243	0.9117	0.3243
2.0000	0.9039	0.7245	0.2774	2.8530	0.6627	0.8786	0.3076	0.8786	0.3076

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.0000	0.452
FMax	0.5465	0.247
F0.1	0.251	0.1134
F35%SPR	0.2889	0.1306

Weights in kilograms

Figure 8.2.1 VIIe plaice: UK(E&W) commercial fleet LPUE and effort; and survey CPUE

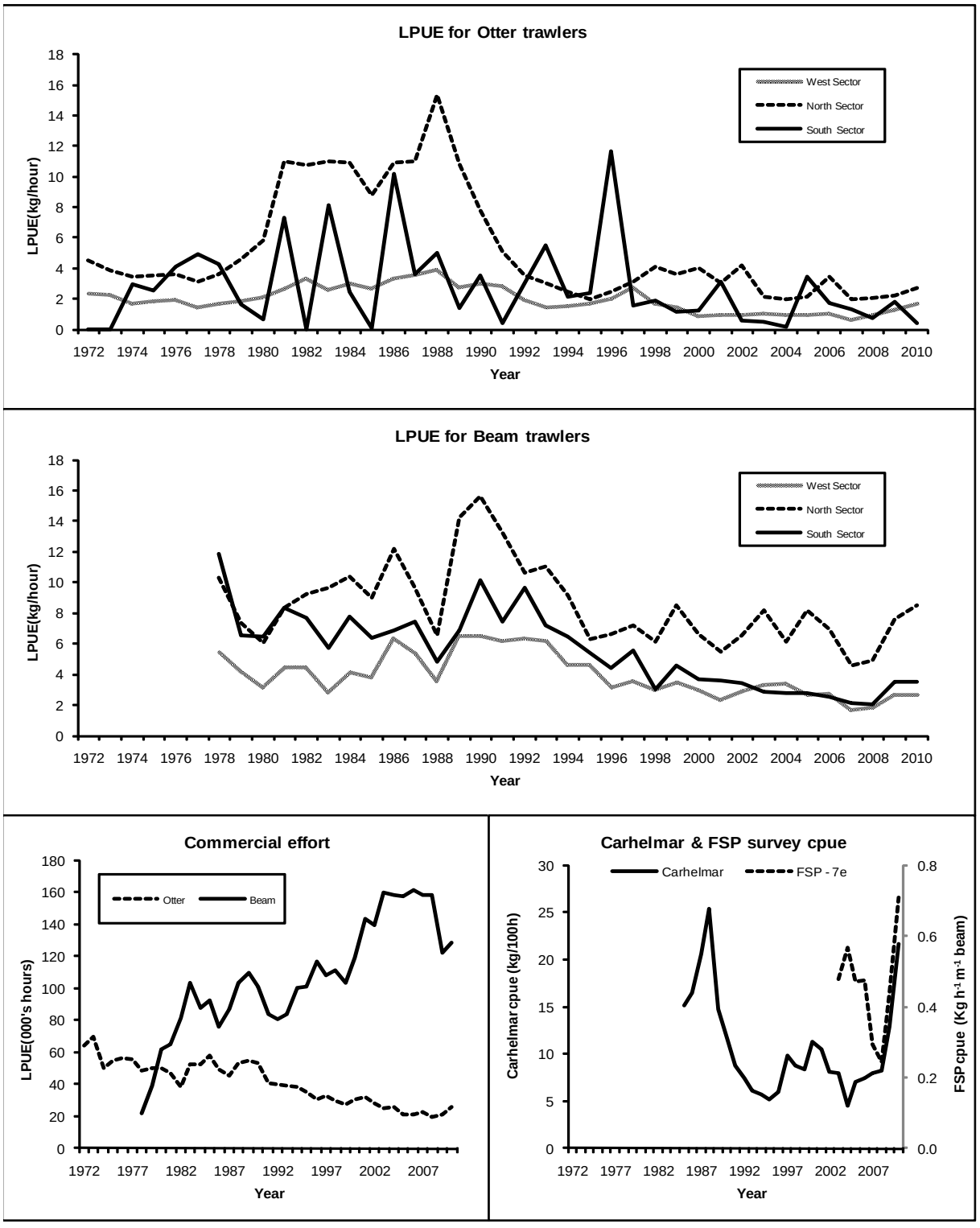


Figure 8.2.2 Plaice VIIe Discards - French Annual by fleet (2010)

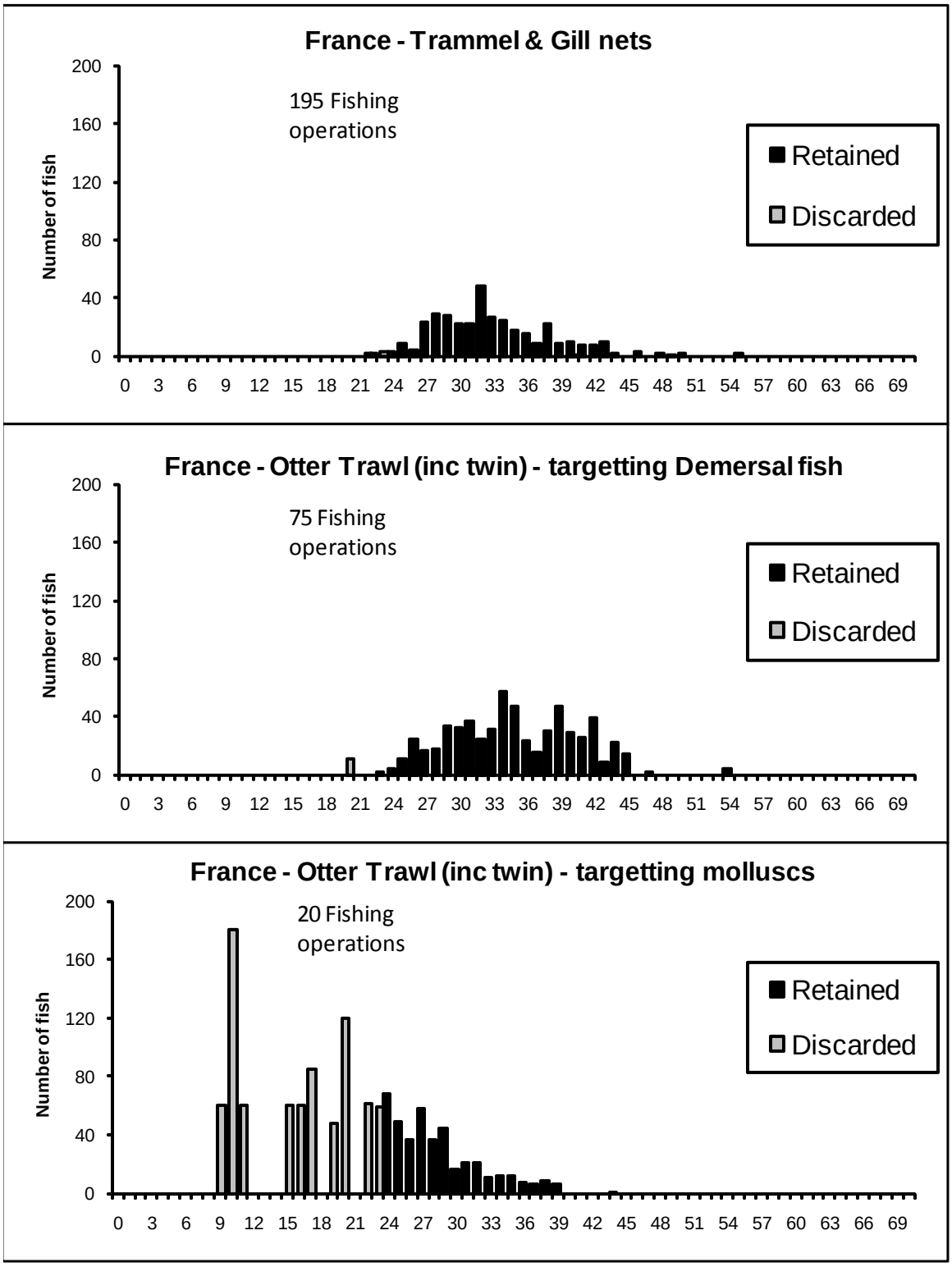


Figure 8.2.2 (cont.) Plaice VIIe Discards - UK by Quarter (2010)

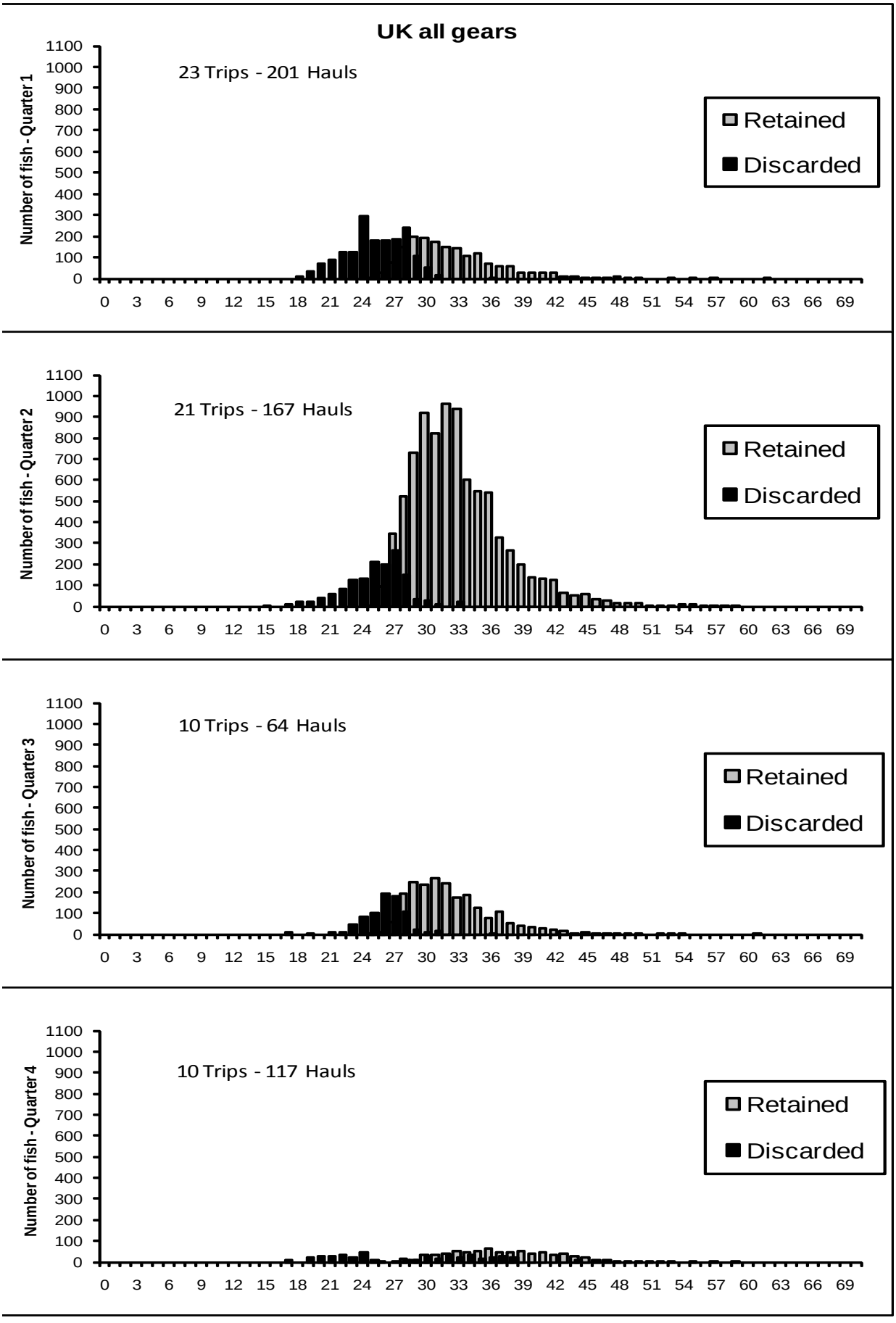


Figure 8.2.2 (cont.) Plaice VIIe Discards - Belgium by Quarter (2010)

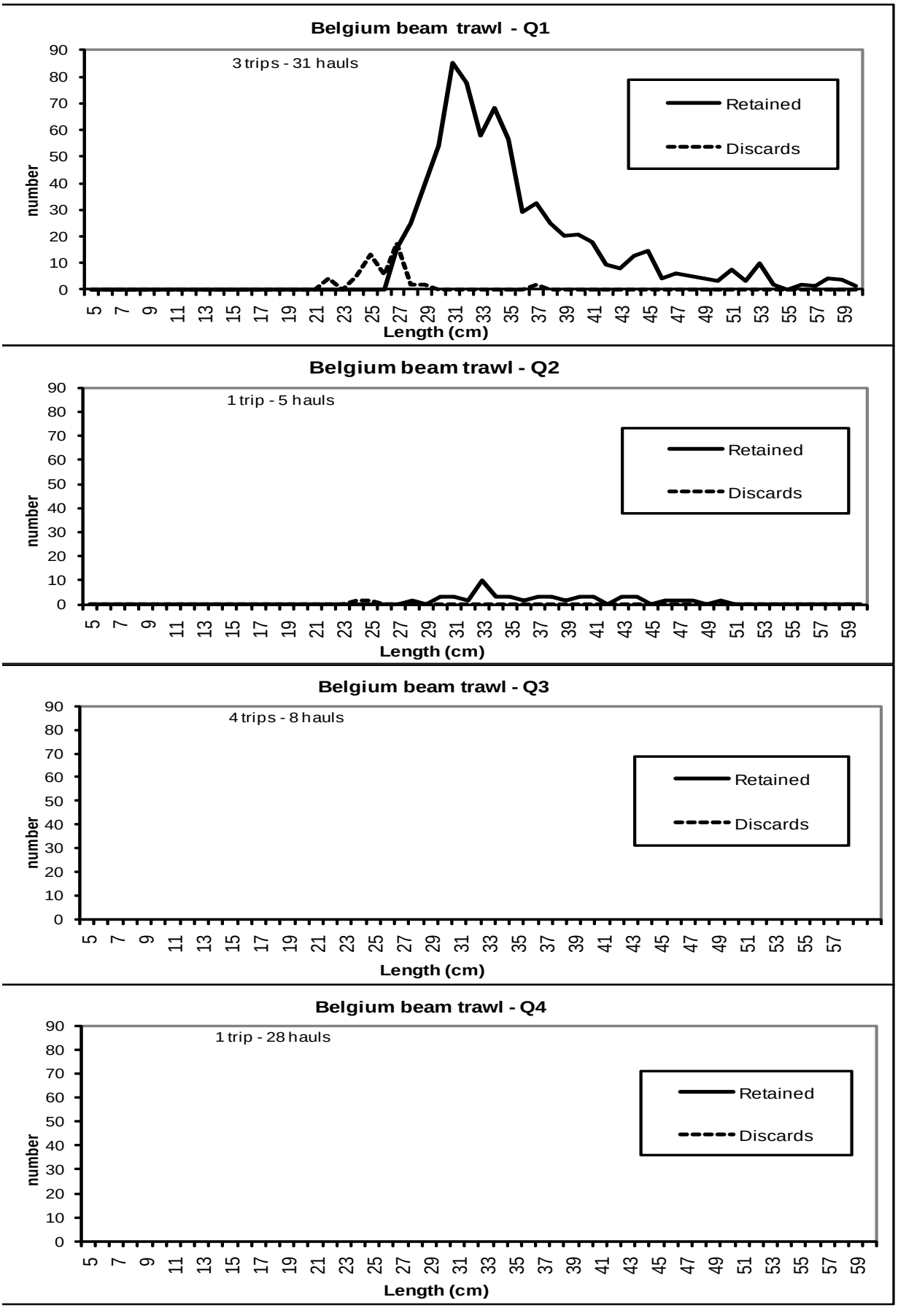


Figure 8.2.3 : Plaice in Division VIIe Length distributions of UK (England & Wales) landings from 2001 to 2010

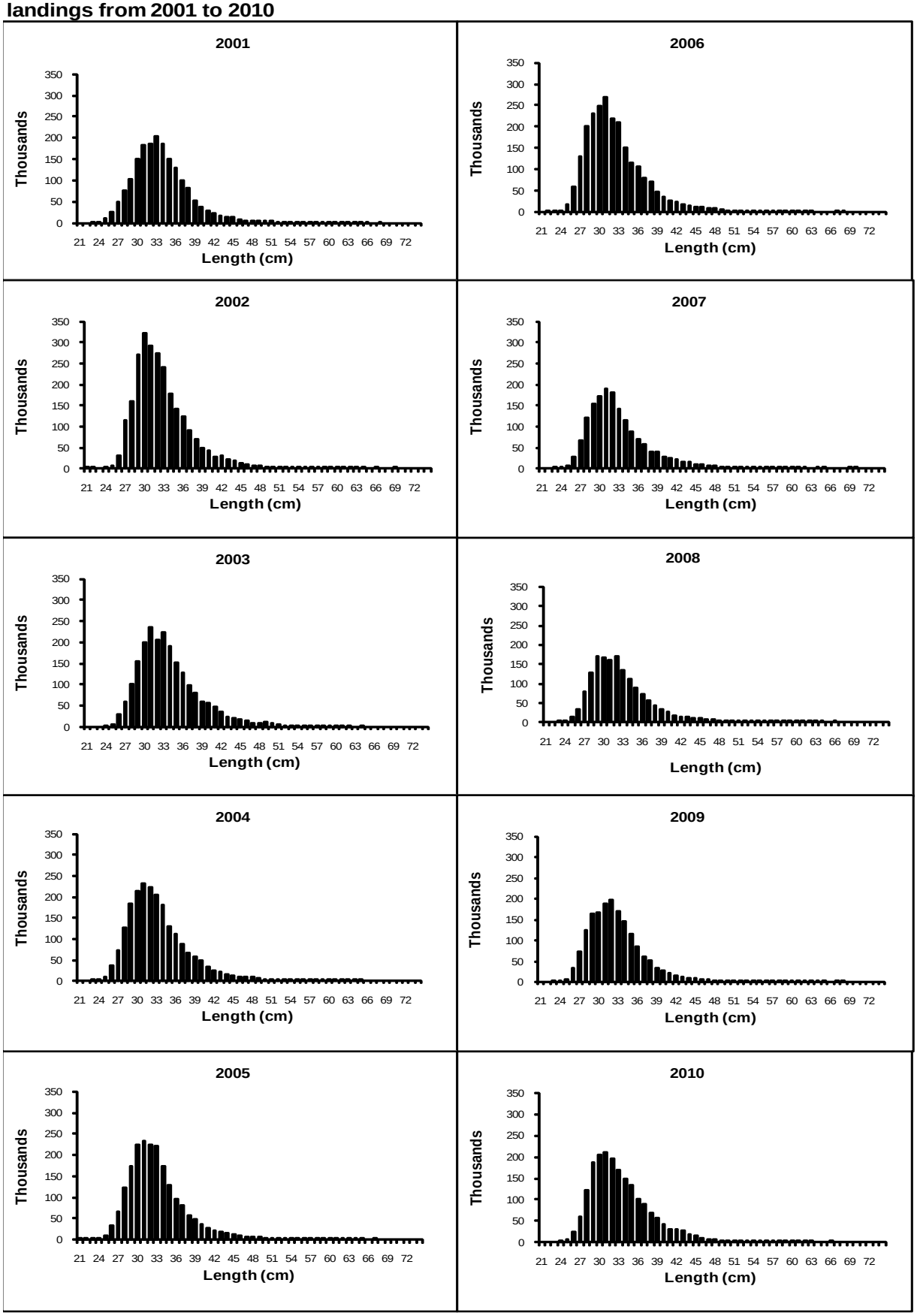


Figure 8.2.4 : Plaice in Division VIIe Age composition of international landings 2001-2010

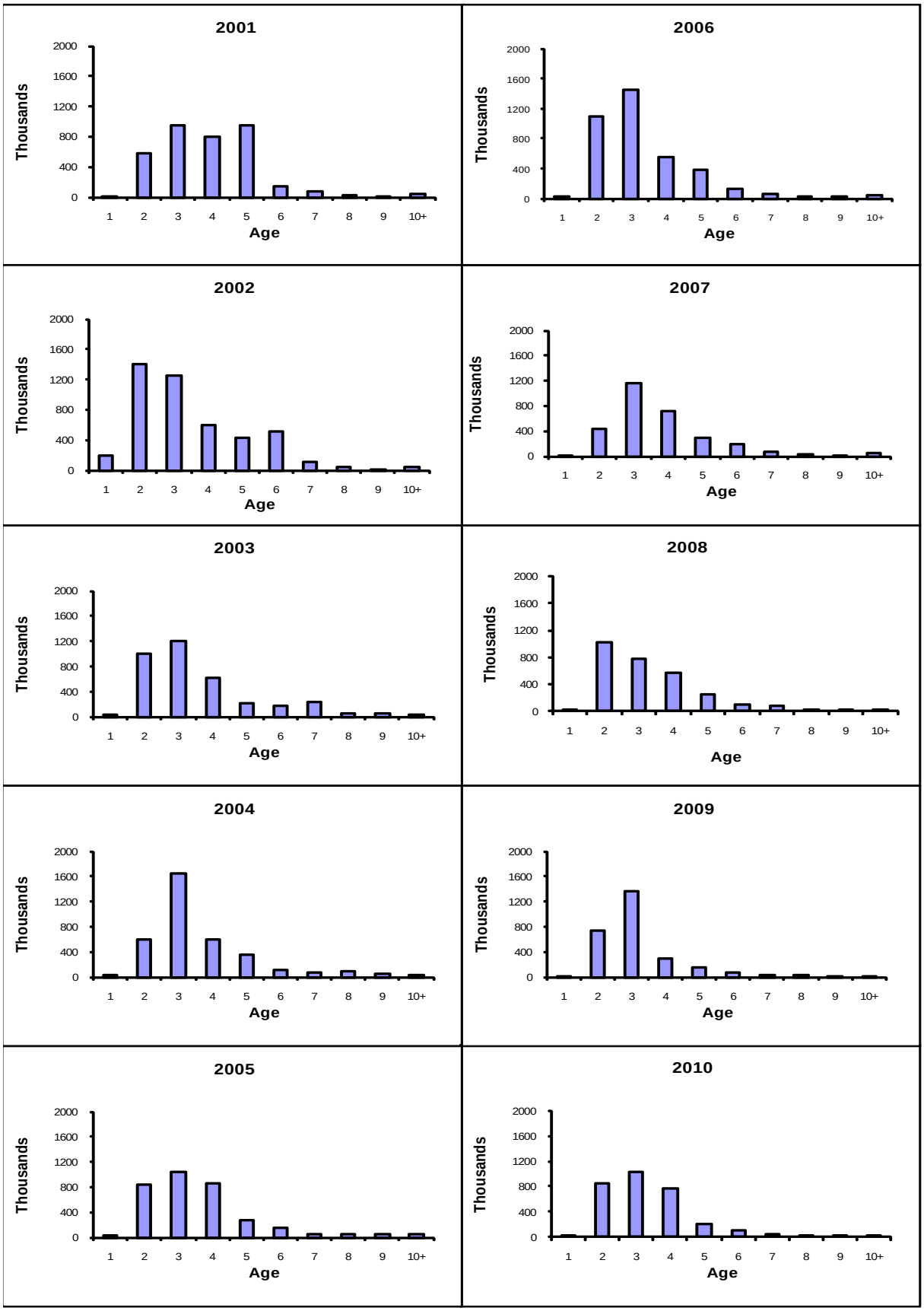


Figure 8.2.5 VIIe Plaice fleet log catchability residuals from the final run

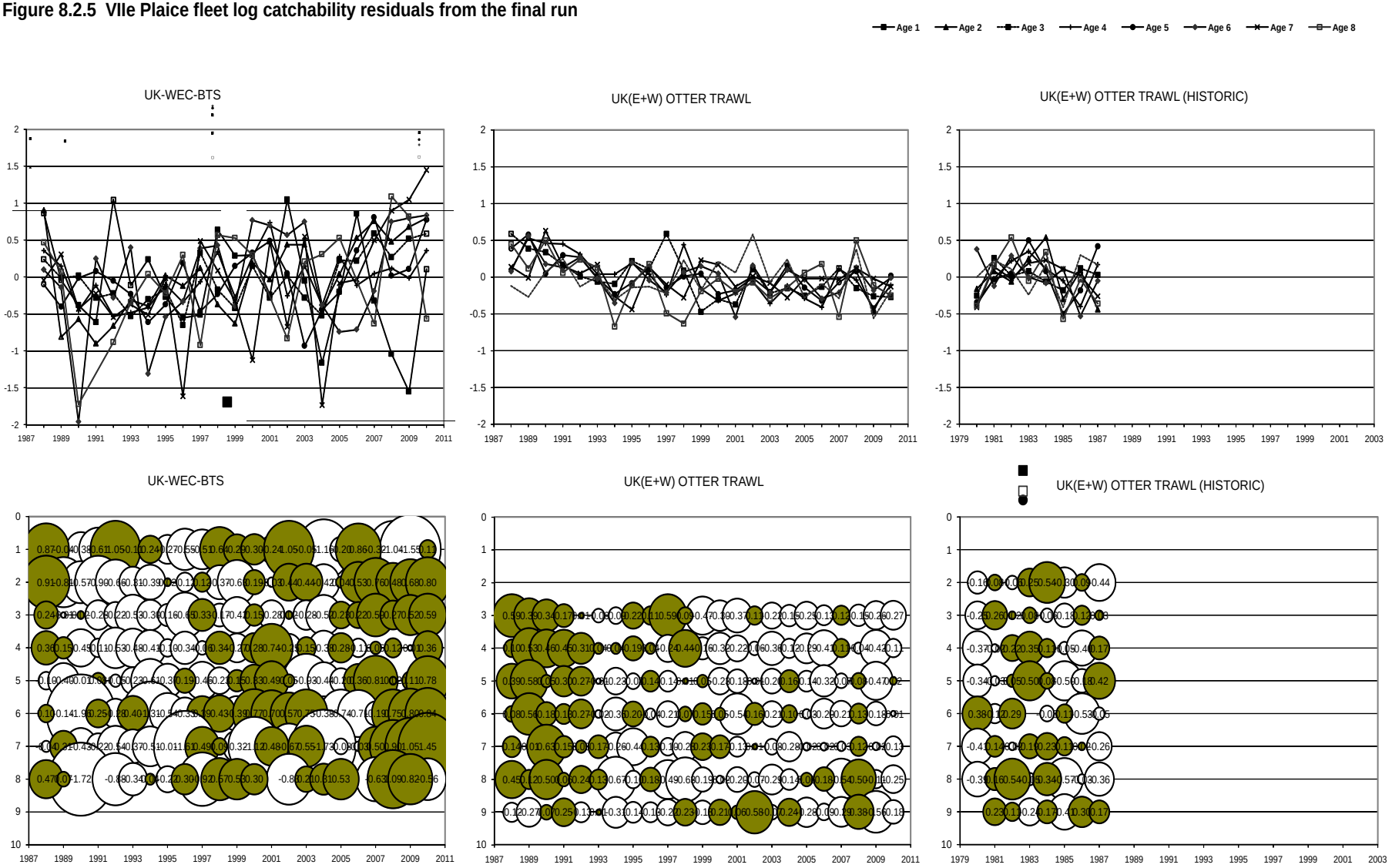


Figure 8.2.5 (cont.) VIIe Plaice fleet log catchability residuals from the final run

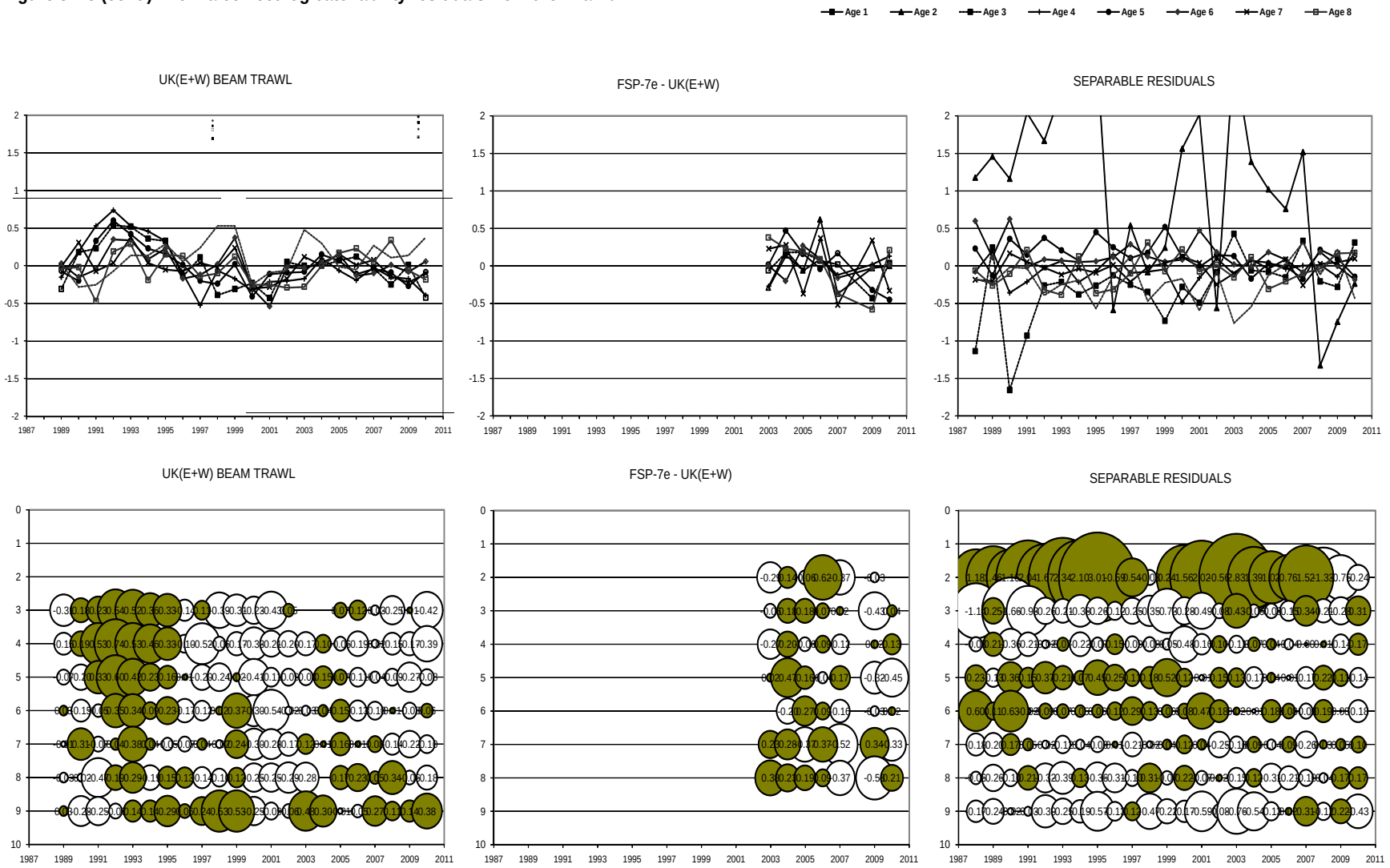
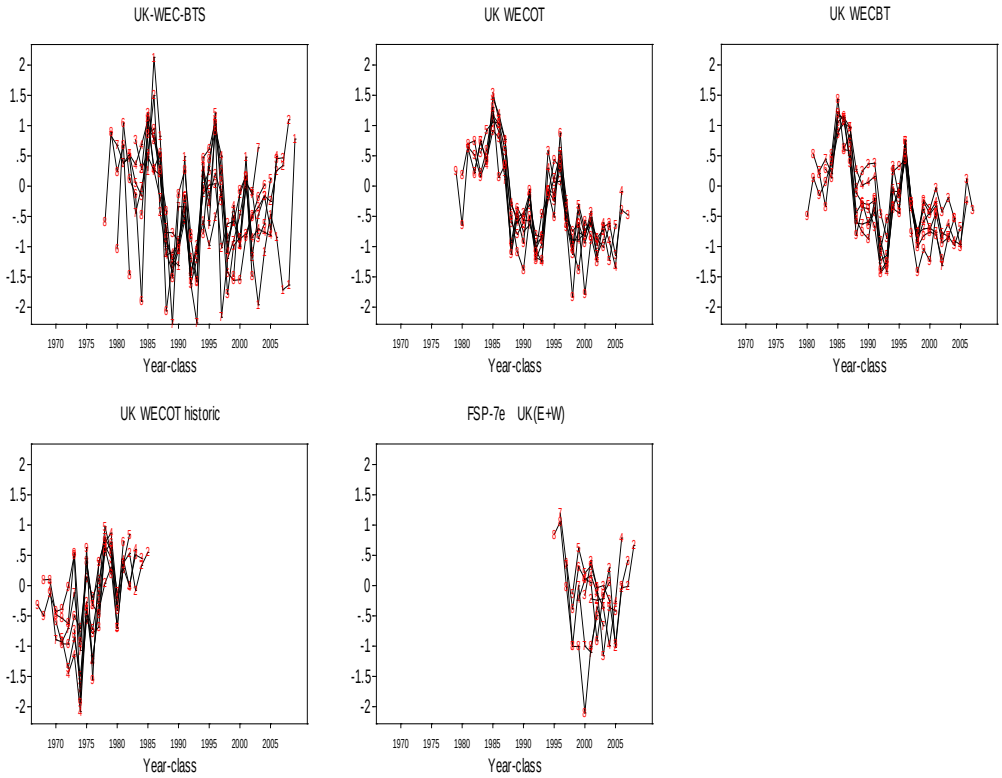


Figure 8.2.6 VIIe Plaice – Surba results

Tuning fleets by year-class



Tuning fleets by year

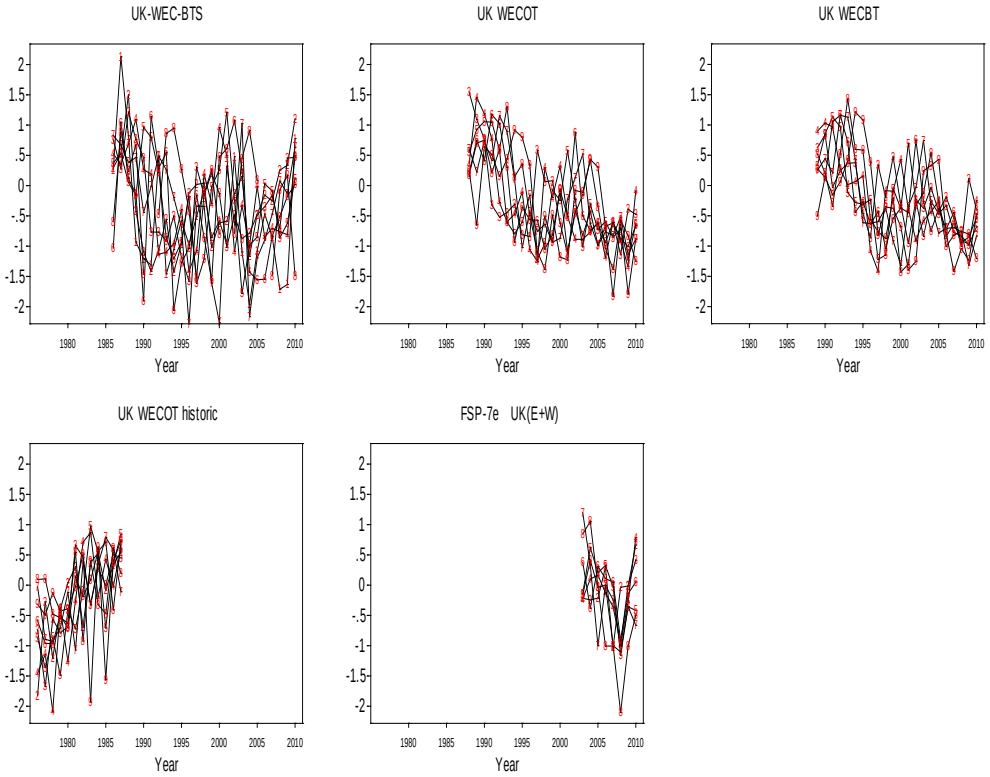
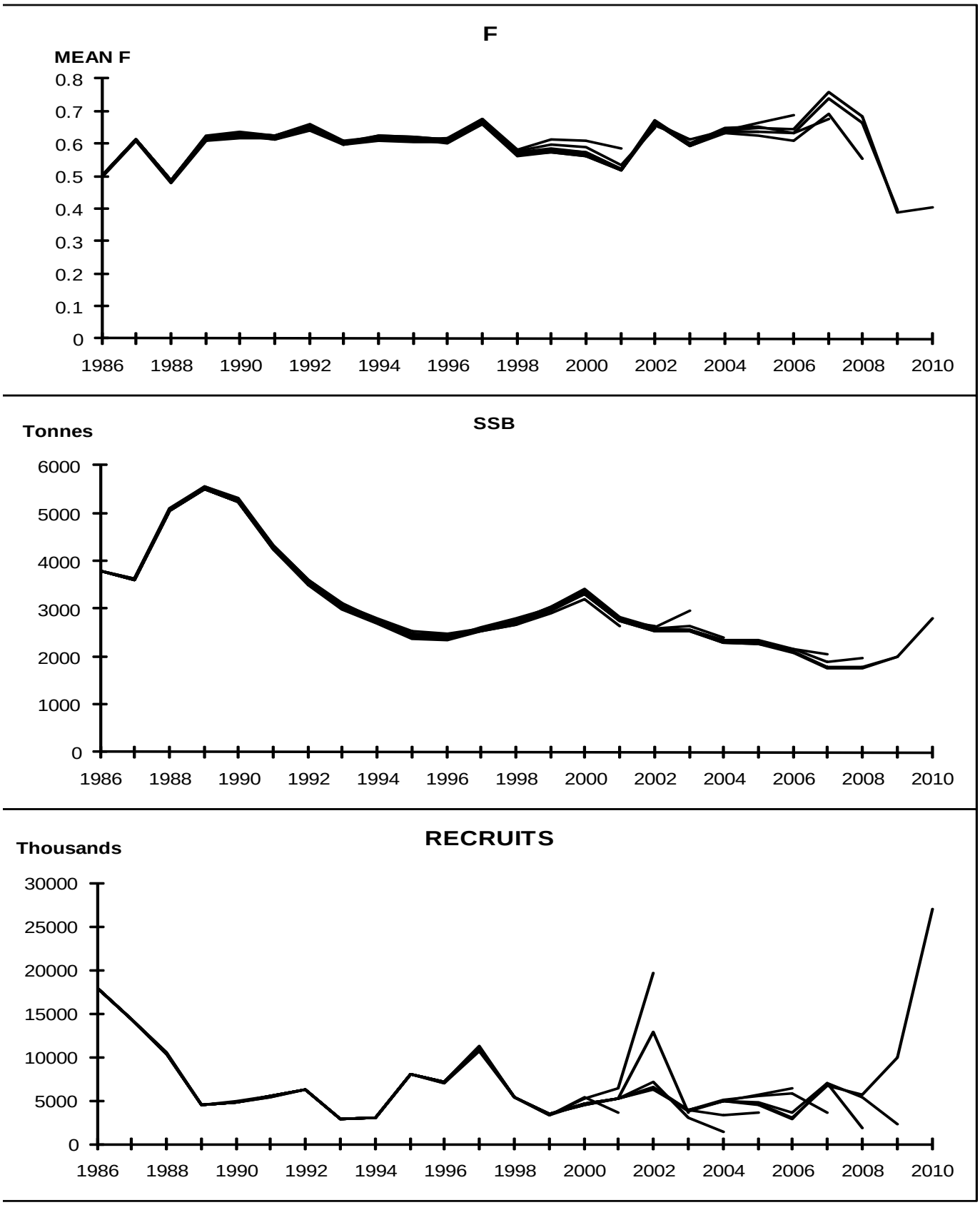


Figure 8.2.7 **VIIe Plaice: Retrospective XSA results**
(Shrinkage SE=2.5)



Note: the retrospective analysis was run without the short FSP survey

Figure 8.2.8 Plaice in Division VIIe (Western Channel)

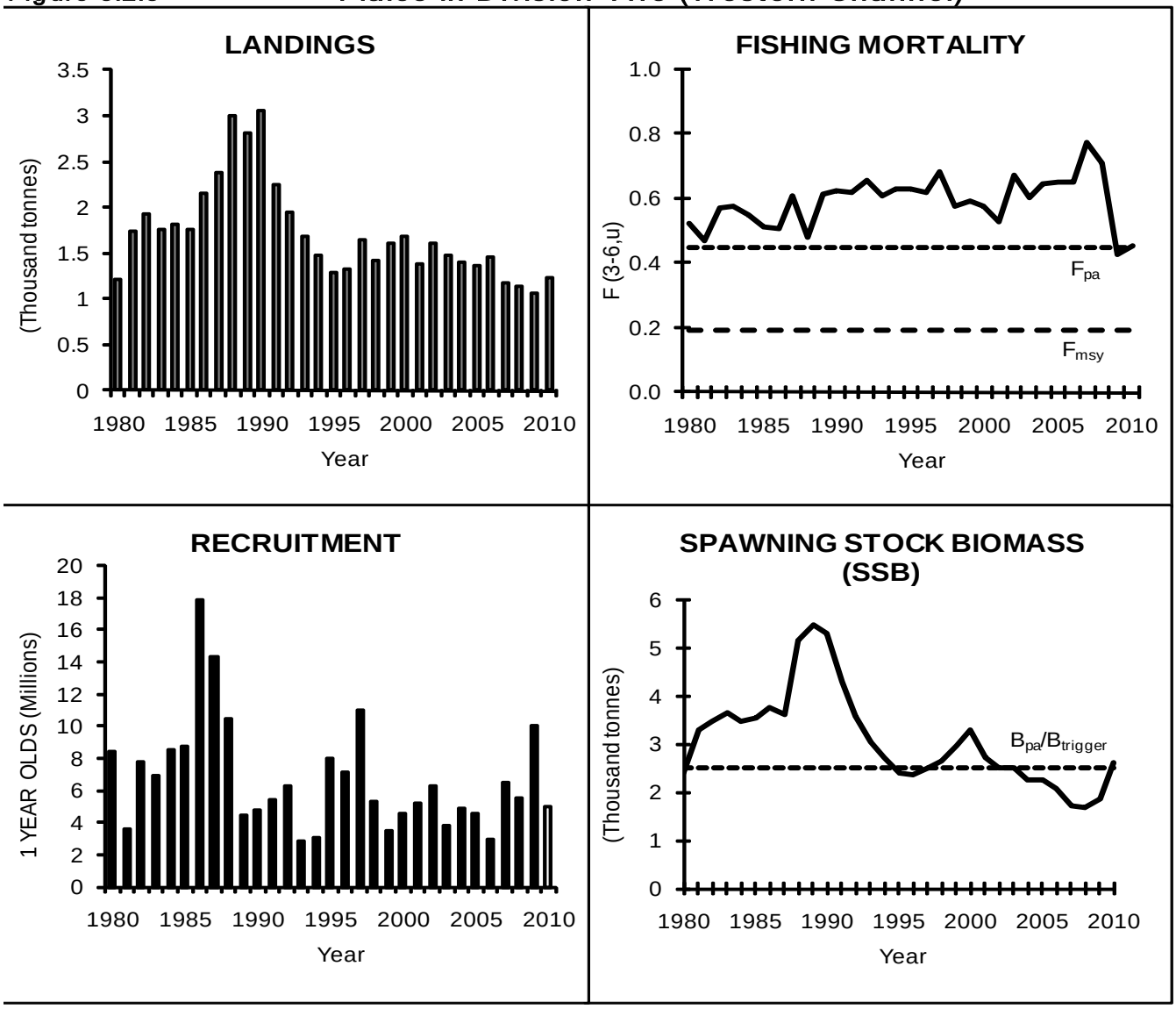
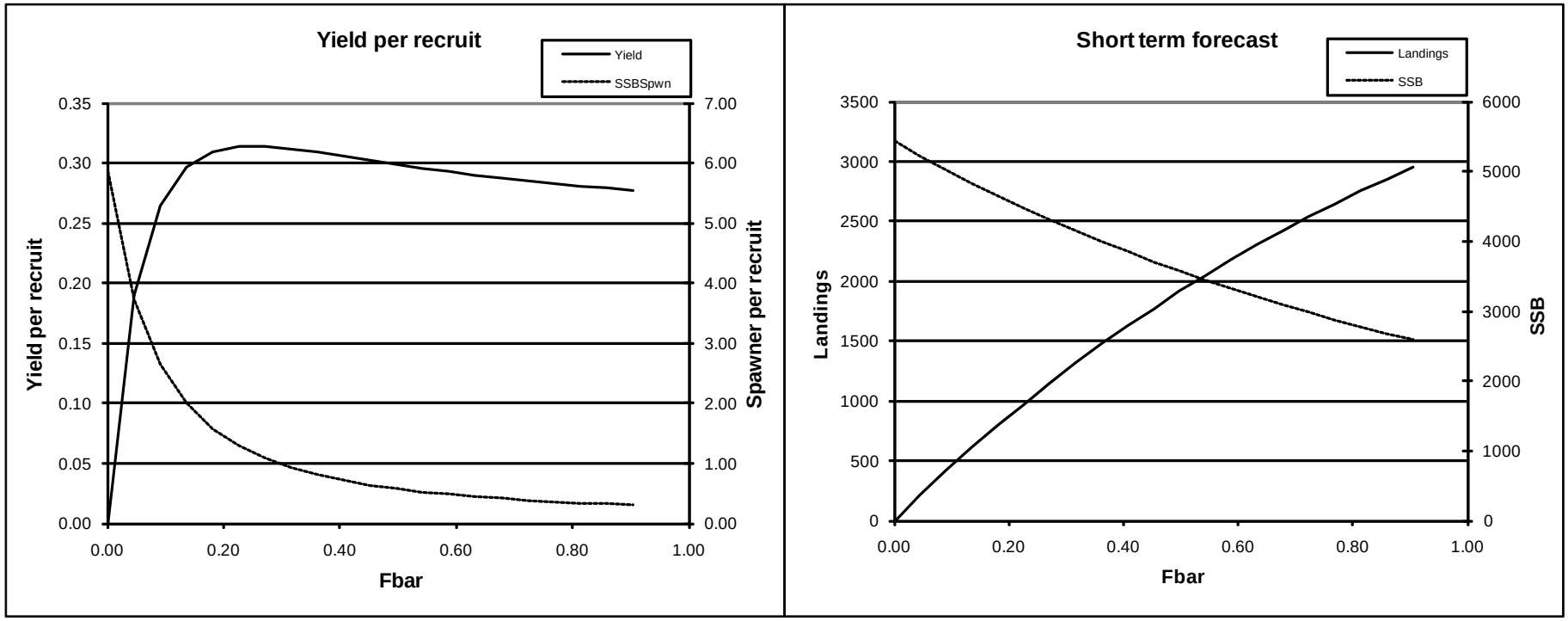


Figure 8.2.9 VIIe Plaice : Yield per recruit and short term forecast results



MFYPR version 2a
Run: p7e2011
Time and date: 08:49 15/05/2011

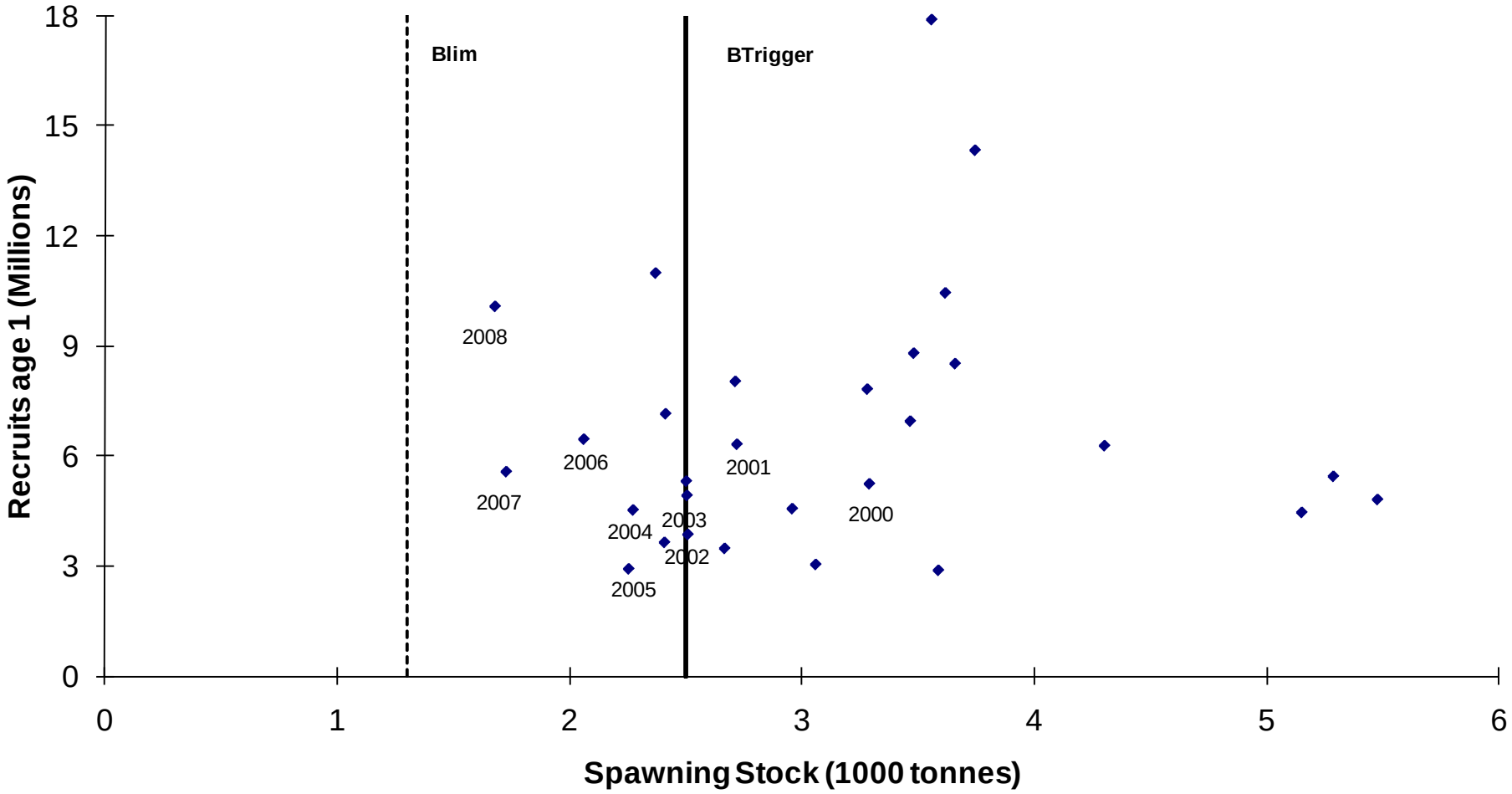
Reference point	F multiplier	Absolute F
Fbar(3-6)	1.0000	0.4520
FMax	0.5465	0.2470
F0.1	0.2510	0.1134
F35%SPR	0.2889	0.1306

Weights in kilograms

MFDP version 1a
Run: p7e2011wg
W.CHANNEL PLAICE 2011 WGCSE forecast inputs
Time and date: 18:31 14/05/2011
Fbar age range: 3-6

Input units are thousands and kg - output in tonnes

Figure 8.2.10 Plaice in VIIe. Stock-Recruitment



8.3 Sole in Division VIIe

Type of assessment in 2011

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).

In 2009 WKFLAT benchmarked this assessment, but failed to develop an update procedure, because it was not possible to address or even elucidate the cause of the substantial and persistent retrospective bias in F and SSB. Consequently the WG only updated data tables, performed an assessment according to previous update setting and commented on useful indicators of stock trends.

The management plan is inoperable in the absence of an analytical TAC estimate. Following a series of analyses an interim constrained model fit to the historic information was developed and is presented as a final assessment.

ICES advice applicable to 2010

Precautionary reference points established in 2001 for this stock are no longer valid and there is no accepted assessment.

Survey, lpue, and the exploratory assessment suggest low stock size and high fishing mortality relative to historic estimates.

Single stock exploitation boundaries

ICES advises on the basis of exploitation boundaries in relation to precautionary considerations that fishing effort and catches should be reduced although it is not possible to determine the appropriate scale of such reductions.

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 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 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.

Technical consideration

Technical Comments:

- The two commercial tuning fleets show pronounced negative residuals around 2003–2005, associated mainly with the 1998 year class. The WG notes that the commercial fleets indicated a bigger 1998 year class than was indicated by the survey, and suspects this may be a result of mixing between VIIe and VIIfg occurring beyond the western limit of the survey. The WG should consider spatial mapping of cpue data from the different fleets in the English Channel and VIIfg, linking VMS with logbook data and shore-based and at-sea sampling data.
- The WG states that "recruitment estimates are consistent between the single-fleet XSA runs, although the final estimates vary slightly". However the recruitment estimates from the survey and commercial fleets diverge substantially in the final years. The XSA diagnostics show that at ages 3–5, the UK beam trawl survey generates much larger survivors' estimates and lower F estimates than the commercial fleets, with the differences becoming less pronounced at the older ages. Differences are also apparent in the combined-age cpue where the UK beam trawl survey seems stable but noisy whereas lpue in the beam trawl fishery has been declining continuously since the 1990s. The WG should review the appropriateness of the commercial fleets for providing indices for the younger age classes.
- F_{bar} in the report model settings table and stock annex table is age 3–7, however the WG has used an F_{bar} of 3–9 in the assessment and advice sheets.
- The short-term predictions previously used F_{sq} for the interim year (as area misreporting meant the TAC was not limiting). This year a TAC constraint was used for 2010 on the basis that "recent evidence suggests that the TAC is likely to be observed" although the evidence is not described. In practice, the TAC constraint leads to an F in 2010 of 0.24 which is close to the low F estimate of 0.25 for 2009.
- The SEN file Table 8.3.16 includes a figure for N(1) of 2815 that does not represent either the XSA estimate or the GM of 4332. This may have no impact on the F_{MSY} bootstrap computations.

The negative residuals in the single fleet runs for commercial tuning fleets over the period 2003–2005 are apparent for all ages and as such are not associated with a specific year class as implied by the review group. In the final assessment the UK-CBT fleet (not the UK-OBT fleet) does have larger residuals for this cohort but only for three years so cannot be the only cause of the retrospective. The 2002 YC is indicated to be stronger in the survey than in the commercial fleets and this is likely to have contributed also in the index evaluation plots this can be tracked to age 9 at which point it is highly abundant. This supports the idea of a lack of a closed population

particularly at recruitment ages as already investigated/shown by WKFLAT 2009. Currently there is no data available to further examine this effect, but the stock is scheduled to be benchmarked in 2012 when information from a new survey will be evaluated.

The WG agrees that the solution is less than ideal, but it is likely the "best compromise" currently possible. The commercial fleet is almost certainly not representative of abundance in the fleet, due to retargeting effort towards areas where other fishing opportunities are available; however sole are still caught in lower numbers as shown by the temporal residual pattern particularly in the UK-CBT fleet. Removing the tuning of the younger ages from the commercial fleets will lead to a larger discontinuity at the transition and a larger retrospective pattern. In any case, given the up-date process it is not possible to change the procedure at this time and it is hoped that the issue can be addressed in the next benchmark process.

The reason for using this new age range is the extensive age distribution with a sizeable portion of the population still found in the plus group even at age 12. WKFLAT 2009 discussed this and came to the conclusion that it would be desirable to cover a larger proportion of the stock. Unfortunately, because the assessment was eventually rejected this change is not documented in the report. The annex has not been updated recently so does not reflect this change. The new age range is also retained in this assessment for consistency with the management plan evaluations used by the commission.

The use of a TAC constraint was associated with the fact that most of the misreporting was historically associated with the UK beam trawl fleet, which last year was constrained from area misreporting by a single area licence scheme. This year the French fleet shows substantial over quota official landings (Table 1), however the most recent assessment indicates that F=0.24 as used by last year's forecast was an appropriate value for F_{sq} (more by luck than reckoning).

The methodology used to estimate F_{msy} is an equilibrium estimate and strips the early results so this has no impact. The sen file was not used in the short-term forecast.

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 2010 were 740 t, 20% above the 2010 TAC (618 t). WG landings included information based on French sales slips indicated total international landings were 688 t in 2010, 11% 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 landings and France reporting the majority of the remainder. **However, in the last two years, the proportion landed by the UK has fallen to around 50% with a similar proportion now landed by France.**

Management applicable to 2010 and 2011

2010 (Council Regulation (EC) No23/2010)

Species: Common sole *Solea solea*		Zone: VIIe (SOL/07E.)
Belgium	22	
France	233	
United Kingdom	363	
EU	618	
TAC	618	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 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.

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.

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 2009 reported landings (+4.50 t UK; -0.8 t Guernsey; +71 t France), 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 (Tables 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 when some UK age information was used to supplement sparse French age information at larger lengths. This year, France provided modified fleet age composition data for 2009 to cater for differences observed in the length structures for the otter trawlers targeting demersal fish compared to those targeting mollusc. French 2010 data was also provided in this form.

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 2010 is again minor in this stock (Figure 8.3.3a–e) for both the UK, French and Belgian fleets. Substantial discarding is shown in quarter 1/2 for the UK fleet, but this anomaly is associated with the data from the UK 50% project which last year was shown not to be representative of the discarding in the fleet as a whole, likely due to some incentives that changed fishers behaviour during the trips sampled for this project (WGCSE 2010). Unfortunately, this year the data was not supplied in a way that this information could be separated from other discard data. Following conclusion of the project (quarter 2–4) discarding has dropped to the normal very low levels.

French discarding is also insignificant with respect to its fleet targeting sole, but one fleet (Figure 8.3.3d labelled FRMtrawl) locally targeting cuttlefish inshore in the Baie de Granville has indicated substantial discarding of small sole. The 2nd quarter of 2010, the discard samples are located in only ICES rectangle 26E7, which accounts for 7 tonnes of sole landings and only one of the seven sampled trips by this métier shows significant discarding of small sole. Therefore the special discarding pattern does not change the overall picture of low discarding of sole in the area, but the métier specifically targeting cuttlefish inshore should be monitored closely, and some management or technical measures should be sought in order to avoid such a discarding of sole.

Belgian discard information was provided for the first time this year and also shows only minor discarding of sole.

More generally discarding 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) have very limited effort and hence contribute only a very small percentage to the landings (<5%). The selectivities of the gears used to target sole 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 October 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. (Table 8.3.6, Figure 8.3.4).

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 2001 YC 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. Inclusion of this fleet should be reconsidered in the next benchmark.

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 (Table 8.3.6, Figure 8.3.4). 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 less than 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. 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 (Table 8.3.7, Figure 8.3.4) 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 Figures 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. 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 1980s 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.

See also the stock annex for historic fleet data used in the assessment.

Information from the fishing industry

The fisheries science partnership, conducted cooperatively between CEFAS and the UK industry has provided evidence of the wide dispersal and wide-ranging age distribution for this stock.

8.3.3 Stock assessment

Model used: Reformulated XSA assessment

Software used: FLR – FLXSA (FLCore 1.4-3 - "Golden Jackal" ; R 2.4.1)

Model Options chosen: data as in previous years (See Stock Annex) but with additional shrinkage to stabilise F trends as used for last year's advice.

Input data types and characteristics: catch numbers-at-age without discards, five tuning fleets, one survey, two current commercial cpue series, two historic cpue series.

Data screening

Data screening of the catch-at-age, weights, tuning information and ancilliary 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-COT) 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

WKFLAT 2009 described the assessment methodology used prior to 2009 as unsuitable for management advice, but failed to develop a more suitable methodology. The management plan is inoperable in the absence of an analytical TAC estimate.

The WG fitted the XSA model using the previous settings, which indicated a much reduced retrospective pattern in the last two years, and considered re-introducing the old assessment methodology. However, the retrospective bias observed in previous years remained apparent and no explanations for the historic pattern can be given. Previous studies by the ICES Working Group on Assessment Methods (ICES 1991, ICES CM1991/Assess:25) established that where retrospective bias patterns are severe, such that estimates are considered unreliable, shrinkage to the mean fishing mortality of the previous years at each age could be used to provide coherent population and fishing mortality estimates that can be taken forward into stock forecasts. An XSA with heavy shrinkage was therefore considered to be the most likely methodology to provide quantitative information suitable for management advice. The results from exploratory runs established that an increased level of shrinkage (0.5 from 1.0) and an increased time period over which this is applied (10 years from 5 years) was optimal for consistent series of estimates. All other settings were maintained as previously and the complete set of settings is shown in the text table below.

Figures 8.3.9–8.3.11 show the residual plots from the final fitted model, a comparison with the 2010 assessment including a run replicating the settings used prior to the benchmark (WKFLAT 2009), and the respective XSA survivor weightings. XSA diagnostic tables, stock number-at-age and fishing mortality-at-age are shown in Tables 3.8.8–3.8.10.

A seven year retrospective analysis was run for the interim assessment (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.

		WG 2011
Catch-at-age data		1969–2010, 1–12+
Fleets	UK-BTS – Survey	1988–2010, 1–9
	UK-Inshore – Commercial	1973–1987, 2–11
	UK-Offshore – Commercial	1973–1987, 3–11
	UK Combined Beam Trawl - Commercial (UK-CBT)	1988–2010, 3–11
	UK Otter trawl – Commercial (UK-COT)	1988–2010, 3–11

Taper	No
Ages catch dep. Stock size	None
q plateau	8
F shrinkage se	0.5
year range	10
age range	5
Fleet SE threshold	0.5

Catch data	Age 1 catches = 0
Plus group	12
F_{Bar} Range	F(3–9)

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 for twelve years before declining slightly its lowest level in 2008. There has been an increase in the last two years to just below 2800 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 0.3 in 2009 and 2010, commensurate with the improved compliance associated with the single area licensing scheme introduced in the UK.

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 still slightly higher than recent TACs.

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. Last year's F forecast for 2010 assumed a TAC constraint, which given the overshoot of the TAC appears inappropriate. Consequently, the WG agreed to use the F pattern observed over the last three years, rescaled to the final year F given the trend in F over the last three years. The mean catch and stock weights-at-age 2008–2010 were also used.

Estimating year-class abundance

As implemented previously, the geometric mean recruitment over the entire time-series (1969–2008) 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
2008	2885	XSA	62%	-	38%
2009	4301	GM (1969–2008)			
2010	4301	GM (1969–2008)			
2011	4301	GM (1969–2008)			

Complete input data for the short-term forecast is shown in Table 8.3.12, and resulting forecast estimates landings in 2011 to be 670 t, 40 t less than the TAC (Table 8.3.13).

SSB estimated at 2570 t in 2011 will rise to 2650 t in 2012 at the current level of F assuming GM (1969–2008) recruitment for the 2009 year class which has been estimated by XSA to be much larger (8910), but this estimate is not thought to be very reliable.

The proportions that the 2008–2012 year classes will contribute to the landings in 2012, and to the SSB in 2013, are given in Table 8.3.14. 27% of the landings for 2012, and 38% of the SSB for 2013 rely on year classes for which GM recruitment has been assumed. The 2009 year class that has been replaced with GM (1969–2008) contributes to 22% of the landings in 2012 and 22% of the SSB in 2013.

A full management options table is provided in Table 8.3.15. The management plan for this stock requires F_{2012} to be 85% of the average $F_{07\text{-}09} = 0.288$ until such time as the management target ($F_{MSY} = 0.27$) is reached. This occurred in 2009 so that the 2012 TAC according to the management plan is 777 t. This represents a 9% increase in the TAC from 2011 to 2012 and thus does not exceed the 15% annual increase cap implemented in the plan. 777 t is therefore the TAC consistent with the management plan for 2012.

8.3.5 Biological reference points

Biological reference points were rejected by WKFLAT 2009 due to a lack of an appropriate assessment to evaluate their suitability. Reference points should be revised once an appropriate assessment methodology has been fully developed.

WKFRAME2 provided general comments on the appropriate choice of $B_{trigger}$ suggesting the B_{pa} based on B_{loss} are inappropriate as the precaution implied by the B_{pa} is already incorporated with the lower choice of F in the MSY management framework. The WG considered revising current reference points, but suggests that this would be

more appropriately carried out during or after the benchmark process has been completed.

In the meantime ICES is moving towards management advice based on MSY reference points. Management of this stock in the short term is likely to be on the basis of the management plan so that a lack of PA reference points is unlikely to significantly impact management decisions in either the short or medium term.

8.3.6 MSY evaluation

Stochastic analyses performed by WGSSDS in 2006, assuming no variability in M, suggested that yields of 865 t could be safely extracted from the stock at levels of F=0.27 while the probability of SSB dropping below lowest observed SSB values would remain at less than 5% levels. This value remains consistent with the results of the current assessment and is accepted as the best estimate of F_{msy} available for this stock (WGCSE2010). More elaborate risk based stochastic evaluations of the management plan have been carried out by SG-MOS-1006 (Part C) suggesting that the fundamental stock dynamics or the selection pattern have not changed so that this assessment still represents the best of our knowledge.

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.

The WG has provided an interim assessment as a means of providing management advice for 2012, which implies a TAC of 770 t in 2012. Catches at this level are likely to maintain F around the long-term management target.

8.3.8 Uncertainties in assessment and forecast

The WG provided a constrained interim assessment due to the need for management advice in relation to the management plan, as the current plan makes no provisions as to how to manage the stock in the absence of a full analytical assessment. The methodology provided is as robust as possible under the currently available understanding of the stock dynamics and at present does not appear to suffer from the retrospective pattern, which led to the rejection of the assessment as suitable for management advice by WKFLAT 2010. However, the retrospective analysis suggest that even the new methodology still retains some retrospective bias in the earlier period so that the uncertainty in the current estimates of F and SSB is likely to be greater than indicated by the assessment output diagnostics.

In addition, this year's short-term forecast suffers from two specific uncertainties the size of which cannot be determined by the assessment. The first is the likely F in 2011. Last year the WG assumed the TAC to be constraining, however the 2010 landings data suggests that this may not have been appropriate as the TAC was overshot by 10%. Given the most appropriate method for estimating F_{sq} (rescaling $F_{bar(08–10)}$ to the final year due to a trend in F) suggests the TAC will be undershot by 5% which seems even less likely. Despite this the WG took this as the only scientifically defensible method for estimating catches with the consequence that if the 710 t TAC is taken in 2011 the forecast will overestimate SSB in 2012. The other uncertainty relates to the size of the 2009 year class estimated to be very strong in the survey, however this has not been seen to be reliable in recent times so that this value has been replaced with $GM_{(69–08)}$ potentially underestimating 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 provided 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

Currently only one survey index is used in the assessment (UK-WEC-BTS) which provides good stability to the assessment in general. Year-class tracking is internally consistent and agrees well with information from commercial tuning fleets. However, in the recent past there is some question regarding the consistency of the tuning-series due to a vessel effect in 2002 and 2004. In addition in recent years it has become apparent that there are some differences in the year-class consistency between the commercial and survey tuning information. Specifically, the 1998 year class known to have been very strong in VIIf&g is not represented in the survey that operates solely in the eastern part of the area. This suggests that there may be both an open population as well as an incomplete mixing problem in the data contributing to the inconsistency of the assessment.

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 was insufficient at older ages to raise the length compositions, so that UK data was used to cover the larger fish. The use of commercial tuning data is unavoidable, as there is little information available for older ages from the survey.

Consistency

The interim assessment provided by the WG is highly consistent with the previous methodology as it uses the same information, but weights the value of the different sources differently. The previous retrospective bias with respect to overestimating F and underestimating SSB is still apparent historically though not observed recently and is likely caused by the difference between the cohort signals in the survey and commercial information. Cohort strength has been relatively even in recent years, but a retrospective pattern may well become apparent again if the 2009 cohort observed in the survey is confirmed in the future.

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 due to a lack of legally acceptable evidence.

Levels of underreporting 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 and 2010 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.
2011	VIIe Sole	WKFLAT 2009 could not recommend an appropriate assessment procedure for this stock for the following reasons: Closed population and complete mixing assumptions of the assessment are violated. Tuning data indicate differences in trends in F and recruitment resulting in a serious retrospective pattern in the assessment. Survey information only partially covers the stock area. Effort correction parameters / methodologies may require updating as the main beam trawl fleet has restructured substantially recently. This effort would be greatly enhanced by an internationally coordinated survey that more appropriately covers the management area and is able to assess recruitment dynamics irrespective of the sources of recruitment and environmental drivers.	2012	Experts with expertise in spatial modelling of stock dynamics and survey specialist to help evaluate the new stratified random survey in the area.

8.3.10 Management considerations

This stock is subject to a management plan based on reductions in fishing mortality in relation to historic levels of F. Previously both the most recent and the target fishing

mortality and population estimates were continually revised by subsequent assessments, which is why the assessment was rejected by WKFLAT 2009.

A constrained interim assessment model has been fitted in order to provide management advice in relation to the management plan, as the current plan makes no provisions as to how to manage the stock in the absence of a full analytical assessment. The model is considered to provide population and mortality estimates that are coherent and suitable for the provision of stock forecasts.

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.

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.

Estimates of F_{MSY} and its proxies were all considered highly uncertain by WGCSE2010 for this stock and therefore not considered appropriate. The current management plan is considered appropriate to achieving high long-term yields consistent with MSY.

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.

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 codend 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 multispecies fishery have undoubtedly 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 even though 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.

This should be investigated further by the next benchmark.

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		385			1	3	374	3	-82	701
2010	17		359			2		362	2	-53	688

Table 8.3.2 Sole VIIE Catch Numbers at Age in 000's

Age	1969	1970	1971	1972
1	0	0	0	0
2	89	53	51	146
3	322	232	200	412
4	80	322	246	167
5	148	90	198	115
6	210	83	65	112
7	21	112	80	14
8	50	13	156	25
9	26	35	10	134
10	20	52	35	38
11	9	22	54	54
+gp	63	113	113	106
Total	1037	1127	1207	1323
Landings	353	391	432	437

Table 8.3.2 Sole VIIE Catch Numbers at Age in 000's continued

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0	0	0	0	0	0	0	0	0	0
2	71	45	82	167	426	250	227	175	245	128
3	396	349	567	419	318	1123	803	559	806	1451
4	433	220	170	472	384	347	811	497	651	916
5	89	178	199	161	206	214	250	630	467	553
6	99	71	115	135	102	189	229	126	389	352
7	120	80	28	92	70	103	174	183	179	240
8	17	43	53	46	74	72	103	140	126	136
9	52	32	26	58	10	77	90	65	76	113
10	30	24	22	51	24	38	104	56	58	81
11	4	55	24	14	32	27	28	130	55	61
+gp	136	106	171	213	159	203	290	342	211	294
Total	1446	1202	1456	1830	1804	2644	3108	2902	3262	4324
Landings	459	427	491	616	606	861	1181	1269	1215	1446

Table 8.3.2 Sole VIIE Catch Numbers at Age in 000's continued

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0	0	0	0	0	0	0	0	0	0
2	91	333	287	246	487	443	390	341	450	316
3	753	663	1700	1618	808	1438	871	902	415	1434
4	1573	826	756	971	1090	596	1233	581	482	417
5	583	758	469	421	427	728	497	553	289	297
6	351	325	585	321	204	374	509	244	220	115
7	267	204	179	336	224	153	225	264	93	112
8	294	129	97	84	229	162	110	143	111	61
9	119	152	103	75	47	109	107	103	68	74
10	73	54	85	90	50	39	113	75	37	26
11	37	28	29	74	41	50	48	85	31	23
+gp	262	255	125	127	162	171	214	235	145	90
Total	4401	3727	4414	4363	3770	4262	4316	3525	2341	2964
Landings	1498	1370	1409	1419	1280	1444	1390	1315	852	895

Table 8.3.2 Sole VIIE Catch Numbers at Age in 000's continued

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0	0	0	0	0	0	0	0	0	0
2	209	97	95	365	216	265	280	307	145	332
3	704	657	308	445	831	606	915	599	1401	1251
4	1107	558	629	364	724	536	500	751	531	843
5	350	558	427	298	325	336	398	367	497	387
6	219	112	411	235	180	209	255	229	268	322
7	151	106	131	257	194	151	114	107	178	129
8	78	49	101	68	173	80	103	53	100	105
9	60	57	61	61	44	127	54	68	55	94
10	56	44	33	49	20	35	107	51	43	33
11	31	50	18	37	40	34	25	88	42	18
+gp	79	99	142	143	88	162	123	91	159	85
Total	3045	2388	2356	2321	2835	2543	2874	2710	3419	3599
Landings	904	800	856	833	949	880	957	914	1069	1106

Table 8.3.2 Sole VIIE Catch Numbers at Age in 000's continued

Age	2003	2004	2005	2006	2007	2008	2009	2010	geom mean 08-10	arith mean 08-10
1	0	0	0	0	0	0	0	0	0.00	0.00
2	598	398	258	500	201	281	166	67	145.97	171.24
3	835	1080	468	786	852	752	540	336	515.06	542.88
4	953	448	834	472	755	678	385	388	466.07	483.57
5	645	445	449	606	293	376	333	325	343.69	344.40
6	130	526	366	250	362	163	202	203	188.33	189.30
7	74	164	293	224	179	184	66	127	115.59	125.73
8	50	116	113	185	130	105	74	49	72.47	75.98
9	58	61	80	85	110	71	37	70	57.05	59.48
10	63	54	45	56	55	67	50	21	41.06	45.99
11	14	35	24	31	27	39	35	33	35.91	36.00
+gp	61	85	96	87	99	89	65	77	76.60	77.22
Total	3482	3412	3027	3282	3062	2805	1955	1695	2102.68	2151.78
Landings	1078	1075	1039	1023	1015	908	701	688	759.39	765.67

Table 8.3.3 Sole VIIE Catch Weights at Age in kgs

Age	1969	1970	1971
1	0.000	0.000	0.113
2	0.188	0.187	0.151
3	0.245	0.223	0.222
4	0.332	0.294	0.296
5	0.329	0.314	0.367
6	0.367	0.354	0.350
7	0.522	0.434	0.359
8	0.455	0.498	0.431
9	0.463	0.442	0.455
10	0.606	0.512	0.476
11	0.647	0.528	0.388
+gp	0.660	0.593	0.653

Table 8.3.3 Sole VIIE Catch Weights at Age in kgs continued

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	0.000	0.000	0.144	0.142	0.139	0.118	0.000	0.000	0.000	0.000
2	0.194	0.203	0.183	0.181	0.170	0.197	0.180	0.187	0.189	0.174
3	0.227	0.224	0.224	0.214	0.217	0.248	0.241	0.237	0.254	0.226
4	0.272	0.262	0.281	0.299	0.286	0.302	0.303	0.327	0.343	0.322
5	0.369	0.310	0.379	0.358	0.323	0.356	0.390	0.423	0.389	0.382
6	0.408	0.381	0.434	0.403	0.390	0.399	0.439	0.460	0.525	0.478
7	0.458	0.414	0.372	0.435	0.454	0.502	0.377	0.468	0.560	0.515
8	0.495	0.459	0.464	0.497	0.413	0.463	0.486	0.477	0.609	0.534
9	0.402	0.466	0.475	0.591	0.475	0.517	0.489	0.565	0.646	0.599
10	0.454	0.537	0.487	0.651	0.478	0.484	0.488	0.522	0.655	0.620
11	0.508	0.654	0.474	0.535	0.583	0.552	0.540	0.569	0.600	0.710
+gp	0.600	0.561	0.731	0.676	0.628	0.681	0.670	0.725	0.783	0.661

Table 8.3.3 Sole VIIE Catch Weights at Age in kgs continued

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.120	0.000	0.088	0.000	0.106	0.098	0.091	0.110	0.158	0.105
2	0.213	0.188	0.209	0.162	0.174	0.174	0.170	0.167	0.216	0.182
3	0.208	0.251	0.242	0.225	0.237	0.245	0.244	0.222	0.270	0.255
4	0.276	0.272	0.304	0.296	0.297	0.310	0.312	0.275	0.322	0.323
5	0.345	0.307	0.379	0.358	0.354	0.370	0.375	0.326	0.370	0.386
6	0.424	0.390	0.389	0.389	0.407	0.425	0.432	0.375	0.416	0.445
7	0.495	0.419	0.478	0.469	0.456	0.474	0.484	0.422	0.458	0.499
8	0.507	0.475	0.539	0.520	0.502	0.518	0.531	0.467	0.498	0.549
9	0.520	0.532	0.559	0.531	0.544	0.557	0.572	0.510	0.534	0.594
10	0.523	0.610	0.601	0.519	0.583	0.590	0.608	0.551	0.567	0.634
11	0.561	0.553	0.722	0.584	0.618	0.618	0.639	0.590	0.597	0.669
+gp	0.659	0.667	0.639	0.817	0.703	0.665	0.694	0.692	0.664	0.742

Table 8.3.3 Sole VIIE Catch Weights at Age in kgs continued

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.088	0.000	0.122	0.133	0.164	0.000	0.000	0.158	0.141	0.000
2	0.166	0.146	0.183	0.192	0.214	0.186	0.191	0.208	0.201	0.203
3	0.238	0.209	0.241	0.248	0.262	0.244	0.247	0.257	0.257	0.245
4	0.305	0.268	0.295	0.301	0.308	0.300	0.300	0.303	0.309	0.287
5	0.366	0.324	0.347	0.351	0.354	0.354	0.350	0.347	0.357	0.326
6	0.423	0.376	0.396	0.397	0.399	0.406	0.397	0.389	0.400	0.365
7	0.474	0.425	0.442	0.441	0.442	0.455	0.441	0.429	0.440	0.402
8	0.520	0.470	0.484	0.481	0.484	0.503	0.482	0.467	0.475	0.438
9	0.561	0.513	0.524	0.518	0.524	0.548	0.520	0.502	0.507	0.472
10	0.597	0.551	0.561	0.552	0.564	0.592	0.555	0.535	0.534	0.505
11	0.627	0.587	0.595	0.583	0.602	0.633	0.586	0.566	0.557	0.537
+gp	0.684	0.672	0.671	0.652	0.695	0.734	0.661	0.636	0.645	0.615

Table 8.3.3 Sole VIIE Catch Weights at Age in kgs continued

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	mean 08-10
1	0.123	0.101	0.122	0.123	0.106	0.117	0.147	0.094	0.000	0.080
2	0.181	0.173	0.176	0.180	0.168	0.183	0.197	0.176	0.168	0.180
3	0.236	0.241	0.230	0.235	0.226	0.244	0.245	0.252	0.257	0.251
4	0.290	0.306	0.282	0.289	0.280	0.299	0.292	0.322	0.338	0.317
5	0.342	0.367	0.334	0.342	0.331	0.350	0.337	0.385	0.411	0.378
6	0.391	0.425	0.385	0.393	0.378	0.395	0.382	0.443	0.475	0.433
7	0.439	0.479	0.435	0.443	0.421	0.436	0.425	0.494	0.532	0.484
8	0.485	0.530	0.485	0.492	0.461	0.471	0.468	0.540	0.579	0.529
9	0.529	0.577	0.533	0.539	0.497	0.501	0.509	0.579	0.619	0.569
10	0.570	0.620	0.581	0.585	0.529	0.526	0.549	0.612	0.650	0.604
11	0.610	0.660	0.628	0.629	0.558	0.546	0.588	0.639	0.673	0.633
+gp	0.705	0.746	0.756	0.746	0.667	0.616	0.652	0.702	0.699	0.685

Table 8.3.4 Sole VIIE Stock Weights at Age in kgs

Age	1969	1970	1971
1	0.040	0.045	0.030
2	0.125	0.120	0.090
3	0.200	0.195	0.170
4	0.270	0.255	0.240
5	0.330	0.305	0.295
6	0.380	0.355	0.345
7	0.425	0.395	0.390
8	0.460	0.430	0.420
9	0.490	0.465	0.445
10	0.520	0.490	0.470
11	0.550	0.510	0.490
+gp	0.609	0.541	0.544

Table 8.3.4 Sole VIIE Stock Weights at Age in kgs continued

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	0.055	0.035	0.040	0.071	0.095	0.086	0.090	0.064	0.052	0.038
2	0.130	0.105	0.125	0.144	0.146	0.156	0.156	0.141	0.125	0.119
3	0.200	0.170	0.200	0.221	0.198	0.221	0.217	0.216	0.206	0.197
4	0.265	0.235	0.265	0.267	0.247	0.278	0.276	0.287	0.288	0.276
5	0.325	0.290	0.320	0.327	0.294	0.332	0.330	0.352	0.360	0.358
6	0.380	0.340	0.370	0.385	0.338	0.382	0.380	0.414	0.436	0.427
7	0.420	0.390	0.410	0.435	0.380	0.425	0.425	0.463	0.513	0.490
8	0.460	0.435	0.455	0.479	0.417	0.462	0.463	0.502	0.575	0.543
9	0.490	0.475	0.490	0.516	0.456	0.497	0.498	0.539	0.620	0.582
10	0.520	0.510	0.515	0.545	0.491	0.527	0.526	0.574	0.650	0.616
11	0.540	0.540	0.530	0.569	0.523	0.553	0.555	0.608	0.674	0.645
+gp	0.558	0.585	0.571	0.628	0.595	0.629	0.630	0.719	0.714	0.699

Table 8.3.4 Sole VIIE Stock Weights at Age in kgs continued

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.038	0.040	0.032	0.095	0.071	0.058	0.050	0.081	0.128	0.065
2	0.117	0.120	0.108	0.150	0.140	0.137	0.131	0.139	0.187	0.144
3	0.195	0.195	0.192	0.204	0.206	0.210	0.208	0.195	0.243	0.219
4	0.265	0.250	0.268	0.258	0.268	0.278	0.278	0.249	0.296	0.290
5	0.335	0.307	0.339	0.311	0.326	0.341	0.344	0.300	0.346	0.355
6	0.398	0.365	0.400	0.364	0.381	0.398	0.404	0.350	0.393	0.416
7	0.455	0.420	0.453	0.416	0.432	0.450	0.459	0.398	0.437	0.473
8	0.506	0.475	0.501	0.468	0.480	0.497	0.508	0.444	0.478	0.524
9	0.536	0.520	0.545	0.520	0.524	0.538	0.552	0.488	0.516	0.572
10	0.562	0.570	0.577	0.571	0.564	0.574	0.591	0.531	0.551	0.614
11	0.585	0.615	0.607	0.621	0.601	0.605	0.624	0.571	0.583	0.652
+gp	0.632	0.709	0.696	0.790	0.691	0.659	0.687	0.675	0.654	0.731

Table 8.3.4 Sole VIIE Stock Weights at Age in kgs continued

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.048	0.000	0.091	0.103	0.139	0.000	0.000	0.132	0.110	0.000
2	0.128	0.114	0.153	0.163	0.189	0.156	0.162	0.183	0.172	0.181
3	0.202	0.178	0.212	0.221	0.238	0.215	0.220	0.233	0.230	0.224
4	0.272	0.239	0.268	0.275	0.285	0.272	0.274	0.280	0.284	0.266
5	0.336	0.296	0.322	0.326	0.331	0.327	0.325	0.326	0.333	0.307
6	0.395	0.350	0.372	0.374	0.376	0.380	0.374	0.369	0.379	0.346
7	0.449	0.401	0.419	0.419	0.420	0.431	0.419	0.410	0.421	0.384
8	0.498	0.448	0.463	0.461	0.463	0.480	0.462	0.448	0.458	0.420
9	0.542	0.492	0.505	0.500	0.504	0.526	0.501	0.485	0.492	0.455
10	0.580	0.532	0.543	0.536	0.544	0.570	0.537	0.519	0.521	0.489
11	0.613	0.570	0.578	0.568	0.583	0.612	0.571	0.551	0.546	0.521
+gp	0.677	0.659	0.659	0.641	0.677	0.717	0.650	0.624	0.643	0.602

Table 8.3.4 Sole VIIE Stock Weights at Age in kgs continued

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	mean 08-10
1	0.094	0.063	0.095	0.094	0.074	0.083	0.122	0.051	0.000	0.058
2	0.152	0.137	0.149	0.152	0.138	0.151	0.172	0.136	0.121	0.143
3	0.209	0.207	0.203	0.208	0.197	0.214	0.221	0.215	0.214	0.217
4	0.263	0.274	0.256	0.263	0.254	0.272	0.268	0.287	0.299	0.285
5	0.316	0.337	0.308	0.316	0.306	0.325	0.315	0.354	0.376	0.348
6	0.367	0.396	0.360	0.368	0.355	0.373	0.360	0.415	0.444	0.406
7	0.415	0.452	0.410	0.419	0.400	0.416	0.404	0.469	0.505	0.459
8	0.462	0.505	0.460	0.468	0.442	0.454	0.447	0.518	0.557	0.507
9	0.507	0.554	0.509	0.516	0.479	0.486	0.489	0.560	0.600	0.550
10	0.550	0.599	0.557	0.562	0.514	0.514	0.529	0.596	0.636	0.587
11	0.591	0.641	0.605	0.607	0.544	0.536	0.569	0.626	0.663	0.619
+gp	0.688	0.732	0.734	0.726	0.661	0.614	0.640	0.698	0.696	0.678

Table 8.3.5 Sole VIIE Landings Length Frequency Distributions

Length	UK BeamTrawl	UK other	French Nets	French Trawl	French Trawl Mol
19	0	0	0	109	0
20	0	0	0	420	0
21	0	0	971	713	0
22	174	0	1359	0	0
23	57	81	0	707	0
24	1286	155	929	1541	18081
25	4400	595	3384	3792	10791
26	10687	2140	1262	9029	8121
27	17713	3792	6990	12953	16469
28	27118	4796	7393	12701	22936
29	34239	5708	9195	16605	34908
30	41375	6539	6311	24071	10410
31	50442	6696	7253	19048	11411
32	68265	8430	10557	16375	4672
33	74818	8709	7490	18869	6012
34	71855	10829	6987	18652	5733
35	67860	7483	6248	13277	9298
36	57578	8238	4033	8871	1669
37	48520	6151	2185	6173	2664
38	42409	4750	8567	10346	3109
39	31253	4448	2049	13405	5210
40	20049	3786	3556	9473	0
41	16144	2332	4787	6926	0
42	10635	5646	3131	9576	0
43	7464	1404	3034	1852	0
44	8257	2761	3341	5438	1551
45	5089	912	0	3050	0
46	2802	644	2208	288	0
47	1564	265	0	305	0
48	707	288	1189	300	0
49	497	251	679	0	0
50	117	29	846	0	0
51	216	42	251	1280	0
52	108	76	316	0	0
53	0	5	121601	244904	173044
54	10	0	0	1280	0
55	82	0	1189	0	0
56	0	0	0	0	0
57	0	0	0	0	0
58	0	0	0	0	0
59	0	0	0	0	0
Total	723790	107981	239291	492329	346089

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	1.24	1.52	2.01
1989	35.29	86.80	200.99	520.43	69.36	5.70	6.00	1.16	1.20	1.66
1990	36.35	78.51	238.56	474.06	43.72	6.56	6.04	0.73	1.38	1.67
1991	27.93	64.94	165.12	296.01	72.58	5.91	4.56	1.21	1.25	1.26
1992	29.47	61.95	169.31	291.50	78.13	5.74	4.70	1.31	1.21	1.30
1993	31.08	65.31	199.90	281.75	49.63	6.43	4.31	0.83	1.36	1.19
1994	34.77	73.47	189.29	317.87	40.66	5.44	4.33	0.68	1.15	1.20
1995	31.30	76.80	158.01	328.93	37.78	5.05	4.28	0.63	1.07	1.18
1996	33.16	94.91	164.71	300.93	48.72	4.97	3.17	0.82	1.05	0.88
1997	34.15	88.68	192.26	332.09	63.11	5.63	3.74	1.06	1.19	1.03
1998	43.41	83.09	186.94	306.70	65.83	4.31	3.69	1.10	0.91	1.02
1999	42.82	73.17	185.15	271.41	54.50	4.32	3.71	0.91	0.91	1.02
2000	49.07	79.58	202.29	250.02	51.94	4.12	3.14	0.87	0.87	0.87
2001	65.65	92.42	302.55	300.74	74.67	4.61	3.25	1.25	0.97	0.90
2002	61.55	92.19	293.79	298.56	43.18	4.77	3.24	0.72	1.01	0.89
2003	67.25	107.01	277.64	329.50	50.28	4.13	3.08	0.84	0.87	0.85
2004	56.25	108.64	206.17	239.23	57.99	3.67	2.20	0.97	0.77	0.61
2005	51.49	107.66	198.42	255.15	35.67	3.85	2.37	0.60	0.81	0.65
2006	50.87	110.87	225.31	238.63	49.10	4.43	2.15	0.82	0.93	0.59
2007	65.32	94.07	237.46	213.78	62.91	3.64	2.27	1.05	0.77	0.63
2008	76.21	83.37	222.79	170.25	73.55	2.92	2.04	1.23	0.62	0.56
2009	63.66	58.99	184.35	115.31	77.38	2.90	1.95	1.30	0.61	0.54
2010	74.52	54.00	202.08	93.77	99.20	2.71	1.74	1.66	0.57	0.48

Table 8.3.7 Fleet tuning information used in the assessment

W-CHANNEL SOLE 2011 WGCSE, 1-14, SEXES COMBINED,
105
UK-CBT
1988 2010
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
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
UK-COT
1988 2010
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

Table 8.3.7 Fleet tuning information used in the assessment (continued)

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

UK-WEC-BTS									
1988	2010								
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

Table 8.3.7 Fleet tuning information used in the assessment (continued)

UK-Inshore
1973 1987
1 1 0 1
2 14
15.76 28.3 142.9 145.8 28.7 28.7 33.8 4.9 15.2 8.4 1.0 8.4 12.7 1.2
12.58 17.2 117.7 67.5 51.6 18.0 19.3 11.0 8.2 5.8 12.0 3.1 4.8 2.9
12.84 30.0 163.3 41.9 45.1 21.2 4.8 10.0 4.9 3.7 3.7 7.0 3.8 5.2
12.58 63.6 137.5 139.9 44.9 32.6 21.4 11.4 14.4 11.7 2.9 3.7 16.0 4.6
14.01 169.7 106.7 114.5 57.4 24.3 15.8 18.1 2.5 5.3 6.4 3.5 4.5 8.2
22.31 117.8 449.7 124.4 72.1 54.5 28.5 21.1 22.5 10.4 6.7 5.8 5.9 3.5
31.15 114.2 342.9 310.5 89.6 70.2 51.1 32.4 28.1 30.2 7.3 6.8 17.3 3.6
42.40 131.4 322.7 221.1 257.7 36.9 46.3 37.1 18.1 13.7 32.5 9.2 7.6 8.9
46.36 161.9 478.9 320.6 190.5 123.1 52.6 37.8 22.1 15.7 12.1 11.3 3.4 3.7
51.68 86.0 857.6 442.0 215.7 113.5 70.6 43.0 33.6 22.2 16.7 10.3 8.2 7.6
51.09 76.8 353.4 623.5 210.6 80.1 78.3 94.1 33.8 26.4 5.3 6.5 34.8 5.1
48.21 177.7 280.2 309.0 257.0 88.6 43.9 39.6 38.1 8.5 5.9 13.9 17.5 4.0
54.87 57.7 598.4 320.7 168.7 198.1 37.2 29.9 45.9 32.4 17.7 7.6 4.2 5.6
53.46 103.2 823.1 361.7 111.3 82.9 87.1 23.2 9.3 7.6 17.8 4.2 5.1 9.4
35.61 116.6 183.2 269.3 93.4 17.1 16.7 32.0 5.9 9.0 3.6 7.8 4.5 5.2

UK-Offshore
1973 1987
1 1 0 1
3 14
5.64 24.6 37.3 8.9 13.0 16.8 2.1 6.6 4.3 0.7 4.3 4.3 0.7
6.72 30.3 25.7 23.8 12.2 14.4 7.1 5.4 4.5 11.3 2.3 2.4 2.4
13.94 85.2 32.5 42.1 29.2 7.3 13.1 6.4 5.8 6.9 10.8 3.8 8.7
7.36 38.6 58.4 22.7 24.2 17.3 8.1 10.2 9.8 2.9 3.0 8.8 4.2
9.88 36.1 57.7 34.9 21.7 15.5 15.3 2.1 5.3 7.9 3.5 3.0 8.8
14.50 140.5 57.7 40.4 44.9 25.8 16.6 17.9 9.7 7.7 5.3 3.6 3.5
20.38 107.9 145.1 50.6 58.2 46.4 25.5 22.4 28.3 8.3 6.3 10.6 3.7
28.18 103.1 104.9 147.7 31.1 42.7 29.7 14.7 13.0 37.9 8.8 4.7 9.0
28.75 142.8 142.1 101.9 96.6 45.3 28.2 16.7 13.9 13.1 10.0 2.0 3.5
39.85 317.9 243.4 143.3 110.7 75.7 39.9 31.6 24.5 22.5 11.3 5.9 9.0
66.45 104.1 433.6 167.6 116.5 100.9 104.4 47.8 27.7 19.8 9.2 18.7 10.2
49.07 152.8 234.7 214.8 133.2 69.9 22.9 54.3 28.5 7.8 29.7 8.2 6.7
47.15 245.2 130.3 110.8 211.1 75.6 26.7 31.6 15.5 7.1 0.0 7.9 6.8
34.66 425.5 215.7 100.2 79.1 70.0 15.2 7.9 30.1 28.6 5.3 13.7 7.6
47.41 158.4 344.2 138.8 53.3 50.7 95.7 22.7 19.0 26.1 13.8 14.2 14.6

Updated sk 10/5/10 QA IDH 10/5/10
updated idh 4/5/11

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics
FLR XSA Diagnostics 2011-05-19 16:11:26

CPUE data from index.final
Catch data for 42 years. 1969 to 2010. Ages 1 to 12.

fleet	first age	last age	first year	last year	alpha	beta
UK-CBT	3	11	1988	2010	0	1
UK-COT	3	11	1988	2010	0	1
UK-WEC-BTS	1	9	1988	2010	0.75	0.8
UK-Inshore	2	11	1973	1987	0	1
UK-Offshore	3	11	1973	1987	0	1

Time series weights :
Tapered time weighting not applied

Catchability analysis :
Catchability independent of size for all ages
Catchability independent of age for ages >7

Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 10 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 = 0.5

Regression weights
Year

2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	1	1	1	1	1	1	1	1	1

Estimated population abundance at 1st Jan 2011
Age

1	2	3	4	5	6	7	8	9	10	11	12
0	8060	2299	1299	1316	1112	754	403	168	203	57	109

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

XSA fleet diagnostics for UK-CBT

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
3	0.510	0.397	0.470	0.159	0.434	0.274	0.431	-0.191	-0.414	0.286	0.082	0.192	-0.106	0.063	0.194	-0.093	-0.268	-0.334	-0.253	-0.037	-0.370	-0.447	-0.980
4	0.421	0.522	0.439	0.243	0.269	0.334	0.271	0.441	-0.127	0.287	0.039	-0.020	0.088	-0.181	-0.294	-0.018	-0.551	-0.364	-0.302	-0.297	-0.289	-0.504	-0.407
5	0.494	0.531	0.407	0.434	0.203	0.521	0.055	0.276	-0.055	0.273	0.026	0.002	-0.013	0.086	-0.262	-0.134	-0.633	-0.455	-0.242	-0.289	-0.541	-0.311	-0.375
6	0.573	0.528	0.668	0.382	-0.327	0.335	-0.110	0.078	-0.006	-0.125	0.361	0.069	-0.108	0.118	0.222	-0.852	-0.071	-0.195	-0.378	-0.432	-0.170	-0.202	-0.357
7	0.139	0.444	0.442	0.202	0.162	0.393	0.103	0.382	-0.134	0.311	0.203	0.165	-0.313	0.073	0.095	-0.454	-0.960	-0.043	-0.062	-0.109	-0.299	-0.421	-0.319
8	0.294	0.187	0.443	0.162	0.007	0.133	-0.290	0.450	0.051	-0.140	-0.110	0.183	-0.025	-0.081	0.060	-0.436	-0.144	-0.705	0.218	-0.029	0.346	-0.493	-0.083
9	0.207	0.323	0.694	0.574	-0.029	0.398	0.175	0.073	0.201	-0.065	-0.177	-0.340	0.149	0.252	-0.406	0.134	-0.323	-0.015	-0.012	0.021	-0.085	-0.058	-0.404
10	-0.329	0.152	0.387	0.411	-0.306	-0.095	0.495	-0.163	0.051	-0.621	0.030	-0.102	-0.112	0.090	-0.127	-0.060	-0.150	0.086	-0.021	-0.321	0.110	-0.422	-0.151
11	0.544	0.654	0.125	0.105	-0.022	0.341	0.008	-0.112	0.114	0.233	0.209	-0.079	0.046	0.014	-0.082	-0.214	0.205	0.053	-0.018	-0.055	0.190	-0.331	-0.065

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	-6.8195	-6.6135	-6.6083	-6.6717	-6.7688	-6.8413	-6.8413	-6.8413	-6.8413
S.ELogq	0.3727	0.3371	0.352	0.3666	0.3436	0.2901	0.2876	0.2654	0.2234

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
3	0.338	0.051	0.261	0.091	0.116	-0.030	0.142	-0.333	0.028	0.380	0.043	0.144	-0.302	0.063	-0.249	-0.466	-0.579	0.361	0.009	0.191	-0.079	0.361	-0.542
4	0.332	0.235	0.225	-0.138	-0.161	0.009	0.196	0.283	0.241	0.131	0.071	-0.003	0.021	-0.285	-0.625	-0.314	-0.757	0.378	0.005	0.039	-0.029	0.058	0.087
5	0.379	0.301	0.199	-0.196	-0.354	0.217	0.128	0.118	0.105	0.299	-0.016	0.178	-0.039	0.005	-0.498	-0.339	-0.814	0.219	0.061	0.122	-0.277	0.129	0.073
6	0.428	0.372	0.472	-0.351	-1.031	0.061	-0.040	-0.093	0.028	0.006	0.286	0.161	-0.098	0.077	0.077	-0.802	-0.231	0.468	-0.159	-0.006	0.105	0.163	0.108
7	-0.077	0.399	0.173	-0.636	-0.625	0.136	0.313	0.211	-0.058	0.375	-0.028	0.430	-0.322	0.149	0.020	-0.441	-1.191	0.601	0.107	0.299	0.041	-0.034	0.159
8	0.072	0.307	0.136	-0.542	-0.937	-0.146	-0.144	0.251	0.120	-0.108	-0.235	0.497	-0.112	-0.034	-0.130	-0.437	-0.437	-0.047	0.449	0.393	0.640	0.050	0.394
9	-0.288	0.430	0.544	-0.770	-1.036	0.139	0.299	-0.091	0.123	-0.047	-0.249	-0.067	0.210	0.489	-0.673	-0.038	-0.601	0.668	0.200	0.405	0.277	0.487	0.083
10	-0.976	0.163	0.174	-0.211	-1.302	-0.426	0.621	-0.285	0.093	-0.629	-0.281	0.193	-0.037	0.197	-0.116	-0.220	-0.391	0.692	0.102	0.120	0.502	0.215	0.451
11	0.167	0.778	-0.149	-0.682	-1.304	0.215	0.155	-0.367	0.040	-0.056	0.230	0.371	0.032	0.146	-0.055	-0.036	0.013	0.882	0.112	0.198	0.683	0.359	0.506

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	-15.9672	-15.8515	-15.8784	-15.926	-16.0254	-16.0751	-16.0751	-16.0751	-16.0751
S.ELogq	0.2871	0.2828	0.2891	0.3608	0.4106	0.3731	0.4518	0.4816	0.4628

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
1	-1.192	-0.264	0.282	0.161	-0.625	-0.205	-0.467	0.311	1.200	-0.017	0.209	-0.415	-0.098	-0.010	-0.812	1.255	0.575	-0.352	-0.634	-0.132	0.656	0.574	0.000
2	-0.562	-0.446	-0.296	0.245	0.217	-0.575	-0.434	-0.949	0.065	0.368	0.160	0.022	-0.239	0.316	-0.951	0.187	0.560	0.014	0.045	0.639	0.056	0.660	0.897
3	0.208	0.333	-0.160	0.061	0.379	-0.005	-0.042	-0.541	-0.481	0.165	0.168	0.016	-0.334	-0.080	-0.270	-0.460	-0.073	-0.642	-0.167	0.157	0.456	0.395	0.916
4	0.368	0.680	-0.307	0.188	0.020	0.029	-0.030	-0.113	-0.442	-0.177	0.353	-0.039	-0.092	0.075	-0.632	-0.257	-0.609	-0.277	-0.275	-0.001	0.364	0.592	0.581
5	0.799	0.477	-0.029	0.084	0.352	-0.350	-0.310	-0.124	0.296	-0.308	-0.176	-0.171	-0.020	0.156	0.107	-0.853	-0.763	-0.679	0.131	-0.353	0.527	0.560	0.645
6	0.758	0.757	-0.285	0.673	-0.042	-0.106	-0.755	0.156	0.390	0.333	0.226	-0.396	0.283	0.211	-0.589	-1.069	-0.613	-0.295	0.026	0.567	-1.169	0.183	0.756
7	NA	0.721	0.130	-0.252	-0.233	0.062	-0.551	-0.502	-0.114	0.378	0.582	-0.240	-0.497	0.438	-0.761	-0.638	0.712	-0.794	-0.385	-0.594	0.558	1.065	0.915
8	0.938	0.113	-0.450	0.707	0.034	-0.607	-1.141	0.056	-0.291	0.118	0.060	-0.140	0.011	-0.222	-0.812	0.406	0.726	-0.958	0.199	-0.671	0.198	0.874	0.852
9	-0.518	0.609	0.810	0.303	0.409	-0.069	-0.365	0.177	-0.445	0.558	-0.130	-0.053	0.568	-0.583	NA	-1.058	0.413	0.271	NA	-1.525	0.436	-0.389	1.197

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	-11.2138	-8.6941	-8.3129	-8.6038	-8.8514	-9.2144	-9.1927	-9.3017	-9.3017
S.ELogq	0.5983	0.4936	0.3683	0.3643	0.4488	0.5692	0.5819	0.5927	0.6465

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

XSA fleet diagnostics for UK-Inshore

Fleet q-residuals

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
2	0.186	-0.407	0.200	1.055	1.102	0.617	0.325	0.057	-0.377	-0.569	-0.458	-0.002	-1.439	-0.204	-0.085
3	0.361	0.483	0.477	0.380	0.105	0.300	0.035	-0.295	-0.070	-0.150	-0.490	-0.444	-0.145	-0.043	-0.506
4	0.271	0.098	-0.324	0.680	0.376	0.060	-0.074	-0.400	-0.077	0.139	-0.057	-0.206	-0.038	-0.108	-0.338
5	0.145	-0.029	0.193	0.258	0.262	0.003	-0.030	0.049	-0.040	0.100	0.182	-0.173	-0.261	-0.322	-0.335
6	0.231	0.482	-0.410	0.486	0.104	0.360	0.280	-0.613	-0.085	0.057	-0.072	0.223	0.198	-0.213	-1.029
7	0.561	0.414	-0.521	-0.067	0.013	0.163	0.419	0.045	0.087	-0.293	0.259	-0.021	-0.165	-0.028	-0.868
8	-0.423	-0.156	-0.083	0.538	-0.195	0.017	0.199	0.134	0.099	0.132	0.359	0.016	-0.166	-0.239	-0.231
9	0.369	0.511	-0.826	0.523	-0.895	-0.257	0.233	-0.410	-0.105	0.301	0.361	-0.048	0.415	-0.948	-0.879
10	-0.571	-0.168	-0.081	0.245	-0.378	0.270	-0.068	-0.505	-0.363	0.187	0.564	-0.494	0.033	-0.899	-0.206
11	-0.180	0.193	-0.459	-0.103	-0.264	-0.426	-0.147	0.017	-0.422	-0.073	-0.816	-0.446	0.484	-0.168	-0.772

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	-7.3062	-5.7419	-5.7276	-5.9861	-6.3205	-6.452	-6.4199	-6.4199	-6.4199	-6.4199
S.ELogq	0.6466	0.3453	0.2878	0.1993	0.422	0.3692	0.2521	0.5567	0.3857	0.3397

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

XSA fleet diagnostics for UK-Offshore

Fleet q-residuals

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
3	0.352	0.475	0.467	0.368	0.093	0.290	0.025	-0.305	-0.080	-0.160	-1.253	-0.346	-0.163	0.453	-0.216
4	0.279	0.104	-0.317	0.686	0.384	0.066	-0.067	-0.393	-0.069	0.147	-0.339	-0.155	-0.443	0.152	-0.035
5	0.135	-0.043	0.175	0.245	0.246	-0.012	-0.044	0.034	-0.055	0.084	-0.176	-0.237	-0.397	0.139	-0.092
6	0.178	0.432	-0.460	0.436	0.052	0.309	0.229	-0.663	-0.138	0.004	-0.248	0.325	0.125	-0.114	-0.467
7	0.514	0.373	-0.559	-0.119	-0.033	0.119	0.371	-0.003	0.040	-0.339	-0.126	0.051	0.320	-0.188	-0.419
8	-0.376	-0.100	-0.028	0.599	-0.147	0.074	0.250	0.187	0.151	0.184	0.067	-0.683	-0.261	-0.361	0.445
9	0.429	0.587	-0.775	0.581	-0.853	-0.188	0.298	-0.343	-0.041	0.366	0.312	0.156	0.060	-0.811	0.049
10	-0.347	0.072	0.153	0.471	-0.162	0.498	0.158	-0.282	-0.140	0.413	0.216	0.565	-0.686	0.777	0.122
11	0.357	0.626	-0.051	0.300	0.162	0.011	0.273	0.446	0.002	0.352	0.105	-0.318	-0.411	0.607	0.790

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	-6.4641	-6.0716	-6.119	-6.0324	-6.0763	-6.2867	-6.2867	-6.2867	-6.2867
S.ELogq	0.4543	0.3112	0.1808	0.3426	0.3084	0.3338	0.4896	0.3938	0.3386

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2009 at terminal Age 1

Source	Age 1
fshk	1
	0.0000
UK-CBT	1
	0.0000
UK-COT	1
	0.0000
UK-WEC-BTS	8060
	2.6773

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	NaN	NA	NA	NA	0	NA	0.000
UK-CBT	NaN	NA	NA	NA	0	NA	0.000
UK-COT	NaN	NA	NA	NA	0	NA	0.000
UK-WEC-BTS	8060	0.611	NaN	NaN	1	1.000	0.000

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
8060	0.611	Inf	1	Var Ratio	0.000

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2008 at terminal Age 2

Source	Age 1	Age 2
fshk	1	670
	0.0000	4.0000
UK-CBT	1	1
	0.0000	0.0000
UK-COT	1	1
	0.0000	0.0000
UK-WEC-BTS	4083	5641
	2.6054	3.8276

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	670	0.493	NaN	NaN	1	0.383	0.090
UK-CBT	NaN	NA	NA	NA	0	NA	0.000
UK-COT	NaN	NA	NA	NA	0	NA	0.000
UK-WEC-BTS	4949	0.389	0.159	0.408	2	0.617	0.013

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
2299	0.305	1.056	3	Var Ratio	0.027

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2007 at terminal Age 3

Source	Age 1	Age 2	Age 3
fshk	1	1	948
	0.0000	0.0000	4.0000
UK-CBT	1	1	487
	0.0000	0.0000	3.2099
UK-COT	1	1	756
	0.0000	0.0000	3.2099
UK-WEC-BTS	2505	2513	3247
	1.9742	2.9002	3.2099

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	948	0.448	NaN	NaN	1	0.216	0.290
UK-CBT	487	0.500	NaN	NaN	1	0.173	0.503
UK-COT	756	0.500	Inf	Inf	1	0.173	0.352
UK-WEC-BTS	2780	0.307	0.089	0.290	3	0.437	0.109

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
1299	0.206	0.308	6	Var Ratio	0.220

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2006 at terminal Age 4

Source	Age 1	Age 2	Age 3	Age 4
fshk	1	1	1	905
	0.0000	0.0000	0.0000	4.0000
UK-CBT	1	1	842	876
	0.0000	0.0000	2.4487	3.1243
UK-COT	1	1	1888	1436
	0.0000	0.0000	2.4487	3.1243
UK-WEC-BTS	1154	1392	1953	2355
	1.4875	2.1853	2.4487	3.1243

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	905	0.442	NaN	NaN	1	0.164	0.341
UK-CBT	861	0.356	0.020	0.056	2	0.228	0.356
UK-COT	1619	0.356	0.136	0.382	2	0.228	0.205
UK-WEC-BTS	1765	0.264	0.156	0.590	4	0.379	0.190

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
1316	0.169	0.141	9	Var Ratio	0.247

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2005 at terminal Age 5

Source	Age 1	Age 2	Age 3	Age 4	Age 5
fshk	1	1	1	1	705
	0.0000	0.0000	0.0000	0.0000	4.0000
UK-CBT	1	1	768	672	764
	0.0000	0.0000	1.9023	2.5383	3.1306
UK-COT	1	1	1027	1178	1196
	0.0000	0.0000	1.9023	2.5383	3.1306
UK-WEC-BTS	590	2107	1755	2010	2119
	1.2006	1.7637	1.9023	2.5383	3.1306

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	705	0.442	NaN	NaN	1	0.135	0.362
UK-CBT	733	0.294	0.044	0.149	3	0.255	0.351
UK-COT	1145	0.294	0.045	0.152	3	0.255	0.238
UK-WEC-BTS	1746	0.238	0.197	0.829	5	0.355	0.163

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
1112	0.148	0.143	12	Var Ratio	0.245

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2004 at terminal Age 6

Source	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
fshk	1	1	1	1	1	438
	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
UK-CBT	1	1	727	565	553	528
	0.0000	0.0000	1.2776	1.7130	2.4458	3.1858
UK-COT	1	1	913	733	858	840
	0.0000	0.0000	1.2776	1.7130	2.4458	3.1858
UK-WEC-BTS	531	789	883	1086	1321	1607
	0.7534	1.1068	1.2776	1.7130	2.4458	2.3561

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	438	0.446	NaN	NaN	1	0.129	0.364
UK-CBT	569	0.264	0.061	0.232	4	0.279	0.291
UK-COT	833	0.264	0.040	0.151	4	0.279	0.208
UK-WEC-BTS	1114	0.233	0.144	0.620	6	0.312	0.159

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
754	0.139	0.126	15	Var Ratio	0.227

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2003 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	319
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
UK-CBT	1	1	313	300	235	330	293
	0.0000	0.0000	0.7969	1.0591	1.6277	2.3093	3.0767
UK-COT	1	1	407	419	306	475	473
	0.0000	0.0000	0.7969	1.0591	1.6277	2.3093	3.0767
UK-WEC-BTS	716	409	341	403	683	484	1007
	0.4968	0.7299	0.7969	1.0591	1.6277	1.7080	2.1726

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	319	0.439	NaN	NaN	1	0.132	0.321
UK-CBT	293	0.247	0.057	0.231	5	0.292	0.345
UK-COT	425	0.247	0.083	0.334	5	0.292	0.250
UK-WEC-BTS	593	0.232	0.155	0.665	7	0.283	0.185

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
403	0.135	0.078	18	Var Ratio	0.262

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2002 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	122
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
UK-CBT	1	1	120	124	126	142	110	155
	0.0000	0.0000	0.5724	0.7433	1.1133	1.6895	2.4782	3.1335
UK-COT	1	1	241	169	190	187	163	249
	0.0000	0.0000	0.5724	0.7433	1.1133	1.6895	2.4782	3.1335
UK-WEC-BTS	590	295	89	128	118	52	488	395
	0.3256	0.4784	0.5724	0.7433	1.1133	1.2496	1.7500	2.1372

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	122	0.443	NaN	NaN	1	0.126	0.322
UK-CBT	132	0.235	0.061	0.257	6	0.306	0.300
UK-COT	200	0.235	0.080	0.340	6	0.306	0.209
UK-WEC-BTS	212	0.236	0.317	1.341	8	0.263	0.198

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
168	0.131	0.098	21	Var Ratio	0.244

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2001 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	156
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
UK-CBT	1	1	155	141	159	131	150	124	135
	0.0000	0.0000	0.3746	0.5066	0.7249	1.1079	1.7015	2.4338	3.0121
UK-COT	1	1	114	296	215	201	211	213	220
	0.0000	0.0000	0.3746	0.5066	0.7249	1.1079	1.7015	2.4338	3.0121
UK-WEC-BTS	90	244	188	154	231	357	354	485	670
	0.2217	0.3258	0.3746	0.5066	0.7249	0.8194	1.2015	1.6600	1.7160

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	156	0.434	NaN	NaN	1	0.128	0.353
UK-CBT	137	0.227	0.033	0.145	7	0.315	0.394
UK-COT	212	0.227	0.060	0.262	7	0.315	0.272
UK-WEC-BTS	365	0.241	0.180	0.746	9	0.241	0.167

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
203	0.129	0.08	24	Var Ratio	0.283

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 2000 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	42
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
UK-CBT	1	1	52	33	36	39	51	81	54	49
	0.0000	0.0000	0.1681	0.2365	0.3117	0.4814	0.7242	1.2033	2.1046	2.9834
UK-COT	1	1	36	27	71	49	77	109	93	90
	0.0000	0.0000	0.1681	0.2365	0.3117	0.4814	0.7242	1.2033	2.1046	2.9834
UK-WEC-BTS	57	22	36	31	29	59	32	70	39	1
	0.1019	0.1497	0.1681	0.2365	0.3117	0.3560	0.5114	0.8207	1.1990	0.0000

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	42	0.432	NaN	NaN	1	0.165	0.378
UK-CBT	53	0.241	0.081	0.334	8	0.338	0.315
UK-COT	84	0.241	0.110	0.457	8	0.338	0.210
UK-WEC-BTS	42	0.268	0.119	0.445	9	0.159	0.379

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
57	0.142	0.068	26	Var Ratio	0.292

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

Year Class 1999 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	106
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
UK-CBT	1	1	132	107	58	90	102	106	100	71	102
	0.0000	0.0000	0.2290	0.3186	0.4751	0.6362	0.9199	1.3165	1.8204	2.3710	3.0969
UK-COT	1	1	85	79	48	174	121	161	144	135	181
	0.0000	0.0000	0.2290	0.3186	0.4751	0.6362	0.9199	1.3165	1.8204	2.3710	3.0969
UK-WEC-BTS	99	149	83	84	51	81	74	56	168	1	1
	0.1489	0.2187	0.2290	0.3186	0.4751	0.4706	0.6496	0.8979	1.0371	0.0000	0.0000

Source	Survivors	int s.e.	ext s.e.	Var Ratio	N	Scaled W	F est.
fshk	106	0.440	NaN	NaN	1	0.130	0.262
UK-CBT	92	0.209	0.065	0.309	9	0.363	0.295
UK-COT	142	0.209	0.105	0.500	9	0.363	0.202
UK-WEC-BTS	87	0.237	0.155	0.655	9	0.144	0.310

term. Surv.	int s.e.	ext s.e.	N	Var. Ratio	F
109	0.126	0.044	28	Var Ratio	0.255

Table 8.3.9 Sole VIIE Stock Numbers at Age in 000's

Age	1969	1970	1971	1972	1973
1	1610	3976	2955	2619	3580
2	2180	1456	3597	2674	2370
3	2438	1888	1267	3207	2281
4	761	1900	1488	956	2510
5	1072	613	1413	1112	706
6	1672	829	470	1090	897
7	181	1313	671	363	879
8	583	143	1081	531	315
9	667	481	118	831	457
10	298	580	402	97	625
11	102	250	475	331	51
+gp	720	1291	982	653	1697
Total	12284	14721	14919	14464	16367

Table 8.3.9 Sole VIIE Stock Numbers at Age in 000's continued

Age	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	3357	3143	7206	5072	4714	5164	8948	5157	4165	6581
2	3240	3038	2843	6520	4589	4266	4673	8096	4666	3769
3	2076	2889	2671	2414	5495	3914	3644	4061	7093	4101
4	1687	1547	2074	2018	1881	3903	2778	2765	2908	5038
5	1859	1317	1238	1428	1461	1373	2760	2041	1883	1760
6	554	1513	1002	967	1096	1118	1005	1898	1403	1177
7	717	434	1260	778	777	812	794	789	1348	935
8	681	574	366	1052	638	605	570	545	544	992
9	269	576	469	287	882	509	450	382	373	363
10	365	213	497	368	250	725	375	345	274	230
11	536	307	172	401	311	190	557	286	257	171
+gp	1035	2171	2632	1996	2311	1975	1458	1101	1242	1211
Total	16378	17720	22430	23301	24406	24554	28010	27468	26156	26328

Table 8.3.9 Sole VIIE Stock Numbers at Age in 000's continued

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	7838	4237	6451	4208	4118	3148	7912	4371	3806	2598
2	5955	7092	3834	5837	3807	3726	2849	7159	3955	3443
3	3324	5071	6144	3235	4818	3024	3001	2253	6050	3279
4	2995	2377	2971	4021	2158	2992	1907	1857	1644	4110
5	3062	1924	1432	1765	2601	1386	1535	1173	1221	1091
6	1038	2050	1295	895	1191	1661	782	863	786	823
7	731	630	1299	866	616	721	1019	476	571	602
8	592	468	401	855	571	412	438	670	342	410
9	617	412	331	283	556	363	268	261	501	251
10	216	414	275	227	211	399	226	145	171	383
11	139	144	294	163	158	154	254	134	96	131
+gp	1241	624	504	645	541	689	701	631	374	331
Total	27748	25444	25230	23001	21346	18675	20892	19992	19518	17453

Table 8.3.9 Sole VIIE Stock Numbers at Age in 000's continued

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	3723	4390	3666	4856	3854	7102	5881	4093	6015	3079
2	2351	3369	3972	3317	4393	3487	6426	5321	3704	5442
3	2917	2035	2958	3247	2796	3723	2889	5523	4677	3036
4	2298	2014	1548	2253	2147	1954	2499	2044	3665	3042
5	2666	1548	1224	1054	1351	1433	1292	1547	1344	2514
6	654	1881	994	825	645	902	918	820	927	849
7	536	485	1311	676	575	384	573	612	488	532
8	401	384	314	942	427	377	239	417	385	319
9	297	316	252	220	688	311	243	166	282	248
10	171	214	228	170	157	501	230	156	98	166
11	294	112	162	159	134	109	351	159	100	57
+gp	576	862	633	349	630	541	365	598	463	255
Total	16881	17609	17263	18068	17798	20823	21906	21457	22146	19538

Table 8.3.9 Sole VIIE Stock Numbers at Age in 000's continued

Age	2004	2005	2006	2007	2008	2009	2010	2011 survivors	geom mean 04-10	arith mean 04-10
1	4377	4885	4088	3534	2379	2886	4301[a]	0	4082	4437
2	2786	3960	4420	3699	3198	2152	2611	3891	3173	3261
3	4355	2142	3338	3524	3156	2626	1790	2299	2876	2990
4	1952	2914	1493	2273	2378	2140	1863	1299	2105	2145
5	1845	1340	1843	902	1338	1507	1570	1316	1443	1478
6	1662	1247	785	1091	538	853	1047	1112	977	1032
7	644	1003	780	472	643	332	580	754	604	636
8	411	426	629	493	257	407	237	403	389	409
9	241	261	278	394	323	133	297	168	263	275
10	170	160	160	171	252	224	85	203	167	175
11	90	102	103	92	102	163	155	57	112	115
+gp	216	403	286	341	229	302	359	360	298	305
Total	18748	18844	18203	16985	14791	13726	19501			

[a] XSA estimate (8907) replaced with GM recruitment69-08

Table 8.3.10 Sole VIIE Fishing Mortality at Age

Age	1969	1970	1971
1	0.000	0.000	0.000
2	0.044	0.039	0.015
3	0.149	0.138	0.182
4	0.117	0.196	0.191
5	0.157	0.167	0.159
6	0.141	0.111	0.157
7	0.132	0.094	0.134
8	0.094	0.099	0.164
9	0.041	0.079	0.092
10	0.074	0.099	0.095
11	0.096	0.096	0.129
+gp	0.096	0.096	0.129
Fbar3-9	0.119	0.126	0.154

Table 8.3.10 Sole VIIE Fishing Mortality at Age continued

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.059	0.032	0.015	0.029	0.064	0.071	0.059	0.058	0.040	0.032
3	0.145	0.202	0.194	0.231	0.180	0.149	0.242	0.243	0.176	0.234
4	0.203	0.200	0.147	0.123	0.273	0.223	0.215	0.247	0.208	0.285
5	0.115	0.142	0.106	0.173	0.147	0.164	0.167	0.212	0.274	0.275
6	0.115	0.123	0.145	0.083	0.153	0.118	0.200	0.242	0.141	0.242
7	0.042	0.155	0.124	0.069	0.080	0.099	0.150	0.254	0.277	0.272
8	0.050	0.057	0.068	0.102	0.143	0.077	0.126	0.197	0.299	0.280
9	0.185	0.126	0.134	0.048	0.141	0.038	0.096	0.205	0.164	0.233
10	0.540	0.052	0.073	0.114	0.115	0.070	0.175	0.164	0.170	0.195
11	0.187	0.088	0.114	0.086	0.089	0.087	0.097	0.167	0.282	0.224
+gp	0.187	0.088	0.114	0.086	0.089	0.087	0.097	0.167	0.282	0.224
Fbar3-9	0.122	0.144	0.131	0.118	0.160	0.124	0.171	0.229	0.220	0.260

Table 8.3.10 Sole VIIE Fishing Mortality at Age continued

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.029	0.026	0.061	0.043	0.070	0.092	0.130	0.117	0.135	0.068
3	0.242	0.214	0.235	0.435	0.324	0.305	0.376	0.361	0.380	0.215
4	0.402	0.398	0.343	0.407	0.421	0.336	0.343	0.568	0.386	0.319
5	0.370	0.428	0.301	0.296	0.369	0.294	0.348	0.473	0.476	0.300
6	0.306	0.376	0.399	0.356	0.302	0.274	0.401	0.389	0.397	0.312
7	0.207	0.358	0.347	0.354	0.318	0.317	0.303	0.398	0.319	0.230
8	0.305	0.374	0.261	0.247	0.249	0.330	0.354	0.329	0.419	0.191
9	0.383	0.421	0.299	0.304	0.274	0.193	0.231	0.371	0.515	0.320
10	0.370	0.405	0.306	0.242	0.421	0.262	0.215	0.353	0.427	0.311
11	0.285	0.257	0.242	0.236	0.307	0.306	0.402	0.393	0.432	0.276
+gp	0.285	0.257	0.242	0.236	0.307	0.306	0.402	0.393	0.432	0.276
Fbar$_{3\text{-}9}$	0.316	0.367	0.312	0.343	0.322	0.293	0.337	0.413	0.413	0.270

Table 8.3.10 Sole VIIE Fishing Mortality at Age continued

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.088	0.066	0.044	0.030	0.102	0.071	0.066	0.088	0.052	0.029
3	0.287	0.256	0.270	0.173	0.172	0.314	0.258	0.299	0.246	0.310
4	0.310	0.333	0.295	0.398	0.284	0.412	0.305	0.313	0.380	0.319
5	0.295	0.412	0.248	0.343	0.295	0.392	0.304	0.345	0.355	0.412
6	0.167	0.329	0.199	0.261	0.285	0.260	0.417	0.353	0.305	0.420
7	0.232	0.307	0.233	0.333	0.231	0.359	0.323	0.375	0.219	0.364
8	0.208	0.224	0.139	0.322	0.258	0.214	0.219	0.338	0.264	0.292
9	0.168	0.287	0.228	0.227	0.294	0.234	0.216	0.202	0.346	0.429
10	0.173	0.166	0.318	0.175	0.256	0.135	0.265	0.255	0.265	0.343
11	0.290	0.286	0.198	0.189	0.271	0.307	0.314	0.272	0.303	0.327
+gp	0.290	0.286	0.198	0.189	0.271	0.307	0.314	0.272	0.303	0.327
Fbar$_{3\text{-}9}$	0.238	0.307	0.230	0.294	0.260	0.312	0.292	0.318	0.302	0.364

Table 8.3.10 Sole VIIE Fishing Mortality at Age continued

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	mean $F_{08\text{-}10}$
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.099	0.123	0.163	0.071	0.127	0.059	0.097	0.085	0.027	0.070
3	0.330	0.341	0.302	0.261	0.284	0.293	0.288	0.244	0.220	0.251
4	0.277	0.400	0.276	0.358	0.404	0.430	0.356	0.210	0.247	0.271
5	0.360	0.314	0.292	0.435	0.424	0.417	0.350	0.264	0.245	0.286
6	0.455	0.176	0.404	0.369	0.408	0.429	0.383	0.287	0.228	0.299
7	0.325	0.159	0.312	0.367	0.358	0.508	0.358	0.235	0.262	0.285
8	0.339	0.179	0.353	0.328	0.369	0.324	0.559	0.213	0.244	0.339
9	0.431	0.281	0.307	0.388	0.389	0.348	0.264	0.349	0.284	0.299
10	0.432	0.513	0.410	0.347	0.454	0.419	0.331	0.267	0.293	0.297
11	0.215	0.292	0.532	0.288	0.383	0.362	0.524	0.257	0.256	0.346
+gp	0.215	0.292	0.532	0.288	0.383	0.362	0.524	0.257	0.256	0.346
$Fbar_{3\text{-}9}$	0.360	0.264	0.321	0.358	0.377	0.393	0.366	0.257	0.247	0.290

Table 8.3.11 Sole VIIE Summary Table

Year	Recruits[000']	TSB[t]	SSB[t]	Landings[t]	Yield//SSB	FBar3-9
1969	1609	3340	2741	352.72	0.13	0.119
1970	3975	3601	3007	389.61	0.13	0.126
1971	2955	3287	2750	431.92	0.16	0.154
1972	2618	3559	2725	436.55	0.16	0.122
1973	3580	3897	3269	458.25	0.14	0.144
1974	3357	4001	3225	426.52	0.13	0.131
1975	3142	5139	4130	500.63	0.12	0.118
1976	7206	5587	4186	614.25	0.15	0.160
1977	5072	6021	4340	604.58	0.14	0.124
1978	4714	6575	4807	868.31	0.18	0.171
1979	5164	6749	5292	1170.17	0.22	0.229
1980	8947	6705	5208	1268.10	0.24	0.220
1981	5157	6335	4764	1217.81	0.26	0.260
1982	4165	6224	4730	1437.95	0.30	0.316
1983	6581	5892	4638	1503.84	0.32	0.367
1984	7838	5824	4552	1362.66	0.30	0.312
1985	4237	5973	4000	1400.09	0.35	0.343
1986	6451	5623	3903	1418.02	0.36	0.322
1987	4207	5420	3968	1279.28	0.32	0.293
1988	4118	5157	3881	1443.13	0.37	0.337
1989	3148	4516	3394	1389.36	0.41	0.413
1990	7912	5201	3251	1306.25	0.40	0.413
1991	4371	4484	2969	852.20	0.29	0.270
1992	3805	4188	2836	895.68	0.32	0.238
1993	2598	3614	2831	903.83	0.32	0.307
1994	3723	4235	3156	800.26	0.25	0.230
1995	4389	4481	3233	855.85	0.26	0.294
1996	3666	4654	3051	833.38	0.27	0.260
1997	4855	3790	2880	949.66	0.33	0.312
1998	3853	3949	2919	880.05	0.30	0.292
1999	7101	4924	2886	955.93	0.33	0.318
2000	5880	4921	2864	911.73	0.32	0.302
2001	4093	4507	2923	1068.62	0.37	0.364
2002	6014	4789	3077	1105.32	0.36	0.360
2003	3078	4446	3148	1078.12	0.34	0.264
2004	4376	4264	2934	1073.92	0.37	0.321
2005	4884	4354	3032	1036.77	0.34	0.358
2006	4087	3842	2597	1015.53	0.39	0.377
2007	3534	3882	2613	1014.65	0.39	0.393
2008	2378	3659	2428	908.12	0.37	0.366
2009	2885	3393	2599	700.48	0.27	0.257
2010	4301[a]	3320	2759	687.51	0.25	0.247

[a] replaced XSA estimate (8907) with GM recruitment69-08

Table 8.3.12 Sole VIIE Short-term Forcast Input Table

2011

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	4301	0.10	0.00	0.00	0.00	0.058	0.000	0.080
2	3891	0.10	0.14	0.00	0.00	0.143	0.059	0.180
3	2299	0.10	0.45	0.00	0.00	0.217	0.214	0.251
4	1299	0.10	0.88	0.00	0.00	0.285	0.231	0.317
5	1316	0.10	0.98	0.00	0.00	0.348	0.244	0.378
6	1112	0.10	1.00	0.00	0.00	0.406	0.255	0.433
7	754	0.10	1.00	0.00	0.00	0.459	0.243	0.484
8	403	0.10	1.00	0.00	0.00	0.507	0.289	0.529
9	168	0.10	1.00	0.00	0.00	0.550	0.255	0.569
10	203	0.10	1.00	0.00	0.00	0.587	0.253	0.604
11	57	0.10	1.00	0.00	0.00	0.619	0.295	0.633
12	360	0.10	1.00	0.00	0.00	0.678	0.295	0.685

2012

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	4301	0.10	0.00	0.00	0.00	0.058	0.000	0.080
2		0.10	0.14	0.00	0.00	0.143	0.059	0.180
3		0.10	0.45	0.00	0.00	0.217	0.214	0.251
4		0.10	0.88	0.00	0.00	0.285	0.231	0.317
5		0.10	0.98	0.00	0.00	0.348	0.244	0.378
6		0.10	1.00	0.00	0.00	0.406	0.255	0.433
7		0.10	1.00	0.00	0.00	0.459	0.243	0.484
8		0.10	1.00	0.00	0.00	0.507	0.289	0.529
9		0.10	1.00	0.00	0.00	0.550	0.255	0.569
10		0.10	1.00	0.00	0.00	0.587	0.253	0.604
11		0.10	1.00	0.00	0.00	0.619	0.295	0.633
12		0.10	1.00	0.00	0.00	0.678	0.295	0.685

2013

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	4301	0.10	0.00	0.00	0.00	0.058	0.000	0.080
2		0.10	0.14	0.00	0.00	0.143	0.059	0.180
3		0.10	0.45	0.00	0.00	0.217	0.214	0.251
4		0.10	0.88	0.00	0.00	0.285	0.231	0.317
5		0.10	0.98	0.00	0.00	0.348	0.244	0.378
6		0.10	1.00	0.00	0.00	0.406	0.255	0.433
7		0.10	1.00	0.00	0.00	0.459	0.243	0.484
8		0.10	1.00	0.00	0.00	0.507	0.289	0.529
9		0.10	1.00	0.00	0.00	0.550	0.255	0.569
10		0.10	1.00	0.00	0.00	0.587	0.253	0.604
11		0.10	1.00	0.00	0.00	0.619	0.295	0.633
12		0.10	1.00	0.00	0.00	0.678	0.295	0.685

Table 8.3.13 Sole VIIE Single Option Output

Year=2011 F / F08-10= 0.852 Fbar= 0.247

Age	F	Catch No	Yield	Stock No	Biomass	SS No	SSB
1	0.000	0	0	4301	248	0	0
2	0.059	213	38	3891	556	545	78
3	0.214	422	106	2299	498	1035	224
4	0.231	255	81	1299	370	1144	326
5	0.244	272	103	1316	459	1290	449
6	0.255	239	103	1112	452	1112	452
7	0.243	155	75	754	347	754	347
8	0.289	96	51	403	205	403	205
9	0.255	36	21	168	92	168	92
10	0.253	43	26	203	119	203	119
11	0.295	14	9	57	35	57	35
12	0.295	88	60	360	244	360	244
Total		1833	673	16165	3625	7071	2571

Year=2012 F / F08-10= 0.852 Fbar= 0.247

Age	F	Catch No	Yield	Stock No	Biomass	SS No	SSB
1	0.000	0	0	4301	248	0	0
2	0.059	213	38	3891	556	545	78
3	0.214	609	153	3318	719	1493	324
4	0.231	330	105	1680	478	1479	421
5	0.244	193	73	933	325	915	319
6	0.255	200	87	933	379	933	379
7	0.243	160	78	780	358	780	358
8	0.289	128	68	535	272	535	272
9	0.255	59	33	273	150	273	150
10	0.253	25	15	118	69	118	69
11	0.295	35	22	142	88	142	88
12	0.295	69	47	281	191	281	191
Total		2021	719	17187	3834	7495	2648

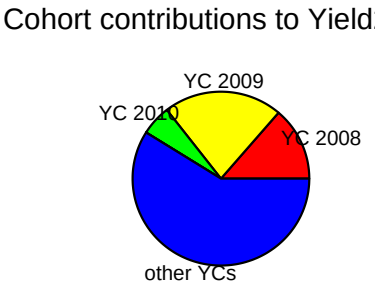
Year=2013 F / F08-10= 0.852 Fbar= 0.247

Age	F	Catch No	Yield	Stock No	Biomass	SS No	SSB
1	0.000	0	0	4301	248	0	0
2	0.059	213	38	3891	556	545	78
3	0.214	609	153	3318	719	1493	324
4	0.231	477	151	2425	690	2134	607
5	0.244	249	94	1207	420	1183	412
6	0.255	142	62	662	269	662	269
7	0.243	135	65	654	301	654	301
8	0.289	132	70	553	281	553	281
9	0.255	78	44	363	200	363	200
10	0.253	41	25	192	113	192	113
11	0.295	20	13	83	51	83	51
12	0.295	70	48	286	194	286	194
Total		2165	763	17935	4041	8147	2828

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	Yield2011	Yield2012	SSB2011	SSB2012	SSB2013
2008	XSA	14.8	13.7	8.5	14.9	15.8
2009	GM 69-08	5	21.8	2.8	12.4	22
2010	GM 69-08		5.6		2.8	12.6
2011	GM 69-08					2.9
2012	GM 69-08					



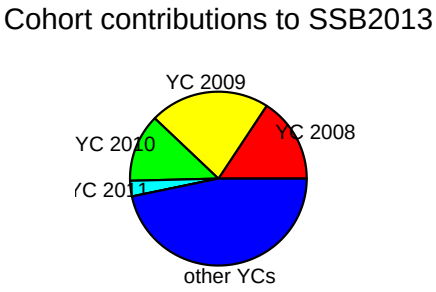


Table 8.3.15 Sole VIIE Management Options Output

SSB 2012	TSB 2012	F-mult	F	basis	Yield 2012	SSB 2013	TSB 2013	%SSB-Change	%TAC-Change
2648	3834	0.0	0.000	Fsq	0	3519	4778	33	-100
2648	3834	0.1	0.025	Fsq	80	3442	4697	30	-89
2648	3834	0.2	0.049	Fsq	157	3367	4617	27	-78
2648	3834	0.3	0.074	Fsq	233	3294	4539	24	-67
2648	3834	0.4	0.099	Fsq	308	3222	4463	22	-57
2648	3834	0.5	0.124	Fsq	380	3153	4388	19	-46
2648	3834	0.6	0.148	Fsq	451	3085	4316	16	-36
2648	3834	0.7	0.173	Fsq	520	3018	4245	14	-27
2648	3834	0.8	0.198	Fsq	588	2953	4175	12	-17
2648	3834	0.826	0.204	Fsq	605	2937	4157	11	-15
2648	3834	0.9	0.222	Fsq	654	2890	4107	9	-8
2648	3834	0.987	0.244	Fsq	710	2836	4050	7	0
2648	3834	1.0	0.247	Fsq	719	2828	4041	7	1
2648	3834	1.033777	0.255	Fsq	740	2808	4019	6	4
2648	3834	1.093117	0.270	Fsq	777	2772	3981	5	9
2648	3834	1.1	0.272	Fsq	782	2768	3977	5	10
2648	3834	1.157	0.286	Fsq	817	2734	3941	3	15
2648	3834	1.2	0.297	Fsq	843	2709	3914	2	19
2648	3834	1.3	0.321	Fsq	904	2651	3852	0	27
2648	3834	1.4	0.346	Fsq	962	2595	3792	-2	36
2648	3834	1.5	0.371	Fsq	1020	2540	3733	-4	44
2648	3834	1.6	0.395	Fsq	1076	2487	3675	-6	52
2648	3834	1.7	0.420	Fsq	1131	2434	3619	-8	59
2648	3834	1.8	0.445	Fsq	1185	2383	3564	-10	67
2648	3834	1.9	0.470	Fsq	1237	2334	3510	-12	74
2648	3834	2.0	0.494	Fsq	1289	2285	3458	-14	82
2648	3834	1.033777	0.255	Fmsy	740	2808	4019	6	4
2648	3834	1.093117	0.270	Fmp F	777	2772	3981	5	9

Figure 8.3.1 Sole VIIE International Landings Age Compositions

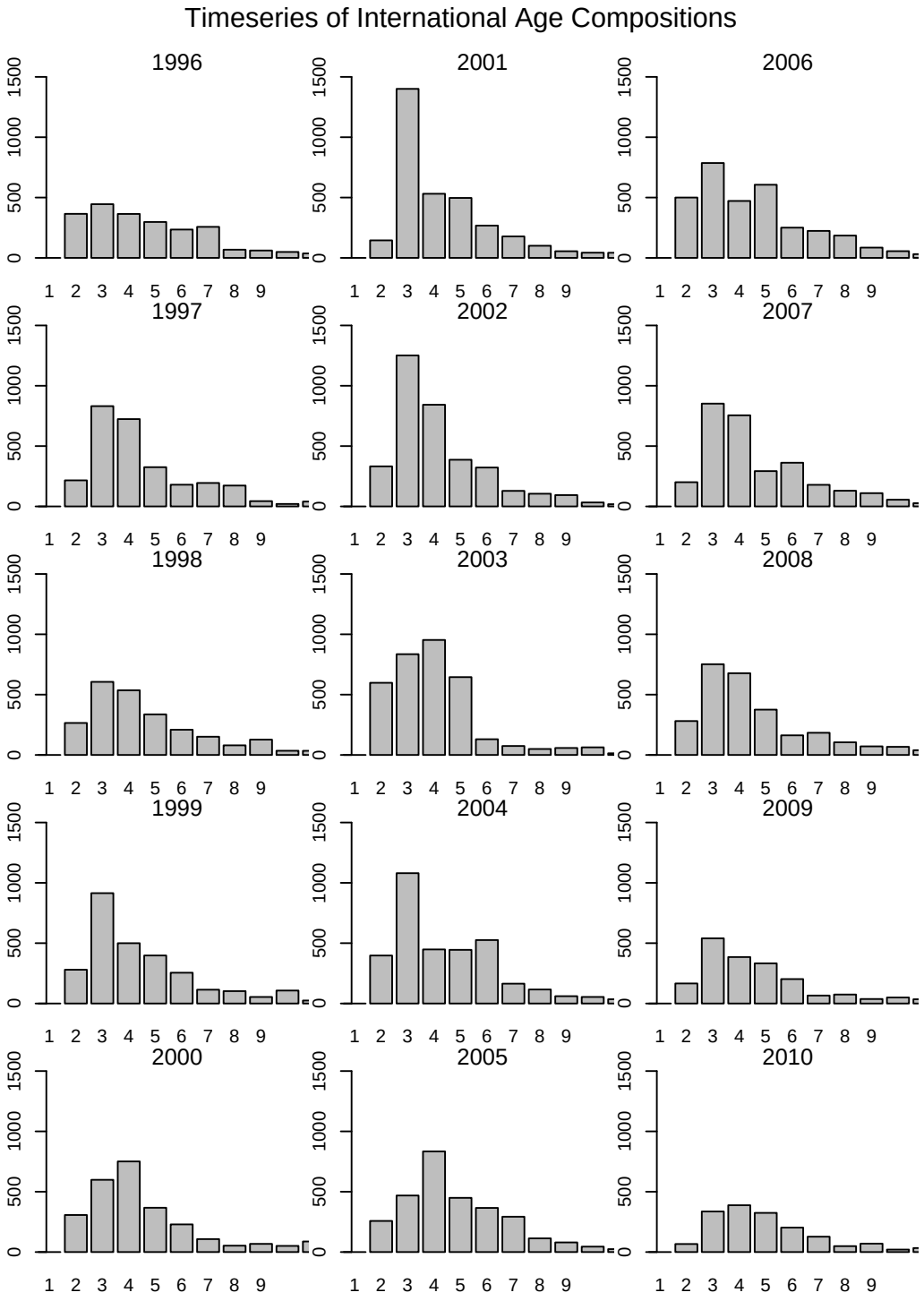
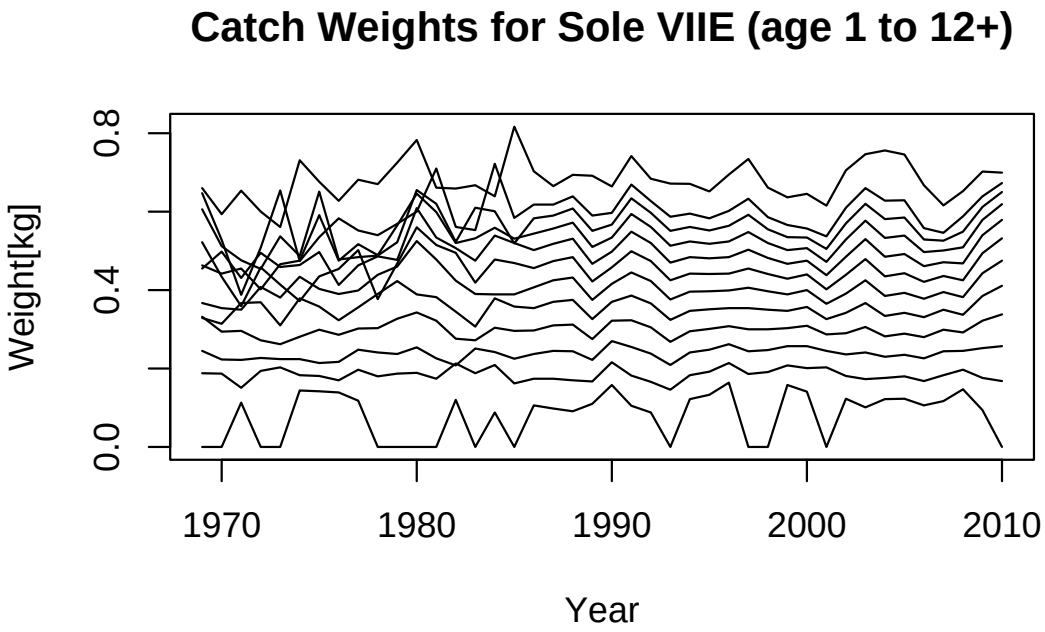


Figure 8.3.2 Sole VIIE Catch and Stock Weights at Age



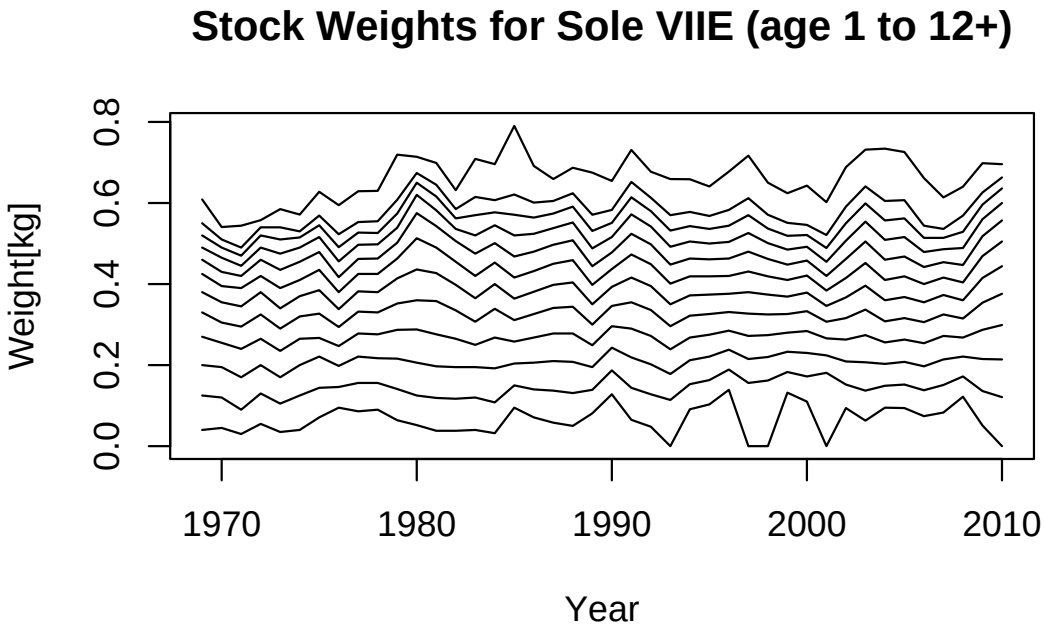


Figure 8.3.3a Sole VIIE Discards by Quarter, Fleet

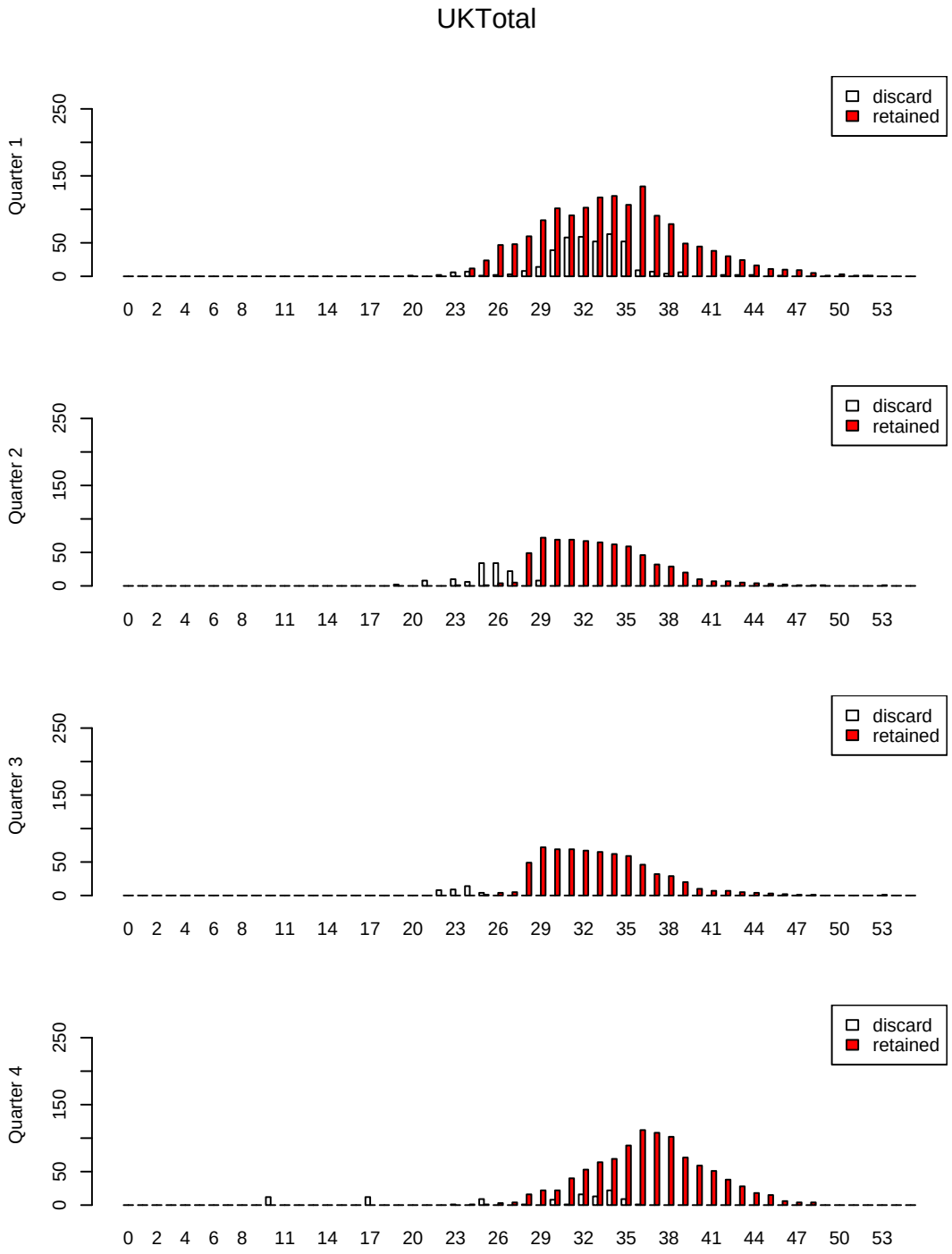


Figure 8.3.3b Sole VIIE Discards by Quarter, Fleet continued

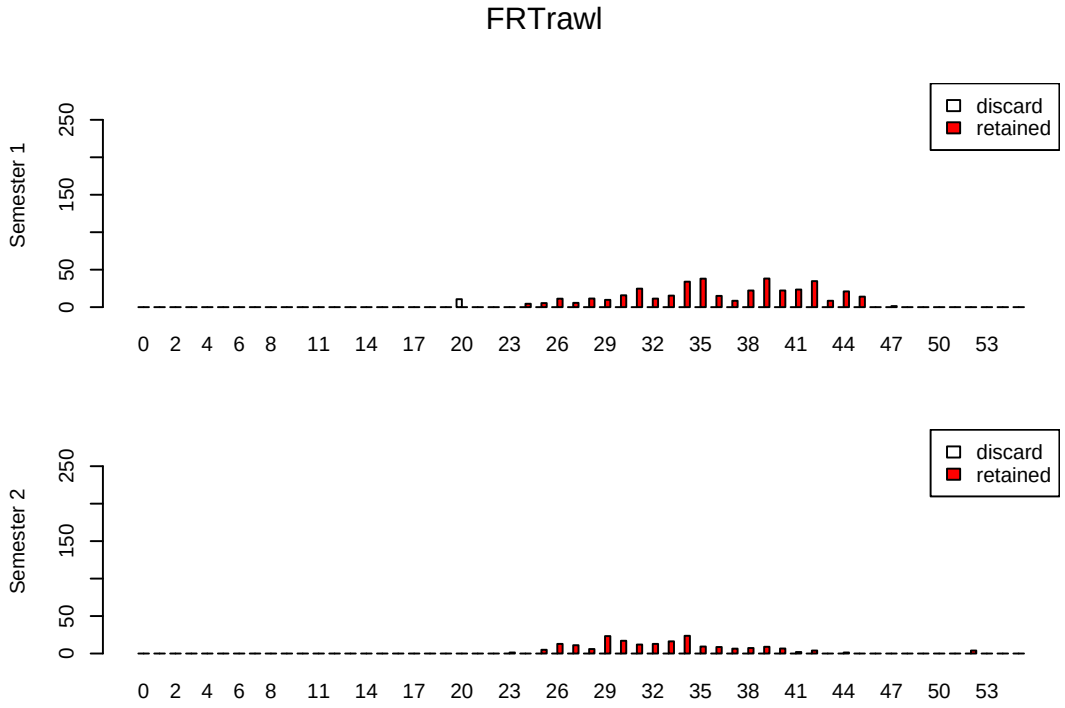


Figure 8.3.3c Sole VIIE Discards by Quarter, Fleet continued

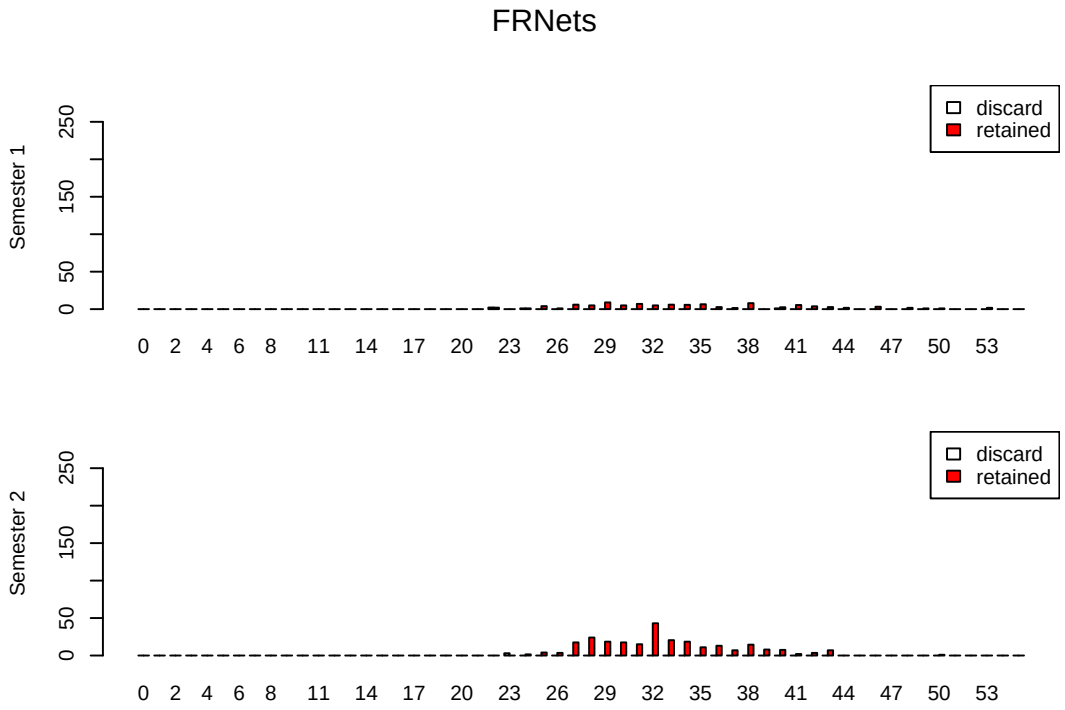


Figure 8.3.3d Sole VIIE Discards by Quarter, Fleet continued

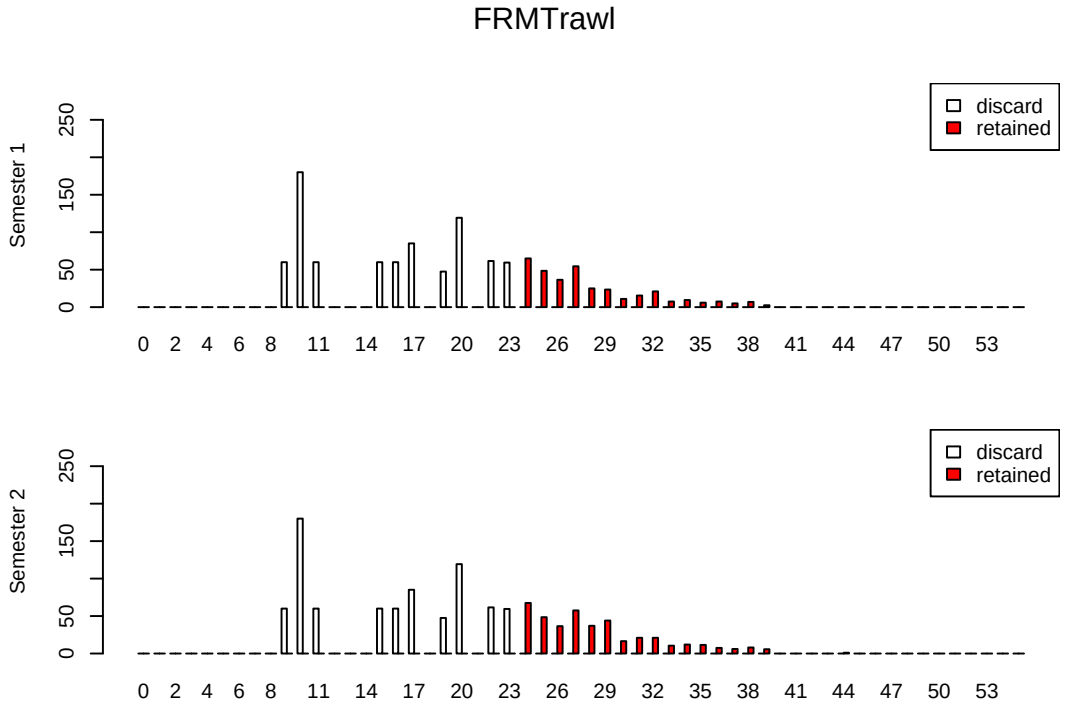


Figure 8.3.3e Sole VIIE Discards by Quarter, Fleet continued

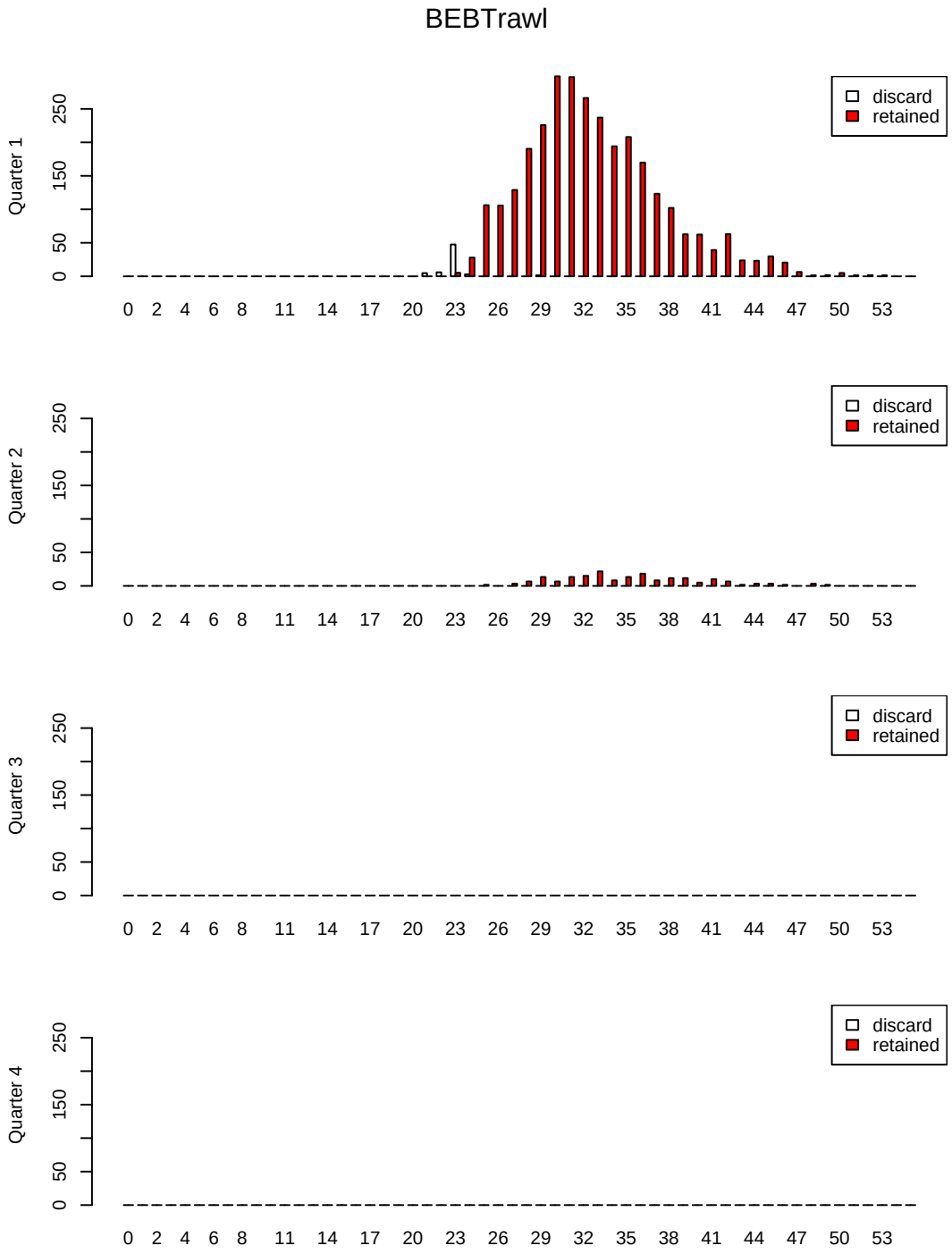


Figure 8.3.4 Sole VIIE LPUE and effort

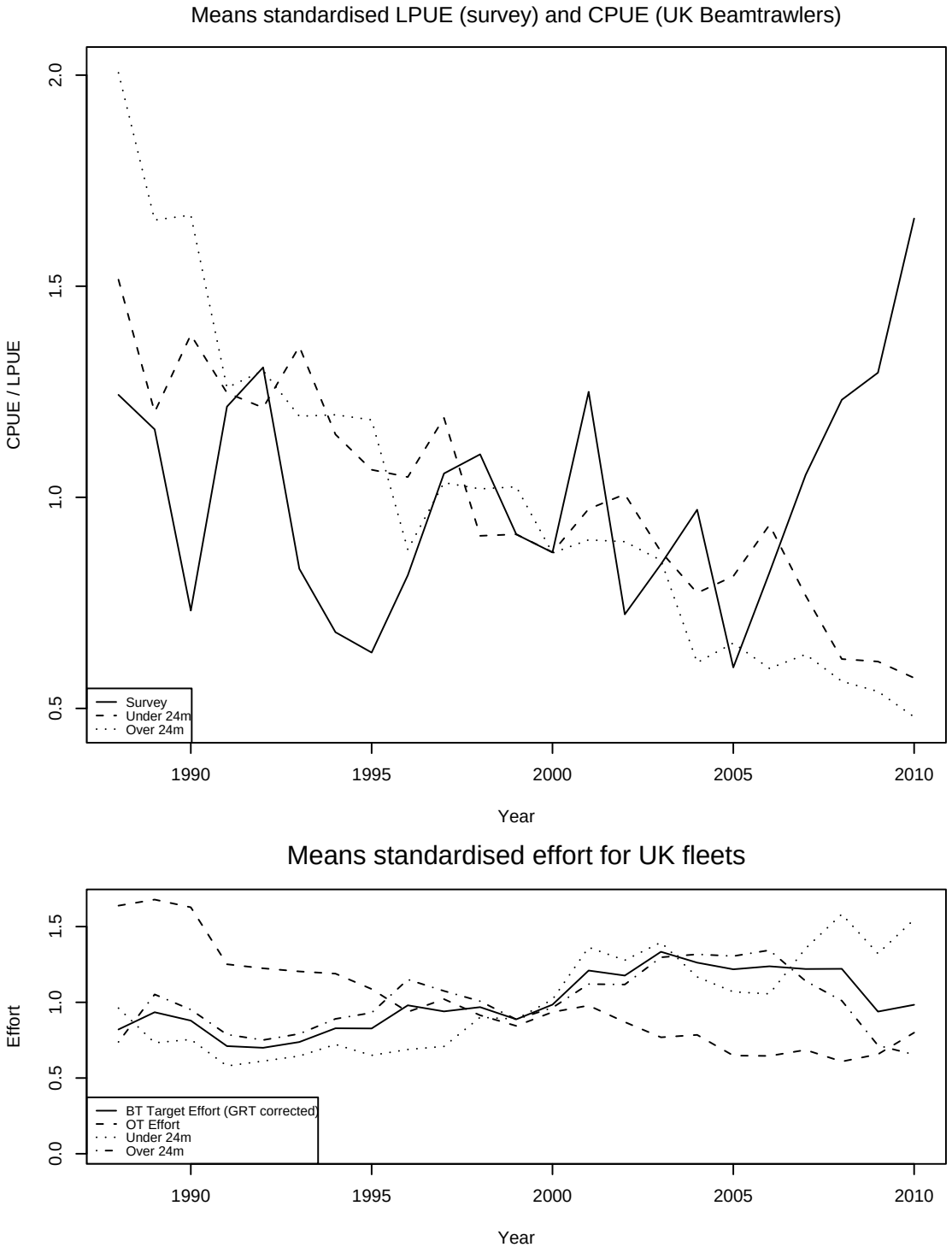


Figure 8.3.5 Sole VIIE Log CPUE by Yearclass
note the cohorts differ on the x-axes due to the differences in the length and age range of the tuning series

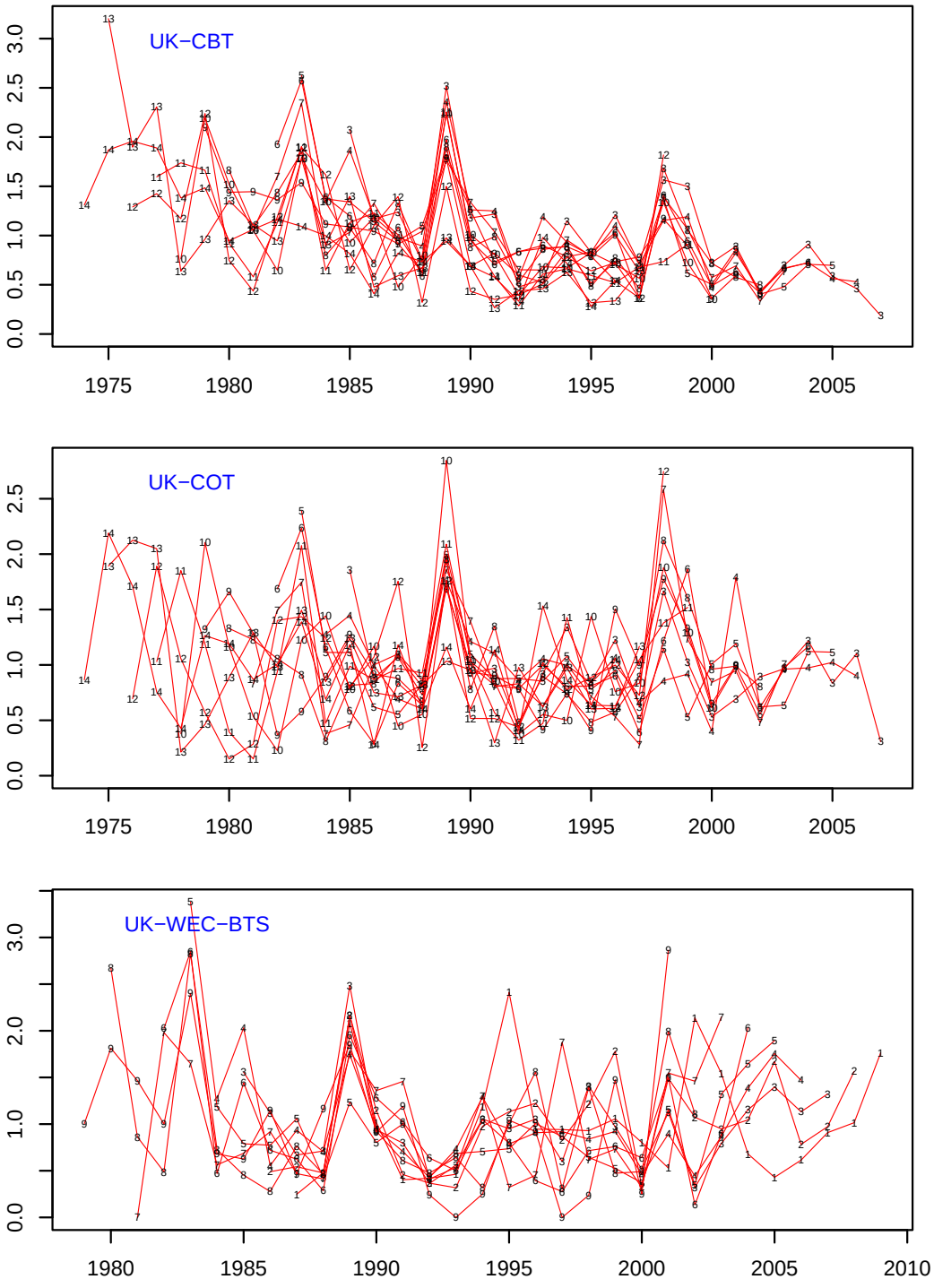


Figure 8.3.6 Sole VIIE Log CPUE by Year
note the cohorts differ on the x-axes due to the differences in the length and age range of the tuning series

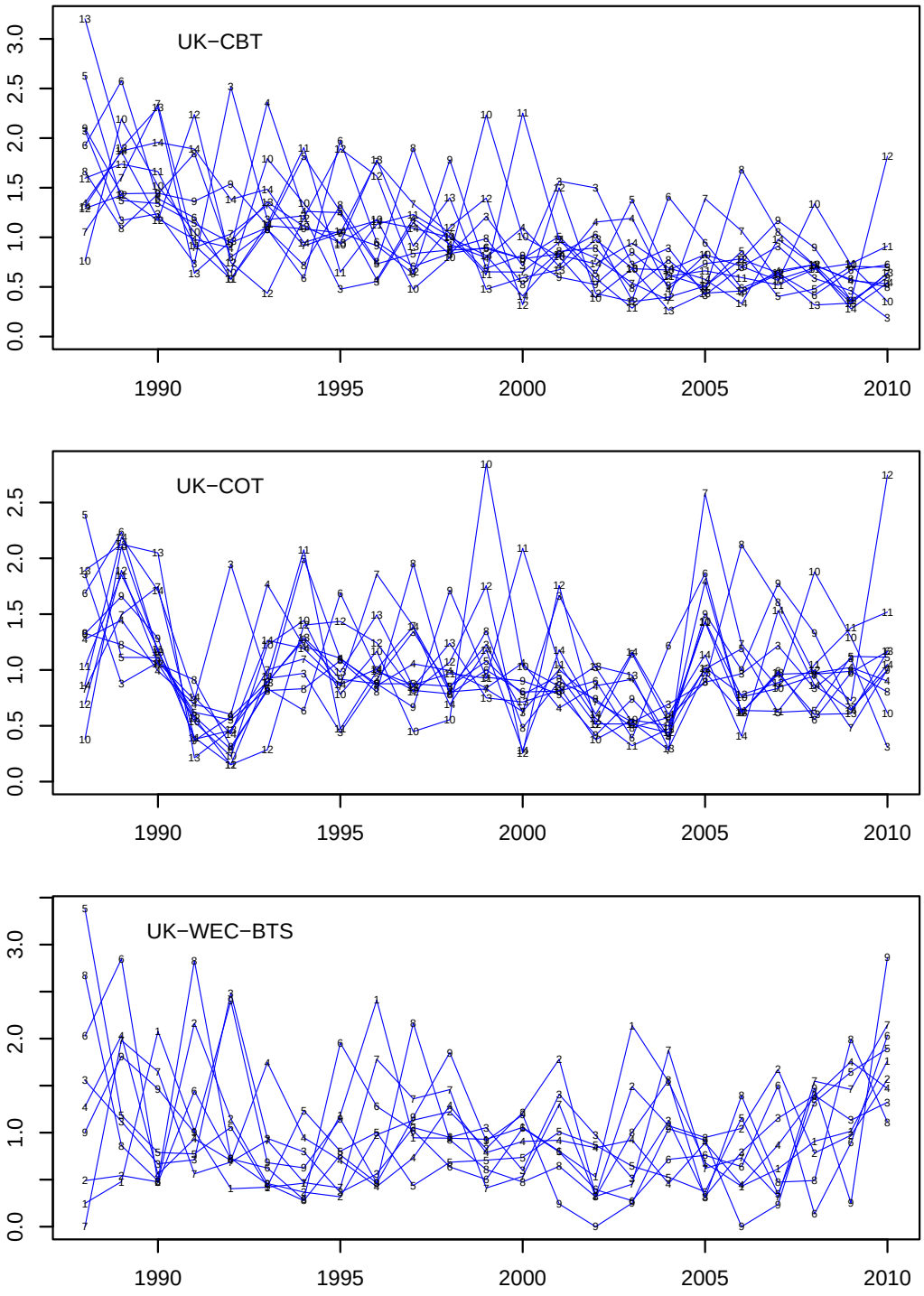


Figure 8.3.7 Sole VIIE Single Fleet log catchability Residuals

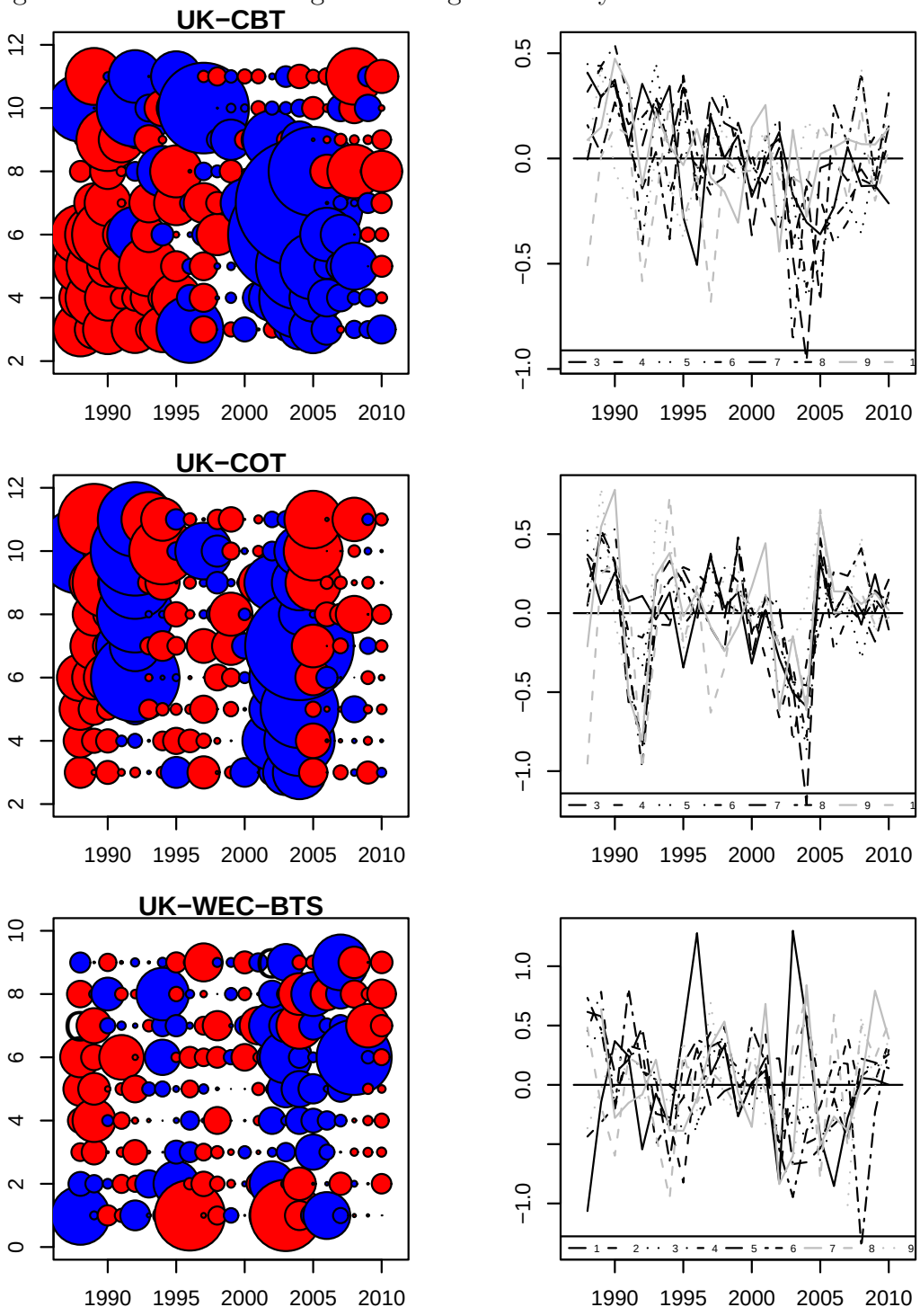


Figure 8.3.8 Sole VIIE Single Fleet Summary

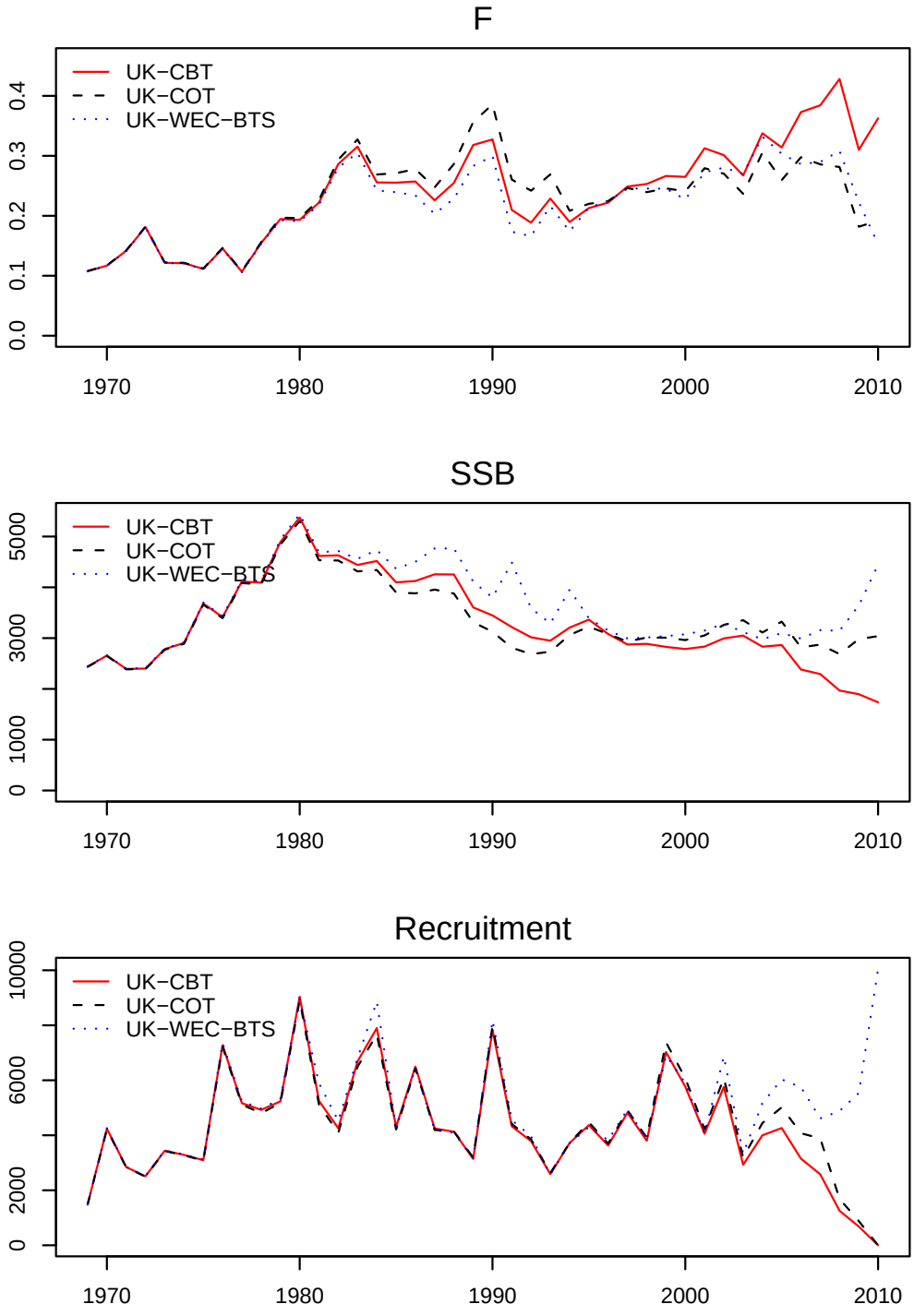


Figure 8.3.9 Sole VIIE Final XSA Fleet log catchability Residuals

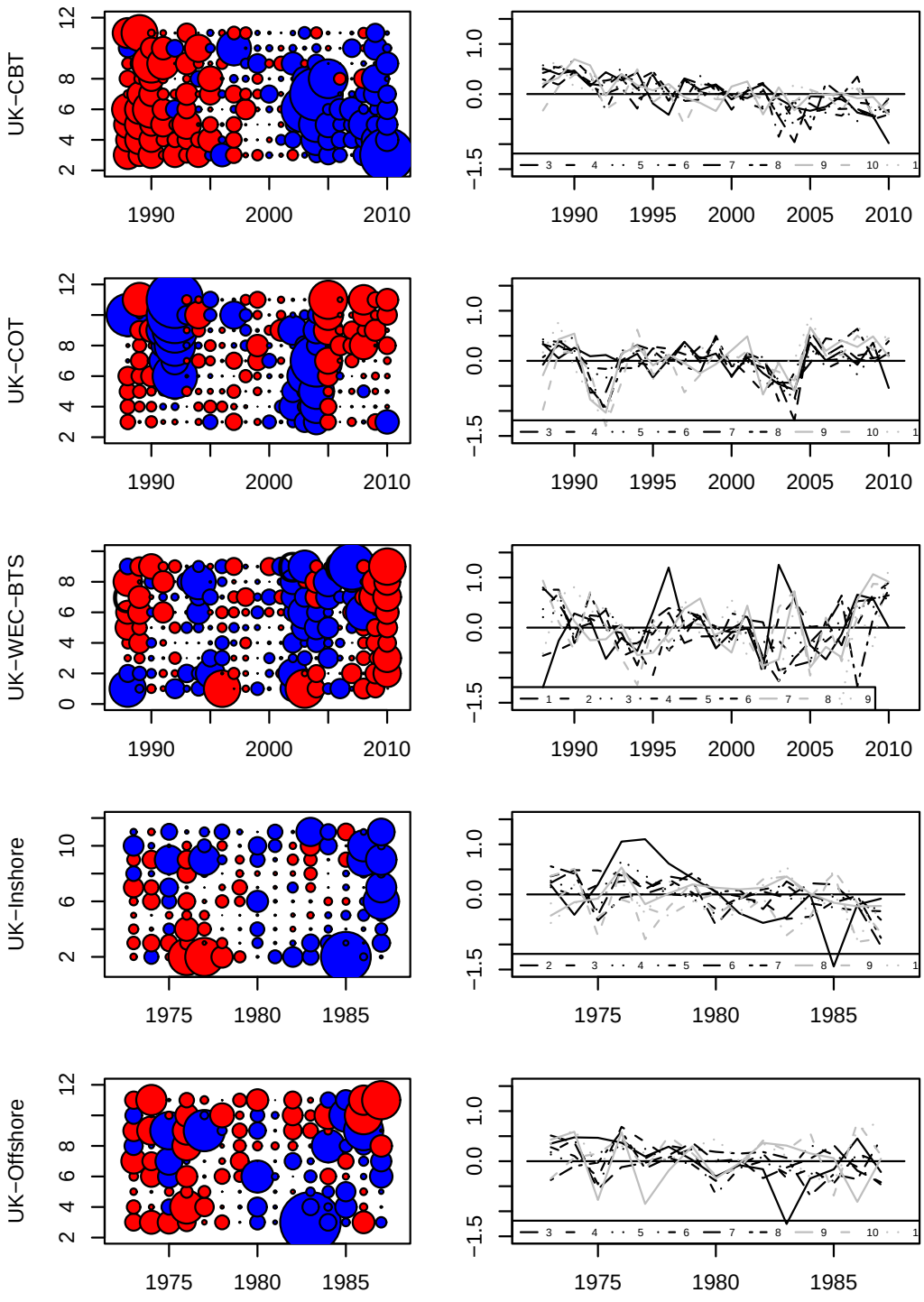
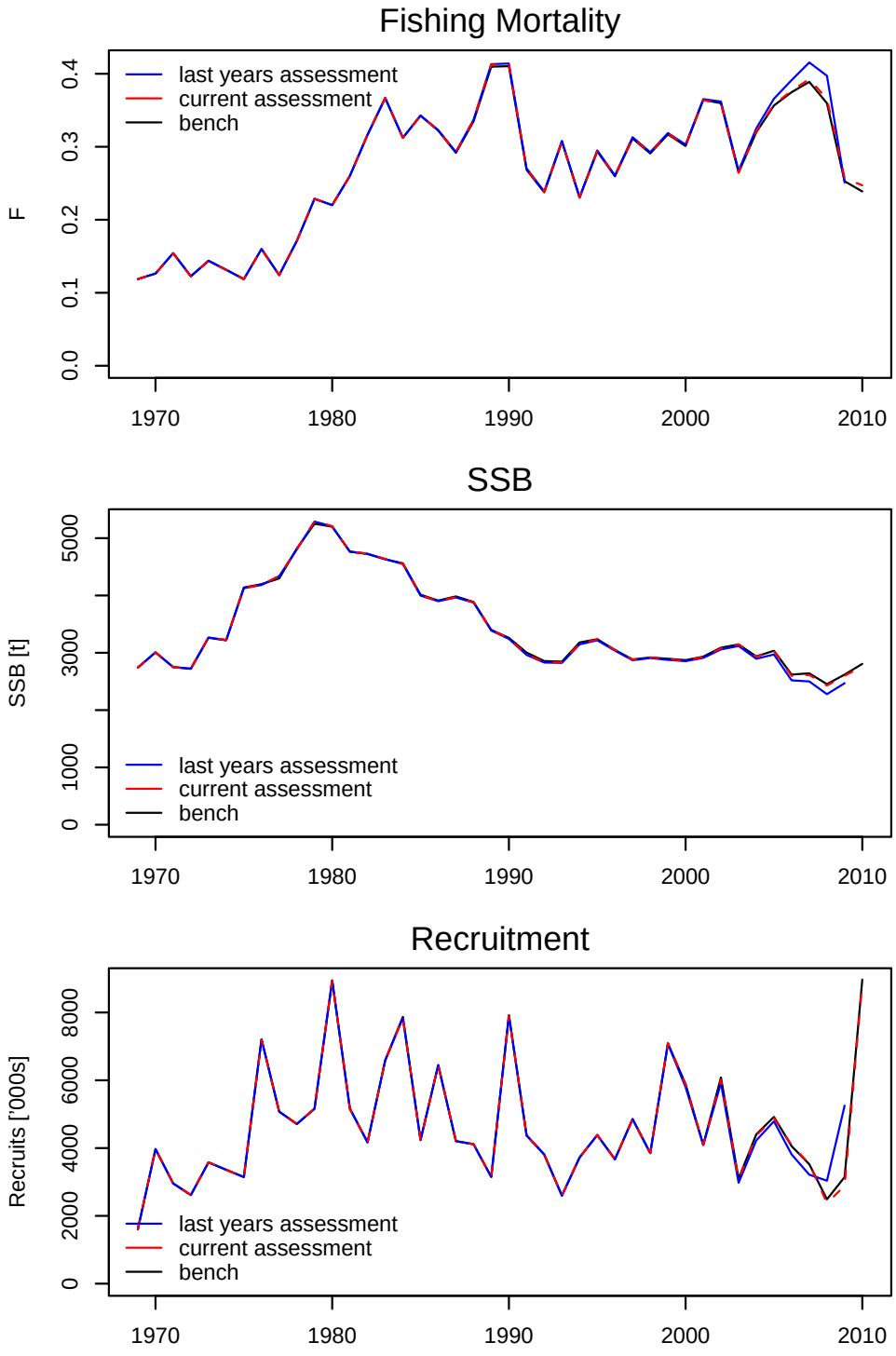


Figure 8.3.10 Sole VIIE Final XSA and previous XSAs



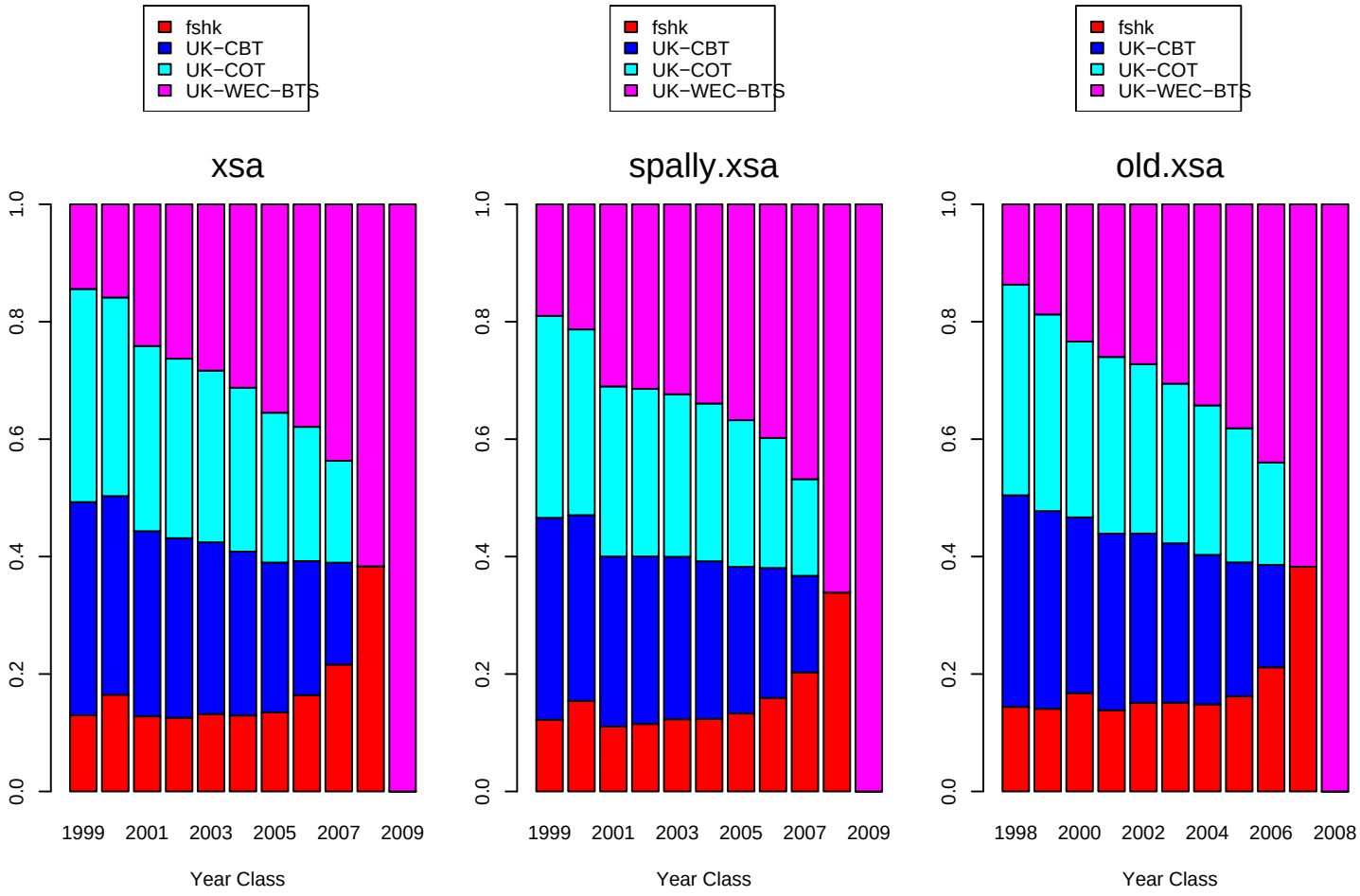
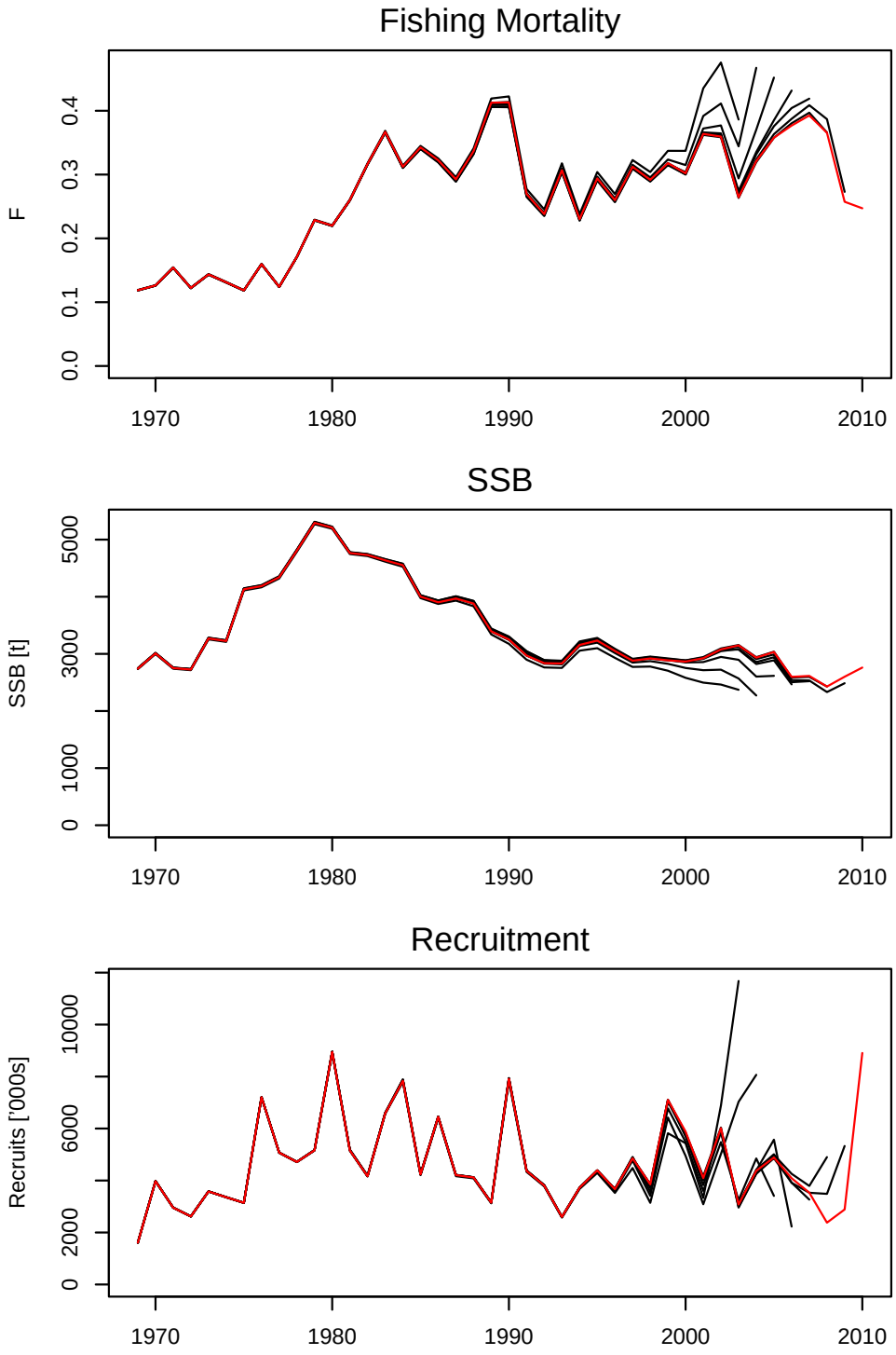


Figure 8.3.11 Sole VIIE Final and previous Assessment weights

Figure 8.3.12 Sole VIIE XSA Retrospective Plots



9.2 Pollock in the Celtic Seas (ICES Subareas VI and VII)

Type of assessment in 2011

No assessment.

9.2.1 General

Stock identity

This section is not dedicated to a 'stock', it relates to a species in a wider region where data are available. The stock structure of pollock populations in this ecoregion is not clear. ICES does not necessarily advocate that VI and VII constitutes a management unit for pollock, and further work is required.

Biology

0-group pollock are found in shallow coastal waters and may therefore be protected from fisheries in the early life stages. Pollock is bentho-pelagic, 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 pollock in the Celtic Sea ecoregions is caught by trawls and gillnets, and other gears come to complement the landings, such as trolling line, seine nets 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

Pollock may be caught by bottom-trawl surveys such as EVHOE-WIBTS-Q4 and IGFS-WIBTS-Q4 (Figure 9.2.2). The small number of individuals caught by EVHOE-WIBTS-Q4 makes it hardly informative the trends of abundance indices (Figure 9.2.3).

Data

The nominal landings are given in Tables 9.2.1 and 9.2.2 for ICES Subarea VI and VII respectively.

Table 9.2.1. Landings of pollock 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	2010*
Belgium	-	-	-	<0.5	<0.5	-	-	-	-	-	-
Denmark	-	-	-	-	-	-	-	-	-	-	-
France	11	8	9	3	2	23	3	10	8	6	4
Germany	2	-	-	-	-	-	-	-	-	-	-
Ireland	62	108	26	88	68	28	25	21	21	5	34
Netherlands	-	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	1	1	-	-	6	1	-	<0.5
Portugal	-	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	4	-	-	-	-
Sweden	-	-	-	-	-	-	-	-	-	-	-
UK	116	101	96	111	65	16	5	21	23	25	39
Subarea VI	191	217	131	203	136	67	37	58	53	36	78

* provisional

Table 9.2.2. Landings of pollock 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	2010*
Belgium	71	100	117	113	104	98	79	91	76	42	35
Denmark	-	-	-	-	-	-	-	-	-	-	-
France	2422	2515	2481	2284	1914	2198	2213	1970	1579	1641	1709
Germany	-	-	-	-	-	-	-	-	-	-	-
Ireland	1069	1274	1308	1151	1049	728	809	782	738	828	935
Netherlands	-	-	-	-	1	1	1	3	1	4	2
Norway	-	-	-	-	-	-	-	-	-	-	-
Spain	5	9	17	12	13	16	28	1	14	3	-
UK	1810	1987	1999	1788	1705	1684	1531	1764	1453	1545	1384
Subarea VII	5377	5885	5922	5348	4786	4725	4661	4611	3861	4063	4065

* provisional

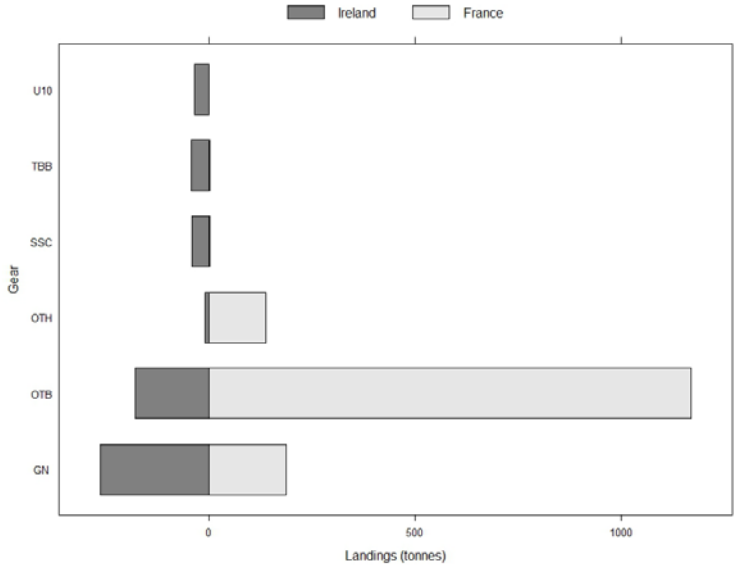


Figure 9.2.1. Pollock in the Celtic Seas. Catches per gear over the period 2003–2010 for Ireland and France.

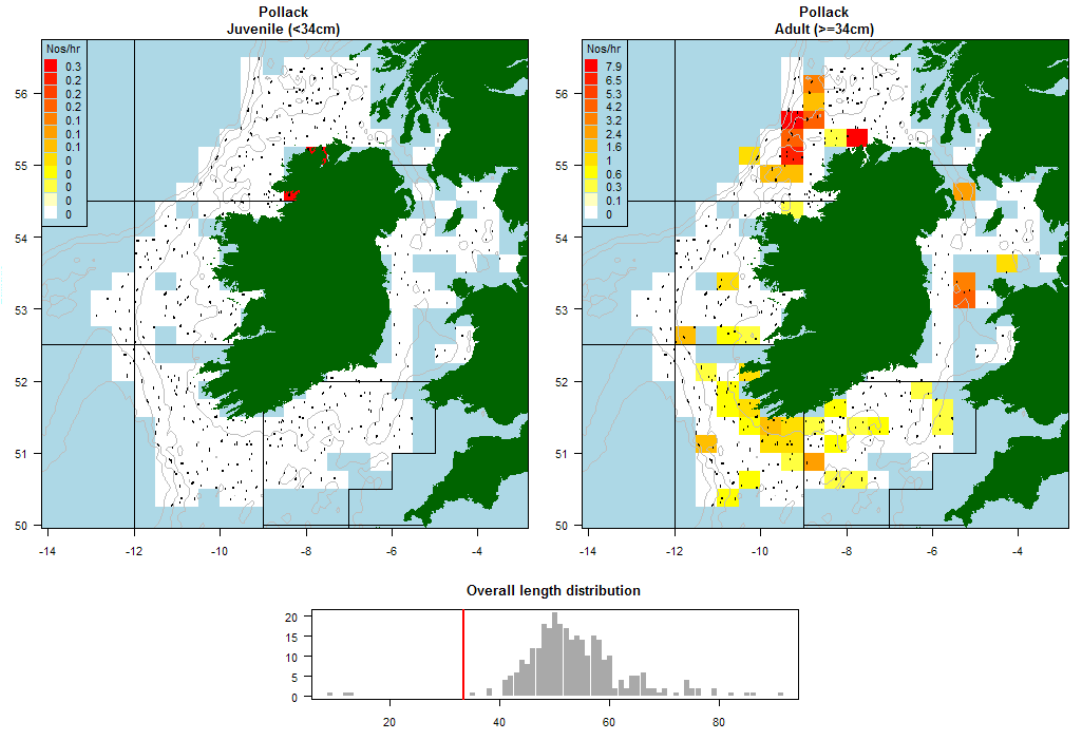


Figure 9.2.2. Pollock in the Celtic Seas. Distribution of catches and length distribution profile from IGFS-WIBTS-Q4.

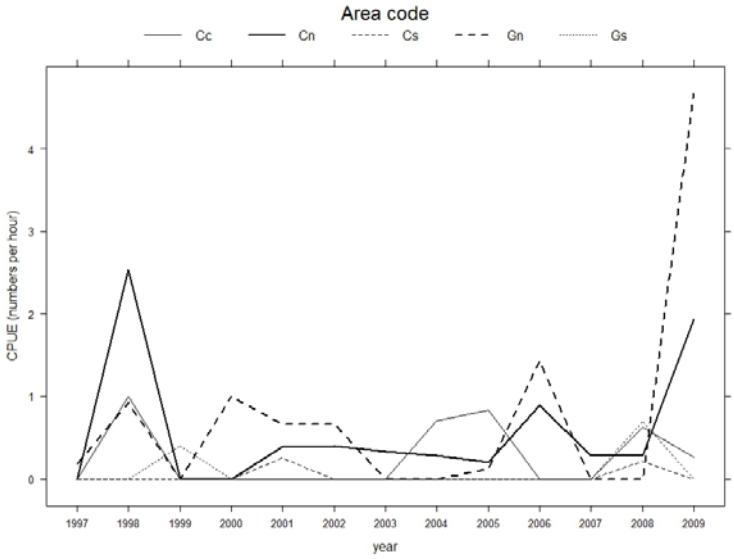


Figure 9.2.3. Pollock in the Celtic Seas. Abundance index from the EVHO-WIBTS-Q4 survey.

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Annex 2: Stock Annexes

Stock Annex 3.2: Cod VIa

Stock-specific documentation of standard assessment procedures used by ICES.

Stock:	West of Scotland Cod (Division VIa)
Working Group:	Celtic Seas Ecoregion
Last updated:	19 May 2011

A. General

A.1. Stock definition

Cod occur mainly in the central and northern areas of Division VIa. Young adult cod are distributed throughout the waters to the west of Scotland, but mainly occur in offshore areas where they can occasionally be found in large shoals. Tagging experiments have shown that in late summer and early autumn there is a movement of cod from west of the Hebrides to the north-coast areas. There is a return migration in the late winter and early spring. There is only a very limited movement of adult fish between the West Coast and the North Sea.

Recent surveys of spawning fish distribution in ICES area VIa (West of Scotland) suggested the persistence of the main spawning concentrations identified over 50 years ago by egg surveys. From 383 cod tagged during the spawning season and recaptured during successive spawning seasons >90% were recaptured within 80 km of coastal release sites, such as the Clyde, Moray Firth and the Minch. Cod released at these coastal spawning grounds also tended to remain in these areas during the summer feeding season implying that they belonged to resident spawning groups, (Wright *et al*., 2006).

A.2. Fishery

The minimum landing size of cod in the human consumption fishery 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*.. 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. Cod is believed to be no longer targeted in any fisheries now operating in ICES division VIa. Cod are a bycatch in *Nephrops* and anglerfish fisheries in Division VIa. These fisheries use a smaller mesh size than the 120 mm mandatory for cod targeted fisheries, but landings of cod are restricted through bycatch regulations.

2000 onwards

Emergency measures were introduced in 2001 to allow the maximum number of cod to spawn (see emergency measures below). Council Regulation No 423\2004 introduced a cod recovery plan affecting Division VIa. The measures only took effect, however east of a line defined in Council Regulation No 51\2006 known as the west of Scotland management line (see Figure A9.1). For 2009 a new line was defined in the cod long-term management plan Council Regulation No 1342\2008 (Figure A9.1).

Vessels operating west of this line and conforming to criteria within the plan can claim extra fishing effort up to specified limits but are now otherwise still under the jurisdiction of the management plan.

From mid September 2003 to mid July 2004 the Irish trawl fishery off Greencastle, Co. Donegal that traditionally targets juvenile cod was closed. The closure was instigated by the local fishing industry to allow an assessment of seasonal closure as a potential management measure. The fishing industry again called for and received statutory instruments closing the fishery from November 2004 until mid February 2005 and from mid November until 14th February 2006. The closure is expected to have reduced the Irish fishing mortality on cod that would otherwise have occurred in 2003 to 2005. The closure was not continued after 2005 because all vessels that fished in the area had been decommissioned. More generally, 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.

At the end of 2005 the 'Registration of Buyers and Sellers' regulation (The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005: Statutory Instrument 2005 No. 1605 & The Registration of Fish Sellers and Buyers and Designation of Auction Sites (Scotland) Amendment Regulations 2005: Scottish Statutory Instrument 2005 No. 438) was introduced in the UK and became fully operational from 1st January 2006. This implemented an EU directive as did the Irish 'Sales Notes' legislation. In summary these require that fish processed and sold in the UK and Ireland can be traced through the supply chain.

Because of restrictive TACs, seasonal/spatial closures of the fishery, and effort restrictions based on bycatch composition the probability of misreporting and under reporting in the past is considered to have been high. From 2006 under reporting is expected to have reduced to low or negligible levels due to the 'Buyers and Sellers' and 'Sales Notes' acts.

Technical measures

Technical measures regarding demersal fishing gear are laid out in Commission regulation (EC) 850/98 and were amended by regulation (EC) 2056/2001 specifically aimed at aiding cod recovery. Under regulation (EC) 2056/2001 the minimum mesh size for vessels fishing for cod 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, 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. The increase in minimum mesh size from 100 to 120 mm in 2001/2002 partly caused a shift to *Nephrops* targeted fisheries using 80 mm mesh sizes.

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. WGFTFB2006 report that this has greatly reduced effort at depths greater than 200 m in VIa. The measure was aimed to protect monkfish and deep-water shark and it is unclear what effect it will have on cod.

Emergency measures, area closures 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.

From mid September 2003 to mid July 2004 the Irish trawl fishery off Greencastle, Co. Donegal that traditionally targets juvenile cod was closed (Irish Statutory Instrument (SI) No. 431 of 2003). In December 2003 the closed area was extended along its eastern edge by amendment to the Statutory Instrument (SI No. 664 of 2003). A new Statutory Instrument (SI No. 670 of 2004) reinstated the closed area from 1st November 2004 until 14th February 2005. The closure was not instigated after 2005. This was because all vessels that fished in the area had been decommissioned.

The following area closures were in effect in 2008:

1) 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.

2) A closure introduced in 2004 by Council Regulation No. EC 2287\2003, known as the 'windsock'.

The closed areas that remain in force were reviewed by the STECF group on evaluation of closed area schemes (STECF-SGMOS-07–03).

Effort reductions for much of the international fleet to 16 days at sea per month have been imposed since February 2003 (EU 2003\0090). Initially days at sea allowances were defined by calendar month. From 2006 the limit was defined on an annual basis. The maximum number of days a fishing vessel 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:	2007:	2008:
	Monthly limit			Annual limit		
Demersal trawls, seines or similar towed gears of mesh size ≥ 100 mm except beam trawls1;	9	10	9			
Demersal trawls, seines or similar towed gears of mesh size between 70 mm to 99 mm except beam trawls1;	25	22	21			
Demersal trawls, seines or similar towed gears of mesh size ≥120 mm except beam trawls;				91	85	70
Demersal trawls, seines or similar towed gears of mesh size 100 mm to 119 mm except beam trawls;				91	84	69
Demersal trawls, seines or similar towed gears of mesh size between 90 mm to 99 mm except beam trawls;				227	227	227
Demersal trawls, seines or similar towed gears of mesh size between 70 mm to 89 mm except beam trawls;				227	227	204
Demersal trawls, seines or similar towed gears of mesh size between 16 mm to 31 mm except beam trawls.	23	20	19	228	228	228

[1] **Replaced by new mesh size ranges.**

For 2009 effort limits were changed to be on the basis of a kWdays effort pot assigned per nation per fleet effort category. The baselines assigned in 2009 were based on track record per fleet effort category averaged over 2004-2006 or 2005-2007 depending on national preference. The following table lists the new fleet effort categories and shows how they map to the previous gear groups.

Gear group (2006–2008)	Gear group 2009
Demersal trawls, seines or similar towed gears of mesh size ≥120 mm except beam trawls;	TR1
Demersal trawls, seines or similar towed gears of mesh size 100 mm to 119 mm except beam trawls;	TR1
Demersal trawls, seines or similar towed gears of mesh size between 90 mm to 99 mm except beam trawls;	TR2
Demersal trawls, seines or similar towed gears of mesh size between 70 mm to 89 mm except beam trawls;	TR2
Demersal trawls, seines or similar towed gears of mesh size between 16 mm to 31 mm except beam trawls.	TR3

The documents listing these days at sea limitations are:

Year of application	Regulation
2003	(EC) No 2341/2002–Annex XVII
2004	(EC) No 2287/2003–Annex V
2005	(EC) No 27/2005–Annex IVa
2006	(EC) No 51/2006–Annex IIa
2007	(EC) No 41/2007–Annex IIa
2008	(EC) No 40/2008–Annex IIa
2009	(EC) No 43/2009–Annex IIa
2010	(EU) No 53/2010-Annex IIA
2011	(EU) No 57/2011-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.

Subsequently it has been possible for vessels to qualify for extra days at sea if special conditions (specified in the Annex) are met, (see relevant regulation Annex for details).

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 Annex I (with additional measures in Reg (EC) 2056/2001).

Management plan

Council regulation (EC) No 423\2004 set out a multi-annual recovery plan that constrains effort to specified harvest control rules. For stocks above $\mathbf{B}_{lim}$, the harvest control rule (HCR) requires:

1) setting a TAC that achieves a 30% increase in the SSB from one year to the next,

2) limiting annual changes in TAC to ± 15% (except in the first year of application), and,

3) a rate of fishing mortality that does not exceed $\mathbf{F}_{pa}$.

For stocks below $\mathbf{B}_{lim}$ the Regulation specifies that:

1) conditions 1–3 will apply when they are expected to result in an increase in SSB above $\mathbf{B}_{lim}$ in the year of application,

2) a TAC will be set lower than that calculated under conditions 1–3 when the application of conditions 1–3 is not expected to result in an increase in SSB above $\mathbf{B}_{lim}$ in the year of application.

For 2009 Council regulation (EC) No 423\2004 was repealed and replaced by Council regulation (EC) No 1342\2008. 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 to 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 to 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 to 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 and 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.

Cod avoidance measures

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 scheme was incentivised by rewarding participating skippers with additional days at sea. The real-time closures system discourages vessels from operating in areas of high cod abundance. The numbers of RTCs implemented throughout the cod recovery plan area were 15, 144 and 165 in 2008, 2009 and 2010 respectively; most of these were located in the North Sea. The number of RTCs west of Scotland was four in 2008, 20 in 2009 and 19 in 2010, representing 27, 14 and 12% of total RTCs in each year. The closures (mandatory in 2009 and 2010) are determined by landings per unit of effort, based on fine scale VMS data and daily logbook records and also by on-board inspections. The small number of RTCs west of Scotland results from few instances of high lpue in the area.

Based on new in-year information on cod movement from tagging the dimensions of the RTCs were increased by four times from July 2010. The use of more species and size selective gears (some trialled by the Marine Laboratory in Aberdeen) formed a further series of options within the scheme. These included the 'Orkney trawl, the use of nets with 130 mm codends and larger meshes in the square meshed panels of *Nephrops* trawls. Out-turn results for 2009 were reviewed by STECF (2010) who concluded that the measures included in Conservation Credits scheme were in the right direction but needed to be strengthened.

Decommissioning schemes

Between 2001 and 2003 165 Scottish vessels were decommissioned from the overall Scottish fleet (all areas), representing a 34% reduction in number of vessels compared to 1999. The Scottish Government estimates this represented a 30% reduction in effort by trawls of over 100 mm mesh. It is not known what proportion of these reductions came from Area VIa.

A.3. Ecosystem aspects

Geographic 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 ar-

eas 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

B1.1. Landings

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				

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 nominated by the 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 (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 (E/W), UK (NI) and Norway (distributed proportionately over quarters), and 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\cod-iris\input data\xsa_ica**

B1.2. Discards

EU countries are now required under the EU Data Collection regulation to collect data on discards of cod and other species. To date estimates of discards are available only from UK (Scotland) and Ireland. Observer data are collected using standard at-sea sampling schemes. Results are reported to ICES. A table of data made available by year is given below.

Country	1978–2003	2004–2005	2006–2009	2010
UK(Scotland)	X	X	X	X
Ireland		X		X

The quantity, length and age of cod discarded by Scottish *Nephrops* trawlers are collected during observer trips on board commercial vessels. Cod discarded by boats using other gears (heavy trawl, seine, light trawl and pair trawl) are also collected by Scotland. Cod discarded by otter board trawl and otter board/twin rig gears are collected by Ireland.

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.

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

B.3. Surveys

Four research vessel survey-series for cod in VIa have been available to the Working Group since 2005. 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 1985–2008.

The survey gear is a GOV trawl, and the design is a minimum of one station per rectangle, but with more depending on logistic limitations. Ages are reported from 0 to the maximum obtained. The ages reported to ICES are restricted to 1–7. 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, was discontinued in 2003 and has been replaced, (by the IRGFS). There were also problems regarding consistency of survey methodology.

- Scottish fourth-quarter west coast groundfish survey (ScoGFSQ4): ages 0–8, years 1996–2007.

The Scottish quarter four survey was presented to the WG for the first time in 2005. To date it has not been accepted as suitable for inclusion in an assessment.

- Irish fourth-quarter west coast groundfish survey (IRGFS); ages 0–3, years 2003–2007.

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 randomized stations. Effort is recorded in terms of minutes towed.

For surveys existing at the time survey descriptions are given in Appendices 1 and 2 of the report of the 1999 meeting of the Northern shelf working group (ICES CM 2000/ACFM:1). Up to 2008 the WG could not use the IreGFS, IRGFS or ScoGFSQ4 surveys in survey based analyses using the available software, due to insufficient number of ages consistently tracked by these surveys, (both the IreGFS and ScoGFSQ4 surveys track ages 1 and 2 well but not other ages). Therefore, all subsequent analyses were carried out using only the ScoGFSQ1 series.

B.4. Commercial cpue

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.

Table A9.1 summarize commercial effort and landings-per-unit effort. No commercial cpue data have been used in the final assessment presented by the WG during any meeting since 1999, although the Scottish series were previously used in exploratory and comparative analyses. 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. No cpue data has been presented for years after 2005.

B.5. Other relevant data

None.

C. Historical stock development

Models used: XSA (up to 2001 WG); TSA (2002 and 2003 WG); TSA and XSA (2004 WG); SURBA (2005 WG). SURBA and TSA (2006 and 2007 WG); TSA (2008 WG).

Software used: Lowestoft VPA suite; 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	1978–last data year	1–7+	Yes
Canum	Catch-at-age in numbers	1978–last data year	1–7+	Yes
Weca	Weight-at-age in the commercial catch	1978–last data year	1–7+	Yes
West	Weight-at-age of the stock at spawning time.	1978–last data year	0–7+	Yes:
Mprop	Proportion of natural mortality before spawning	1978–last data year	1–7+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1978–last data year	1–7+	No – set to 0 for all ages in all years
Matprop	Proportion mature-at-age	1978–last data year	1–7+	No – the same ogive for all years
Natmor	Natural mortality	1978–last data year	1–7+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range	Usage
Research Vessel Survey				
Tuning fleet 1	ScoGFS-Q1	1985–last data year	1–7	Used since ????
Tuning fleet 2	IreGFS-Q4	1993–2002	0–3	Not used
Tuning fleet 3	ScoGFS-Q4	1996–last data year	0–8	Not used
Tuning fleet 4	IRGFS – Q4	2003–last data year	0–3	Not used
Commercial cpue data				
Tuning fleet 5	Scottish Seiners	1978–last data year	1–6	Not used
Tuning fleet 6	Scottish Light Trawlers	1978–last data year	1–6	Not used
Tuning fleet 7	Irish Otter Trawlers	1995–last data year	1–7	Not used

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 5 years or the 5 oldest ages

S.E. of the mean to which the estimate are shrunk = 2.00

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

TSA

The current set-up of TSA was adopted at WGNSDS2006 and reviewed and confirmed at WGNSDS2007. The main issues are summarized in the following bullet points while long standing parameter values are given in a text table.

- No persistent trend in survey catchability is included as there is no *a priori* reason to suspect a trend in survey catchability and, without landings data to contrast against, there is no divergence between catch and survey data to measure.
- At WGNSDS2007 a TSA run was also performed with catch data excluded for the years 1995-2005 but 2006 catch data included, (i.e. assuming 2006 commercial data to be unbiased). The mean F estimate reduced sharply for the terminal year but the WG concluded that such an approach introduced an inconsistency in the mortality time-series. It was considered the mortality estimate reverted from an estimate of mortality over and above M to one of fishing mortality. The WG also considered that the terminal year estimate combined with the current fixed value of natural mortality would be an underestimate of overall mortality.
- The mean fishing mortality reference points for VIa cod were determined under the assumption of M=0.2. The values of mean F from the current assessments are estimates of mortality over and above M i.e. mortality from fishing plus non fishing mortality which cannot be encompassed within the standard value for natural mortality. For management purposes this combined mortality would still need to fall below the level of F_{lim}, as higher levels of mortality over and above M are considered to have led to stock decline in the early 1980s.
- Using TSA run on a reduced set of catch data would allow conventional forecasts based on absolute assessment results (forecasts using relative assessment results were considered of limited use in a previous year) while also producing assessment results that matched (to the greatest extent possible) the SSB trends found from an agreed best SURBA run and which accounted (to a greater or lesser extent) for unallocated mortality.

TSA parameter settings for analyses conducted at 2004, 2005, 2006, 2007 and 2008 WG.

Parameter	Setting	Justification
Age of full selection.	am = 4	Based on inspection of previous XSA runs.
Multipliers on variance matrices of measurements.	Blandings(a) = 2 for ages 6, 7+ Bsurvey(a) = 2 for age 1, 5, 6	Allows extra measurement variability for poorly sampled ages.

Parameter	Setting	Justification
Multipliers on variances for fishing mortality estimates.	H(1) = 4	Allows for more variable fishing mortalities for age 1 fish.
Downweighting of particular data points (implemented by multiplying the relevant q by 9)	Landings: age 2 in 1981 and 1987, age 7 in 1989. Discards: age 1 in 1985 and 1992, age 2 in 1998. Survey: age 1 in 2000, age 2 in 1993, age 6 in 1995. Ages 4, 5, 6 in 2001 (the latter are from a single large haul, 24 fish > 75 cm in 30 mins). Age 3 in 2008 (large haul near 4W line). Age 2 in 2011.	Large values indicated by exploratory prediction error plots.
Discards	Discards are allowed to evolve over time constrained by a trend. Ages 1 and 2 are modelled independently.	
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, 1980) 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.	

SURBA

The model settings for the preferred SURBA run in 2005, 2006 and 2007 were:

	Year range:	1985–2005
	Age range:	1–6
	Catchability at-age:	0.0256, 0.1035, 0.4711, 0.7493, 1.0, 0.6685
2005 WG	Age weighting:	1.0, 1.0, 1.0, 1.0, 1.0, 1.0, for all ages in all years
	Lambda:	2.0
	Cohort weighting:	Not applied
2006 WG	Year range:	1985–2006
	Age range:	1–6
	Catchability at-age:	0.0304, 0.1045, 0.2092, 0.4443, 0.7217, 1
	Age weighting:	1.0, 1.0, 0.0, 0.0, 0.0, 1.0 for 2001 1.0, 1.0, 1.0, 1.0, 1.0, 1.0 for all other years
	Lambda:	2.0
	Cohort weighting:	Not applied

	Year range:	**1985–2005**
	Age range:	1–6
	Catchability at-age:	0.0256, 0.1035, 0.4711, 0.7493, 1.0, 0.6685
	Year range:	**1985–2007**
	Age range:	1–6
	Catchability at-age:	0.0226, 0.1036, 0.2000, 0.4167, 0.6885, 1
2007 WG	Age weighting:	1.0, 1.0, 0.0, 0.0, 0.0, 1.0 for 2001 1.0, 1.0, 1.0, 1.0, 1.0, 1.0 for all other years
	Lambda:	2.0
	Cohort weighting:	Not applied

Values (but not method of determination) of catchabilities-at-age differed between WGs. Catchabilities-at-age were derived by comparing raw survey indices with numbers-at-age estimates from a TSA run. These ratios were then standardized relative to a given reference age. The justification is that even if there are concerns over misreporting of commercial data, so long as the relative catch numbers between ages remain constant the catchabilities generated using a catch-at-age analysis will be valid. A TSA run not allowing a trend in survey catchability and using all years of available catch data is chosen to provide the TSA output.

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 WGNSDS2008

Initial stock size: Taken from XSA or TSA for age 1 and older.

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.

- Natural mortality: Set to 0.2 for all ages in all 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.

Weight-at-age in the catch: Average weight of the three last years.

Exploitation pattern: Average of the three last years. Not partitioned to give landings and discard F as the WG consider the mortality outputs from TSA not to represent F at age but rather estimated total mortality that cannot be accounted for by the standard value used for natural mortality. Therefore that it was not possible to determine the proportion of the mortality caused by fishing.

Intermediate year assumptions: *Status quo* Z-0.2 (0.2 being the current value assumed for natural mortality at all ages).

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.

In 2006–2011 short-term projections were made but it was considered little confidence could be placed in the short-term projections. This was because concerns over the reliability of the commercial catch-at-age data lead to use of a catch-at-age analysis but with landings and discards data removed from 1995 onward. The WG considers the mortality outputs from TSA not to represent F at age but rather estimated total mortality that cannot be accounted for by the standard value used for natural mortality. These mortality values are currently labelled 'Z-0.2' (0.2 being the current value assumed for natural mortality-at-all-ages). Consideration of the diagnostics lead to the conclusion that mean Z-0.2 is estimated with considerable uncertainty (these estimates are based on the age structure indicated by the survey series, which are known to be noisy).

In 2005 projections were attempted using outputs from a survey based assessment and an ad-hoc spreadsheet. Similar concerns over adequate estimation of mortality also apply in this case.

E. Medium-term projections

Medium-term projections have been carried out in previous years using the Aberdeen software suite.

Medium-term predictions have not been made at any of the 2005 to 2008 working groups on the grounds that recruitment could not be assumed to conform to historical patterns given the stock was at a historic low.

F. Long-term projections/Yield and biomass-per-recruit

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.

Long-term projections have not been performed since 2008 because it is not considered appropriate to do so when the assessment is conducted as an update assessment.

Yield and biomass per recruit are taken from ICES standard graphs.

G. Biological reference points

Reference Point	Technical Basis
F_{MSY} = 0.19	B_{pa}
$B_{trigger}$ = 22 000 t	Provisional proxy by analogy with North Sea cod Fmax. Fishing mortalities in the range 0.17–0.33 are consistent with F_{MSY}
B_{pa} = 22 000 t	Previously set at 25 000 t, which was considered a level at which good recruitment is probable. Since 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

MSY Explorations

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 A9.5 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 a9.6 to a9.8 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} was very close to F_{lim}. For the smooth hockey-stick SRR F_{crash} was estimated between F_{lim} and F_{pa}. The value of F_{MSY} was well defined and considerably lower than F_{pa} for all three SRR. The level of removals possible at the estimated F_{MSY} was poorly defined however. Circles showing the data points 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 were inside confidence limits for these metrics at the estimated Z-0.2 mortality rates by 2010.

Figure a9.9 shows estimation of yield-per-recruit. F_{max} was well defined for this stock. Comparison of F_{max} to F_{MSY} estimated using the three SRRs (Figures a9.6–a9.8) 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}.

H. Other issues

Natural Mortality: A report by the Sea Mammal Research unit (SMRU, 2006) gives estimates of cod consumed by grey seals to the west of Scotland for two years, based on analysis of collected seal scats. The estimated values and their confidence limits are given in the following text table.

Year	Total consumption (Tonnes)	95% C.I.	Cod TSB from 2008 assessment (Tonnes)
1985	5372	3023–8831	30 267.6
2002	7131	4128–9920	12 789.3

These values, although highly uncertain, suggest predation mortality on cod is greater than can be accommodated by the standard value of natural mortality used for gadoid species in ICES Division VIa. A working document detailing approaches to quantify the level of mortality caused by seal predation and the results obtained was submitted to WGNSDS2008, (Holmes, 2008).

I. References

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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.

Table A9.1. Cod in Division VIa. Landings-effort series made available to the WG. Effort (first column) is given as reported hours fished per year, numbers landed are in thousands.

ScoSEI	Scottish seiners					
1978	2005					
1	1	0	1			
1	6					
33 617	743.00	224.48	64.14	41.83	13.01	3.72
38 465	120.91	128.90	197.32	25.17	19.13	5.03
38 640	403.38	223.25	75.45	37.21	13.44	4.13
37 208	26.53	473.12	129.81	42.39	7.95	0.88
36 689	405.78	139.18	137.35	31.99	14.11	3.76
38 080	1205.65	509.03	65.34	58.51	14.63	4.88
29 561	275.95	56.40	78.78	25.58	17.39	10.23
26 365	982.36	199.94	27.31	23.41	4.88	4.88
19 960	348.05	84.78	30.70	6.35	4.23	1.06
26 332	4461.36	552.51	48.68	67.56	18.88	4.97
21 383	63.84	451.06	41.87	4.98	3.99	1.00
39 350	560.31	138.71	152.45	31.07	6.74	4.16
23 235	99.96	566.35	31.11	60.19	11.87	2.06
25 787	364.64	132.65	164.98	16.25	28.93	8.39
20 273	1390.05	228.60	35.92	46.85	4.09	5.01
24 315	86.98	389.31	87.56	10.26	16.08	2.90
21 305	175.94	138.49	145.48	23.03	5.90	4.96
21 950	134.47	372.92	68.30	60.81	9.78	2.11
15 205	82.21	318.54	106.62	17.28	15.61	1.30
11 449	317.44	102.89	77.06	23.31	12.33	13.52
11 166	98.32	656.93	28.31	12.89	3.30	1.31
8638	40.64	60.26	58.57	2.03	1.08	0.74
6431	243.84	32.99	13.49	7.36	0.39	0.35
5893	7.48	101.54	4.62	0.80	1.05	0.07
3817	32.15	25.07	26.48	2.02	0.62	0.30
2370	8.76	31.65	4.56	2.22	0.07	0.01
1159	0.66	0.69	0.60	0.12	0.44	0.05
476	1.67	3.77	0.74	0.54	0.21	0.03

Table A9.1. cont. Cod in Division VIa. Landings-effort series made available to the WG. Effort (first column) is given as reported hours fished per year, numbers landed are in thousands.

	Scottish light trawlers					
ScoLTR						
1978	2005					
1	1	0	1			
1	6					
127 387	2242.51	685.36	185.50	133.92	32.74	7.94
99 803	161.44	212.39	485.00	57.12	31.06	6.01
121 211	694.04	699.09	328.14	129.35	34.24	10.46
165 002	123.59	1588.52	524.05	183.42	31.06	3.88
135 280	1623.74	367.84	616.01	163.81	46.10	5.89
112 332	1634.45	1408.23	196.00	163.65	51.38	18.08
132 217	974.48	593.35	419.46	85.37	93.80	30.56
142 815	6421.55	1734.74	218.21	131.35	21.19	22.25
126 533	1403.22	376.19	384.35	67.13	30.32	3.25
131 720	23524.40	1058.11	143.60	116.68	27.92	12.96
158 191	319.66	2464.85	309.82	49.97	37.98	8.00
217 443	1795.80	291.27	989.06	200.39	46.89	19.53
142 502	195.62	1334.61	87.08	202.71	37.25	6.93
209 901	2081.88	815.93	534.85	38.68	97.23	30.51
189 288	2197.22	655.91	193.06	240.73	17.16	24.27
189 925	246.98	1274.46	301.98	46.14	80.17	10.51
174 879	348.87	458.79	463.67	88.90	16.55	22.76
175 631	488.40	839.26	188.99	168.65	21.32	4.31
214 159	133.75	790.18	355.22	79.78	83.08	9.88
179 605	819.38	371.40	394.35	109.46	18.88	18.82
142 457	181.66	1343.76	100.25	64.43	21.22	5.63
98 993	129.77	226.02	433.87	20.55	19.74	11.62
76 157	988.51	233.22	79.43	119.99	6.99	6.12
35 698	95.85	461.23	51.31	26.92	24.54	1.39
15 174	219.71	85.50	183.12	15.46	5.34	6.88
9357	31.84	192.04	37.63	49.04	2.22	0.82
7113	15.33	25.63	33.93	5.11	10.68	1.20
3063	12.70	37.33	14.32	15.40	2.88	2.79

Table A9.1. cont. Cod in Division VIa. Landings-effort series made available to the WG. Effort (first column) is given as reported hours fished per year, numbers landed are in thousands.

IreOTR	Irish otter trawlers						
1995	2005						
1	1	0	1				
1	7						
56 335	77	453	115	33	6	1	1
60 709	72	200	95	30	15	4	1
62 698	215	120	57	24	6	5	2
57 403	28	138	16	16	7	3	0
53 192	10	65	16	3	2	0	0
46 913	131	42	17	6	1	0	0
48 358	19	90	14	5	3	0	0
37 231	39	32	22	2	1	0	0
39 803	7	37	6	5	1	0	0
35 140	3	7	3	1	1	0	0
30 941	4	8	2	1	0	0	0

Table A9.2. 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 A9.2. 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 hockey-stick

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	

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		

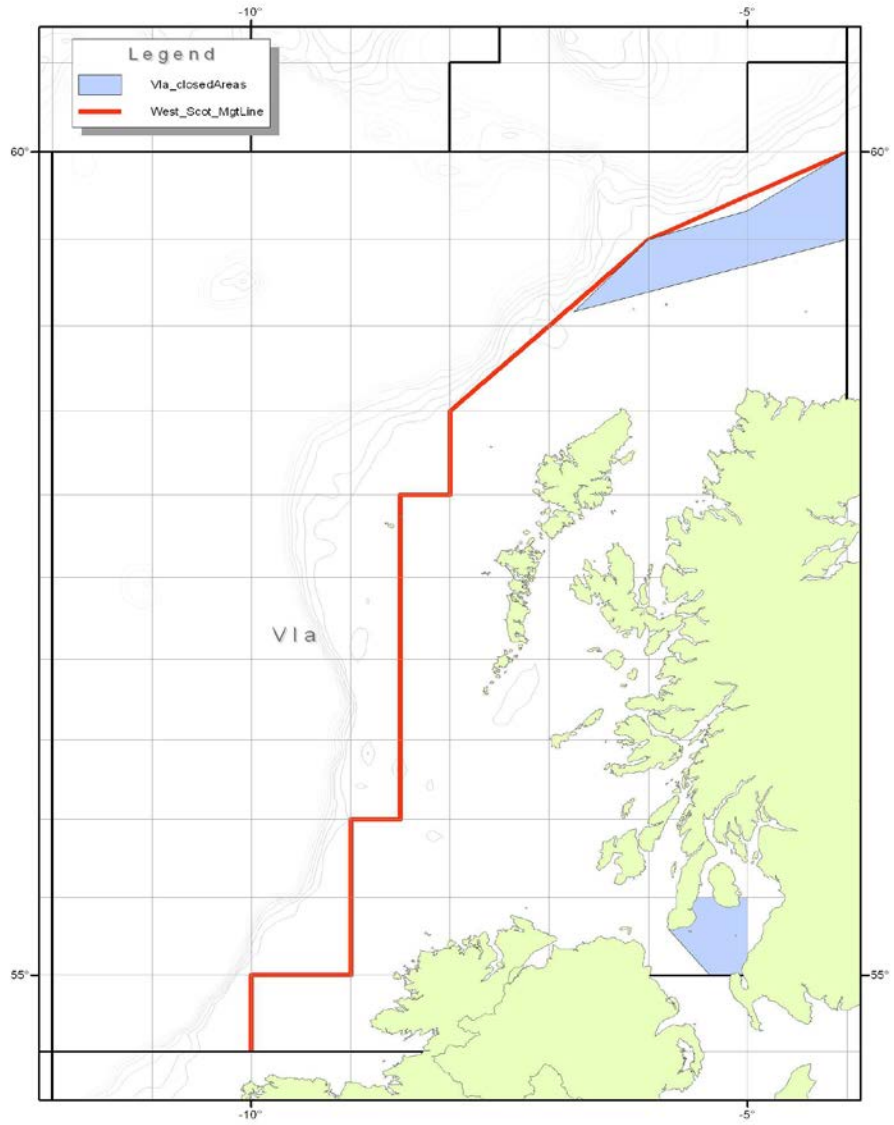


Figure A9.1. Cod in Division VIa. Map showing closed area in the far northeast of VIa known as the 'windsock' introduced by Council Regulation No 2287\2003 and closed area in the Clyde. The Sea Fish (prohibited methods of fishing) (Firth of Clyde) Order 2002. Red line running east of shelf edge is the West of Scotland management line according to Reg (EC) 423/2004 and repealed in 2009.

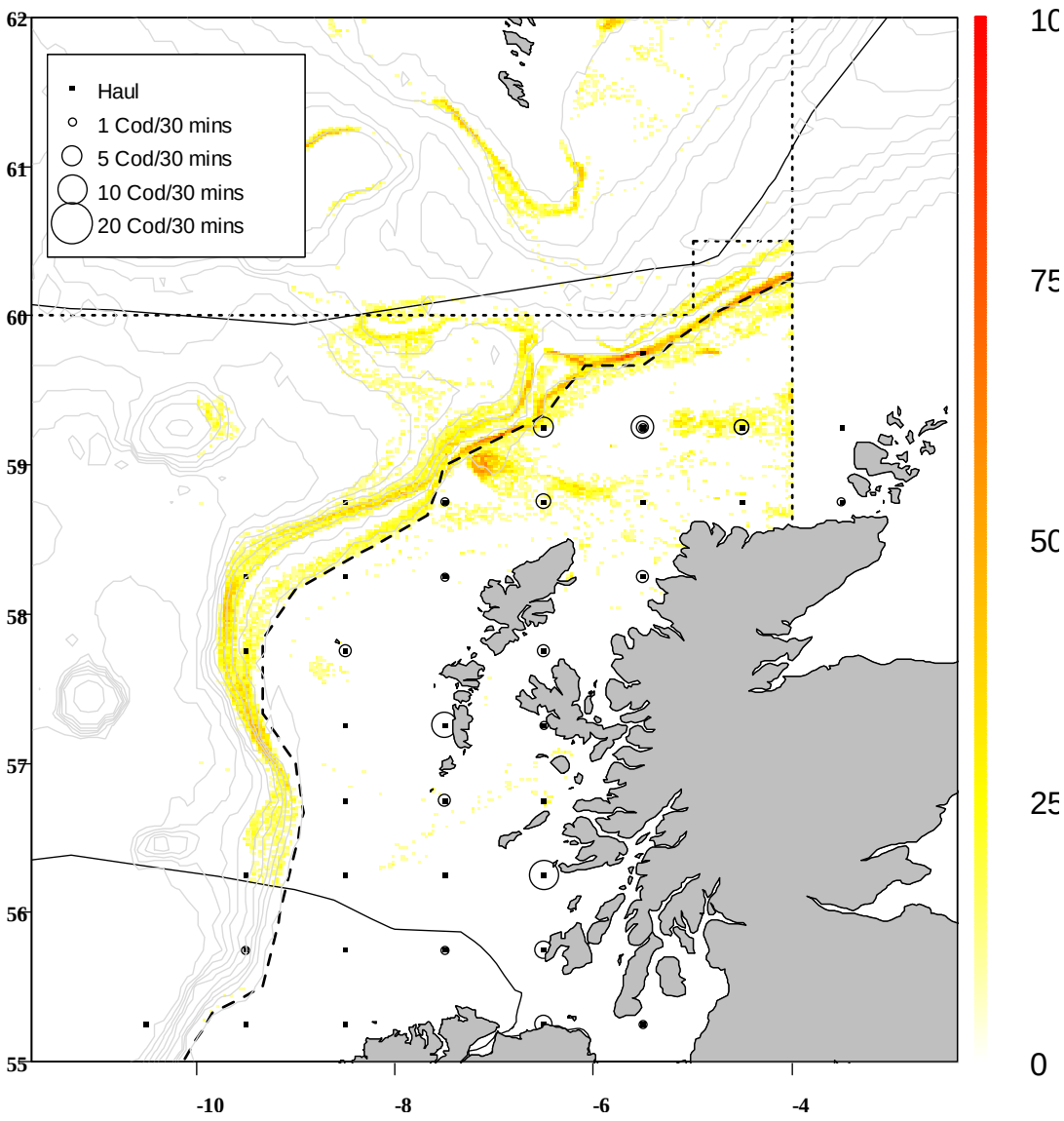


Figure A9.2. Scottish Q1 2010 Survey cpues of Cod plotted over Scottish (and other EU landing into Scotland) VMS data on fishing activity (annual VMS pings per square n.m.) associated with TR1 gear and trips with cod landings. Scottish survey results are centred on the statistical rectangle sampled. 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.

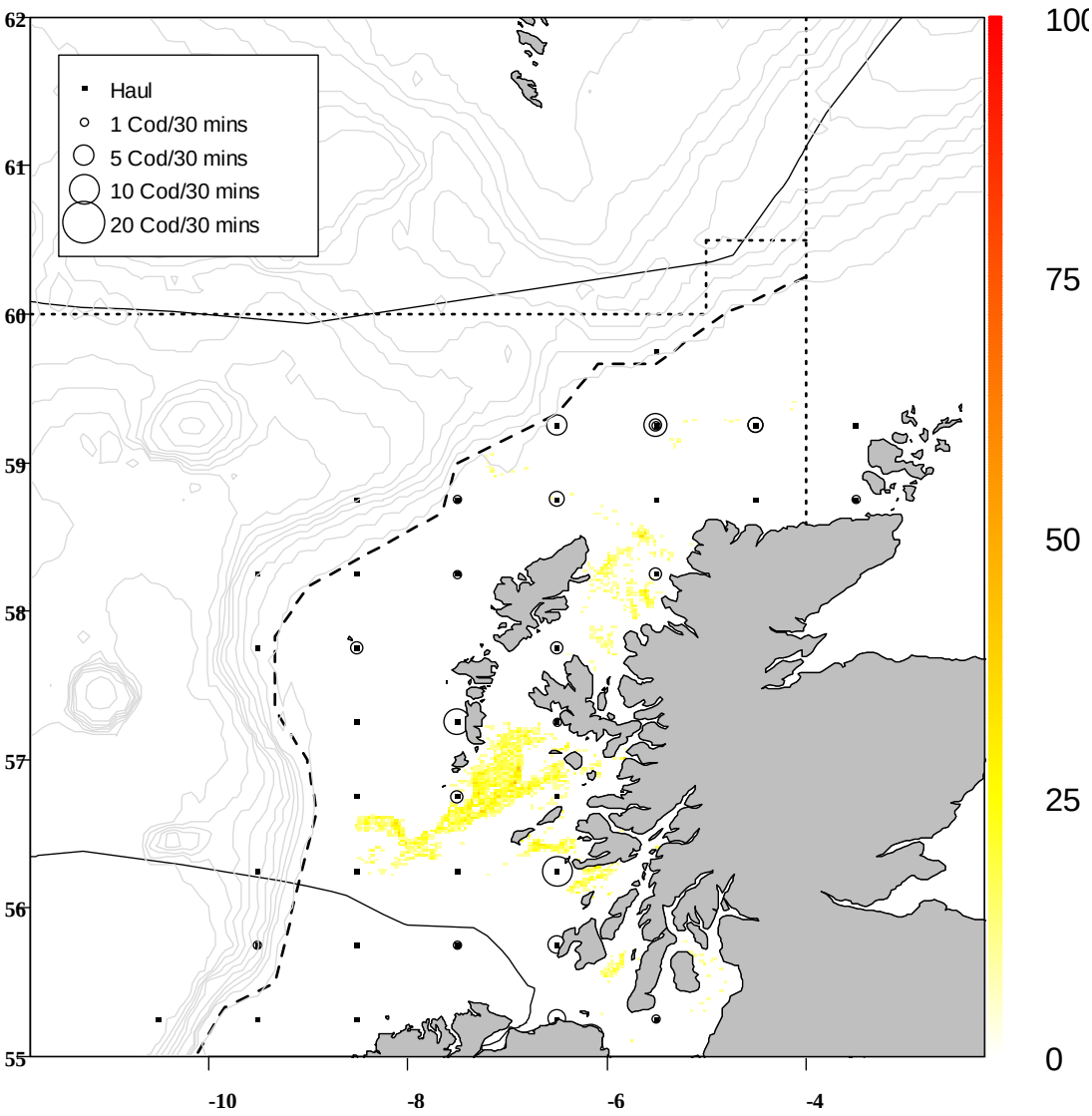


Figure A9.3. Scottish Q1 2010 Survey cpues of cod plotted over Scottish (and other EU landing into Scotland) VMS data on fishing activity (annual VMS pings per square n.m.) associated with TR2 gear and trips with cod landings. Scottish survey results are centred on the statistical rectangle sampled. 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.

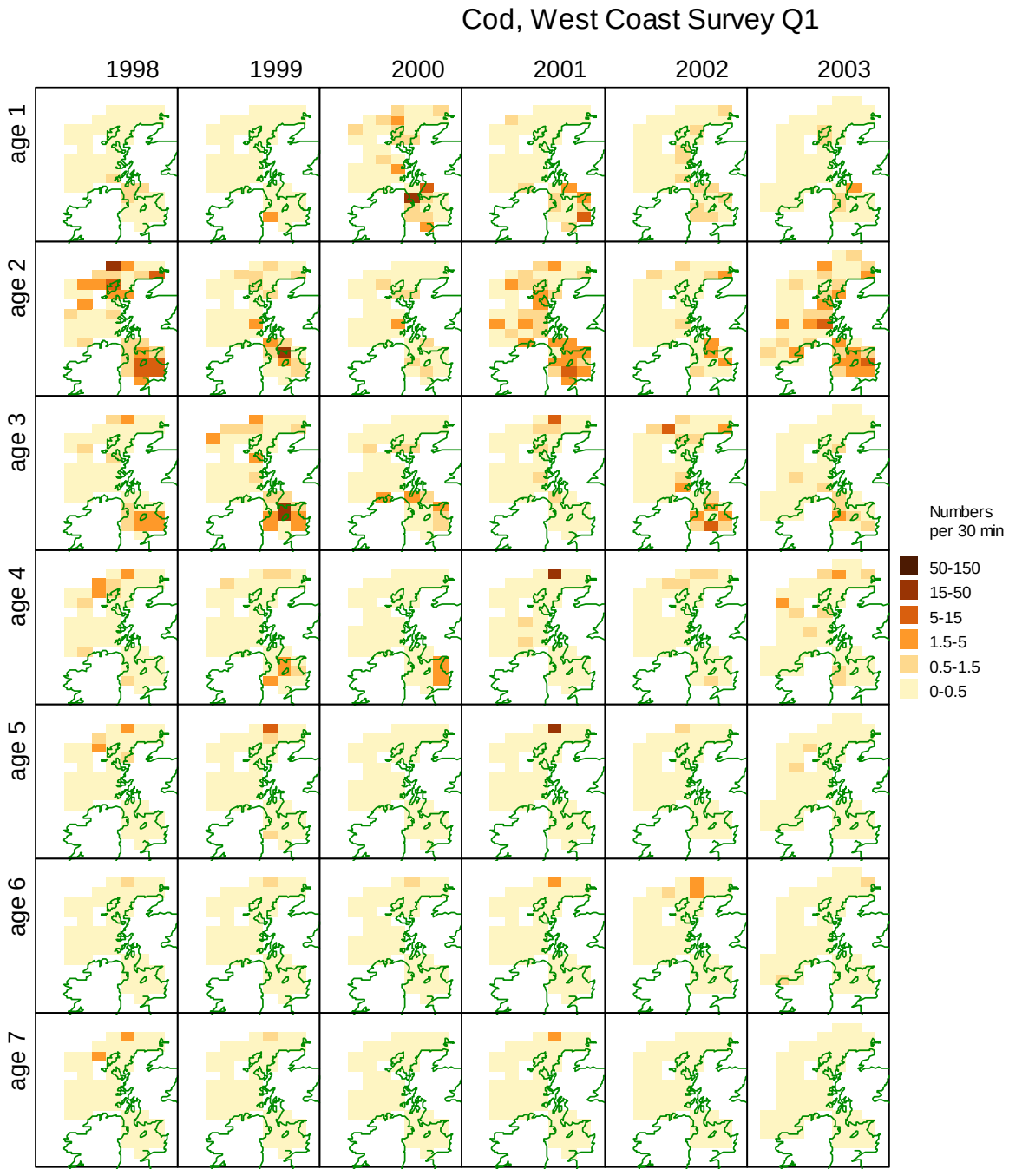


Figure A9.4. Cod in Division VIa. Cpue numbers-at-age by ICES statistical rectangle resulting from Scottish quarter one groundfish survey (ScoGFSQ1). Cohorts can be followed down diagonals.

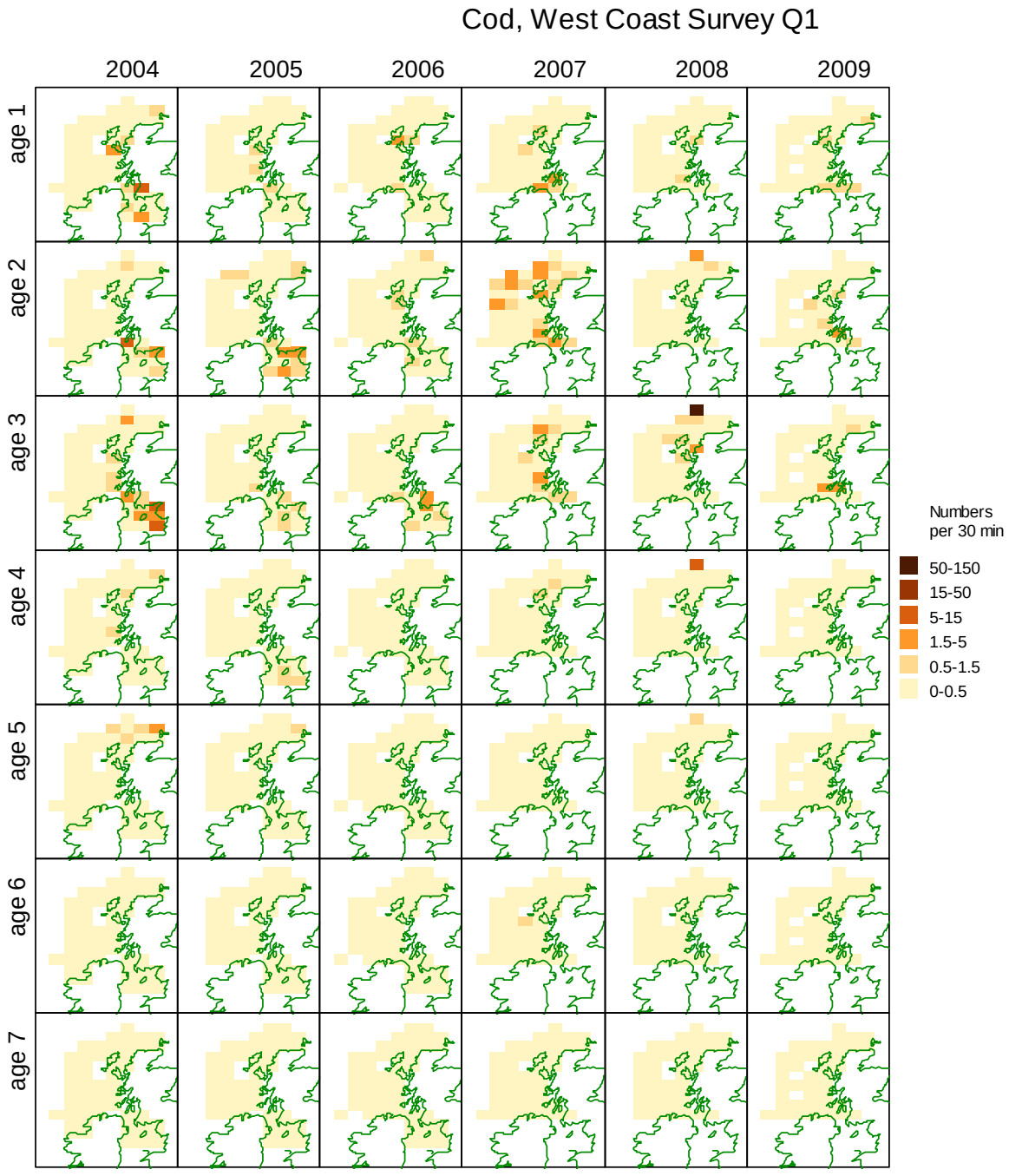


Figure A9.4. cont. Cod in Division VIa. Cpue numbers-at-age by ICES statistical rectangle resulting from Scottish quarter one groundfish survey (ScoGFSQ1). Cohorts can be followed down diagonals.

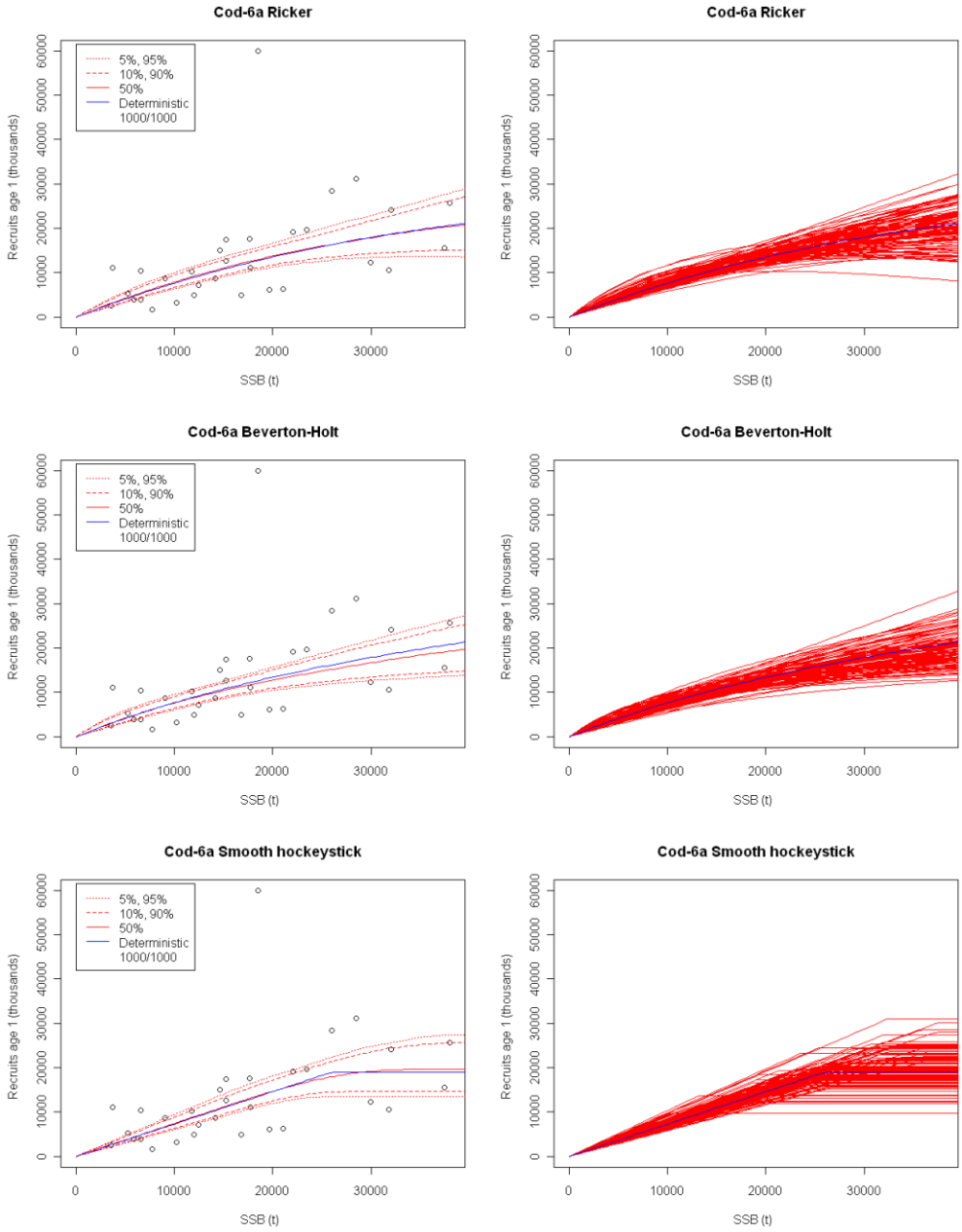


Figure a9.5. Cod in Division VIa. Stock–recruit relationships fitted by srmsymc package. Models were fitted using 1000 MCMC resamples. Left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic 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.

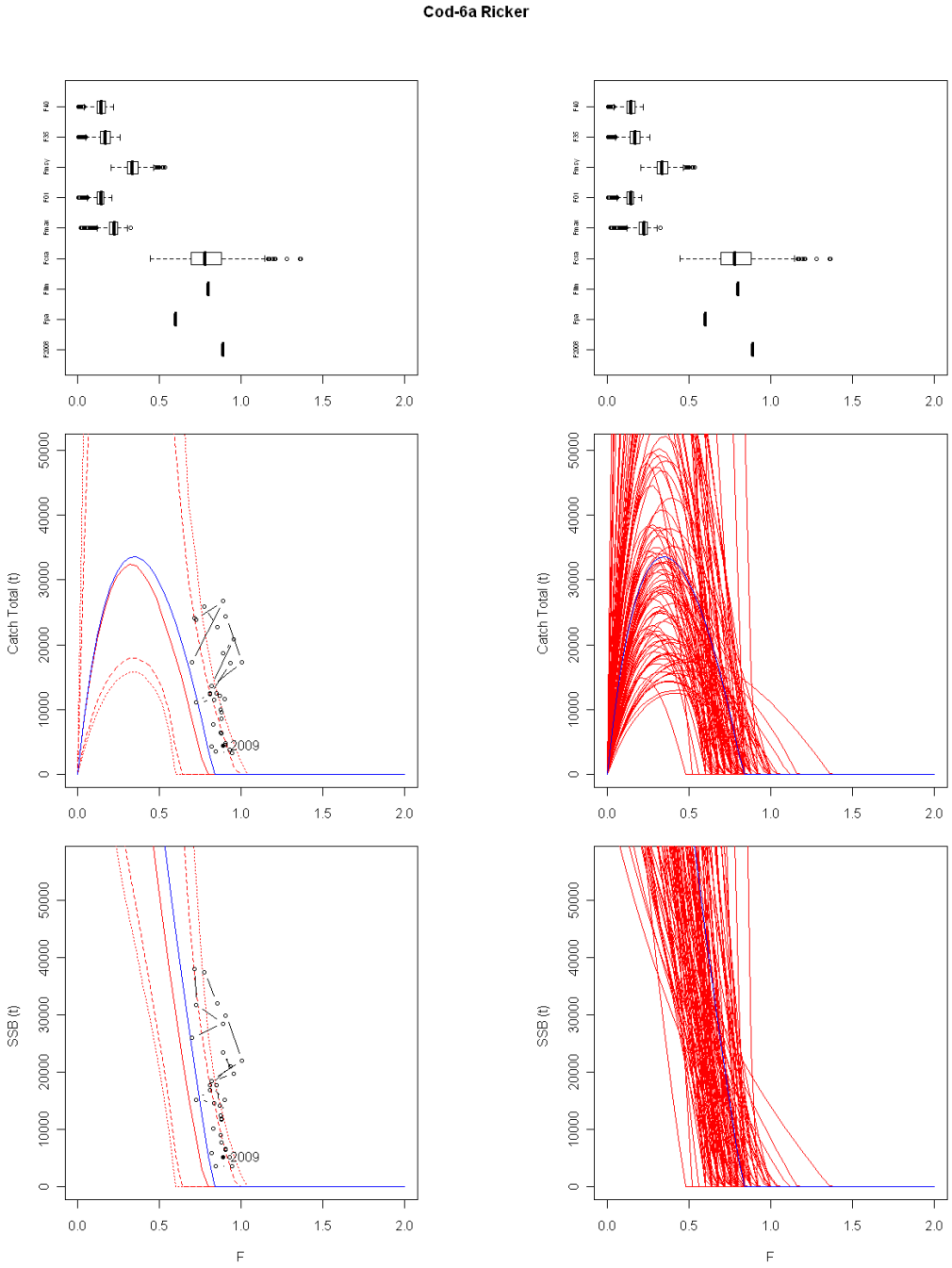


Figure a9.6. Cod in Division VIa. srmsymc package. Estimation of F reference points and equilibrium yield and SSB against mortality using Ricker recruitment model. For yield and SSB plots left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. Circles show data points 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.

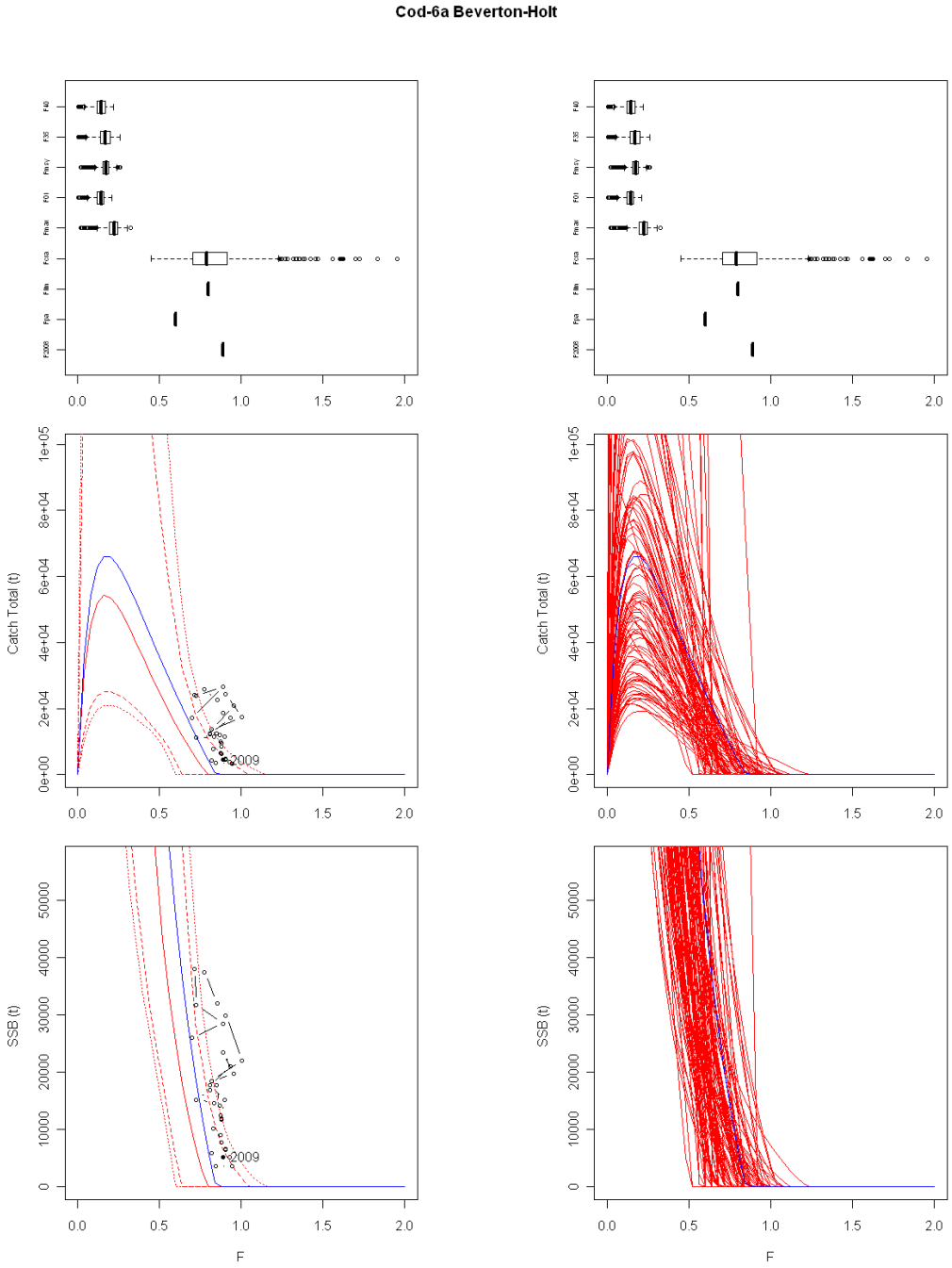


Figure a9.7. Cod in Division VIa. srmsymc package. Estimation of F reference points and equilibrium yield and SSB against mortality using Beverton–Holt recruitment model. For yield and SSB plots left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. Circles show data points 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.

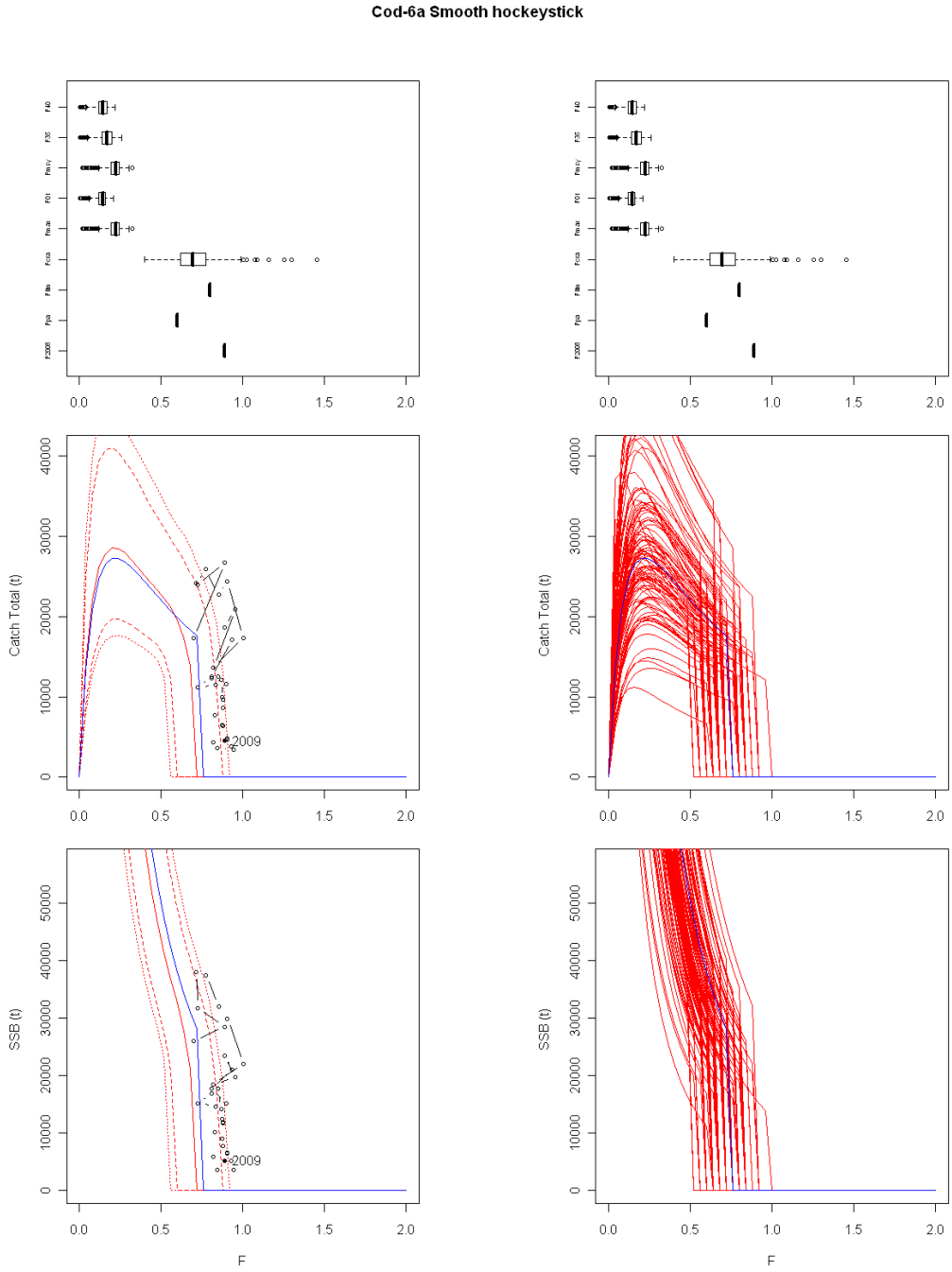


Figure a9.8. Cod in Division VIa. srmsymc package. Estimation of F reference points and equilibrium yield and SSB against mortality using smooth hockey stick recruitment model. For yield and SSB plots left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. Circles show data points 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.

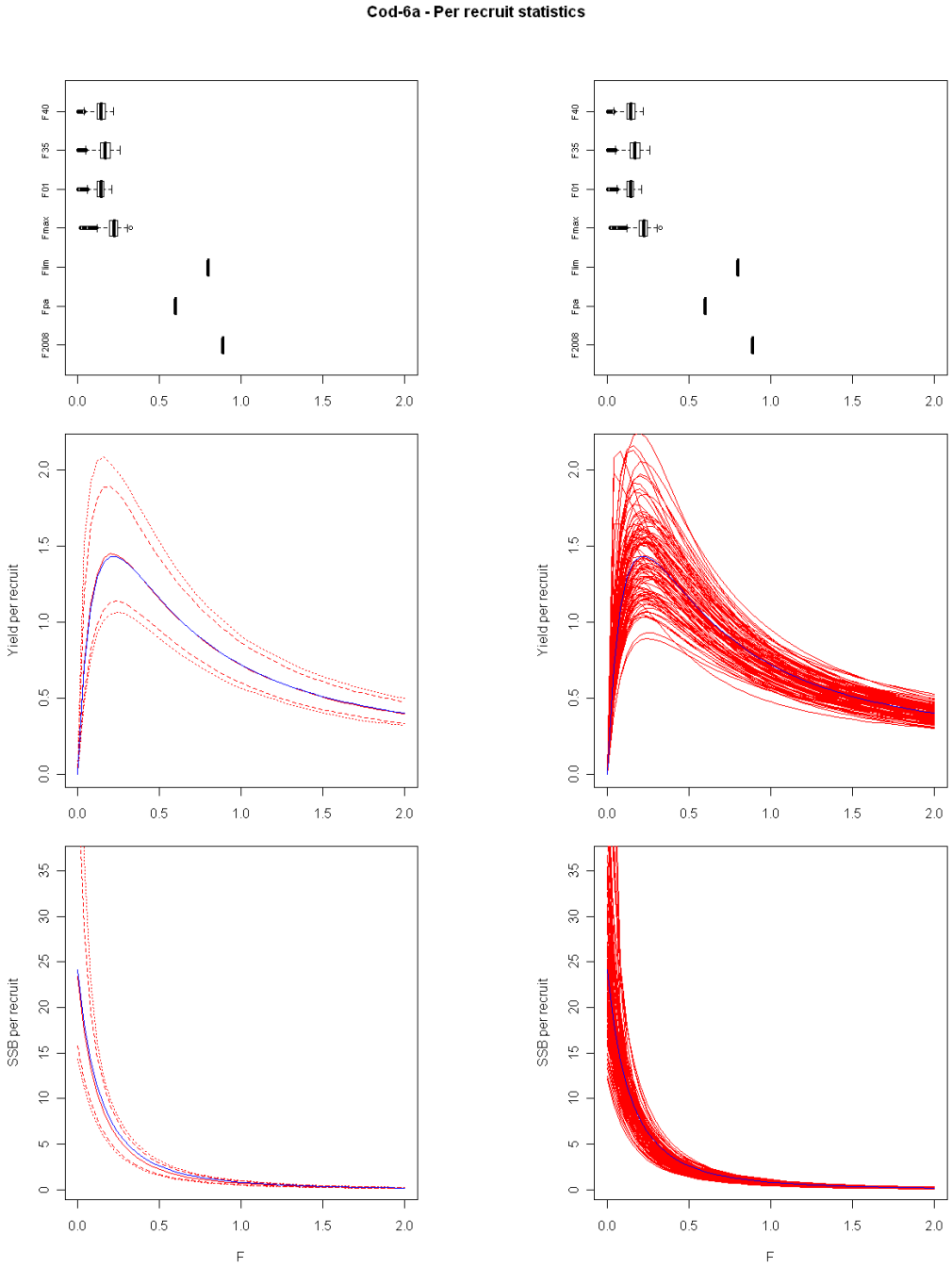


Figure a9.9. Cod in Division VIa. srmsymc package. F reference points and yield-per-recruit and SSB per recruit against mortality. For VIa cod the model has been run using total removals over and above natural mortality, i.e. the *x*-axis represents Z-0.2.

Stock Annex 3.3: Haddock in 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	June 2011

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 trawls[1];	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

Geographic 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 north-east 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 the 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
	σv1	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
	σv2	Persistent changes in discard-ogive slope	0.02	0.61	0.43	0.23	0.002	0.000	0.000
Trend parameters	θv1	Trend parameter for discard-ogive intercept	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
	θv2	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

In the 2011 assessment two factors dictated that an extra run of the assessment was needed. The extra run was due to the changes in the ScoGFS WCIBTS Q1 survey. The gear was changed from "C" to "D" the length of the sweeps and the survey design was also changed. The review group requested an assessment run without the survey as being more suitable at this time as the impacts of these changes can't be accessed at this point.

From Figure 4 to Figure 10 are the resulting plots from the exclusion of the ScoGFS WCIBTS Q1 (2011) from the assessment. Also, from Table 2 to Table 5 are showed the numbers-at-age, fishing mortality and respective standard errors for this assessment.

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

Table 2. Haddock in Division VIa. Estimates of population abundance (in thousands) from the final TSA run excluding the ScoGFS WCIBTS Q1.

Year	1	2	3	4	5	6	7	8+
1978	71511	7953.4752	2466.6573	58817.723	4399.9717	620.54015	472.15325	1033.2709
1979	152330	43262.27	3839.6299	1076.8068	22916.21	1546.7218	231.59062	570.52427
1980	489170	86970.534	17994.279	1493.5997	382.12049	7631.7704	468.74903	251.64741
1981	63918	318221.22	44454.034	7284.759	581.80203	157.17537	3025.8694	272.31699
1982	70160	42795.134	188419.33	22423.229	3527.8024	287.43245	78.978531	1613.3261
1983	45008	47419.349	25310.571	101495.94	11555.727	1834.9871	148.19302	882.6174
1984	318687	28230.425	25364.46	11319.778	46277.706	5274.7842	824.04775	475.5231
1985	73687	195452.91	11938.788	9613.4372	4793.0103	19568.215	2182.2413	537.13964
1986	59942	43044.812	93789.406	4986.6489	3995.988	2099.7876	8166.3103	1164.1055
1987	263894	39377.097	23512.35	47644.009	2529.5418	2051.2944	1094.1885	4780.0425
1988	21886	146013.2	14912.295	8020.9797	16264.165	832.60373	669.73192	1987.1493
1989	17132	11324.424	61304.242	5445.684	2811.0486	5745.6078	300.83283	950.2902
1990	97618	8508.3511	4355.5922	22992.159	1905.0125	935.61648	1928.6168	423.30689
1991	125985	59286.935	3434.92	1804.4692	9453.9793	778.90332	386.22053	961.37077
1992	177127	70527.169	24089.421	1215.8146	681.16251	3461.2513	289.60642	496.81973
1993	176515	111639.32	33294.018	10080.114	524.96368	299.69264	1481.652	338.94809
1994	58444	102117.43	41704.757	9556.0646	3022.1212	146.06625	82.791715	524.97297
1995	203277	33184.159	48377.828	16322.817	3549.3537	1178.9858	57.675828	234.89197
1996	109566	121118.11	15125.276	19784.432	6332.9812	1377.9497	468.35997	115.15626
1997	127295	60405.874	50587.788	5401.3533	7157.1917	2209.4954	489.96244	208.79009
1998	141955	71429.546	24673.25	17860.19	1923.5257	2577.9139	773.10525	247.1552
1999	32178	79038.396	28728.627	8700.4878	6080.6304	691.96806	947.98578	356.44249
2000	500855	17333.064	30527.79	9692.7928	3049.7945	1940.078	240.37994	450.20011
2001	189241	256830.93	5963.04	8740.6736	2765.2091	910.74311	517.6483	196.67606
2002	95560	115130.85	122879.42	2544.8936	3413.207	1083.3432	367.51209	278.00487
2003	114604	63561.211	67029.514	68073.153	1259.5986	1683.2593	551.76604	326.56338
2004	45357	73452.95	34419.271	35576.79	30430.606	564.99894	751.27884	396.7983
2005	30639	28433.304	38762.082	17482.662	16679.717	13678.204	249.13664	515.08943
2006	94621	17625.562	13133.957	15976.778	6492.4124	6341.0195	4849.5477	277.33071
2007	20966	60471.134	8391.8261	6436.0835	6986.1193	2790.1301	2755.6687	2177.3353
2008	10158	13104.436	36378.104	4566.5856	3328.4838	3529.9335	1431.7701	2523.8814
2009	18365	6531.9994	8011.8525	22917.53	2602.1217	1929.0403	2016.2096	2274.1287
2010	81533	12664.574	4030.31	5267.347	14160.908	1586.1879	1182.9705	2632.6019
2011	95193.534	54998.267	7764.4203	2565.9746	3226.4698	8478.6461	965.21726	2316.4433
2012	105073.51	64068.359	33025.829	4830.2377	1506.1355	1893.8226	4976.6627	1926.2176

Table 3. Haddock in Division VIa. Standard errors of estimates of population abundance (in thousands) from the final TSA run excluding the ScoGFS WCIBTS Q1.

Year	1	2	3	4	5	6	7	8+
1978	8047.816	720.02213	292.59288	368.48748	1114.2633	199.48067	116.71953	303.53896
1979	15308.379	4200.0915	321.9664	137.01621	1909.3723	532.21244	102.58537	167.67008
1980	41826.973	8467.3081	2259.1342	167.82466	64.679394	1124.5143	254.84345	100.37396
1981	7151.0116	26840.737	5079.7018	1148.5223	93.084133	36.810453	637.89165	149.62961
1982	7900.8268	4840.9195	16816.503	2696.9709	590.08569	53.931397	21.530754	395.92286
1983	6113.5091	5307.5322	2942.5752	8987.6235	1342.213	312.30536	30.77195	214.82237
1984	35027.434	3471.8591	2642.0116	1233.0267	3526.8804	530.63158	126.37837	88.474553
1985	8314.7465	19457.641	1535.3836	1216.5554	480.46793	1967.9299	312.2743	84.934134
1986	6564.9094	4566.2118	9236.856	581.95808	497.1424	268.7436	1182.3987	197.89924
1987	34455.227	3997.2912	2581.071	4614.2396	278.42778	253.10449	154.80279	709.79358
1988	4285.7269	16083.758	1523.2368	952.53918	1751.1453	114.42887	121.46965	343.19652
1989	4056.0757	1564.1736	6628.4547	611.95585	358.11404	748.85494	53.748503	177.91478
1990	11743.532	1700.4597	569.26886	2816.1787	242.61217	160.12583	369.41823	97.825112
1991	13319.768	6728.7407	541.72771	208.12378	1047.2666	97.996336	69.059769	174.77917
1992	17477.556	6674.3874	2673.4049	174.58838	71.716278	437.08658	44.629669	85.107193
1993	19126.475	10656.266	2927.845	1092.7485	57.304139	30.616036	195.80065	47.290467
1994	11445.441	11514.868	4152.7617	1009.3753	290.82597	12.875464	10.881152	67.523694
1995	27361.903	6830.3195	7186.27	2707.4021	610.41081	192.40582	9.8772315	44.284317
1996	19933.203	18761.41	3367.7688	3676.4663	1264.0729	283.95635	96.660931	25.989949
1997	21784.008	11100.228	9124.7715	1064.85	1233.2848	439.65034	106.2841	46.042932
1998	22251.322	11588.279	4373.3613	3144.7812	302.28035	366.27004	140.20554	46.31955
1999	9697.6841	12619.856	4966.4943	1409.1149	1061.5343	105.4437	150.01419	65.291462
2000	99749.748	5313.7587	6130.9273	1877.6321	530.7579	437.31598	48.979366	94.653203
2001	23728.835	47224.205	1636.952	1751.635	508.93025	157.29416	140.86146	49.087387
2002	14538.046	13149.114	19815.713	423.65652	532.33845	152.92911	55.261147	57.725933
2003	14797.78	9359.1337	7806.4929	10078.225	195.6214	259.83585	81.709469	53.775576
2004	6359.8097	9525.6149	5013.9967	4411.447	4400.4975	94.582143	133.02731	68.145255
2005	4310.2684	3723.8898	5487.2049	2370.077	2045.405	2080.8805	45.572073	91.222077
2006	7762.7082	2255.9424	1416.0222	1814.3702	723.64159	759.82252	825.3342	51.529964
2007	3056.4805	4828.5479	1211.2025	709.33563	852.99106	374.44104	429.95394	442.51684
2008	3317.4527	1787.3493	3310.0543	631.6582	398.57987	500.09007	233.69894	442.72866
2009	6761.1634	2241.1756	1132.7681	2253.5259	406.26526	271.52157	338.19498	395.57128
2010	27865.592	4874.5738	1556.3631	865.77603	1689.2063	289.5536	198.21796	453.22054
2011	52620.084	20387.56	3314.0283	1070.0563	630.6655	1347.5353	211.90094	438.97704
2012	58015.433	35942.85	13332.474	2194.1733	674.85376	478.75295	1127.3521	480.08213

Table 4. Haddock in Division VIa. Estimates of fishing mortality from the final TSA run, excluding the ScoGFS WCIBTS Q1.

Year	1	2	3	4	5	6	7	8+
1978	0.2801407	0.4259988	0.6256183	0.748457	0.7517203	0.7378178	0.7282394	0.7328911
1979	0.3607167	0.6557689	0.7401778	0.844548	0.8696603	0.8560245	0.8627367	0.8619518
1980	0.241463	0.4736201	0.6255159	0.7071036	0.6586505	0.6819481	0.6787033	0.6723439
1981	0.2048262	0.3372398	0.4752327	0.4995819	0.4980031	0.4862474	0.5016633	0.4970092
1982	0.1874498	0.3216716	0.4048949	0.4657545	0.4585819	0.4652356	0.4672813	0.4582116
1983	0.2854268	0.430143	0.4364142	0.4705608	0.4864126	0.4932777	0.49228	0.5055616
1984	0.2915295	0.6088407	0.739729	0.6563878	0.6488383	0.6777962	0.6786875	0.6695123
1985	0.3374131	0.5329396	0.6633582	0.6674804	0.6247853	0.6728626	0.6487989	0.641802
1986	0.2130673	0.4068797	0.4707794	0.4679124	0.4556456	0.444357	0.4630799	0.4643127
1987	0.3919381	0.7662297	0.8748018	0.8738184	0.9110475	0.9189747	0.8939703	0.8813878
1988	0.4041582	0.6690786	0.8068914	0.8457092	0.840587	0.8183077	0.8222225	0.8307971
1989	0.4070528	0.6916005	0.7739596	0.836685	0.8715339	0.8751634	0.8682541	0.8654675
1990	0.2998287	0.6669672	0.6825961	0.6817791	0.6865166	0.6717372	0.6841574	0.6833512
1991	0.3672765	0.700521	0.8119483	0.7631985	0.8045777	0.7810298	0.801316	0.7854941
1992	0.2362223	0.500076	0.6584714	0.6318142	0.5816159	0.6161878	0.6091012	0.6008879
1993	0.3411066	0.7377768	1.0007849	0.9330382	0.9074721	0.9822204	0.9439314	0.9511132
1994	0.3703304	0.5321287	0.7292375	0.7887066	0.7331227	0.724985	0.7548749	0.7440576
1995	0.3192126	0.5788908	0.6941574	0.7415358	0.7431782	0.7227438	0.7304985	0.7318265
1996	0.3939535	0.6739112	0.8284382	0.8163859	0.851652	0.8327976	0.8261324	0.8326644
1997	0.3848211	0.7001126	0.8480591	0.8277414	0.7903399	0.8528204	0.8333944	0.8303033
1998	0.3868974	0.7114993	0.8383579	0.8805377	0.8154444	0.7966374	0.853627	0.8373704
1999	0.4055253	0.7471427	0.8847201	0.8623489	0.9210298	0.8557984	0.8514007	0.8773267
2000	0.4653342	0.8803753	1.050134	1.0586355	1.0074155	1.1136759	1.048776	1.0583254
2001	0.2833783	0.5471881	0.7063514	0.7447327	0.7136201	0.6930111	0.7486184	0.7262055
2002	0.2080154	0.3380771	0.4168398	0.5035448	0.5051211	0.4734209	0.4725187	0.488252
2003	0.2447802	0.4172415	0.4283251	0.5999919	0.6053099	0.6104133	0.6030516	0.5925732
2004	0.2659952	0.4379506	0.4817654	0.5530988	0.5996363	0.6185723	0.6038554	0.5973425
2005	0.3659529	0.5898514	0.673865	0.7922827	0.7683985	0.8281742	0.8171597	0.8055306
2006	0.2676572	0.5078184	0.5087606	0.6180234	0.6405769	0.6295882	0.650079	0.6264798
2007	0.2539264	0.3120421	0.4078046	0.4582252	0.4768448	0.4630574	0.4665538	0.4640192
2008	0.1962177	0.2978398	0.2588325	0.3569122	0.3437475	0.3572891	0.351279	0.350951
2009	0.1631909	0.2627823	0.2163613	0.2814186	0.293566	0.2883315	0.2902716	0.2860528
2010	0.1937057	0.2892568	0.2515049	0.2901382	0.3129344	0.2967356	0.3008983	0.2982318
2011	0.1959614	0.3100117	0.2746561	0.3327913	0.3327913	0.3327913	0.3327913	0.3327913
2012	0.1959614	0.3100117	0.2746561	0.3327913	0.3327913	0.3327913	0.3327913	0.3327913

Table 5. Haddock in Division VIa. Standard errors of estimates of log fishing mortality from the final TSA run, excluding the ScoGFS WCIBTS Q1.

Year	1	2	3	4	5	6	7	8+
1978	0.216327	0.153943	0.155712	0.120613	0.130479	0.141081	0.145204	0.143505
1979	0.202123	0.140957	0.131111	0.126375	0.118933	0.132668	0.141431	0.140081
1980	0.224433	0.152603	0.152975	0.130735	0.139576	0.13467	0.148	0.148941
1981	0.225173	0.163842	0.150697	0.140907	0.14508	0.151609	0.151537	0.156191
1982	0.216659	0.158383	0.14789	0.135283	0.13884	0.145465	0.153875	0.148365
1983	0.194277	0.143198	0.156403	0.128009	0.132271	0.138251	0.147112	0.144391
1984	0.232806	0.141634	0.128653	0.133157	0.125499	0.139923	0.146855	0.148303
1985	0.200769	0.143742	0.142702	0.127014	0.130979	0.134517	0.145043	0.146667
1986	0.216387	0.150761	0.144573	0.136944	0.138589	0.143369	0.148707	0.151329
1987	0.205299	0.124976	0.126174	0.109093	0.114521	0.125986	0.13501	0.131131
1988	0.211524	0.138968	0.127091	0.11698	0.11829	0.130548	0.138643	0.136591
1989	0.217171	0.149561	0.136678	0.118726	0.1221	0.12731	0.140428	0.138971
1990	0.208263	0.146553	0.150216	0.129618	0.131246	0.137839	0.144075	0.146866
1991	0.201051	0.13818	0.1446	0.120581	0.120662	0.132102	0.140709	0.138762
1992	0.210226	0.143656	0.140723	0.129829	0.130176	0.136727	0.146075	0.145515
1993	0.202165	0.127725	0.115375	0.108749	0.11137	0.129772	0.132918	0.137581
1994	0.242318	0.198187	0.187114	0.167468	0.171483	0.180166	0.183733	0.183394
1995	0.33756	0.275335	0.262188	0.243813	0.24541	0.247962	0.250589	0.25059
1996	0.327236	0.257542	0.257135	0.233473	0.233651	0.236275	0.238403	0.240279
1997	0.314866	0.241967	0.226215	0.210605	0.210558	0.213039	0.217023	0.219063
1998	0.320966	0.243793	0.236193	0.211179	0.212996	0.215219	0.218233	0.220795
1999	0.331146	0.25144	0.241304	0.224104	0.222452	0.22462	0.226343	0.229257
2000	0.32838	0.248623	0.22406	0.212903	0.212742	0.214346	0.218016	0.220285
2001	0.333147	0.254611	0.243596	0.222509	0.223888	0.224306	0.226755	0.229452
2002	0.343267	0.264833	0.258365	0.236311	0.234699	0.235574	0.235835	0.239555
2003	0.340369	0.263781	0.249304	0.230009	0.229295	0.230862	0.23323	0.235322
2004	0.346772	0.264659	0.252693	0.236739	0.23636	0.238408	0.239932	0.241859
2005	0.322319	0.237694	0.208644	0.192467	0.192916	0.19758	0.202712	0.203148
2006	0.242972	0.165861	0.157021	0.131383	0.13257	0.13732	0.145748	0.149499
2007	0.249086	0.179887	0.17255	0.142378	0.142819	0.146655	0.154775	0.156992
2008	0.255616	0.196814	0.197231	0.15543	0.156507	0.15796	0.166382	0.16804
2009	0.264232	0.217325	0.220137	0.172079	0.172005	0.173316	0.180603	0.182149
2010	0.306473	0.266484	0.264087	0.20038	0.200474	0.202711	0.208871	0.209069
2011	0.455873	0.406688	0.405991	0.379917	0.379917	0.379917	0.379917	0.379917
2012	0.48177	0.435519	0.434868	0.410632	0.410632	0.410632	0.410632	0.410632

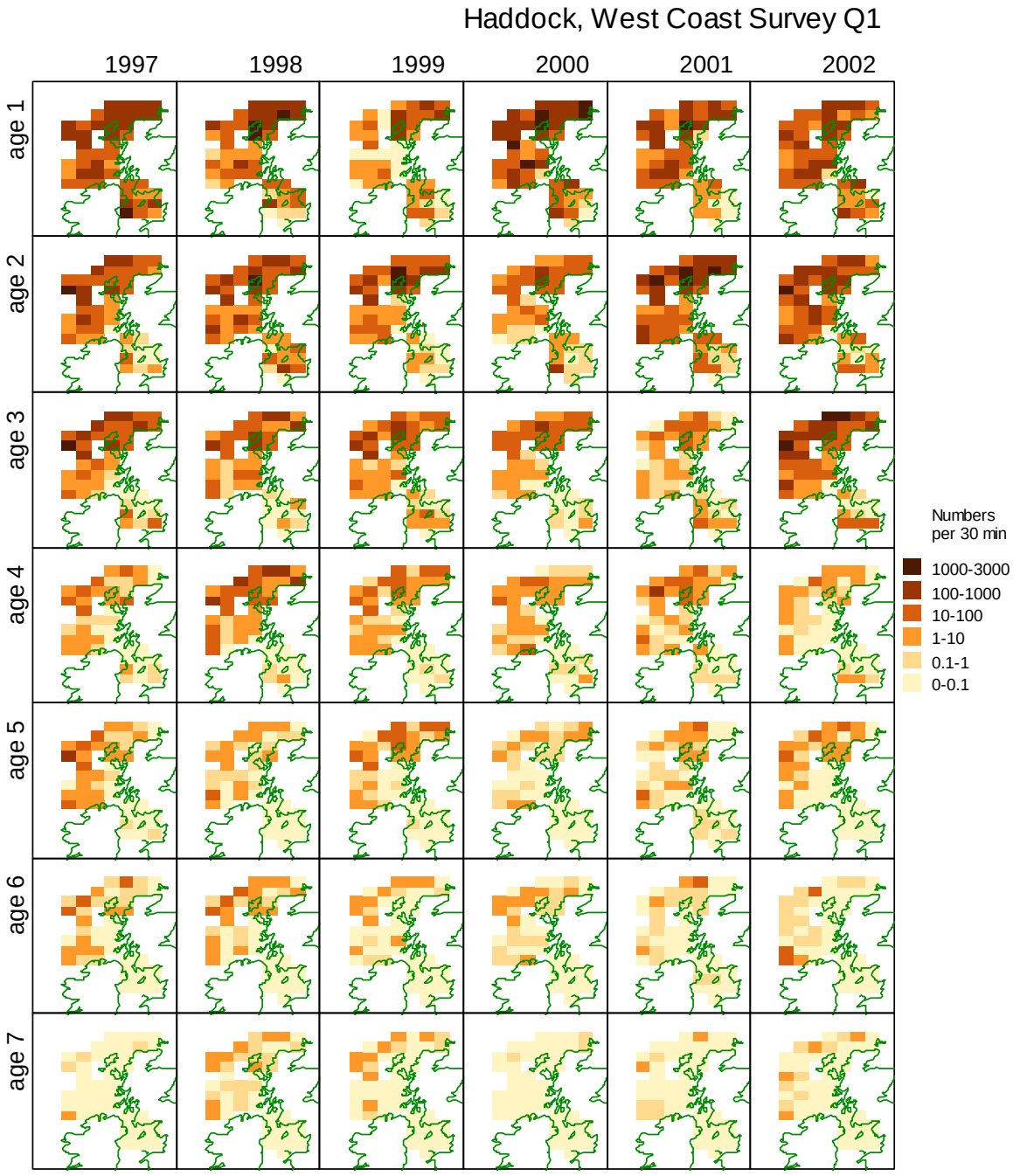


Figure 1. Haddock in Division VIa. Number per 30 min tow, averaged over ICES statistical rectangles from the west of Scotland groundfish Q1 (IBTS) survey 1997–2002, ages 1–7.

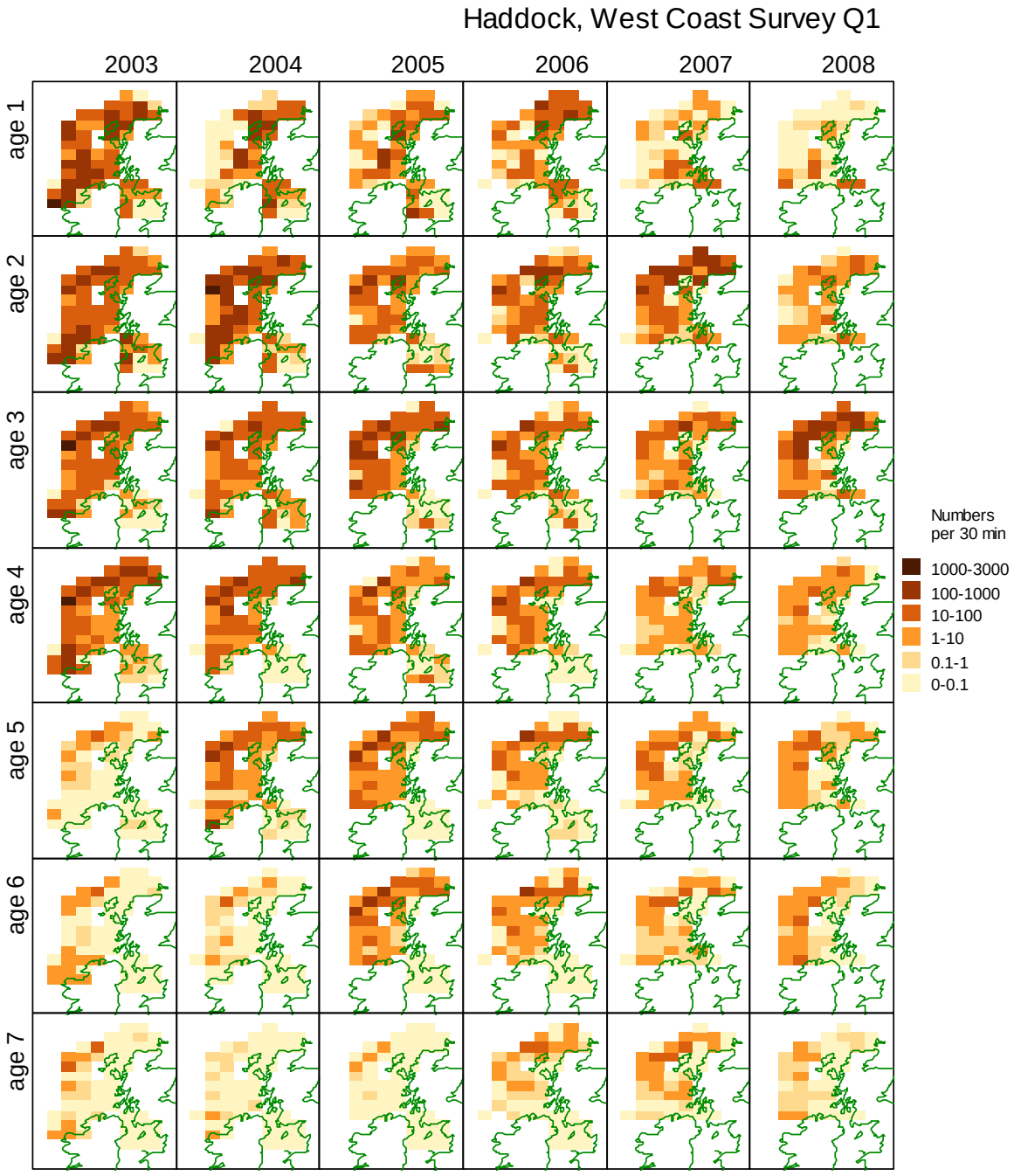


Figure 1. continued. Haddock in Division VIa. Number per 30 min tow, averaged over ICES statistical rectangles from the west of Scotland groundfish Q1 (IBTS) survey 2003–2008, ages 1–7.

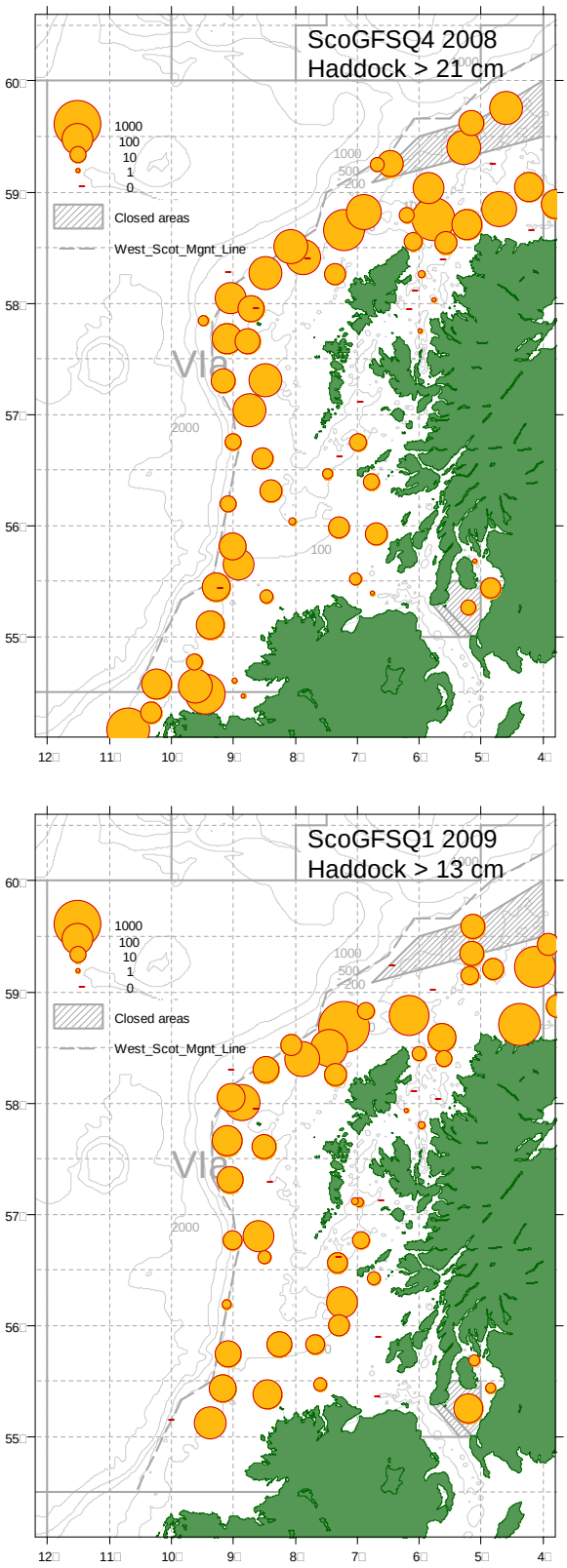


Figure 2. Haddock in Division VIa. Numbers per 30 min tow from the Scottish groundfish surveys (ScoGFS): Quarter 4 (2008) and Quarter 1 (2009).

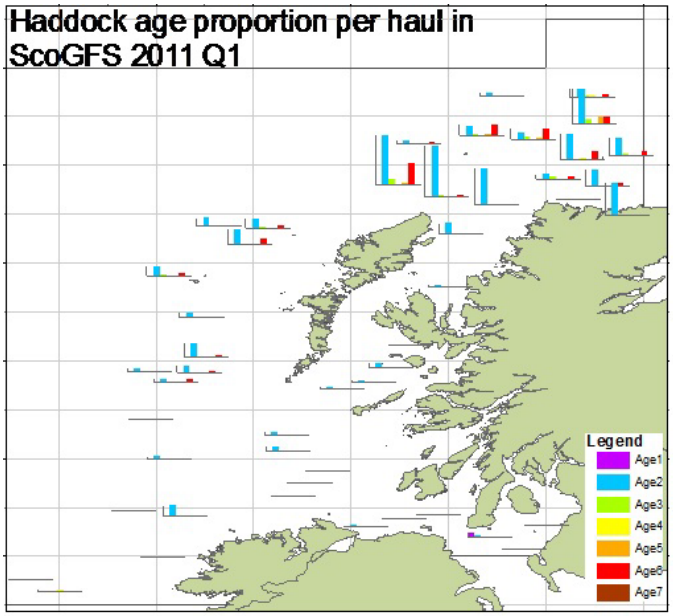


Figure 3. Haddock in Division VIa. Proportion per haul from the Scottish groundfish surveys (ScoGFS): Quarter 1 (2011).

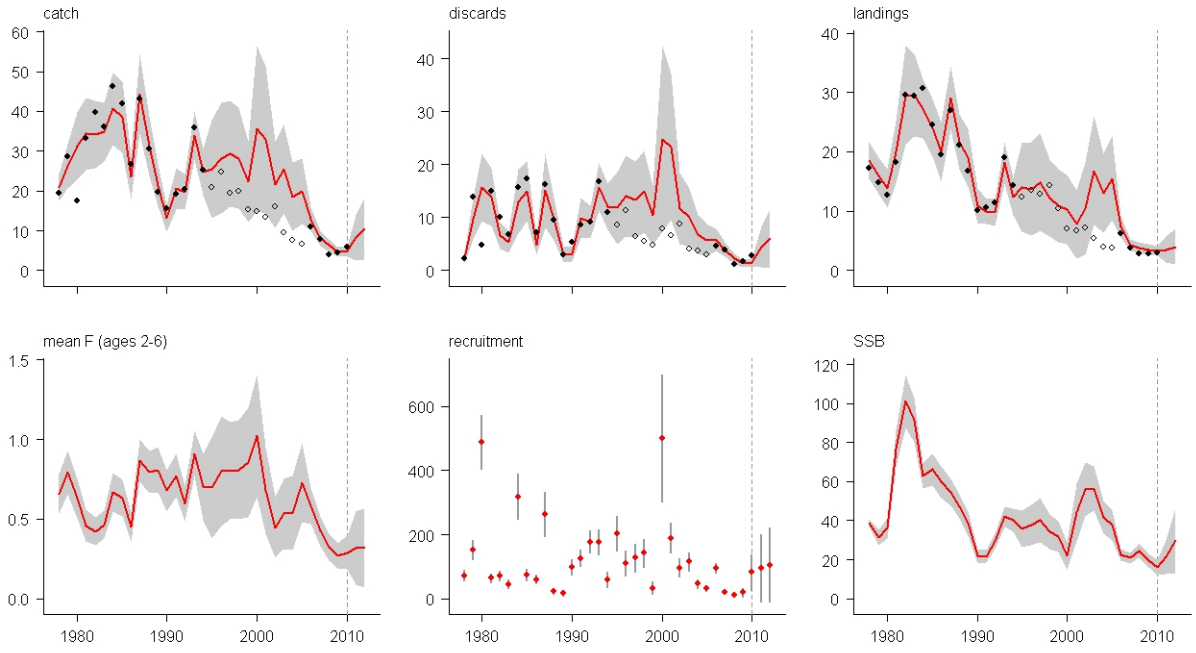


Figure 4. Haddock in Division VIa. TSA stock summaries from the final run (excluding the ScoGFS WCIBTS Q1 2011) with catch data included 1978–1994 and 2006–2010. Estimates are plotted with approximate pointwise 95% confidence bounds. Dots indicate observed values for catch, landings and discards. Values presented to the right of the vertical dashed line are forecasted by the model.

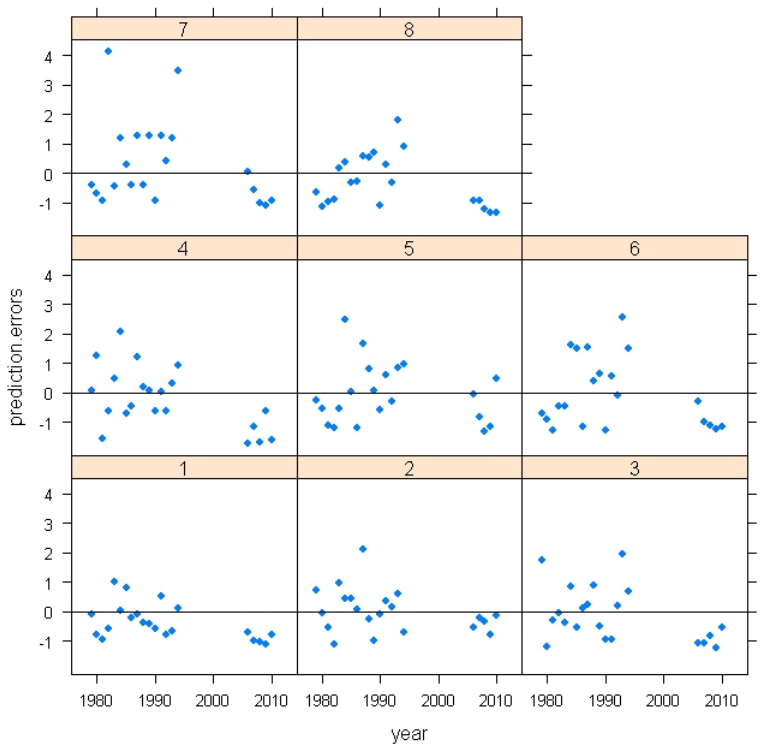


Figure 5. Haddock in Division VIa. Standardized landings prediction errors from the final TSA run, excluding the ScoGFS WCIBTS Q1 (2011).

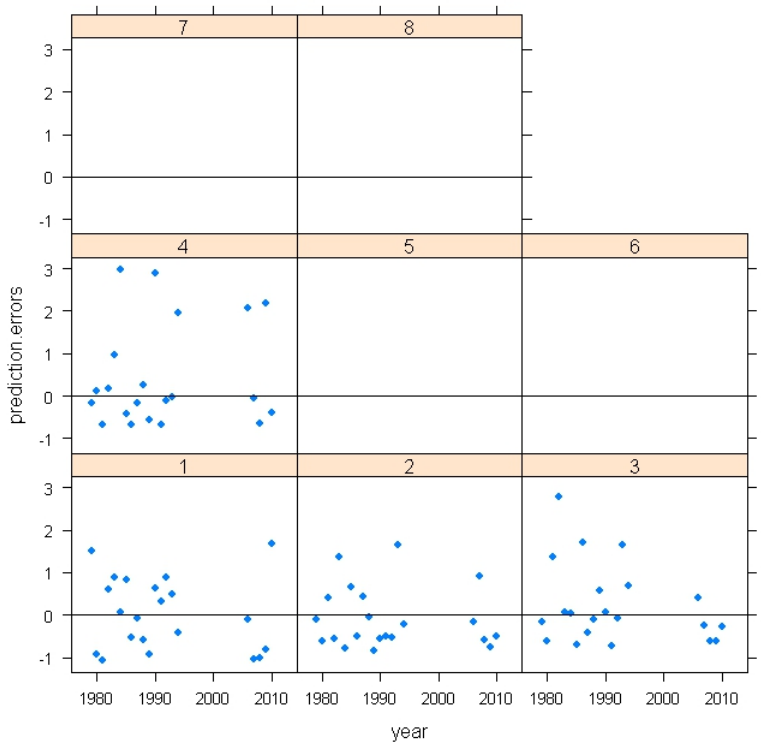


Figure 6. Haddock in Division VIa. Standardized discards prediction errors from the final TSA run, excluding the ScoGFS WCIBTS Q1 (2011).

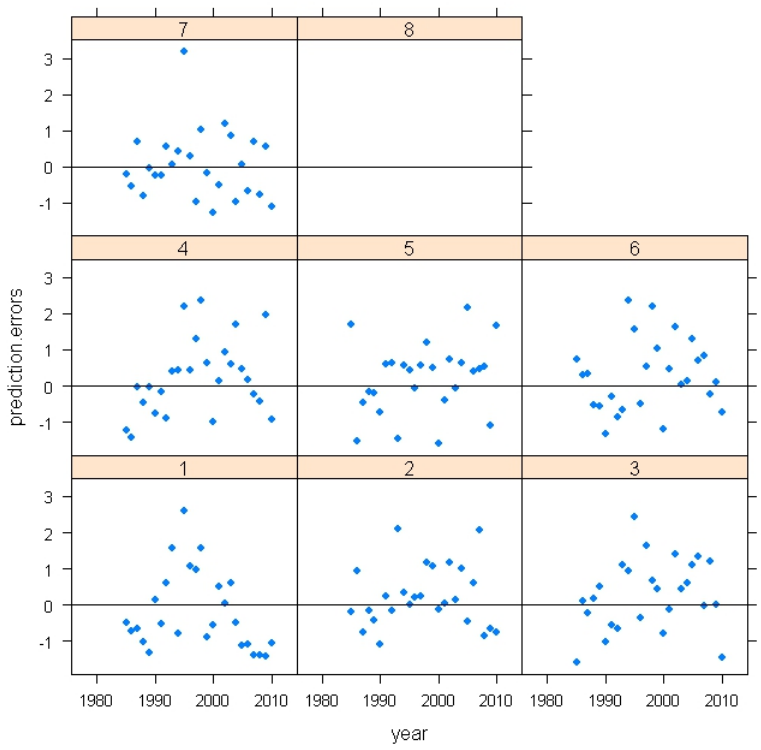


Figure 7. Haddock in Division VIa. Standardized ScoGFS Q1 prediction errors from the final TSA run, excluding the ScoGFS WCIBTS Q1 (2011).

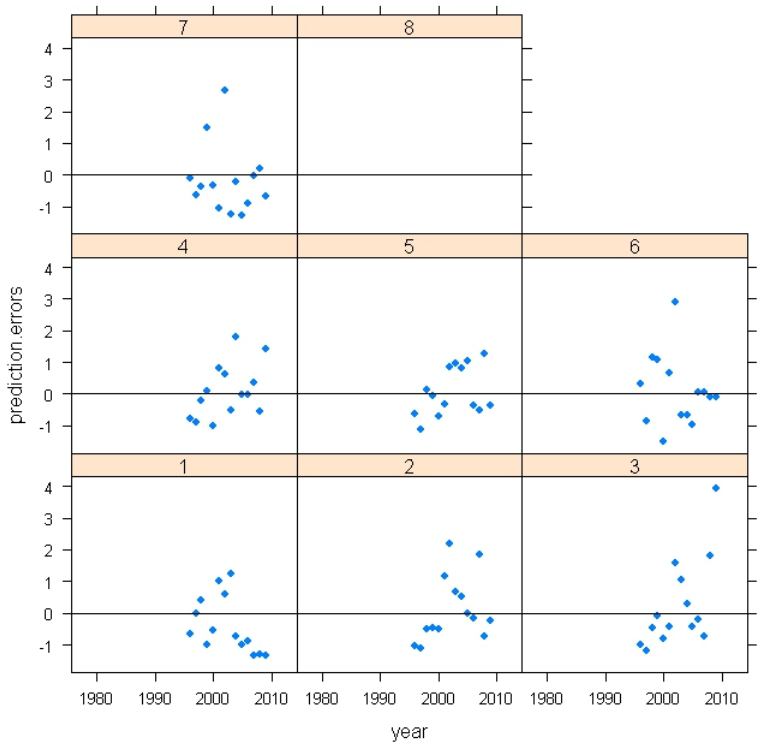


Figure 8. Haddock in Division VIa. Standardized ScoGFS Q4 prediction errors from the final TSA run, excluding the ScoGFS WCIBTS Q1 (2011).

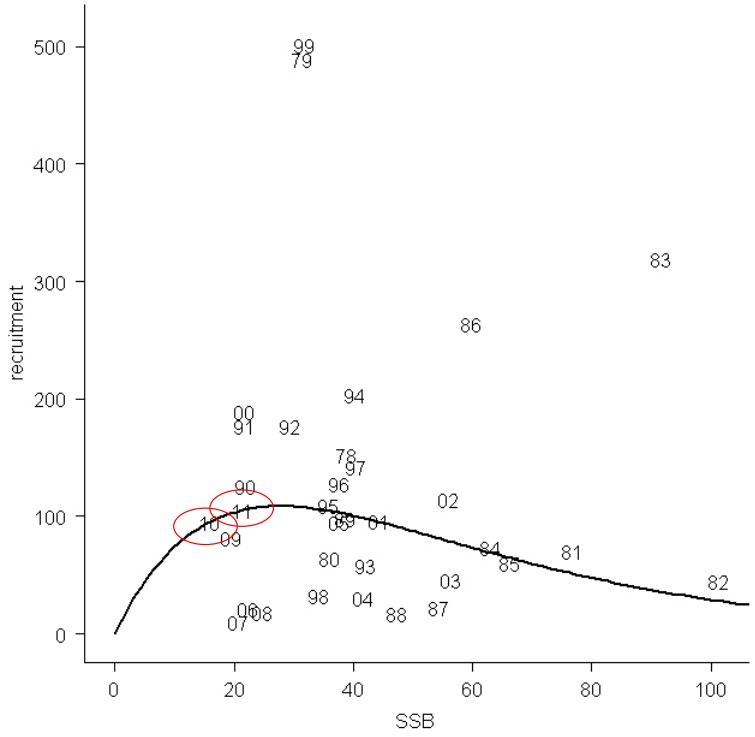


Figure 9. Haddock in Division VIa. Stock–recruit plot from the final TSA run (excluding the ScoGFS WCIBTS Q1 2011), points labelled as year classes. Predicted recruitments are circled: for the 2009 year-class recruiting in 2010 (using ScoGFS Q1 data); and the 2010 year-class recruiting in 2011 (based on the underlying Ricker model).

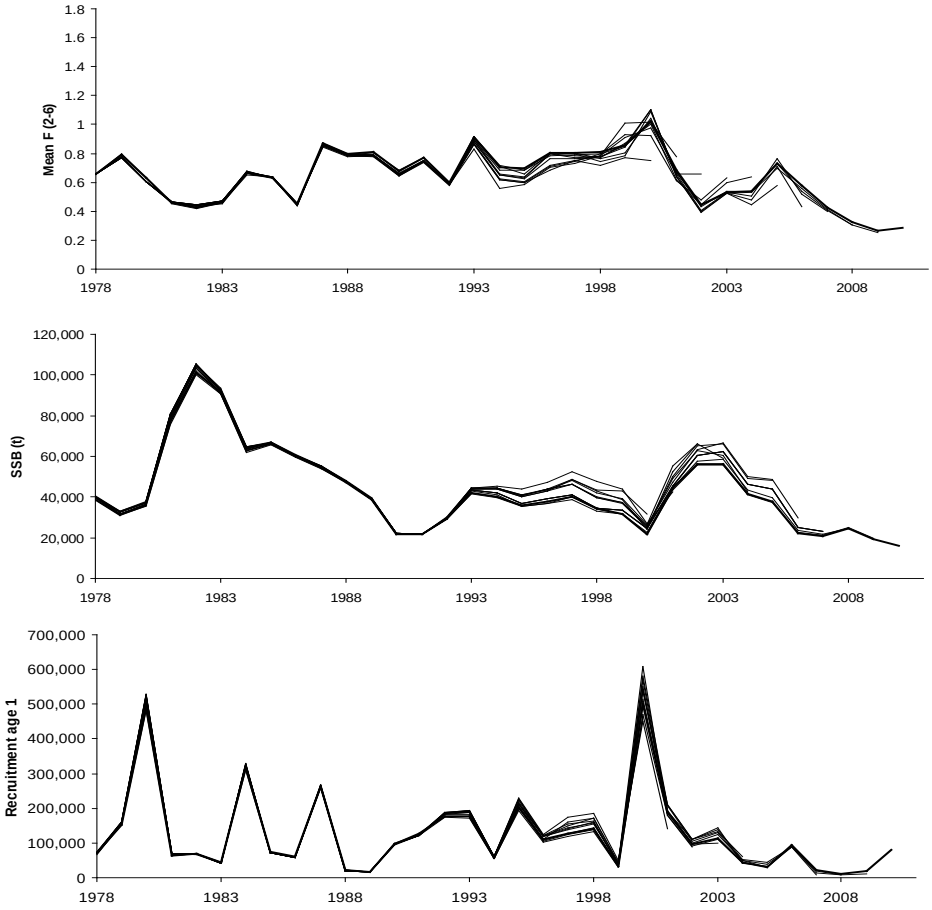


Figure 10. Haddock in Division VIa. Estimates of Mean F_{2-6}, SSB and recruitment from retrospective TSA runs, excluding the ScoGFS WCIBTS Q1 (2011).

Stock Annex 3.4: Whiting in Area VI

Stock-specific documentation of standard assessment procedures used by ICES.

Stock	Whiting (Area VI)
Working Group	Assessment of Northern Shelf Demersal Stocks
Date	17 May 2007
Last updated	25 May 2010 (a.jaworski@marlab.ac.uk)

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 Area 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.

While an exploration of stock identity in the North Sea has been carried out, stock definition in Area VI and surrounding waters remains poorly defined (ICES-SGISIMUW, 2005). Tagging experiments on recruiting fish have shown that whiting stocks west of Ireland are distinct from those in the Minches, Clyde and the Irish Sea. On the basis of preliminary results from FRS project MF0464, there appears to be three putative populations of whiting are found in VIa, between which interchange is limited. These are along the northwest of Scotland, the Stanton Bank region and the Firth of Clyde. Maximum likelihood analysis indicates a high degree of mixing for adult whiting between IVa whiting and the VIa component off the northwest of Scotland. Within VIa, there was little indication of interaction between population components in the south and that off the northwest coast.

A.2. The fishery

The demersal fisheries in Division VIa are predominantly conducted by otter trawlers fishing for cod, haddock, anglerfish and *Nephrops*, with bycatches of whiting, saithe, megrim, lemon sole, ling and a number of skate species. 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 Area VI occurs largely in Division VIa with the UK, Ireland, Spain 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 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.

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

No information.

B. Data

B.1. Commercial catch

Monthly length frequency distribution data were available from Scotland for Area VIa. A total international catch-at-age distribution for Division VIa was obtained using the raising procedure described in Section 2.3 to raise 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 age compositions are generally available from both Scotland and Ireland, but in recent years (2006 and 2007) lack of access to fishing vessels by Irish observers has meant that no Irish data have been collected. Work is underway to revise the Scottish discard estimates with an aim to reduce bias and increase precision. Such revisions are particularly important for the estimation of total catch for this stock which has

very high discards across a wide age range. A working document set out the methodology of this work at the 2004 meeting of WGNSDS (Fryer and Millar, 2004).

B.2. Biological

Natural mortality is 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, in the Irish Sea.

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.

B.3. Surveys

Four research vessel survey-series for whiting in VIa were available to the Working Group in 2007. 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 1985–2010.

The survey gear is a GOV trawl, and the design is a minimum of one station per rectangle, but with more depending on logistic limitations. 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 0–5, years 1993–2002.

The Irish quarter four survey was a comparatively short series, was discontinued in 2003 and has been replaced by the IRGFS.

- Scottish fourth quarter west coast groundfish survey (ScoGFSQ4): ages 0–8, years 1996–2009.

The Scottish quarter four survey was presented to the WG for the first time in 2007.

- Irish fourth quarter west coast groundfish survey (IRGFS); ages 0–6, years 2003–2009.

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. There were 41 stations sampled in 2003, 44 in 2004 and 34 in 2005, corresponding to 1229, 1321 and 1010 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 2008.

The indices are provided in Table B.1.

The distribution of catches per unit of effort from the surveys in 2008 are given in Figure B.1 for the Scottish fourth quarter west coast groundfish survey (ScoGFSQ4); and Figure B.2 for the first quarter west coast groundfish survey (ScoGFSQ1).

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 (Table B.2) and include:

- 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

Data to update these time-series were not available for 2006 or 2007.n

B.5. Fecundity

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 Area VI.

C. Historical stock development

Whiting has never been a particularly valuable species and has tended not to be targeted by commercial fishermen. It tends to be taken more as a bycatch, with other species fished more intensively in Division VIa, such as haddock, cod and anglerfish. As with other gadoids in VIa, whiting stocks have declined steadily since the late 1970s.

D. Short-term projection

Not done.

E. Medium-term projections

No medium-term projections are carried out for this stock.

F. Yield and biomass-per-recruit/long-term projections

Not done.

G. Biological reference points

Precautionary approach reference points:

> VIa-"Long-term information on the historical yield and catch composition all indicate that the present stock size is low. A survey-based assessment covering the more recent period indicates that the stock is at its lowest level over this time period. Total mortality is at the highest level over the time period. 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."

VIb-"Landings of whiting from Division VIb are negligible. No assessment has been carried out on this stock."

H. Other issues

None.

I. References

J. R. G. Hislop. 1975. The breeding and growth of whiting, *Merlangius merlangus*, in captivity. J. Cons. int. Explor. Mer, 36(2): 119–127.

Hislop, J. and Hall, W. 1974. The fecundity of whiting, *Merlangius merlangius* (L.), in the North Sea, Minch and at Iceland. J. Cons. int. Explor. Mer, 36(1): 42–49.

ICES. 2000. ICES CM 2000/ACFM:1.

ICES-SGSIMUW. 2005. Report of the Study Group on Stock Identity and Management Units of Whiting. ICES CM 2005/G:03.

Table B.1. Available survey tuning-series. For IreGFS, effort is given as minutes towed, numbers are in units.

SCOGFSQ1: Scottish Groundfish Sruvey – 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	1526	403	68	10	9	10
1987	10	6938	1054	584	143	36	2	1
1988	10	567	3469	653	189	42	5	1
1989	10	910	505	586	237	48	3	0
1990	10	1818	572	122	216	61	4	1
1991	10	3203	277	298	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	9384	2238	635	341	135	30	5
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	0.4
2000	10	12862	471	152	34	10	11	0
2001	10	4653	1954	242	41	8	1	1
2002	10	5542	1028	964	86	15	1	1
2003	10	6934	746	436	300	32	2	4
2004	10	5888	1566	189	131	44	9	1
2005	10	1308	723	183	35	8	11	2
2006	10	1441	466	282	77	0.3	3	0.6
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

IR-WCGFS : Irish West Coast GFS (VIa) - Effort (min. towed) - Whiting number-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

(cont). Whiting in VIa. Available survey tuning-series. For ScoGFSQ4, numbers are standardized to catch-rate per 10 hours. "+" indicates value less than 0.5 after standardizing.

IRGFS: 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

ScoGFSQ4 : Quarter four 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	1124	149	100	20	1	0	+
1999	10	8203	2338	582	141	33	24	1	1	0
2000	10	4434	4055	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	0.9	0.7	0
2006	10	415	296	140	101	35	8	3	0.5	0
2007	10	1894	434	326	99	83	48	0.6	0	0
2008	10	2297	208	78	110	28	24	4	0	+
2009	10	4833	236	178	50	58	12	6	6	0

Table B.2. Commercial cpue tuning-series available to whiting in VIa.

2009 WHITING AREA 6A							
108							
SCOLTR: Scottish Light Trawl: Effort in hours: Numbers-at-age (thousands)							
1965	2005						
1	1	0	1				
1	7						
37387	2011.623	469.253	3512.923	393.473	14.925	5.445	0.909
40538	1036.117	926.485	162.985	5508.27	333.46	32.68	6.196
80916	2539.797	4967.604	1637.023	101.256	2456.915	133.979	12.466
65348	1931.014	3404.448	1868.458	677.298	51.295	844.125	58.939
106856	46.897	8823.442	2211.584	578.006	278.879	28.188	516.892
129741	94.958	5275.823	8514.611	712.848	143.241	35.554	3.428
137728	1566.57	4472.064	1026.561	9818.08	337.772	63.477	25.237
154288	13450.885	4637.042	1716.159	334.786	5435.152	309.86	29.756
93992	4613.649	12778.492	680.372	148.997	42.975	478.522	39.083
88651	7452.711	15917.02	1773.837	159.241	17.112	6.477	78.812
132353	10597.964	6684.991	10431.537	837.283	79.71	12.155	2.811
139225	10858.324	15481.895	3550.826	5483.438	412.525	13.045	4.668
143574	18222.115	4276.619	5983.177	773.244	1126.782	74.579	1.916
127387	9805.191	5887.935	1561.61	1814.903	127.832	244.126	3.76
99803	1846.163	9530.148	2446.896	368.018	290.896	31.887	57.01
121211	1856.938	4385.272	4359.469	1052.873	170.989	172.29	10.997
165002	983.137	13544.1	4617.56	1330.75	504.711	152.752	62.619
135280	8248.806	2593.129	10934.792	1899.759	316.934	74.891	62.409
112332	4809.036	4322.894	2548.597	8292.216	1696.241	253.9	54.475
132217	29865.064	4084.418	2582.188	1149.781	5206.862	592.972	221.473
142815	9243.535	11577.551	2515.313	663.96	360.662	917.939	82.73
126533	3187.288	6006.487	2693.592	621.738	98.497	50.635	93.945
131720	12328.429	6004.925	2767.12	1229.144	147.776	43.178	32.132
158191	5358.52	15325.219	2988.119	1334.433	316.668	46.956	2.997
217443	3161.234	1640.767	5226.339	1473.139	434.728	129.89	14.252
169667	4110.42	4152.38	972.043	1380.502	386.872	51.478	6.092
209901	7018.52	2968.053	3981.784	336.752	423.153	73.429	5.829
189288	9761.596	6548.587	1727.049	2100.437	113.974	102.439	10.66
189925	2623.886	10105.623	4392.988	1169.932	1701.769	51.678	46.841
174879	3251.43	6503.608	5363.793	1739.967	333.927	291.821	13.881
175631	1775.509	5661.947	5310.813	1995.375	569.453	114.177	107.935
214159	2738.034	8043.865	4647.63	2543.265	833.461	213.15	24.196
179605	3107.284	3973.701	5098.515	1858.52	532.696	95.153	39.379
142457	3997.939	3171.019	2547.76	2327.54	654.589	149.808	79.812
98993	559.916	3273.961	1709.217	814.593	793.265	122.037	34.883
76157	4363.101	2324.771	2202.561	627.094	169.833	201.883	8.678
35698	575.281	2603.626	1358.595	783.414	117.804	37.996	5.442
15174	389.652	848.153	1566.132	374.617	166.509	16.845	5.038
9357	565.293	207.507	273.115	578.307	100.052	41.916	0.206
7116	1769.901	1215.938	242.922	199.9	221.001	27.997	3.138
3063	217.522	400.094	268.966	23.085	27.158	14.318	2.462

Table B.2. continued.

SCOSEI: Scottish Seine: Effort in hours: Numbers-at-age (thousands)						
1965	2005					
1	1	0	1			
1	6					
153103	8570.938	4534.63	19453.707	1412.984	62.399	15.334
156511	2872.249	12671.39	1491.149	13027.566	736.15	68.22
158208	7058.77	23604.969	5804.573	363.182	5528.921	304.951
150094	11817.932	14128.65	4897.227	1409.535	134.705	1651.222
140718	1314.237	19167.426	4024.433	1038.908	420.643	45.006
95629	979.255	2065.056	9177.95	815.703	176.987	51.144
98748	3280.938	6459.36	2466.983	14808.06	484.003	73.488
70741	20563.777	7286.501	1143.727	588.902	3139.349	112.588
59596	16428.303	16410.354	1995.231	373.15	97.243	886.47
56448	8764.309	28089.33	3578.12	289.184	22.105	9.317
56420	15931.473	9161.576	13093.543	585.337	37.682	9.127
57090	7559.305	30718.529	6226.15	4887.683	283.504	18.081
41920	14522.98	4873.693	6783.85	584.118	1035.664	43.296
33599	9880.994	4708.252	812.33	1086.089	65.835	152.233
38465	3779.036	13497.126	3739.924	473.079	392.189	16.481
38700	2222.899	3686.353	4277.55	1081.223	273.049	118.803
37208	789.787	9229.84	3128.155	1025.456	426.614	90.387
36689	1146.222	1977.49	9664.041	1183.655	229.857	68.248
38080	3803.96	3110.436	1942.945	5805.497	1181.95	138.395
29561	3965.733	2170.117	1220.296	382.107	2024.552	218.843
26365	18813.885	6473.455	1248.851	327.561	171.234	557.447
19960	1423.965	4902.12	1815.778	359.211	53.845	24.911
26332	8664.831	3706.126	2068.674	916.903	142.281	19.137
21383	7392.194	8210.657	1658.022	1078.674	218.449	22.005
39350	2182.008	1845.431	4488.746	1282.547	272.354	186.923
27664	2699.332	2964.297	687.892	940.682	279.68	34.508
25787	4160.412	2318.718	3285.513	305.785	290.789	53.282
20273	7513.958	5370.645	1341.721	1622.613	102.037	101.204
24315	1509.725	6046.03	2291.531	675.422	789.292	22.916
21305	1725.208	3310.909	2498.717	701.186	108.245	140.133
21950	721.806	2616.333	2260.832	970.329	298.966	83.208
15205	1270.19	2353.781	1371.875	819.771	297.3	67.732
11449	1096.1	1273.361	1933.262	696.409	187.498	33.748
11166	4251.142	1659.104	1010.394	614.297	265.65	62.355
8638	823.21	2152.386	706.708	294.599	179.097	43.194
6431	2601.077	887.944	755.637	152.896	66.565	19.536
5893	728.924	1007.442	454.373	240.788	40.285	22.082
3817	335.558	583.357	482.121	132.428	40.991	2.935
2370	3130.339	260.924	133.135	290.007	34.543	8.6
1173	7323.289	758.611	165.379	83.46	77.222	2.096
476	676.408	225.196	143.246	10.154	15.355	3.048

Table B.2. continued.

SCONTR: Scottish Nephrops Trawl: Effort in hours: Numbers-at-age (thousands)					
1965	2005				
1	1	0	1		
1	6				
101975	1659.715	453.604	1101.02	102.448	4.875
116972	613.623	951.561	154.546	785.807	44.575
135811	1788.967	2002.916	444.377	15.668	322.969
166713	1761.346	1850.07	637.399	159.199	12.641
155131	736.536	2706.572	437.098	155.072	44.263
144704	439.172	645.419	1379.363	127.922	31.719
127638	1072.488	444.198	235.897	1405.7	60.499
185397	3744.591	1908.742	232.266	70.731	730.108
186342	3462.89	5445.012	486.932	168.428	24.824
186342	1933.55	5427.964	650.405	87.286	11.605
203053	5916.971	2730.363	2846.712	319.449	35.425
224347	4061.224	4343.339	893.637	1142.92	125.278
196403	3573.612	1393.724	1431.401	168.241	289.689
219562	6053.242	2596.492	417.688	570.766	110.339
273713	659.614	3413.303	934.795	207.461	216.936
254147	1439.22	1529.161	1377.826	281.539	44.696
286461	1090.91	5250.686	1199.303	430.934	105.108
288902	2882.413	422	2552.725	439.981	95.697
293396	2702.936	1289.896	464.524	1258.148	205.504
312947	15763.118	731.211	414.638	132.72	870.58
384215	14885.186	3109.454	505.209	225.601	91.132
368971	2231.072	1259.03	707.734	246.405	8.838
395355	12048.819	1562.25	799.307	375.73	43.994
397682	19926.506	12751.985	539.705	138.471	31.741
379169	9854.602	485.161	443.582	152.424	71.883
390391	7434.593	1407.942	58.831	63.502	8.758
414817	13745.576	1280.079	294.651	27.112	43.958
391325	15245.132	3122.017	453.21	211.635	19.575
406753	6063.665	2833.312	611.27	159.111	112.856
380688	22785.318	4821.332	2174.707	613.104	18.004
333756	14759.284	5645.468	494.013	362.773	33.499
345007	14700.369	1316.965	633.638	192.741	44.427
354884	7854.017	1893.631	387.294	176.713	17.444
350882	13268.769	1926.434	620.474	116.935	63.417
337585	7208.116	1905.577	475.713	92.945	80.71
332659	31208.406	934.503	360.23	101.447	28.855
305743	1743.097	1271.809	189.3	80.436	14.844
258169	7281.766	1291.392	483.271	29.948	8.517
255729	4468.485	586.213	191.646	197.557	41.643
232356	3881.27	1310.954	239.992	157.625	102.126
220936	1738.881	829.542	258.178	41.47	16.707

Table B.2. continued.

IreOTB : Irish otter trawl - Effort in hours - numbers-at-age (thousands)							
1995	2005						
1	1	0	1				
1	7						
56335	222	298	530	461	92	28	98
60709	165	531	670	281	175	33	12
62698	99	358	515	282	339	133	89
57403	51	1092	552	312	186	218	232
53192	98	315	437	266	198	109	123
46913	50	131	188	303	158	76	65
48358	14	304	144	101	126	100	44
37231	31	162	388	27	65	97	47
39803	90	294	604	492	131	30	0
35140	33	387	266	245	200	28	21
30941	23	159	188	78	41	19	2

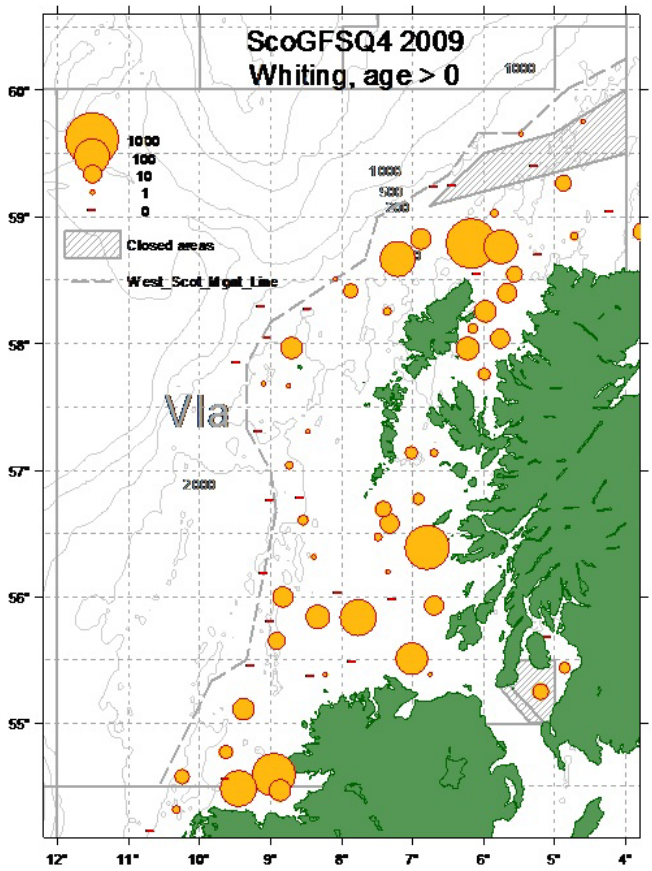


Figure B.1. Map of the west coast of Scotland showing the catch per unit of effort of whiting during the 2009 Scottish fourth quarter west coast groundfish survey. Each circle is centred on the sample location and the size of the circle is proportional to the number density (n/30 min fished) of whiting at age 1+, according to the legend (top left).

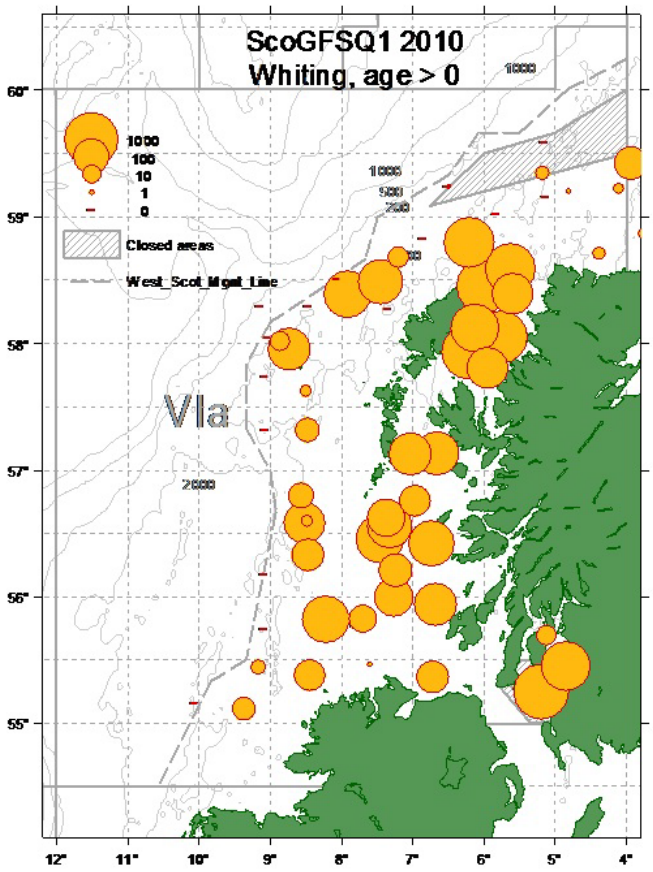


Figure B.2. Map of the west coast of Scotland showing the catch per unit of effort of whiting during the 2010 Scottish first quarter west coast groundfish survey (ScoGFSQ1). Each circle is centred on the sample location and the size of the circle is proportional to the number density (n/30 min fished) of whiting at age 1+, according to the legend (top left).

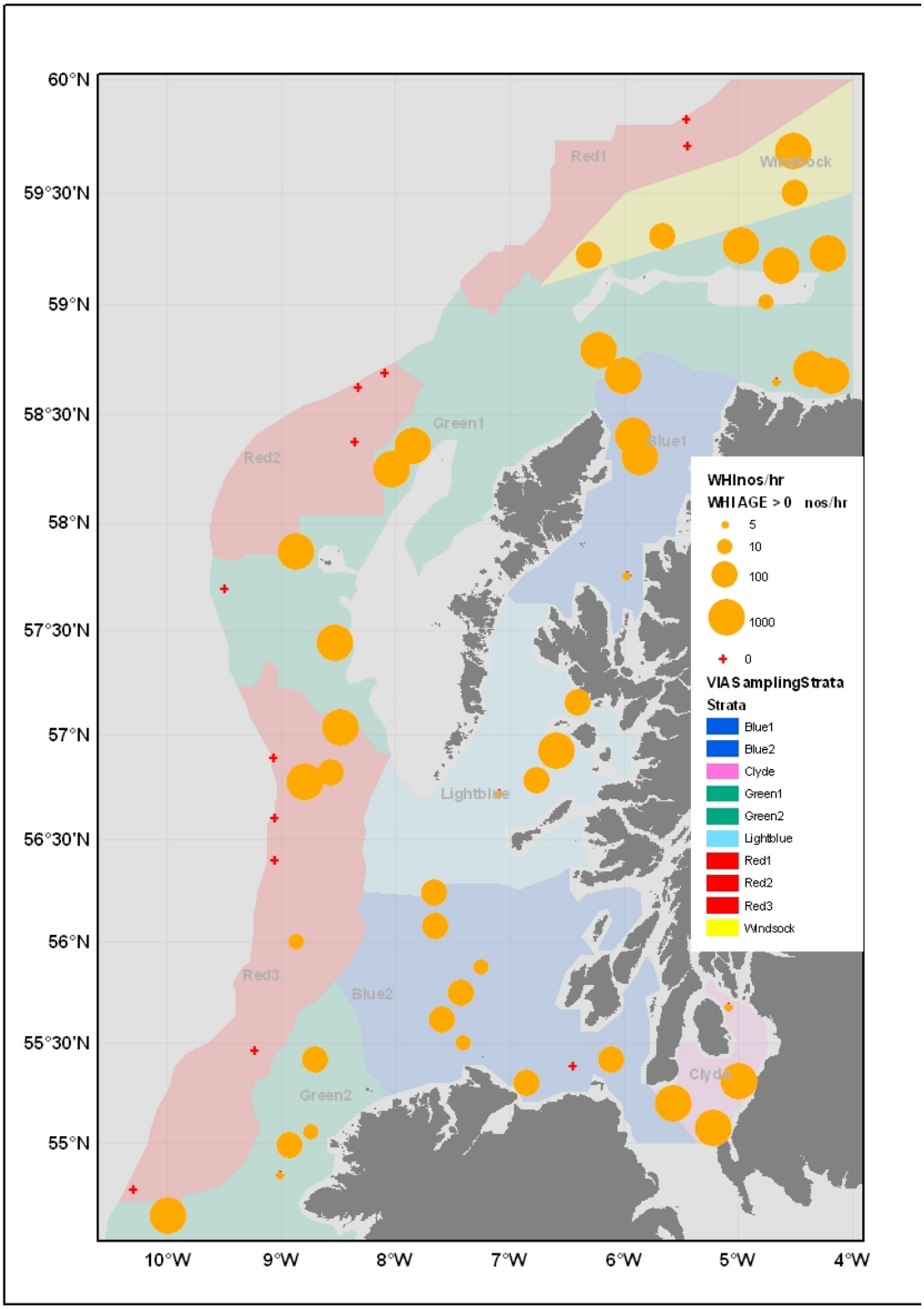


Figure B.3. Map of the west coast of Scotland showing the catch per unit of effort of whiting during the 2011 Scottish first quarter west coast groundfish survey (ScoGFSQ1). Each circle is centred on the sample location and the size of the circle is proportional to the number density (n/30 min fished) of whiting at age 1+, according to the legend.

Stock Annex 4.3: 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 2010
Revised by	Vladimir Khlivnoy, Andrzej Jaworski

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 the 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 to 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:

$$P_L = S_L p_L \tag{1}$$

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 4.3.1) which may be described by the following formula:

$$S_L = \frac{1}{1+\exp(S_1 - S_2 L)}. \tag{2}$$

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 4.3.1), 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 distri-

butions 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 4.3.6 in the main report) 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 4.3.7 in the main Report).

Total numbers and weight landed and discarded by age on the Scottish observer trips in 1999 and 2001 are presented in Stock Annex, Tables 4.3.1 and 4.3.2.

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 (Figure 4.2.5). 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:

$$ND_L = PD_L \times NP_L \tag{3}$$

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 4.3.3) 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 4.3.4.

The proportion of fish discarded from catches at different sizes may be determined and modelled using a logistic curve (Stock Annex, Figure 4.3.5) 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 4.3.3). 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 4.3.6).

Aboard Irish vessels, larger fish are retained (Stock Annex, Figure 4.3.7). 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 val-

ues 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 2 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 Rus-

sian 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 4.2.4, Table 4.2.8). 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:

			Total stock		Spawning stock	
Survey type	Area component	Area (sq. miles)	Abundance (106)	Biomass (103 t)	Abundance (106)	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 4.2.1 and Table 4.2.7. Commercial cpue series for the different fleets are shown in Figure 4.2.2.

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 to 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 to 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 4.2.2). 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 4.2.3).

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
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-year	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	1991–2008	1–7+	Yes
Canum	Catch-at-age in numbers	1991–2008	1–7+	Yes
Weca	Weight-at-age in the commercial catch	1991–2008	1–7+	Yes
West	Weight-at-age of the spawning stock at spawning time.	1991–2008	1–7+	Yes
Mprop	Proportion of natural mortality before spawning	1991–2008	1–7+	No, set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1991–2008	1–7+	No, set to 0 for all ages in all years
Matprop	Proportion mature-at-age	1991–2008	1–7+	No, the same ogive for all years
Natmor	Natural mortality	1991–2008	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	1991–2008	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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Table 4.3.1. 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 4.3.2. 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 4.3.3. 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

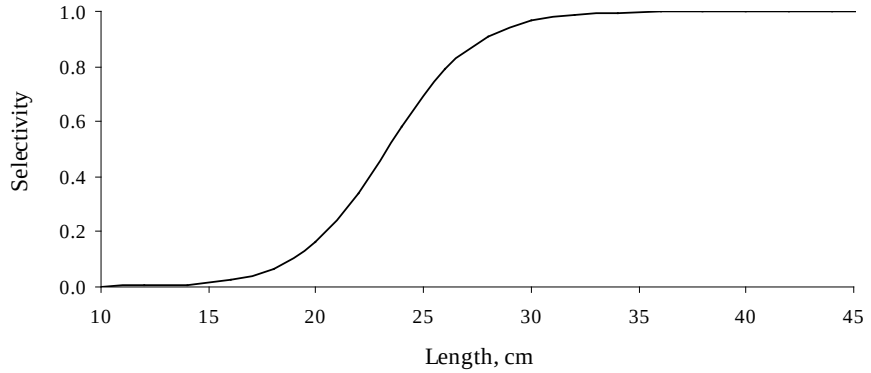


Figure 4.3.1. Theoretical haddock selectivity curve used to estimate the proportion of haddock lifted on board Russian trawlers.

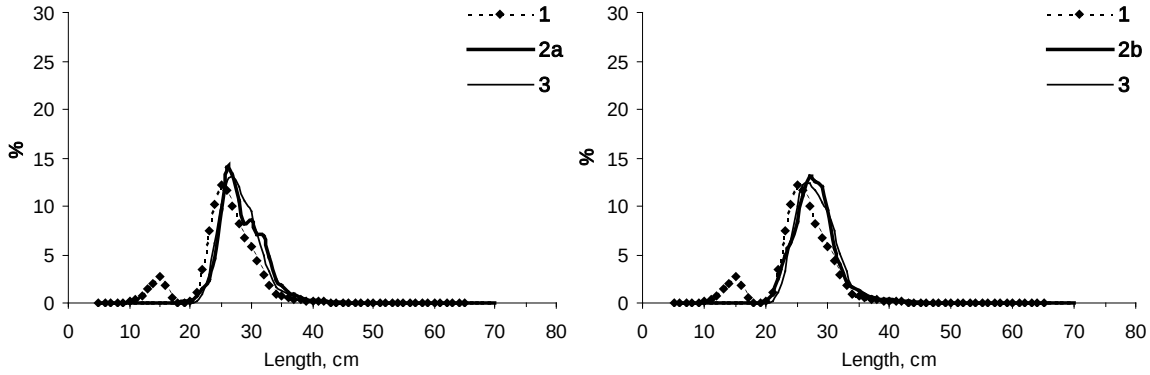


Figure 4.3.2. Length distribution of haddock in 2003: 1 – by Scottish groundfish survey, 2a – by commercial Russian trawlers in June, 2b – by commercial Russian trawlers in July, 3 – theoretically derived.

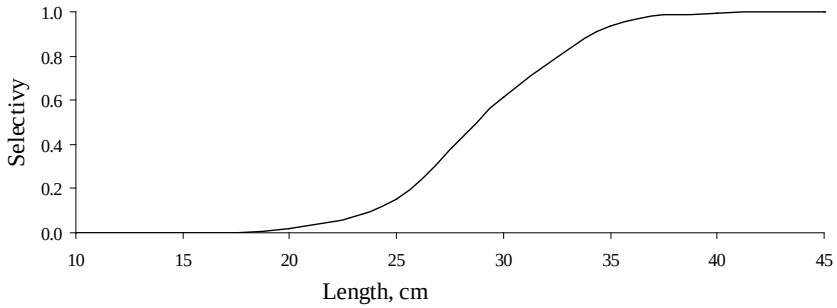


Figure 4.3.3. Theoretical haddock selectivity curve used to estimate the proportion of haddock lifted on board Scottish trawlers.

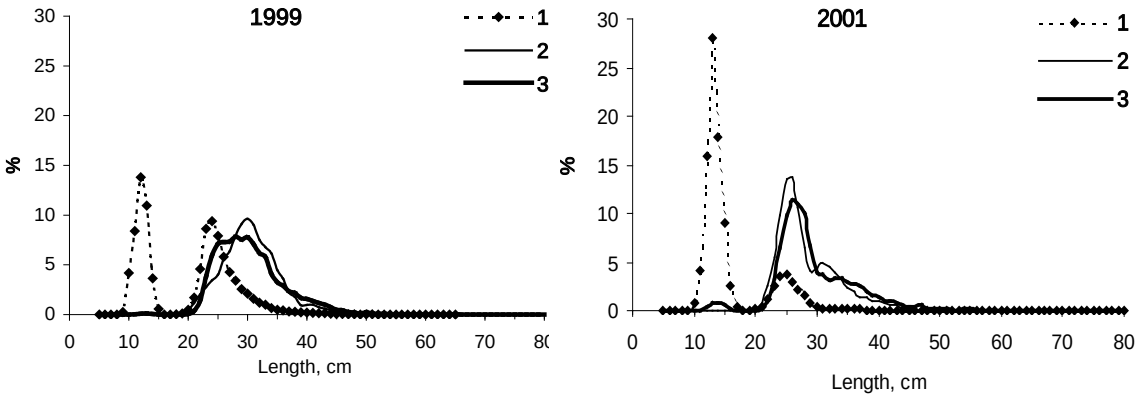


Figure 4.3.4. Length distribution of haddock in 1999 and 2001: 1 – by Scottish groundfish survey, 2 – by commercial Scottish trawlers, 3 – theoretically derived.

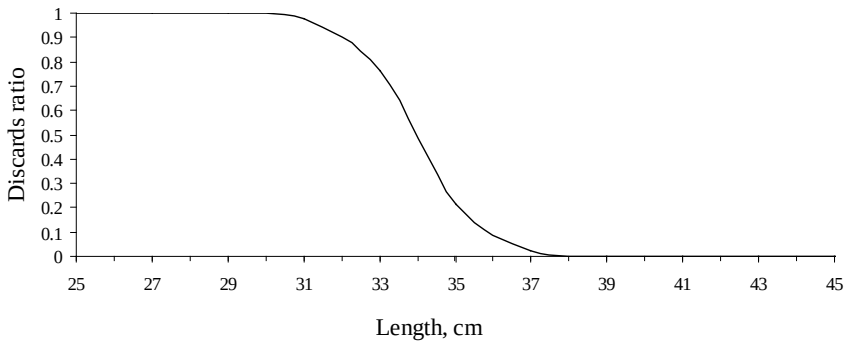


Figure 4.3.5. Selectivity curve used to estimate the proportion of discarded haddock in catches Scottish trawlers.

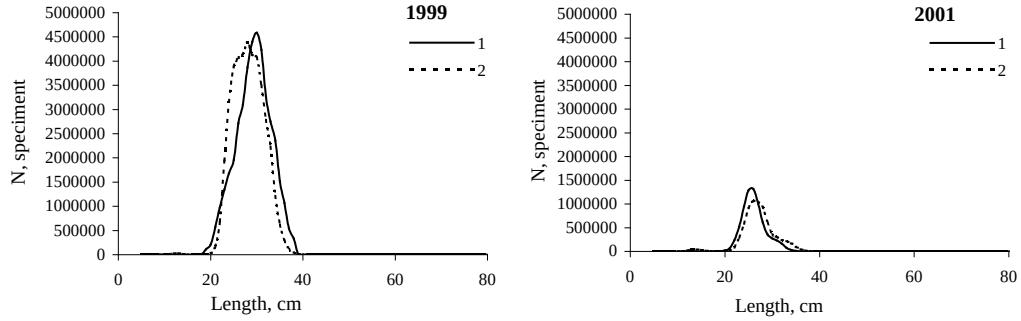


Figure 4.3.6. Length distribution of discarded haddock in catches Scottish trawlers in 1999 and 2001: 1 – research data; 2 – theoretically derived.

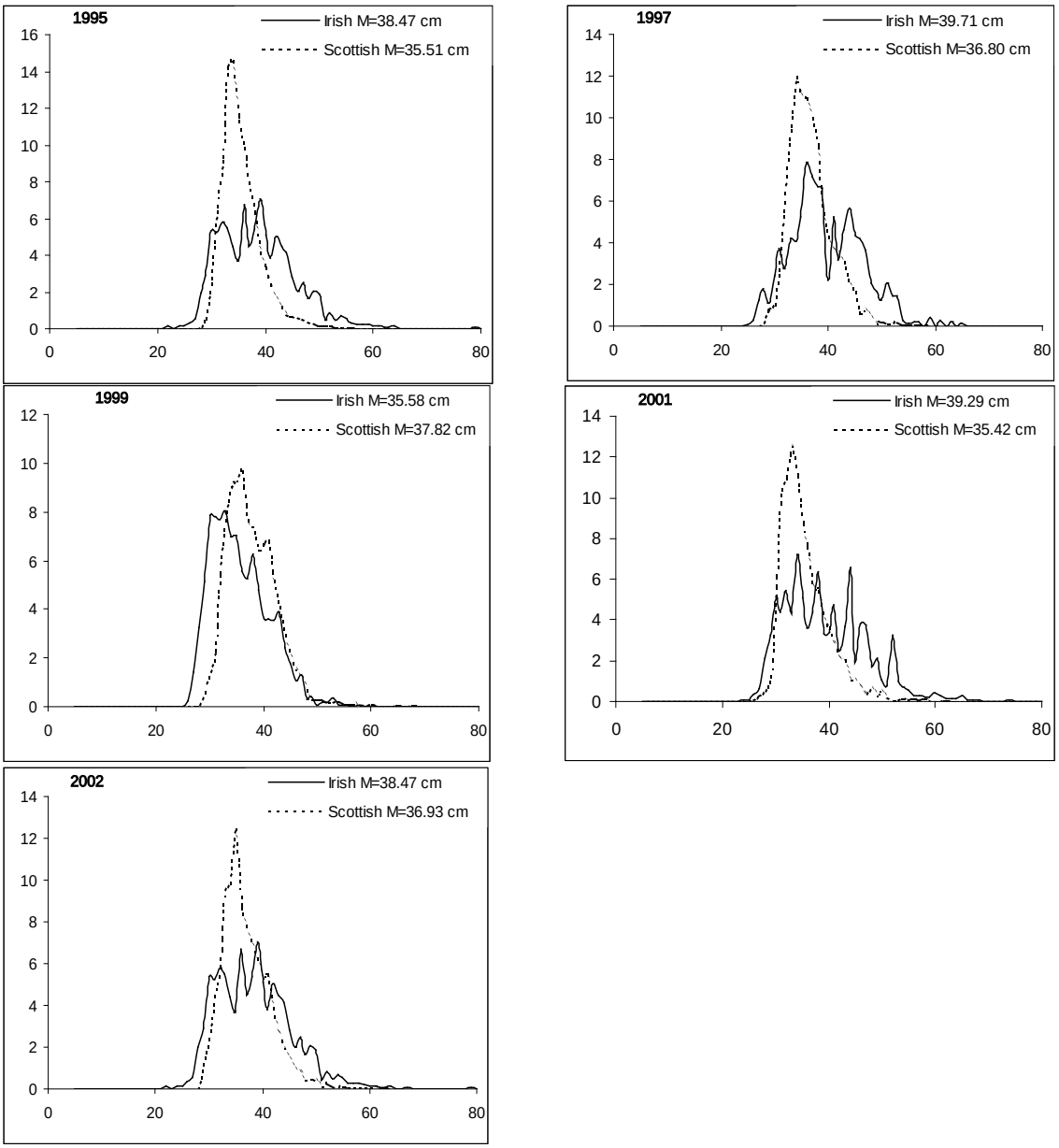


Figure 4.3.7. Length distribution of haddock landings in VI b (Scottish and Irish data).

Stock Annex 5.2: 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 substrate 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 20–40m.

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, DEEP-CLEAN, (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 2 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 and 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 propor-

tion 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 and 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 WG 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/hr for boats targeting *Nephrops* to over 100 kg/hr 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 to 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 (hr)	lpue (kg/h)	Landings (t)	Effort (hr)	lpue (kg/h)	Landings (t)	Effort (hr)	lpue (kg/h)	Landings (t)	Effort (hr)	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

Stock Annex 6.3: 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	P-J. 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 100mm 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

B1.1. 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 the 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), and 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**.

B1.2. 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 2001 and 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 the 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 due to 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) showed, 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, while age was the main factor in females. Interannual variation in the proportion mature was mostly confined to the age 2 group, while 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 of 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 showed 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:

$$L_{t,yc} = LI_{yc} .(1-\exp(-K(t-t_0)))$$

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 show 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 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 (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 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 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 due to 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 (nine 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 hr]
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 hr]
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 historic 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. Since 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 in terms of 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

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Stock Annex 6.4: 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 WGNEPH. 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.

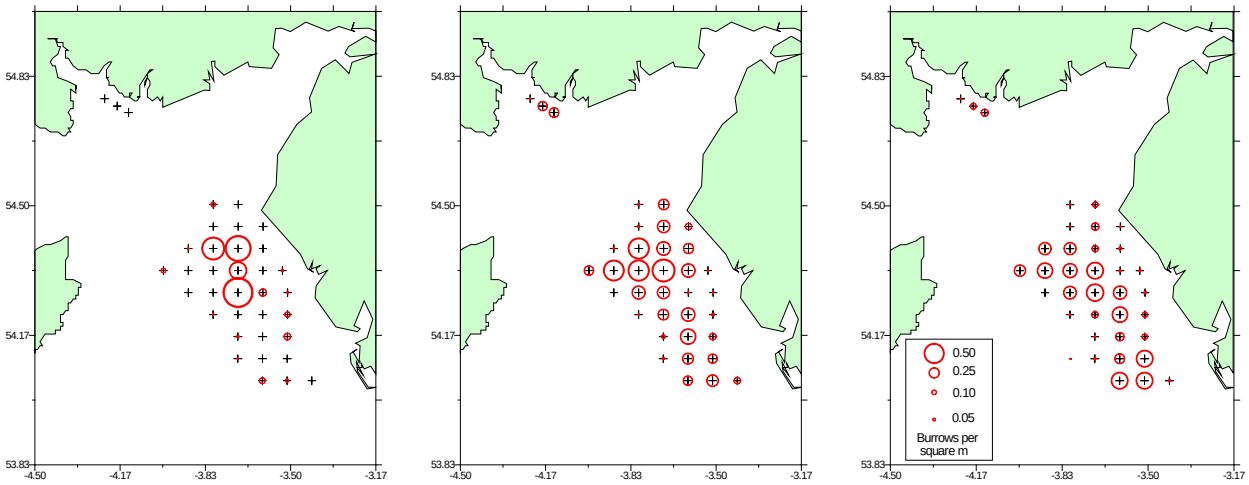


Figure B.3.1. Station distribution and relative burrow density, from August TV surveys 2007 to 2009.

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 east 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	"

Stock Annex 6.5: 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 affect 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 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%	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%

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.

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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 surveys															
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	"

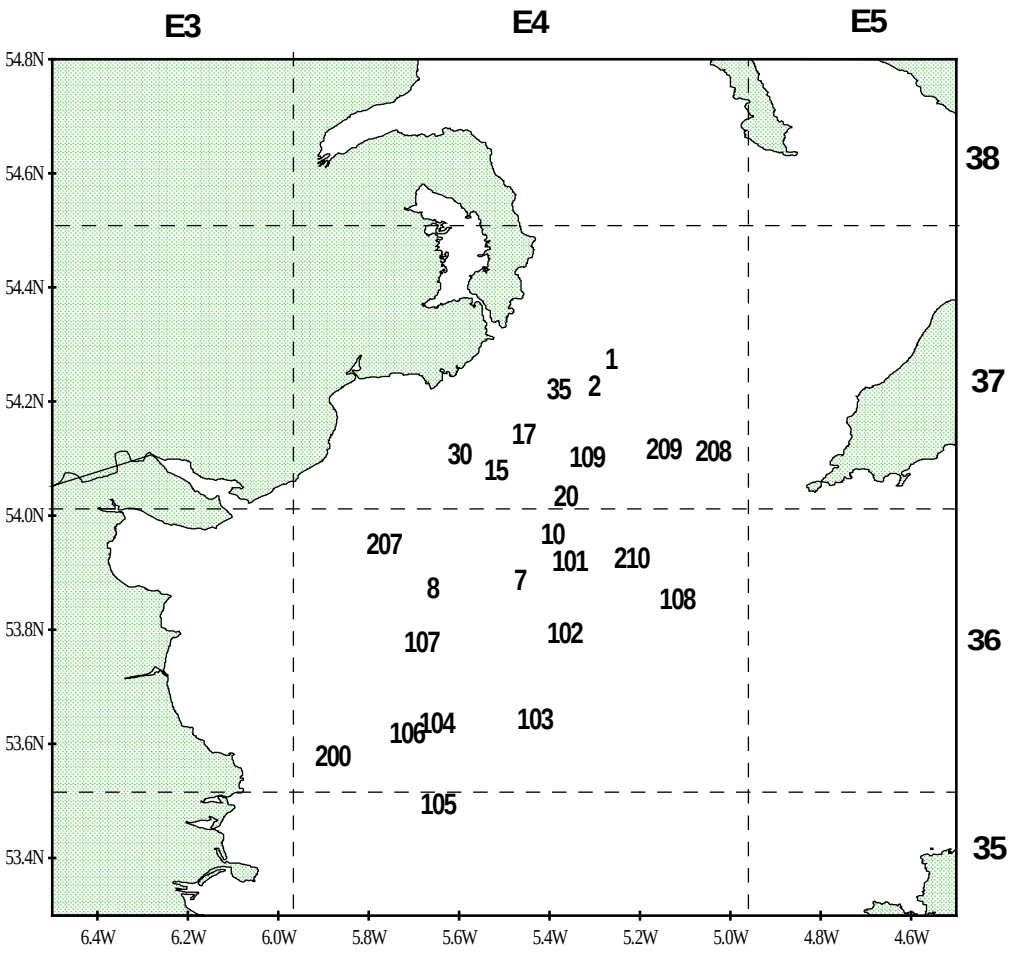


Figure 1: Western Irish Sea Nephrops stations

Stock Annex 6.6: 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	WGNSDS 2008
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 bycatches 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 the summer months. 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. Most recently, Ireland introduced a further decommissioning scheme in 2008, which aims to remove 11 140 GT from the fleet register. This is targeted at vessels over ten years of age and >18 m in length. To date the majority of applications emanate from east and west coast ports from vessels, which traditionally target *Nephrops* with uptake from the southeast also. It is expected that much of the actual effort removed from the decommissioning scheme may be partially negated through the introduction of ~21 modern second-hand vessels (mostly ex-French) into the fleet over the last few years.

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.

Whereas 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. Because of the need to fish further away from their home port and in rougher sea conditions, many of the older and smaller wooden vessels are being replaced with new and second-hand steel vessels. Most of these newer vessels are French-style twin-riggers. To maximize the return on their investment, many of the owners of newer vessels are opting for relief skippers and crews so that the vessels are fishing as much as possible.

In 2006, for the Irish fleet for the first time, *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 7g where in general, better prices are obtained for their catch. Two significant fleet movements occurred in 2006 for the Irish fleets. Firstly, there was a brief shift in effort by the *Nephrops* fleet towards the Aran Grounds around October due to reports of good fishing in the area. Also, some of the larger twin-riggers in the fleet switched to tuna fishing in the Bay of Biscay during the summer months.

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 investi-

gated. Young whiting are common in the diets of larger predators such as cod and anglerfish.

B. Data

B.1. Commercial catch

B1.1. 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 the 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), and 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**.

B1.2. Discards

The Irish Sea *Nephrops* fishery takes place on the whiting nursery grounds of the north-western 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 WGNSDS 2006 revised Irish discard estimates (1996–2005) 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 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 for 2004.

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 re-

search 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 two. 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 whereas 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 2005. 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): ages 0 and 1, years 1988–2002: 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-October): ages 0–5, years 1992–2005: 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 sea-

bed 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 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-March): ages 1–5, years 1992–2006: Description as for UKNI-GFS-October above.
- UK(Northern Ireland) Methot-Isaacs–Kidd Survey (UKNI-MIK): age 0, years 1993–2005: 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): 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 NIGFS-March 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 2007 Working group:

- UK (NI) groundfish survey: March 1992–2007.

- UK (NI) groundfish survey: October 1992–2006.
- 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 1994–2006.
- UK (E&W) beam trawl survey: 0-1 gp cod, 1988–2006.

FSP surveys of Irish Sea round fish: 2004–2007.

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

Model used:

XSA (up to 2002)

SURBA 2.0-2003

SURBA 3.0-2004

SURBA 2.2-2005

Software used:

Lowestoft VPA suite

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:

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

For analysis of alternative procedures see WG reports from WGNSDS 1997–2005.

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.

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 the 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. Revised Discard estimates raisesd according to the method outlined in Borges *et al.,* 2005.

	1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
Age	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	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	17091.56	0.018	442.07	0.010
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	7347.29	0.034	2531.84	0.035
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	731.35	0.101	783.68	0.091
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	142.50	0.165	129.28	0.159
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	96.30	0.218	40.12	0.154
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	0.00	0.000	24.48	0.371
6	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	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	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	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	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	0.00	0.000	0.00	0.000
OTB Discards (tonnes, whole weight)		520.8		#####		1010.3		71.6		434.3		1054.5		1100.9		523.6		680.3		201.3

Sampling Information	1996	1997	1998	1999	2000	2001	2002	2003	2004	
Number of Trips	8	8	7	4	10	2	1	9	11	8
Number of Hauls	48	44	58	40	111	34	7	60	122	96

Stock Annex 6.7: Irish Sea plaice

Stock-specific documentation of standard assessment procedures used by ICES.

Stock	Plaice (Division VIIa)
Working Group	Celtic Seas Ecoregion
Date	18th May 2011
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 A1). 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.

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 A1). 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.

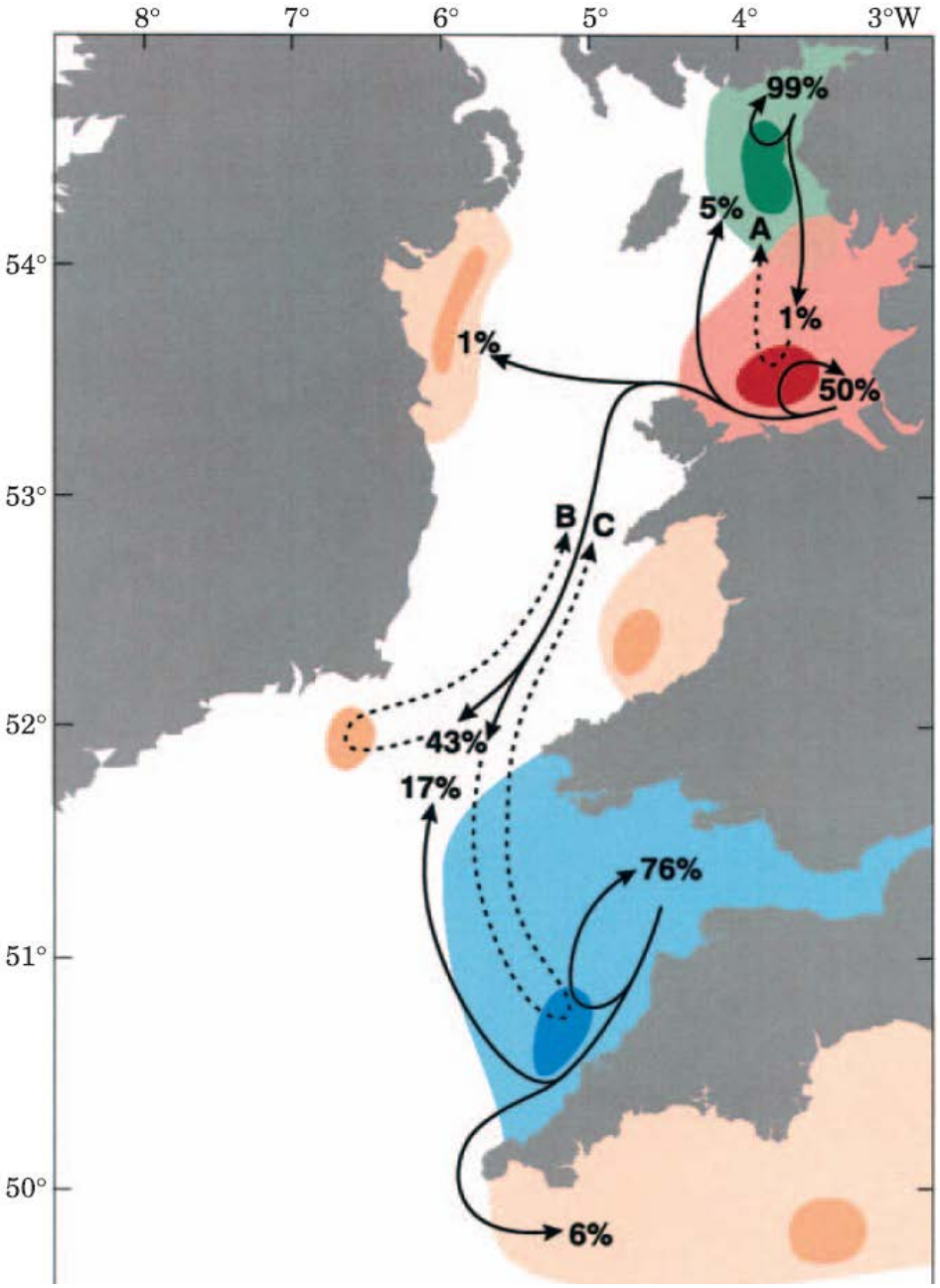


Figure A.1. Principal substock areas and movements of plaice on the west coast of England and Wales. Percentages are the recaptures rates of tagged plaice <25 cm total length when released, and >26 cm when recaptured in English and Welsh commercial fisheries. Tagging exercises in 1979–1980 and 1993–1996 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 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 meshnets 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 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 or 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 mechanizms 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 B1 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 A2). Survey data indicate that males of ages 1–5 and females of age 1–3 are generally below minimum landing size (MLS, Figure A3).

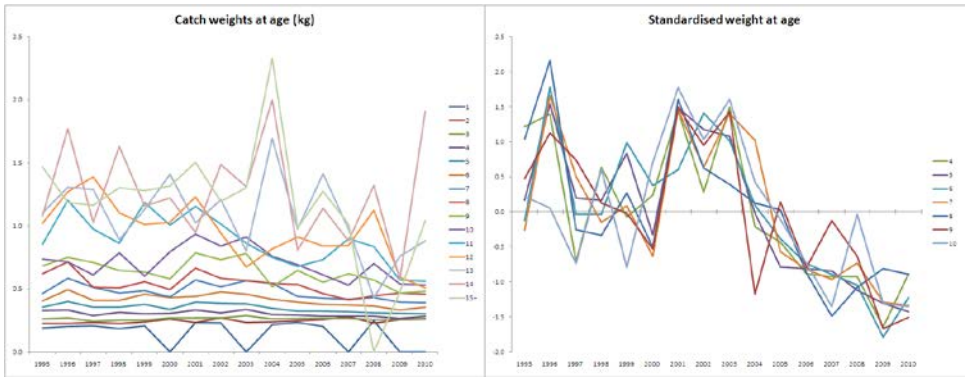


Figure A2. Commercial weight-at-age data 1995–2010 (raw, left and standardized, right).

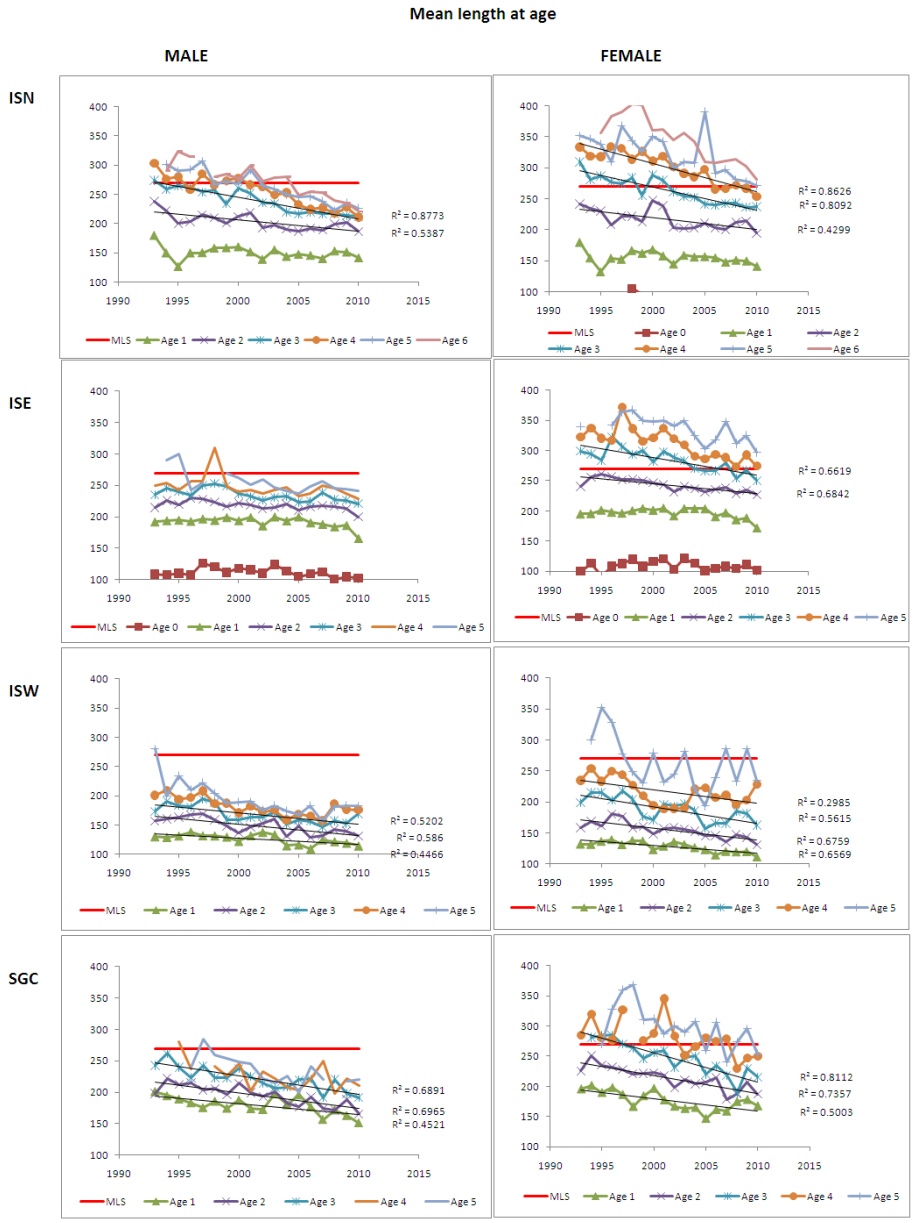


Figure A3. Mean length (cm)-at-age data 1993–2010 by sex and area within the Irish Sea: Irish Sea North (ISN), Irish Sea East (ISE), Irish Sea West (ISW), St George's Channel (SGC).

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; WD9 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 WD9 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 A4 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.

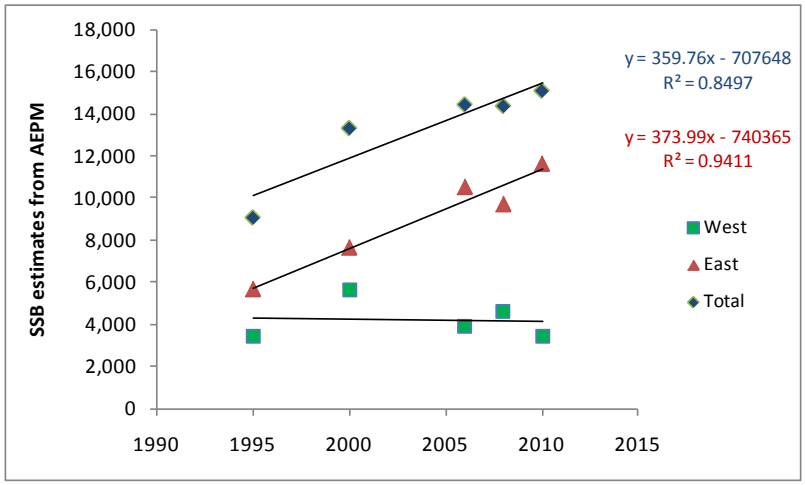


Figure A.4. AEPM estimates by year and substrata.

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 re-scaled 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 geographic 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}	3100 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 3 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.

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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	Netherlands	Derivation of international landings and discards	% sampled
1978	Len. comp.	quarterly[1]	quarterly[1]	quarterly[1]		Irish raised to Irish and N.Irish; UK raised to UK (E&W) and Scotland	85
	ALK	quarterly[1]	quarterly[1]	quarterly[1]		Belgian raised to Belgian, Dutch and French	
	Age comp.	quarterly[1]	quarterly[1]	quarterly[1]		UK + Bel + IR combined to total int. separate sex	
1979							
1980	Len. comp.	quarterly[1]	quarterly[1]	quarterly[1]		Irish raised to Irish and N.Irish; UK raised to UK (E&W), Sco and IOM.	86
	ALK	quarterly[1]	quarterly[1]	quarterly[1]		Belgian raised to Belgian, Dutch and French	
	Age comp.	quarterly[1]	quarterly[1]	quarterly[1]		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	Netherlands	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	Source Data	UK	Belgium	Ireland	Netherlands	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			92[3]
	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			90[3]
	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.	

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
Assessment model		AP
Tuning fleets	UK-BTS Sept (Trad)	Series omitted
	UK(E&W)-BTS-Q3	1993–2010, 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	1993–2010
	NIGFS-WIBTS-Q4	1993–2010
Time-series weights		n/a
Num yrs for separable		n/a
Reference age		n/a
Terminal S		n/a
Catchability model fitted		n/a
SRR fitted		n/a
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 N-at-age, yrs ages r		2004–2010, ages 1–5

Stock Annex 6.8: Sole VIIa

Stock-specific documentation of standard assessment procedures used by ICES.

Stock	Irish Sea Sole (Division VIIa)
Working Group	WGCSE
Date	6 February 2011
Revised by	WKFLAT 2011/Sofie Nimmegeers, Willy Vanhee, Kelle Moreau

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 to 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. The Netherlands 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 2% 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.

A.3. Ecosystem aspects

No information.

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 and Northern Ireland. 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, whereas 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

1988–2009: 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 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 years classes.

B.4. Commercial cpue

Cpue 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).

Cpue 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 2008–2009 (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 the lowest value of the time-series in 2009.

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
Assessment Model	XSA	SURBA	XSA	XSA	XSA
Fleets					
BEL-CBT	1975–2003 4–9		omitted	omitted	omitted
UK-CBT	1991–2003 2–9		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

ASSESSMENT YEAR	2004	2005	2006	2007–2010	WKFLAT 2011
UK (BTS-1Q)	1993–1999 2–9		1993–1999 2–7	1993–1999 2–7	omitted
Time-ser. Wts	tricubic 20yrs		linear 20 yrs	linear 20 yrs	uniform
Power Model	none		none	none	none
Q plateau	5		5	7	4
Shk se	0.8		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
Pop Shk se	0.3		0.3	0.3	0.3
Prior Wting	none		none	none	None
Plusgroup	10		8	8	8
F_{bar}	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 long-term geometric mean recruitment (1970–penultimate estimate) 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, scaled to the last year's Fbar (4–7) if a trend in F was detected (not scaled to the last year's Fbar (4–7) if no 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 Fbar (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 Fbar (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}. 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.

I. References

ICES. 2002. Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks (WGNSDS). ICES CM 2002/ACFM:02. 448 pp.

ICES. 2010. Report of the Working Group on the Celtic Seas Ecoregion (WGCSE), 13–19 May 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:09. 1430 pp.

ICES. 2010. Report of the Working Group on Celtic Seas Ecosystems, 12–20 May 2010, Copenhagen, Denmark. ICES CM 2010/ACOM:12. 1435pp.

Stock Annex 7.2: Cod in 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	WKROUND 2009, WGCSE 2009-2010
Revised by	Robert Bellail, 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. The assessed area has gradually increased from VIIfg before 1994 to VIIfgh, to VIIefgh in 1996 and finally to VIIe–k.

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.

In 1994, at the request of ACFM, the 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 VIIfgh in earlier years (1988–1990), and SSBs trends were similar in the period 1988–1992. The patterns of recruitment (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 historical (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, WD3). 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.

Migrations are known to occur in this cod stock. Cod can be caught throughout the English Channel (ICES Areas VIId and VIIe) in autumn (quarter 4) and winter (quarter 1), being more aggregated during the spawning season in January/February. Electronic tagging experiments in the English Channel (VIId and VIIe) have shown that cod tagged on or close to English Channel spawning grounds in quarters 4 and 1 either remain close to the point of release (residency), or move to feeding grounds to the south and/or west. Smaller fish (<50 cm) are more likely to be resident. Migrants tend to move offshore to deeper areas, whereas the habitat selection of residents is less clear cut.

From the migratory phenotypes identified by electronic tagging, historical mark-recapture experiments can be re-evaluated. Although sample size is limited, results from data on the movements of adult cod (>50 cm) show that, after tagging in VIIe (the western Channel) in quarters 1 and 4, 47% of cod (27 of 58) are recaptured in ICES Areas VIIf through VIIj, while 48% are recaptured in VIIe (i.e. are probably resident). In contrast, no adult cod tagged in VIId were recaptured in ICES Areas VIIf through VIIj, 5% moved into VIIe and 51% remain in VIId. Juvenile cod are more likely to be recaptured in the same area that they were tagged in. These figures vary slightly when recaptures are separated into autumn/winter and spring/summer seasons, but are broadly comparable. The data therefore provide evidence that cod in the eastern English Channel and western English Channel might be classed as separate substocks, and that movement of cod between eastern English Channel and the Celtic Sea is limited, whereas movement between the western Channel and the Celtic Sea is frequent.

A.2. Fishery

Cod in Divisions VIIe–k are mainly taken as components of catches in mixed demersal trawl fisheries with a minor part by gillnets. 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 led the landings to spread across the first three quarters of the year.

WGSSDS has been collating a database of landings and effort for the Celtic Sea. Available data on cod landings are analysed and presented. Effort data are not yet fully available for similar investigations. Recent temporal and spatial patterns in landings distributions for the main fleets catching Celtic Sea Cod are shown in Figure A.2.1 and Figure A.2.2. Highest landings are in quarter 1 when the cod aggregate to spawn. There is an indication that Q1 landings have declined in 2006 and 2007 as a result of the closure of a known spawning area at Trevose Head, although this was not the case in 2005 the first year of introduction of the closure. In most years there is a distinct peak in landings in February or March. The scale of this peak may be related to the relative strength of age 2 fish entering the fishery. The majority of the landings come from VIIg, ~55%, and the relative contributions of different ICES Divisions to the landings has been fairly stable over recent years. In 2002 there were larger than normal landings from rectangle 30E4 in VIIf.

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.

A.3. Ecosystem aspects

No environmental drivers are known for this stock.

B. Data

B.1. Commercial catch

Landings

On a quarterly basis, France and UK (E+W) have provided catch numbers-at-age and catch weights-at-age for their landings. Ireland has provided with the same data in Divisions VIIg and j separately and estimates of misreporting in VIIg. Landings only are available for Belgium.

Irish data are first aggregated to the landings in VIIe–k and then both datasets for France, UK and Ireland are added 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.

Nothing is hidden in the aggregating procedure but the level of available data has changed and consequently the aggregation procedures. Compiling the previous reports of the WGSSDS and before the reports of the WGIRCS shows the following datasets available and the history of the aggregation procedures to produce the landings numbers-at-age series:

Year range	Landings VIIe–k	Length structure (Ls) VIIe–k	Age structure (As) VIIe–k
1971–1976	Annual VIIfgh expanded to Annual VIIe-k using the mean landings VIIe-k	UK VII fg raised to international landings in VIIfg	UK alks VIIa to UK Ls VIIfg then UK VIIfg As raised to international landings

Year range	Landings VIIe-k	Length structure (Ls) VIIe-k	Age structure (As) VIIe-k
1977–1980	1988-1997 over the mean landings VIIfgh 1988–1997 as a ratio	UK VIIfg + FRVIIfg raised to international landings in VIIfg	UK alks VIIa to UK Ls VIIfg and FR Ls VIIfg then As summed and raised to international landings
1981–1987		UK VIIfg FR VIIfg raised to VIIfgh	FR alks VIIfg to UK&FR Ls VIIfg then As summed and raised to international landings
1988–1989		UK VIIfg UK VIIe FR VIIfg raised to VIIfgh	FR alks VIIfg to FR Ls UK alks VIIfg to UK Ls UK alks VIIe to UK Ls then As summed and raised to international landings
1990		UK VIIfg UK VIIe FR VIIfg raised to VIIfgh IR VIIg	FR alks VIIfg to FR Ls UK alks VIIfg to UK Ls UK alks VIIe to UK Ls IR alks VIIg to IR Ls then As summed and raised to international landings
1991–1998		UK VIIfg UK VIIe FR VIIfg raised to VIIfgh IR VIIg IR VIIj annual	FR alks VIIfg to FR Ls UK alks VIIfg to UK Ls UK alks VIIe to UK Ls IR alk VIIg to IR VIIg Ls IR alk VIIj to IR VIIj Ls then sum of As VIIg or VIIfg raised to VIIfgh international, As UK VIIe raised to VIIe international, As IR VIIj raised to VIIjk international landings, (VIIfgh internat+ VIIe internat + VIIjk internat) = VIIek
1999–2001		UK VIIfg UK VIIe FR VIIfg raised to VIIfgh IR VIIg IR VIIj quarterly	FR alks VIIfgh to FR Ls UK alks VIIfg to UK Ls UK alks VIIe to UK Ls IR alk VIIg to IR VIIg Ls IR alk VIIj to IR VIIj Ls then sum of As VIIg or VIIfg raised to VIIfgh international, As UK VIIe raised to VIIe international, As IR VIIj raised to VIIjk international landings, (VIIfgh internat+ VIIe internat + VIIjk internat) = VIIek

Year range	Landings VIIe–k	Length structure (Ls) VIIe–k	Age structure (As) VIIe–k
2002–…		FR-VIIe–k	FR alks VIIfgh to FR Ls
		UK VIIe–k	UK alks VIIfg to UK Ls
		IR VIIg	UK alks VIIe to UK Ls
		IR VIIj	IR alk VIIg to IR VIIg Ls
			IR alk VIIj to IR VIIj Ls
			Then sum As UK raised to UK landings in VIIe-k,
			Sum As IR raised to IR landings in VIIe–k,
			Then AsUK+As IR+ As FR raised to international landings

At each step of the aggregations, mean weight-at-age is the weighted mean by numbers-at-age.

Discards

Discards data sampled under EU/DCR since 2003 have been generally presented in previous WGSSDS 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. On an annual basis, 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 improve estimates of French landings from 2003 at ICES WKROUND 2009. This procedure could not be used in later years as highgrading has also occurred in that years.

In 2008 the French self-sampling programme on Celtic Sea cod has produced datasets enabling estimation of discarding and highgrading rates on a quarterly basis. Assuming the same pattern of discarding in recent years, estimates of French discarding and highgrading back to 2006 were also computed. Estimates of highgrading were also calculated for the French tuning fleets used in the analysis (ICES WKROUND, 2009, WD 17). Since the WKROUND, the database of the 2008 self sampling has increased and led to a slight update of the estimates of the level of French highgrading.

Lpue

The table below summarizes the available data.

Name	Area	series
FR gadoid fleet [1]	VIIfgh	1983–…
FR Nephrops fleet [1]	VIIfgh	1983–…
FR otter trawlers [2]	VIIe	1983–…
FR otter trawlers [2]	VIIfgh	1983–…
FR otter trawlers [2]	VIIe–k	1983–…
UK otter trawlers	VIIe	1972–…

Name	Area	series
UK otter trawlers	VIIe–k	1972–…
UK beam trawlers	VIIe–k	1978–…
IR otter trawlers	VIIg	1995–…
IR beam trawlers	VIIg	1995–…
IR Scottish seiners	VIIg	1995–…
IR otter trawlers	VIIj	1995–…
IR beam trawlers	VIIj	1995–…
IR Scottish seiners	VIIj	1995–…

[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 for 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 in VIIe–k.

Maturity

The maturity ogive applied since 1999, was estimated from the datasets of the UK-WCGFS survey (first 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. 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 (M=0.2) for the whole range of years and ages.

B.3. Surveys

Three survey-series are available. The common range of ages used is 1–5:

The discontinued UK-WCGFS (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 for calibration.

The FR-EVHOE survey (1997–…), during the fourth quarter, covers the Divisions VIIfghj. The full series is used.

The IrGFS survey (2003–…), during the fourth quarter, in VIIg and VIIj is also used in the assessment. It is the main contributor to the terminal year estimates, partly because this series is short.

The absolute numbers of cods caught in all of these surveys are extremely low.

B.4. Commercial cpue

Two French commercial fleets are used for tuning: the French trawlers targeting Gadoids in Divisions VIIf, g, h (FR-GADOIDS) and the French *Nephrops* trawlers in VIIf,g,h (FR-*NEPHROPS*), for which cod is generally a bycatch. Both fleets account on average for ~30% of the international landings from 1988; the series starts in 1983. Other commercial fleets used are the English West Coast otter trawlers (UK-WECOT) in VIIe from 1988 and the Irish 7J otter trawlers (IR-7J-OT) in VIIj from 1995. Both fleets fish throughout the majority of the assessed area.

B.5. Other relevant data

Input from industry

No new datasets.

C. Historical stock development

Model used:

The Separable VPA was used at the former Irish Sea and Bristol Channel WG and the Laurec–Shepherd model in the period 1987–1992. The XSA was the model used subsequently. SURBA was also used for survey catch-at-age analysis in 2005–2007.

Corrections for some misreporting estimates have been integrated into the datasets used in the assessment but the change of discarding practices to manage the restricting national quotas may impact the assessment. This also affects the reliability of the commercial tuning fleets used.

In previous assessments (2006, 2007 and 2008), adding a new year of data has generally raised the stock numbers at younger ages (age 1 and 2) resulting in increased estimates of recruitment strength. These upwards revisions are considered a result of the recent highgrading practices. Given this uncertainty and the recent reports from the industry of underreporting the XSA assessment, which assumes unbiased catch data cannot be applied. Improved datasets on landings, recorded and highgrading are required before XSA could be used.

WKROUND (2009) evaluated XSA with adjusted recent catch levels against B-Adapt and the SAM state-space model, which estimate additional unallocated mortality. All models exhibited different patterns in the recent years with a high degree of uncertainty. The Group concluded that no model could be recommended as a basis for providing advice

on recent stock trends until further investigations or additional datasets were available to resolve the situation.

D. Short-term projection

No decision has been taken on the forecast methodology.

E. Sensitivity analysis and medium-term projections

Medium-term forecasts are not provided for this stock.

F. Long-term projections

Long-term forecasts are not provided for this stock.

G. Biological reference points

Reference points

	Type	Value	Technical basis
Precautionary approach	B_{lim}	6 300 t	$B_{lim} = B_{loss}$.(B76), the lowest observed spawning-stock biomass.
	B_{pa}	8 800 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.
	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 account the uncertainty assessments.
Targets	F_y	Not defined.	

(unchanged since: 2004)

Due to the current uncertainties on the state of this stock, the Benchmark WK is unable to make new proposals for the Reference Points and the 2004 values remain.

H. Other issues

None.

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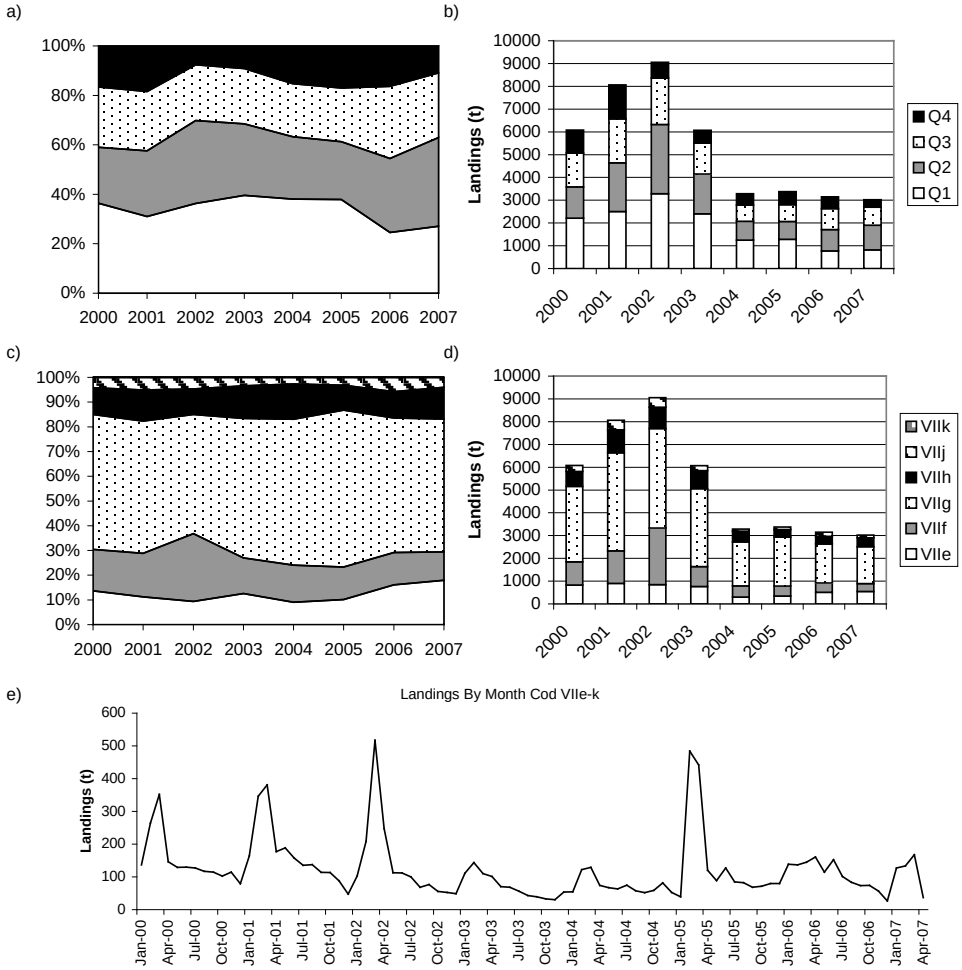


Figure A.2.1. Temporal and spatial patterns in landings patterns for Celtic Sea cod (VIIe–k).

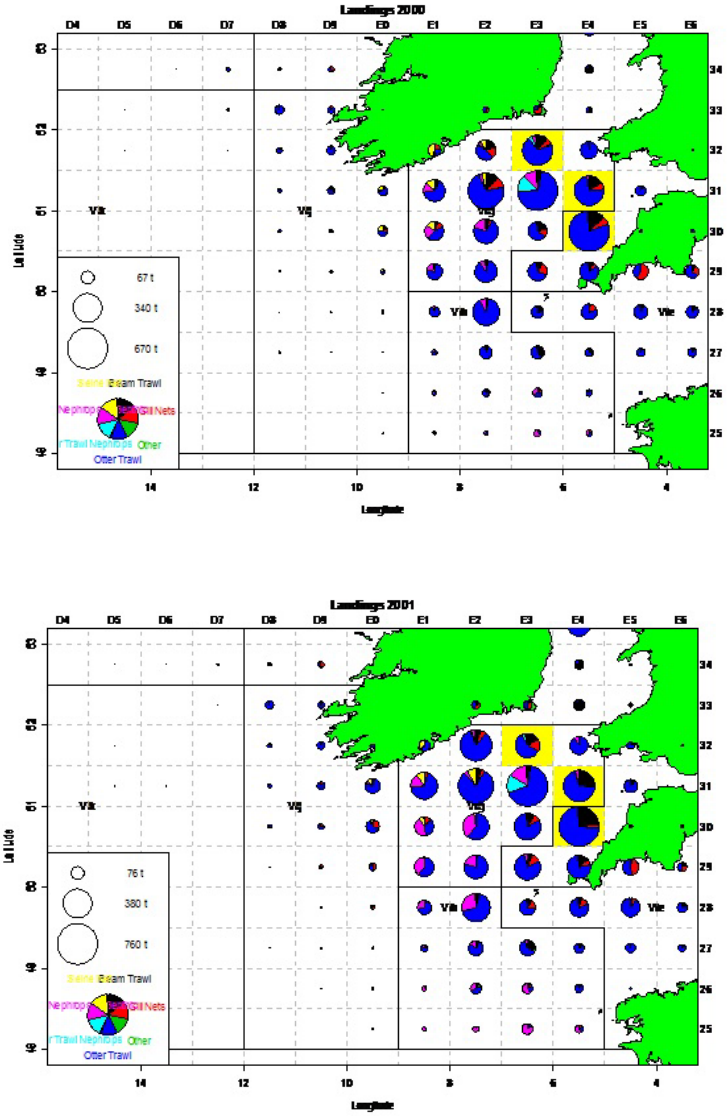


Figure A.2.2. The spatial and temporal distribution of cod landings from the Celtic Sea, from 2000–2007 by gear type. The closed rectangles are highlighted in yellow. Each year is scaled to, the maximum.

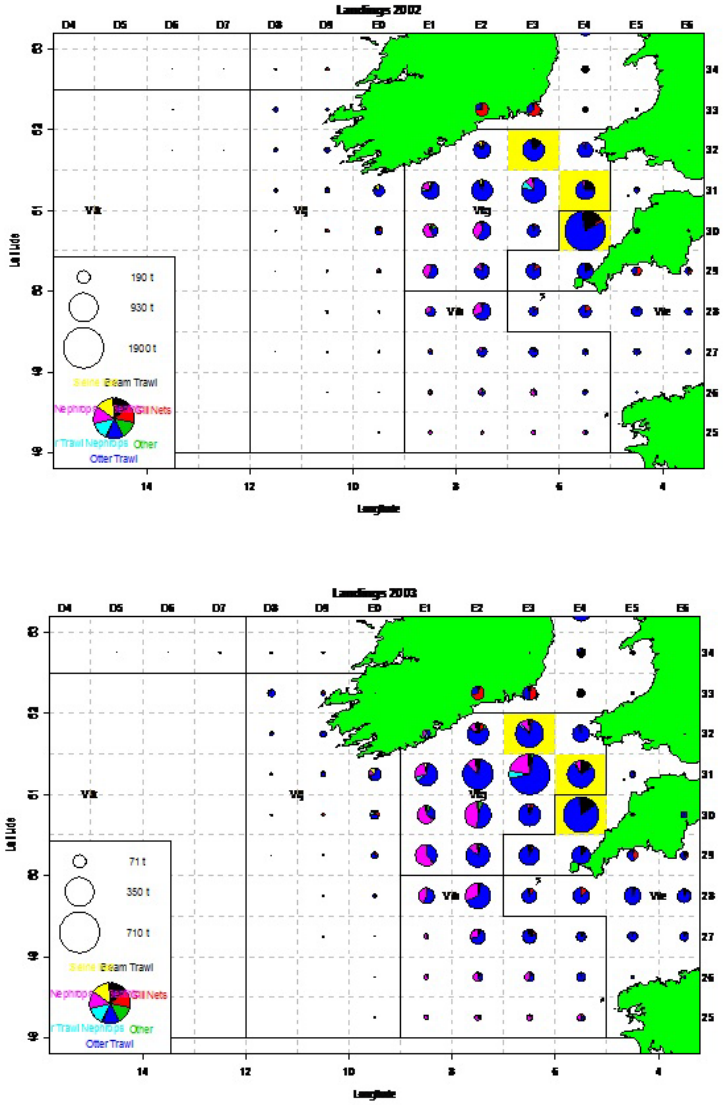


Figure A.2.2. continued.

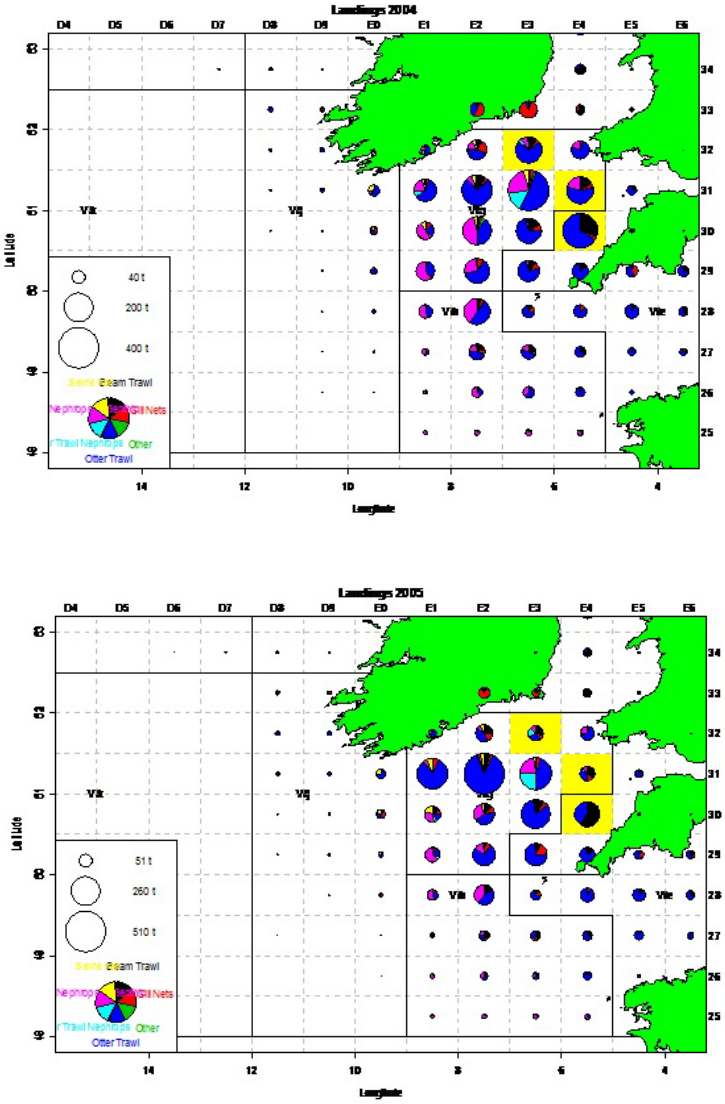


Figure A.2.2. continued.

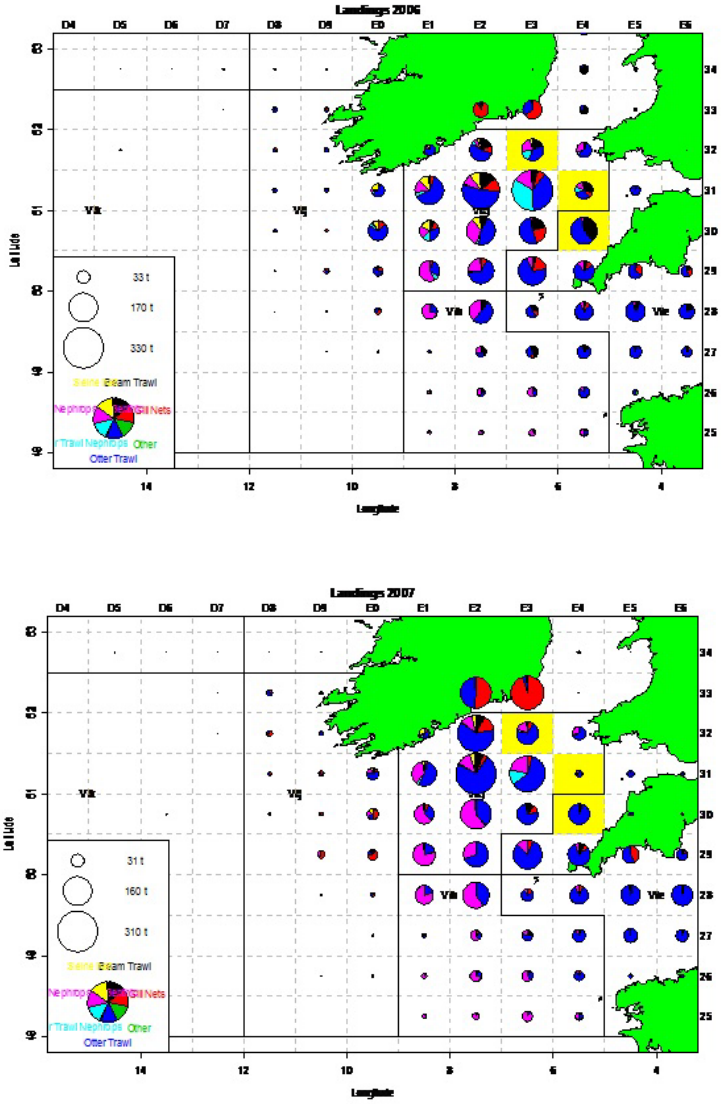


Figure A.2.2. continued.

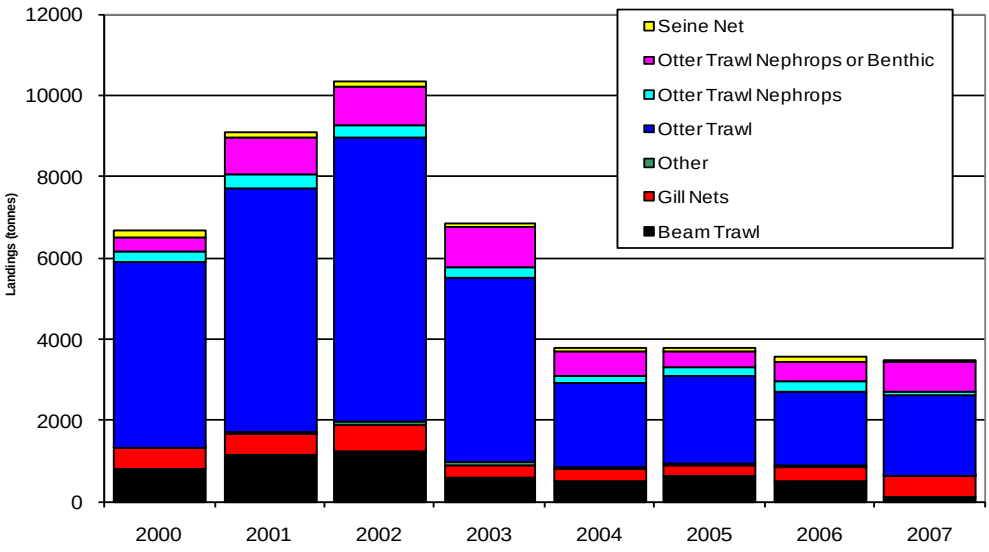


Figure A.2.2. continued.

Stock Annex 7.4: Haddock VIIb–k

Stock-specific documentation of standard assessment procedures used by ICES.

Stock	Haddock VIIb–k
Working Group	WGCSE
Date	last revision 11/05/11
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 without a clear long-term trend.

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, under-size, 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. The UK catch numbers 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 VIIf,g,h catch numbers are combined with Irish VIIg data to estimate VIIf,g,h catch numbers. Since 2009, the French catch 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

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

In the absence of a direct estimate of natural mortality, a constant value of 0.2 was assumed for all age classes and years. 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

All surveys described below are coordinated by the IBTSWG (International Bottom-trawl Survey Working Group).

The UK7efghjWCS first-quarter annual groundfish 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 survey was not included in the assessment because it was discontinued and all cohorts are in the converged part of the vpa.

The French 7fghj EVHOE-WIBTS-Q4 annual groundfish is carried out on the RV Thalassa. Age data are available from 2001 onwards. ALK data from the Irish survey 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 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.

Between 1999 and 2002 Ireland carried out the fourth-quarter Irish Sea-Celtic Sea Groundfish Survey (ISCSGFS) in VIIag on RV Celtic Voyager. The survey used a GOV Trawl with a mean vertical opening is 6 m and door spread 48 m. In 2003 the ISCSGFS survey was replaced by the fourth-quarter Irish Groundfish Survey (IGFS-WIBTS-Q4) which covers VIaS, 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 IGFS-WIBTS-Q4 (7g) index used in the assessment is a combination of the ISCSGFS and IGFS in VIIg. The two survey-series were standardized by swept-area estimates.

The IGFS also provides indices for VIIb and VIIj. (IGFS-WIBTS-Q4(7b) and IGFS-WIBTS-Q4(7j) These indices are currently not used. It is believed that a significant amount of recruitment takes place in VIIb and the north of VIIj, these divisions are not covered by the EVHOE or IGFS-WIBTS-Q4(7g) indices, therefore it would be worth considering including the IGFS-WIBTS-Q4(7b and 7j) indices at the next benchmark assessment.

The commercial IR7bjOTB fleet consists mainly of vessels from 15 to 35 m in length, operating from the west and southwest coast of Ireland.

Vessels of the Irish OTB fleet in VIIg regularly switch between targeting *Nephrops* to targeting whitefish. Significant numbers of new boats have also been added to this fleet, making it unsuitable as a tuning fleet.

The commercial FR7fghGAD fleet consists of French vessels targeting gadoids.

Consistency

The surveys used in the assessment generally show good internal consistency for ages 0 to age 3 or 4. The current surveys also show reasonably good agreement in the estimated

numbers of recruits (age 0). The tuning fleets used in the assessment generally show good consistency from the age of 2 or 3 up to ages 6 or 7.

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 gadoid trawlers in VIIfgh since 1993 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 for the Irish otter trawl fleets in VIIbgj since 1995. French discard data are available since 2005 and UK discard data are available since 2003. The French and UK data are not raised to the national level.

Because the Irish discard data cover nearly the entire time-series, these data were used to estimate discard numbers-at-age by raising them to the international level. Otter trawlers account for most of the international effort in VIIb–k, no attempt was made to estimate discards for the other main gears (seine and beam trawl). No discard data were available for 1993–1994, discarding in these years was estimated from the average of 1995–1999, which was a period with relatively low discarding.

Irish otter trawl discard length distributions were raised to the national level of discards by estimating the mean length distribution per trip and multiplying this by the total number of otter trawl trips following recommendations by Borges *et al*., (2005).

Irish discard data from VIIgj were used to estimate international discards by using the ratio of the international effort in VIIe–k to the Irish effort in VIIgj. This approach assumes that Irish discarding in VIIjg is representative of the international discards and does not take differences in vessel power or target species into account.

The age structure of young haddock appears to vary between years and between VIIb and VIIgj It was therefore considered appropriate to apply separate Age–Length Keys (ALKs) to VIIb and VIIgj on an annual basis. For years where age data were insufficient or absent, the average ALK of all years was applied for the relevant area (This was considered appropriate because of the fast growth there is relatively little length-overlap between age classes). For many years, it was possible to clearly identify the youngest cohorts from the length distributions. Based on this, some spurious age readings were adjusted. The following rules were applied to correct the data:

Area	Year	Lengths	Change ages from	Change ages to	Observations affected
VIIb	all	<14	1	0	14
VIIb	2003	>14	0	1	28

VIIb	96,97,99,00,01,02,04,05	>15	0	1	8
VIIb	2006	>18	0	1	31
VIIb	all	>25	1	2	110
VIIb	all	<20	2	1	10
VIIgj	all	<22	2	1	28
VIIgj	all	<25	3	2	7

The changes affected 236 age observations out of a total of 3021.

C. Historical stock development

Model used: XSA

Software used: FLR, VPA95

Exploratory data analysis and the assessment were carried out using FLR under R version 2.8.1 with packages FLCore 2.2, FLAssess 2.0.1, FLXSA 2.0 and FLEDA 2.0.. A separable assessment was performed using the Lowestoft VPA95 software to screen for outliers in the catch numbers. The final assessment was performed in R as well as the Lowestoft VPA95 software.

Model settings Separable VPA (data screening only)

Option	Setting
Year range	1993–current
Age range	1–8+
Year weighting	Default
Age weighting	Default
Reference age	2
Terminal F	From previous year's XSA
Terminal S	1.25

Model settings XSA

The model settings below have been unchanged since 2007.

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year
Caton	Catch in tonnes	1993–current	0–8+	Yes
Canum	Catch-at-age in numbers	1993–current	0–8+	Yes
Weca	Weight-at-age in the commercial catch	1993–current	0–8+	Yes
West	Weight-at-age of the stock at spawning time.	1993–current	0–8+	Yes
Mprop	Proportion of natural mortality before spawning	1993–current	0–8+	No
Fprop	Proportion of fishing mortality before spawning	1993–current	0–8+	No
Matprop	Proportion mature-at-age	1993–current	0–8+	No
Natmor	Natural mortality	1993–current	0–8+	No

A plus group of 8+ was used. Age group 0 was included in the assessment data to allow inclusion of 0-group indices in the XSA runs. However, catch numbers-at-age 0 were set to zero to avoid spurious F-shrinkage effects at this age.

Model Options:

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 (see regression plots in the report). 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	IR7bjWCGFS	1993–2002	Not used
Survey	UK7efghjWCS	1996–2004	Not used
Survey	FR7fghjEVHOE	1997–current	0–5
Survey	IR7gSAGFS	1999–current	0–5
Survey	IR7bIGFS	2003–current	Not used
Survey	IR7jIGFS	2003–current	Not used
Commercial	IR7bjOTB	1995–current	2–7
Commercial	FR7fghGAD	2002–current	2–6

The age ranges used in the assessment were based on an analysis of internal consistency and residuals. The surveys catch few fish over the age of 5 and the commercial fleets discard most fish under the age of 2 as well as a considerable number of 2-year-olds. These were retained in the fleets because they do show good internal consistency as well as agreement with other fleets.

History of previous assessments, changes are highlighted using bold font.

		2002 XSA	2003 XSA	2004 XSA	2005 XSA	2006 XSA	2007–current XSA
Catch data	Years	93–01	93–02	93–03	93–04	93–05	93–06
	Ages	1–8+	1–8+	0–8+	3–8+	3–8+	0–8+
Survey tuning fleets							
IR7bjWCGFS	Years	93–01	93–02	93–02	93–02	93–02	Not used
	Ages	1–1	1–1	0–3	3–3	3–5	
UK7efghjWCS	Years	98–01	98–02	98–03	Not used	98–03	Not used
	Ages	1–3	1–3	1–5		3–5	
EVHOE-WIBTS-Q4	Years	Not used	Not used	97–03	97–04	97–05	97–current
	Ages			0–3	3–3	3–5	0–5
IGFS-WIBTS-Q4(7g)	Years	Not used	Not used	Not used	Not used	Not used	99–current
	Ages						0–5
IR7gISCSGFS	Years	Not used	Not used	97–03	97–04	Not used	Not used
	Ages			0–3	3–3		
Commercial tuning fleets							
IR7bjOTB	Years	95–01	95–02	95–03	95–04	95–05	95–current
	Ages	1–7	1–7	1–7	3–7	3–7	2–7
FR7fghGAD	Years	Not used	Not used	Not used	Not used	Not used	02–current
	Ages						2–6
Model options							
Ages catch dep stock size		None	None	None	None	None	None
Q plateau		4	4	4	4	4	4
Taper		No	No	No	No	No	No
F shrinkage SE		1.5	1.5	1.5	1.5	1.5	1.5
F shrinkage year range		5	5	5	5	5	5
F shrinkage age range		3	3	3	3	3	3
Fleet SE threshold		0.3	0.3	0.3	0.3	0.3	0.3
Prior weights		No	No	No	No	No	No

D. Short-term projection

Model used: Multifleet Deterministic Projection. Landings and discards are modelled as separate fleets.

Software used: MFDP1a

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 long-term GM (omitting the last two years).

Natural Mortality: 0.2 for all ages in all years as used in XSA

Maturity: knife-edge at age 2 for all years as used in XSA

F and M before spawning: Set to 0 for all ages in all years as used in XSA

Weight-at-age in the stock and catch: average from last three years

Exploitation pattern average from last three years (from XSA)

Intermediate year assumptions: *status quo* F.

Stock–recruitment model used: None, the long-term GM recruitment-at-age 0 is used.

F_{bar} range: ages 2–5

Rescale to last year: No

E. Medium-term projections

None.

F. Yield and biomass per recruit

MSY estimates were evaluated using the srmsymc ADMB package See report of WGCSE 2010 for a description of the yield-per-recruit analysis.

G. Biological reference points

It is not possible to derive precautionary reference points for this stock from the short time-series of information available.

H. Other issues

None.

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Stock Annex 7.5: *Nephrops* in VIIb 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 associ-

ated 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 potentially 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

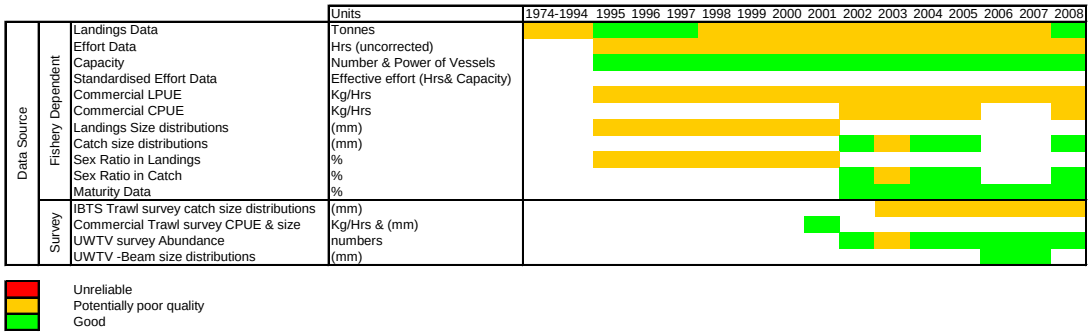
An emerging time-series of temperature and salinity data are available for a transect through the Aran Grounds (Nolan and Lyons, 2006). In all years since 1999 (except 2001) the 53°N section has exhibited positive anomalies in temperature of between 0.2°C and 2°C (Figure A.3.1). In 2001, the temperature 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 of 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	species detection rate	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/hr with an increasing trend since 2004, to the highest observed (59 kg/hr) 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

Fernand, L., Nolan, G.D., Raine, R., Chambers, C.E., Dye, S.R., White, M. and Brown, J. 2006. The Irish coastal current: A seasonal jet-like circulation. *Continental Shelf Research*, Vol. 26, Issue 15, 1775–1793.

ICES. 2006. Report of the Workshop on *Nephrops* Stocks. Annex 6: Working Document by Lordan and Gerritsen. ICES CM 2006/ACFM:12.

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.

ICES. 2008. Report of the Workshop and training course on *Nephrops* Burrow Identification (WKNEPHBID). ICES CM: 2008/LRC: 03 Ref: ACOM.

ICES. 2008. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim (WGHMM). ICES CM: 2008/ ACOM:07.

ICES. 2005. Using UWTV surveys to develop a conceptual ecosystem model of Aran Grounds *Nephrops* population distribution. ICES CM 2005/L:30 Annual Science Conference.

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					
2007	No Sampling				

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	"

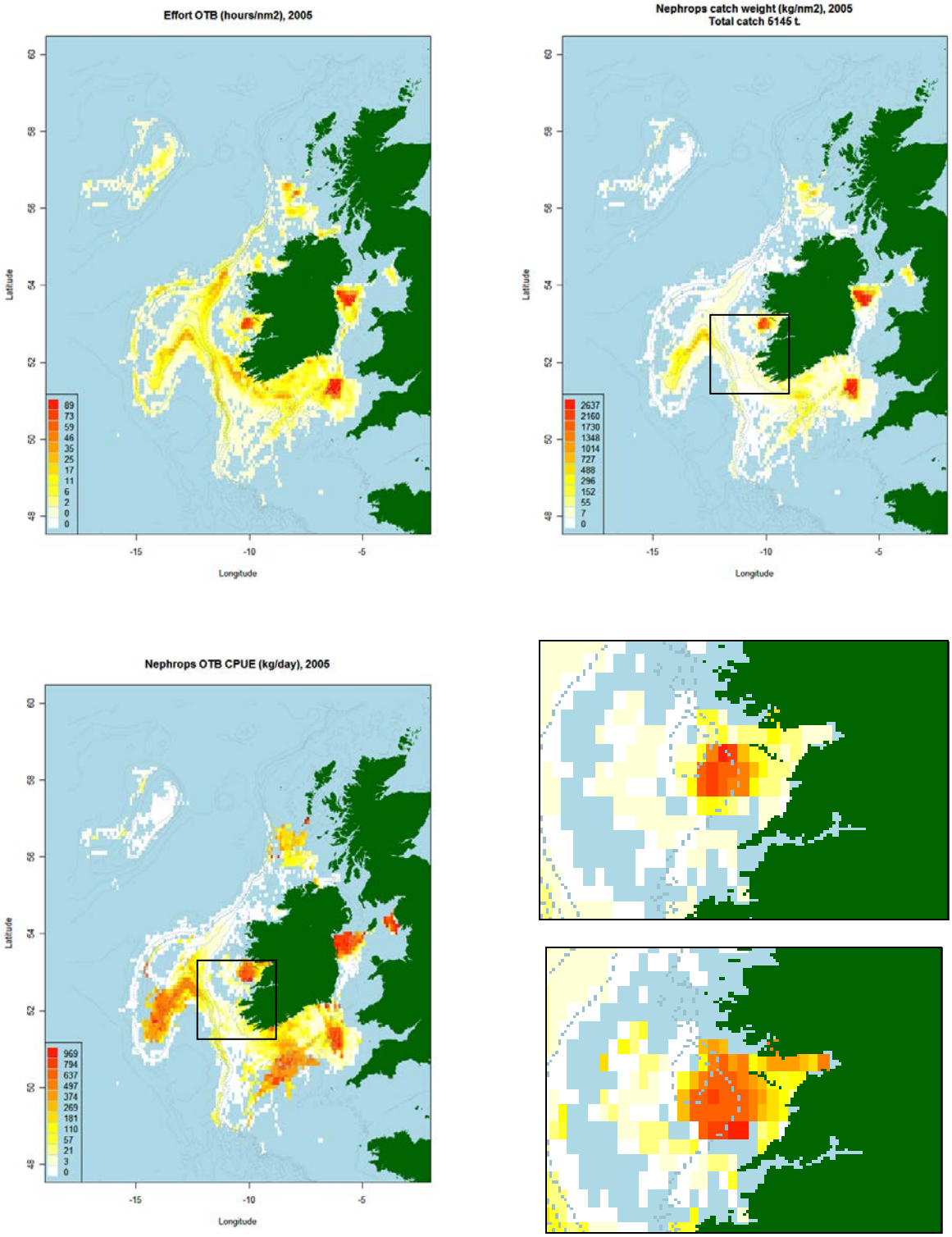


Figure A.2.1. Effort, catch and catch per unit of effort for *Nephrops*, Irish otter trawlers in 2005. The boxed and zoomed in plots show a zoomed in view of landings and lpue from the fishery on the Aran Ground.

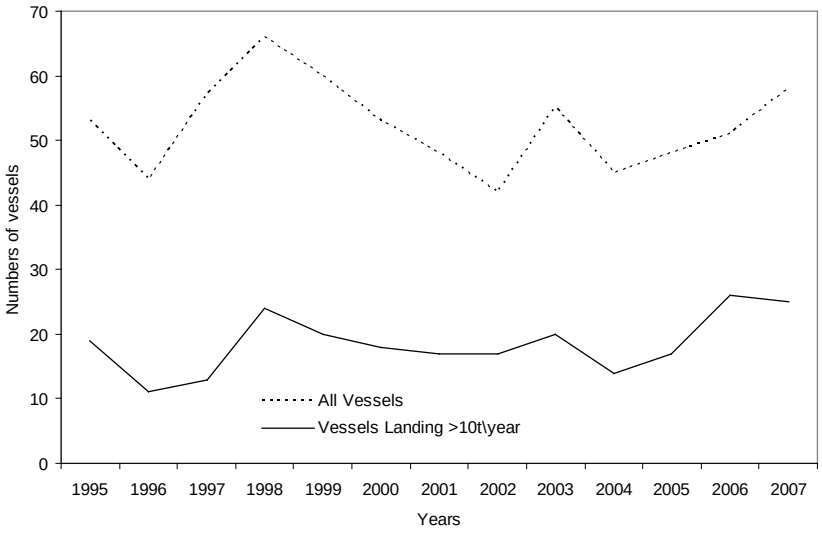


Figure A.2.2. Time-series of the number of Irish vessels reporting landings of *Nephrops* from FU17. The vessels with annual landings >10 t/yr can be considered the main participants in the fishery these general account for ~85% of the total landings.

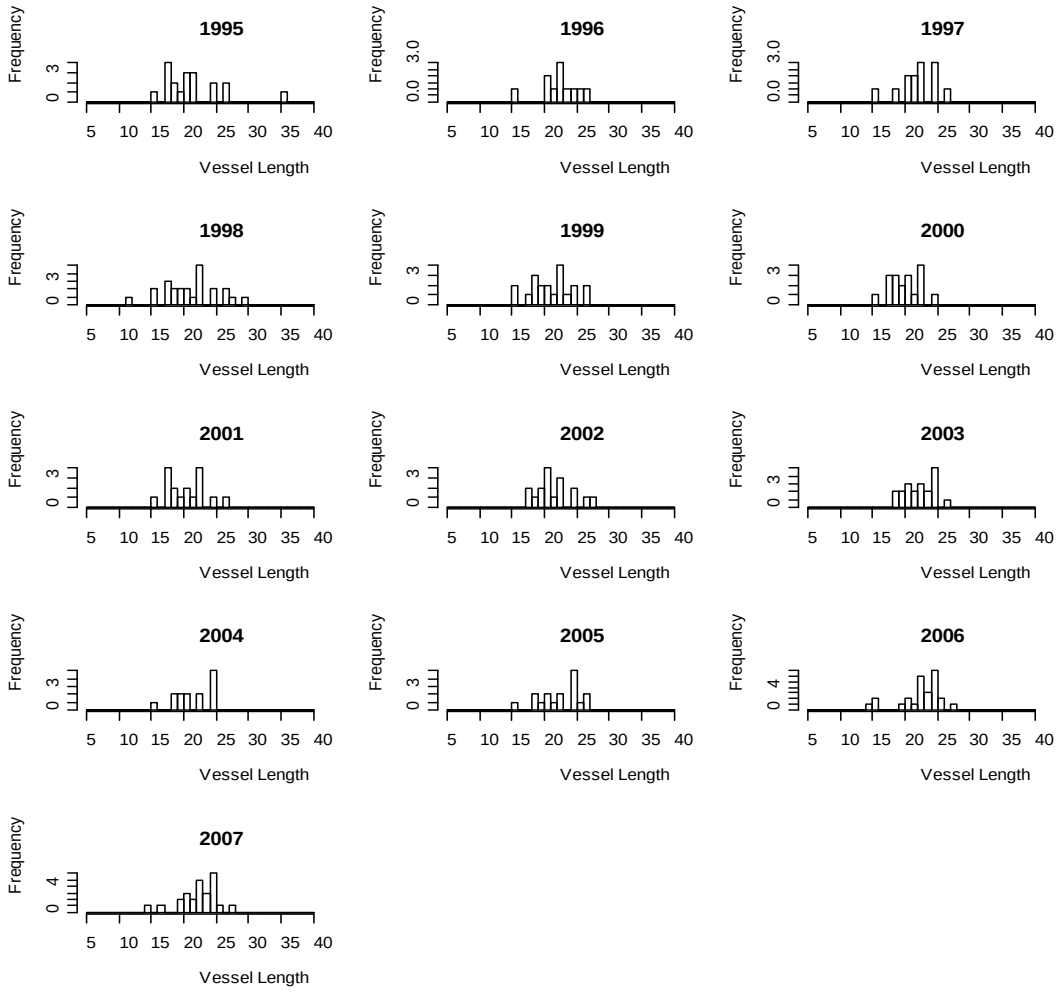


Figure A.2.3. The time-series of length distributions of Irish vessels landing >10 t of *Nephrops* from FU17.

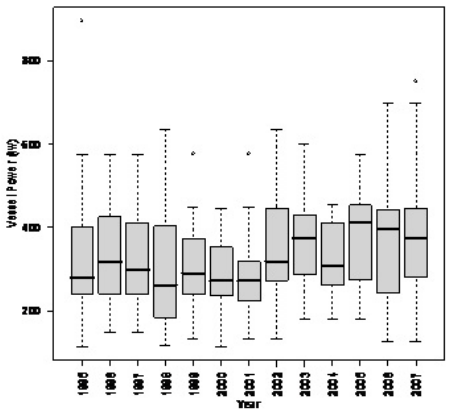


Figure A.2.4. Box plot of the time-series of vessel power in KW of Irish vessels landing >10 t of *Nephrops* from FU17.

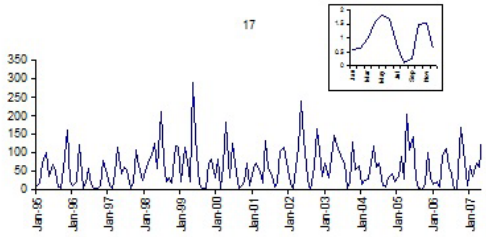


Figure A.2.5. Monthly landings of *Nephrops* from FU17 from 1995–2007. The inset shows the average pattern for all years.

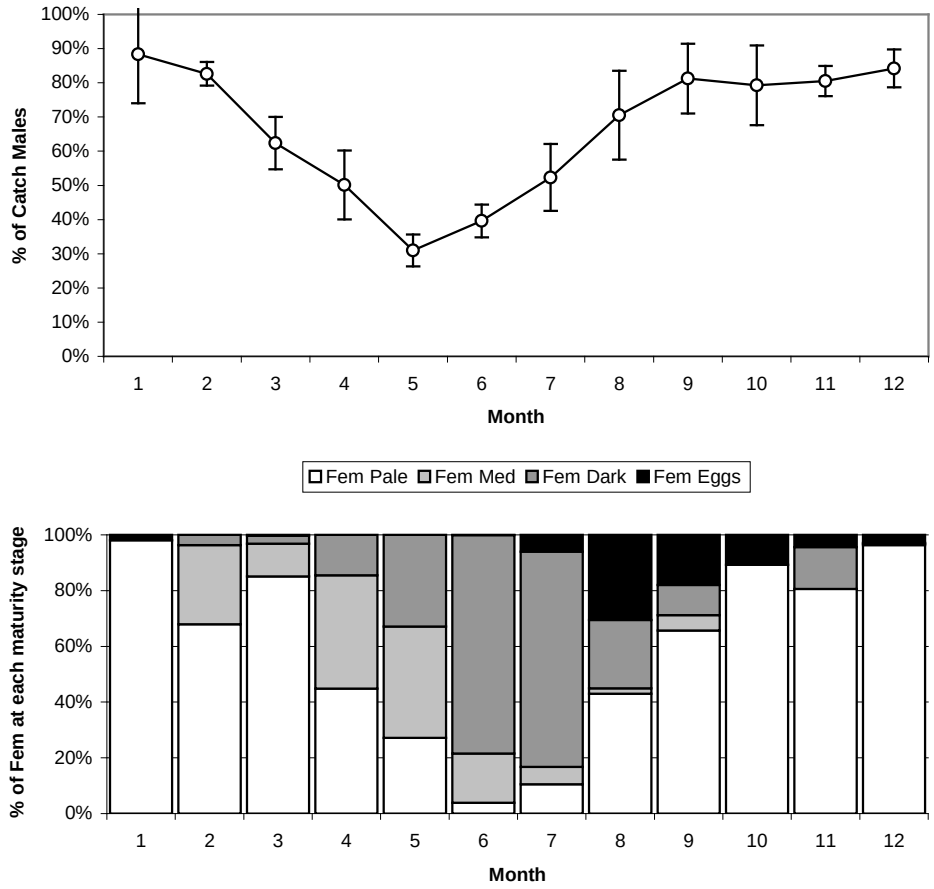


Figure A.2.6. The upper panel shows the sex ratio in sampled catches 2003–2008 (error bars = 95% confidence intervals). The low panel shows the female maturity schedule i.e. percentage at each maturity stage by month.

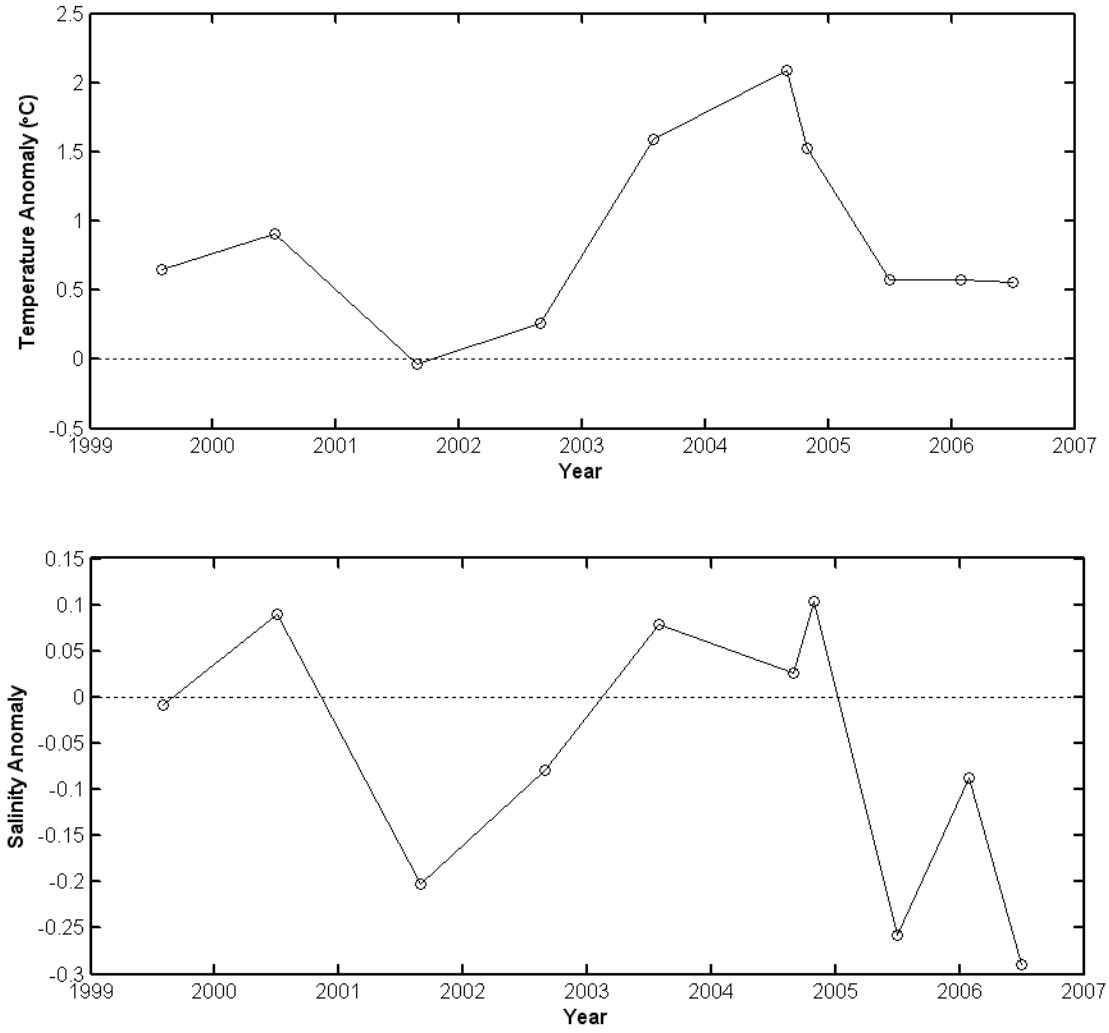
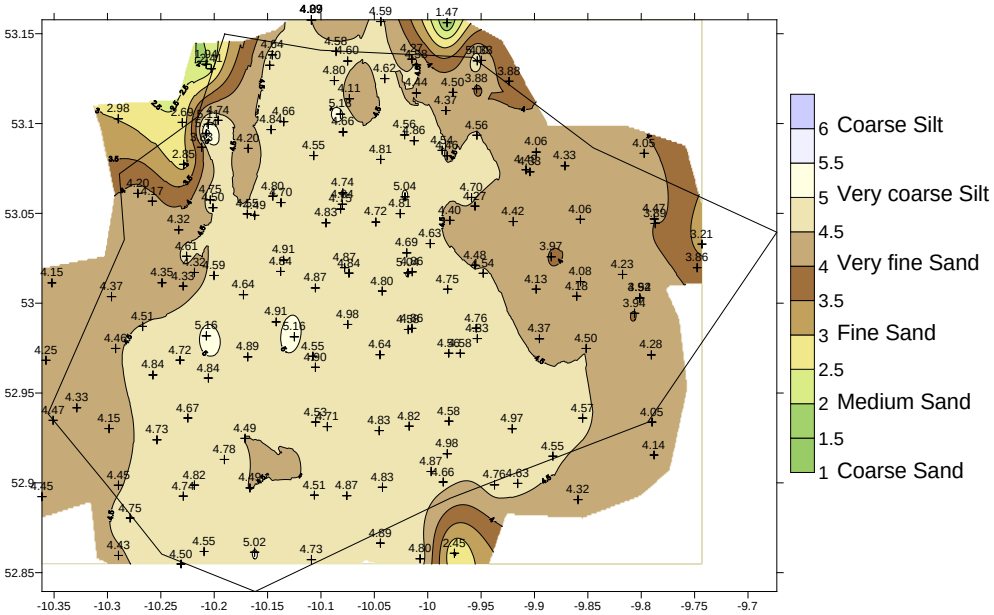


Figure A.3.1. Anomalies in temperature (upper panel) and salinity (lower panel) for the 53°N section running through the Aran Grounds (1999–2006).

a)



b)

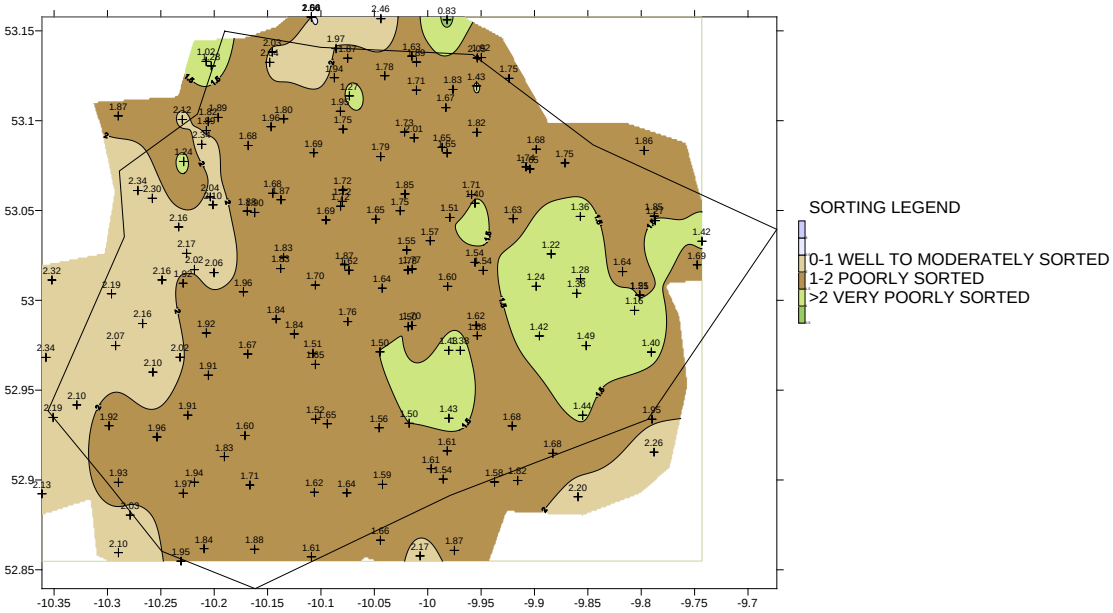


Figure A.3.1. Contour and post plots of the a) mean size (phi) and classification based on the Friedman and Sanders (1978) scales and b) sorting (σ_g) of the sediments on the Aran Grounds based on PSA results from samples collected from 2002–2006.

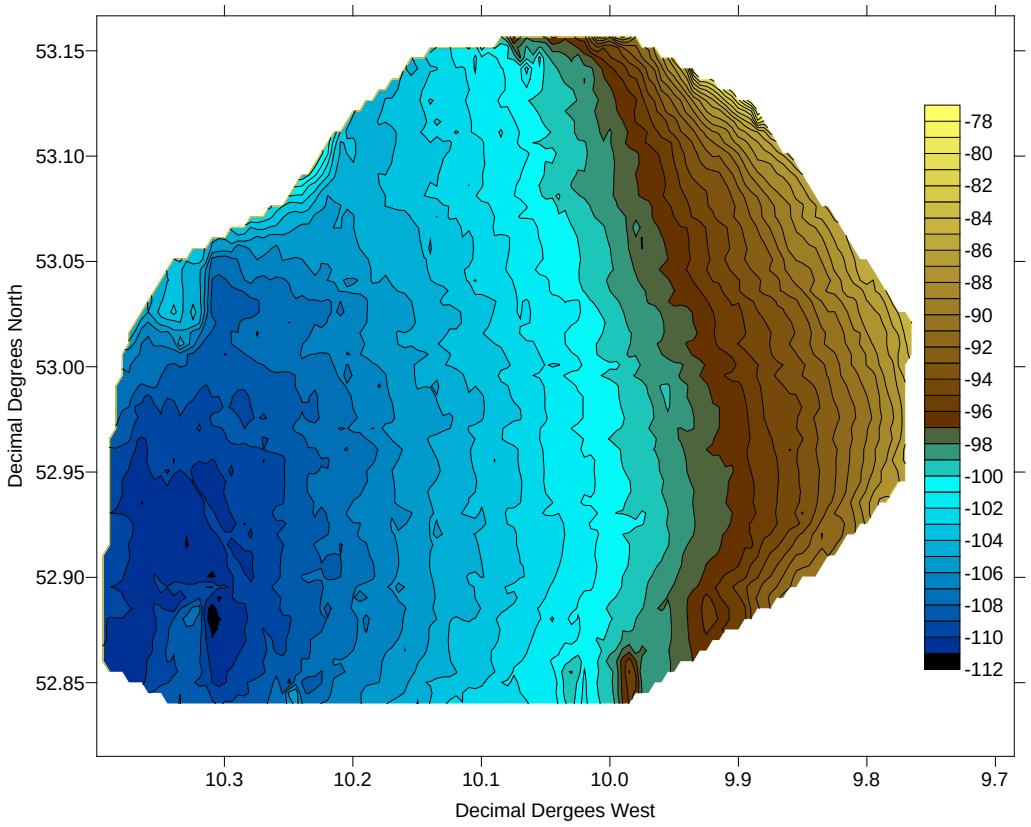


Figure A.3.2. The bathymetry of the Aran grounds.

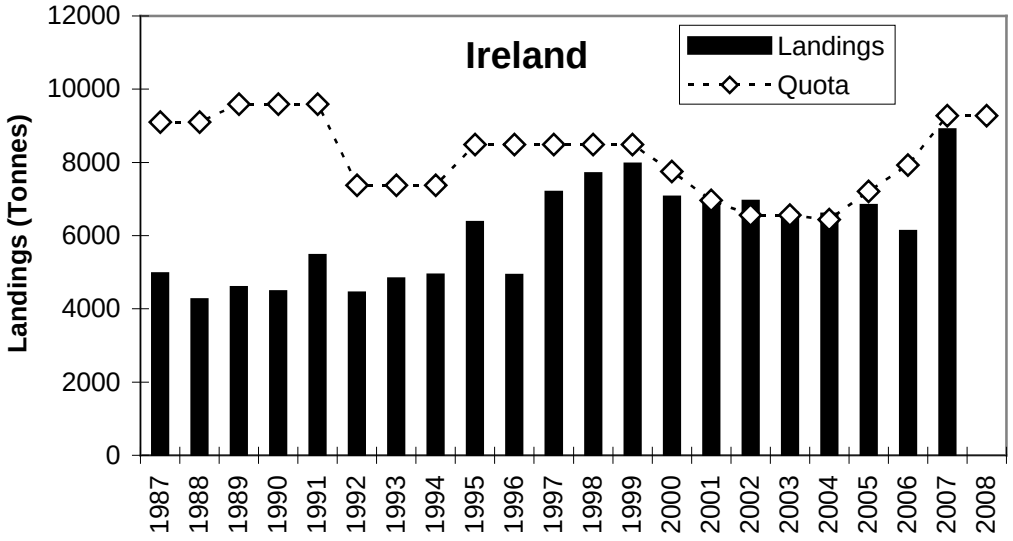


Figure B.1.1. *Nephrops* landings and quota for Ireland since the introduction of TACs in 1987.

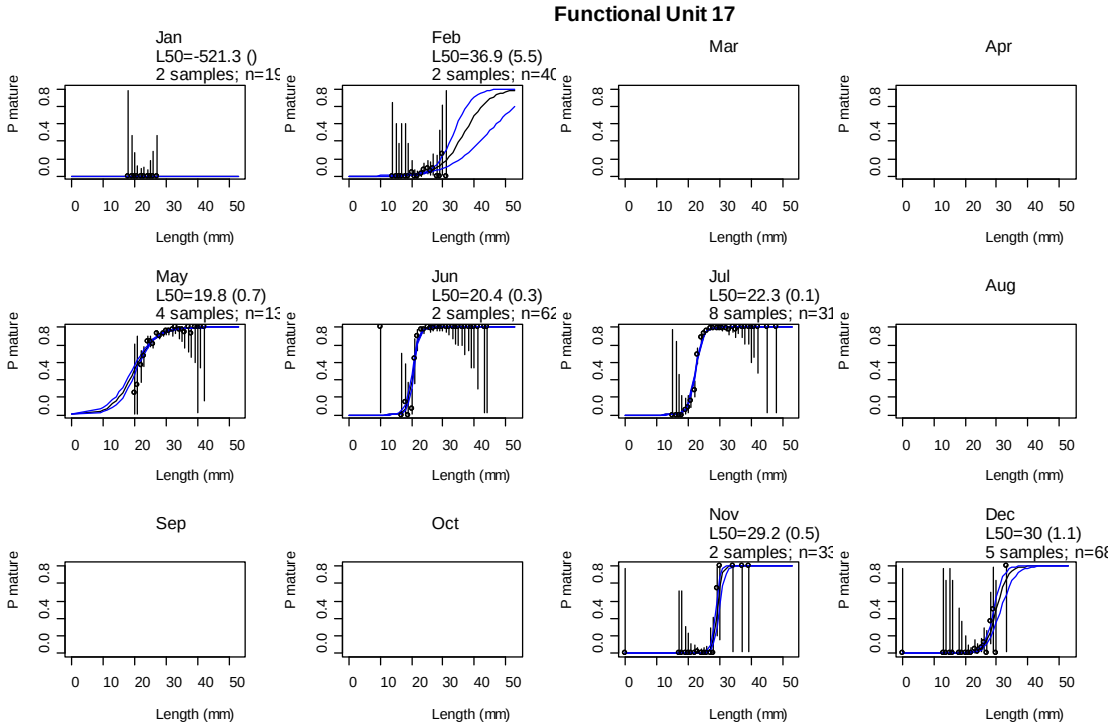


Figure B.2.1. Female proportions mature-at-length for FU17. The 95% confidence limits of the proportions mature-at-length are indicated by the vertical bars. The black curve indicates the model and its standard errors are given by the blue lines. The L_{50} is the estimated length at 50% maturity and its standard error is given between brackets. Blank plots indicate no sampling took place.

Stock Annex 7.6: *Nephrops* in VIIb FU16, Porcupine Bank

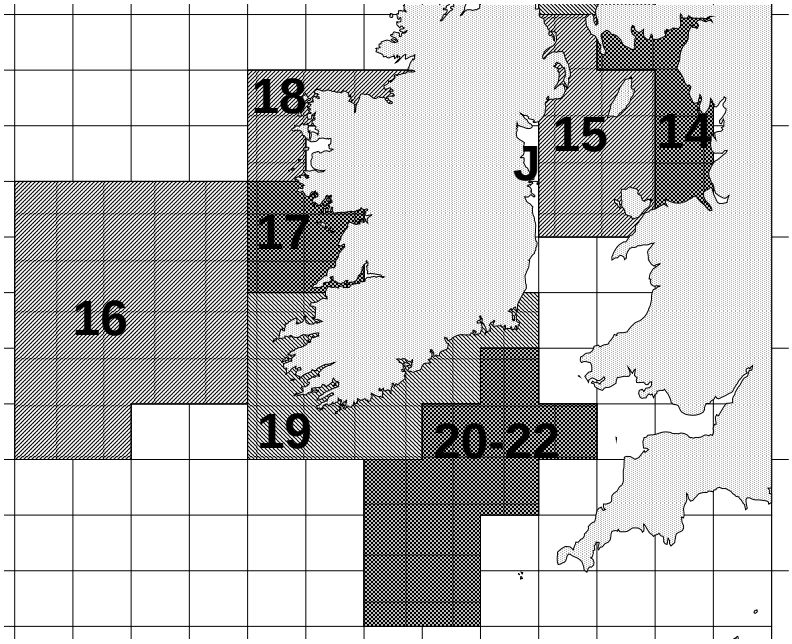
Stock-specific documentation of standard assessment procedures used by ICES.

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 FU16 also fishes in Division VIIg–h and was described in detail in the 1999 WGNEPH Report (ICES, 1999a). The French fleet only lands large *Nephrops* from this FU. Investigation of the landings data by statistical rectangle carried out by WGNEPH 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 multi-purpose 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 which *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 mechanizm 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 is 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.

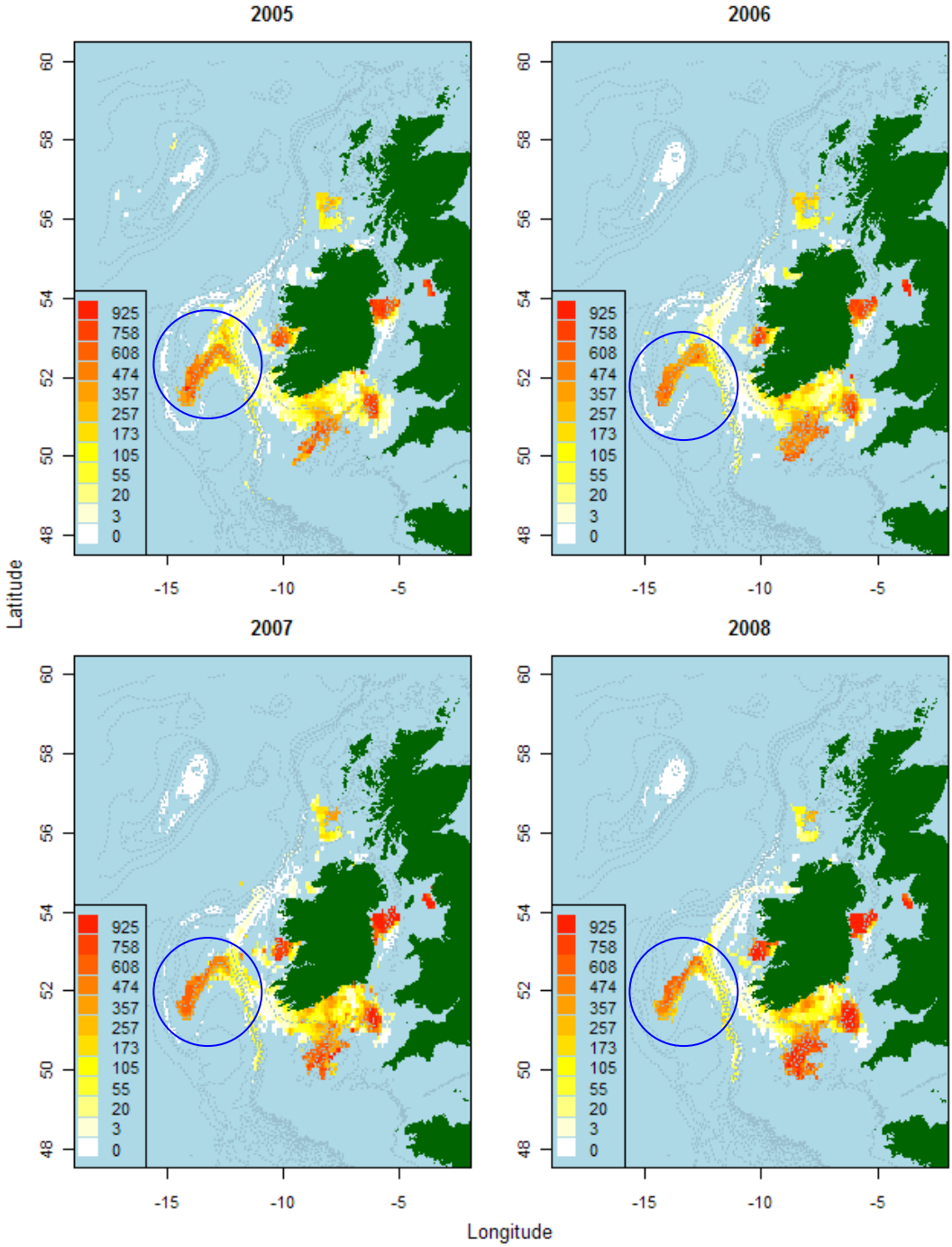


Figure 1. The spatial distribution of lpue of *Nephrops* caught by Irish otter trawlers between 2005–2008 derived using integrated VMS and logbook records.

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 (FU20–22)
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 this survey is provided in the IBTS Report (ICES, 2010) and in previous IBTS reports. Figure 2 and 3 give gear parameters and spatial distributions of *Nephrops* catches on the Spanish Porcupine survey.

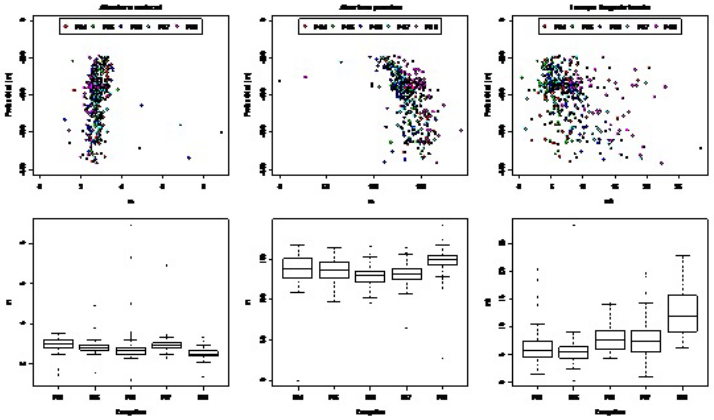


Figure 2. Door spread, vertical opening and time to settle on the ground between 2004 and 2008.

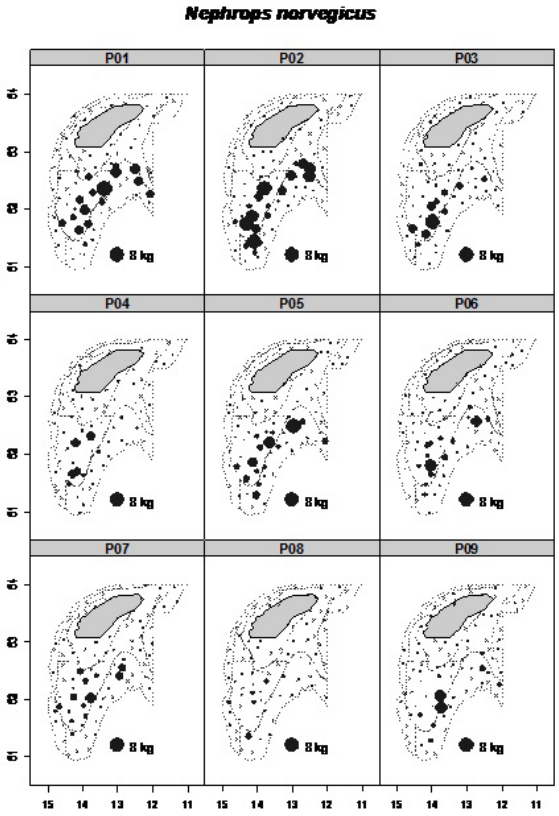


Figure 3. Distribution of *Nephrops norvegicus* catches in biomass in Porcupine surveys between 2001 and 2009.

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 addition 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 Ecoregion 13–19 May 2009.

Stock Annex 7.7: *Nephrops* in VIIfgh FU20–22 (Celtic Sea)

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 (FU20–22; 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 FU20–22 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 FU20–22, but biological references on close areas with similar hydrological conditions (FU15; Western Irish Sea) indicate a first size of functional maturity of 29–31 mm CL.

As reported by the WG*NEPH* 2004 and the WGSSDS 2005 and 2006, *Nephrops* in FU20–22 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' Organizations 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. FU23–24) 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 FU20–22, depending on the tides in the Irish Sea. Other vessels switch from targeting finfish in the winter to *Nephrops* in the 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 10 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 mechanizms 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 whereas 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, only 2003 has been entirely sampled in the FU20–22 area; 2002 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 for 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 2000s). 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 fitting 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

tested 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 FU23–24 *Nephrops* (Bay of Biscay; WGHMM) can also be included in the final fitting.

Particularities for FU20–22 *Nephrops* stock

The approach summarized above was already developed on the FU23–24 *Nephrops* stock (Bay of Biscay) and its validation was investigated during the WGHMM 2007 (Figure 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 FU20–22. 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 for 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 *a priori* coefficient of variation around the initial Lm (CV of 0.10 and 0.20 were

[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.

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 FU20–22 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 FU20–22.

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:

$$ND_{jklm} = NL_{jklm}.\exp(-\alpha_k.(L-L50_k))$$

or

$$ND_{jklf} = NL_{jklf}.\exp(-\alpha_k.(L-L50_k)) \quad [1]$$

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 (1991 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 1997 sampling data. However, there is no new information for the 1st and 2nd quarters (the 2005 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 1997 parameters, but the simulation for the other two quarters is based on 2005 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 ($\phi(L)=\alpha/2$ 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:

$$\varphi(L) = \frac{\alpha}{1 + \exp(-\gamma\beta.(L - Lm)} \text{ for } L \leq Lm$$

[2] This procedure is performed only on Irish dataset whereas it is not pertinent for French data (only one year dataset).

$$\varphi(L) = \frac{\alpha}{1 + \exp(\beta.(L - Lm)} \text{ for L>Lm} \quad [3]$$

with a complementary coefficient γ: if γ=1 the whole probability density is symmetrical, if γ<1 the skewness of the distribution is positive if γ>1 the skewness is negative (γ=1 for Irish discards, $\gamma \neq 1$ for French discards).

The fitting of ϕ(L) is processed on two stages:

- *Lm and α are fixed*: α is initially fixed at 2*ϕmax 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:

$$\beta = \frac{1}{n} \sum_{L=L\min}^{L\min+n-1} \ln\left[2.\frac{\varphi\max}{\varphi(L)} - 1\right]^{\frac{1}{L-Lm}} \quad [4]$$

(L_{min}= 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.
- $L_m \geq L_{min}$ [L_{min}=(1-$Z_{1-\alpha/2}$.CV)*Lm] (usually: α=0.05=>$Z_{1-\alpha/2}$=1.96)
- $L_m \leq L_{max}$[L_{max}=(1+ $Z_{1-\alpha/2}$.CV)*L_m]
- 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 method. The calculation can also be carried out according to parametric procedure (Lin,

[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.

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 four columns for French data, three for Irish):

$$[J] = \begin{bmatrix} \frac{\partial\varphi(L_1)}{\partial\alpha} & \frac{\partial\varphi(L_1)}{\partial\beta} & \frac{\partial\varphi(L_1)}{\partial\gamma} & \frac{\partial\varphi(L_1)}{\partial Lm} \\ \frac{\partial\varphi(L_2)}{\partial\alpha} & \frac{\partial\varphi(L_2)}{\partial\beta} & \frac{\partial\varphi(L_2)}{\partial\gamma} & \frac{\partial\varphi(L_2)}{\partial Lm} \\ \vdots & \vdots & \vdots & \vdots \\ \frac{\partial\varphi(L_{nc})}{\partial\alpha} & \frac{\partial\varphi(L_{nc})}{\partial\beta} & \frac{\partial\varphi(L_{nc})}{\partial\gamma} & \frac{\partial\varphi(L_{nc})}{\partial Lm} \end{bmatrix} \quad [8]$$

[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:

$$\frac{\partial\varphi(L)}{\partial\alpha} = \frac{\varphi(L)}{\alpha} \quad [9]$$

$$\frac{\partial\varphi(L)}{\partial\beta} = \gamma.(L - Lm).\varphi(L).\left(1 - \frac{\varphi(L)}{\alpha}\right) \text{ if } L \le Lm \quad [10a]$$

$$\frac{\partial\varphi(L)}{\partial\beta} = -(L - Lm).\varphi(L).\left(1 - \frac{\varphi(L)}{\alpha}\right) \text{ if } L > Lm \quad [10b]$$

$$\frac{\partial\varphi(L)}{\partial\gamma} = \beta.(L - Lm).\varphi(L).\left(1 - \frac{\varphi(L)}{\alpha}\right) \text{ if } L \le Lm \quad [11a]$$

$$\frac{\partial\varphi(L)}{\partial\gamma} = 0 \text{ if } L > Lm \quad [11b]$$

$$\frac{\partial\varphi(L)}{\partial Lm} = -\beta.\gamma.\varphi(L).\left(1 - \frac{\varphi(L)}{\alpha}\right) \text{ if } L \le Lm \quad [12a]$$

$$\frac{\partial\varphi(L)}{\partial\gamma} = \beta.\varphi(L).\left(1 - \frac{\varphi(L)}{\alpha}\right) \text{ if } L > Lm \quad [12b]$$

[4] DDL is equal to nc-4 for French discards, but equal to nc-3 for Irish data (parameter γ is omitted).

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 (called 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 θ_1, θ_2, …, θ_k it is possible to present the variance of Φ by:

$$V[\Phi] \approx \sum_{i=1}^{k}\left(\frac{\partial\Phi}{\partial\theta i}\right)^2 .V[\theta i] + 2.\sum_{i=1}^{k-1}\sum_{j=i+1}^{k}\frac{\partial\Phi}{\partial\theta i}.\frac{\partial\Phi}{\partial\theta j}Cov[\theta i,\theta j] \quad [13]$$

Then, the variance of simulated discards vs. size, V[Ψ(L)], is written as:

$$V[\Psi(L)] \approx a(\alpha)^2.V[\alpha] + a(\beta)^2.V[\beta] + a(\gamma)^2.V[\gamma] + a(Lm)^2.V[Lm] + 2.a(\alpha).a(\beta).Cov[\alpha,\beta] + 2.a(\alpha).a(\gamma).Cov[\alpha,\gamma] + 2.a(\alpha).a(Lm).Cov[\alpha,Lm] + 2.a(\beta).a(\gamma).Cov[\beta,\gamma] + 2.a(\beta).a(Lm).Cov[\beta,Lm] + 2.a(\gamma).a(Lm).Cov[\gamma,Lm] \quad [14]$$

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 (Figure 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). The Table 6 and Figure 16 present discard rates by sex and combined for the overall time-series.

Table 5. French *Nephrops* trawlers, Celtic Sea (FU20–22). 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	125 752	4.62	30.278	3.25	25773	13.79	0.293	32.11	0.768	44.61
1988	425 396	4.88	28.917	5.28	59518	16.97	0.260	39.24	0.534	56.57
1989	99 536	4.02	31.061	4.36	14417	13.86	0.221	33.01	0.740	45.69
1990	81 530	8.74	30.579	8.28	12219	28.86	0.221	61.77	0.866	92.51
1991	389 726	5.69	29.479	5.70	57932	18.85	0.218	40.78	0.868	60.75
1992	377 075	18.48	30.752	14.57	61039	58.97	0.314	142.51	0.534	193.98
1993	118 210	199.42	31.299	147.10	20679	612.24	0.258	1356.53	0.879	1956.90
1994	93 687	7.62	31.438	6.77	14384	24.84	0.232	54.91	0.830	79.80
1995	131 541	136.57	31.808	95.39	25096	418.52	0.273	880.20	0.808	1323.18
1996	82 811	6.05	32.357	5.61	12121	20.20	0.255	49.20	0.637	66.91
1997	96 612	6.21	32.403	2.11	18050	15.36	0.673	46.01	0.397	55.62
1998	30 494	7.62	31.393	10.98	3453	28.85	0.161	61.94	0.893	94.65
1999	36 900	12.14	31.827	10.67	5618	40.01	0.236	84.90	0.791	127.28
2000	22 234	46.41	33.790	56.24	2655	171.90	0.175	359.92	0.863	552.62
2001	98 962	5.59	31.766	7.43	11594	20.94	0.191	46.64	0.682	69.25
2002	34 283	18.42	33.466	21.52	4223	66.86	0.193	150.64	0.762	217.87
2003	59 692	4.73	34.452	3.48	9659	15.04	0.285	36.31	0.638	49.26
2004	29 493	9.36	33.546	9.20	4050	32.24	0.202	69.23	0.874	103.22
2005	15 097	18.92	34.739	17.57	2098	65.03	0.205	136.51	0.873	206.98
2006	17 286	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 (FU20–22). 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) whilst 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 (FU20–22). 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 (FU20–22). 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 generalizing this first overview.

Table 9. Irish *Nephrops* trawlers, Celtic Sea (FU20–22). Relationships between discarded numbers by sampling (Nobs) and by simulation (Nexp).

year/quarter		Nexp=Ψ(Nobs)	ρ^2	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* FU20–22 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* assessment by trawling is 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 geo-statistical 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 FU20–22 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 FU20–22 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) whilst 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 h against 101 980 h for 2007 whereas the Irish fishing effort remained stable (59 727 h against 59 899 h 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

None.

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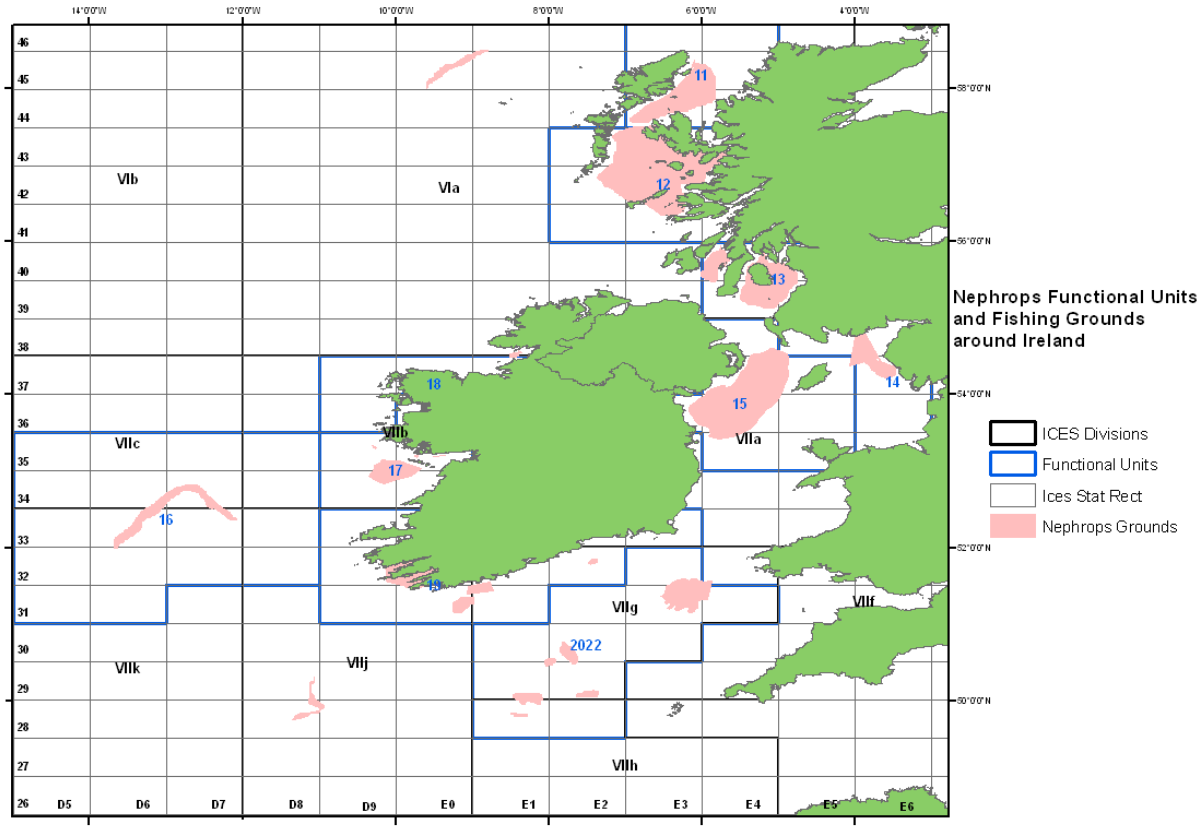


Figure 1. Functional units 20–22 (*Nephrops* grounds in Celtic Sea).

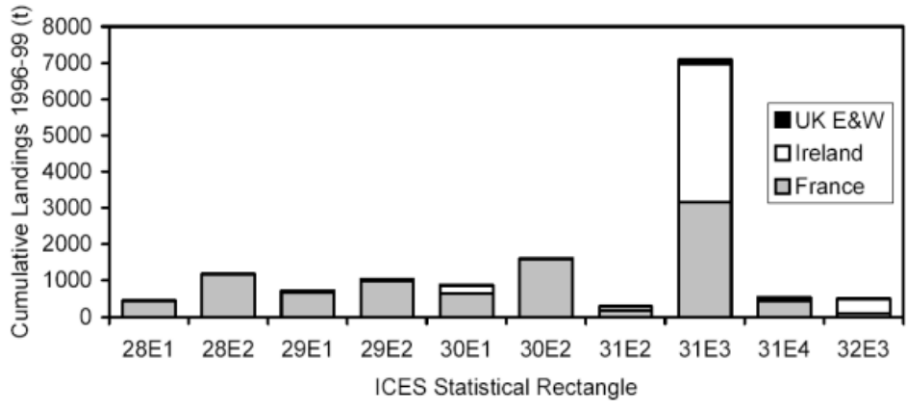
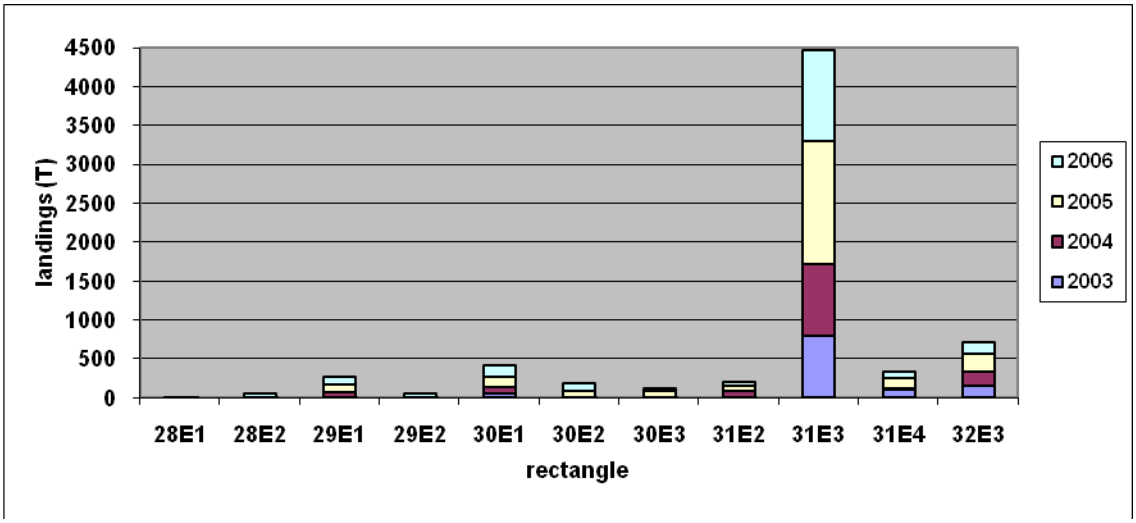


Figure 2. *Nephrops* FU20–22 (Celtic Sea). Spatial distribution of landings of the main fleets (average value of the period 1996–1999).



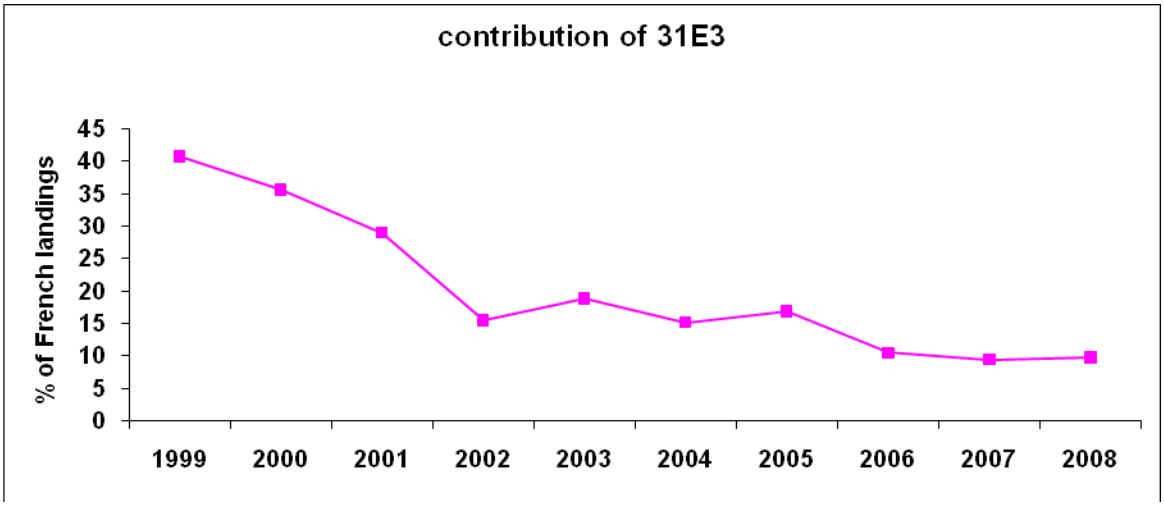
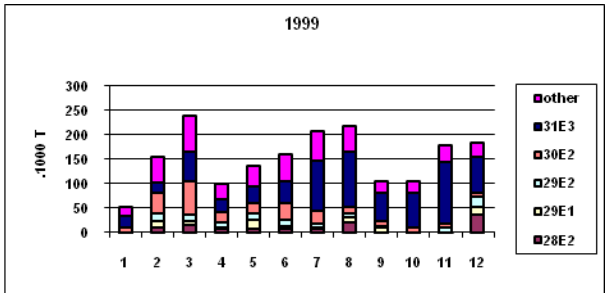
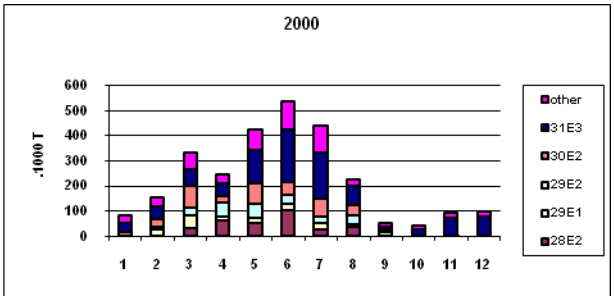
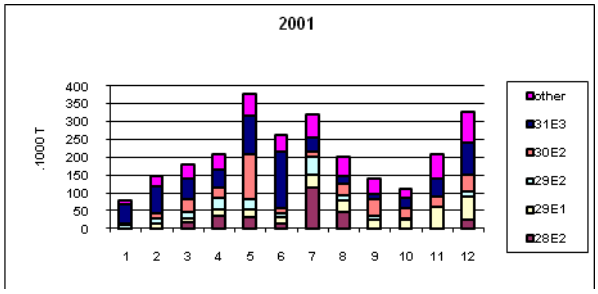
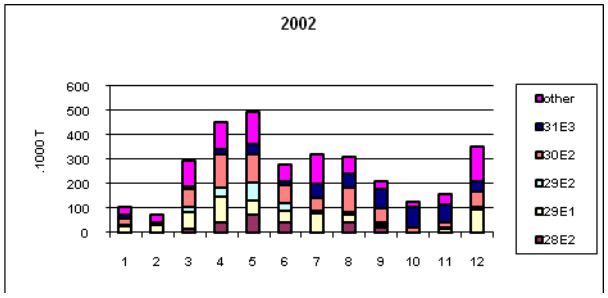


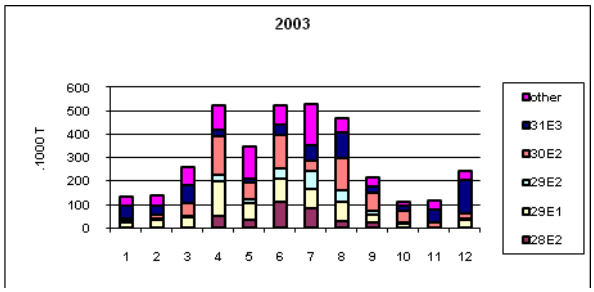
Figure 3. *Nephrops* **FU20–22 (Celtic Sea). Above: Spatial and by year distribution of Irish landings. Below: Contribution of the rectangle 31E3 (concentrating more than 2/3 of the total Irish production) in the total French landings. Years 1999–2008.**

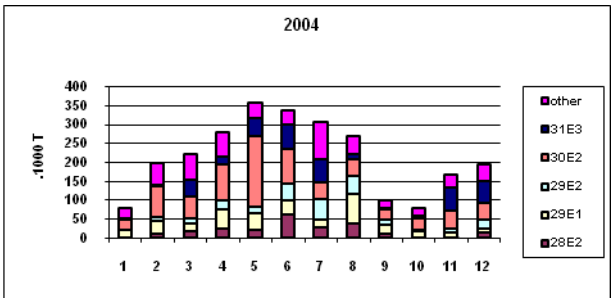

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28E2

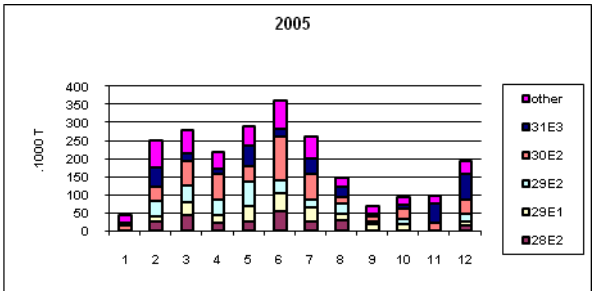

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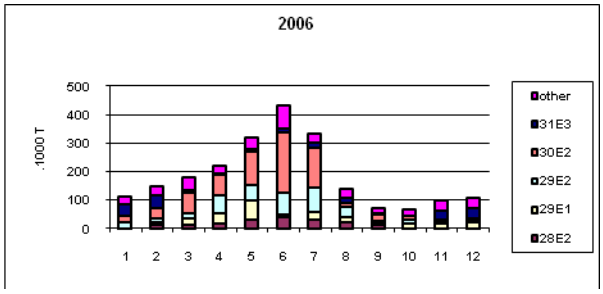

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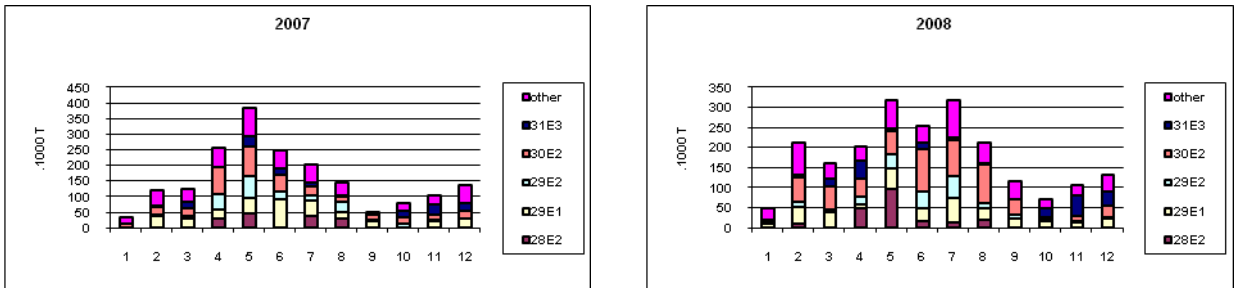


Figure 4. *Nephrops* **FU20–22 (Celtic Sea). Spatial and monthly distribution of French landings.**

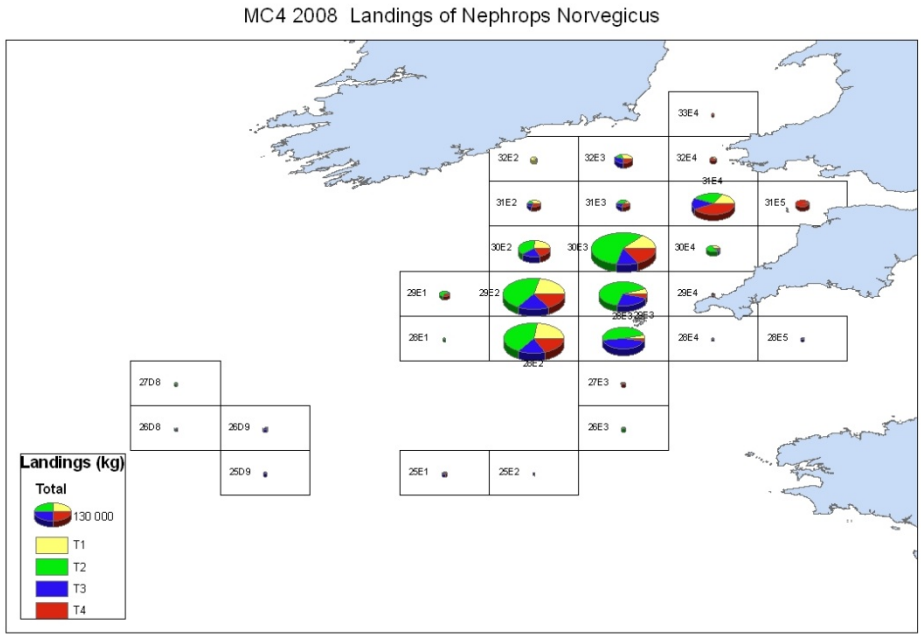


Figure 5. *Nephrops* **FU20–22 (Celtic Sea). Spatial distribution of French landings in 2007.**

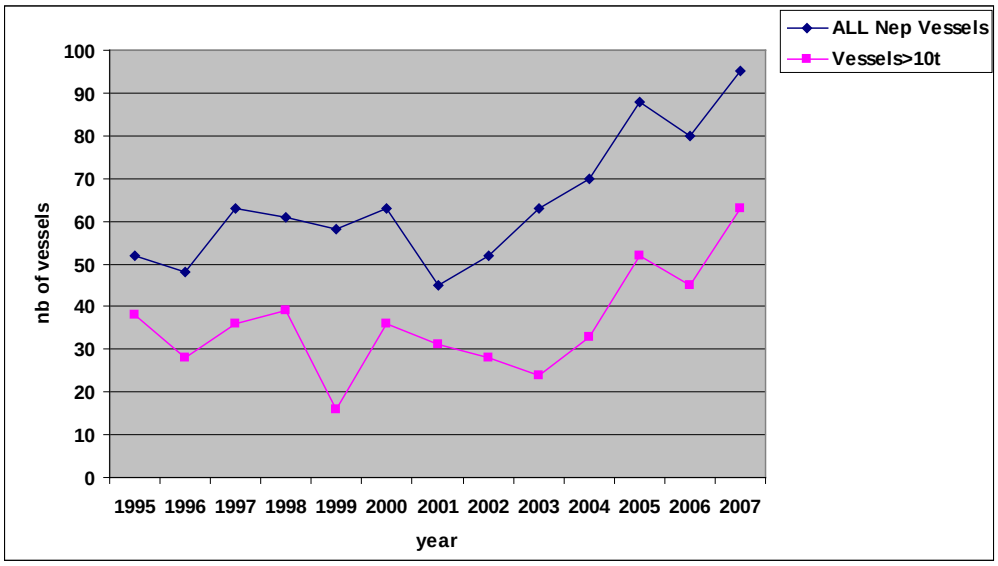


Figure 6. *Nephrops* **FU20–22 (Celtic Sea). Number of Irish trawlers involving** *Nephrops* **landings.**

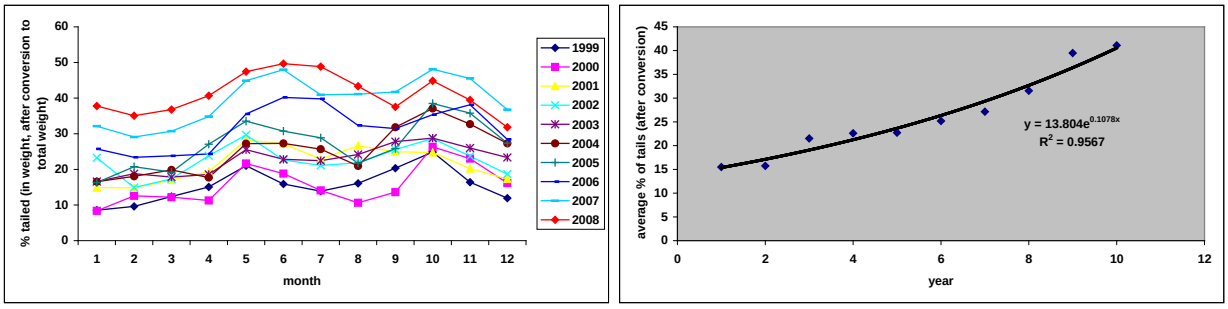


Figure 7. *Nephrops* **FU20–22 (Celtic Sea). Tailed proportion (in converted weight) in landings by month (left) and by year (right).**

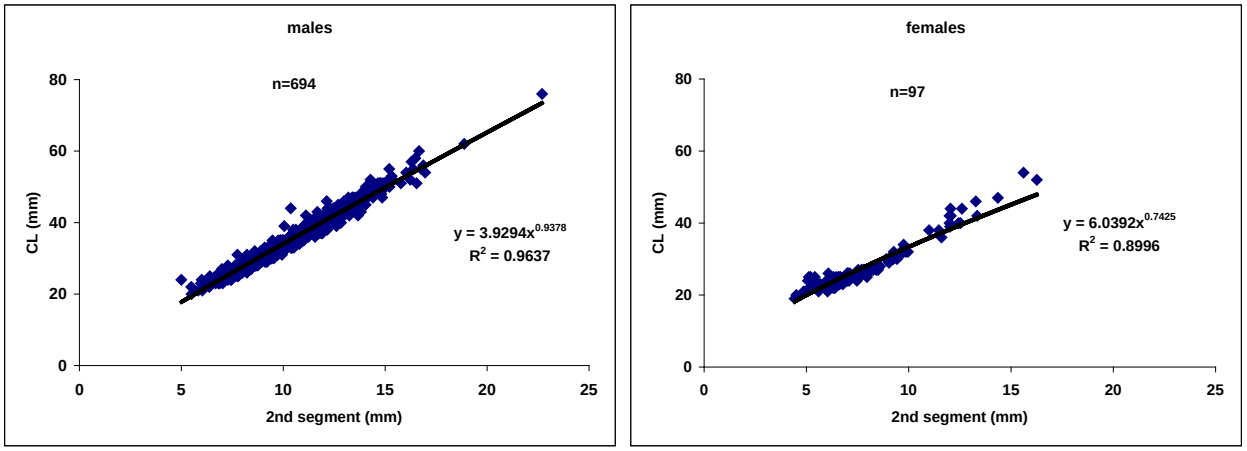


Figure 8. *Nephrops* **of the Celtic Sea (VIIfgh, FU20–22). Biometric relationships (CL vs. 2nd abdominal segment by sex). Data harvested during the survey EVHOE 2007.**

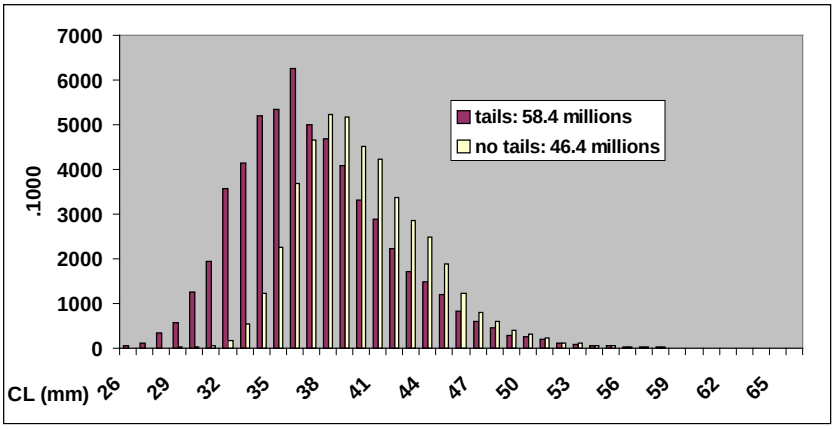


Figure 9. *Nephrops* **of the Celtic Sea (VIIfgh, FU20–22). French landings for 2008. Length distributions (1) including the data on tails and (2) using the previous method (no sampling of tails; the total tailed proportion was apportioned in the smallest category of entire** *Nephrops* **at auction).**

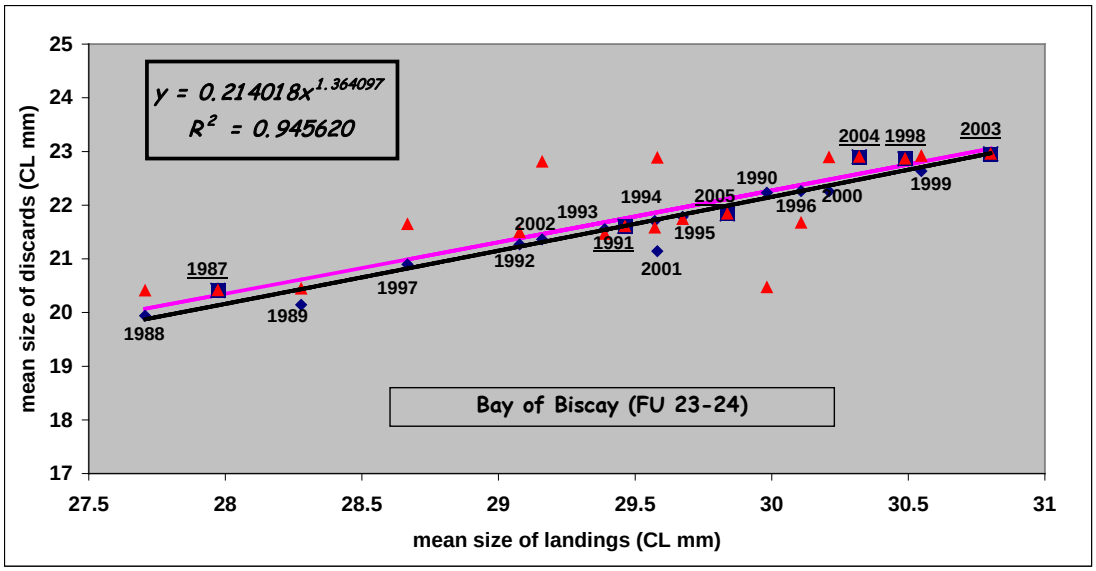


Figure 10. *Nephrops* **of FU23–24 (Bay of Biscay). Final results of logistic derivation of discards. Relationship between mean sizes of landings and discards. The triangular fonts represent the results of the** *status quo* **(proportional derivation) method. The underlined years correspond to the available 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.**

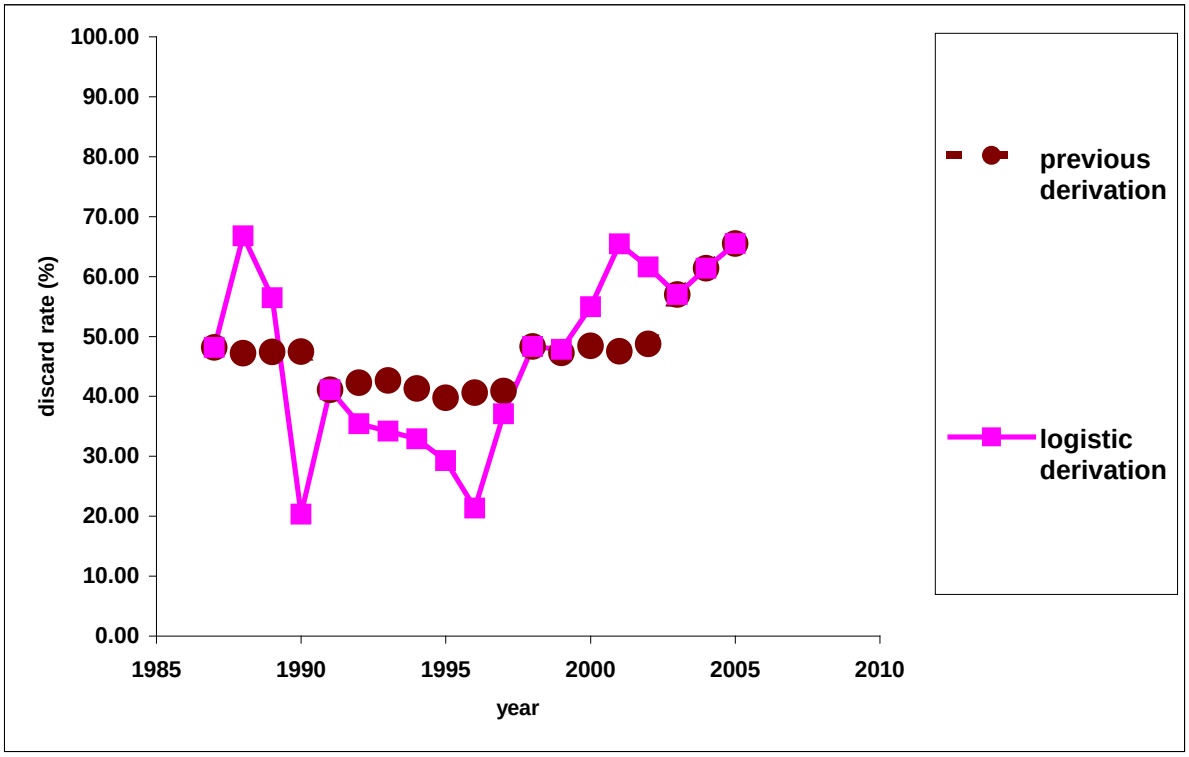


Figure 11. *Nephrops* **of FU23–24 (Bay of Biscay). Comparison between discard rates obtained by previous (proportional) derivation and by logistic derivation. Combined sexes and whole year datasets.**

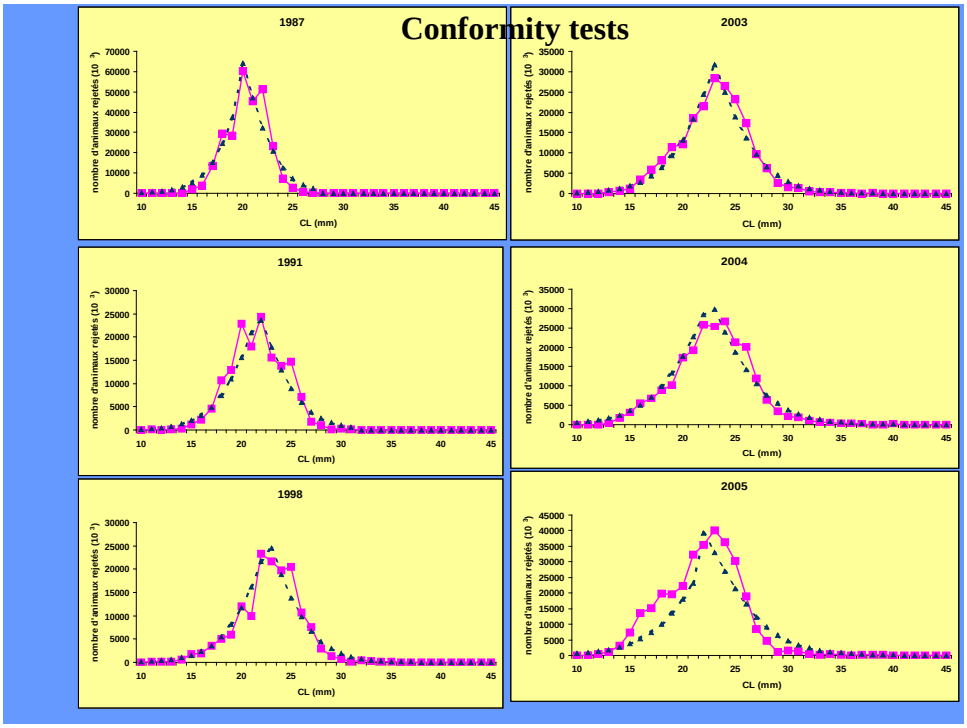


Figure 12. *Nephrops* **of FU23–24 (Bay of Biscay). Comparison between distributions of length frequencies (carapace length, CL in mm) of discards obtained by sampling and by simulation (broken lines).**

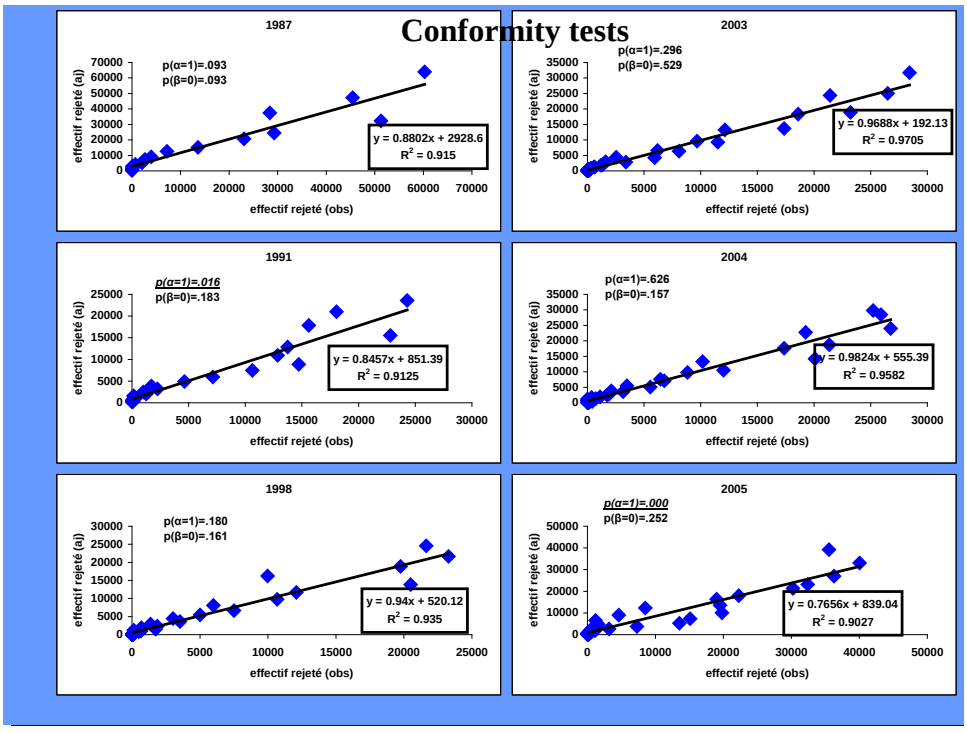
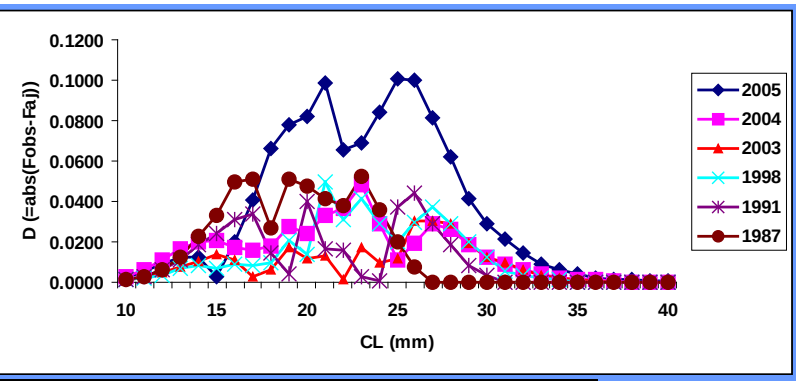


Figure 13. *Nephrops* **of FU23–24 (Bay of Biscay). Comparison between discarded numbers of individuals obtained by simulation (y-axis) and by sampling (x-axis). Statistical tests on linear regressions of Y vs. X by year.**



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 FU23–24 (Bay of Biscay). Statistical test (Kolmogorov–Smirnov) between cumulated frequencies of sampled and simulated discards by year.**

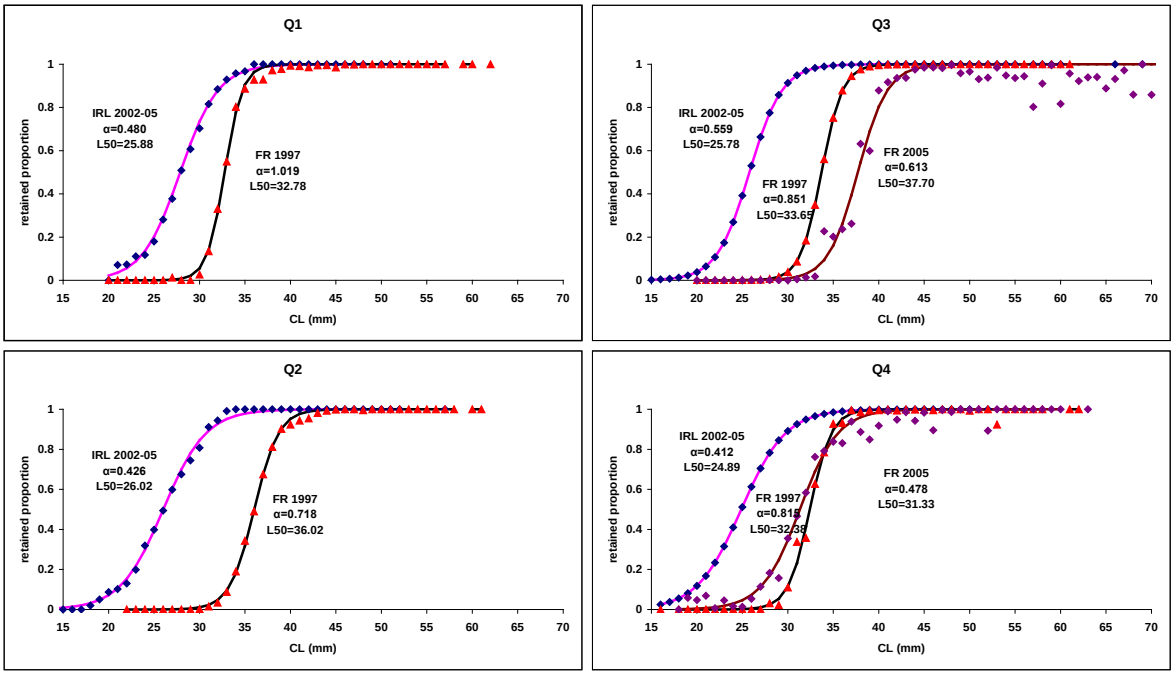


Figure 15. *Nephrops* **FU20–22 (Celtic Sea). Different hand-sorting logistic curves by quarter, country and dataset. In 2005 no sample was collected in France during the 1st quarter and 2nd quarter providing inconsistent results.**

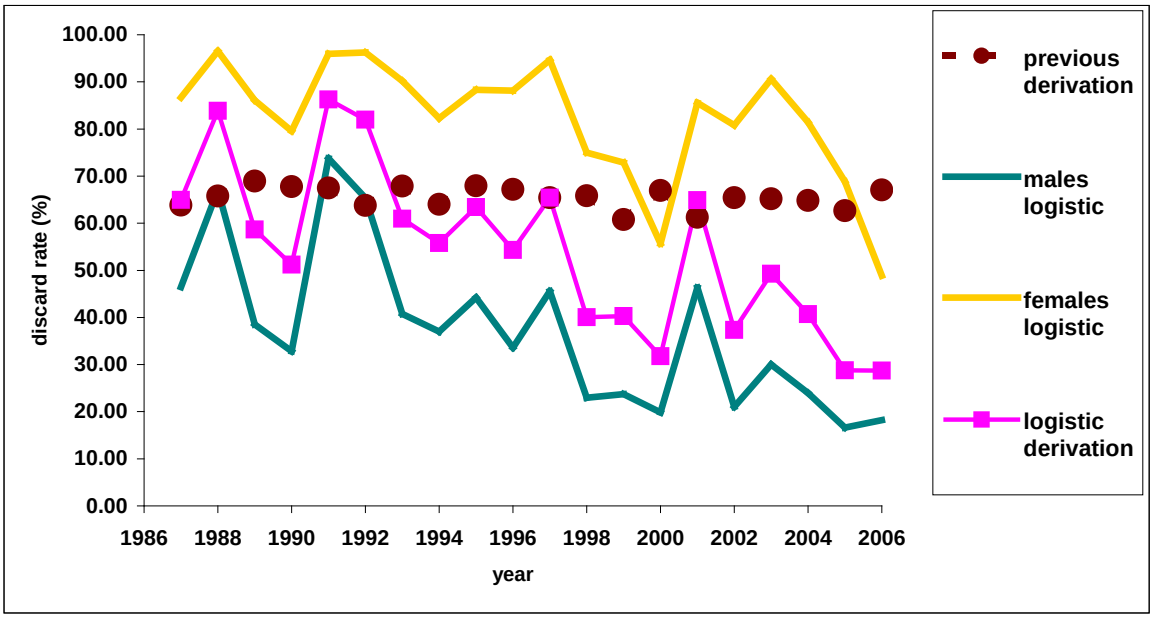
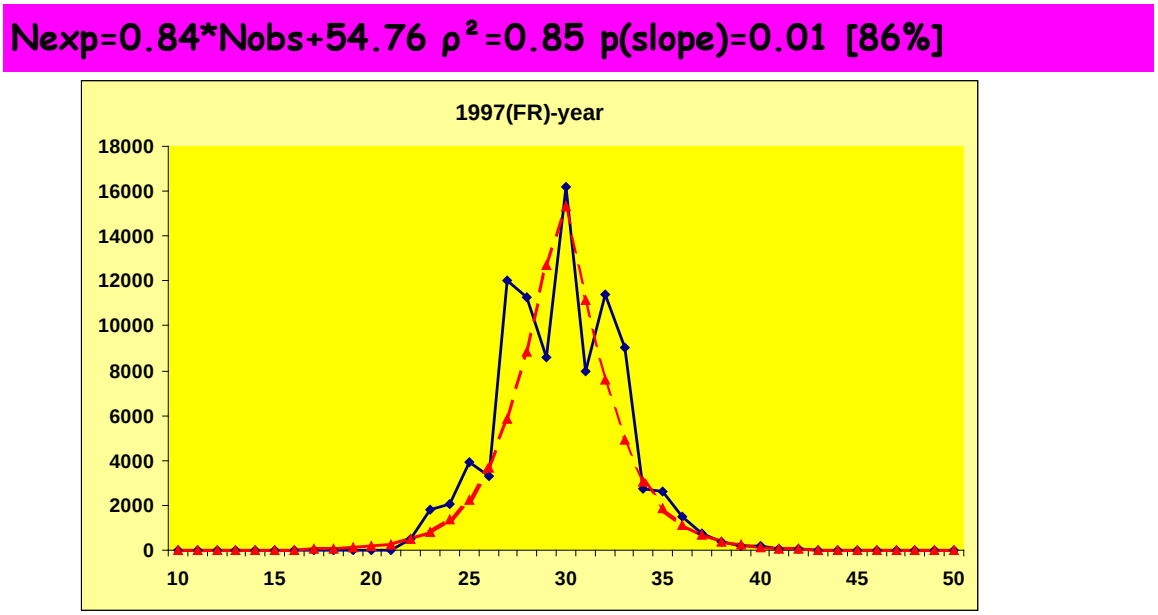


Figure 16. *Nephrops* **of FU20–22 (Celtic Sea). Comparison between discard rates obtained by previous (proportional) derivation (used by WGNEPH until 2004) and by logistic derivation. Combined sexes and whole year datasets.**



year	disc	Lm	CV(Lm)	α	CV(α)	β	CV(β)	ρ²
1997	83 306	29.807	1.29	32 335	9.42	0.538	6.43	0.913

Figure 17. *Nephrops* **of FU20–22 (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).**

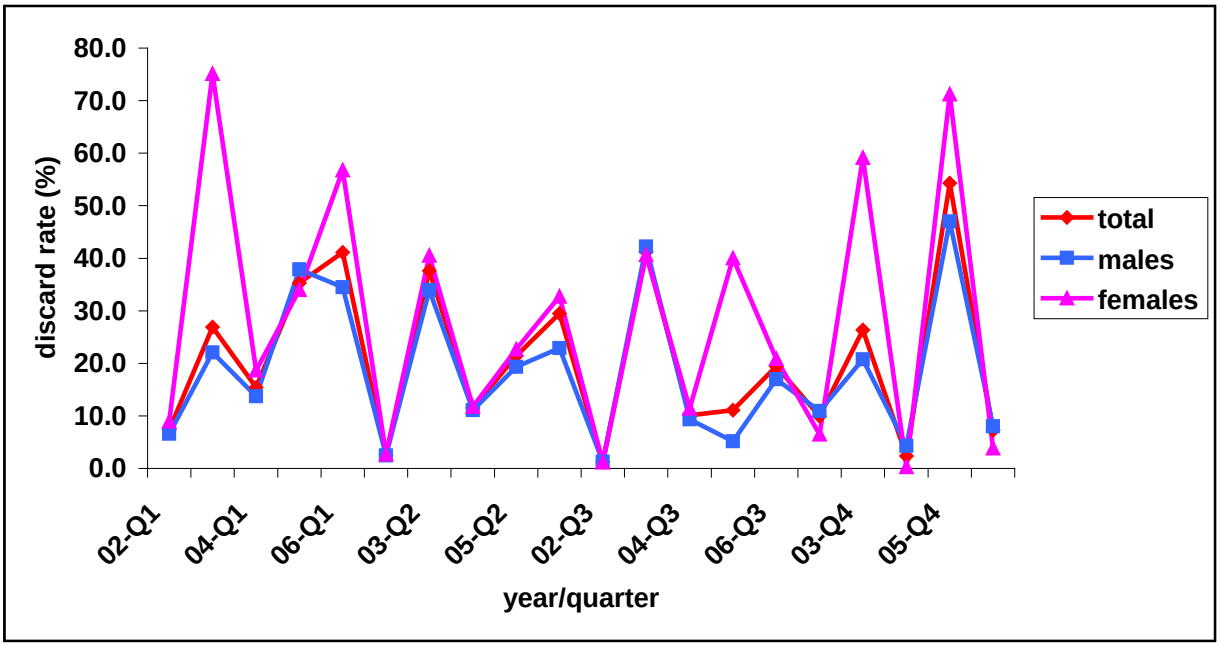


Figure 18. *Nephrops* **of FU20–22 (Celtic Sea). Discard rate (%) of Irish trawlers by year and quarter.**

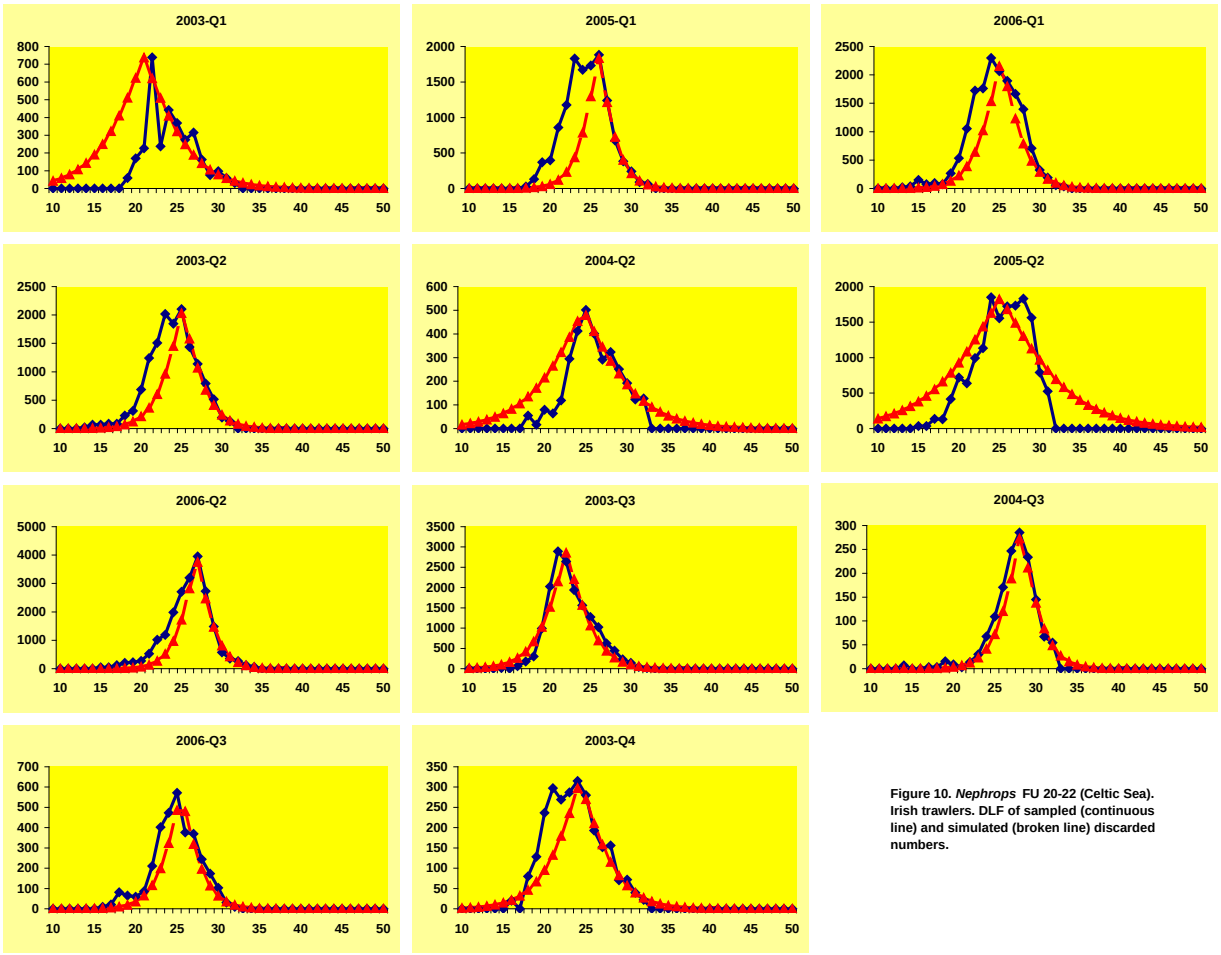


Figure 10. *Nephrops* FU 20-22 (Celtic Sea). Irish trawlers. DLF of sampled (continuous line) and simulated (broken line) discarded numbers.

Figure 19. *Nephrops* FU20–22 (Celtic Sea). Irish trawlers . DLF of sampled (continuous line) and simulated (broken line) discarded numbers.

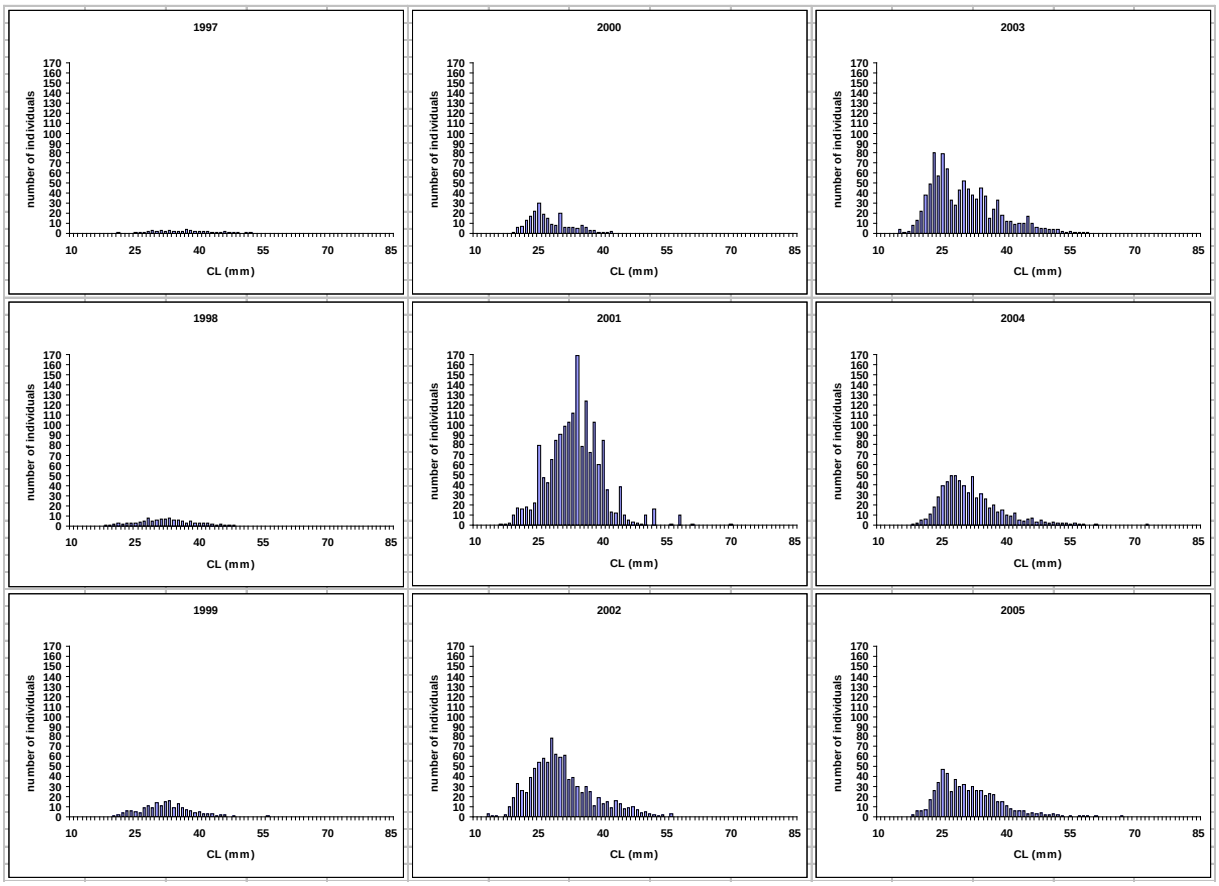


Figure 20. *Nephrops* FU20–22. Indices of the French groundfish survey EVHOE.

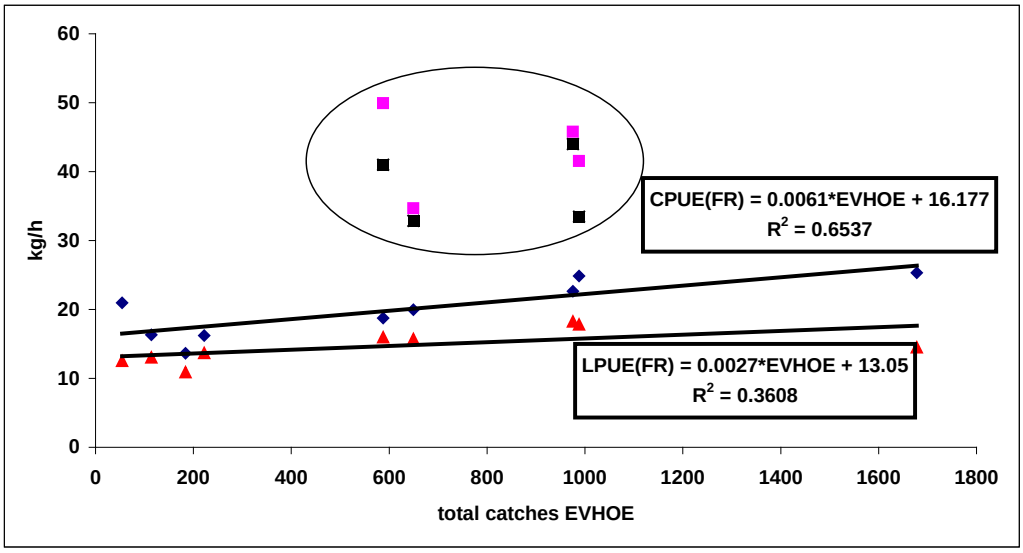


Figure 21. *Nephrops* FU20–22. Comparison of indices EVHOE and of commercial lpue and cpue for French and Irish trawlers.

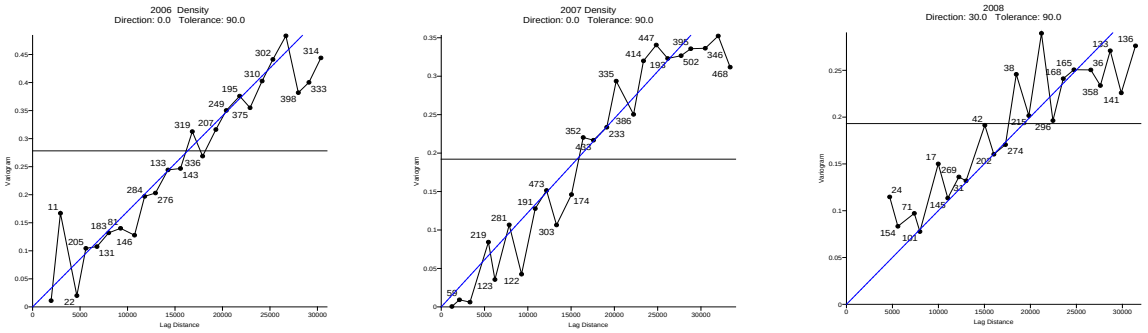


Figure 22. Omnidirectional mean variograms for the Celtic Sea FU20–22 by year from 2006–2008.

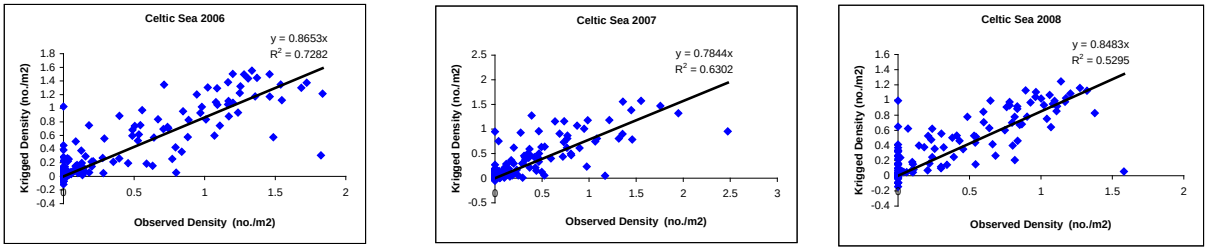


Figure 23. Cross validation plots for the Celtic Sea FU20–22 by year from 2006–2008.

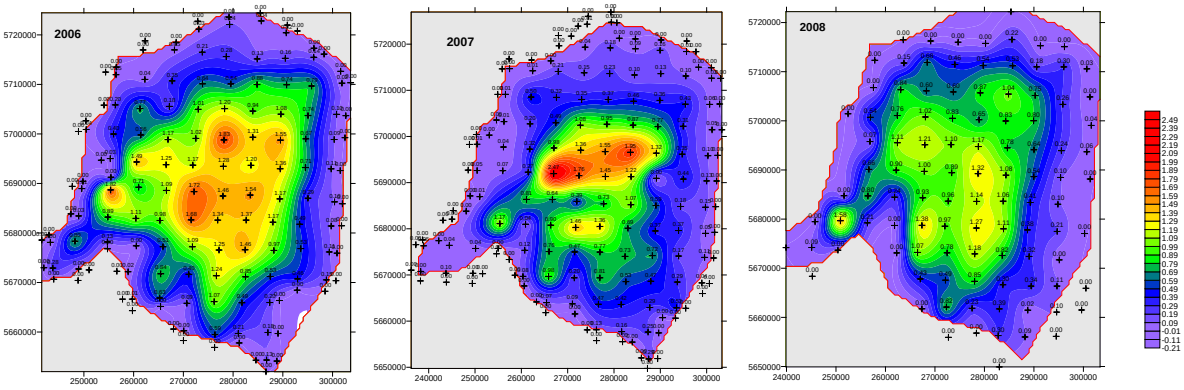


Figure 24. Contour plots of the krigged density estimates for the Celtic Sea FU20–22 by year from 2006–2008.

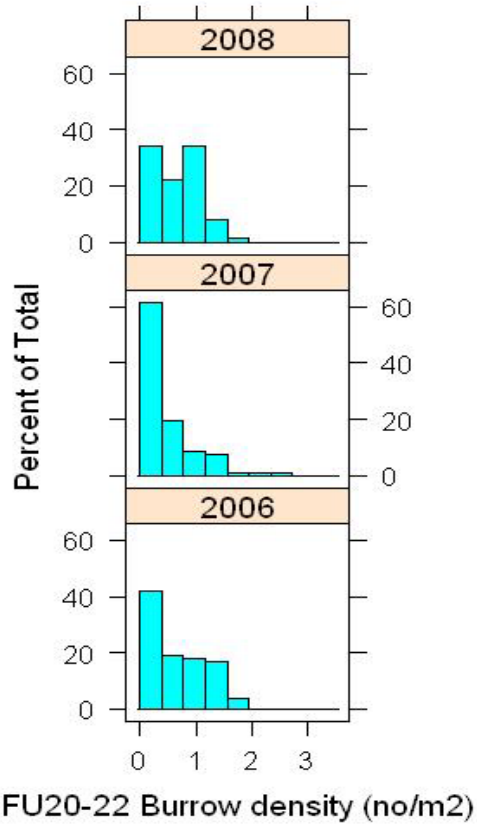


Figure 25. Burrow density distributions for the Celtic Sea FU20–22 by year from 2006–2008.

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

Stock Annex 7.10: Celtic Sea plaice

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. Historical 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.

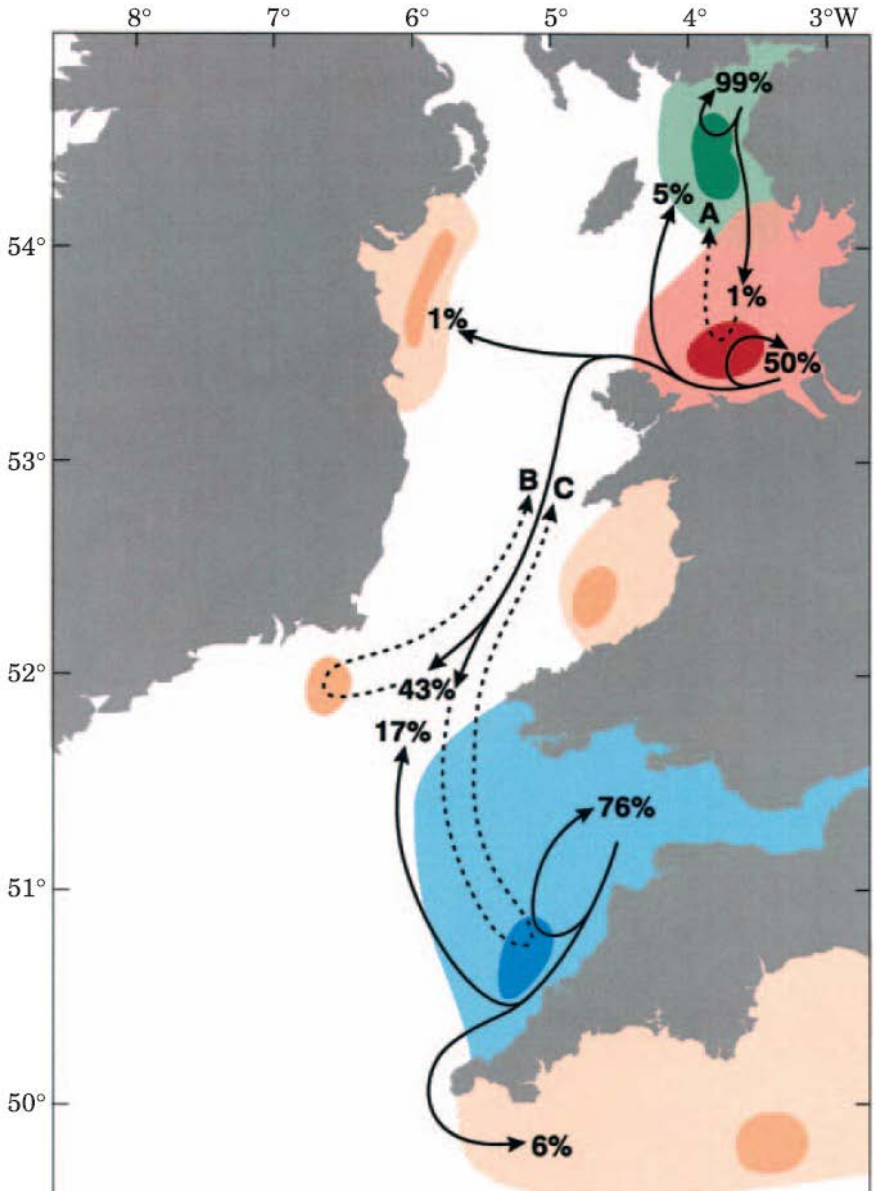


Figure A.1. Principal substock areas and movements of plaice on the west coast of England and Wales. Percentages are the recaptures rates of tagged plaice <25 cm total length when released, and >26 cm when recaptured in English and Welsh commercial fisheries. Tagging exercises in 1979–1980 and 1993–1996 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 or 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 mechanizms 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, and 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 1984-88 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 'un-sampled' 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 Ipue

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

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Stock Annex 7.15: 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
$\mathbf{F}_{lim}$	No Proposal	No Proposal	1.18 $_{(\mathbf{F}lim=\mathbf{F}loss)}$	No Proposal
$\mathbf{F}_{pa}$	No Proposal	No Proposal	0.72 ($\mathbf{F}_{pa}=\mathbf{F}_{lim} \times e^{-1.645 \times 0.3}$)	No Proposal
$\mathbf{B}_{lim}$	15,000 t	15,000 t	15 000 t $_{(\mathbf{B}lim=\mathbf{B}loss)}$	15,000 t $_{(Blim=Bloss)}$
$\mathbf{B}_{pa}$	18,000 t	21,000 t	21 000 t $_{(\mathbf{B}pa=\mathbf{B}loss \times 1.4)}$	21,000 t $_{(Bpa=Bloss \times 1.4)}$

The technical basis of ACFM's 1998 B_{pa} proposal is given below (1999 WG text):

$B_{pa} = B_{lim} \times 1.4 = 21\,000$ t. In the past the WG have selected MBAL as 18 000 t based on evidence of reduced recruitment at SSB's <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)
$F_{pa} = F_{lim}$ x e-1.645*0.3 = 0.72

The currently adopted reference points are as follows:

	Current Reference Points
$\mathbf{F}_{lim}$	No Proposal
$\mathbf{F}_{pa}$	No Proposal
$\mathbf{B}_{lim}$	15,000 t ($B_{LIM} = B_{LOSS\ 1983}$, $ACFM_{1998}$)
$\mathbf{B}_{pa}$	21,000 t ($B_{PA} = B_{LOSS\ 1983}$ x 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

Stock Annex 8.2: Western Channel plaice in VIIIe

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 called 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 whilst spawning in the Channel (eastern and western areas) during January and February showed that 20% spent the 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 re-analysed 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 6 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 the summer in VIIe, while 56% migrate to the North Sea. Given the assumptions involved in these calculations and the relatively small numbers of adult tags returned the estimates of movement rates are subject to great variability. The limitations of the data do not permit an estimate of annual movement probabilities. Recent studies based on data storage tags suggest that the retention rate of spawning plaice tagged in the eastern 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 mid-water 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 Fr., 300 Eng. and 7 CI).

Similarly, potting (960 Fr., 275 Eng and 560 CI) 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 Fr., 60 Eng and 13 CI). Handlines are used for mackerel, bass, pollock and ling by small boats working along

both the English (390) and French (120 Fr and 90 CI) 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 and 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 CVs 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 4 m '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 of 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 shows 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 and 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 and then raised to include the catches form the 'other' gears. These ACs were then combined across gears and 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 and 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 historical 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%; Age2–26% Age3–52%,Age4–86% 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–FMSY 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 WGCSE2010.

	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}, and 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 ob-

served, 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, whilst 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 F's and little or no response in recruitment to the range of SSB's 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 F_{sq} is currently too high and should be reduced, whilst 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 SSBMT<Bpa)
B_{lim}	1300 t	(equal to Bloss)	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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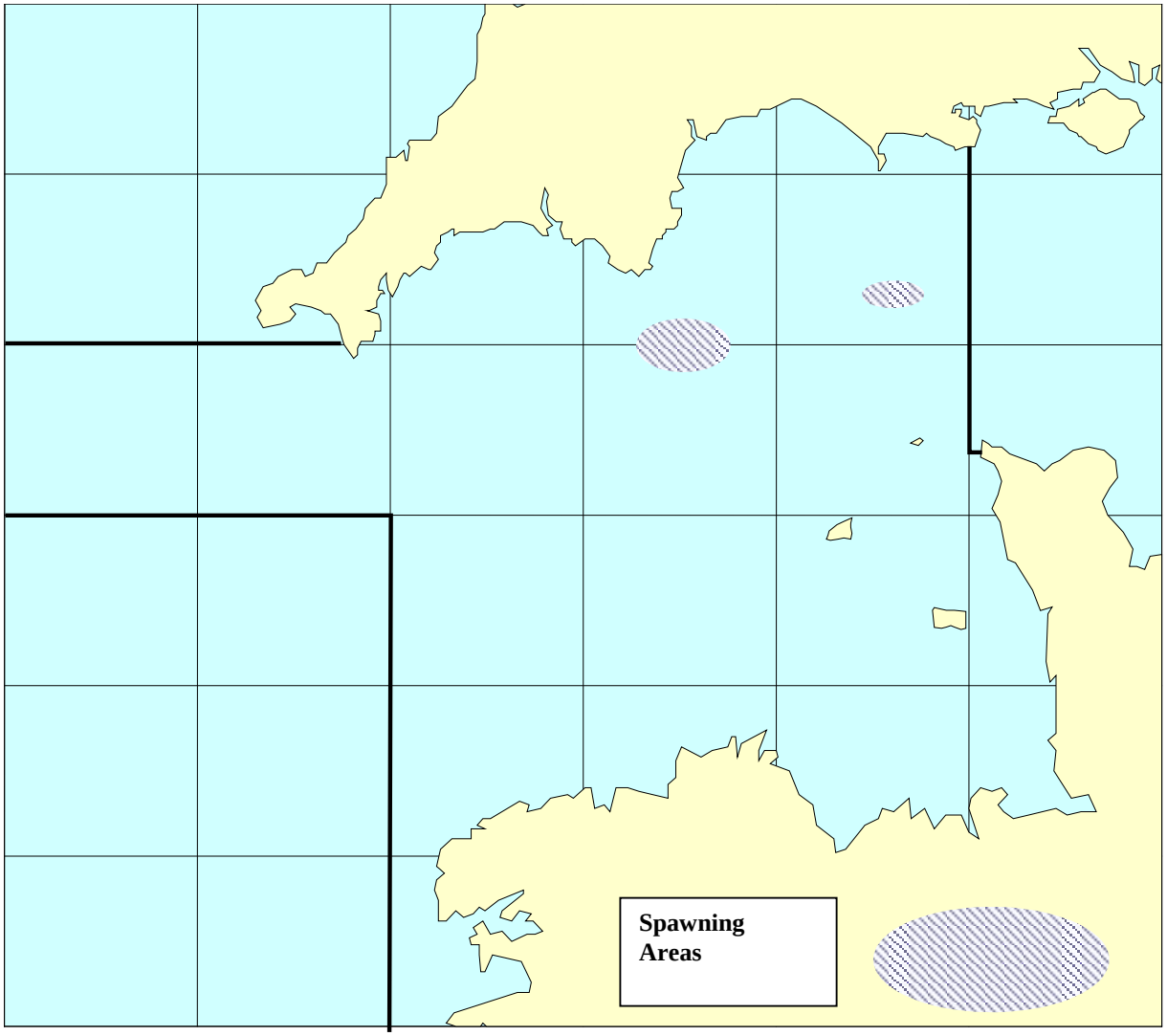


Figure A. Map of spawning areas for VIIe plaice.

Table A. VIIe plaice - Catch Derivation table for assessment years 1981–2008 * stock assessed as VIId,e plaice.

		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

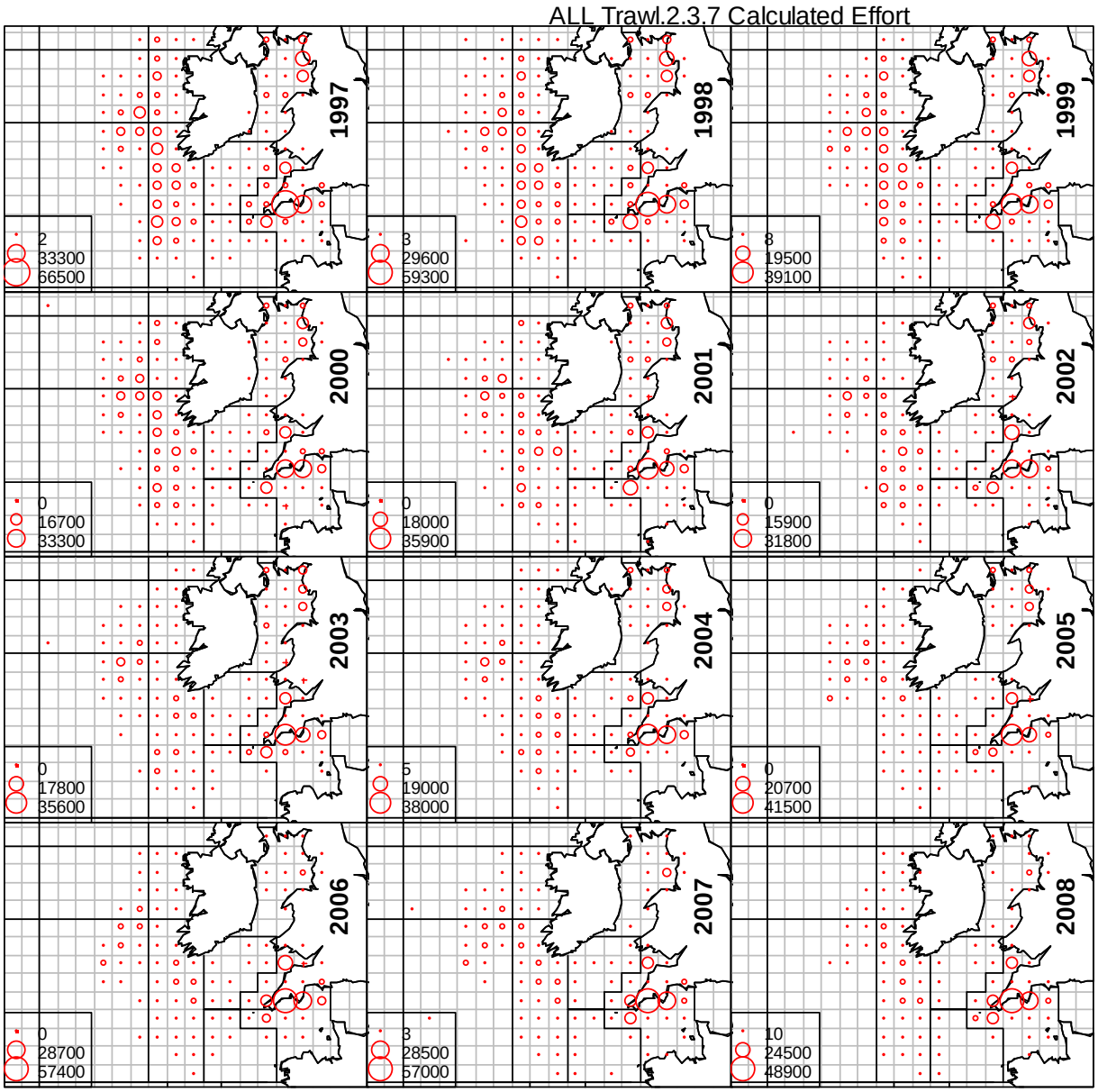


Figure B. UK(E+W) Otter trawl fleet effort (hours fished); based on demersal landings.

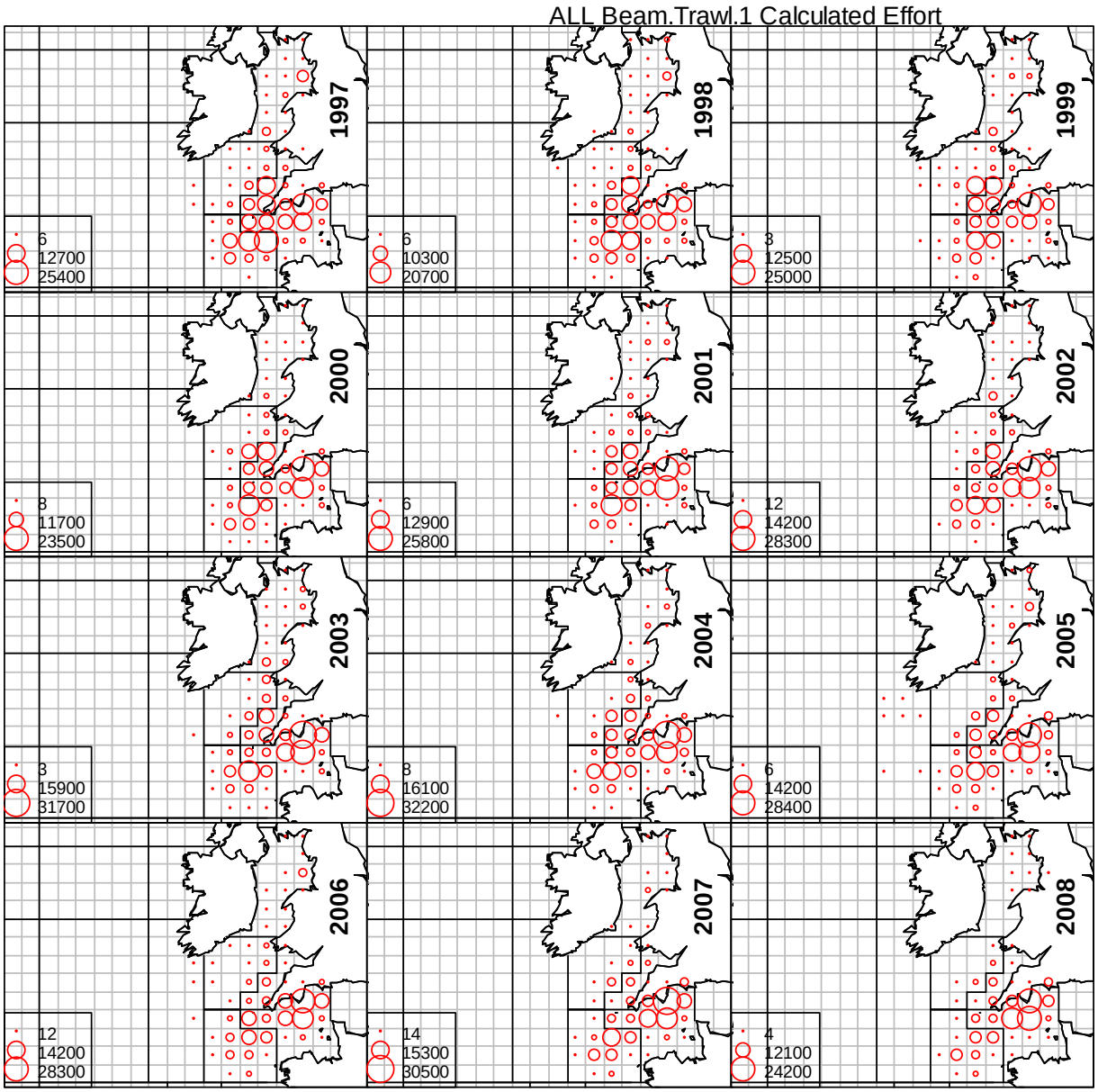


Figure C. UK(E+W) Beam trawl fleet effort (hours fished); based on demersal landings.

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

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
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)																						
																				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		20yrtai	20yrtai	20yrtai	20yrtai	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	0.2	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.

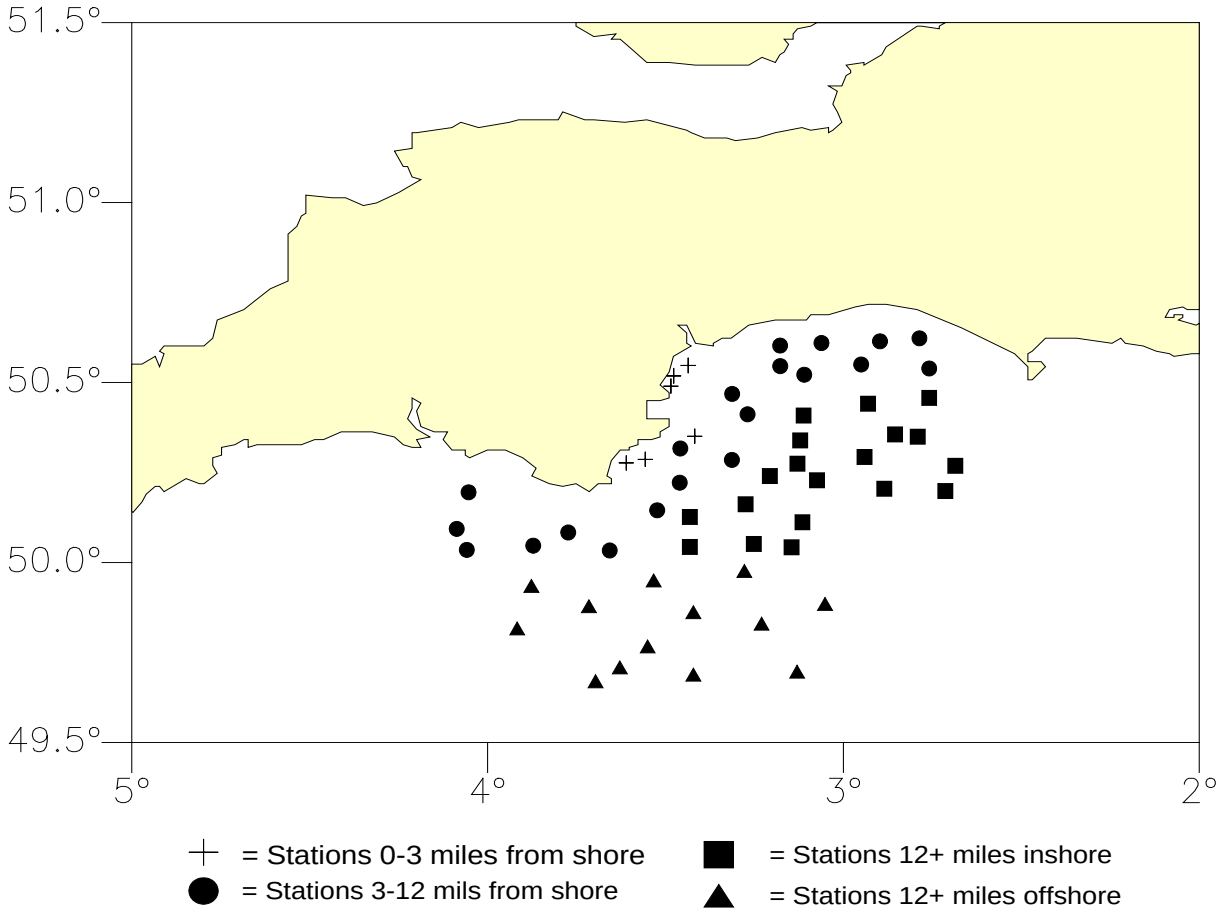
The AC's are calculated by proportioning a length distribution (LD) to an appropriate age–length key (ALK). To account for possible population differences within ICES Division VIIe, biological samples are taken from sectors stratified by distance from shore (see map). The survey bands (in miles) are 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 * 6 m beam trawls
	1989–2001 – 2 * 4 m beam trawls
	– 1* 4 m beam trawl
	2005–Present – 2 * 4 m 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

Stock Annex 8.3: Sole in Division VIIe

Stock-specific documentation of standard assessment procedures used by ICES.

Stock	Sole in Division VIIe (Western Channel)
Date:	19/02/2009
Revised by	Sven Kupschus (WKFLAT)

A. General

A.1. Stock definition

The management area for this stock is strictly that for Area 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.

The source of recruitment to the stock is not clear either as little is known about spawning and nursery grounds in the management area. Additionally, tagging information suggests that during years of strong sole recruitment in Area VIIf,g some juveniles may migrate to VIIe. The stock boundary to VIId is also likely to be poorly defined as it represents no natural boundary to sole movement. During periods of strong recruitment in VIId a substantial portion of the VIId recruits (up to 30%) may move into VIIe where their impact will be felt very strongly as a consequence of the much smaller stock size in the latter region. The ingress of juveniles from other areas may explain the lack of a suitable stock–recruitment relationship for this stock.

The assessment method used until 2008 does not deal with uncertainty about stock boundaries.

A.2. Fishery

The principal gears used for sole in the Western Channel are otter- and beam trawls, for the UK fleet and entanglingnets 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 to 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 cuttlefishing 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 3 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.

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 7e catches. In 2002 the UK industry indicated that there had been substantial misreporting of landings to two rectangles in Area 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, WGNSDS: VIIa, WGSSDS: 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,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

Currently the only available survey 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. The 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.

Appendix 1 provides a history of the survey and details the survey methodology and objectives.

B.4. Commercial cpue

In the early part of the 20th century the fishery for VIIe sole was largely prosecuted by otter trawlers and inshore netters. During the mid to late 1970s landings sharply increased with a considerable increase in nominal effort as the beam trawl fleet developed. Otter trawl effort declined with levels in 2002 being about half that of effort found in the late seventies. Beam trawl effort in hours fished has continued to rise since 1988, but at a slower rate than previously as a consequence of licensing and quota restrictions, but boat size and power as well as beam sizes have also increased suggesting that the effective effort has continued to rise more sharply than suggested by the effort data alone.

Lpue has declined since the late eighties in both the otter and beam trawl fleets suggesting a marked decline in the SSB of this stock. Interestingly the catch-at-age information for these fleets does not suggest a marked decline in the age structure over this time suggesting the decline may be associated with environmental impacts rather than fishing, but given the uncertainty in current landings data, it is difficult to distinguish between the potential causes of the discrepancy between the lpue and catch-at-age data. Little information is currently available regarding the development of the French fishery on this stock on the southern side of the Channel.

The UK beam trawl fleet in recent years has been landing large quantities of cuttlefish during winter. Investigations of the landings data indicated that misreporting was particularly high during the period of the cuttlefish fishery indicating that lpue was unlikely to be substantially lower than during the remainder of the year, justifying the inclusion of all trips in the lpue time-series. Similarly, there was no indication of differences in lpue for those trips split between divisions (misreporting to VIId) so

that trips reporting to VIIe as well as those reporting to the two adjacent rectangles in VIId were included in the derivation of the tuning fleets.

UK beam trawl effort has climbed markedly since 1992. Otter trawl effort has stabilized following its decline during the 1980s and early 1990s.

For the purpose of the lpue tuning effort used in the assessment until 2008 a subset (vessels greater than 13.27 m) of the boats operating in VIIe is taken and their combined landings over the period are used to calculate lpue. The commensurate effort figure in kWh for their effort is used for each individual landing. The relationship between the kWh and the landings is then used to determine the relationship between lpue and power, and a correction made to effort values for changes in the fleet composition. A map of the areas corresponding to the lpue series exploring spatial changes in the distribution of effort is shown in Figure B4.1. The latter procedure is now very dated and should be look at with some urgency, as it may be contributing to the retrospective pattern.

For the calculation of lpue, landings misreported to VIId (see catch data section) are corrected in the same manner as the catch data. No corrections are made to the effort statistics, as the time spent in VIId for the purposes of misreporting has been negligible.

B.5. Other relevant data

None.

C. Historical stock development

WKFLAT 2009 concluded that at the present time it is not possible to perform a quantitative assessment on the stock that could be seen to be representative of recent trends in F and SSB. Therefore no assessment, short-term forecast or sensitivity analysis can be performed. Some suitable information is available from the survey (Appendix 1) that could be used for management until such time that a suitable assessment model can be developed.

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 subsequent good recruitment in 1980, 1984, 1986 and 1990 leading to an apparently depressed recruitment period since 1991. It is unclear whether this reduction in recruitment is linked to the decline in SSB, environmental effects, or is an artefact of the misreporting of landings as a consequence of the TAC constraints introduced in 1987, and becoming restrictive in 1989.

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 VIIe sole assessments and details the assessment model used (XSA) and the parameters and settings used in each year's assessment until 2008.

D. Short-term projection

In lieu of an assessment no short-term prediction is carried out.

E. Medium-term projections

Not applicable for the time being.

F. Long-term projections

Not applicable for the time being.

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+
$\mathbf{F}_{lim}$	0.36 ($\mathbf{F}_{loss}$ WG98)	0.28 ($\mathbf{F}_{loss}$ WG01)
$\mathbf{F}_{pa}$	0.26 ($\mathbf{F}_{lim}$*0.72)	0.20 ($\mathbf{F}_{lim}$*0.72)
$\mathbf{B}_{lim}$	1800 t ($\mathbf{B}_{loss}$= B_{73} WG98)	2000 t ($\mathbf{B}_{loss}$= B_{00} WG01)
$\mathbf{B}_{pa}$	2500 t ($\mathbf{B}_{lim}$*1.4)	2800 t (Historical development)

The assessment methodology that formed the basis for these precautionary reference points is rejected by WKFLAT and these reference points are therefore no longer considered appropriate. The reference point table will therefore be updated as follows:

	Type	**Value**	**Technical basis**
Precautionary approach	B_{lim}	Undefined	
	B_{pa}	Undefined	
	F_{lim}	Undefined	
	F_{pa}	Undefined	
Targets	F_{mgt}	0.27	EC Multi-annual plan.

(unchanged since 2009).

Once a new assessment methodology has been accepted its implications on reference points will need to be evaluated.

H. Other issues

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 VIIe sole. Years 2007–2009 are deemed a recovery plan, with subsequent years being deemed management plan. For 2008 the TAC is 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 exceeds a 15% change in TAC, a 15% change in TAC shall be implemented.

I. References

Horwood, J. 1993. The Bristol Channel sole (*Solea solea* (L.)): a fisheries case study. Advances in marine biology. 1993, vol. 29, pp. 215–367.

Pawson, M.G and Harley, B.F.M. 1997. (unpubl.: Cefas internal report).

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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
	ALK	quarterly	-	UK+France raised to total international	
	Age composition	quarterly	-		

		source			
Year of WG	**Data**	**UK**	**France**	**derivation of international landings**	**% sampled**
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%

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	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	Yes	Yes	Yes	Yes
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

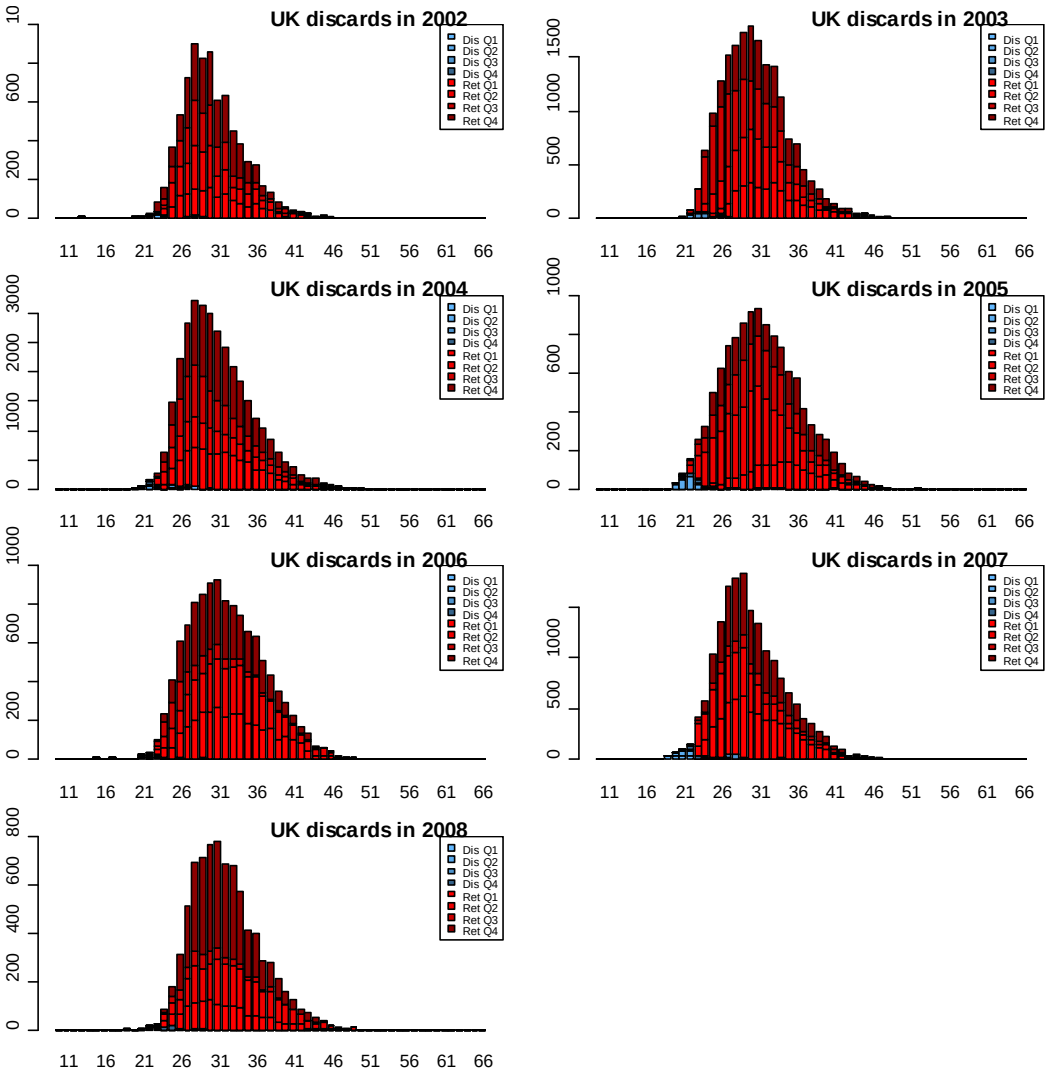


Figure A.2.1. Time-series of UK discard data raised to trip information.

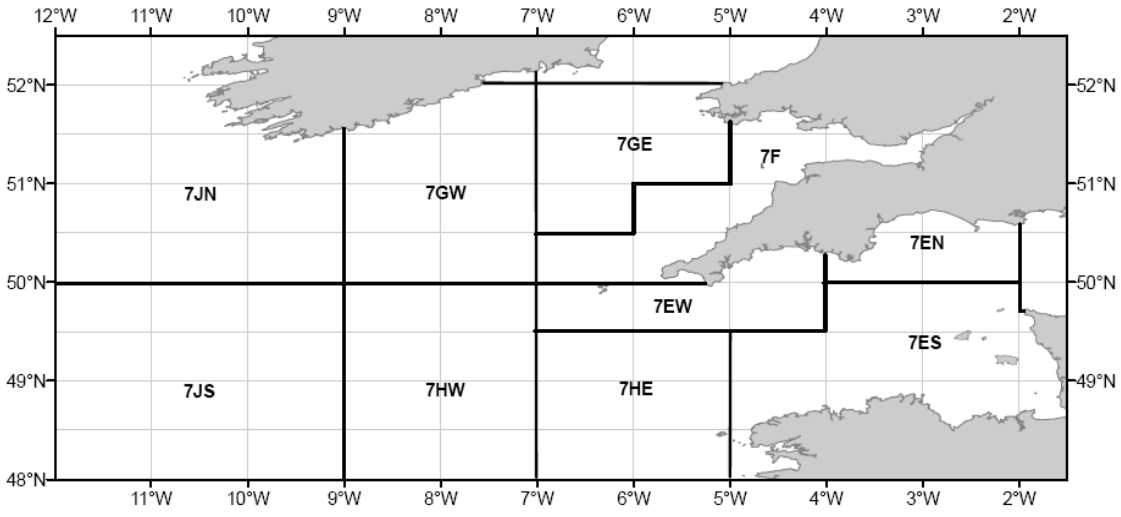


Figure B4.1. Areas used for the calculation of lpue time-series exploring temporal changes in the distribution of stock and effort.

Appendix 1: Beam trawl surveys of the western English Channel (ICES Division 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'.

As a consequence of 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)

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 present)

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)

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 1 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 present)

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'.

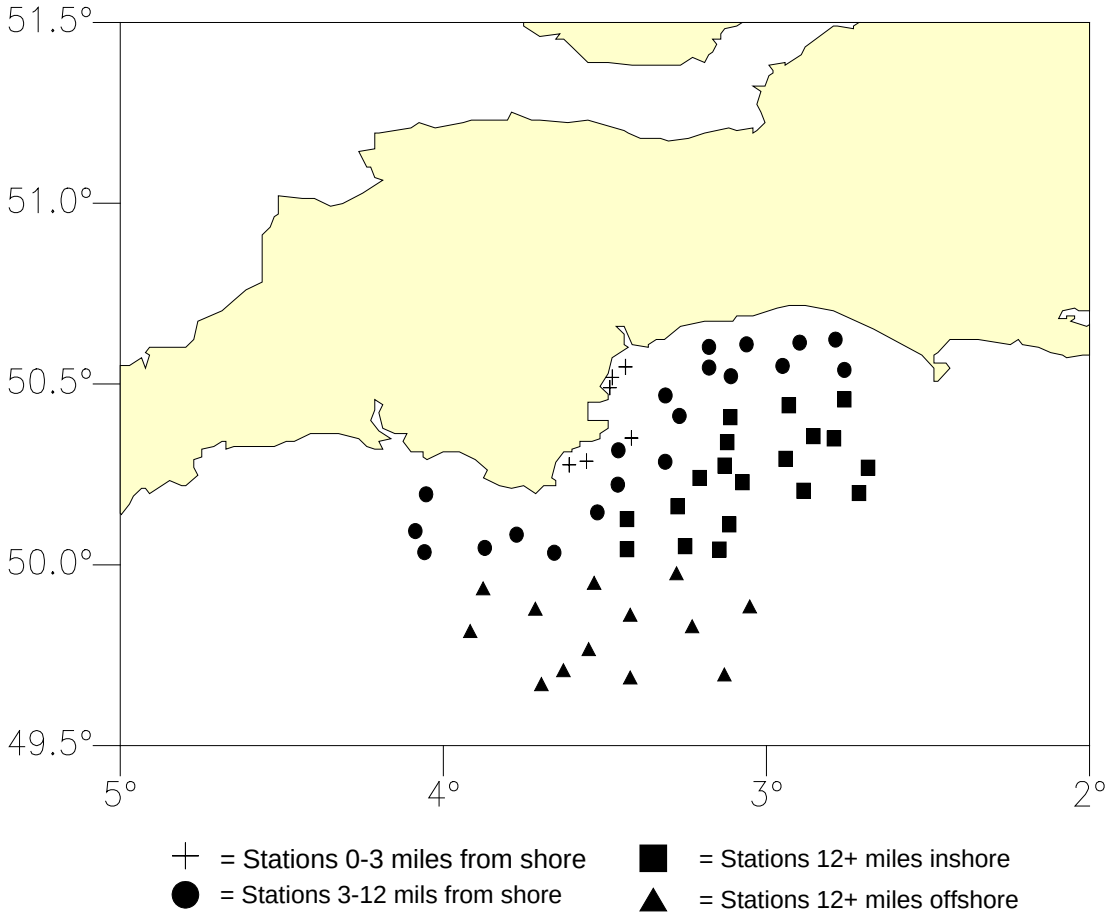
Between 1984 and 1990 a total survey age–length key was applied to the 'grid' length distribution, but from 1990 onwards stratum stratified age–length keys were used.

The Table below demonstrates the stratifications currently used to calculate the 'near-west groundfish survey' abundance indices.

		ALK stratified by			LD stratified by			
Species	**Sector**	**Sector**	**Depth band**	**Sex**	**Sector**	**Depth band**	**Sex**	**Used in assessment?**
Plaice	VIIe	✓	✓	✓	✓	✓	✓	✓
Sole	VIIe	✓	✓	X	✓	✓	X	✓

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 * 6 m beam trawls
	1989–present , except 2002,2004	– 2 * 4 m beam trawls
	2002, 2004	– 1* 4 m beam trawl
Mean towing speed	4 knots over the ground	
Tow duration	30 minutes	
Vessel used	F.V. Bogey 1	1984–1988
	F.V. Carhelmar	1989–2001, 2003 and 2005–present
	R.V. Corystes	2002 and 2004

Annex 3: Summary of Working Documents presented to WGCSE 2011

WD01 Discarding of Haddock in VIIb-k; Comparison between the Irish and French discard data 2005-2010

Hans Gerritsen, Marine Institute, Ireland

A large proportion of haddock catches up to age three are discarded. Because recruitment is highly variable and the stock is relatively short-lived, it is important to take these discards into account in the assessment. Discard data are available from the Irish otter trawl fleets in VIIbgj from 1995 onwards. French discard data are available from 2005 onwards. Although the French do not appear to catch significant numbers of one-year-olds and the Irish do, discard ogives appeared to be similar and the assessment did not seem to be sensitive to the absolute number of one-year-olds. Therefore it looks likely that the Irish discarding pattern can be used to estimate historic discards and that French discard data should be included from 2005 onwards (This would require the data to be disaggregated by age and raised to the French fleets). For data before 2005 it may be advisable to raise the discard numbers of one-year-olds only to the Irish fleets while the older fish should be raised to the international fleet.

WD02 Distribution of Juvenile Haddock in VIIb-k based on IGFS and EVHOE WIBTS; 4Q surveys

Hans Gerritsen, Marine Institute, Ireland

The 2009 year class of haddock VII–-k appears to be the largest since the time-series began in 1993. In response to the assessment performed by the WGCSE in 2010 the review group commented that "A key question is where in the Celtic Seas this abundance of small haddock will be located, and hence where would measures to avoid discarding be best targeted. The WG should monitor the distribution of these fish through surveys and observer data and provide managers with this information". Both juvenile and are widely distributed throughout VIIb and g and the north of VIIj. The survey results of 2010 show a similar distribution of juveniles to the average of all years, so there is no reason to conclude that the 2009 cohort is distributed differently to young haddock in other years. Juveniles are particularly abundant in VIIb. The area with the highest abundance of juveniles in VIIb has a relatively low fishing effort, which may offer some protection from discarding. There are also some areas in VIIg and j with high numbers of juveniles. The fishing effort in these areas is moderate, which may result in significant levels of discarding.

WD03 Irish fisheries; science-research partnership trawl survey of the Porcupine Bank *Nephrops* grounds July 2010

Dave Stokes and Colm Lordan, Marine Institute, Ireland

The *Nephrops* fishery on the Porcupine Bank takes place on a large area, approximately 7000 km², of complex muddy habitat between depths of 300 to 470 m. Irish effort has been increasing and Ireland is now responsible for the majority of the landings. The scientific advice has indicated that the stock has declined and fishing mortality should be reduced to the lowest possible level. This Irish Fisheries Science Research Partnership (IFSRP) survey was developed in consultation to address the

pressing need for data from the closed area established by the EC between 1st May to 31st July 2010. 46 hauls were carried out and the results indicate high cpue for the survey relative to recent observations for the fleet. Strong patterns in size and sex ratio were observed spatially. The male biased sex ratio and size-at-maturity are similar to historical observation. The size distributions of the catches are very different to the Spanish survey in the area which took place two months later. The utility of the survey for monitoring the stock is discussed.

WD04 Update on the 2010 UWTV survey of the western Irish Sea *Nephrops* grounds (FU15)

Colm Lordan, Jennifer Doyle and Richard Briggs (AFBI)

Since 2003 a joint UWTV survey has been carried out by the Marine Institute (Ireland) and AFBI (Northern Ireland). For the first time in 2009 this survey was used to develop catch options for the stock using a bias corrected survey estimate as an absolute measure of stock size and recent discard rates and mean weight to forecast catch as set out by the benchmark process in 2009. This report details the results of the 2010 survey for the western Irish Sea *Nephrops* stock and also presents individual's counting performance against the reference counts as measured by Linn's concordance correlation coefficient (CCC) as recommended by SGNEPS 2009.

WD05 Update on the 2010 UWTV survey of Aran, Galway Bay and Slyne Head *Nephrops* grounds (FU17)

Colm Lordan and Jennifer Doyle. Marine Institute, Ireland

This is the ninth data point in a time-series of UWTV surveys on the 'Aran grounds'. The survey covers three distinct mud patches; the Aran Ground, Galway Bay and Slyne Head. These have approximate areas of 940, 41 and 26 km^2 respectively. For the first time in 2009 this survey was used to develop catch options for the stock using a bias corrected survey estimate as an absolute measure of stock size and recent discard rates and mean weight to forecast catch (ICES, 2009a). This report details the results of the 2010 survey and updates the catch option table using the most recent survey estimate and also presents individual's counting performance against the reference counts as measured by Linn's concordance correlation coefficient (CCC) as recommended by SGNEPS 2009. There was also a minor data revision to survey years 2006 and 2008 due to the amalgamation of survey data to a SQL server. This revision did not change the overall perception of the survey-series.

WD06 Gadoid abundance from the 2010 West coast industry–science survey

P. G. Fernandes, R. Watret, I. Penny and F. McIntyre, Marine Scotland Science, Marine Laboratory, Scotland

Marine Scotland Science conducts two surveys each year of the fish in the shelf seas west of Scotland; the Quarter 1 Scottish VIa International Bottom Trawl Survey (Q1 Sco.VIa.IBTS) and the Quarter 4 Scottish VIa International Bottom Trawl Survey (Q4 Sco.VIa.IBTS). In Quarter 1 of 2010, an additional survey of the gadoid fish species was conducted as part of the West Coast Industry Science Forum; the "industry–science survey". The aims of this analysis of the industry–science survey results is to produce an absolute estimate of abundance for the principal gadoid species (rather than the index of relative abundance which is normally produced from the two IBTS surveys), and to compare the estimates at age from the industry–science survey with

the indices at age produced from the Q1 Sco.VIa.IBTS. The planning and execution of the industry–science survey involved the explicit participation of the fishing industry, using two chartered trawlers to conduct the survey. Abundance estimates were calculated on the basis of certain assumptions about the catchability of the net. Minimum and best estimates of the total stock and spawning–stock biomass of cod were lower than those produced by the ICES assessments, whilst biomass estimates for haddock were more in line with assessment values. The 'best' estimates at age for all species are compared with the indices produced by the IBTS. These were very similar in the case of haddock and whiting, but less comparable in the case of cod. Estimates of uncertainty in the industry–science survey are also provided. The estimates of cod were very uncertain with measures of relative standard error in excess of 75%. There was less uncertainty in the estimates of haddock (RSE~20%) and whiting (RSE~12%). The results from the survey and the principles of its design have since been used to redesign the IBTS surveys.

WD07 Preliminary assessment of Northern Shelf megrim (*Lepidorhombus* spp. in VIa–IVa) using Bayesian state–space surplus production models

Coilın Minto and Norman Graham, Marine Institute, Ireland

An age-aggregate surplus production assessment model is applied to available landings and survey data for Megrim. Commercial landings from ICES Su-areas VIab–IVa and survey data from the International Bottom Trawl quarter 1 surveys as well as the dedicated monkfish survey data are used. The model is implemented within a flexible Bayesian framework that can accommodate multiple sources of information while propagating the uncertainty associated with each source.

WD08 Celtic Sea Cod Survey 2010 Report

Eoghan Kelly, Norman Graham and Macdara Ó Cuaig, Marine Institute, Ireland

As a result of historical problems with commercial catch data there is at present no assessment of cod in the Celtic Sea. Consequently it is not possible to accurately estimate the size, age structure and distribution of this stock or what proportion is being caught. This has led to restrictions on fishing opportunities which have resulted in discarding of marketable fish. To overcome these problems a dedicated survey in quarter one was planned to monitor both the concentration of fish and their maturity during the spawning period. The first of such surveys was carried out by the Marine Institute from 14–23 March 2010.

The average catch rates for the entire survey area were 30.1 cod per km^2 and 25.3 kg per km^2. There was no significant difference in catch rates between the random scientific stations and the stations selected by industry. Catches were dominated by small, young individuals and 80% were one year old. Higher catches were found inside the Celtic Sea Conservation Area although there was no difference found in the maturity pattern. Growth rate in the survey area was rapid and higher than for other cod stocks. The combination of good recruitment and fast growth provides an opportunity for high yields to be taken by the fishing industry in this area.

The survey presented here 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.

WD09 Egg production survey estimates of spawning-stock biomass of cod, haddock and plaice in the Irish Sea: 1995–2010

Mike Armstrong[1], Steven Beggs[2], Freya Goodsir[1], Lorraine Greenwood[1], David Maxwell[1], Steve Milligan[1], Enda O'Callaghan[2], Angelika Prael[2], Sam Roslyn[1], Alison Walton[1], Oliver Williams[1], Elaine Warren[2], and Peter Witthames[3]

(1) Cefas, Lowestoft, (2) Agri-Food and Biosciences Institute, Belfast, (3) Consultant (Fecund Fish)

This Working Document summarises the results of applications of the Annual Egg Production method to estimate spawning–stock biomass of cod and plaice in the Irish Sea in 1995, 2000, 2006, 2008 and 2010, and haddock in 2006, 2008 and 2010. This represents an update of the Working Document submitted to WGCSE in 2010 (Armstrong *et al*., 2010), which included a revision of previous published results from the 1995 and 2000 surveys (Anon, 1997, 2002; Armstrong *et al*., 2001) to ensure consistency with the more recent estimates.

This work is conducted jointly between Cefas and AFBI (Belfast). The Marine Institute (Galway) assisted with fecundity estimates in surveys up to 2008.

WD10 Update on the 2010 UWTV survey on the Celtic Sea *Nephrops* grounds

Colm Lordan and Jennifer Doyle, Marine Institute, Ireland

This is the fifth in a time-series of UWTV surveys on the 'Smalls grounds'. The 2006 survey covered the distinct mud patches of the Smalls Grounds and also indicator stations on the Labadie Bank, Nymphe Bank and Seven Heads, whereas the 2007 to 2010 survey covered the Smalls grounds only due to poor weather and time constraints. This report details the results of the 2010 survey for the Smalls ground *Nephrops* stock and discusses the background to calculating the bias correction factor to the UWTV survey estimate, using mean weight in the landings, mean proportions of the catch retained and harvest ratios at different reference points from an SCA analysis to calculate landings options. It also presents individual's counting performance against the reference counts as measured by Linn's concordance correlation coefficient (CCC) as recommended by SGNEPS 2009. There was a minor data revision to survey years 2006 and 2007 due to the amalgamation of survey data to a SQL server. This revision did not change the overall perception of the survey-series.

WD11 Trends in abundance of cod, haddock and whiting from UK Fisheries Science Partnership roundfish surveys of the Irish Sea: 2004–2011

Mike Armstrong, Shaun Doran, Samantha Elliott and Peter Randall, CEFAS, Lowestoft

This Working Document is derived from a draft Fisheries Science Partnership report currently in preparation, for use by the ICES Working Group on the Celtic Seas Ecoregion. The results are not to be cited without permission from the primary author. The final report will eventually be published on the Cefas website.

The Irish Sea roundfish survey was developed in 2003 as a fully collaborative project between the fishing industry and Cefas scientists. It forms part of the UK Fisheries Science Partnership funded by the UK's Department for Environment, Food and Rural Affairs (Defra). The scope of the FSP programme, and reports for all completed projects, are available on the FSP page of the Cefas website (http://www.cefas.defra.gov.uk/publications/scientific-series/fisheries-science-partnership-reports.aspx).

The main objective of the Irish Sea roundfish survey is to develop a time-series of data to track year-on-year changes in abundance, population structure and distribution of the target species (cod, haddock and whiting). The results of the surveys provide information supporting the scientific assessment of the stocks and the management of the fisheries in the Irish Sea.

This report updates the series of abundance indices presented in a Working Document to the 2010 WGCSE meeting to include indices for 2004–2011.

WD12 Standardised lpue time-series for the Irish Porcupine *Nephrops* fleet

Hans Gerritsen and Colm Lordan, Marine Institute, Ireland

The main fishers operating on the Porcupine Bank (FU16) expressed concern that the Irish *Nephrops*-directed otter trawl lpue time-series may be biased due to changing fishing practices. The fishery, particularly by the freezer vessels, has become increasingly selective in targeting behaviour. Targeting behaviour has shifted from high volumes of smaller prawns to lower volumes of large prawns. The fishing effort has also become less seasonal with larger freezer vessels operating throughout the year. A GLM analysis indicated significant vessel effects throughout the time-series. A range of other explanatory variables also showed significant effects (month, windspeed, ICES rectangle). However, after vessel effects were included in the model, other explanatory variables did not influence the standardised lpue estimates noticeably. The main concern raised by industry i.e. that vessels are now targeting more selectively for larger *Nephrops* has not been explicitly tested in the model since spatially explicit sampling data at the resolution required does not exist. It remains possible that the long lpue trend is biased in the past and not reflective of stock abundance.

Annex 4: Technical Minutes

Celtic Sea Review Group 1 Report

- RGCS1
- By correspondence 7 June 2011
- Participants: Asgier Anglen (Chair), Rick Officer and Rainer Oberst, Pieter-Jan Schön and Joël Vigneau (WG Chairs), Cristina Morgado, Barbara Schoute and Mette Bertelsen (Secretariat)
- Working Group: WGCSE

Review process

The roundfish stocks and the *Nephrops* stocks were reviewed by RGCS2.

RGCS1 considered the following stocks:

Fish stocks	Perform assessment	Advice
Anglerfish (*Lophius piscatorius* and *L. budegassa*) in IIa–VI	Y	Update
Megrim (*Lepidorhombus* spp) in Subarea VI and IV	Y	Update
Plaice in Division VIIb,c (West of Ireland)	Y	Update
Plaice in Divisions VIIh,k (Southwest of Ireland)	Y	Same advice as last year
Plaice in Divisions VIIf,g (Celtic Sea)	Y	Update
Plaice in Division VIIe (Western Channel)	Y	Update
Plaice in Division VIIa (Irish Sea)	Y	Update
Sole in Division VIIb, c (West of Ireland)	N	Catch statistics only
Sole in Divisions VIIh-k (Southwest of Ireland)	Y	Same advice as last year
Sole in Divisions VIIf,g (Celtic Sea)	Y	Update
Sole in Division VIIe (Western Channel)	Y	Update
Sole in Division VIIa (Irish Sea)	Y	Update

These were reviewed along with four herring stocks and one sprat stock from HAWG, and stocks of megrim and anglerfish from WGHMM. The Review Group conducted its work by correspondence. The reviews have been carried out according the Guidelines provided by ICES. This involved:

- Checking that update assessments have been correctly implemented using the methods described in the Stock Annexes;
- Checking that the assessments have been implemented correctly;
- Ensuring the assessment results and forecast results are carried over correctly to the advice sheets and advising ICES of any errors detected;
- Evaluating the ability of the stock assessments for providing credible management advice, and suggesting alternative advice where assessments do not appear appropriate;
- Providing recommendations to the Working Group to help with future development of the assessments through benchmarking.

The list of stocks was shared so that each reviewer wrote a first draft for a number of stocks. Then the two other reviewers gave their comments.

General comments

The WG report is well organized and readable. The SharePoint site is well updated and structured, although not fully completed at the starting date of the review.

Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Division IIa, IIIa, Subarea IV and VI (report Section 5.2)

1) Assessment type: Update

2) Assessment: Trends. No analytical assessment is presented

3) **Forecast:** Not presented

4) Assessment model: None presented. Trends in abundance and biomass derived from surveys are presented as relative indicators of stock status.

5) Consistency: No analytical assessment has been conducted on this stock since 2004. Survey-series 2005–2008 revised.

6) **Stock status:** Survey-derived trends suggest that recent biomass is similar to the previous three years, but that abundance has declined by >25% over the survey period.

7) **Man. Plan.:** There is no management plan is in place for the stock.

General comments

An age-structured analytical assessment is not available due to inadequate sampling, difficulties in age estimation, and the absence of a time-series of age data.

The previous assessment (2004) was length-structured. A length-structured assessment is also precluded by poor quality data.

As an alternative, a dedicated anglerfish survey was initiated in 2005 with the aim of estimating absolute abundance. Trends in biomass and abundance derived from these survey data appear to be a useful indicator of relative stock status. However, the catchability of the survey (and hence its ability to estimate absolute abundance) remain uncertain.

The WG Report does not provide any ecosystem information and the Stock Annex reports that ecosystem aspects were not considered. Information exists for some aspects of the ecosystem interactions of this stock (e.g.: Connolly *et al*. (2009). MEFEPO Northwestern Waters Atlas. Marine Institute). Relevant ecosystem aspects should be drawn from the literature and incorporated into the assessment documentation.

Technical comments

Endeavours to understand the catchability of the Scottish industry–science partnership survey are noted and encouraged. Given the difficulties in tracking age classes in the survey, and in estimating age at all, it may be more fruitful to develop biomass-related survey indicators rather than age-disaggregated indices.

Conclusions

Even if the ageing and sampling difficulties besetting this stock are quickly overcome a time-series of catch-at-age data will not be available for several years. Further development of alternative methods of stock assessment (such as the preliminary Bayes-

ian biomass dynamic surplus production model proposed for Northern Shelf megrim) is strongly encouraged.

There is currently no accepted analytical basis for management advice. The status of the stock in relation to MSY and PA indicators is unknown. In the absence of an analytical assessment, trends in biomass and abundance derived from survey data appear to be the only available indicators of relative stock status.

Megrim (*Lepidorhombus* spp) in Subarea VI (West of Scotland and Rockall) and Subarea IV (North Sea) (report Section 5.3)

1) **Assessment type**: Update

2) Assessment: No analytical assessment is presented.

3) Forecast: Not presented

4) **Assessment model:** None presented. Trends in mortality and biomass levels derived from surveys are presented as relative indicators of stock status.

5) Consistency: No analytical assessment has been conducted on this stock since 1999. The assessment data are consistent with those available to the most recent Benchmark meeting (WKFLAT, February 2011).

6) Stock status: Trends in mortality and biomass levels derived from surveys are presented as relative indicators. The absolute state of the stock is unknown. Relative to levels in 2005, survey data suggest that biomass has increased, and that fishing mortality has fallen. Fishing effort for several fleets catching megrim has also fallen over this period.

7) **Man. Plan.:** No management plan is in place for this stock. The TAC and assessment areas for this stock are different.

General comments

An age-structured analytical assessment is not available due to inadequate sampling, difficulties in age estimation, and the absence of a time-series of age data.

As an alternative, WKFLAT (2011) considered a preliminary assessment based on a biomass dynamic surplus production model, tuned to survey data from Divisions IVa and VIa & b. Trends in biomass and exploitation rate derived from the surplus production model appear to be a useful indicator of relative stock status.

The WG Report does not provide any ecosystem information and the Stock Annex reports that ecosystem aspects were not considered. Information exists for some aspects of the ecosystem interactions of this stock (e.g.: Connolly *et al*. (2009). MEFEPO Northwestern Waters Atlas. Marine Institute). Relevant ecosystem aspects should be drawn from the literature and incorporated into the assessment documentation.

Technical comments

The preliminary Bayesian biomass dynamic surplus production model developed for this stock is tuned to several survey time-series from Divisions IVa and VIa & b. These survey data are reasonably consistent over recent years.

For the Scottish industry–science partnership survey, posterior estimates of catchability of around 0.4 are indicated with greatest probability ($q5$ and $q6$ in Figure 3 of the Working Document: Minto, C. and Graham, N. Preliminary assessment of Northern Shelf megrim (*Lepidorhombus* spp. in VIa–IVa) using Bayesian state–space surplus

production models). This survey is intended to provide absolute estimates of abundance, and hence catchability estimates should be close to one. Catchability values of around 0.4 suggest that the abundance estimates derived from this survey are overestimated 2.5 fold within the preliminary surplus production model, or that the survey abundance estimates represent around 40% of the absolute abundance.

Conclusions

Even if the ageing and sampling difficulties besetting this stock are quickly overcome a time-series of catch-at-age data will not be available for several years. Further development of alternative methods of stock assessment (such as the preliminary Bayesian biomass dynamic surplus production model) is strongly encouraged.

There is currently no accepted analytical basis for management advice. The status of the stock in relation to MSY and PA indicators is unknown. In the absence of an analytical assessment, trends in biomass and exploitation rate derived from survey data appear to be a useful indicator of relative stock status.

Plaice in Division VIIb,c (West of Ireland) (report Section 7.9)

1) **Assessment type**: No assessment
2) **Assessment**: None
3) **Forecast**: None
4) **Assessment model**: None
5) **Consistency**: -
6) **Stock status**: -
7) **Man. Plan.**: None

General comments

Only landings are presented for this stock stock, and uncertainty due to the exchange between Division VIa and VII b,c are discussed without quantification.

Technical comments

The unit of the landings in Table 7.9.1 is not defined (as in last year's report).

Plaice in Divisions VIIh,k (Southwest of Ireland) (report Section 7.11)

1) **Assessment type:** SALY, based on catches and sampling in VIIjk in 1993–2010
2) **Assessment**: trends
3) **Forecast**: none
4) Assessment model: catch curve analysis and yield-per-recruit analysis
5) Consistency: Same approach as last year
6) **Stock status**: Unknown
7) **Man. Plan.**: None

General comments

The WG addressed the TORs by updating the tables and catch-curve analysis.

The WG considers that plaice in VIIh is likely to be a different stock. Sampling in VIIh is incomplete. Only sampling in VIIjk has been analysed and raised to landings in VIIjk. This is a small fishery, with a noticeable decline in landings over time. No information is provided on discard patterns.

Catch-curve estimates of Z varied between 0.6 and 1.2. The estimate for Z appears to be quite variable. These levels of Z are quite high compared to other plaice stocks. There is a possibility that this can be the consequence of declining catchability-at-age due to age-related shifts in distribution and/or seasonal migrations.

In the YPR curve, F_{max} is estimated to be 0.24. Recent values of Z ranged from 0.6 to 1.2, with M=0.12 this would result in an F of between 0.48 and 1.08. This is well above F_{max}, however the catch-curve Z's may be biased.

It appears that no survey covers this stock, as no information on this is provided in the report.

Technical comments

Trends in fishing effort would be valuable supporting information.

Conclusions

The RG agrees that the analysis could indicate that recent F is well above F_{max} and $F_{0.1}$.

Plaice in Divisions VIIf,g (Celtic Sea) (report Section 7.10)

1) **Assessment type:** Update, changed model

2) **Assessment**: analytical

3) **Forecast**: no forecast

4) **Assessment model:** AP tuned with one surveys and three commercial time-series

5) **Consistency:** The assessment model was changed from XSA to AP. In addition, settings of the model were changed, but, the settings were not compared with the values of 2010.

6) **Stock status:** Recruitment and F_{bar} significantly differed between the estimates of 2010 and 2011, especially for the last years. SSB is above B_{pa}=1800 t.

7) **Man. Plan**.: No

General comments

The migration of plaice in Division VIIa is presented in the stock annex and documented migration into VIIfg and VIIe. On the other hand the stock annex of Division VIIe presents another picture. It is suggested that the migration structure of plaice in the different stock annexes should be compared und unified.

The WG describes the problem of discards and change the assessment models to reconstruct the historical discard rates. However, effects of migration were not discusses in the report.

The WG provides an update assessment, but the assessment method was changed from 2010 to 2011 from XSA to AP to incorporate estimates of discards before 2004. Furthermore, settings of the model were changes. Estimates of Recruitment and F_{bar}

significantly changed from the estimations in 2010 to 2011. Different approaches were presented related to advice applicable to 2011.

The WG Report and the Stock Annex do not provide any ecosystem information. Management plan is also not provided.

The recruitment based on the new assessment in 2011 was significantly higher than the estimates in 2010, but the estimates are uncertain.

Technical comments

The use data in combination with the used assessment method only provide relative trends of the stock development. The estimates of the assessments in 2010 and 2011 differ for the last years of the time period.

RG proposed detailed evaluation of the survey design and the estimation procedure to improve the usability of the estimates and the understanding of the stock dynamics which further can be improved by the incorporation of the migration intensity between the different stocks.

Conclusions

The change of the assessment model between 2010 and 2011 in combination with change of model settings makes it difficult to understand the reasons for the changed recruitment and F_{bar} for the last years off the time-series. The RG agrees with the WG that only trends of the stock development can be provided due to the reasons of uncertainty (discards, survey indices, migration pattern).

Additional studies are proposed to investigate the reasons of the high discard level although the total catch was significantly lower than the TAC due to the low demand of the market. There are many options to reduce the discard by the fishermen (changes of the mesh sizes on the codend, change of the catch intensity in areas and seasons with high discard rates, etc.), especially if the TAC is not a limitation factor.

Plaice in Divisions VIIe (Western Channel) (report Section 8.2)

1) **Assessment type:** Update, Benchmarked in 2010 (WKFLAT 2010)

2) **Assessment**: Analytical

3) **Forecast:** Short-term forecast provided

4) **Assessment model:** XSA tuned by three commercial fisheries and two surveys**.** SURBA was used for examining tuning series. Separable VPA was used for screening catch-at-age.

5) **Consistency:** The assessment was made the same settings as last year as defined by stock annex. Retrospective pattern seem fine.

6) **Stock status:** Estimated fishing mortality declined sharply from around 0.7 in 2004–2008 to 0.43 in 2009 and 0.45 in 2010. This relates to reduced fishing effort in 2009 and 2010 compared to previous years. The SSB has increased from the lowest observed (1144 t) in 2008 to 3371 t in 2011. This is above the proposed MSY $B_{trigger}$ (2500 t) and also above the 1980–2010 average. The estimated F in 2010 is above the proposed F_{MSY} of 0.14–0.31. Recent recruitments are above average, and the stock is expected to further increase at F_{sq} or lower. The earlier precautionary reference points are not considered relevant, but have not been replaced by new values.

7) **Man. Plan**.: None

For consideration in the ADGCSE

The reference to the existing PA reference points should be considered removed from the advice document. The 2010 benchmark led to an upward adjustment of SSB throughout the series caused by the addition of VIId data. WKFLAT 2010 concluded that the basis for the previous B_{lim} and B_{pa} is no longer valid. (The B_{lim} value now lies well below all historic SSB values in the assessment). In addition, the WG has since 2004 argued that the PA points did not reflect the stock–recruit pattern for the stock. WKFLAT 2010 could not come to a consensus with regards to suitable precautionary reference points but clearly stated that F_{sq} 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 Stock Annex contains several proposals for PA points, but they are all considered unreliable by the WGCSE 2011. They question whether PA points are urgently needed within the MSY-framework.

General comments

There is no EU management plan for this stock. The catch of this stock is managed by a TAC applied to Division VIId and VIIe combined.

The RG found no errors in the implementation of the assessment and forecast, and the results were carried over correctly to the advice sheets. Catch options and advice under PA approach need to be clarified at the ADG.

An important mixed fishery issue is the bycatch of plaice in the sole fishery in VIIe, which is subject to the sole management plan. 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. For plaice the 40% F reduction between 2008 and 2009 is confirmed by the 2011 assessment.

Last year the RG suggested that raised discards estimates should be tabulated and a quantitative evaluation made of the likely fishing mortality rate due to discarding. This is not done, but the report states that "As the time-series of data expands, the WG will be able to better determine how to include these data in the assessment appropriately". Several informative graphs show the available data on discards by length groups.

Technical comments

None.

Conclusions

The RG accepts the assessment as a basis for management advice.

Plaice in Division VIIa (Irish Sea) (report Section 6.7)

1) **Assessment type**: Update

2) **Assessment**: Analytical

3) **Forecast**: no forecast

4) Assessment model: AP (Aarts and Poos) tuned with one survey (numbers-at-age) and two survey biomass indices

5) Consistency: The assessment model was changed from FLICA to AP. In addition, settings of the model were changed like number of tuning fleets

and used age groups. SSB and F_{bar} significantly differed between the estimates of 2010 and 2011, especially for the last years.

6) **Stock status:** SSB estimates for 2009 and 2010 are above B_{pa} (3100 t) and F is below F_{pa} (0.45)

7) **Man. Plan.**: No

General comments

The migration of plaice in Division VIIa is presented in the stock annex and documented migration into VIIfg and VIIe. On the other hand the stock annex of Division VIIe presents another picture. It is suggested that the migration structure of plaice in the different stock annexes should be compared und unified.

The WG describes the problem of discards and change the assessment models to reconstruct the historical discard rates. However, effects of migration were not discussed in the report.

The WG provides an update assessment, but the assessment method was changed from 2010 to 2011 from FLICA to AP to incorporate estimates of discards before 2004. Furthermore, settings of the model were changes. Estimates of SSB and F_{bar} significantly changed from the estimations in 2010 to 2011.

The WG Report and the Stock Annex do not provide any ecosystem information. Management plan is also not provided.

Technical comments

The used data in combination with the used assessment method only provide relative trends of the stock development. The estimates of the assessments in 2010 and 2011 differ for the last years of the time period.

The survey indices used on the assessment model do not presents similar trends. Detailed evaluation of the survey design and the estimation procedure can improve the usability of the estimates and the understanding of the stock dynamics which further can be improved by the incorporation of the migration intensity between the different stocks.

Conclusions

The change of the assessment model between 2010 and 2011 in combination with change of model settings makes it difficult to understand the reasons for the changed SSB and F_{bar} for the last years of the time-series. The RG agrees with the WG that only trends of the stock development can be provided due to the reasons of uncertainty (discards, survey indices, migration pattern).

Additional studies are proposed to investigate the reasons of the high discard level although the total catch was significantly lower than the TAC due to the low demand of the market. There are many options to reduce the discard by the fishermen (changes of the mesh sizes on the codend, change of the catch intensity in areas and seasons with high discard rates, etc.), especially if the TAC is not a limitation factor.

Sole in Division VIIb, c (West of Ireland) (report Section 7.12)

1) **Assessment type**: no advice

2) **Assessment**: not presented

3) **Forecast:** not presented

4) **Assessment model**: none

5) **Consistency**:

6) **Stock status**: unkown

7) **Man. Plan**.: none

General comments

Only landings are presented for this stock and uncertainty due to the exchange between Division VIa and VIIb,c are discussed without quantification. 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.

Sole in VIIb are mainly caught by Irish vessels.

Technical comments

The unit of the landings in Table 7.9.1 is not defined as in the year before.

Conclusions

There are no suitable data on which to base meaningful advice.

Sole in Divisions VIIh–k (Southwest of Ireland)) (report Section 7.14)

1) **Assessment type:** SALY, based on catches and sampling in VIIjk in 1993–2010

2) **Assessment**: None

3) **Forecast**: None

4) Assessment model: catch curve analysis; Yield-per-recruit analysis

5) Consistency: Same approach as last year

6) **Stock status:** The recent F is indicated to be moderate.

7) **Man. Plan**.: None

General comments

The WG addressed the TOR by updating the catch data and Z estimates.

Area VIIh is considered part of the stock for assessment purposes (management unit) yet it is not believed to be part of the biological stock. Only sampling in VIIjk has been analysed and raised to landings in VIIjk.

The estimated Z is variable. The Z was peaking in 2003 and on its lowest in 2007. The WG estimate of landings does not show a similar trend but is rather stable in this period.

In the YPR curve, F_{max} is estimated to be 0.32 and $F_{0.1}$ to be 0.15. Recent (2006–2010) values of Z ranged from 0.15 to 0.45, with M=0.10 this corresponds to an F between 0.05 and 0.35. This is about the same level as F_{max}.

Technical comments

Are there any data on fishing effort of fleets taking the bulk of the sole catch? Does this suggest any trend in F?

Typos: Section 7.14.2; "the remainder of Section 7.14 concerns Irish data only in VIIgjk"...should be VIIjk? Section 7.14.3(second last line); M=1.0, should be 0.1?

Conclusions

The RG agrees that the analysis indicates that recent Fs are at or below F_{max}.

Sole in Division VIIf,g (Celtic Sea) (report Section 7.13)

1) **Assessment type**: Update

2) **Assessment**: Analytic

3) **Forecast**: Presented

4) Assessment model: XSA tuned with one survey, and two commercial cpue series

5) Consistency: The assessment data and model formulation used are consistent with the approach adopted since 2006

6) **Stock status:** The stock status is consistent with the previous assessment. SSB remains relatively steady at a level close to the long-term average, and well above B_{pa} (2200 t). Fishing mortality (F_{4-8}) remains near the lowest levels observed in the time-series, lower than F_{pa} (0.37) and F_{MSY} (0.31). Model estimates of recent recruitment are consistent with the long-term geometric mean recruitment. However the most recent recruitment is estimated to be the weakest in the time-series.

7) **Man. Plan.:** No management plan is in place for this stock.

General comments

The WG has screened the survey and commercial tuning data independently of the Catch-at-Age data, and report that all tuning-series shows good cohort tracking and consistency between ages. However, the WG report and Stock Annex both note that differing survivor estimates arise from the UK beam trawl survey and UK Beam trawl fleet. Further evaluation of these tuning time-series, independent of their inclusion in the stock assessment, is suggested. This will better ascertain the quality of these tuning data, and their suitability for inclusion in the assessment.

The text in Section 7.13.3 incorrectly defines the recruiting year class as 2007 rather than 2009. The paragraphs in this section are very similar to, but not identical with those in the Stock Annex. These paragraphs should be cross-checked for consistency and accuracy.

The Stock Annex contains large amounts of text that have been copied from the WG report and are specific to a particular year. The Stock Annex appears to be the text from the 2010 WG assessment report. Ideally the stock annex text should be written with generality such that it does not require an annual update.

The method of calculation of the international catch numbers-at-age is inadequately and inconsistently described in the WG report and Stock Annex (the stock annex actually refers to the "Stock Annex" for "further details"!). It is not clear how the age composition of unsampled fleets is derived, or whether age composition and weight-at-age data are available for Ireland.

Neither the Stock Annex, nor the WG Report, provides any information on Ecosystem aspects. Relevant ecosystem aspects should be drawn from the literature and incorporated into the assessment documentation.

Technical comments

The model formulation proposed for Sole in VIIa at the most recent Benchmark meeting (WKFLAT, February 2011) reduced the age for which catchability is considered as being independent of age from >=7 to ages >=4. The q-plateau for Sole in VIIfg however remains at age >=7. The WG should consider whether the life history and fisheries for Sole in these neighbouring stocks are so different that the different model settings are warranted.

Adoption of a combined Age–Length Key to calculate the catch-at-age data for the major fishing nations would be a major improvement to the assessment. The methods recently adopted for VIIa Sole for the calculation of catch numbers, catch weights and stock weights are likely to reduce the interannual variation in derived biomass and catch estimates. Such approaches should be considered for VIIfg, and could be implemented at the next benchmark assessment for VIIfg Sole. In the interim, the WG should in its next report provide a clear description of the current method of calculation of international catch numbers-at-age.

The failure to update the Belgian beam trawl commercial tuning-series places increasing reliance on the UK commercial and survey tuning-series for estimating survivors of all ages. Given the inconsistencies between these UK series and the WG's inability to explain these discrepancies it would be wise to update the Belgian tuning-series as soon as possible. It is noted that a means of resolving these issues was proposed in 2009 but has not been investigated. It is suggested that this work proceed without further delay such that improved tuning-series will be ready in advance of the next benchmark assessment.

Conclusions

The Stock Annex for Sole VIIfg requires revision. It is not currently an adequate description of the general assessment procedure for this stock.

The assessment has been performed consistent with the approach adopted at assessment WGs since 2006. Notwithstanding the Review Group's suggestions above, the current assessment performs consistently from year to year, and is considered a good basis for management advice. The forecasts are also considered to be a sound foundation for the development of management advice. The estimates contained in these forecasts do not require revision before the advice drafting group, but their basis is incorrectly referenced in the WG report (The source for the 2010 recruitment should read $GM_{71\text{-}08}$, not 5025).

Sole in Division VIIe (Western Channel) (report Section 8.3)

1) **Assessment type:** update according to 2010 assessment. Benchmark procedure in 2009 failed to develop an update procedure due to retrospective bias problem. WGCSE 2010 introduced a modified model setting.

2) **Assessment**: analytical

3) **Forecast:** short-term forecast provided

4) Assessment model: XSA, two commercial tuning fleets and one survey (+2 historic commercial tuning fleets)

5) Consistency: Last years' assessment and forecast was accepted and the current assessment and forecast is accepted. F_{2009} is revised up by 2% and SSB_{2010} is revised up by 15%. These revisions are partly influenced by a 12% upward revision of the 2009 catch.

6) **Stock status:** F in 2009 and 2010 is estimated below F_{MSY} and the target F in management plan. SSB in 2011 (2571 t) is below MSY $B_{trigger}$ (2800 t). PA reference points were rejected by WKFLAT 2009. This also questions the basis for the chosen MSY $B_{trigger}$.

7) **Man. Plan.:** A management plan for this stock was agreed in May 2007 (Council Regulation (EC) No 509/2007). The long-term management target is F=0.27. The plan specifies a max TAC change of 15% for 2012. The plan has been evaluated by ICES.

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 5 to 10 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.

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.

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 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.

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.

Should the MSY $B_{trigger}$ based on a former B_{pa} still be used? (ADG to decide?)

Conclusions

The RG accepts the assessment and forecast as basis for advice.

Sole in Division VIIa (Irish Sea) (report Section 6.8)

1) **Assessment type**: Update

2) **Assessment**: Analytical

3) **Forecast**: Presented

4) **Assessment model:** XSA tuned with one survey

5) Consistency: The assessment data and model formulation used are consistent with the approach adopted at the most recent Benchmark meeting (WKFLAT, February 2011).

6) Stock status: The stock status is consistent with the previous assessment. SSB remains at the lowest levels estimated for the time-series (at ~1200 t in 2009 and 2010). SSB remains well below both B_{pa} (3100 t) and B_{lim} (2200 t). Fishing mortality (F_{4-7}) remains near the lowest levels observed in the time-series, close to F_{pa} (0.3) but greater than F_{MSY} (0.16). Model estimates of recent recruitment are less than half the long-term geometric mean recruitment.

7) Man. Plan.: There is no management plan in place for Irish this stock.

General comments

The Benchmark assessment (WKFLAT 2011) recommended several changes to the model formulation. These have all been implemented in the new assessment. As these changes were all implemented together it is not possible to deduce from the WG report the impact of each particular change to the model formulation.

This stock is tuned with just one cpue time-series, the UK(E&W) Q3 beam trawl survey. The WG has properly screened these tuning data independently of the Catch-at-Age data, and report that the survey-series shows good cohort tracking and consistency between ages.

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. Information exists for some aspects of the ecosystem interactions of this stock (e.g.: Connolly *et al*. (2009). MEFEPO Northwestern Waters Atlas. Marine Institute). Relevant ecosystem aspects should be drawn from the literature and incorporated into the assessment documentation.

Technical comments

The use of a combined Age–Length Key to calculate the catch-at-age data for the major fishing nations is a major improvement to the assessment. Application of the age composition of the sampled fleets to the unsampled fleets represents a minor uncertainty in the catch-at-age data as the unsampled fleets account for a very minor proportion of the landings (~2%).

Methods adopted for the calculation of catch weights and stock weights are consistent with the new basis for calculation of the catch numbers-at-age, and are likely to reduce the interannual variation in derived biomass and catch estimates.

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 formu-

lation independent of any other changes to ascertain the impact on the assessment and its retrospective performance.

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.

Conclusions

The assessment has been performed consistent with the approach adopted at the most recent Benchmark meeting. The Review Group's considerations are matters that can easily be addressed in the next update assessment as they do not represent changes to the benchmarked model formulation, but matters that will help interpret the quality of the data, and their impact on model performance. The forecasts are considered to be a sound foundation for the development of management advice and do not require revision before the advice drafting group.

Celtic Sea Review Group 2 Report

- RGCS2
- By correspondence 7 June 2011
- Participants: Mike Armstrong (Chair), Marie Storr-Paulsen and Svein Iversen, Pieter-Jan Schön and Joel Vigneau (WG Chairs), Cristina Morgado and Michala Ovens (Secretariat)
- Working Group: WGCSE

General

The Review Group considered the following stocks:

Fish Stock	Stock Name	Advice
cod VIIe–k	Cod in Division VIIe–k (Celtic Sea)	Update
cod-iris	Cod in Division VIIa (Irish Sea)	Update
cod-rock	Cod in Division VIb (Rockall)	Catch statistics only
cod-scow	Cod in Division VIa (West of Scotland)	Update
had-7b–k	Haddock in Divisions VIIb–k	Update
had-iris	Haddock in Division VIIa (Irish Sea)	Update
had-rock	Haddock in Division VIb (Rockall)	Update
had-scow	Haddock in Division VIa (West of Scotland)	Update
whg-7e–k	Whiting in Divisions VIIe–k	Update
whg-iris	Whiting in Division VIIa (Irish Sea)	Update
whg-rock	Whiting in Division VIb (Rockall)	Catch statistics only
whg-scow	Whiting in Division VIa (West of Scotland)	Update
Pol-celt	Pollock in the Celtic Seas	Collate data
nep-11	*Nephrops* in Division VIa (North Minch)	Update
nep-12	*Nephrops* in Division VIa (South Minch)	Update
nep-13	*Nephrops* in Division VIa (Firth of Clyde)	Update
nep-14	*Nephrops* in Division VIIa (Irish Sea East)	Update
nep-15	*Nephrops* in Division VIIa (Irish Sea West)	Update
nep-7bcj	*Nephrops* in Division VIIb,c,j,k (Porcupine Bank)	Update
nep-17	*Nephrops* in Division VIIb (Aran Grounds, FU 17)	Update
nep-19	*Nephrops* in Division VIIa,g,j (Southeast and West of IRL, FU 19)	Update
nep-20–22	*Nephrops* in Divisions VIIfgh (Celtic Sea, FU 20–22	Update

Special requests

No special requests were addressed.

Review process

The Review Group conducted its work by correspondence and through WebEx conference facilities organized by ICES. The reviews were carried out according the Guidelines provided by ICES, particularly focusing on the need to Quality Assure the assessment results supporting the provision of fishery management advice by ICES in the annual ACOM advice sheets. All stocks were reviewed by at least two reviewers. This involved:

- Checking that update assessments have been correctly implemented using the methods described in the Stock Annexes;
- Checking that the assessments have been implemented correctly, which could involve re-running the assessments to ensure the results in the WG report can be replicated exactly;
- Ensuring the assessment results and forecast results are carried over correctly to the advice sheets and advising ICES of any errors detected;
- Evaluating the ability of the stock assessments for providing credible management advice, and suggesting alternative advice where assessments do not appear appropriate;
- Providing recommendations to the Working Group to help with future development of the assessments through benchmarking.

General comments

The Review Group appreciated the efforts by the Working Group in addressing many of the RG comments and recommendations made last year. A number of general issues common to many stocks and raised by RGCS last year, remain unresolved and are discussed below together with other general issues arising this year:

1) Discard estimates

Fleet-raised estimates of discards are included in the assessments of Area VI gadoids, and haddock in VIIb–k, and in the assessments of *Nephrops* stocks. In other cases (e.g. whiting in VIIa and VIIe–k, haddock in VIIa, cod in VIIa and VIIe–k), international raised discards data sufficient for inclusion in assessments are not provided due to inadequate coverage or no agreed methods for raising. EU member States are required through the Data Collection Framework to collect data on discards for fleets where discarding exceeds a specified percentage, and are expected to meet precision targets (albeit very stringent ones). This has been a requirement since the inception of the DCR/DCF. The WGCSE should encourage intersessional work to agree raising procedures and compile international raised discards data for years with sufficient fleet coverage, with associated quality metrics as advised by ICES WKACCU and WKPRECISE including summaries of sampling rates by country.

2) Biological sampling on surveys

Considerable archives of biological data collected on surveys exist for many stocks. However, very little of this is used by the WG to provide time-series of biological parameters such as maturity, length/weight-at-age, etc. For example, the practice of using mean weights-at-age in annual commercial catches (or even worse, in landings) as values for weight-at-age in the stock, is prevalent despite the existence of good data from surveys at different times of year, which can be modelled to obtain year and age or year-class effects (see VIIa haddock for example). This is proposed by the WG for some stocks but needs to be followed up actively and included in the ToRs for benchmarks.

3) Commercial lpue tuning data

There are a number of roundfish and *Nephrops* stocks where commercial lpue is still presented or used in the assessments. Although the WG mentions the effects of changes in accuracy of catch reporting, and the potential for trends in catchability due to changes in fleet activities, structure and technology, there are no quantitative evaluations other than the modelling of *Nephrops* lpue in FU16. The RG was advised

that France has a project to develop improved fishery tuning-series for French fleets, however the WGCSE should ensure that future benchmarks include full statistical evaluation and (where appropriate) modelling of commercial tuning fleet data if these are to be used. VMS data linked to EU logbook data, and observer data, provide an opportunity to examine spatio-temporal patterns in cpue, at least for the larger vessels.

4) Benchmarking

Last year's RG noted that few of the stocks covered by WGCSE had been the subject of benchmark assessments, and is glad to see that several roundfish stocks are to be benchmarked in 2012. Suggestions for topics to be addressed during the benchmarking are listed in the WG report for cod and other stocks and in general the RG supports these suggestions. Although it is important to identify major failings to be addressed, the WG should consider that the benchmarking process should cover the compilation and evaluation of all data and aspects of population dynamics that feed into the assessment and advice. The WG is invited to read the proposals in PGCCDBS 2011 for the data compilation process leading up to benchmark assessments, including the formation of data subgroups, setting full terms of reference for benchmark data compilation and evaluation, allocation of responsibilities and timelines, and planning a data workshop prior to the benchmark assessment meetings (ACOM will review the PGCDDBS report later this year). A full set of ToRs suitable for a typical benchmark data compilation process is given by PGCCDBS and could be used or adapted by the WG as a template for forthcoming benchmarks for WGCSE stocks.

5) Quality of official landings data

For many stocks in the working group the reported landings are considered more accurate since introduction of Buyers and Sellers legislation in 2006. Supporting evidence of this should be sought prior to benchmarking of stocks.

6) Stock Annexes

Stock Annexes should be brought fully up to date and any out-of-date analyses revised if they are still thought to be useful, or removed if no longer of use and aren't necessary for interpreting historical data or assessments.

7) *Nephrops* assessments

The assessments and advice for most of the *Nephrops* stocks in Subareas VI and VII have fallen into a common approach based on UWTV surveys, yield-per-recruit F_{MSY} estimates based on results of length-based assessments, and supporting trends indicators. The RG appreciates the efforts by WGCSE to standardize the methods and streamline the reports, and many of the recommendations by last year's RG have been adopted by the WG. However the RG encourages WGCSE to develop approaches to estimate precision of biomass estimates and catch forecasts relative to F_{MSY}, taking account the variance (and covariance) in both. For example, there is often considerable variability of mean weights in landings and discard rates used for catch forecasts, which also reflects variability of the inputs to the procedures for estimating F_{MSY} based on recent fishery length compositions and discard rates. It is also not clear if the different discard survival rates adopted for *Nephrops* FUs (ranging from 0% to 25%) represent real differences between stocks.

8) Overview sections

The area overview sections are generally among the last to be written by the WG, and are often not available to the RG to check any references to tables or figures in the

overviews. For example the Irish Sea overview section was not available for the RG at the time of review.

9) Forecasts for trends only stocks

There are some stocks such as VIIb–k haddock where an analytical assessment model is run but the results are used as relative trends only. This procedure loses any quantification of the possible direction of future catches particularly if strong or weak year classes are likely to have a strong impact (as is the case for VIIb–k haddock). The RG considers that ICES should base advice for "trends only" stocks on both the historical trends and the possible short-term changes in catches based on forecasts where these can be carried out with sufficient confidence. Otherwise there is a strong risk of inappropriate management actions being imposed on data-poor stocks for which there is some knowledge of how catches may change in the short term.

Cod in Division VIIe–k (Celtic Sea) (report Section 7.2)

1) **Assessment type**: Update

2) **Assessment:** exploratory XSA; survey and fishery trends

3) **Forecast:** none provided

4) **Assessment model**: XSA

5) Consistency: failed benchmarked in 2009, no new assessment proposed in 2010; XSA in 2011

6) Stock status: exploratory analysis suggests that F has decreased, SSB is stable and 2009 year class is relatively strong.

7) Man. Plan.: No agreed management plan has been developed yet. However, a long-term management plan is 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.

General comments

The specific ToR for VIIe–k cod was to perform an update assessment (as opposed to SALY). Last year the WG continued to follow the WKROUND advice not to perform an analytical assessment due to catch uncertainties. This year, an exploratory XSA has been carried out. The data include age compositions corrected for highgrading and misreporting.

The WG report and Stock Annex do not include any ecosystem information relevant to this stock and its fisheries, or any information on climate changes that could affect the stock. This was also highlighted by the RG last year. Given the location of the stock at the southern limits of the species range, this is a major omission that the WG should address. The Stock Annex comment that "no environmental drivers are known for this stock" is not correct given the history of studies on cod and climate.

There is no agreed Management Plan for this stock.

A French self-sampling programme has been introduced in 2009 and a large part of the data for French fleets is derived from this data source.

The WG has not used mixed fishery data in the stock section or annex other than a statement of which fisheries cod is caught in. Cod in the Celtic Sea are often taken as a minor bycatch in a range of trawl and netting fisheries targeting a diverse range of

species. Management measures to conserve cod could impact a wide range of fisheries that do not target cod and the impact of this needs to be evaluated.

Official landings data from France were revised for 2009 and catches had to be derived from landings reported by fishing organizations. Only 68% of the French quota was taken, resulting in an apparent sharp reduction in discarding/highgrading in 2009.

There is no information on the absolute level of misreporting for this stock but there is evidence that misreporting increased from 2002 when quotas became restrictive with a maximum in 2008. In the last two years the problem seems to have decreased.

Discarding (mainly highgrading with some undersized cod) and landings misreporting had been exacerbated since 2003, when quotas became increasingly restrictive. Discard estimates are not used in the assessments as there is no complete time-series covering all the main fleets.

The two main problems in assessing the stock are: 1) perceived problems with accuracy of catch-at-age data in the 2000s due to highgrading (although attempts have been made to adjust for this), and (2) available surveys lack robust trends mainly due to their low catch rates, with all current survey-series taking place in autumn when cod are dispersed and often present in non-trawlable grounds. In 2010 the Marine Institute and the Federation of Irish Fishermen 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 ICES Study Group on Survey Trawl Standardization. The RG supports the new survey and believes it will improve the assessment in future, but will require several years to indicate stock trends.

The stock will be benchmarked in 2012.

Technical comments

1) It is stated that French landings have been corrected with highgrading estimates from 2003 to 2005 and there is a reference to a working document in 2006. However, the RG did not have access to this WD and it would be beneficial if all relevant information was placed in the stock annex.

2) Long tables of 1 cm interval LFDs by country (Tables 7.2 and 7.2.4a, etc.) take up a lot of report space. It is not necessary to have both tables and graphs showing the same information. Plots are better for LFDs. Some of the tables do not indicate year of sampling.

3) There is no information in the stock-annex (or in the WG text) on how stock weights are estimated. However in the table headings it is stated that stock weight equals 1st quarters values; the WG should confirm if this is catch weight or landed weight.

4) In Table 7.2.3 the Sums-of-Products for 2010 is only 77%. SOPs gives 4185 t compared to WG landings of 3229 t. WG Chairs were advised, and error was identified (age 6 CN = 9, not 92; age 7 = 0, not 2). All XSA results, tables and figures were re-run.

5) The internal consistency regressions for both EVHOE and IBTS 4th Q have negative slopes for age 3–4; could there be immigration of older fish or is it just noisy data?

6) The Stock Annex needs to be updated. Only two commercial and two scientific surveys are listed to be used in the assessment. However eleven

tuning fleets are listed in the WG text, and four commercial fleets and three scientific surveys are used in the XSA. There are no XSA settings available in the stock annex and they can therefore not be checked against the settings used in this year's assessment. Table 7.2.9 would be easier to read if the tuning fleets used in the assessment were highlighted in bold.

7) The next benchmark should review whether commercial tuning fleets should include lpue down to age 1. Inclusion of landed numbers of partially selected, heavily discarded ages is usually considered bad practice due to apparent changes in catchability associated with changes in discard practices.

8) In the XSA results, selectivity appears to change strongly around the mid-2000s with Fs at ages >3 much lower than younger ages. Is this explainable by changes in fishing patterns, e.g. Trevose closure? This makes the F(2–5) decline rather faster than the 2-gp F (apart from the low 2-gp F for 2010).

9) The RG appreciates the WGCSE providing comparative XSA runs using all fleets and an additional run using surveys only, and notes that this makes little difference to the results.

10) The WG makes a strong statement that the range of the stock has contracted, based on the plots in Figures 7.2.6–7.2.8. It is not clear if this is the case (the yellow areas cover the same area each year) or if what is being seen is a general reduction in the overall catch level across the stock range.

11) The RG supports the recommendations for the 2012 benchmark (however see general comments at start of this report). An important question for the WG to address is how the bias/imprecision in catch-at-age values due to discarding, and errors in other variables, can be accounted-for in a suitable analytical model formulation.

Conclusions

The RG agrees with the use of the comparative XSA runs as indicators of stock trends but not for providing absolute estimates of recent F or catch forecasts.

The RG supports the continued efforts to improve the input data, including the instigation of the new Q1 survey by the Marine Institute and the Federation of Irish Fishermen in 2010.

Cod in Division VIIa (Irish Sea) (report Section 6.2)

1) **Assessment type**: Update

2) **Assessment**: analytical

3) **Forecast: N**o detailed short-term forecast given. Boot-strap B-adapt used for medium-term forecasts.

4) Assessment model: B-Adapt-F.exe (13/5/06) with five survey indices and estimation of removals bias from 2000 onwards.

5) Consistency: very consistent with last year

6) **Stock status:** The spawning–stock biomass has declined tenfold since the late 1980s and is suffering reduced reproductive capacity, with SSB in 2010 (947 t) reaching a record low, well below the B_{lim} of 6000 t. The low SSB is confirmed by annual egg production surveys. 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. SSB in 2010 is expected to increase due to an improvement in recruitment in 2009.

7) **Man. Plan.:** In 2008 the EU adopted a long-term plan for cod stocks and the fisheries exploiting those stocks (Council Regulation (EC) 1342/2008) that repeals Regulation (EC) No 423/2004, and has the objective of ensuring the sustainable exploitation of the cod stocks on the basis of maximum sustainable yield while maintaining a target fishing mortality of 0.4 on specified age groups.

General comments

The report is well written and has a good structure. The WG addressed the ToRs by providing an update with associated management advice.

The assessment was carried out according to the stock annex description. The RG found no errors in the implementation of the assessment, and the results were carried over correctly to the advice sheets.

The WG report and Stock Annex do not include any ecosystem information. Previous WGs (2006) documented a relationship between temperature in spring and cod recruitment anomalies and this is mentioned in the Annex. However the assessment and advice do not take climate effects into account. The WG report includes information on stock structure and migrations based on tagging studies, indicating mixing of cod stocks between the Irish Sea, west of Scotland and the Celtic Sea.

The stock is subject to an EU multi-annual management plan. ICES (2009 Advice) evaluated the management plan, and considers the implementation to Irish Sea cod is not in accordance with the precautionary approach if a constraint on interannual TAC adjustments is applied, given the poor state of the stock.

The WG has not used mixed fishery data in providing management advice.

Discards data are not included in the assessment. Data presented up to 2010 show discarding on the observer trips to have been predominantly undersized cod at ages 0 and 1, rather than the highgrading or over-quota discards observed in some other cod stocks. However, over-quota discards of fish >MLS is observed in some fleets in 2010. The RG noted that discards data for UK(E&W) are presented by gear up to 2006 but for combined gears thereafter.

The RG acknowledged the effort to apply an alternative method (the state space SAM model) which gave a very similar result as the B-adapt. The RG was not able to evaluate the application of this model from the information provided.

The major issue with this assessment is the apparently large "removals bias" estimated by B-Adapt over the 2000–2010 period. The bias multiplier remains between 2 and 3. This represents the multiplier that has to be applied to the landings-at-age to remove any catchability trends in the surveys. The WG still has no knowledge of the cause of such removals, or the extent to which the bias may reflect catchability trends in the surveys. The TAC has not been fully utilized for a number of years, and reported landings are considered more accurate since introduction of Buyers and Sellers legislation in 2006.

The WG Irish Sea overview section was as last year not available to the RG to evaluate effort trends. Last year's WG showed large declines in the whitefish trawl effort (100 mm+ mesh) during the 2000s, and more stable *Nephrops* trawl effort. It is difficult to reconcile this with the lack of any recovery in age composition as shown by the

continued very high Z. All available trawl data indicate a truncated age distribution in the Irish Sea. The declining SSB is supported by the Fishery Science Partnership surveys not included in the assessment, and the low SSB < B_{lim} is supported by the results of surveys using the Annual Egg Production Method since 1995.

In the whiting VIIa section there is a description of the *Nephrops* fishery where the Swedish sorting grid has been implemented since 2009 in a large part of the fleet. However, the effect of the grids on cod is not mentioned in the VIIa cod section.

Technical comments

1) The Stock Annex should be updated

2) The state space SAM model also has a multiplier function (as B-adapt) however there is no description in the text if this function has been added.

3) As last year's RG pointed out, the survey NIGFS_Oct (0 gr) has slope < 1 with very high t-value of 3.66 indicating a density-dependent catchability for this age. Future benchmarks should consider how 0-gp trawl indices are handled in the assessment, as the preferred habitat for 0-gp cod would be inshore rough ground poorly covered by the surveys.

4) No new F_{MSY} evaluation has been conducted since last year's assessment.

5) Fleet-raised discards estimates are needed for all countries with significant discarding of cod, to produce a matrix of discards-at-age. It is important to have adequate estimates of discards-at-age to evaluate changes in selectivity due to technical measures.

6) Very good internal consistency is apparent in the UK(NI) March GFS, which is important as this is the main survey driving the assessment.

7) Figure 6.2.15 uses term "catch bias" -need consistent use of one term for this. "Removals bias" or "bias factor" could be used; see North Sea cod assessment report and use same terminology to avoid confusion.

Advice sheet

Landings trends figure is wrong; reported landings line includes misreporting from 1991–1999.

Benchmark

The RG supports the extensive list of benchmark recommendations for VIIa cod. However see general comments at start of this report concerning a structured approach to setting ToRs for benchmark data compilation and evaluation. The RG supports the WG group recommendation that the assessment of this stock should be benchmarked in the context of a benchmarking of all three western waters cod stocks, given the availability of new data not included in the assessments (FSP surveys; egg production survey estimates; discards data collected in the 2000s through the DCF) and improving knowledge of metapopulation structure and movements of cod in the overall ecoregion. The WG has suggested an initial Data Workshop to collate and interpret existing and new data on cod stock; the RG highly support this initiative, which is in line with PGCCDBS 2011 recommendations for benchmark assessments.

The RG suggests the following issues need to be included in the benchmark assessment:

1) Mean weight-at-age in landings is used both for stock and catch weight, which gives biased estimates for age group 1 in particular, and is affected by changes in selectivity. This could be improved by using modelled 1st quarter survey weights as stock weights (as done for 7a haddock). Maturity data from the surveys should also be modelled to provide smoothed trends in the maturity ogive.

2) It is known that the UK(NI) March GFS survey often has catches dominated by male cod, due to spawning behaviour patterns. Year effects in the survey could be generated by changes in sex ratio caused by behaviour. There may be merit in computing indices separately for males and females before combining using a more robust figure for sex ratio at age (~0.5 according to previous publications on Irish Sea cod maturity).

3) The mortality rate is still very high on this stock although there is a very limited fishing on the stock and the quota has not been fished in recent years. It will be beneficial to use discard data to evaluate F due to discarding although this is unlikely to explain the continued high mortality at the older ages.

4) A modelling framework is needed that is not constrained to estimate equal removals-biases for all ages and fleets and that can avoid the need to truncate the oldest true age to 4 for the entire time-series.

Conclusions

The RG accepts the updated assessment as a basis for providing advice on the state of the stock relative to biological reference points.

Cod in Division VIb (Rockall) (report Section 4.2)

1) **Assessment type:** No advice; catch statistics only

2) Assessment: not presented

3) Forecast: not presented

4) Assessment model: none

5) Consistency:

6) **Stock status:** unknown

7) Man. Plan.: none

General comments

Official landings have been below 100 t since 2004. The maximum landings close to 2000 t, were in 1985 and 1988.

Conclusions

There are no data allowing an assessment of stock trends. However both the Scottish and Irish time-series of lpue show a fall in 2010 relative to previous years.

Cod in Division VIa (West of Scotland) (report Section 3.2)

1) **Assessment type**: update

2) **Assessment**: analytical

3) **Forecast**: Short-term deterministic forecast using WGFRANSW software.

4) **Assessment model**: TSA

5) **Consistency**: This year's assessment is very similar to the results from last year

6) **Stock status**: SSB 6580 t in 2010 is below B_{lim} (14 000 t) and Z-0.2 (0.82) is estimated to be above F_{lim} (0.8). However the Z-0.2 estimate has very large confidence intervals and is not considered to represent a fishing mortality F at age but rather estimates of total mortality above M=0.2.

7) **Man. Plan**.: 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). ICES WGCSE (2009) reviewed the plan in relation to west of Scotland cod and could not conclude that it was precautionary.

General comments

The WG addressed the ToRs by providing an update with associated management advice.

T**h**e assessment was carried out according to the stock annex description. The RG could not run the TSA model and could only check the documented inputs which are in accordance with the annex. The results were carried over correctly to the advice sheets.

The WG report and Stock Annex only include ecosystem information in respect to the possible role of seal predation as a source of the unaccounted mortality. Climate effects on cod production are not considered.

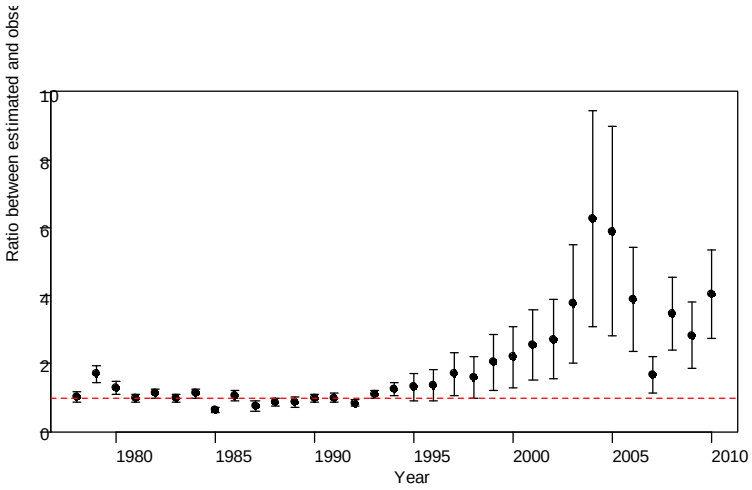
The stock is subject to an EU multi-annual management plan.

The WG has not used mixed fishery data in providing management advice.

Discarding/highgrading appears to be a major problem with discard rates in 2009 as high as 82% at age 4 but fell to 42% in 2010. The 2005 year class has been very heavily discarded.

The increase in discards-at-ages one and two and additional ages of cod discarded since 2006 are not able to influence the assessment due to the exclusion of all fishery data from 1995 onwards. A new version of the model is now capable of fitting discard proportions across more ages and can be considered at the planned benchmark in 2012. To consider discards from 2006 requires commercial data (landings and discards) to be reintroduced from 2006, as done for VIa haddock and whiting.

The main issue with this assessment is the exclusion of all fishery (landings and discards) data other than weights-at-age, from 1995 onwards. Effectively the assessment is a survey-based model calibrated against fishery catch-based population estimates pre-1995. The model gives a clear picture of a major decline in abundance at all ages, with a slight upturn in recent years due to improved recruitment of the 2005 and 2008 year classes. The removals predicted from the survey based Z (minus 0.2 for M) drift progressively away from the WG figures for fishery catches until 2004–2005, then the difference starts to reduce between 2004–2009 but increased again in 2010(see WG Figure 3.2.13 below).



Last year's WG ran an additional TSA run reintroducing the landings and discards-at-age data for 2006 onwards, as has been done for VIa haddock and whiting, as the WG indicated more accurate catch reporting since 2006 under the Buyers and Sellers legislation. This gave qualitatively the same picture of stock trends as given by the baseline model, and gave "true" F estimates for recent years close to F_{lim} (0.8); i.e. very similar to the Z-0.2 estimates for the most recent years from the baseline model. The arguments put forward by the WG last year for not adopting this as the final model are firstly that the model estimates of removals are scaled downwards to an extent that they are the same as the WG catch data in the mid-1990s, whereas the WG states there is evidence of inaccurate catch reporting at that time. Secondly, the TSA model as currently configured can only handle discards up to age 2 whereas discarding across a wider age range is currently occurring. The first of these arguments may be spurious, as the confidence intervals around the model-predicted removals in the 1990s are wide and could encompass the likelihood of misreporting. The second problem (discard age range) would have required reconfiguring the TSA. Nonetheless, the exercise was useful in indicating that recent F could be of the same magnitude as the Z-0.2 from the baseline model. The effects of including recent catch data in the model was not discussed by this year's WG.

Technical comments

1) Stock weight and catch weight are the same data. No description can be found in the stock annex. More robust and realistic (for younger ages) stock weights could be obtained from Q1 survey data, for example by modelling age and year effects. Q1 fishery data could be included for fully selected ages, although since 2006 the discard rate has increased for older age groups which may affect mean weights estimates.

2) Several aspects of the design of the ScoGFS-WIBTS-Q1 were changed at the same time in 2011. A new groundgear was introduced to allow fishing on rougher seabed types, the strata were altered, stations within strata were selected at random rather than the previous fixed-station design, and mean catch rates in strata were weighted by stratum area rather than number of tows. Although these changes seem to be an improvement in survey design and compatibility with the Irish survey, the RG considers the changes are sufficient to invalidate the use of the 2011 data as part of the existing series pending an evaluation of changes in catchability. The RG therefore

requested an additional TSA run excluding the Q1 2011 survey indices to be available for the Advice Drafting Group.

3) Cohort tracking in Q1 survey has become very poor.

4) The WG should explain the differences between the official landings figures and the WG estimates.

5) The WG report is still not giving any indication of the sampling effort for estimating discards by fleet/country. The methods used to raise discards data are only briefly described in the "uncertainties and bias" section of the WG report.

6) Table 3.2.3 shows survey data; with data in bold used in the final assessment age 1–6. The table provided in the stock annex gives the available input data but not the used input data. The WG should revise the annex to clearly state the "update" assessment inputs (e.g. age ranges in surveys).

7) Figure 3.2.15 shows the fitted S–R curve in the TSA is heavily driven by the 1986 y.c. and bulk of other yc lie below it. The stock–recruit relationships fitted by srmsymc package for last year's MSY calculations fitted the data better.

Benchmark recommendations

The RG supports the extensive list of benchmark recommendations for VIa cod. However see general comments at start of this report concerning a structured approach to setting ToRs for benchmark data compilation and evaluation. The RG recommends that the VIa cod benchmark addresses metapopulation structure in western waters, and consider the implications of mixing of populations between neighbouring stock areas in VIIa, west of Ireland and in the North Sea (see VIIa cod benchmark proposals).

Conclusions

The RG considers the updated TSA assessment to be appropriate to providing management advice for the stock, confirming that SSB is well below B_{lim} and fishing mortality is likely to be well above any F_{MSY} candidates.

Haddock in Divisions VIIb–k (report Section 7.4)

1) **Assessment type**: Update

2) **Assessment**: Indicator of trends only.

3) **Forecast**: Short-term forecast presented, not used in advice sheets due to uncertainties in the data and the estimate of the large 2009 year class.

4) **Assessment model**: XSA, tuned with two surveys and two commercial fleets.

5) **Consistency**: XSA has been performed with the same settings as before with the exception of missing data for French commercial tuning fleets in 2009 and 2010. Updated results up to 2009 are similar to last year's run.

6) **Stock status**: The state of the stock is not precisely known due to uncertainties in the discards data and there are no accepted biological reference points. SSB is perceived to be increasing. The stock is highly dependent on the incoming recruits. Between 2002–2008 no strong year classes have been

observed, whereas the 2009 year class seems to be the highest on record as age 0 and 1. The 2010 yc is below average.

7) **Man. Plan**.: None

General comments

The WG addressed the ToRs relevant to providing advice through an update assessment.

The assessment was carried out according to the stock annex description. The RG found no errors in the implementation of the assessment and forecast, and the assessment results were carried over correctly to the advice sheets. No forecast is given in the advice sheets.

The Stock Annex contains some limited information on ecosystem aspects or environmental drivers and was updated in 2011.

There is no EU management plan for this stock.

The WG has not used mixed fishery data in providing management advice. The proposed increase in square mesh panels to 120 mm will impact other species such as whiting and all such measures should be viewed in the context of mixed species catches.

The WG has done a good job with the available data. The time-series available for the assessment is short although a longer series of landings data are available.

In 2009 and 2010 the total landings were below TAC but the national quota appeared to become restrictive again for Ireland and Belgium (but not for France and the UK).

The major source of uncertainty in the assessment is the estimates of discards which are based on very small numbers of Irish observer trips, extrapolated to all fleets. There are also some uncertainties concerning landings data. Discarding appears to be an important feature in the fishery, comprising a large fraction of the catches up to age 3 and including fish above MLS. Sampling intensity of demersal fleets in the Celtic Sea needs to increase to improve the quality of discards estimates for haddock and other demersal stocks.

The WG estimates that the average discard rate over the last ten years was 70% by number and 45% by weight. However in 2010 discarding increased to 82% by number and 56% by weight. The short-term forecast predicts a further substantial increase in both landings and discards in 2011 due to the very strong 2009 year class. Landings are expected to remain high in 2012 at *status quo* F but discards of undersized haddock will reduce as the 2009 year-class fish grow past the MLS (assuming same discard ogive as recent years).

The French tuning fleet data for 2009 and 2010 were not available due to problems with the French logbooks database.

Survey data for VIIb–k haddock have variable area coverage but appear to be consistent in tracking year classes, and provide a consistent index showing a potentially very large 2009 year class. The potential of the new Irish Q1 joint science–industry survey to provide additional data on haddock is not mentioned.

Technical comments

1) RG appreciates the inclusion of a longer term series of landings data as requested last year. Clearly shows that the fishery has been very variable in response (presumably) to sporadic recruitments as suggested.

2) It is stated correctly in the report the average of the discard in the last ten years and also illustrated by some very nice Figures 7.4.3b; however there could have been more discussion on the discard level in 2010 that increased by 17% in number and nearly 25% in weight.

3) Despite the poor quality of the discards data, the assessment appears to perform quite well, with good consistency of survivors' estimates, good retrospective performance for recent years, very consistent with last year's assessment. Some indices generate slopes differing from 1 with high t-value, probably reflecting the variability of the data (e.g. IRL-OTB (7bj) for age 6 and the FR-GAD for age 4).

4) The RG agrees with the advice from last year's RG that the data for VIIb–k haddock are more suitable for inclusion in a statistical modelling framework in which the nature and magnitude of the errors in the different datasets are accounted for, and the bias and variance in the population estimates can be properly evaluated. This should be explored before any future benchmark.

5) The WG has declined to put forward any candidate F_{MSY} values due to concerns that the stock–recruit relationship is not well captured. It is clear that the Ricker model would not be a robust choice. However, last year's analyses showed that the range of B&H and hockey-stick F_{MSY} and yield-per-recruit $F_{0.1}$, $F_{35\%}$ and F_{MAX} values for landings are within the range 0.18–0.26.

6) In Summary Table 7.4.9, it would be useful to give the F(2–5) separated by landings and discards.

Advice sheet

Given that the assessment is quite consistent, and provides selectivity estimates, weights-at-age, etc., a YPR could be updated.

Conclusions

The WG has taken note of earlier recommendations from RG and made a good compilation of the steps needed before making a benchmark assessment. Particular progress is needed on obtaining and making best use of available discards data, and evaluating the quality of available datasets using ICES Quality Assurance Framework.

The RG agrees that the WG assessment is suitable for indicating general trends. However, the forecast also has a useful exploratory role, given the possibility of a very large 2009 year class entering the fishery, and could be used to guide management decisions given the potential for a very large increase in catches in 2012. The short-term forecast indicates that the catch weight could increase from 22 kt in 2010 (10 kt landed) to 65 kt in 2011 (30 kt landed) and reduce to 44 kt in 2012 (37 kt landed) at *status quo* F, although precision is not indicated and is likely to be relatively poor.

Haddock in Division VIIa (Irish Sea) (report Section 6.3)

1) **Assessment type**: update

2) **Assessment**: survey trends

3) **Forecast**: Short-term forecast of abundance from SURBA model

4) **Assessment model**: Single fleet SURBA analysis, using only the NIGFS-Mar survey

5) **Consistency**: Updated survey trends are very consistent with last year's assessment.

6) **Stock status**: SSB decreased sharply in 2010 due to poor recruitment but is expected to increase following stronger recruitment in 2009 and 2010. Total mortality (Z=2–3) appears relatively stable. There are no MSY reference points.

7) **Man. Plan**.: 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).

General comment

The assessment was carried out according to the stock annex description and the WG addressed the ToRs. The RG found no errors in the assessment.

Mixed fishery data are not used when formulating management advice by the WG. Potential impacts of Swedish grids being used in some *Nephrops* trawlers should be considered.

The WGCSE was unable to provide absolute values for F_{MSY} proxies (not updated in 2011), as there are insufficient data to derive estimates of F_{MSY} with any degree of precision.

The method used by the WG to estimate stock weights based on survey data could be further developed and applied to other stocks (cod and whiting) with good survey data but noisy stock weights from fishery sampling at older ages. The weight-at-age in the stock shows a very clear decreasing trend over time, stabilizing in more recent years.

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.

The 2009 and 2010 year classes appear to be above average which is expected to cause an increase in SSB from the very low value observed in 2010. The index of total mortality appears relatively stable.

The survey data show very coherent year-class signals and appear to give a very clear picture of the development of the stock.

Technical comments

1) The stock annex needs updating. The most recent version found by the RG was on the WG SharePoint for 2009.

2) The Irish Sea overview was not available for the RG at present time and therefore reference to this section cannot be checked.

3) It is stated in the report that: The NIGFS-WIBTS-Q4 survey has good internal consistency (see Stock Annex); however in the stock annex found by the RG (maybe an old version) this plot was not present.

4) The main problem with the historical yield-per-recruit analysis is the absence of discard fishing mortality. The Advice sheets no longer show YPR reference points.

Advice sheet

1) In the advice sheets F_{pa} at 0.5 is included however in the WG report it is stated that the Working Group no longer considers an F_{pa} value determined in association with other haddock stocks as appropriate.

Conclusions

The RG considers the updated survey-based analysis to provide an appropriate basis for formulating management advice based on relative abundance trends. The different surveys provide a consistent picture of the stock development.

The RG also agrees that the state of the stock with regard to reference points is uncertain as there are no biological reference points calculated, and the fishing mortality cannot be estimated directly from the surveys without independent knowledge of the survey selectivity characteristics across the age classes. The apparently very high Z from the survey age data is at odds with the low ratio of fishery landings to egg production estimates of SSB in 2006 and 2008.

The absence of reliable discard estimates is a serious deficiency that must be addressed if management is to be based on catch-at-age analysis, and if the fishery selectivity is to be defined and monitored in relation to technical measures to reduce discard fishing mortality. 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.

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 VIIb–k stock would be beneficial.

Haddock in Division VIb (Rockall) (report Section 4.3)

1) **Assessment type**: Update

2) **Assessment**: analytical

3) **Forecast**: Short-term forecast provided

4) **Assessment model**: XSA tuned with 1 survey and including discards.

5) **Consistency**: Updated assessment results in 60% upward revision of 2008 F and a small downward revision of SSB. Assessment does not exhibit retrospective bias but appears to be unstable due to weak shrinkage used with noisy data. The survey-series has been revised since last year.

6) **Stock status**: F is below F_{pa} =0.4 and close to F giving long-term equilibrium yield. SSB has been above B_{pa} =9000 t 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} in 2013.

7) **Man. Plan**.: None

General comments

The WGCSE addressed the ToRs in providing an updated assessment with associated management advice.

The assessment was carried out according to the stock annex description. However the RG has some concerns as the only survey used for tuning was not conducted in 2010.

Substantial discarding occurs in the EU fisheries but has only been directly estimated in a few years. For other years, the WG conducts a convoluted process to infer discards from the Scottish survey length frequencies together with theoretical selection parameters and a discarding ogive, tuned using data from the few historical years with observer data. It remains unclear if these estimates are robust over the full time-series since there appears to have been no observer data since 2001 other than a few trips sampled by Ireland in 2007–2009 and none in 2010 to validate the figures inferred from survey and fishery length compositions. As no survey has been conducted and no discard trip has been conducted in 2010 the discard estimate from 2010 was calculated using an average proportion of discards/landings-at-age in 1999–2009.

Improved sampling of discards is needed. The RG supports the WG recommendation for the need for technical measures to reduce discarding.

Ecosystem aspects: The Stock Annex describes closures on Rockall to protect vulnerable habitats. In order to protect cold-water corals, three areas (Northwest Rockall, Logachev Mounds and West Rockall Mounds) are closed since January 2007. A new area to protect cold-water corals (Empress of British Banks) was established by the NEAFC in 2007. These are in addition to the Rockall Haddock Box to protect prerecruits that has been in place since 2002.

There is no EU management plan in place for this stock.

The WG has not used mixed fishery data in providing management advice. The stock annex and WG report do not provide information to evaluate bycatches in the directed haddock fishery.

A major signal in the fishery data is the very sharp reduction in Russian landings of haddock from around 5000 t in 2004–2005 to only 198 t in 2010. UK landings declined in the mid-2000s but have subsequently increased again.

Technical comments

1) Table 4.3.14 highlights 1995, 1997, 1999 and 2001 as years with discards estimates calculated directly from observer trips. The Stock Annex also mentions 1998 and 2000 as years with Irish discards estimates (both are years with no survey). Why were these data not used for estimating discards?

2) The method of calculating discards in 2010 is not clearly explained. Although an average discard rate was applied to 2010 landings, the WG report says that the discard rate in 2010 was the lowest in the series (do you mean the quantities discarded?)

3) Although the biological parameters do not change between years the report should state how they were derived.

4) Mean weights-at-age 6 and 7+ in total catch were higher in 2010 compared to 2006–2009 and was therefore recalculated using a linear regression; however there is no explanation why the data are not to be trusted (actually the same pattern is seen in both fleets). The RG would like some documentation before real data are excluded.

5) Data screening; report states that SURBA gives steep decline in Z after 2000. However the Zs since mid-2000s are closer to earlier values.

6) Tuning did not converge after 180 iteration. This could be an indication of data or model problems. Following comment from RG to the WG Chairs, the XSA was re-run to 50 iterations, as per last year's run. This made very little difference to the results. The report tables were updated.

7) Figure 4.3.34 shows correlation between 0 group in the survey and age 1 in VPA. The regression has a positive intercept indicating that a zero 0-group index would predict 10 000 cod age 1.

8) The WG omitted to over-write the XSA estimate of 1-year-olds in 2010 with an RCT3 prediction for use in forecasts. The RG advised the WG chairs, who arranged for the RCT3 input and output files to be included and the forecasts updated.

9) The forecast value for the 2010 year class at age 1 uses the 5th percentile for recruitment. The arguments for this are rather weak given that SSB similar to 2010 have generated quite large recruitments in the past, and haddock are well known for very variable recruitment.

10) As pointed out last year by the RG the F_{MSY} output table for the different stock–recruit options is not given in the WG report.

11) The RG could not evaluate the significance of the results of the StatCam model, or interpret the differences with the XSA, as the method is not explained anywhere.

Advice sheets

In the summary figure on first page, the 2010 recruitment estimate should be identified as the 25th percentile for the entire time-series.

Conclusions

The RG accepts the updated XSA run as a basis for providing advice and forecasts as the assessment is consistent with last year's run.

Haddock in Division VIa (West of Scotland) (report Section 3.3)

1) **Assessment type**: Update

2) **Assessment**: Analytical

3) **Forecast**: Short-term

4) **Assessment model**: TSA, tuned with two surveys

5) **Consistency**: The current assessment method has been in use since 2006 and is considered consistent. A new survey design has been applied in the ScoGFS-WIBTS Q1. The assessment is therefore no longer a simple update.

The retrospective downward adjustment of F in 2009 was relatively large with the new assessment.

6) **Stock status**: ICES classifies the stock as being at risk of reduced reproductive capacity. The stock is below B_{pa} since 2005. F has decreased in the same time period without any positive response on SSB and is now estimated to be below F_{pa}. The 2009 year class appears stronger than in recent years. There is no indication of an effect of SSB on recruitment over the range of SSB observed.

7) **Man. Plan**.: There is a proposed management plan and it is evaluated by ICES as precautionary

General comments

The WG addressed the ToRs in providing an update assessment with associated management advice.

The TSA modelling approach was carried out according to the stock annex description, although the input data for the 2010 and 2011 WG assessments have included fishery data from 2006 onwards. The RG could not run the TSA and was only able to check the model settings.

Ecosystem consideration is not discussed in the report or stock annex (which only includes some basic haddock biology under the heading "Ecosystem aspects".)

The proposed management plan has been evaluated by ICES and "*ICES advises that a harvest rule with a target fishing mortality of 0.3 and a TAC constraint of ±15% is consistent with the precautionary approach*."

The WG provides some indication that haddock is taken in mixed fisheries but does not use mixed fishery data in providing advice in support of management.

Catch data are only considered reliable in the periods 1978–1994 and 2006–2010. This is a change compared to assessments prior to 2010 where catch data after 1994 were not used.

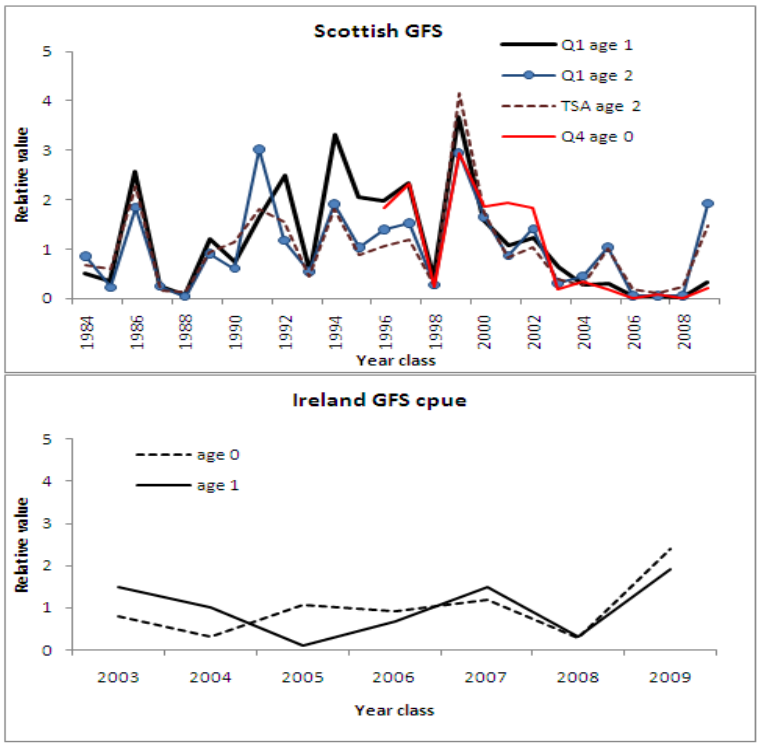
In recent years the uptake of quota has generally been low; however in 2010 the TAC uptake was 109% reflecting the recruitment of the 2009 year class.

Technical comments

1) No stock annex was available.

2) The main technical issue for this assessment is the inclusion of abundance indices from the ScoGFS-WIBTS-Q1 survey in 2011, as this survey has been radically changed. The move from a systematic to a stratified random survey in Q1 with new strata and sampling intensities, plus a new groundgear and stratum raising procedures, effectively means a new survey-series with potentially different overall catchability-at-age and a different selectivity pattern than before. The impact of the new survey design is not mentioned by WGCSE until the quality section of the report. As the survey revises the strength of the 2009 year class upwards substantially, with a big impact on forecasts, the accuracy of the indices is critical. Crucially there are no maps or data presented to evaluate the data on the strong year class; e.g. what is the precision (now that the survey is random stratified!). The plots below show that the TSA estimate for 2009 year class at age 2 is heavily driven by the Q1 survey indices at age 2. The Scottish Q4 survey at age

0 and Q1 survey at age 1 both indicated improved recruitment in this year class, but still below the long-term average. The IreGFS Q4 at ages 0 and 1 indicate similar improvement in 2009 yc, but relatively not as large an increase as shown by the ScoGFS Q1 at age 2. Hence the derivation of the large index at age 2 in Q1 2011 Scottish survey needs to be investigated. The RG notes that the WG down weighted an outlying large index at age 6 in the same survey in TSA, but did not consider down weighting the large age 2 index. Pending investigation of the 2011 Q1 results, given the new design and gear, RGCS2 advised the WG chairs that the assessment and forecasts should be redone without the 2011 Q1 survey data, and supporting evidence from the 2011 survey (e.g. distribution maps) should be provided. The results with and without the 2011 survey indices would be available to the Advice Drafting Group to evaluate the impact on stock status and forecasts.



3) The very large downward revision in terminal F in the updated assessment including the 2011 Q1 survey may well be due to the large 2011 survey index.

4) Section 3.3.3 should clearly give the arguments (from last year) for re-including fishery data from 2006 onwards and why this is different from VIa cod where the data are still not included.

5) Figure 3.3.9: stock–recruit relationship. The estimates do not support a Ricker model, which may give poor indication of stock dynamics and MSY. Last year's MSY section stated that there is no ability to distinguish between Ricker, B&H and hockey-stick.

6) Section 3.3.7 argues that the fishery data are more accurate (precise) than the survey data. However this ignores the often poor precision of discards estimates based on relatively small sampling coverage, not to mention ad-

ditional biases due to the vessel selection procedure and incomplete sampling frames.

7) RG recommends that stock weights should be derived from the Q1 survey using suitable modelling approaches (see VIIa haddock), rather than using weights-at-age in fishery catches which may alter following changes in gear selectivity.

8) As requested by the RG last year, the WG should clarify if down weighting of individual data points in TSA described in the WG report were the same as in previous assessments.

Benchmarking

RGCS2 agrees with the proposed analyses for the benchmarks but suggests additional work:

- Evaluation of precision of the survey catches-at-age, and review of survey estimation procedures (including collection and use of age data allowing for spatial variations in age compositions at length);
- There appear to be linkages with the North Sea stock. Any benchmark assessment of North Sea haddock and VIa haddock should be done in the same meeting to allow these connections and their effect on the assessments to be explored.

Advice sheet

Relevant estimates were carried over correctly to the advice sheet.

Conclusions

The RG considers the updated assessment with 2006–2010 catch data, and excluding the Scottish Q1 survey data for 2011 would provide an appropriate basis for providing management advice. However, the assessment requires benchmarking to validate the data and assessment approach and explore other assessment approaches and other information not included at present.

Whiting in Divisions VIIe–k (report Section 7.15)

1) **Assessment type**: Update

2) **Assessment**: Indicator of trends only.

3) **Forecast**: Short-term forecast provided but not used in advice sheets.

4) **Assessment model**: FLXSA tuned with two commercial and three survey indices.

5) **Consistency**: The assessment is consistent with last year's update but shows periods of retrospective bias. The bias in SSB has decreased lately.

6) **Stock status**: The SSB estimate for 2010 (42 kt) is well above B_{pa} (21 kt); however SSB is normally overestimated. There is no F_{lim} or F_{pa} defined.

7) **Man. Plan.**: None

General comments

The WG addressed the ToR requiring an update assessment and associated management advice. The assessment was carried out according to the stock annex description, with the exception of missing French commercial lpue for 2009 and 2010 in the

tuning file which was not updated. The RG found no errors in the implementation of the assessment and forecast. However, both the F_{MSY} and the short-term predictions are considered very unreliable and are not carried forward to the advice sheets.

The WG report and the Stock Annex do not contain any information on ecosystem aspects or environmental drivers.

There is no EU management plan for this stock.

The WG has not used mixed fishery data in developing advice for this stock. A brief description is given in the WG report of fisheries taking whiting.

The problem of missing French landings data for 2009 in last year's assessment is now rectified, and French landings (but not effort) are available for 2009 and 2010. Due to absence of the French effort data, the French commercial tuning lpue fleets have no data for 2009 and 2010.

A minor error was identified and corrected in this year's assessment whereby age 7 mean weights have historically been used as in the calculation of SSB rather than a weighted average mean weight for 7+.

As with VIIb–k haddock, the discard issue for the whiting stock is considerable (>50% by fleet/quarter) and is discussed at length by the WG, which excluded discards data from the assessment. Discards data of variable coverage are provided to the WG but are not used for the following reasons given by the WG: 1) don't have discards data for the full period of landings-at-age data; 2) sampled fleets are not representative of the main fleets in the fishery and 3) need to examine and agree the best raising procedures for the various fleets. In the "recommendation for the next benchmark" section, the WG at least makes a clear proposal for work that needs to be done to make use of the discards data. The same proposal should apply to Area VII haddock and other stocks with significant discarding not included in the assessment. The WG should ensure that these proposals are followed up and a commitment is made to resolving the discards data issues.

The TAC has not been utilized in many years and in 2010 only 60% of the TAC was landed. However the TAC area does not fully correspond to the assessment area.

Technical comments

1) An explanation is missing for the difference in WG landings estimate and the official landings.

2) The internal consistency of the surveys is generally quite poor. There is also poor coherence between survey trends by age class; does this reflect spatial differences? Some of the year-class time-series for IR-GFS-7G shows a negative correlation in the internal consistency plot for age groups 3–4 and 4–5. This survey has relatively high weighting in the assessment up to ages 4–5.

3) The estimation errors in the catch data make XSA a questionable model for this assessment. As with VIIb–k haddock, the RG suggests exploring a more statistical model that can deal with a variety of different datasets of differing quality and more accurately deal with the types and magnitude of errors.

4) There are strongly patterned non-random q residuals across all age groups, possibly related to absence of discards estimates (F_{bar} estimates also show patterning). Recent retrospective performance is ok for SSB but there is a

tendency for strong year classes to get revised downwards. RG agrees with the WG that this is probably due to exclusion of discards from the assessment.

5) The WG should provide a comparative plot of this year's and last year's assessment results.

Benchmark recommendations

RGCS2 agrees with proposed benchmark recommendations; however see general comments at start of this report about the overall data compilation and review process. A major problem to be addressed is the treatment of discards and the difficulties in estimating recent year-class strength based on the surveys.

Advice sheet

Information from the WG report has been carried over correctly to the advice sheets.

Conclusions

The RG supports the use of the updated XSA assessment as providing an indication of longer term trends but not for providing a forecast. The assessment shows difficulties in estimating recruitment. The estimate of the 2008 year class is shifted down by 29% and the 2009 year class upwards by 44%. The indication is nevertheless that the last three year classes are improved compared to the preceding ones in the 2000s and would be expected to build the spawning stock and lead to improved catches.

Estimates of SSB for recent years have increased well above the B_{pa} of 21 000 t due to the improvement in recruitment.

Whiting in Division VIIa (Irish Sea) (report Section 6.6)

1) **Assessment type**: Update

2) **Assessment**: survey trends; no assessment since 2007

3) **Forecast**: not presented

4) **Assessment model**: SURBA

5) **Consistency**: Retrospective SURBA runs show consistent trends compared to previous assessments.

6) **Stock status**: The state of the stock is unknown, however the stock is perceived to be subject to high fishing mortality and is at an extremely low level. Existing biological reference points are from XSA assessments no longer considered valid.

7) **Man. Plan**.: No management plan has been agreed or proposed

General comments

The WG has addressed the ToR in providing an updated assessment using a survey based model, able to provide information on relative trends. The SURBA model has been implemented using the approach outlined in previous assessments. The Stock Annex does not tabulate SURBA model settings.

The whiting fishery for human consumption in VIIa has effectively disappeared and most of the catch is now discarded in the small mesh fisheries. A range of discards data is presented by the WG but the data are patchy and there is no unified set of discards-at-age for the full period up to 2010. Some fleets do not appear to have discards

data after 2002 despite the DCF requirement to collect discards data for stocks with significant discard rates. It is therefore not possible to evaluate the full extent of discarding at age. The RG emphasizes the importance that steps are taken to obtain robust and reliable estimates of discards, otherwise the effectiveness of technical measures to reduce discarding will be difficult to quantify.

The TAC in 2010 was set at a very small value of 157 t, but even this was not fully utilized. In 2011 TAC was further reduced to 118 t. The reported landings are claimed to be more accurate since introduction of Buyers and Sellers legislation in 2006.

The Irish Sea whiting stock is primarily caught by otter trawlers which 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 decline since 2003. Effort in the 70–89 mm *Nephrops* fisheries has remained relatively stable. The RG notes that despite the reduction in whitefish trawl effort, apparent mortality estimates of whiting from the surveys have been increasing. Other sources of loss of adult fish from the Irish Sea other than fishing in VIIa should be investigated in any future benchmark assessment.

In 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. The WG reports that this is expected to reduce the whiting catches of these vessels by 60% in weight. Furthermore, a small number of vessels began utilizing an inclined separator panel which is expected to reduce whiting catch by 76% in weight. Preliminary Irish discard data shows a reduction in 45% by number of whiting on boats using these selectivity devices. The RG recommends that the uptake of such devices is reported in future WGCSE reports, together with any observer or self-sampling data that demonstrates changes in catch size composition compared to vessels without the devices.

Catch-at-age data has not been updated since 2003 due to very low landings and lack of discards estimates for all the main métiers.

Technical comments

1) The Stock Annex is still several years out of date (this was pointed out by last year's RG) and should be updated before next year's WG.

2) Figure 6.6.1 should present the catch series broken down into landings and discards.

3) As pointed out by last year's RG, and not commented on in this year's report: The decline in survey catch rates >MLS appears particularly sharp between 2003 and 2004 in the eastern Irish Sea. The tuning file for the March-East survey suggests this occurs over the age range, indicating a shift in whiting distribution or a change in catchability. The WG should evaluate causes for this.

4) In the text Section 6.6.3; final update assessment it is stated that "Recruitment appears to have been good in 2006 and 2008" and this is evident in both surveys (Figures 6.6.10 and 6.6.13, actually 6.6.11 and 6.6.14). However in the plots in the report and in the advice sheet Figure 5.4.25.1, this is not readily apparent.

Advice sheet

1) Landings plot contains discards, and has the wrong scale (maximum ~200 kt; should be ~20 kt). See Tables 6.6.1 and 6.6.10 in WG report.

2) In the text it is stated that "No precautionary reference points have been defined for this stock." However in the advice sheet and stock annex biological reference points are stated; they should be removed from the advice sheet if they are no longer relevant.

Conclusions

The RG considers that the SURBA model indices of abundance provide credible information showing a severe decline in biomass of whiting in the Irish Sea since the mid 1990s, and may be used as the basis for providing advice. Available discards data show that most of the whiting catch is discarded but there is no single coherent set of fleet-raised discards data for tracking changes in discarding over time.

Whiting in Division VIb (Rockall) (report Section 3.5)

The WG provided an update of the landings table. International landings have declined from almost 500 t in the early 1990s to less than 20 t in recent years.

Whiting in Division VIa (West of Scotland) (report Section 3.4)

1) **Assessment type**: Update

2) **Assessment**: Assessment of trends only.

3) **Forecast**: None

4) **Assessment model**: SURBA and TSA exploratory analytical assessment.

5) **Consistency**: The stock has not been assessed since 2007.

6) **Stock status**: It is not possible to evaluate stock status relative to reference points. SSB and recruitment appear to have declined to a very low level. There are indications of F declining below F_{pa}=0.6, but a sequence of low recruitments led to a fall in SSB in recent years.

7) **Man. Plan.**: None

General comments

There are no outlined procedures in the Stock Annex.

There are no ecosystems considerations described.

The WG describes mixed fisheries as a problem as whiting is mainly linked with fisheries for cod and haddock in VIa that are affected by the cod management plan. Shifts in effort to small mesh *Nephrops* fisheries would worsen the exploitation pattern for whiting. There has been mandatory use of larger square mesh panels for the TR2 (*Nephrops*) fleet since 2008 and a mandatory increase in mesh size to 120 mm in the TR1 fleet since 2009. The RG recommends that the WG should use future assessments to try to evaluate if the partial selectivities by fleet have been altered by these measures.

There is no management plan for VIa whiting.

The WG has responded to an ACOM request to carry out an update of the TSA model, which was not applied in the previous two years. Commercial fishery data from 2006 were reintroduced in view of reports of improved accuracy of catch statis-

tics. Experimental runs using both in SURBA and TSA were performed to evaluate different possibilities for the assessment. The only survey used in the final TSA run, the ScoGFSQ1, had a major change in design and gear in 2011 (see Technical comments below). The other survey (ScoGFSQ4) normally used for comparison was not conducted in 2010 due to technical problems. The comparisons show that the VIa whiting assessment suffers a similar problem to the North Sea whiting assessment in that trends in abundance from surveys and model fits to commercial fishery data diverge considerably in earlier years. The trends are more similar since the mid 1990s, suggesting the problem lies in a change in data or stock dynamics around the mid-1990s. The North Sea WG considers this could be due to bias in catch estimates, changes in survey catchability, or changes in natural mortality due to predation or regime shift. The VIa whiting TSA was fitted allowing a trend in survey catchability, which resulted in a marked trend of increasing catchability being fitted. The WG can provide no explanation for this. The RG supports the WG recommendation that this is explored in some depth in future benchmark assessments.

Substantial discarding occurs in this stock. This year the WG has estimates of discards from the Irish and Scottish discard programmes and states that Scottish discards are being reworked. It is important that discards data are fully worked up by country and fleet prior to any benchmark assessment.

Technical comments

1) Reasons for differences between official and WG landings figures should be given.

2) In the stock annex the stock weight-at-age is calculated with the formula : (CW i,j + CW i+1,j+1)/2 = SW at start of year; however the WG report states that the catch mean weights-at-age were also used as stock mean weights-at-age. It is not clear if the formula has been applied as there is no table with stock weights. The RG recommends using survey data to estimate stock weights-at-age to avoid changes in stock weights associated with changes in fishery gear selectivity.

3) For reasons given in the VIa haddock review, the RG considers the changes to the Scottish Q1 goundfish survey gear, design and analysis procedures in 2011 are sufficient to invalidate the use of the 2011 data as part of the existing series, pending an evaluation of changes in catchability. Unlike the haddock results, the addition of the Q1 survey does not seem to have revised the perception of the strength of the 2009 year class which appears stronger than other recent year classes though still below-average. However, the survey indicates a sharp increase in SSB in 2011. The RG has requested a TSA run excluding the 2011 indices, for comparison [AWAITING RESULTS].

4) Survey internal consistency correlation is poor for ScoGFS-WIBTS-Q4 but good for the younger adjacent age classes in ScoGFS-WIBTS-Q1. The correlations become negative between young and old ages; possible evidence of density-dependent mortality in year classes? Or ageing errors?

5) There are no assessment model settings in the stock annex, and it is therefore not possible to check the settings used in this year's assessment.

6) The TSA run fits the fishery catch data for 2006–2010 very closely. This is also observed in the 6a haddock assessment. Is this a true reflection of

more accurate catch data or does the lengthy period with no catch data included allow the model flexibility to fit accurately to the recent catch data?

Benchmark recommendations

The stock is due to be benchmarked in 2012. The WG provides few recommendations to guide the preparation for this. The RG recommends that benchmarking of North Sea and west of Scotland whiting should ideally take place at the same time as there appear to be similar problems with the long-term data for both stocks, and linkages between whiting in the two areas could be evaluated.

Advice sheet

1) The correct figures have been carried into the Advice sheets.

2) Advice is given on the basis of the MSY approach, however there are no MSY reference points provided.

Conclusions

The RG considers that the updated TSA and SURBA analysis, excluding the 2011 Q1 survey data, are suitable for providing advice on recent stock trends since the mid-1990s, but there are some difficulties in interpreting stock trends for earlier years. Even given the uncertainties in the performance of the assessment the stock is likely to have declined to the lowest observed biomass by the late 2000s.

Pollock in the Celtic Seas (ICES Subareas VI and VII)

1) **Assessment type:** No advice; catch statistics only

2) **Assessment**: not presented

3) Forecast: not presented

4) **Assessment model**: none

5) **Consistency**:

6) **Stock status**: unknown

7) **Man. Plan**.: none

General comments

This is not a "stock" but it relates to a species in a wider region where data are available. The nominal landings are given for each of the two Subareas VI and VII. Subarea VII provided 98% of the landings in 2010.

The RG considers that WGCSE has inadequately addressed the Terms of Reference for this stock ("Collate data"). The fisheries for pollock are significant (4000–8000 t in Area VII in last 30 years). Pollock is on the DCF list as a species for sampling in western waters, and recent data should also be available from the DCF fleet-based national sampling programmes.

WG states that "The overall gear contribution is unknown due to the lack of complete statistics." Surely Member States have landings by gear type as this is mandatory on EU logbooks?

The RG would have liked to see the following data in order to advise on future directions for supporting ICES advice on pollock in western waters:

- Full description of the fisheries taking pollock, 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.

Although the ToR was only to collate data, an evaluation of potential sources of information on relative abundance over time would have been useful;– for example, how could useful cpue data be obtained from line or gillnet fisheries?

Advice sheet

Figure 3 is not very useful and possibly misleading as we do not expect the Evhoe survey to be a useful index of abundance for pollock which are associated with rocky areas and wrecks where the survey does not fish. The figure should be removed.

Conclusions

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.

General comments on WGCSE *Nephrops* stocks 2011

WGCSE has responded positively to most of the corrections, comments, and suggestions given in last year's RGCS report.

The WG states that the UWTV bias factors include expert judgment, but there is no knowledge of the precision of this, or of the constancy of the bias factors (e.g. edge effects) when burrow density is changing. This needs further investigation.

The introduction of the buyers and sellers legislation in UK in 2006 has improved the reliability in the reported landings, but complicates the interpretation of longer term trends in landings and lpue.

The geostatistical approach in Division VIIa (FU14) and Aran seems promising and should be considered also in other areas.

There is a general lack of comparisons with the present assessment with previous ones (except for FU15).

There are no management plans for the different stocks.

Since observed harvest ratios are now being compared to F_{MSY} (rather than Pa ref points which include buffer for estimation error), ICES should be providing precision estimates and evaluating contribution to precision due to the survey, mean weights, discard ratios, etc. i.e. what is the probability that the observed harvest ratio each year was at or below the F_{MSY} harvest ratio?

Nephrops in Division VIa (FU11 North Minch) (report Section 3.5)

1) **Assessment type**: Update

2) **Assessment**: Fishery trends and absolute abundance estimates from UWTV survey. Stock underestimated due to UWTV not covering sea loch areas.

3) **Forecast**: Short-term prediction of landings for 2012 at various harvest ratios using catch option table developed during the benchmark WG (WK*NEPH* 2009).

4) **Assessment model**: 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.

5) **Consistency**: The UWTV series have been adjusted using VMS areas, which are larger than previously estimated from sediment charts.

6) **Stock status**: Abundance estimates from UWTV have declined from the high estimates in 2003–2006. The current harvest ratio is just below the F_{MSY} proxy ($F_{35\%SpR}$). The length frequency distribution, mean size and mean weight of *Nephrops* have all been stable for the time-series. There is no MSY transition stage since the current harvest rate is below F_{msy} proxy.

7) **Man. Plan**: There is no management plan for this stock.

General comments

The assessment was carried out according to the stock annex description and the WG addressed the ToRs. The 2011 assessment calculated the area covered by the *Nephrops* population using filtered VMS data from vessels targeting *Nephrops*, rather than the British Geological Survey sediment maps as for the other stocks. This approach was supported by last year's RG. The VMS area is larger than the BGS areas.

Based on the criteria adopted previously by the WG for choosing F_{MSY} proxies according to *Nephrops* productivity, RG supports the WG proposal for a combined-sex $F_{35\%SpR}$ as the F_{MSY} reference point for this stock. As last year, the F_{MSY} was computed using combined length compositions from trawl and (new) creels. The creel fishery accounts for 24% of the landings. The $F_{35\%SpR}$ harvest ratio is adjusted this year to 12.5% compared to 13.3% last year, based on the analysis of updated length compositions from the trawl and creel fisheries.

Length compositions and mean weights have been relatively stable over time.

Discards are included in the assessment and forecast. The observed discard rate shows a marked decline in 2010.

Technical comments

1) The RG appreciates the inclusion of Table 3.5.10 with all the variables for the catch forecasts.

2) The discard rate was very low in 2010, as observed in other *Nephrops* stocks in this area. The WG did not provide a clear reason for this. In 2010, discard trips in quarters one and two have not been completed and as such, fill-ins from quarters four and two were applied respectively. The WG does not indicate what bias this procedure could introduce.

Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

Conclusions

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 $F_{35\%spr}$ (combined between sexes) is consistent with the approach adopted by the WGCSE for choosing F_{MSY} proxies for *Nephrops*.

Nephrops in Division VIa (FU12 South Minch) (report Section 3.6)

1) **Assessment type**: Update

2) **Assessment**: Absolute abundance UWTV survey estimates; considered as underestimates due to survey not covering sea lochs.

3) **Forecast**: Short-term prediction of landings for 2012 at various harvest ratios using catch option table developed during the benchmark

4) **Assessment model**: 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 (WK*NEPH*, 2009).

5) **Consistency**: Methods are the same as last year.

6) **Stock status**: The UWTV series indicate that abundance has declined from the high estimates in the early 2000s to around the same values in the late 1990s, but increased in 2010 to near the 2001 biomass. The harvest ratio in 2010 was considerable lower than the $F_{35\%spr}$ F_{MSY} proxy. The length frequency distribution and mean size of *Nephrops* have all been stable for the time-series.

7) **Man. Plan.**: None

General comments

The assessment and provision of advice in 2011 followed the process defined by the benchmark WG and the WG fulfilled the ToRs.

The 2011 assessment did not apply VMS data to estimate the area of *Nephrops* habitat, as done for the assessment in FU11. The RG endorses the proposals by the WG to explore the use of VMS data for this purpose.

This year's assessment is performed using combined length compositions from trawl and (new) creels. The WG considers the incorporation of creel length compositions has improved the estimates of harvest ratios. Length compositions and mean weights have been relatively stable over time.

Estimates of discard rates are included in the assessment. The technical aspects and general fishery information is well described in the Stock annex, and the WG gives a good overview of the MSY work done and clear view of the preferred F_{MSY}.

Technical comments

1) No table of mean weights in landings is given so the RG could not check 2008–2010 mean figure used in forecasts.

2) A better explanation is needed as to why the discard rate in 2009 and 2010 is so low compared to earlier years.

Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

Conclusions

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.

Nephrops in Division VIa (FU13 firth of Clyde) (report Section 3.7.)

1) **Assessment type**: update

2) **Assessment**: Fishery lpue trends and UWTV survey estimates

3) **Forecast**: Short-term prediction of landings for 2012 at various harvest ratios using catch option table developed during the benchmark

4) **Assessment model**: 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 (WK*NEPH*, 2009).

5) **Consistency**: Methods are the same as last year.

6) **Stock status**: The UWTV series indicate that abundance increased until mid-2000s followed by a declining trend with population levels fluctuating around the values prior to the maximum abundance in 2004. Recent harvest ratios are above the $F_{35\%spr}$ F_{MSY} proxy. The length frequency distribution and mean size of *Nephrops* have all been stable for the time-series. The Sound of Jura subarea appears to have very low harvest ratios.

7) **Man. Plan**: none

General comments

The assessment and provision of advice in 2011 followed the process defined by the benchmark WG and the WG fulfilled the ToRs.

For the second time an attempt was made to use the UWTV data available for the Sound of Jura. Although the dataseries is incomplete it indicates a lower burrow density and lower harvest ratios than in the Clyde.

The length composition indicators (>35 mm) are relatively stable over time. Estimates of discard rates are included in the assessment.

Technical comments

1) Are the sharp dips in burrow count in 1999 and 2007 explainable by any factors such as weather affecting survey efficiency?

2) The WG should provide an explanation for the very low estimate of discard rate in 2010, which results in a lower average discard rate in the landings forecast. Low discard rates in 2010 are estimated for all three Area VI FUs. Last year's RG noted that recent discard rates were much higher than had been used in the F_{MSY} calculations. The F_{MSY} has been recalculated this year using trawl and creel LFDs and discard ogives for 2008–2009.

3) The WG should encourage the collection of the necessary biological and fishery data to allow F_{MSY} reference points to be estimated separately for the Sound of Jura population, which has a relatively low burrow density. The RG agrees with the use of the Clyde discard rates and F_{MSY} calculations as an interim approach (combined sex $F_{35\%SpR}$ HR of 14.5%, based on low burrow density).

Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

Conclusions

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 $F_{35\%SpR}$.

Nephrops in Division VIIa (FU14 Irish Sea East) (report Section 6.4)

1) **Assessment type**: Update

2) **Assessment**: Fishery lpue trends and UWTV survey estimates

3) **Forecast**: Short-term prediction of landings for 2012 at various harvest ratios using catch option table developed during the benchmark

4) **Assessment model**: 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 (WK*NEPH*, 2009).

5) **Consistency**: As last year, advice is based on UWTV survey, but applying a geostatistical method for the first time together with other modifications to the estimation methods for the UWTV surveys, which together result in substantial increases to biomass estimates for 2008 and 2009.

6) **Stock status**: The WG proposes $F_{0.1}$ as the F_{MSY} proxy (harvest ratio = 9.8%). The HR in 2010 was 7.4%. Compared to other fisheries in VII the absolute population density of this stock is relatively low.

7) **Man. Plan**: None

General comments

The assessment and provision of advice for 2012 generally followed the process defined by the benchmark WG and the WG fulfilled the ToRs. However the UWTV survey methods adopted by the 2011 WG differed from the previous assessment in using geostatistics to estimate burrow numbers in the UWTV survey and in changing the algorithm used to calculate the distance towed on each station. The combination of these changes has resulted in a 36% increase in the burrow density estimates for 2008 and a 60% increase for 2009, the two previous years with UWTV survey estimates.

The time-series of abundance estimates is too short to be compared with lpue trends. The RG notes the biases in lpue trends introduced by improvements in accuracy of landings reporting since 2006.

The assessment determines the health of the stock by looking at trends in total landings, lpue, size composition, and biological data from the commercial fisheries.

There are no stock-specific growth rates for FU14 and figures for FU15 are adopted.

The combination of the increased burrow count in 2010 compared to 2009, and the revised UWTV analysis methods has resulted in a landings forecast at $F_{35\%Comb}$ that is 87% larger than ICES advice for 2011 given last year.

Technical comments

1) As last year, Table 6.4.1 giving official landings is missing.

2) Due to lack of data none of the length derived metrics have been updated for 2011.

3) As with other *Nephrops* stocks, more accurate catch reporting since the introduction of Buyers and Sellers legislation has resulted in an apparent increase in landings and lpue which causes misleading trends plots (Figures 6.4.1–6.4.3) This should be clearly indicated on the figure legends.

4) No table of discards and landings estimates is provided to show trends in estimated discard rates. It is therefore not possible to validate the mean discard rate for 2006–2008 used in the catch forecast. (Discard rates in 2010; only five trips sampled so data not used; in 2009–2010 observed trips: discard rate much lower than 2008 but WG had concerns over the estimates and has used 2006–2008 rates and mean landings weights in the catch forecast).

5) The final table in the stock annex indicates discard survival is zero, and no reference is made in the text of incorporation of a non-zero discard survival in the F_{MSY} calculations or catch forecasts. In this respect the assessment is inconsistent with other stocks which assume some survival.

6) The text table in the Section 6.4.4 states that the discard rate is 27.9% based on sampling in 2006–2008. At the bottom of the table it says that the "Prop of removals retained by the fishery" is 0.79. Which is correct, given that discards survival is taken as being zero? Or has a discard survival rate been included?

7) The survey bias factor used this year is 1.14; "as per WK*NEPH* 2009". Last year a figure of 1.2 was used, with the same reference to WK*NEPH*. This is also the figure in the Stock Annex. Which is correct?

8) In the spreadsheet with the tables for this section, the bias-corrected abundance estimates are calculated as a figure multiplied by 1.019. This figure is not documented anywhere.

9) The WG should provide a clear table showing all the time-series data (landings, discards, discard rates, mean weights, etc). See Table 6.5.8 in FU15 report and similar table in other *Nephrops* sections. It has proven impossible to track the variables and calculations for this stock and the RG cannot therefore validate the catch forecasts.

Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

Conclusions

The RG agrees that the UWTV survey and associated F_{MSY} values represent an appropriate means of providing quantitative management advice, but has difficulty validating some of the inputs used in the catch forecasts.

The WG is concerned about how well the UWTV survey covers the distribution area, but on the other hand the WG is not conclusive when stating rather vaguely *: there may be a need to increase the survey area further south to ensure that the edge of the ground has been sampled*.

Nephrops in Division VIIa (FU15 Irish Sea West) (report Section 6.5)

1) **Assessment type**: Update

2) **Assessment**: Fishery lpue trends and UWTV survey estimates

3) **Forecast**: Landing predictions for 2012 presented

4) **Assessment model**: 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 WK (WK*NEPH*, 2009).

5) **Consistency**: Methods are the same as last year. No new MSY explorations were carried out.

6) **Stock status**: The WG argues use of F_{max} as F_{MSY} proxy (Harvest ratio = 17.1%). The UWTV survey indicates a constant high abundance over the time-series of the surveys and the 2010 survey estimate is around average. The harvest ratio in 2010 was estimated to be 15%. Reported landings have been stable around 9000 tonnes without a negative impact on the stock.

7) **Man. Plan**.: None

General comments

The assessment was carried out according to the stock annex description and the WG addressed the ToRs. The RG found no errors in the assessment.

The fishery is well described in WG and stock annex. Mixed fisheries data are not used in providing management advice. Discards estimates are included in the assessment. There is no management plan for this stock but the fishery is affected by measures implemented for cod. The cod closure affects the distribution of fishing to some extent. The effort control regime has also influenced the switching of effort into the *Nephrops* fishery.

Technical comments

1) The introduction of Buyers and Sellers legislation has resulted in an apparent increase in landings and lpue which causes misleading trends plots (Figure 6.5.1). This should be clearly indicated on the figure legends.

2) Table 6.5.7: multiplying the burrow density (n/m^2) by the area gives values different from the ones in the table; more than can be explained by rounding errors. The WG should explain this.

3) The calculation of $B_{trigger}$ using trawl survey indices scaled to the UWTV estimates no longer appears valid due to the very different trends now apparent in the two time-series (Figure 6.5.5). If the UWTV trends are correct, then some other factors are affecting the trends in the trawl survey in a non-random fashion. The high values in 2003 and 2004 are not apparent in

the April survey (Figure 6.5.4). The RG recommends that the $B_{trigger}$ value based on the rescaled trawl survey indices is not used or presented.

Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

Conclusions

The RG agrees that the UWTV survey and associated F_{MSY} values represent an appropriate means of providing quantitative management advice, but the proposed $B_{trigger}$ value is suspect.

The RG agrees with the WG that management on a FU level would be beneficial.

The RG agrees that F_{max} (harvest ratio 17.1% combined between sexes) is consistent with the approach adopted by WGCSE for choosing F_{MSY} proxies for *Nephrops*.

Nephrops in Division VIIb,c,j,k (FU16 Porcupine Bank) (report Section 7.6)

1) **Assessment type**: update

2) **Assessment**: trends

3) **Forecast**: not presented

4) **Assessment model**: No Analytical Assessment

5) **Consistency**: Consistent with last assessment

6) **Stock status**: Status of the stock cannot be evaluated because reference points have not been determined for this stock. A decline in abundance in the 2000s has been reversed by improved recruitment and the sex ratio has returned to a more usual value.

7) **Man. Plan.**: There is no management plan for this stock, but there are Area Closures, MLS and mesh size regulations. The closure displaced effort to other parts of the *Nephrops* grounds.

General comments

The assessment was carried out according to the stock annex description and the WG addressed the ToRs in providing updated series of indicators.

General ecosystem information has not been provided, and mixed fishery data are not used in support of management advice.

Technical comments

1) The RG appreciates the involvement of industry in discussing lpue trends, and the responsive action of WGCSE. WD12 provides a valuable analysis of the Irish lpue data exploring effects of rectangle, month, vessel, etc. on lpue. The lpue series from all countries would benefit from being standardized in the same way. Figure 10 in WD12 shows lpue trends by rectangle. For the main rectangles with *Nephrops* landings, the trends don't show the large decline over time given by the model fits or the aggregated data. Why is this?

Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

Conclusions

The RG agrees with the WG that the stock indicators suggest the state of the stock has improved from last year when the stock was considered to be severely depleted with an unnatural sex ratio that could impair productivity. Nonetheless, despite the small proportion male, the stock appears to have produced a better recruitment in 2009, which will need to be protected to promote rebuilding of the biomass. Unfortunately the discard practices are poorly known and sampled and unless this is rectified it will not be known if the 2009 recruitment is being heavily fished and discarded.

Nephrops in Division VIIb (Aran Grounds, FU17) (report Section 7.5)

1) **Assessment type**: Update

2) **Assessment**: Fishery lpue trends and UWTV survey estimates

3) **Forecast**: Short-term

4) **Assessment model**: 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 WK (WK*NEPH*, 2009).

5) **Consistency**: Methods are the same as last year plus attempts to incorporate decisions taken at WKFRAME for the provision of MSY advice by ICES.

6) **Stock status**: The 2010 UWTV estimate is close to average of the series. Recent harvest rates have fluctuated around 8% compared with $F_{35\%spr}$ F_{MSY} proxy harvest rate of 10.5%.

7) **Man. Plan**: none

General comments

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.

Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

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*.

Nephrops in Division VIIa,g,j (southeast and west of Ireland, FU19) (report Section 7.8)

1) **Assessment type**: None
2) **Assessment**: None
3) **Forecast**: None
4) **Assessment model**: none
5) **Consistency**: Cannot be evaluated
6) **Stock status**: The status of the stock cannot be evaluated. Sampling indicates a decline in mean size of indviduals.
7) **Man. Plan**.: None

General comments

This FU was not assessed and no data analysis was carried out in 2009–2010. The only available information for the FU19 is from the UK March groundfish survey during 1984–2004 that indicated some decline in mean size. In 2006 there was some UWTV stations covered in the FU19 but there does not seem to be an annual coverage of the area. The WG states that the area is heterogeneous and UWTV surveys would be very hard to carry out on an accurate and regular basis.

No ecosystem considerations are presented in report.

As last year, no information on discarding is provided.

The fishery description contains information about mixed fisheries and indicates that it is of importance, but there are no indications how it can be used in future advice.

Technical comments

1) As last year, Table 7.8.1 presents landings from FU18 and 19 but it is not referred to in text how the fisheries in FU18 and 19 are connected.

Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

Conclusions

RG agrees that analytical assessment is not possible to perform on this FU.

It is recommended that the WG gives some suggestion how the sampling and survey data can be improved.

Nephrops in Divisions VIIfgh (Celtic Sea, FU20–22 (report Section 7.7)

1) **Assessment type**: update
2) **Assessment**: Fishery lpue trends plus UWTV survey for FU22

3) **Forecast**: Only for FU22 (UWTV)

4) **Assessment model**: no

5) **Consistency**: consistent with last year's methods and stock annex

6) **Stock status**: Considered to be stable at a high level based on long-term indicators, lpue, mean size, recent UWTV surveys. Harvest ratios since 2006 have fluctuated around the proposed F_{MSY} of 10.9%.

7) **Man. Plan.**: no

General comments

The assessment was carried out in accordance with the description in the Stock annex. The WG report and the Stock Annex for this FU are comprehensive but difficult to follow in places due to the amount of detail.

MSY explorations were carried out for the FU22 component (which represents 50% of the landings) using the Bell/Dobby model to determine harvest rates associated with various potential F_{MSY} proxies. As with most other stocks the WG concluded that $F_{35\%Spr}$ is appropriate as an F_{MSY} proxy for FU22. This corresponds to a harvest rate of 10.9%.

No French lpue and effort indices for 2009 were available.

Technical comments

1) Data from the EVHOE survey were cited but time-series plots of number caught by year, etc, were not found. The utility of the survey for supporting the *Nephrops* assessment could be explored but the results would need to be validated. The experiences in FU15 (Irish Sea west) where there are dedicated trawl surveys as well as a UWTV survey should be reviewed before the Evhoe survey is used for *Nephrops*.

2) Table 7.7.18, showing landings by rectangle and year, might be better presented as a series of maps?

3) Some values of sex ratio are given in the text, but no data on trends in sex ratio are provided.

4) Tables 7.7.3–7.7.14: There is no need for all this detailed LFD tabulation in the assessment report. It could go in the Stock Annex. If any comparisons are needed to make a point, this is best done graphically.

5) Tables 7.7.16 and 7.7.17: again a lot of LFD detail that could be better shown graphically. Interpretation of variation is also difficult because the number of trips providing the data is not tabulated.

6) Table 7.7.19; why is lpue of French twin trawl vessels less than that of single-trawl vessels?

Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

Conclusions

The RG considers that the fishery lpue indicators provide relatively little information for evaluating stock trends. Irish and French fleets show different lpue trends but it is not clear if this reflects shifts in activities between different grounds.

The UWTV results for the Smalls (FU22) grounds indicate a stable abundance over the last four years. The RG recommends that VMS and other data be used to map out the *Nephrops* grounds more accurately (see VIa stocks) to allow the possibility of extending the UWTV coverage to include other significant mud patches (Labadie/Nymphe/Seven Heads ground) on an annual basis if funding is available for this. The Annex indicates that UWTV was tried on very small areas of these three grounds in 2006 but that poor weather precluded surveys in 2007 and 2008. The different allocation of French and Irish Effort between the four main grounds would argue for UWTV coverage of all areas given the different trends in effort of these fleets. The WG proposal to develop fishery data (length compositions, discard rates, etc.) specifically for the Smalls is a necessity for developing the UWTV survey for providing quantitative management advice for this ground. However the other mud patches should not be ignored.

The back calculation of discard rates when fishing procedures such as tailing rates are changing is rather difficult and should be replaced by direct observations whenever possible. However, the method should be further evaluated for the next benchmark.